Y

ALDFG Vulnerability Assessment of Bumble Bee Seafoods

The Global Ghost Gear Initiative (GGGI)

Final Report

May 2025

Submitted by

MRAG

MRAG Ltd is an independent fisheries and aquatic resource consulting company dedicated to the sustainable use of natural resources through sound, integrated management practices and policies.

Established in 1986, MRAG has successfully completed projects in more than 60 countries. Our in-house experts have a wide variety of technical expertise and practical experience across all aspects of aquatic resource management, policy and planning, allowing us to take a multi-disciplinary approach to every project. Our capability to service an extensive array of resource management needs is further extended through our network of associations with internationally acclaimed experts in academic institutions and private organisations worldwide.

MRAG Ltd

18 Queen Street

London

W1J 5PN

T: +44 (0) 20 7255 7755

F: +44 (0) 20 7499 5388

W: www.mrag.co.uk

Document Control			
Title	ALDFG Vulnerability Assessment of Bumble Bee Seafoods		
Document ID	Final Report		
MRAG ID	US3187		
Version	Final		
Prepared by		Approved by	
Catherine Whitley, John Pearce, Emily Vella and Pippa Howarth		Robert Wakeford	
17/01/2025		19/05/2025	
Internal Use Only	Client Only	General Release	
☐	☒	☐	

Table of Contents

Executive Summary **1**
1 Introduction **4**
1.1 The Issue of Abandoned, Lost or Discarded Fishing Gear **4**
1.2 Bumble Bee and Abandoned, Lost or Discarded Fishing Gear **6**
1.3 Objectives and Implementation **6**
2 Characterization of Bumble Bee's Supply Chain **7**
2.1 Methods **7**
2.1.1 Data Collation 7
2.1.2 Data Analysis 8
2.1.3 Data Gaps 8
2.2 Results **9**
2.2.1 Tuna Raw Material 9
2.2.2 Non-Tuna Species 19
3 Stakeholder Engagement **20**
3.1 Methods **20**
3.1.1 Questionnaire Design 20
3.1.2 Questionnaire Dissemination 21
3.1.3 Analysis 21
3.2 Results **21**
3.2.1 Survey Responses by Stakeholder Group and Species 21
3.2.2 Primary Causes of Fishing Gear Loss 23
3.2.3 Common Practices Implemented by Vessels to Prevent Gear Loss 25
3.2.4 Availability of Waste Reception Facilities at Port(s) of Landing 26
3.2.5 Waste Reception Facilities Disposal of End-of-Life Fishing Gear. 28
4 ALDFG Vulnerability Risk Assessment **33**
4.1 Methodology **33**
4.1.1 Likelihood – Impact Framework 33
4.2 Results **36**
4.2.1 Tropical Tuna Species Introduction 37
4.2.2 Identified Gear Classes 39
4.3 Tuna Risk Assessments **40**
4.3.1 Skipjack and Yellowfin Tuna Purse Seine Fishery (FAD Associated) 40
4.3.2 Skipjack and Yellowfin Tuna Purse Seine Fishery (Free School) 49

4.3.3 Albacore Tuna Longline Fishery 52
4.3.4 Yellowfin Tuna Longline Fishery 60
4.3.5 Tuna Pole and Line Fishery 62
4.4 Risk Assessment Summary 69
4.4.1 Likelihood of ALDFG 70
4.4.2 Impacts of ALDFG 72
4.4.3 Inherent Risk 73
4.4.4 Mitigation Measures 74
4.4.5 Residual Risk 75
4.4.6 Risk Exposure 76
5 Deep-Dive Analysis 77
5.1 Skipjack and Yellowfin Purse Seine Fisheries 77
5.1.1 Main Causes of ALDFG 77
5.1.2 Further Stakeholder Consultation 78
5.1.3 Spatial Analysis of Fisheries Activity Data 78
5.1.4 Location of Port Visits 79
5.1.5 Conclusion 81
5.2 Albacore Longline Fisheries 82
5.2.1 Main Causes of ALDFG 82
5.2.2 Further Stakeholder Consultation 82
5.2.3 Spatial Analysis of Fisheries Activity Data 82
5.2.4 Location of Port Visits 84
5.2.5 Conclusion 85
5.3 Blue Swimming Crab 87
5.3.1 Main Causes of ALDFG 87
5.3.2 Further Stakeholder Consultation 87
5.3.1 Spatial Analysis of Fisheries Activity Data 88
5.3.1 Conclusion 88
6 Validation and Recommendations 89
6.1 Validation Workshop 89
6.2 Development of SMART Indicators 90
6.3 Development of Priority Recommendations 91
6.4 Identification of Priority Recommendations 93
6.5 Activities for Immediate Implementation 96
Recommendation 1: Review of Tuna FIP Workplans and Provision of Feedback 96

Recommendation 2: Support Trialing GGGI Reporter App on Connors Bros Fleet 100
6.6 Easy Wins: High Priority Activities with Short Timeframe 103
Recommendation 3: Support Research and Increase Access to Port Reception Facilities 103
Recommendation 4: Explore Potential for Enhanced Gear Marking 107
6.7 Major Projects: Medium Priority Activities with Long Timeframe 109
Recommendation 5: Advocate to RFMOs on Gear Marking 109
Recommendation 6: Trial Remote Electronic Monitoring Systems 111
6.8 Long Horizon Goals: Medium to Low Priority Activities 113
Recommendation 7: Support Participation in Existing FAD Retrieval Initiatives 113
Recommendation 8: Support Expanded Vessel Participation in FAD Trials 115
Recommendation 9: Encourage Crew Training on Safe Retrieval of Lost or Abandoned Fishing Gear 117
7 References 119

List of Tables

Table 1. Summary of procurement data received. 7

Table 2. Bumble Bee tuna raw material by species, total tonnage and description for the period 2016 - 2022. 11

Table 3. Bumble Bee raw material (tonnes and percentage) by flag State (with top five contributing flag States highlighted) for the period 2016 - 2022. 12

Table 4. Bumble Bee raw material (tonnes and percentage) by gear type for the period 2016 - 2022. 14

Table 5. Total tonnage of Bumble Bee raw material by port of landing for the period 2016 - 2022. 15

Table 6. Bumble Bee tuna raw material (tonnes) by top ten ports of transshipment and species for the period 2016 - 2022. 17

Table 7. Summary of non-tuna products (cans) within Bumble Bee's supply chain by species / species group and country of origin for the period 2022 - 2023. 19

Table 8. Four stakeholder groups involved in Bumble Bee's supply chain. 20

Table 9. Breakdown of questionnaire responses by stakeholder groups. 22

Table 10. Summary table of responses for each species per stakeholder group. Numbers in brackets indicate a partial response. 22

Table 11. Factors causing potential gear loss. 23

Table 12. Ports with port reception facilities that accept the disposal of fishing gear, along with their gear collection method and requirements (NA = Not Answered). 28

Table 13. Risk framework. 33

Table 14. Likelihood of loss ratings. 34

Table 15. Impact ratings. 34

Table 16. Inherent risk matrix. 35

Table 17. Mitigation ratings. 36

Table 18. Residual risk ratings. 36

Table 19. List of each species and gear type combination. 37

Table 20. Expected lifespan of each longline component. 59

Table 21. Total number of port visits made by the top 20 tuna purse seine vessels between 2018 – 2023. (Source: Global Fishing Watch Vessel Viewer). 80

Table 22. Total number of port visits made by the top 20 tuna longline vessels between 2019 – 2022. (Source: Global Fishing Watch Vessel Viewer).....85

Table 23. Examples from recommendations of the SMART indicator criteria.....91

Table 23. Cost estimate brackets for activity.....92

Table 24. Summary of Recommendations.....95

List of Figures

Figure 1. Map of all Bumble Bee tuna supply chains. Arrow size reflects the magnitude of tuna fish landings, measured in tonnes. 10

Figure 2. Bumble Bee raw material (tonnes) by tuna species (2016 – 2022). 12

Figure 3. Bumble Bee tuna raw material (tonnes) by source (i.e. flag State of the catching vessel) (2016 – 2022). 13

Figure 4. Bumble Bee raw material (tonnes) by gear type (2016 – 2022). 14

Figure 5. Tile plot of Bumble Bee raw material (tonnes) landing direct into port (all species) by flag State, port and gear type (divided by red dashed line) (2016 – 2022). 16

Figure 6. Total direct landings of tuna (yellow for albacore landings; blue for tuna (nei) at each major port. Bubble size reflects magnitude of landings (tonnes) (2016 – 2022). 16

Figure 7. Tile plot of Bumble Bee raw material transshipped (tonnes, all species) by flag, port and gear type (divided by red dashed line) (2016 – 2022). 18

Figure 8. Total transshipped landings of tuna at each major port. Bubble size reflects magnitude of landings (tonnes) (2016 – 2022). 18

Figure 9. Comparison of purse seine and longline vessel-reported gear loss drivers. 24

Figure 10. Frequency of measures employed by purse seine and longline fishing vessels to prevent fishing gear loss. 26

Figure 11. Availability of port reception facilities at key ports of landing. 27

Figure 12. Acceptance of end-of-life fishing gear at ports with port reception facilities. 28

Figure 13. Availability of port reception facilities at major ports receiving direct landings of tuna and their ability to accept end-of-life fishing gear. Bubble size indicates tuna landings (tonnes). 30

Figure 14. Vessel tracks of yellowfin longline fishing vessel Arwa between January 1, 2023 and January 1, 2024 (Global Fishing Watch, 2024). 61

Figure 15. Likelihood assessment by fishery. 71

Figure 16. Impact assessment by fishery. 72

Figure 17. Inherent risk assessment by fishery. 73

Figure 18. Mitigation by fishery. 74

Figure 19. Residual risk assessment by fishery. 75

Figure 20. Spatial distribution of the top 20 purse seine tuna vessel activity and port visits between 2018 – 2023. (Source: Global Fishing Watch Vessel Viewer – public data). 79

Figure 21. Spatial distribution of top 20 longline tuna vessel activity and port visits between 2019 – 2022. (Source: Global Fishing Watch – public data). 84

Figure 22. Prioritization Matrix. 93

Acronyms

Acronym	Definition
ACAP	Agreement on the Conservation of Albatrosses and Petrels
AFAD	Anchored Fish Aggregating Device
ALDFG	Abandoned, Lost and Discarded Fishing Gear
APRI	Asosiasi Pengelolaan Rajungan Indonesia
BPF	Best Practice Framework
BSC	Blue Swimming Crab
CLAV	Consolidated List of Authorised Vessels
CMM	Conservation and Management Measures
CPC	Contracting Party or Cooperating Non-Contracting Party
DFAD	Drifting Fish Aggregating Device
EEZ	Exclusive Economic Zone
EOL	End-of-Life (Fishing Gear)
ETP	Endangered, Threatened of Protected Species
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organisation (of the United Nations)
FFA	Forum Fisheries Agency
FSM	Federated States of Micronesia
GGGI	Global Ghost Gear Initiative
GPS	Global Positioning System
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
iFIMS	Integrated Fisheries Information Management System
IOTC	Indian Ocean Tuna Commission
ISSF	International Seafood Sustainability Foundation
LOA	Length Overall
MAF	Ministry of Agriculture and Fisheries
MAFWR	Ministry of Agriculture, Fisheries and Water Resources (Oman)
MPA	Marine Protected Area

Acronym	Definition
MSC	Marine Stewardship Council
NEAFC	North East Atlantic Fisheries Commission
NEI	Not Elsewhere Included
PNA	Participants to the Nauru Agreement
PNG	Papua New Guinea
PRF	Port Reception Facility
PVR	Proactive Vessel Register (ISSF)
RFMO	Regional Fisheries Management Organisation
SFA	Seychelles Fishing Authority
SMART	Specific, Measurables, Achievable, Relevant and Time-bound
SQL	Structured Query Language
UNEP	United Nations Environment Programme
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
YSLME	Yellow Sea Large Marine Ecosystem

Glossary

End-of-Life	In the context of fishing gear, the term 'end-of-life' is used to denote the stage at which the used gear is prepared for disposal, recycling, reuse etc. This stage concludes when the gear is either returned to nature through combustion or deterioration or is recycled or reused.
Fish Aggregating Device	A natural (e.g. floating logs) or artificial structure that attracts and retains fish making them easier to catch. FADs may be anchored in a single location (AFAD) or allowed to drift with the currents (DFAD).
Free-Entry	Seafood products which have not been subject to customs duty upon entry
Gear Conflict	The accidental physical interaction or collision between two vessel's fishing gears or intentional vandalism of fishing gear such as the cutting of buoy lines or nets if fishing gear is set on top of one another, resulting in subsequent gear loss,
Port of Landing	The first port where fish (or fisheries products, if processed onboard a fishing vessel) are first unloaded from a fishing vessel onto land.
Port of Transshipment	The port where fish (or fisheries products, if processed onboard a fishing vessel) are transferred from a fishing vessel to another fishing vessel or a carrier vessel for onward transfer of the fish.
Port Reception Facilities	The infrastructure, services, and facilities available at ports to manage and handle various types of waste generated by ships. These facilities are essential for ensuring the proper disposal, treatment, or reception of ship-generated waste to prevent marine pollution and maintain the health of marine ecosystems.

Executive Summary

Abandoned, lost or otherwise discarded fishing gear (ALDFG), also known as derelict fishing gear, is a major contributor to marine pollution, with profound impacts on wildlife, marine habitats, and food security. The prevalence of ALDFG has increased in recent decades, driven by the expansion of global fishing activities and use of durable, plastic-based materials in gear manufacturing. The significant scale of ALDFG has prompted global efforts to examine the factors that lead to intentional and/or unintentional gear loss. Causes of ALDFG include poor weather conditions, gear conflicts and snagging on underwater structures. These drivers and subsequent impacts of ALDFG vary depending on gear type, region and the robustness of fisheries management governing national and/or regional fisheries. Therefore, effective solutions to avoid, minimize and remediate ALDFG depend on the fishery-specific context.

Bumble Bee Seafoods (Bumble Bee), a North American leader in canned and packaged seafood, has been actively addressing marine plastic waste as a member of the Global Ghost Gear Initiative (GGGI) since 2018. A key objective of this partnership is to better assess and determine causes of gear loss within Bumble Bee's wild capture supply chain and implement solutions to address ALDFG, in line with GGGI's Best Practice Framework for wild capture fisheries (C-BPF).

The GGGI commissioned MRAG Ltd (MRAG) to conduct a comprehensive vulnerability risk assessment and analysis across the entirety of Bumble Bee's supply chain, identifying gaps in fishing vessels' best practice to prevent ALDFG and recommending solutions that exceed standard protocols, marking the first time a seafood company has undertaken such a detailed evaluation of ALDFG risk. This study, conducted over an 18-month period, was guided by seven primary objectives: (i) analyzing procurement data over a six year period (2018 – 2023) and identifying gaps across fisheries, ports, and gear types; (ii) mapping the supply chain to identify key stakeholders; (iii) distributing stakeholder surveys to collect insights on fishing practices, gear loss, and port facilities; (iv) conducting a vulnerability risk assessment for species and gear types using GGGI's C-BPF; (v) analyzing three high-risk fisheries as case studies; (vi) developing recommendations with structured implementation pathways to facilitate their application and monitor their performance; and (vii) validating findings through a stakeholder workshop.

To achieve these objectives, three primary methods of data collection were utilized: a preliminary data request for procurement information held by Bumble Bee with regards to their supply chain, a desk-based review of publicly available peer-reviewed and grey literature, and a stakeholder survey shared with identified stakeholders to collect additional data and information on fishing gear at each stage of the supply chain. In total, 50% of the 107 invited stakeholders responded to the survey, representing a diverse spectrum of participants from various sectors, including fishers, fishing companies, seafood suppliers and port authorities. Responses from stakeholders informed the identification of various fisheries (combination of species harvested by certain gear type) supplying raw material to Bumble Bee and yielded key insights fundamental to understanding the ALDFG risk within Bumble Bee's supply chain, including (i) the primary causes of fishing gear loss; (ii) existing practices implemented by vessels to prevent or minimize gear loss; and (iii) the availability of port reception facilities (PRF) where vessels typically operate and their capability to accept end-of-life (EOL) fishing gear.

Based on the information gained through the stakeholder responses and desk-based literature review, a vulnerability risk assessment was performed using a likelihood–impact approach to identify potential hotspots within each fishery where fishing gear is most likely to become ALDFG and its potential environmental impacts. This assessment took into consideration the geo-spatial area of fishing grounds, local fishing methods, the potential for ghost fishing, fishing gear maintenance and repair and the presence of EOL processes for responsible gear disposal.

Results from the vulnerability risk assessment indicate blue swimming crab gillnet and trap, and shrimp gillnet fisheries have a high to very high risk of ALDFG, followed by tropical purse seine and temperate longline tuna fisheries that have moderate levels of risk. Of these tuna fisheries, the highest levels of likelihood of moderate risk comes from tropical purse seine fisheries using fish aggregated devices (FADs) that have a high likelihood of gear loss at some stage during fishing operations. In contrast, non-tuna finfish fisheries generally show a low level of risk, with only the pilchard purse seine fishery showing a moderate level of risk.

Following completion of a vulnerability risk assessment of Bumble Bee's entire wild capture seafood supply chains, a deep-dive analysis was conducted to further explore the drivers of gear loss and reveal areas of highest risk of ALDFG in two high volume fisheries (skipjack and yellowfin tuna purse seine fisheries (FAD associated) and albacore tuna longline fisheries) and one very high-risk fishery (blue swimming crab gillnet and trap fishery in Indonesia). These findings led to specific recommendations for additional activities beyond standard practice to drive both feasible and robust solutions to the highlighted risks of ALDFG, further solidifying Bumble Bee's leadership in this sphere.

Based on the findings of this study, a set of recommendations has been developed, which outline actionable steps for Bumble Bee to implement, each supported by a structured implementation pathway and estimated timeline to accomplish each action. Prioritization of each recommendation was informed by expert judgement to determine the potential impact, cost, ease of implementation and strategic importance of each activity, as well as extensive stakeholder engagement and a Validation Workshop with Bumble Bee and GGGI, on its feasibility for successful implementation. Notably, nine strategic recommendations have been selected for implementation. A list of additional recommendations is provided in Annex 12. These recommendations have been categorized into high priority recommendations for immediate and near-term implementation; medium priorities with longer timeframes for completion; and lower priority activities. These include:

1) **Activities for Immediate Implementation**
    - Recommendation 1: Review of tuna FIP workplans and provision of feedback
    - Recommendation 2: Support Trialing GGGI Reporter App on Connors Bros Fleet

2) **Easy Wins: High Priority Activities with Short Timeframe**
    - Recommendation 3: Support research and increase access to Port Reception Facilities, including the establishment of a derelict gear collection point in Pohnpei, Federated States of Micronesia (FSM).
    - Recommendation 4: Explore potential for enhanced gear marking

3) **Major Projects: Medium Priority Activities with Long Timeframe**
   - Recommendation 5: Advocate to RFMOs on gear marking
   - Recommendation 6: Trial Remote Electronic Monitoring systems

4) **Long horizon goals: Medium - Low Priority Activities**
   - Recommendation 7: Support participation in existing FAD retrieval initiatives
   - Recommendation 8: Support expanded vessel participation in FAD trials
   - Recommendation 9: Encourage crew training on safe retrieval of lost or abandoned fishing gear

Bumble Bee's proactive engagement in this comprehensive risk assessment highlights their commitment to sustainable fishing practices and environmental stewardship. These recommendations provide a roadmap for reducing ALDFG risks, strengthening the company's position as a leader in sustainable seafood while advancing global efforts to address marine plastic pollution.

1 Introduction

Bumble Bee Seafoods (Bumble Bee) is a North American seafood company headquartered in San Diego, California, known for producing canned and packaged seafood products, including tuna, salmon, sardines, clams, mackerel, and specialty seafood. Established in 1899, Bumble Bee is one of the oldest and most recognized seafood brands in the United States.

Bumble Bee emphasizes sustainability and has partnered with various organizations to promote responsible fishing practices, reduce bycatch, and support seafood traceability initiatives. In recent years, Bumble Bee has actively engaged in addressing environmental challenges, such as the issue of abandoned, lost, or discarded fishing gear (ALDFG), as part of its commitment to sustainable fisheries.

MRAG Ltd (MRAG) was commissioned by the Global Ghost Gear Initiative (GGGI), a program of the Ocean Conservancy, to conduct a vulnerability risk assessment of ALDFG within Bumble Bee's supply chain. This initiative aimed to identify ALDFG vulnerabilities and provide actionable recommendations to Bumble Bee that draw on best practices, fostering practical and sustainable solutions to mitigate ALDFG risks. Notably, this collaboration represents the first instance of a seafood company undertaking such an assessment to address ALDFG within its supply chain.

This report serves as the Final Report and is presented in five sections:

- **Characterization of Bumble Bee's Sourcing Supply Chain**: An analysis of Bumble Bee's procurement data, identifying species and volumes sourced, key ports, and the complexity of supply chains.
- **Stakeholder Engagement**: Development and deployment of a structured questionnaire to address gaps in understanding of Bumble Bee's supply chain practices, drivers of gear loss and current mitigation measures.
- **ALDFG Risk Assessment**: Methodological approaches and results of the risk assessment, highlighting high-risk species and gear-type combinations.
- **Deep-Dive Analysis**: Detailed exploration of specific high-risk fisheries.
- **Conclusions and Recommendations**: Synthesis of findings and tailored recommendations for Bumble Bee to consider supporting the adoption of sustainable practices and reduce ALDFG risks.

1.1 The Issue of Abandoned, Lost or Discarded Fishing Gear

ALDFG poses a significant threat to marine ecosystems through ingestion, entanglement, and habitat degradation. The prevalence and impacts of ALDFG have increased over recent decades, driven by the expansion of global fishing activities and the adoption of synthetic, plastic-based materials in gear manufacturing. These materials persist in the marine environment for extended periods, exacerbating environmental harm. A particularly concerning consequence of ALDFG is "ghost fishing," where lost gear continues to capture and kill marine organisms, contributing to unreported fish mortality and ecological damage, with impacts varying by gear type and ecosystem (Gilman, 2015).

Although there is limited analysis of the global extent of ALDFG, fishing gear is often estimated to account for approximately 10% of global marine litter by volume – equivalent to around 640,000 metric tonnes (hereafter tonnes), as reported by FAO and UNEP (Macfadyen *et al.*, 2009). This figure can be traced to a 1975 publication by the USA's National Academy of Sciences, which estimated that 6.36 million tonnes of marine litter enter the world's oceans each year, of which less than 10% was attributed to ALDFG (US Academy of Sciences, 1975). Since its publication in 2009, the estimate of 640,000 tonnes has been referenced extensively throughout the literature and has only recently been shown to be inaccurate due to its missed citation from the original publication (Richardson *et al.,* 2021; Lebreton *et al.,* 2022), as well as likely being a gross underestimation of the global extent of ALDFG due to fragmented data availability (Stelfox *et al.,* 2016). This illustrates the uncertainty in the quantification, as well as the methodology of quantification, around ALDFG, mainly due to inconsistent reporting, limited data, and the complexity of fishing practices. Loss rates of fishing gear vary substantially depending on gear type and fishing method. The most recent estimates from Richardson *et al.,* (2022) provide a clearer picture of the scale of the issue, reporting annual losses of: 75,049 km² of purse seine nets, 2,963 km² of gillnets, 218 km² of trawl nets, 739,583 km of longline mainlines, over 25 million traps and pots and nearly 14 billion longline hooks, and more.

The significant scale of lost fishing gear has prompted global efforts to mitigate its impacts through advancements in gear design; enhanced vessel technology; stricter management measures (e.g. gear marking); improved lost gear reporting and retrieval systems; and better waste management strategies (Macfadyen *et al.,* 2009; Richardson *et al.,* 2018; FAO, 2019).

Although international law specific to ALDFG remains limited, frameworks like the United Nations Convention on the Law of the Sea (UNCLOS) and UN General Assembly (UNGA) Resolutions encourage States to address ALDFG through national legislation. In the United States, *the Marine Debris Research, Prevention, and Reduction Act* (Public Law 109-449)[1], enacted in 2006, is a primary mechanism to reduce marine debris, supported by the *Save Our Seas 2.0 Act* of 2020 (Public Law 116-224)[2]. These laws mandate the development of federal strategies, NOAA reporting on gear loss impacts, and collaboration with global stakeholders to combat marine debris, which companies such as Bumble Bee are required to comply with.

Despite these regulatory efforts, substantial knowledge gaps persist regarding the scale of ALDFG, particularly across the fishing industry. Initiatives like Ghost Nets Australia[3], Ghost Fishing UK[4], WWF Ghost Gear Project[5] aim to map and mitigate ALDFG. However, the most notable coordinated effort comes from the Global Ghost Gear Initiative (GGGI)[6], the largest cross-sectoral alliance committed to driving solutions for ALDFG worldwide. GGGI's Best Practice Framework for the Management of Fishing Gear for wild capture fisheries (C-BPF)[7], updated in

[1] https://www.govinfo.gov/content/pkg/PLAW-109publ449/pdf/PLAW-109publ449.pdf
[2] https://www.congress.gov/116/plaws/publ224/PLAW-116publ224.pdf
[3] https://oceanearthfoundation.org.au/ghostnets-australia/
[4] https://www.ghostfishing.co.uk/
[5] https://www.worldwildlife.org/projects/stopping-ghost-gear
[6] https://www.ghostgear.org/
[7] https://www.ghostgear.org/resources

2021, provides guidance for a wide range of stakeholders – ranging from gear manufacturers and fishers (commercial and artisanal) to seafood companies and port authorities – offering policies to reduce marine plastic pollution across the fishing industry.

1.2 Bumble Bee and Abandoned, Lost or Discarded Fishing Gear

Since joining GGGI in 2018, Bumble Bee has demonstrated a strong commitment to addressing ALDFG in its seafood supply chain. In its expanded partnership with GGGI, Bumble Bee seeks to go beyond removing derelict fishing gear from the ocean by identifying and addressing the root causes of ALDFG, aligning with the GGGI's C-BPF.

Currently, Bumble Bee implements several best practices outlined in GGGI's C-BPF to mitigate ALDFG risks within its supply chain. This project, however, represents a rigorous effort to analyze vulnerabilities across its entire supply chain, identifying gaps and recommending targeted solutions that exceed standard protocols. To date, Bumble Bee is one of the first seafood companies to engage in this type of evaluation, establishing a clear implementation pathway for improving ALDFG management across its supply chain and setting a precedent for industry-wide improvements in ALDFG management.

1.3 Objectives and Implementation

This study was structured around seven primary objectives, organized within four implementation phases:

Phase I: Inception

1. Collation of procurement data and gap analysis of fisheries, ports, and gear types within Bumble Bee's supply chain.
2. Map the supply chain to identify key stakeholders, including fishers, fishing companies, seafood suppliers and relevant port authorities.

Phase II: Survey

3. Develop and distribute a tailored stakeholder questionnaire for different actors across the seafood supply chain.

Phase III: Analysis

4. Perform an ALDFG vulnerability risk assessment for each identified species and associated gear type using GGGI's C-BPF to evaluate the likelihood of gear loss and its potential impacts.
5. Conduct a deep-dive analysis of three high-risk case studies identified as having significant ALDFG vulnerability.

Phase IV: Reporting, Recommendations, and Dissemination

6. Develop recommendations to reduce ALDFG across Bumble Bee's supply chain, accompanied by structured implementation pathways to facilitate their application and monitor their performance.
7. Organize a validation workshop to present findings and receive feedback from stakeholders.

2 Characterization of Bumble Bee's Supply Chain

Understanding the network and management of Bumble Bee's supply chain was critical for formulating targeted recommendations to mitigate ALDFG vulnerability. This section outlines the data sources and methodologies employed to characterize Bumble Bee's supply chain, along with the key findings derived from this analysis.

2.1 Methods

The characterization of Bumble Bee's supply chain was based on a desk-based data collation and analysis exercise using supply chain data owned and provided by Bumble Bee for the purpose of this study.

2.1.1 Data Collation

The supply chain data provided by Bumble Bee encompassed tabulated procurement data for both tuna and non-tuna species (Table 1). Data were not available for all species encompassed in Bumble Bee's supply chain and those provided varied significantly in scope in terms of the species supplied (e.g. tuna, small pelagics, salmon and shellfish), management frameworks (e.g. RFMO managed international fisheries to small-scale) and the type and scale of the fisheries from which raw materials are sourced.

Table 1. Summary of procurement data received.

Species Group	Species	Data provided	Comments
Tuna	Albacore tuna (*Thunnus alalunga*)	Yes	Granular insights (2016 – 2022) into fishing practices, gear types, and sustainability measures.
	Skipjack tuna (*Katsuwonus pelamis*)	Yes	
	Yellowfin tuna (*Thunnus albacares*)	Yes	
Non-Tuna	Herring (*Clupea harengus*)	Yes	Partial insights (2022 only) into procurement and logistics variables.
	Sprat (*Sprattus sprattus*)	Yes	
	Pacific Mackerel (*Scomber japonicus)*	Yes	
	Blue swimming crab (*Portunus pelagicus*)	Yes	
	Baby clams (*Paphia undulata*)	Yes	
	Shrimp (*Parapenaeopsis* ssp)	Yes	
	Ocean quahog (*Arctica islandica*)	No	Requested by MRAG, but some data duplicated (baby clam) and specific data missing.
	Salmon (pink) (*Oncorhynchus gorbuscha*)	No	Requested by MRAG; however, not included due to unavailability.
	Salmon (red) (*Oncorhynchus nerka*)	No	
	Pollock (*Theragra chalcogramma*)	No	
	Whiting (*Merluccius productus*)	No	

The tuna dataset offered vessel level insights into fishing practices, gear types, and sustainability measures, covering the years 2016–2022. For example, each record included detailed trip-specific information, including trip ID, vessel name and identifier, and the start and end dates of each trip. It also includes key details on fishing operations such as gear types, stock names, FAO fishing areas, Exclusive Economic Zones (EEZs), and transshipment activities. Furthermore, sustainability indicators like status of eco-label certification, participation in grievance programs, and lineage type are provided, offering insights into the environmental responsibility of the operations. The dataset also covers geographic and regulatory aspects, including ports of landing, Regional Fisheries Management Organization (RFMO) affiliations, flag state of vessel, and transshipment locations. Catch data, specifically tonnage (live weight), is also included, facilitating the evaluation of the scale of fishing activities.

In contrast, the non-tuna dataset primarily focuses on procurement and logistics, encompassing purchase order details, vendor and plant information, and delivery years. It also includes product and market data, such as species, category, and target market, as well as volume (in number of cans supplied) and packaging information, including cans, quantities, and total cans shipped.

2.1.2 Data Analysis

Data were imported into a Microsoft Access database for analysis. Data were cleaned to ensure consistency, removing reserved characters (e.g. “&”) and linking the data to the Consolidated List of Authorized Vessels (CLAV)[8]. The latitude and longitude of each landing port were also identified and linked to the data (“port end”) to support geospatial analysis. Queries were designed to extract specific information, such as tonnage by port and species, gear type and status of Marine Stewardship Council (MSC) eco-label certification.

Quantitative data analysis and outputs were performed and generated using statistical software R (R Core Team, 2020). Spatial and temporal analyses and outputs were conducted in geographic information systems (GIS) software QGIS (3.24.2) (QGIS.org, 2022) within the WGS 84 coordinate reference system (EPSG: 3857).

2.1.3 Data Gaps

Procurement data for salmon, whiting and pollock were not provided and therefore a preliminary characterization of the supply chain for these species could not be analyzed. Additionally, while the non-tuna dataset was useful for tracking production and supply chain flow, it lacks critical data on fishing methods, gear types, fishing locations, and sustainability measures, limiting its ability to assess ALDFG risks effectively. The volume of products procured was provided in “total cans shipped” compared to tuna which was given in tonnes (live weight), resulting in the use of different metrics which created challenges in identifying the relative importance of supply chains in terms of volume. These data gaps were subsequently addressed through a stakeholder questionnaire (see section 3, Stakeholder Engagement).

[8] Consolidated List of Authorized Vessels

2.2 Results

Tuna products make up the majority of Bumble Bee's supply chain, accounting for 72.2% of the total volume. In contrast, non-tuna products make up the remaining 28.8%, largely comprising sardine and salmon species. This composition underscores the strategic importance of tuna in Bumble Bee's sourcing and sustainability priorities.

To inform the development of targeted recommendations, the supply chains for both tuna and non-tuna raw material have been characterized to summarize the relative significance of different sources, guiding subsequent tasks to identify where the greatest impacts can be made.

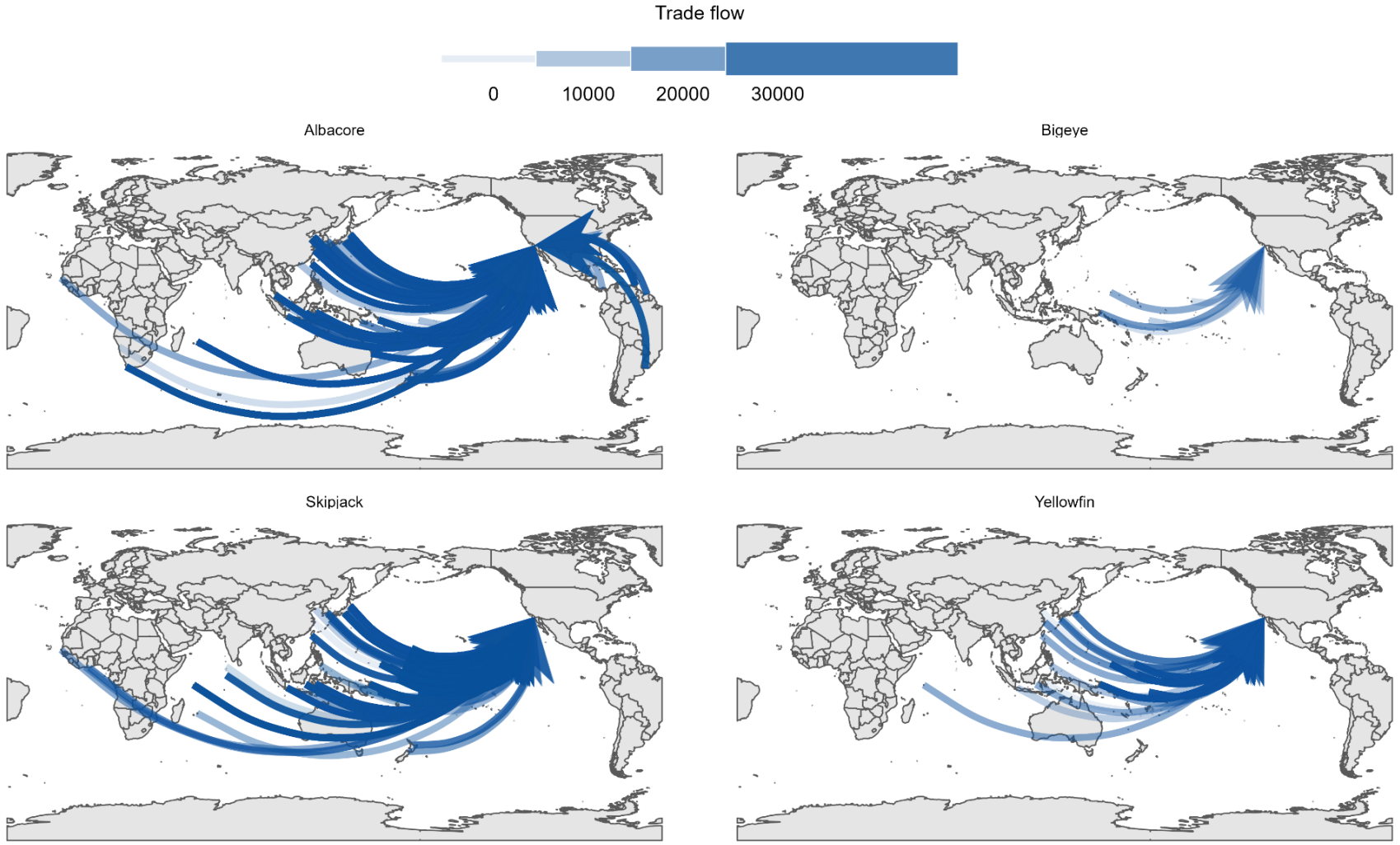
2.2.1 Tuna Raw Material

As a leading global tuna brand, Bumble Bee's supply chains for tuna raw material are inherently complex, involving diverse sourcing locations and vendors. The geospatial distribution of these supply chains provides valuable insight into their extensive reach and diversity (Figure 1).

Key data points include the flag State, gear type, and landing or transshipment ports, as these factors influence intervention opportunities. By focusing on regions and practices associated with high supply volumes and high ALDFG risks, the most effective intervention points can be identified. The analysis centers on the following critical factors:

- Species (see Table 2 and Figure 2)
- Flag State (see Table 3 and Figure 3)
- Gear type (see Table 4 and Figure 4)
- Port of landing (see Table 5 and Figure 5 and 6)
- Port of transshipment (see Table 6 and Figure 7 and 8).

Figure 1. Map of all Bumble Bee tuna supply chains. Arrow size reflects the magnitude of tuna fish landings, measured in tonnes.



2.2.1.1 Species

Reported catch data by species provides insight into the composition of the tuna supply chain, classified by five primary categories: albacore tuna, bigeye tuna, skipjack tuna, tuna (light meat), and yellowfin tuna (Table 2).

Table 2. Bumble Bee tuna raw material by species, total tonnage and description for the period 2016 - 2022.

Species	Tonnage (t)	Percent (%)	Bumble Bee Description	Tonnage (t)	Percent (%)
Albacore tuna	313,998.48	35.64%	Albacore	307,533.5	34.91%
			Free-Entry: Albacore	6,081.53	0.69%
			MSC: Albacore	271.73	0.03%
			MSC: NZ Albacore Troll	111.65	0.01%
Bigeye tuna	582.19	0.07%	Bigeye	582.19	0.07%
Skipjack tuna	5,709.89	0.65%	MSC: Maldives Skipjack	5,709.89	0.65%
Tuna (light meat)	553,211.78	62.80%	FAD-Free: Light Meat	927.22	0.11%
			Free-Entry: Light Meat	8,673.68	0.98%
			Light Meat	448,485.103	50.91%
			MSC: Light Meat	95,125.76	10.80%
Yellowfin tuna	7,433.79	0.84%	Free-Entry: Yellowfin	19.38	0.00%
			MSC: Yellowfin	1,042.37	0.12%
			Yellowfin	6,372.03	0.72%

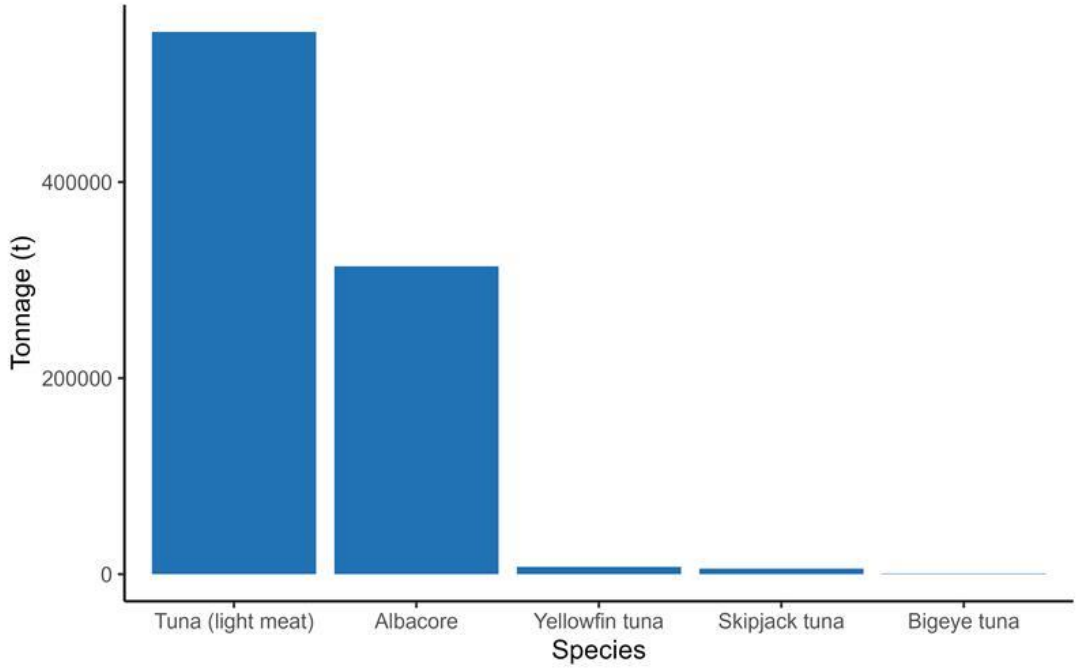
The majority of tuna raw material is classified as “Tuna (Light Meat)”, which constitutes 62.80% of the total supply, equivalent to over 550,000 tonnes, making it the most prominent segment of Bumble Bee’s tuna supply chain (Figure 2). This generic category typically represents skipjack tuna but may also include other species. Under Tuna (Light Meat), generic "Light Meat" dominates, accounting for 50.91%, followed by MSC-certified Light Meat (10.80%), with smaller contributions from Free-Entry Light Meat (0.98%) and FAD-Free Light Meat (0.11%) (Table 2).

Albacore tuna represents another substantial proportion of the total catch, comprising 35.64% of all tuna, equating to just under 314,000 tonnes. Most of this volume is categorized under generic "Albacore" (307,500 tonnes), with the remaining supply made up from smaller shares attributed to certifications or specific fishing methods, such as Free-Entry Albacore (0.69%), MSC-certified Albacore (0.03%), and MSC NZ Albacore Troll (0.01%).

In contrast, bigeye tuna, yellowfin and skipjack tuna provides limited contributions to the supply chain. Bigeye tuna accounts for just 0.07% of the total, with no further sub-categories. Yellowfin tuna contributes 0.84%, primarily under the generic "Yellowfin" classification (0.72%), supplemented by smaller fractions from MSC-certified Yellowfin (0.12%) and Free-Entry Yellowfin (0.00%). Skipjack tuna represents 0.65% of the total catch, all classified under MSC-certified Maldives Skipjack.

Eco-label certifications such as MSC (Marine Stewardship Council) and product labels like “FAD-Free” and “Pole and Line Caught” play a role in segmenting the supply chain by species and fishing methods. However, the results show their overall contribution within their supply chain remains minor compared to generic product labels, which dominate across all categories.

Figure 2. Bumble Bee raw material (tonnes) by tuna species (2016 – 2022).



2.2.1.2 Flag State

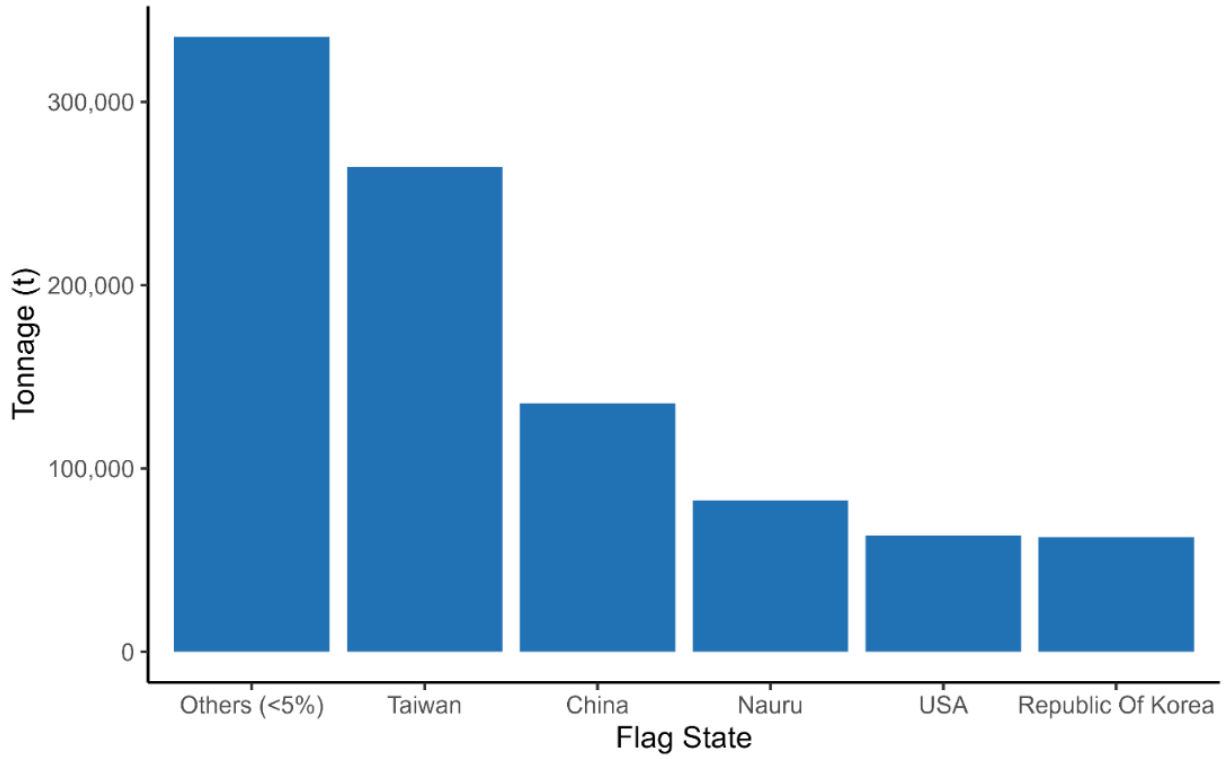
The supply of tuna raw material is heavily concentrated, with nearly 70% of the total raw material sourced from five flag States: Taiwan, China, Nauru, USA and Republic of Korea (Table 3).

Table 3. Bumble Bee raw material (tonnes and percentage) by flag State (with top five contributing flag States highlighted) for the period 2016 - 2022.

Flag State	Tonnage (t)	Percentage (%)	Cumulative Percentage (%)
Taiwan	264,507.65	30.03%	30.03%
China	135,742.54	15.41%	45.44%
Nauru	82,648.33	9.38%	54.82%
USA	63,549.13	7.21%	62.03%
Republic of Korea	62,493.33	7.09%	69.12%
Others <5%	271,995.15	30.89%	100%

Taiwan emerges as the leading flag State, accounting for 30.03% of the total raw material supply, equivalent to 264,507.65 tonnes. China ranks second, contributing 15.41% (135,742.54 tonnes). Combined, these two flag States supply nearly half (45.44%) of the total raw material, underscoring their dominance in Bumble Bee’s global tuna supply chain (Figure 3).

Figure 3. Bumble Bee tuna raw material (tonnes) by source (i.e. flag State of the catching vessel) (2016 – 2022).



In addition to the top five flag States, Pacific Island nations play a significant role as a collective. These include Kiribati (4.96%), Vanuatu (4.74%), and the Federated States of Micronesia (FSM; 4.57%), which collectively supply 14.27% of the total. Other Pacific contributors, such as Fiji (2.20%) and Papua New Guinea (PNG; 1.98%), add smaller yet significant quantities, reflecting the region's importance in the tuna industry.

Contributions from other regions, though present, remain minimal and fragmented. Southeast Asian countries, including Indonesia (1.78%), the Philippines (0.62%), and Malaysia (0.31%), contribute modest amounts, collectively representing approximately 2.71% of the total. Non-Pacific contributors, such as France (0.40%), Spain (0.40%), and Mauritius (0.23%), provide smaller proportions, illustrating the dispersed contributions from regions outside the Pacific and Asia. The full list of flag States is provided in Annex 1, as well as a Sankey plot illustrating the proportion of tuna landing by each flag State into various ports.

To better illustrate the significance of each flag State for specific tuna species, Annex 2 presents the trade flow for the four primary tuna species: albacore, bigeye, yellowfin, and skipjack. The map highlights the key flag States associated with each species, visualizing the geographic distribution and relative importance of trade routes.

2.2.1.3 Gear Type

Bumble Bee's tuna raw material is sourced from four gear types: handline, longline, pole and line and purse seine (Table 4).

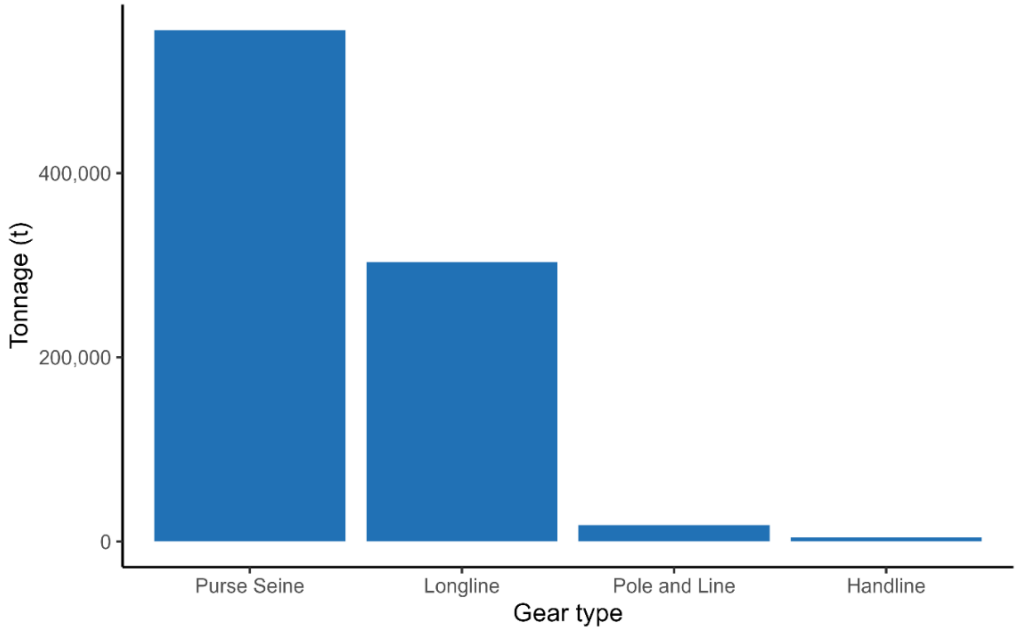
Table 4. Bumble Bee raw material (tonnes and percentage) by gear type for the period 2016 - 2022.

Gear Type	Tonnage (t)	Percentage (%)	Cumulative Percentage (%)
Purse Seine	555,485.59	63.06%	63.06%
Longline	303,390.15	34.44%	97.50%
Pole and Line	17,983.92	2.04%	99.54%
Handline	4,076.48	0.46%	100.00%

Purse seine fishing is the most dominant gear type, accounting for 63.06% of the total tonnage, equivalent to 555,485.59 tonnes (Figure 4). This dominance underscores its efficiency and widespread use in large-scale industrial tuna fishing, particularly for species such as skipjack (and light meat). Longline fishing ranks as the second-largest contributor, supplying 34.44% of the total tonnage (303,390.15 tonnes). This method is often associated with higher-value species such as albacore. Pole-and-line fishing contributes a modest 2.04% of the total (17,983.92 tonnes). Handline fishing represents the smallest share at just 0.46%, equivalent to 4,076.48 tonnes.

The data reveal a clear reliance on traditionally industrial fishing methods, with purse seine and longline fishing collectively contributing 97.5% of the total tonnage.

Figure 4. Bumble Bee raw material (tonnes) by gear type (2016 – 2022).



2.2.1.4 Port of Landing

In total, 12 ports have been identified as receiving direct tuna landings (all species) from vessels sourced by Bumble Bee. Direct landings are dominated by albacore tuna, with minimal contributions from Light Meat tuna (tuna nei) (Table 5). No direct landings of bigeye, skipjack or yellowfin tuna are reported by Bumble Bee.

Table 5. Total tonnage of Bumble Bee raw material by port of landing for the period 2016 - 2022.

Country	Port of Landing	Albacore	Tuna Nei (light meat)
Fiji	Suva	65,835.59	
Mauritius	Port Louis	38,278.02	
Fiji	Levuka	28,592.98	
	High Seas	327.25	
Tonga	Nuku'alofa	265.87	
Indonesia	Jakarta	89.69	
Indonesia	Bali	65.27	
Taiwan	Kaohsiung	4.76	
Indonesia	Kendari I	1.38	
Indonesia	Indonesia		124.80
Japan	Yaizu		8.97
Japan	Yamagawa Port		0.70

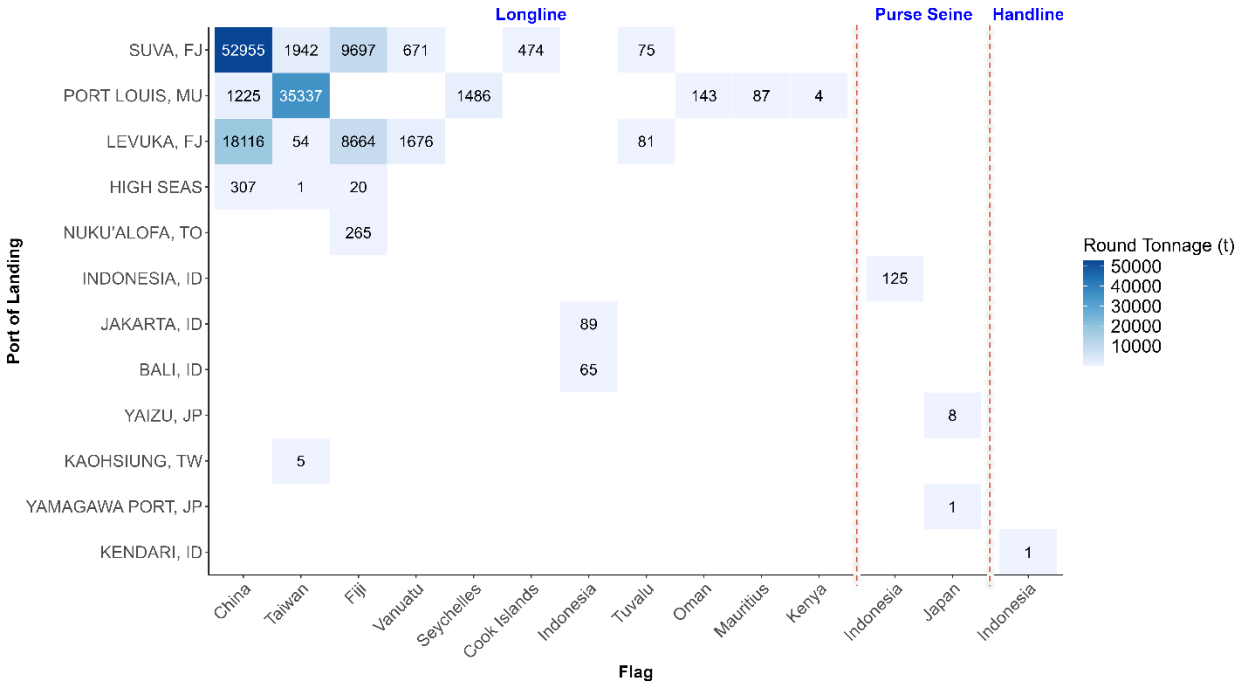
Albacore tuna is predominately caught from longline fisheries, with negligible contributions from handline fisheries, across six different countries: Fiji, Mauritius, Indonesia, Japan, Tonga and Taiwan (Figure 5).

The port of Suva, Fiji, emerges as the most significant in terms of landings (based on tonnage) directly from fishing vessels in the Pacific Ocean, primarily from Chinese and Fijian-registered vessels. In contrast, the Taiwanese fleet primarily operates in the Indian Ocean, landing their catch into Port Louis, Mauritius, though some Taiwanese vessels also fish in the Pacific and land into Suva. Direct landings are also made into these ports amongst others, in smaller contributions from vessels registered under other flag States, including the Cook Islands, Indonesia, Japan, Kenya, Mauritius, Oman, Seychelles, Tuvalu, and Vanuatu. These flag States provide limited but notable inputs to the broader tuna supply network.

Albacore landings are concentrated primarily in Suva, Fiji, which serves as the principal hub for Bumble Bee's albacore supply chain, receiving 65,835 tonnes between the years 2016–2022 - representing the largest share of albacore landings. Port Louis, Mauritius (38,278 tonnes), and Levuka, Fiji (28,592 tonnes), also contribute significantly to albacore landings. Smaller volumes of albacore landings are observed in ports such as Nuku'alofa (Tonga), Jakarta (Indonesia), and Kaohsiung (Taiwan), with landings ranging from 1 to 327 tonnes.

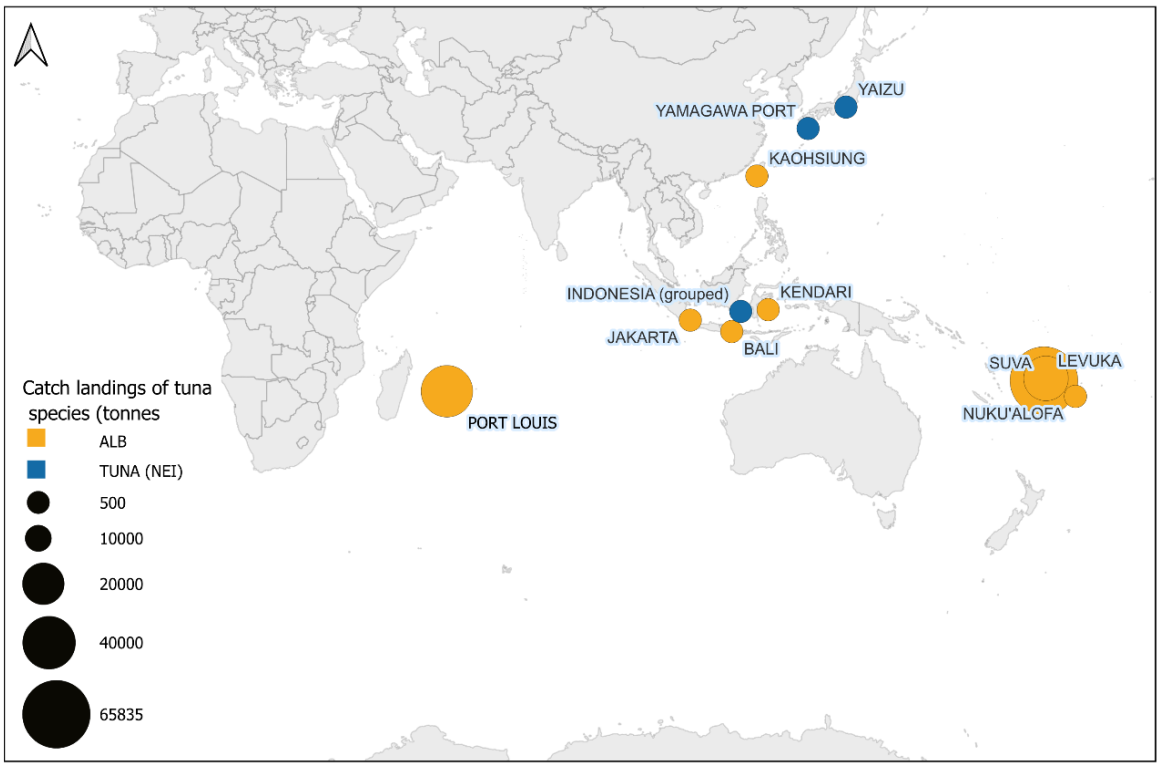
Landings of tuna (light meat) are minimal, with only 124 tonnes recorded in Indonesia, 9 tonnes at Yaizu, Japan and less than 1 tonne in Yamagawa, Japan.

Figure 5. Tile plot of Bumble Bee raw material (tonnes) landing direct into port (all species) by flag State, port and gear type (divided by red dashed line) (2016 – 2022).



A map of the key ports by total tonnage of direct landings and species is illustrated in Figure 6.

Figure 6. Total direct landings of tuna (yellow for albacore landings; blue for tuna (nei) at each major port. Bubble size reflects magnitude of landings (tonnes) (2016 – 2022).



2.2.1.5 Port of Transshipment

Transshipped raw material of tuna exhibits significantly greater geographic diversity compared to direct landings. In total, 78 distinct ports and the high seas were identified as facilitating transshipments. The top 10 ports of transshipment are presented in Table 6, with the following ports accounting for a high percentage of the total transshipped tuna: Majuro, Marshall Islands (22.43%), Rabaul, PNG (13.07%), Tarawa, Kiribati (10.33%), Pohnpei, FSM (9.93%) and Funafuti, Tuvalu (7.19%), with the High Seas accounting for 12.54%. The full list of transshipment ports is provided in Annex 1, as well as a Sankey plot illustrating the proportion of transshipped tuna landings into various ports (Figure 2; Annex 1).

Table 6. Bumble Bee tuna raw material (tonnes) by top ten ports of transshipment and species for the period 2016 - 2022.

Country	Port of Transshipment	Albacore	Bigeye	Skipjack	Yellowfin	Total
Marshall Islands	Majuro	0	0	165,657.33	1,534.99	167,192.3
PNG	Rabaul	3.94	95.28	95,987.90	1,341.31	97,428.43
Kiribati	Tarawa	0	0	76,015.63	991.36	77,006.99
FSM	Pohnpei	0	215.85	72,333.64	1,491.82	74,041.31
Tuvalu	Funafuti	462.44	48.50	52,603.91	440.33	53,555.18
South Africa	Cape Town	17,676.50	0.00	0	0	17,676.50
Seychelles	Port Victoria	0	0.00	17,225.09	40.93	17,266.02
Kiribati	Christmas Island	0	156.82	16,654.70	276.58	17,088.10
Taiwan	Kaohsiung	10,843.31	0	2,347.73	28.35	13,219.39
FSM	Kosrae	86.98	0	10,551.55	0.36	10,638.89
NA	Other Non-Listed Ports	58,226.39	65.74	47,161.78	1,287.76	106,741.67
NA	High Seas	93,162.60	0.00	265.90	0.00	93,428.50

Transshipped tuna predominantly originates from longline and purse seine fisheries, with minimal contributions from handline and pole-and-line fisheries (Figure 7). The longline fleet is primarily flagged in China, Taiwan, and Vanuatu, with most transshipments occurring on the high seas and smaller volumes transshipped in Cape Town, South Africa. Additional longline flag States include Australia, Belize, Cook Islands, Fiji, Indonesia, Japan, Malaysia, Mauritius, Namibia, Oman, Panama, PNG, and the Republic of Korea.

Purse seine-caught fish are largely sourced from vessels flagged in Taiwan, Nauru, the USA, the Republic of Korea, Kiribati, Vanuatu, and PNG. Transshipments for purse seine fisheries primarily take place in Pacific Island States, notably in the ports of Majuro, Rabaul Tarawa, Pohnpei, Funafuti and Christmas Island (atoll in Kiribati).

A map of the key ports by total tonnage of transshipped landings of all tunas is illustrated in Figure 8. Individual species are not shown, as multiple species are landed at each port.

Figure 7. Tile plot of Bumble Bee raw material transshipped (tonnes, all species) by flag, port and gear type (divided by red dashed line) (2016 – 2022).

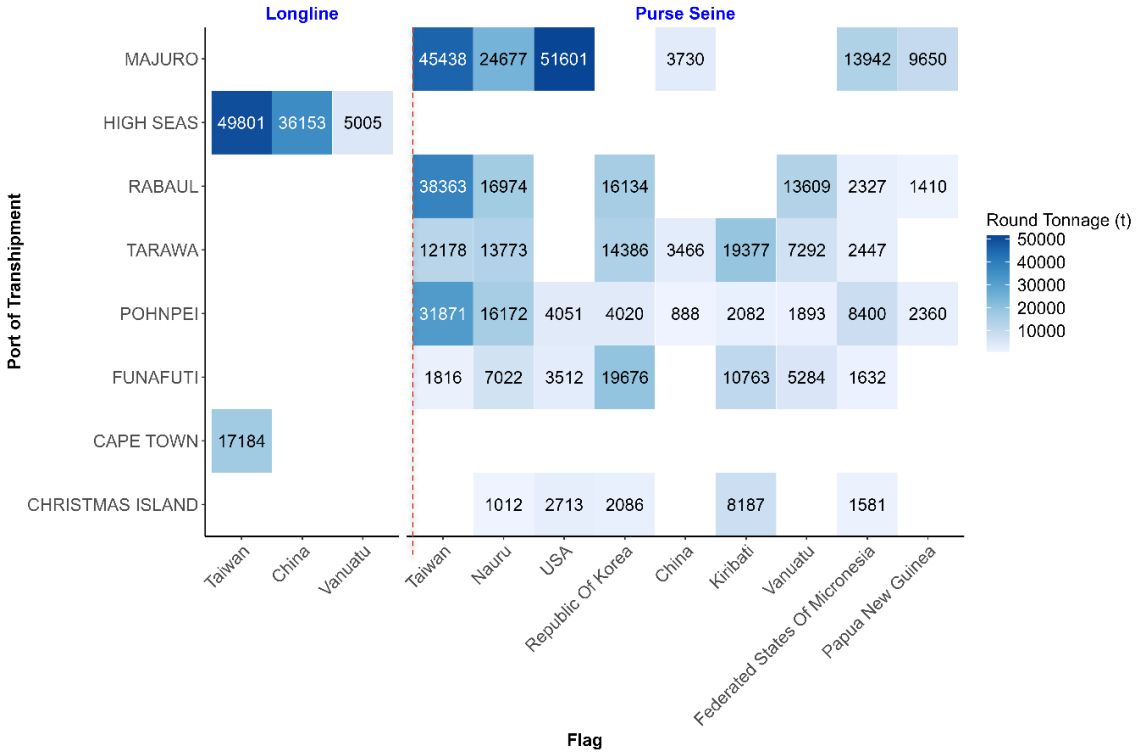
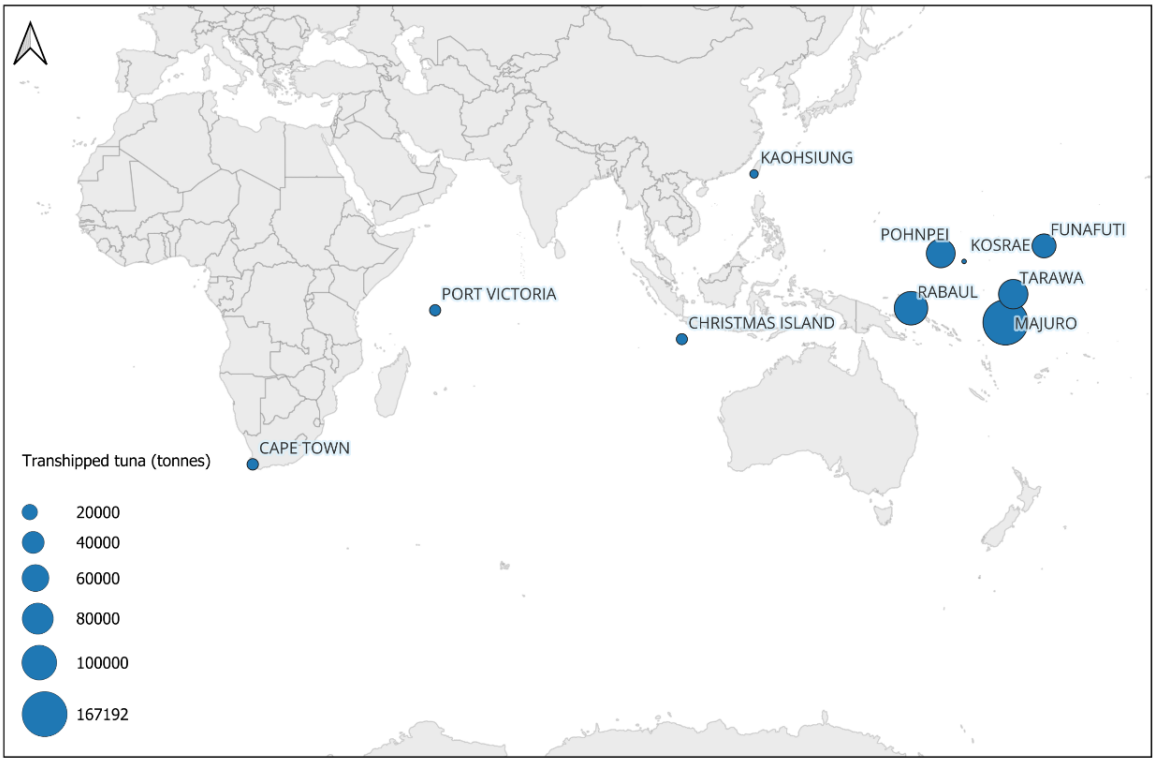


Figure 8. Total transshipped landings of tuna at each major port. Bubble size reflects magnitude of landings (tonnes) (2016 – 2022).



2.2.2 Non-Tuna Species

The supply chains for non-tuna species could not be analyzed with the same level of detail or specificity as those for tuna due to the absence of critical data, including fishing methods, gear types, fishing locations, and sustainability measures for most species. Further, the volume of products procured was provided in “total cans shipped” rather than a tonnage of landings.

As a result, the characterization of non-tuna supply chains is provided at the species level, encompassing 11 species or species groups sourced from seven countries across Europe and Asia. These are visualized through Sankey plots, which illustrate trade flows and highlight the relative importance of species, countries, and vendors. The full characterization of the non-tuna supply chain and corresponding trade flow maps are provided in Annex 3 and Annex 4.

A summary of the relative quantities by species and origin is provided in Table 7. As mentioned previously, no procurement information was provided for whiting, pollock, pink and red salmon. With regards to ocean quahog, some procurement information was provided yet it became apparent that the data was the same as the procurement data for baby clams. Within the baby clam data, the corresponding vendors and volume per seafood product are listed, validating this information. However, the same level of detail was not provided for ocean quahog and therefore it has been excluded from the table below.

Table 7. Summary of non-tuna products (cans) within Bumble Bee’s supply chain by species / species group and country of origin for the period 2022 - 2023.

Species	Total (cans)	Country of Origin
Sprat	37,824,384	Poland (99.11%), Latvia (0.89%),
Herring	10,085,790	Poland (100%)
Blue swimming crab and crab spp.	5,762,028	Indonesia (67.79%), Vietnam (32.21%)
Baby clams	2,986,200	Indonesia (81.43%), China (18.57%),
Shrimp spp.	2,680,320	Indonesia (100%)
European pilchard	1,039,068	Morocco (60.37%), Indonesia (39.63%),
Pacific mackerel	771,120	China (100%)

NB: Product reported as supplied in numbers of cans.

3 Stakeholder Engagement

Targeted engagement with key stakeholders in Bumble Bee's supply chain was conducted to address data gaps identified in the analysis of procurement data, particularly for non-tuna species, and to gather supplementary information on fishing gear usage across the supply chain. Engagement was facilitated through an online questionnaire administered via LimeSurvey[9].

3.1 Methods

The primary objective of the online questionnaire was to identify the perceived main drivers of gear loss and best practices currently employed by fishing vessels to mitigate such losses, as well as obtain insights into the operational and management practices of fisheries.

3.1.1 Questionnaire Design

Four distinct stakeholder groups involved in Bumble Bee's supply chain, were invited to respond to the questionnaire: fishers, fishing companies, seafood suppliers and port authorities (Table 8).

Table 8. Four stakeholder groups involved in Bumble Bee's supply chain.

Stakeholder group	Description
Fishers and vessel operators	Individuals, skipper and crew catching seafood at sea
Fishing companies	Individuals or companies owning several vessels
Seafood suppliers	Processors, wholesalers, suppliers and retailers, potentially owning their own vessels in addition to sourcing seafood from other fisheries
Port authority/ operators	Bodies operating and managing fishing ports

The online questionnaire was tailored to each stakeholder group, with input and review from GGGI, Bumble Bee, FCF Co., Ltd (FCF) and an independent consultant (Annex 5). The questionnaire was designed to be completed in under 20 minutes, consisting of a combination of open-ended and closed questions, often supplemented with visual aids or examples to guide respondents appropriately. It was available to stakeholders in English, Mandarin, Indonesian and Korean.

The questionnaire was structured to gain information on seven themes:

1. **Vessel information (pertaining to fishers exclusively):** Data on vessels e.g. vessel name, registration number, flag State and total length (LOA).
2. **Fishery Information:** Fishing practices employed by vessels, such as their main target species, fishing gear used, location of fishing operations and average length of fishing trip.
3. **Fishing Gear Maintenance and Repair:** Protocols in place for repairing damaged fishing gear, the frequency of gear loss and which fishing gear components are more likely to become lost.
4. **Causes of gear loss:** Factors contributing to, or resulting in, gear loss during a fishing trip.

[9] https://www.limesurvey.org/

5. **Best practice to reduce gear loss:** The current methods used onboard to reduce or prevent the loss of fishing gear and its potential impact on the marine environment.
6. **Reporting gear loss:** Procedures and recipients for reporting lost or discarded fishing gear.
7. **Port reception facilities**: How vessels dispose of fishing gear which can no longer be used in the fishery, with particular attention on the use of port reception facilities and their ability to handle end-of-life (EOL) fishing gear.

3.1.2 Questionnaire Dissemination

A contact list of stakeholders was compiled, with support from Bumble Bee and FCF. A total of 107 individuals were invited to participate in the questionnaire via email, supported by a Letter of Invitation from Bumble Bee. The questionnaire was disseminated on 14 March 2024, followed by several iterations of follow-up emails. The questionnaire was accessible for six months to coincide with the seasonality of fishing activities, particularly for larger pelagic vessels, and concluded at the end of September 2024. Fishing companies and, where possible, seafood suppliers were asked to forward the questionnaire to affiliated fishers given the challenges in contacting fishers directly – supported by FCF.

3.1.3 Analysis

Questionnaire responses were downloaded from LimeSurvey into a Microsoft Access Database. Queries were developed within the database to support the quantitative and qualitative analysis of questionnaire responses within programming language software R Studio (R Core Team, 2022). Further, spatial and temporal analyses were carried out using Geographic Information Systems (GIS) Software QGIS (3.24.2)[10] within the WGS 84 coordinate reference system (EPSG: 3857). The R Script will be provided to Bumble Bee to support any future replicated analysis.

3.2 Results

In total, 53 responses were received, of which 43 were complete and 10 were partially completed – achieving a 50% response rate.

3.2.1 Survey Responses by Stakeholder Group and Species

Table 9 delineates the distribution of responses across the four primary stakeholder groups, with additional representation from stakeholders categorized as "Other". This latter group includes entities such as fish processing companies and shipping agencies. Notably, one response is affiliated with Rabaul port in PNG and two respondents are affiliated with inspectors at the port of Majuro in the Marshall Islands. A complete list of respondents is provided in Annex 6.

[10] https://qgis.org/

Table 9. Breakdown of questionnaire responses by stakeholder groups.

Stakeholder group	Full response	Partial response	Total
Fisher	8	1	9
Fishing Company / Organization	7	-	7
Seafood supplier (owner of vessels)	4	1	23
Seafood supplier (sourced from third parties)	15	3	
Port Authority	5	-	5
Other	4	5	9
Total	**43**	**10**	**53**

Survey responses were received for all species, except whiting and pollock, with some responses encompassing multiple species (Table 10). With no procurement data available for whiting and pollock species, these species were not carried forward to the vulnerability risk assessment.

Table 10. Summary table of responses for each species per stakeholder group. Numbers in brackets indicate a partial response.

Species	Fisher	Fishing Company	Seafood Supplier (owner of vessels)	Seafood supplier (sourced from third parties)	Total
Albacore tuna	1	2		5	8
Skipjack tuna	6	3	1	5	15
Yellowfin tuna	6 (1)	4	1	3	14 (1)
Herring		1	1	4 (1)	6 (1)
Sprat		1	1	2 (1)	4 (1)
Ocean quahog				1	1
Salmon (pink)		1		2	3
Salmon (red)		1		2	3
Pollock					
Whiting					
Mackerel			2	2	4
Blue swimming crab		1		1	2
Baby clams				4 (1)	4 (1)
Shrimp				2 (1)	2 (1)
Sardinella (incl. European pilchards)			1	2	3
Total	**13 (1)**	**14**	**7**	**35 (4)**	**69 (5)**

Responses from stakeholders yielded key insights fundamental to understanding the ALDFG risk within Bumble Bee's supply chain. These findings include:

- The primary causes of fishing gear loss.
- Common practices implemented by vessels to prevent gear loss.
- The availability of waste reception facilities at port(s) of landing.
- Whether these waste reception facilities accept the disposal of fishing gear.

3.2.2 Primary Causes of Fishing Gear Loss

Fishers, fishing companies, and seafood suppliers operating their own fleets identified 16 factors contributing to gear loss during fishing trips, grouped into environmental, operational and external categories (see Table 11). Environmental causes include displacement by currents or animal interactions, snagging on underwater structures, and adverse weather conditions such as storms or swells. Operational and external factors, such as operator error, improper storage, vessel interactions, vandalism, theft, and the high cost of retrieving drifting FADs, further contribute to the loss or abandonment of fishing gear.

Table 11. Factors causing potential gear loss.

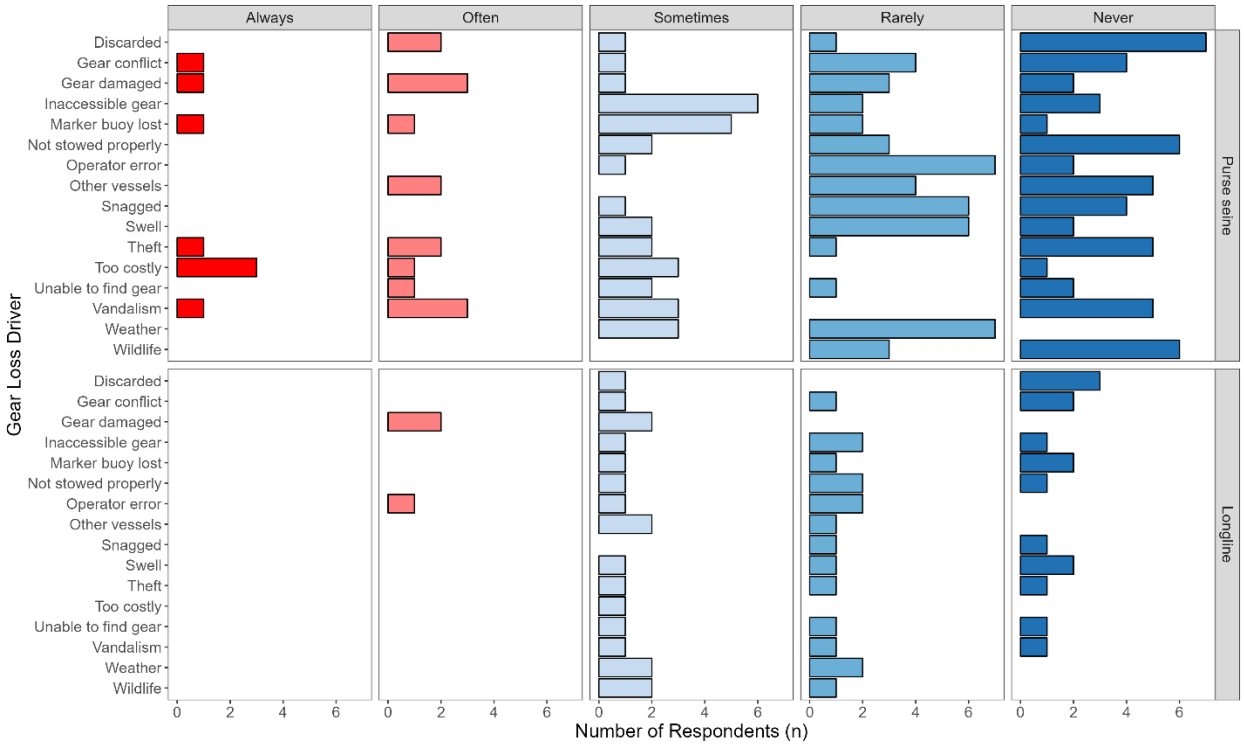
Category	Factor	Description
Environmental	Movement by currents or animals	Gear (e.g. pots and traps) can be displaced by currents, tides, or animal interactions, making locating and or retrieval difficult.
	Snagging on underwater structures	Reefs, rocks, or shipwrecks can trap or snag gear, preventing recovery.
	Loss of marker buoy	Strong currents, vandalism, or wear can detach marker buoys, leaving gear untraceable.
	Poor weather conditions	Storms, high winds, and large swells can damage or displace gear, making retrieval unsafe or impossible.
	Unexpected swells	Large, unexpected swells (height and or period) can displace or submerge marker buoys making retrieval or location difficult.
	Inaccessible areas	Gear may drift into locations that are too shallow, deep, or otherwise unreachable.
	FAD retrieval too costly	Fish aggregating devices may drift far from their deployment site, making recovery costly.
	Wildlife interactions	Large marine animals can interact with and move fishing gear.
Operational	Damage or faults	Wear and tear, defects, or mishandling can render gear unusable or irretrievable.
	Operator error	Mistakes during deployment or misplacement of gear can cause loss
	Storage error	Improper storage of gear can result in accidental loss, exacerbated during rough seas or when a vessel is underway.
	Discarded damaged gear	Non-functional or damaged gear may be intentionally discarded at sea.

Category	Factor	Description
	Vessel traffic	High traffic areas increase the risk of displacement or damage by passing boats.
External	Vessel interactions	Gear can be run over or entangled by direct interactions with other vessels.
	Vandalism	Intentional damage, removal of fishing gear or vandalisms can lead to gear loss or being rendered unusable.
	Theft	Fishing gear may be stolen though stolen gear may still be deployed by other vessels.

These factors were reported by frequency of occurrence, including "Always", "Often", "Sometimes", "Rarely" and "Never" responses (Figure 21; Annex 7) – facilitating analysis of the relative significance of gear loss drivers across different gear types underscoring the differing operational challenges and risk profiles associated with distinct gear types.

For this report, targeted data analysis focused on gear loss drivers in tuna purse seine and longline vessels due to their predominance in the supply chain and of Bumble Bee. Figure 9 illustrates distinct differences in the frequency of gear loss causes between purse seine and longline vessels within the Bumble Bee tuna supply chain. Factors such as the cost of retrieval, theft or vandalism, and gear damage were identified as more frequent contributors to gear loss for purse seine vessels. However, some respondents also reported these factors as "Never" contributing to gear loss, suggesting the influence of other variables, such as geographical differences, in driving losses.

Figure 9. **Comparison of purse seine and longline vessel-reported gear loss drivers.**



In contrast, longline gear demonstrated significantly lower frequencies of gear loss, with respondents predominantly indicating damaged gear and operator (crew) errors as main factors influencing the potential production of ALDFG, cited as “Often”, as well as other vessels, weather and wildlife reported as “Sometimes” contributing to gear loss for longline vessels.

Importantly, many respondents reported discarding gear overboard never occurred. However, it raises concerns that two fishers operating purse seiners reported this as happening “Often”, and one fishing company reporting this happened “Sometimes”, while one longline fishing company also reported discarding occurred “Sometimes”.

3.2.3 Common Practices Implemented by Vessels to Prevent Gear Loss

Fishers, fishing companies, and seafood suppliers reported 13 vessel-level prevention measures to reduce gear loss. The data indicate that all surveyed fishers frequently employed multiple measures, with each fisher reportedly using at least one of these measures. Among the most widely adopted strategies were avoiding high-risk areas; improving gear management through marking, identification, and tracking; and using gear limits to minimize damage. Additional measures include maintaining and modifying gear, adjusting gear configurations, reducing soak times, and retrieving gear before storms. Crew training on effective gear management and the use of biodegradable materials in FADs are also reported, particularly in relation to reducing environmental impact.

Gear marking, gear maintenance, and crew training in gear management emerged as the most important and commonly used measures to reduce gear loss across multiple fisheries, including purse seines, pelagic trawls, gillnets, longlines and traps. However, the extent of adoption varied by gear type. While crew training was frequently reported in purse seine fisheries, it was less emphasized in other gear types, suggesting an area for improvement in those sectors.

A comparison of mitigation measures between purse seine and longline vessels (Figure 10) highlights a greater adoption rate among purse seine operators compared to their longline counterparts. Notably, the aforementioned most common measures yielded at least 7 respondents reporting that these measures were “Always” implemented. In addition, survey responses for purse seine operators indicate vessels consistently implement measures such as “Avoid fishing in overcrowded areas”, “Communicate with other vessels” and “Use biodegradable gear components e.g. FADs”, with most responded reporting “Always” or “Often” to using these measures. This suggests a consistent and proactive approach to preventing gear loss among purse seine operators. In contrast, survey responses yielded very few reports of measures being “Rarely” or “Never” implemented, indicating these measures are widely accepted within this fleet.

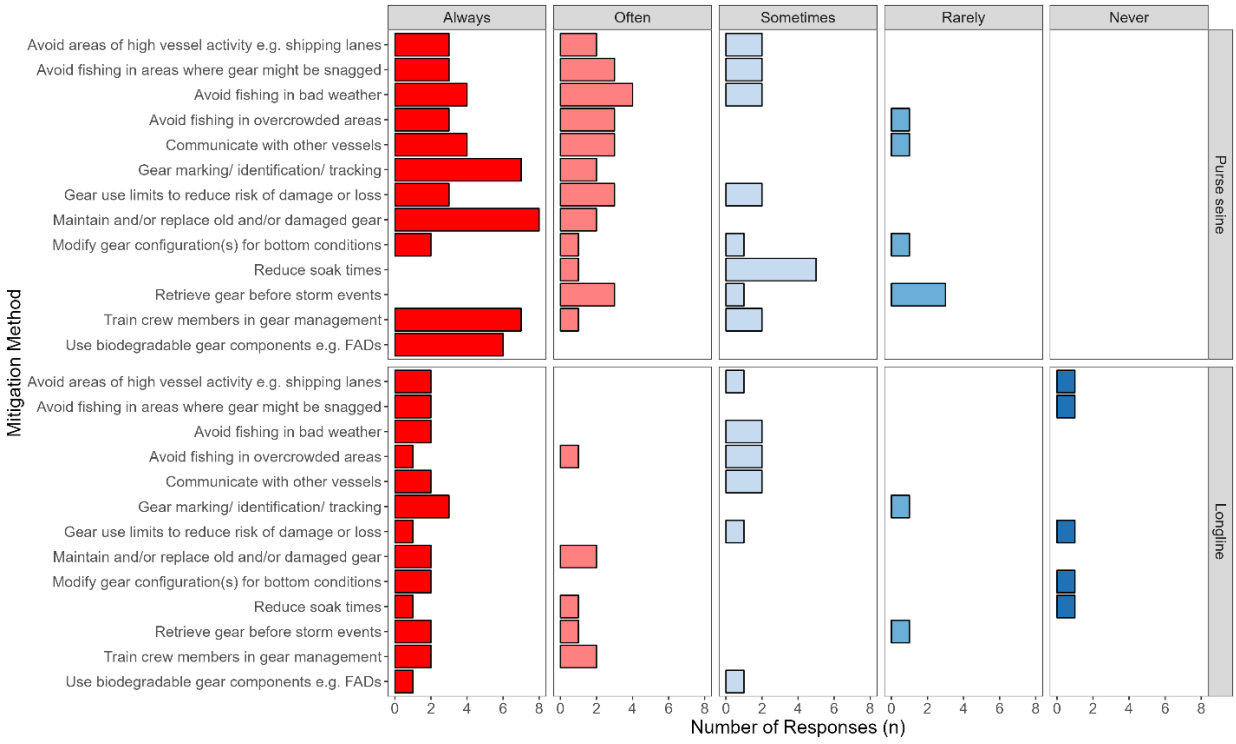
Conversely, in addition to the smaller sample size of respondents, longline operators reported lower overall adoption rates of preventive measures. The lower frequency of “Always” responses suggests a more variable approach to gear loss prevention. This variation in responses may be influenced by operational constraints, economic factors, or differing risk perceptions associated with gear loss in longline fisheries. For example, one fishing company responded “Never” to five measures, having previously indicated that “snagging” and “a high number of vessels” were “Not

Applicable" as causes of gear loss in this fishery, which may have influenced their decision not to adopt certain preventive measures.

It is important to clarify that two fishers responded to the question regarding the use of biodegradable gear components. While the survey referenced biodegradable FADs as an example, these fishers do not use FADs. This is supported by a later question which asked the respondent to suggest additional measures to reduce ALDFG, with one fisher emphasizing the need for more biodegradable fishing gear, specifically mentioning lines and leads.

Overall, these findings suggest that while purse seine fleets generally implement preventive measures as part of routine operations, longline fisheries exhibit greater variability, underscoring the need for more targeted interventions to enhance adoption of gear loss prevention measures.

Figure 10. Frequency of measures employed by purse seine and longline fishing vessels to prevent fishing gear loss.



3.2.4 Availability of Waste Reception Facilities at Port(s) of Landing

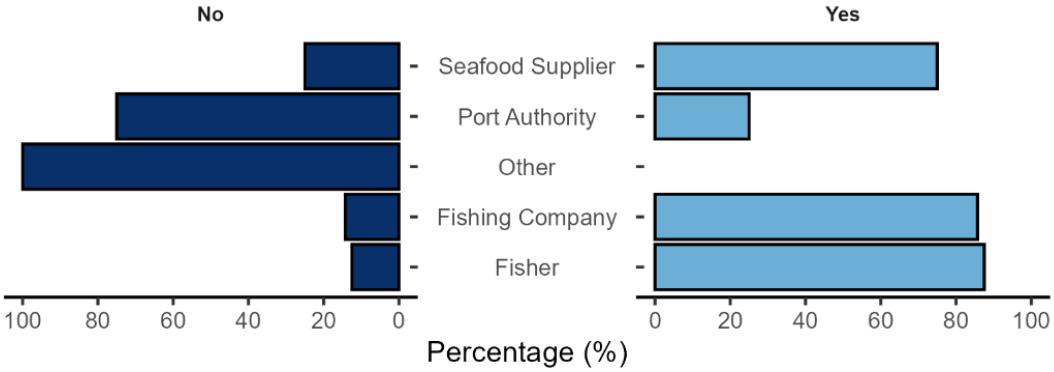
The availability of waste reception facilities, commonly referred to as port reception facilities (PRFs), plays a critical role in enabling proper waste management and disposal for the fishing industry. PRFs encompass the infrastructure, services, and facilities at ports designed to handle various types of ship-generated waste. However, absence of, or inadequacies in PRFs, can significantly hinder proper disposal, especially when it comes to fishing gear. For example, barriers arise when facilities have pre-processing requirements to accept EOL fishing gear or limited opening hours for use, charge fees and do not provide training on how to use the facilities. In such cases, when fishers have little access to PRFs for gear disposal, the likelihood of

discarding at sea increases. Inadequate disposal options can therefore act as a passive driver of gear loss.

From the survey, the majority of respondents across fishers, fishing companies, and seafood suppliers confirmed the presence of PRFs at their respective landing ports (Figure 11). This high percentage is particularly noteworthy for fishers and fishing companies as these stakeholders are the primary users of PRFs, making their insights highly valuable.

A total of seven out of nine fishers and five out of seven fishing companies confirmed the presence of PRF at their ports of landing. For longline fleets, two fishers confirmed PRFs at ports in Mauritius, Seychelles, Singapore, and Cape Town, while two tuna fishing companies confirmed their presence at ports in Fiji and Taiwan. For purse seine fleets, five fishers and several fishing companies identified PRFs at multiple ports within WCPFC region including Majuro, Pohnpei, Rabaul and Taiwan, with a specific note by one purse seiner regarding the availability of PRFs at Manila's main port (Port of Manila) but not its transshipment port (General Santos Port). A fishing company based in Mexico (Grupomar) confirmed their home port in Manzanillo has PRF. In other fisheries, the Canfisco Group in Canada confirmed handling all types of waste at their processing plants, while Thai Union/King Oscar reported PRFs at Scandinavian and Baltic ports for their Northeast Atlantic landings. PT Toba noted the absence of PRFs at coastal landing sites in North Sumatra for the blue swimming crab (BSC) fishery.

Figure 11. Availability of port reception facilities at key ports of landing.



Surveys of seafood suppliers yielded 11 positive responses out of 17 confirming the presence of PRFs at several key ports, including those for tuna longline (e.g. Suva, Levuka, Mauritius, and Kaohsiung), Western Pacific mackerel (Shidao Harbor), salmon (e.g. Cordova, Valdez and Seward in Alaska), ocean quahog (e.g. Point Pleasant, Atlantic City, and Cape May in New Jersey), and herring (e.g. Peterhead, Fraserburgh and Lerwick in the UK, and Skagen in Denmark) fisheries, while others reported no PRFs at ports of landing for the BSC fisheries, namely Batubara in North Sumatra and Gresik, Tuban and Rembang in Java, Indonesia and shrimp fisheries, namely Sibolga and Lampulo, Indonesia.

Among port authorities, two confirmed PRFs at Christmas Island (Kiribati) and Kaohsiung (Taiwan), while three reported the absence of PRFs at THE Port of Spain (Trinidad and Tobago), Kosrae and Pohnpei (FSM), although some fishers contradicted these reports. Additionally, all respondents classified as "Other" reported the absence of PRFs. This included a port agent at

Rabaul (PNG) and a respondent representing a shipping agency in Majuro (Marshall Islands)—the largest tuna transshipment hub in Bumble Bee's supply chain—stating that, "*Broken fishing device and fishing nets usually containerized and shipped back for recycling*."

3.2.5 Waste Reception Facilities Disposal of End-of-Life Fishing Gear.

Fishers, seafood suppliers, and fishing companies predominantly reported that the PRFs they utilized accepted the offloading of unusable EOL fishing gear (Figure 12) and provided valuable insights into the collection process further described in

Table 12.

Figure 12. Acceptance of end-of-life fishing gear at ports with port reception facilities.

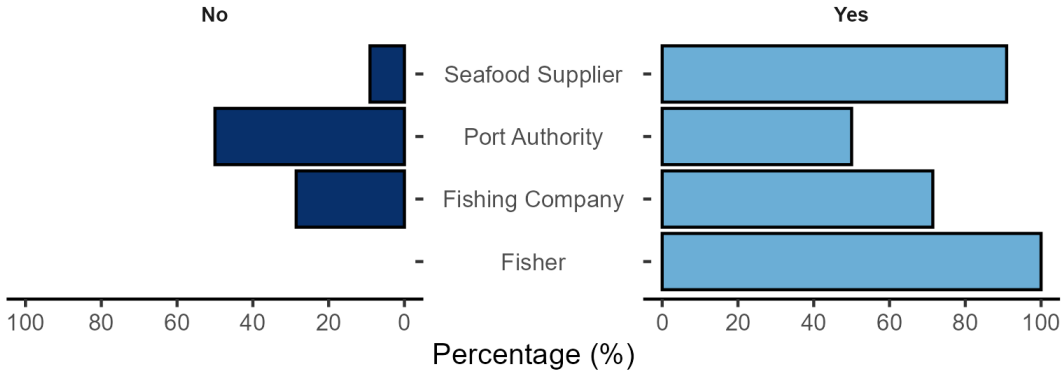


Table 12. Ports with port reception facilities that accept the disposal of fishing gear, along with their gear collection method and requirements (NA = Not Answered).[11]

Country	Port	Gear collection method	Designated areas for different gear types?	Pre-processing required?	Advance notice required?	Fee?	Reporting and documentation
Marshall Islands	Majuro	Ground collection	Yes	Yes	24 hours	Yes	Delivery receipt
FSM	Pohnpei	Delivered to agent	No	No	24 hours	Yes	Delivery receipt
PNG	Rabaul	Delivered to agent	Yes	Yes	48 hours	Yes	Delivery receipt
Philippines	Manila	I don't know	Yes	No	Pre-notification	Yes	Pre-notification
South Africa	Cape Town	Licensed bins for waste control	Yes	No	1 week	Yes	Custom release documents
Oman	Oman		No	No	Unknown	Yes	Unknown

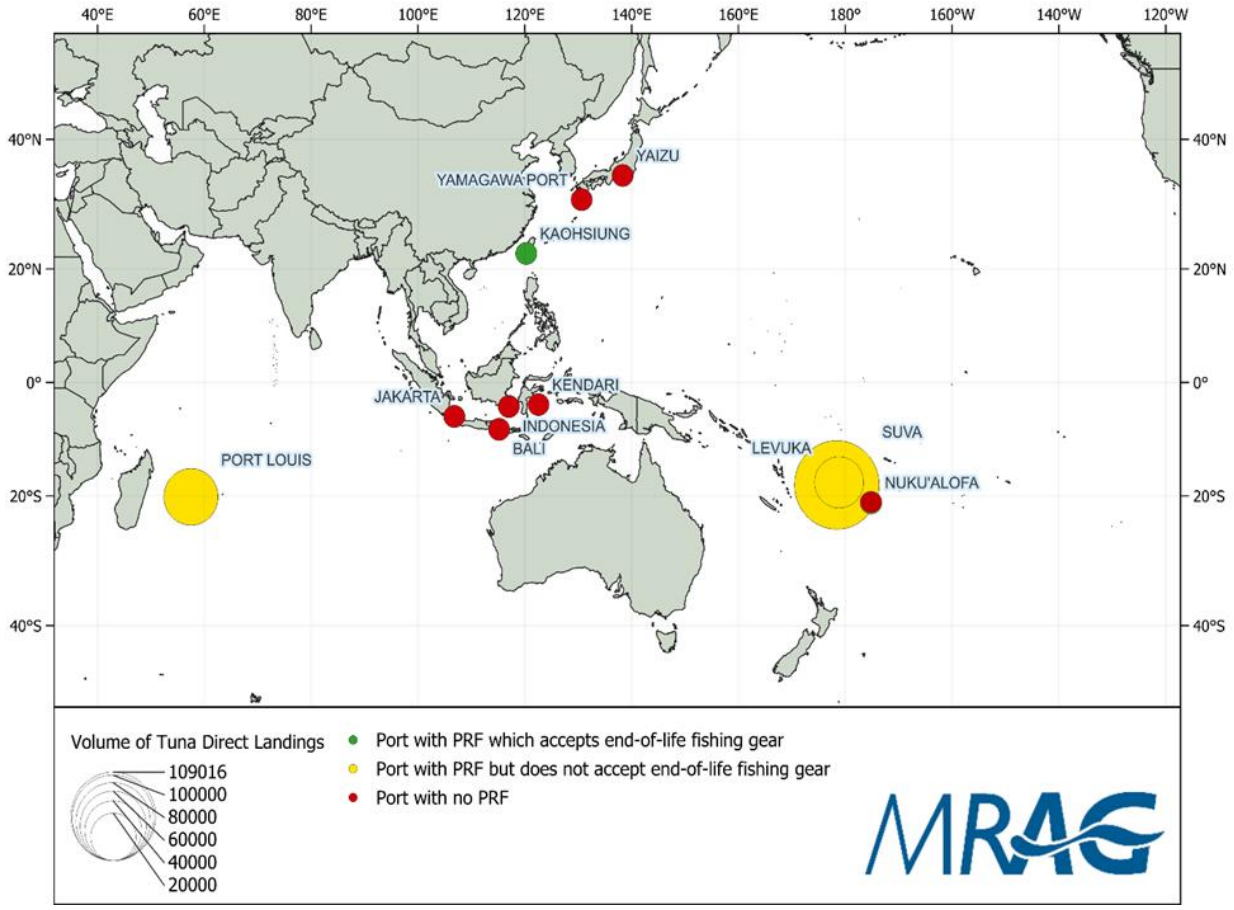
[11] Supplemented by the International Maritime Organisation (IMO) database on PFR

Country	Port	Gear collection method	Designated areas for different gear types?	Pre-processing required?	Advance notice required?	Fee?	Reporting and documentation
Mauritius	Port Louis	Ask someone to collect and handle it					
Seychelles	Port Victoria						
Singapore	Singapore						
Taiwan	Donggang	Designated area for disposal	No	No	None	No	No reporting required
	Kaohsiung	Temporary disposal areas for abandoned nets are available	Yes	Yes	NA	No	Reported to the authority
Mexico	Manzanillo	Bins and containers	Yes	No	None	No	No reporting required
Solomon Islands	Noro	Fishing companies collect waste nets and collaborate with recyclers	NA	NA	NA	NA	NA
Ecuador	Manta						
China	Shidao Harbor	Professionals collect derelict gear, storing it in containers	Yes	No	24 hours	No	No
UK	Plymouth	Recycle through suppliers	NA	NA	NA	NA	NA
	Peterhead	Containers available for non-recyclable gear, charity collections for nets	No	No	NA	No	No
	Fraserburgh						
	Lerwick	Waste management plans are in place	Yes	No	72 hours	Yes	Consignment notices for special waste
United States	New Jersey	Unknown	Yes	NA	Unknown	No	NA
	Naknek, Kodiak, Egegik (Alaska)	Landing areas (in remote Alaska) serviced by seafood processor	Yes	Yes	NA	No	NA
	Cordova, Valdez, Seward (Alaska)	Bins	No	No	NA	No	NA

Figure 13 presents a map categorizing ports receiving direct tuna landings based on their capabilities for handling fishing gear waste. Ports are classified into three categories: those without any PRFs, marked in red; those with PRFs for general fishing waste but lacking facilities to manage fishing gear, marked in yellow; and those equipped with PRFs capable of managing EOL fishing gear, marked in green. As shown, Kaohsiung is the only port receiving direct landings that has a PRF capable of accepting EOL fishing gear for disposal. Additionally, Port Louis (Mauritius), Suva and Levuka (Fiji) have PRFs; however, these facilities lack the capacity to manage EOL fishing gear separately from general waste. The remaining ports do not have PRFs but receive minimal direct landings from vessels supplying Bumble Bee. As such, they are not a major concern for our recommendations.

Corresponding maps for ports receiving transshipped tuna were excluded as carrier vessels are generally unwilling to transport damaged or EOL fishing gear as they are paid on the volume of tuna carried, anything else would restrict their capacity.

Figure 13. Availability of port reception facilities at major ports receiving direct landings of tuna and their ability to accept end-of-life fishing gear. Bubble size indicates tuna landings (tonnes).



From the questionnaire survey, Kaohsiung Port was highlighted as an important port for longline vessels, with well-developed infrastructure and effective management practices for managing EOL fishing gear (Figure 13). Both FCF and the Kaohsiung Port Authority have verified the presence of PRFs that include designated areas for sorting and recycling various types of fishing gear and do not charge a fee to use. This initiative is supported by the Taiwan Fisheries Agency (TFA) and local authorities, who facilitate the collection, sorting, recycling, and disposal processes. FCF reported that by the end of 2021, a total of 84 temporary storage areas had been established at Kaohsiung, where environmental businesses assist in collecting EOL fishing gear and manage the sorting and packaging of these materials for recycling, reuse and disposal of these materials as part of the ‘Kaohsiung City Fishing Port Area Abandoned Fishing Nets

Recycling and Reuse Promotion Project'.[12] This helps to alleviate significant costs, time and labor demands to clean, strip/dismantle and separate gear into its constituent materials, a task which may have otherwise discouraged proper disposal.

Majuro and Cape Town also provide facilities for EOL gear management, offering designated areas to separate different types of fishing gear. However, a fee is required to use these facilities, and Cape Town requires vessels to provide at least one week's notice before gear disposal is processed. Furthermore, while Cape Town does not require pre-processing of gear, Majuro does, which can be particularly time-consuming for purse seine vessels due to the sheer size of their nets. Similarly in Canada, the respondent from Canfisco Group confirmed that in ports, such as Naknek, Ketchikan, Sitka, and Kodiak, is technically accepted but treated as general waste and must undergo pre-processing requirements, such as stripping lead lines and headlines, before waste can be accepted.

In Suva and Levuka (Fiji), damaged fishing gear is currently discarded into general disposal bins alongside other vessel waste, according to a representative from the Fiji Fishing Industry Association. While the stakeholder highlighted the absence of dedicated bins for EOL fishing gear, the fact that these ports allow EOL fishing gear disposal is a step in the right direction. However, further research is needed to improve waste management, particularly given that these ports are significant hubs for direct tuna landings, receiving the highest volume of longline-caught tuna catch tonnage (mainly albacore) in Bumble Bee's supply chain. The survey respondent suggested implementing "*specific recycling bins for damaged or retired fishing gear*", as well as providing "*guidelines to assist vessel operators to ensure all damaged and old gears are discarded appropriately in port*."

Recycling initiatives are gaining traction in several locations. In Noro (Solomon Islands), Tri Marine is reportedly collaborating with net recycling companies to manage EOL fishing gear. In Scotland, ports such as Peterhead and Fraserburgh have implemented systems to separate non-recyclable gear from recyclable nets, which are repurposed for small vessel mooring. These ports also maintain Waste Management Plans to ensure compliance with environmental regulations, including the provision of dedicated waste and recycling bins.

Ports that do not accept the disposal of EOL fishing gear include Pohnpei (FSM) (Table 12). The Pohnpei Port Authority confirmed that most vessels bring damaged gear in for repair or reuse at the port and are advised to retain EOL fishing gear on board until it can be discharged at a suitable facility. Fishers also reported delivering EOL fishing gear to local fishing agents in Pohnpei and Rabaul. The Pohnpei Port Authority emphasized the need for collaboration between port authorities and shipping agents to ensure proper disposal of EOL fishing gear, noting the importance of developing a new waste reception facility for the small port.

Some ports face organizational barriers, such as Christmas Island (Kiribati), who experience administrative challenges including a lack of firsthand information on proper fishing gear disposal

[12] Bureau of Oceanography, Kaohsiung Municipal Government Statistical Analysis of the Establishment of Green Fishing Harbours in Kaohsiung City - The Case of Qianzhen Fishing Harbour

and handling, prevent EOL fishing gear from being accepted. In other cases, despite confirming the absence of PRFs, ports such as the Port of Spain (Trinidad and Tobago) and Kosrae (FSM) face legal restrictions that prevent them from accepting fishing gear for disposal. In Trinidad and Tobago, current legislation does not permit the disposal of fishing gear at ports, while in Kosrae, no laws or regulations exist to govern its proper handling. Additional challenges in Kosrae include a lack of coordination among stakeholders, difficulties in collecting, transporting, and storing damaged gear, and the absence of a local recycling company specializing in fishing gear.

4 ALDFG Vulnerability Risk Assessment

Under this task, our objective was to perform a comprehensive vulnerability risk assessment of all gear types utilized in harvesting each fish species within Bumble Bee's supply chain to identify potential hotspots where ALDFG is likely to occur. Building upon our understanding of external factors influencing ALDFG, the assessment took into consideration the geo-spatial area of fishing grounds, local fishing methods, the potential for ghost fishing, fishing gear maintenance and repair, and the presence of EOL facilities for responsible gear disposal.

4.1 Methodology

A vulnerability risk framework and methodology were designed to assess each combination of species and gear type, emphasizing areas where fishing gear is most likely to become ALDFG and the associated potential environmental impacts. This framework employed a likelihood–impact approach, evaluating each fishery against a series of criteria, referred to as risk factors, that influence the occurrence of ALFDG (see Table 13). Qualitative risk scores were assigned to each fishery, based on expert opinion from insights derived from survey results, a comprehensive literature review and expert knowledge.

As is typical with this type of vulnerability risk assessment, the approach is precautionary. For example, in cases where no data are available, a risk-averse scoring system is applied, meaning a higher risk score will be assigned by default. Similarly, if a score falls between two categories, the higher risk rating is used as the default position.

4.1.1 Likelihood – Impact Framework

The likelihood-impact framework evaluates information based on two key dimensions; the likelihood of an event occurring, and the severity of its impact. For example, a baseball hitting a window might have a high likelihood of occurring and has a major impact (breaking the window), resulting in a high risk. Conversely, a table tennis ball might have the same likelihood but has a negligible impact, resulting in a low overall risk. The intersection of the initial likelihood and impact evaluation determines the **inherent risk** level, which reflects the risk without any mitigation measures in place. Once mitigation strategies are implemented, the framework reassesses the risk to determine the **residual risk** level, representing the actual level of risk after interventions.

This methodology was used to evaluate each species and gear type combination within Bumble Bee's supply chain against four key risk factors to quantify ALDFG vulnerability (Table 13). These risk factors account for the unique characteristics of each fishery, and in the following sections, each risk factor is analyzed, providing a clear rationale for the assigned risk scores.

Table 13. Risk framework.

Risk Factor	Description
Geographic Distribution of Use	Fishery location, existing spatial pressures, depth of fishing activity and local environmental conditions.

Risk Factor	Description
Fishing Practices	Fishery size and associated fishing effort, reported gear loss drivers, frequency of gear loss, strategies for preventing or mitigating gear loss, and potential impacts of gear loss.
Fishing Gear Maintenance and Repair	Fishery's process for recovering, repairing, and replacing damaged gears.
Existence of EOL Processes	Fishery's process for disposing of gear at the end of its useful life.

4.1.1.1 Assessment of 'Likelihood' and 'Impact'

The likelihood of loss considers the likelihood of each gear class to ultimately end up abandoned, lost or discarded, considering various characteristics of each fishery which may increase or reduce its vulnerability. Each risk factor is assessed using a subjective 5-level risk rating (Rare; Unlikely; Moderate; Likely; Almost certain) to indicate the likelihood of fishing gear resulting in ALDFG (Table 14).

Table 14. Likelihood of loss ratings.

Risk Rating	Description	Score
Almost certain	A very high probability exists that the fishing gear (or a proportion of fishing gear) will be lost during fishing operations, i.e. loss is expected to occur at frequent intervals.	5
Likely	A high probability exists that the fishing gear (or a proportion of fishing gear) will be lost during fishing operations, i.e. loss will probably occur in most circumstances.	4
Moderate	A moderate probability exists that the fishing gear (or a proportion of fishing gear) will be lost during fishing operations, i.e. loss will occur at some point.	3
Unlikely	A low probability exists that the fishing gear (or a proportion of fishing gear) will be lost during the specified period, i.e. loss could occur at some time.	2
Rare	A very low probability exists that the fishing gear (or a proportion of fishing gear) will be lost during the specified period, i.e. loss may occur under exceptional circumstances.	1

Impact of loss considers the impact of the fishing gear on marine life and the marine environment once gear becomes abandoned, lost or discarded. This includes the likelihood of ghost fishing, the risk of entanglement with aquatic mammals, reptiles and birds as well as habitat damage. Each risk factor will then be assessed using a subjective 5-level measure (Insignificant; Minor; Moderate; Major; Serious) to indicate the impact of the ALDFG (Table 15).

Table 15. Impact ratings.

Risk Rating	Description	Score
Serious	Significant harm to marine ecosystems, wildlife and sensitive habitats; high risk of ghost fishing, entanglement, ingestion of ALDFG components and microplastic production.	5
Major	Major damage to marine ecosystems, wildlife and sensitive habitats; high probability of ghost fishing, entanglement, ingestion of ALDFG components and potential for microplastic production.	4

Risk Rating	Description	Score
Moderate	Moderate damage to marine ecosystems, wildlife and sensitive habitats; likely occurrence of ghost fishing, entanglement, ingestion of ALDFG components and potential for some microplastic production.	3
Minor	Minor or more localized damage to marine ecosystems, wildlife and sensitive habitats. It is unlikely that ghost fishing will occur.	2
Insignificant	Insignificant or no damage to marine ecosystems, wildlife and sensitive habitats. No ghost fishing is expected to occur, and fishing gear will likely break down relatively quickly.	1

The 'likelihood of loss' and 'impact once lost' ratings per fishing gear and species combination is then combined to generate an **inherent risk**. In other words, inherent risk is the likelihood of loss multiplied by the impact once lost (see Table 16). For example, in fisheries where the risk of losing fishing gear is rare and the resultant impacts are insignificant, this would be rated as a 'very low risk'; by contrast, in fisheries where the risk of losing fishing gear is almost certain and the impact is serious, this will be rated as a 'very high risk'. However, in fisheries where the impact is ranked as "serious," a 'high risk' score is always allocated because the outcome of any loss would cause significant harm. It should be noted that where no information is available, a precautionary approach is taken, and fisheries are scored at a higher level of risk.

Table 16. Inherent risk matrix.

		Impact				
		Insignificant	**Minor**	**Moderate**	**Major**	**Serious**
Likelihood	**Rare**	Very Low	Low	Low	Medium	High
	Unlikely	Very Low	Low	Low	Medium	High
	Moderate	Low	Low	Medium	Medium	High
	Likely	Low	Medium	Medium	High	High
	Almost Certain	Low	Medium	High	High	Very High

4.1.1.2 Assessment of the Adequacy of Existing Mitigation and Management Measures

Any measures to mitigate identified risks, as described by survey responses, are assigned a qualitative rating for their adequacy at mitigating or managing risk (Table 17). This includes mitigation measures such as gear marking, education and awareness building, gear modifications, presence of stowage space designated for damaged or EOL fishing gear, and protocols for fishing gear recovery. If no relevant or available mitigation opportunities exist or mitigation would not have an observed effect on changing the inherent risk, an N/A (non-applicable) will be assigned to the mitigation score.

Table 17. Mitigation ratings.

Rating	Description	Score
Very Strong	Measure would prevent the likelihood or impact of ALDFG	5
Strong	Measure would significantly reduce the likelihood or impact of ALDFG.	4
Moderate	Measure would reduce the likelihood or impact of ALDFG.	3
Weak	Measure would see minimal to no reduction in the likelihood or impact of ALDFG.	2
None	The measure in place is absent or ineffective and is not likely to result in a reduction in the likelihood or impact of ALDFG.	1

4.1.1.3 Rating of Residual Risk

The **residual risk,** or total risk rating, is generated by combining inherent risk with the adequacy of mitigation or management measures (Table 18). In other words, the residual risk is the inherent risk multiplied by the mitigation measure. Residual risk scores were assigned a Red, Amber or Green ("RAG") status to indicate the level of risk associated with each factor.

Table 18. Residual risk ratings.

Mitigation	Inherent risk					
		Very Low	Low	Medium	High	Very High
	Very Strong	Very Low	Very Low	Very Low	Low	Medium
	Strong	Very Low	Very Low	Low	Medium	Medium
	Moderate	Very Low	Low	Low	Medium	High
	Weak	Low	Low	Medium	High	Very High
	None	Low	Medium	High	Very High	Very High

4.1.1.4 Overall Risk

For each key risk factor (i.e. geographic distribution, fishing practices, fishing gear maintenance and repair, and existence of EOL processes) a summary of the five risk assessments were used to generate an overall risk (i.e. average score across the four risk factors) to quantify ALDFG vulnerability in each fishery. These results are presented as "rose plots", to graphically represent levels of risk in Bumble Bee's seafood supply chain (see Annex 8). In these plots, each "petal" corresponds to a specific fishery (defined by species and gear type), with the size of the petal indicating the magnitude of the risk. To enhance clarity, a color-coding scheme is applied, ranging from green (low risk) to deep red (very high risk), as outlined in the corresponding tables.

4.2 Results

Based on procurement data and survey responses, 19 species and gear type combinations were identified (Table 19). To enhance efficiency, species typically caught together in mixed fisheries within the same geographic region – such as herring and mackerel in the Northeast Atlantic – were consolidated.

Table 19. List of each species and gear type combination.

No.	Risk Assessments
1	Skipjack and yellowfin tuna purse seine fishery (FAD associated)
2	Skipjack and yellowfin tuna purse seine fishery (free school)
3	Albacore tuna longline fishery
4	Yellowfin tuna longline fishery
5	Tuna pole and line fishery
6	Herring pelagic trawl fishery
7	Herring purse seine fishery
8	Sprats pelagic trawl fishery
9	Sprats and European pilchard bottom trawl fishery
10	European pilchard purse seine fishery
11	Western Pacific mackerel pelagic trawl fishery
12	Alaska salmon gillnet drift fishery
13	Alaska salmon purse seine fishery
14	Blue swimming crab trap fishery
15	Blue swimming crab gillnet fishery
16	Shrimp gillnet fishery
17	Baby clams bottom trawl fishery
18	Baby clam dredge fishery
19	Ocean quahog dredge fishery

It should be noted that the questionnaire survey only received a 50% response rate and therefore only provided a partial view of the risks within Bumble Bee's supply chain. As a result, the risk assessment was supported by a comprehensive literature review to substantiate and justify the assigned risk scores.

Given the prominence of tuna species in Bumble Bee's supply chain, detailed risk assessments for each tuna fishery are included in the main body of the report. An introduction to each tuna species and associated gear types are presented followed by the corresponding risk assessments. At the beginning of each risk assessment a summary table presents the risk scores associated with each risk factor.

Risk assessments for non-tuna fisheries are provided in Annex 9.

4.2.1 Tropical Tuna Species Introduction

4.2.1.1 Skipjack

Accounting for around 57% of all global tuna catches, skipjack tuna (*Katsuwonus pelamis*) is arguably the most commercially important fish species on earth (ISSF, 2024). Skipjack tuna is a fast growing, opportunistic apex predator, that inhabits tropical and subtropical pelagic waters. A highly migratory species from the family *Scombridae*, skipjack are capable of travelling large distances (Fonteneau*,* 2014) and are found throughout most tropical and subtropical oceans (Chang *et al.,* 2022). For this reason, their management falls under the jurisdiction of multiple

RFMOs. Skipjack exhibit pronounced schooling behavior, forming free-swimming schools as well as schools associated with drifting objects and larger marine animals near the surface (Matsumoto *et al.,* 1984). These aggregations frequently include multispecies schools, particularly with juvenile yellowfin (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*), whose body sizes are similar at early life stages (Alatorre-Ramirez *et al.,* 2017). Skipjack is the smallest among the three, reaching just over 1 m in length, while yellowfin and bigeye tuna may grow up to 2.4 m and 2.5 m fork length, respectively. All three species are fast-swimming, schooling predators feeding on fish, pelagic crustaceans, and squid near the water's surface. Due to their epipelagic distribution (surface to ~ 200 m depth), they are primarily targeted by purse seine fisheries.

4.2.1.2 Yellowfin

Yellowfin tuna (*Thunnus albacares*) is a migratory species of tuna (family *Scombridae*) found throughout tropical and subtropical oceans, including the Atlantic, Indian, and Pacific Oceans, as well as the Mediterranean Sea (Pecoraro *et al.,* 2018). As a transboundary species, yellowfin is managed by several RFMOs and is the second most commercially important tuna species, accounting for approximately 30% of global tuna catches (ISSF, 2024). Similar to skipjack, yellowfin form both free-swimming schools and aggregations around drifting objects. Juveniles often associate with adult skipjack in mixed-species schools, and consequently are caught in the same purse seine fisheries (Alatorre-Ramirez *et al.,* 2017). In addition to purse seine gear, yellowfin are also harvested by pelagic longline vessels targeting larger, solitary individuals in deeper waters (Williams *et al.,* 2015). Despite their capability to dive to depths of up to 300 m (typically when avoiding predators or pursuing prey) yellowfin are physiologically constrained by their inability to thermoregulate in colder waters and their sensitivity to low oxygen levels at depth (Pecoraro *et al.,* 2017). A study using pop-up satellite archival tags (PSATs) found that 90% of yellowfin's recorded depths were between the surface and 100 m, indicating a clear preference for the warm, well-oxygenated waters of the epipelagic zone (Nimit *et al.,* 2020). This depth distribution increases their availability to surface fishing gears and explains their prominence in both purse seine and longline fisheries.

4.2.1.3 Albacore

Albacore tuna *(Thunnus alalunga)* is the second most prevalent species in Bumble Bee's supply chain, comprising 35.64% of all tuna products, yet only account for around 4% of global tuna catches (ISSF, 2024). Albacore is a highly migratory species, caught across temperate and subtropical oceans, and the Mediterranean Sea. Characterized by slow growth, long lifespan, and late maturity, albacore tuna are particularly vulnerable to overexploitation (Nikolic *et al.,* 2016). Albacore's biological characteristics are unique and allow them to swim continuously at very high speeds, covering vast areas in their annual migrations. Their spatial distribution is mainly driven by water temperature and food availability, aggregating in the vicinity of cold, pigment-rich fronts related to coastal upwelling where prey is relatively abundant (Xu *et al.,* 2017). Their global distribution and migratory behavior mean they are considered highly migratory and straddling stocks, migrating through and occurring in multiple EEZs, and therefore require international management through RFMOs. Like all tunas, albacore is a pelagic species meaning it is commonly targeted fisheries throughout the Atlantic, Indian, and Pacific Oceans, as well as the Mediterranean Sea.

4.2.2 Identified Gear Classes

4.2.2.1 Purse Seine

Purse seines are typically used to target smaller, schooling fish that inhabit surface and sub-surface waters above the thermocline, operating at depths up to 200 m (FFA, 2019). This most often includes juvenile yellowfin and bigeye tunas found schooling with adult skipjack tuna, along with other smaller tuna species that typically feed on surface baitfish. Each tuna purse seine operation will typically only last a matter of hours, with searching and fishing operations only occurring during daylight. Purse seine fisheries use two main fishing methods: fishing free schools, and fishing using fishing aggregating devices (FADs) (Wain *et al.,* 2021).

***Free school*:** Purse seine gear involves the use of a large net that encircles schools of fish and closes in on them at the bottom of the net. Seines include a floatline on the top end and a leadline on the bottom, which is typically made of steel with attached purse rings below the chain. The steel line passes through the rings and allows the net to be drawn closed (FAO, 2024b). The average net size reported in Richardson *et al.* (2022) is 49,889 m^2, compared to 728 m^2 used in gillnets, and 5,048 m^2 used in trawls.

FAD associated: FADs are either categorized as drifting FADs (DFADs) or anchored FADs (AFADs), the difference being that DFADs drift freely and AFADs are anchored to the ocean floor and remain in a set location. DFADs are common practice in industrial tuna fisheries and often require the use of Global Positioning System (GPS) and buoys installed with echosounders, so that fishers can track their location, monitor schools of fish by visualization. AFADs are a more popular choice for smaller-scale, artisanal coastal fisheries. Most FAD catches are from DFADs, and it is estimated that over 50% of tropical tuna caught by purse seines are from FAD associated fishing (Wain *et al.,* 2021). Drifting FADs used in tuna fisheries will last for several months floating at sea once deployed. When fished on, DFADs will be checked and may be repaired at sea and redeployed. The lifetime of DFADs that are not repaired has reduced in recent years due to the increase in biodegradable materials used in FAD construction.

4.2.2.2 Longline

Pelagic longlines, occasionally referred to as surface longlines, comprise a series of monofilament lines that hold baited hooks in suspension at a desired fishing depth in the water column. Each longline is a series of repeating units, referred to as ‘baskets’, which are connected to one another via the ‘main line’ which spans the length of the longline. At either end of the main line there are two buoys with GPS beacons attached to help vessels relocate their deployed longline for hauling. Typically, each basket is held in an upward-facing U-shaped curve by two floats at each end of the basket; these may be held at the water's surface or suspended in the water column (called midwater floats). Each hook hangs on a branch line attached to the main line using a clip or swivel, these lines are often referred to as snoods or gangions. Longline gear is a widely practiced fishing method to target tuna fisheries, particularly for pelagic species such as yellowfin and albacore, with sets typically being made for a 24-hour period, setting a line for a few hours, allowing a soak period and then starting to retrieve the line.

4.2.2.3 Pole and Line

Pole and line fishing is a traditional and selective fishing method that uses a long pole, typically made from bamboo or modern fiberglass, equipped with a short line and a barbless hook. This minimalistic gear setup and the targeted nature of the fishing effort make pole and line fisheries one of the most sustainable and low-impact methods of fishing. Bycatch of non-tuna species is negligible and there is no interaction with the seabed, further reducing its environmental footprint, though catches of juvenile yellowfin and bigeye tuna may occur, often being misreported as skipjack. Pole and line fishing is an active fishery, gear is only in the water whilst actively being utilized

4.3 Tuna Risk Assessments

4.3.1 Skipjack and Yellowfin Tuna Purse Seine Fishery (FAD Associated)

Skipjack and yellowfin are often found together in large aggregations, with adult skipjack frequently mixing with juvenile yellowfin tuna, and they are typically caught together in the same purse seine fisheries. This is reflected in stakeholder responses, where the majority (12 out of 13 stakeholders) who either directly target or supply to Bumble Bee confirmed they target / supply both species. Therefore, both species are evaluated under a single assessment.

From the stakeholder feedback, it was identified that all nine fishers that participated in the survey supply tuna species to FCF. A total of six respondents reported they exclusively used purse seines to harvest skipjack and yellowfin tuna. While all six fishers target free-swimming schools, five additionally use DFADs with non-entangling mesh.

Among the fishing companies, Tri Marine, Fong XXX Company, and Grupomar own nine, seventeen, and six purse seiners, respectively. These vessels target only skipjack and yellowfin tuna, with all company vessels focusing on free-swimming schools. Tri Marine and the Fong XXX Company exclusively use DFADs; both companies confirmed that these FADs are made with non-entangling mesh and biodegradable components. For the purposes of this assessment, only the FAD component of purse seine fisheries is evaluated, as purse seine free school methods are scored separately. This approach ensures precautionary scoring by isolating the FAD impact, preventing scoring dilution from purse seine elements already accounted for in the free school assessments.

Among seafood suppliers, Tropical Canning (Thailand) PCL, Unicord Public Company Ltd. (Unicord), FCF, and Pahala Bahari Nusantara primarily source skipjack, yellowfin, and bigeye tuna from purse seine fisheries. While Tropical Canning (Thailand) PCL listed FCF as their main supplier, other key suppliers such as Thai Union who are also key to Bumble Bee's supply chain, were not assessed for their practices due to a lack of survey responses. Tri Marine also sources albacore and skipjack tuna from other fishing companies operating purse seines. Both Tri Marine and FCF confirmed DFADs were used by the vessels they source from, aligning with the fisher responses supplying FCF.

Risk factor	Likelihood	Impact	Inherent	Mitigation	Residual
Geographic Distribution	Likely	Major	High	Moderate	High
Fishing Practices	Almost Certain	Major	Very High	Moderate	High
Fishing Gear Maintenance and Repair	Likely	Major	High	Medium	Medium
Existence of EOL Processes	Likely	Major	High	Moderate	High

4.3.1.1 Geographic Distribution of Use

Stakeholder responses indicate that fishing primarily takes place within the EEZs of Parties to the Nauru Agreement (PNA), such as the Solomon Islands, Kiribati, Cook Islands, as well as the Seychelles and Oman. The stakeholders indicated that RFMO's involved include the Western Central Pacific Fisheries Commission (WCPFC), which governs tuna fishing practices in the stakeholder-associated FAO areas 71 and 77, and the Indian Ocean Tuna Commission (IOTC), governing FAO areas 51 and 57. PNA countries, the Seychelles and Oman each play crucial role in tuna fisheries. Within the Seychelles, the Fishing Authority (SFA) manages the country's tuna fisheries to ensure sustainable practices and compliance with IOTC regulations. In Oman, the Ministry of Agriculture, Fisheries and Water Resources (MAFWR) plays the equivalent role in tuna fishing practices.

Yellowfin and skipjack tuna are primarily targeted in open ocean environments where they aggregate around floating objects or FADs. Purse seine fisheries operate in the pelagic zone, typically deploying nets between the sea surface and 200 m depth to encircle tuna schools. This fishing method minimizes direct seabed contact, reducing the likelihood of fishing gear becoming snagged on the seabed or other underwater obstacles. Several fishers also mentioned they do not operate in areas where other fishing vessels are present, reducing the likelihood of gear conflict and potential for gear damage. However, within the stakeholder responses, some of the main causes of gear loss were attributed to a high number of vessels and conflict with other vessels. In addition, vandalism and theft of DFADs were reported as a major driver for gear loss, indicating that vessels operating in the same fishery are responsible for FAD loss.

Further mitigation measures on a fishery-level were listed in the survey responses. Four stakeholders described communicating with other vessels to coordinate operations, and two stakeholders avoid fishing in overcrowded areas to minimize situations where gear, including FADs, are left unmanaged. At the end of their useful life, FADs will be considered lost (e.g. due to DFADs sinking, locator beacon failure) or they may be purposefully abandoned. Retrieval by either the deploying or other associated vessels for disposal is unlikely. Respondents also indicated that fishing gear is rarely retrieved before storm events, increasing the risk of ALDFG. Considering these physical environmental conditions and the potential associated risks, the factor Geographic Distribution has been designated a likelihood risk score of '**Likely'** due to the large areas over which FAD related purse seine fisheries operate and the large numbers of DFADs in operation making tracking, recovering and repairing all of them is not likely**,** and an Impact score of '**Major'**. Together, these create an Inherent score of **'High'.**

Regarding measures to mitigate ALDFG, provisions exist on both fishery-specific and wider national and RFMO levels. WCPFC Conservation Management Measure (CMM) 2017-04[13] specifically addresses the management of FADs, including requirements for gear marking, tracking, and mandates lost FADs or associated gear to be reported within 24 hours. CMM 2021-01[14], superseding 2018-01[15], also establishes provisions for tuna fisheries, including gear marking and FADs, limits on the number of FADs allowed per vessels, and sets recommendations for the use of biodegradable materials, all of which aid in minimizing environmental impacts. From January 1, 2024, CMM 2023-01 mandates the use of fully non-entangling FADs and encourages transitioning to non-plastic, biodegradable materials for FAD construction. Under paragraph 21 of CMM 2023-01, purse seine vessels are limited to deploying no more than 350 DFADs with activated instrumented buoys.

In the Seychelles, the SFA mandates the marking of fishing gear and requires fishers to report lost gear as part of the broader fisheries management regulations aimed at reducing ALDFG. Enforcement is carried out through patrols, logbook inspections, and the use of observer programs. Non-compliance can result in penalties, although enforcement can be challenging due to resource constraints. The Seychelles Fisheries Act of 2014 provides provisions for the marking of fishing gear and reporting of lost gear. Detailed regulations are available in subsidiary legislation and specific guidelines issued by the SFA.

In Oman, the Ministry of Agriculture and Fisheries (MAF), the predecessor to MAFWR, enacted the Fisheries Law (Royal Decree 26/2013[16]) which states “The fishing gear shall, to the extent possible, also be checked to ensure that […] the markings correspond to those authorized for the vessel”. The FAO[17] also state that since 2010 the MAF organizes annual training for fishermen on a variety of technical topics, including how to “use the latest fishing equipment”. Moreover, the MAF provide regular training to fishermen in fishery aspects including “the use of fishing gears and quality” (FAO, 2024b). Similar to the Seychelles, enforcement involves patrols and inspections, but issues exist around compliance due to the vastness of the fishing grounds and limited enforcement resources.

IOTC has implemented several measures addressing ALDFG, including Resolution 24/02[18], which mandates that all fishing gear used by vessels authorized to operate in IOTC area be appropriately marked to indicate their position and extent. This includes DFADs, which must display vessel-specific identifiers at all times.

---

[13] CMM 2017-04 - Conservation and Management Measure on Marine Pollution

[14] CMM 2021-01 - Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the Western and Central Pacific Ocean

[15] CMM 2018-01 - Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the Western and Central Pacific Ocean

[16] Royal Decree No.26/2013 approving the accession of Sultanate of Oman to the Agreement on Port State Measures to prevent, deter and eliminate Illegal, Unreported and Unregulated Fishing.

[17] FAO Fishery and Aquaculture Country Profiles: Oman

[18] IOTC Resolution 24/02 on management of drifting fish aggregating devices (FADs) in IOTC area of competence - https://iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_2402.pdf

In response to increasing environmental concerns about the contribution of FADs to marine litter, proposal Resolution 24/02 includes clear guidelines for the design and deployment of DFADs. For example, the European Union proposed enhancements to include provisions for managing AFADs, introducing mandatory implementation of increasing degrees of biodegradability in DFADs and mandatory retrieval and reporting of all DFADs (IOTC-2023-SS6-PropA[E]).[19] Specifically, for AFAD deployment, buoys must be clearly marked with a unique IOTC identifier and contracting parties and cooperating non-contracting parties (CPCs) must keep a register of deployed, lost, abandoned, or discarded AFADs and submit annual reports. For DFADs, vessels must provide information on their design, biodegradable materials used, dimensions, and unique identifiers, as well as the instrumented buoy unique identifier, type of buoy activity, and cause of buoy deactivation (retrieved, abandoned or lost). IOTC Scientific Committee also produce reports providing data analysis on ALDFG impacts and management.

Resolution 24/02[20] outlines a comprehensive framework for purse seine vessels using DFADs in IOTC area of competence, including an immediate prohibition on the use of fully non-biodegradable DFADs and gradual transition to fully biodegradable FADs by 2030. Under this measure, CPCs are required to phase out non-biodegradable components by January 2027 replaced with using only DFADs of categories I and II, as set out in Annex 3. Under paragraph 35, CPCs are encouraged to continue trialing biodegradable DFAD designs in a continued effort of design improvement and to share the results with IOTC Scientific Committee or any relevant subsidiary body.

Resolution 24/02 sets DFAD limits, reducing the allowable number of DFADs with an instrumented buoy that a purse seine vessel can follow from 300 to 250 by 2026, reducing further to 225 by 2028. This represents the strictest limit among RFMOs. It also mandates the creation of a FAD register to improve monitoring and control (effective 1 January 2026) and introduces ALDFG-specific measures, including:

- Prohibiting vessels from deliberately discarding DFADs or instrumented buoys;
- Mandating vessels take all reasonable precautions to prevent accidental DFAD loss;
- Requiring immediate retrieval attempts for deactivated DFADs; and
- Obligating vessels to notify authorities immediately when an active buoy becomes deactivated.

Furthermore, under paragraph 28 of IOTC-2023-SS6-PropA[E], the proposal states that CPCs must adhere the scheme to operationalize the FAO Voluntary Guidelines on the Marking of Fishing Gear (VGMFG)[21] in the deployment of AFADs. Similarly, a proposal submitted by multiple CPCs also refers to IOTC's intention to develop a scheme to operationalize the FAO VGMFG

[19] IOTC-2023-SS6-PropAE_-_On_Management_of_FADs_EU.pdf
[20] IOTC Resolution 24/02 on Management of Drifting Fish Aggregating Devices (FADs) in IOTC Area of Competence
[21] FAO Voluntary Guidelines on the Marking of Fishing Gear.

which should be taken into account by IOTC Scientific Committee when developing standards for the individual marking of DFADs (paragraph 38 of IOTC-2023-SS6-PropD_Rev3[E]).[22]

Though various conservation measures are in place across the different RFMOs and are in some instances mandated, data to support RFMO enforcement and the individual fisher's compliance to these measures is lacking. Survey responses were also able to demonstrate fisher-specific measures. Therefore, with responsibilities taken on both RFMO and on an individual level, a Mitigation score of **'Moderate'** has been assigned. Given the Geographic Distribution, the RFMO Mitigation measures in place, and associated impacts of FADs on the wider environment, the Residual risk is '**High'.**

4.3.1.2 Fishing Practices

The use of FADs in purse seine fisheries is a significant contributor toward ALDFG. The risks arise from fishing effort across large fleets with extensive FAD deployment. On average, fishers confirmed a fishing trip will last 30 days, with fishers conducting 10 – 12 trips per year. During fishing operations, purse seines are deployed for approximately 2 – 6 hours at various depths, ranging from 30 m to 200 m, with a mode of 100 m. An '**Almost Certain**' score was allocated for the Likelihood of FAD fishing gear being lost and abandoned due to high deployment numbers within large fleets, exacerbated by the context of remote fishing operations and associated environment.

Ghost fishing in FAD-associated purse seine fisheries has been substantially reduced particularly upon implementation of non-entangling FADs (Herrera and García Horcajuelo, 2018). To this end, as of the January 1, 2024, all FADs in WCPFC area must be Non-Entangling Risk (NER) FADs, as per CMM 2021-01 (superseding CMM 2018-01). Specific details on what constitutes a NER FAD is provided in this document, specifying that netting or mesh materials are prohibited in FAD designs, and materials such as ropes are to be used instead. These materials that are less likely to entangle marine life and reduce instances of wildlife entanglement, lead to fewer ecological impacts. Member countries are required to report on their compliance with NER FADs; their implementation, use, designs, materials used to ensure the non-entangling criteria are met, are part of the data reporting requirements (paragraph 24, sub-paragraph a, b; Annex I, paragraph 2(g)). CMM 2021-01 also recommends biodegradable materials, though this is not a requirement. For instance, bamboo FADs are being tested as a biodegradable option. Due to the materials nature, this gear is more likely to become waterlogged and sink in the open ocean, which reduces potential beaching and encounters with reef habitats.

To further mitigate the occurrence of lost FADs and subsequent impacts, stakeholders commented that their ALDFG mitigation measures included following the RFMO and ISSF requirements for FAD design. Moreover, a number of stakeholders implement gear marking to strengthen mitigation efforts. Six of the 11 participating stakeholders stated all their gear is marked, one responded this was often practiced, one rarely, and three responded not to have any marking system in place. Of the six that mark their gear, marking is located on the buoys.

[22] IOTC-2023-SS6-PropD_Rev3E_-_On_Management_of_DFADs_IND_et_al.pdf

Moreover, six stakeholders surveyed mentioned that their FADs include biodegradable components, with four always using biodegradable elements. Six stakeholders also noted the use of non-entangling mesh in their FAD. Measures to reduce gear loss as indicated by stakeholders, include supply ships taking back damaged gear for land-based repair or disposal, using fully non-entangling FAD designs, and avoiding overcrowded areas.

Observers follow WCPFC Regional Observer Programme Minimum Standard Data Fields, observers collect a minimum of data on FADs, including location of FADs sighted, FAD construction materials, FAD ID and deployment of FADs. WCPFC requirement for 100% observer coverage for purse seine vessels operating between 20°N and 20°S and VMS tracking provides some confidence that set types are appropriately reported, but FAD-related information may not be fully captured.

It is worth noting here that there is a general lack of management of DFADs deployed, and there is a lack of transparency and accountability in DFAD use or recovery. For example, in spite of a requirement by IOTC to submit usage information since 2015, some vessels have not still complied several years later, and there are compliance concerns around DFAD biodegradability measures[23]. This has led to an increase in reporting requirements and much stronger DFAD management in the Indian Ocean.

Implemented in 2016, the PNA FAD tracking programme provides data on FAD position, date and time (MRAG Asia Pacific, 2018). Challenges arose due to geofencing issues, i.e. the limited ability to track FADs once they leave the designated “geofenced areas”, or area within an EEZ where FAD activity is monitored. Once FADs move beyond their defined boundary into international or non-member waters, data are no longer recorded on their movement. This presents challenges in obtaining information on FAD trajectories outside of PNA waters. Information on FAD fate outside PNA states is therefore limited since fishing companies reportedly switch off FAD buoy tracking once FADs are outside PNA EEZs. This poses many concerns because of the potential impacts FADs can have on habitats such as coral reefs, when FADs become stranded. The impact of FAD beaching events has been studied in the WCPO; Escalle *et al*. (2019) estimated at least 5% of buoys in the WP used to track individual DFADs end up beached, with connected FAD potentially damaging sensitive ecosystems such as coral reefs. The 5% figure was considered an underestimate, as buoys may be deactivated before reaching coastlines. Banks and Zaharia, (2020) estimated 44,700 to 64,900 DFADs were deployed annually from 2017 to 2019 in the WCPO. Data from the PNA FAD Tracking Programme estimated that 52% of FADs were reported as lost, and only 11% were retrieved. Furthermore, 8% ended up beached, 15% were deactivated due to unknown reasons, and 14% were deactivated by the fishing companies but left adrift and unmonitored at sea. Of these events (incidents of loss, deactivation, beaching events etc.), 97.5% occurred in PNA member countries, and the remaining took place in non-PNA countries. Banks and Zaharia, (2020) also estimated the beaching of one FAD to impact 2m^2 of coral reefs, with the majority of beaching events (92%) occurring on coral reef habitats, and it is

[23] Data required by IOTC since 2015, to inform improved DFAD management, has still not been submitted by some purse seine fleets to IOTC seven years later.

assumed highly likely no corals survived impacts. To mitigate these effects, indirect measures managing FAD impact on corals include the following: closure periods, zonal restrictions for deployment areas of DFADs, use of non-entangling FADs, limits to number of FADs deployed.

The estimated high volume of FADs being abandoned at sea, combined with their potential to damage marine habitats, justifies a '**Major'** Impact rating. Moreover, the lack of full compliance and transparency further exacerbates the potential for ecological damage.

A '**Moderate'** score has been assigned to Mitigation given the significant progress to implement mitigation measures, as well as the efforts to enforce biodegradable and non-entangling FAD gear components. However, challenges arise around the enforcement of gear marking and reporting requirements, as well as compliance with these aforementioned measures, which potentially limit the effectiveness of legislation and recommendations. This nonetheless reduces the '**Very High'** Inherent score, to a '**High'** Residual risk score.

4.3.1.3 Fishing Gear Maintenance and Repair

Maintaining and repairing gear is an important part of purse seine fishing operations. Stakeholders indicated that gear repair is conducted either by the vessel or the company, with two stakeholders sending damaged gear to third parties in other countries for maintenance. One stakeholder reported discarding and replacing damaged gear, instead of repairing it. Six highlighted that repairs are carried out at sea, with damaged or repaired parts stored on the vessel for shore disposal. There are differing probabilities as to whether these parts are stored on the vessel for future net repairs, and there was an emphasis across stakeholders on never discarding damaged gear overboard. One stakeholder reported that lost gear is often successfully retrieved, one stated it is sometimes retrieved, and two stated it is rarely retrieved. When lost gear is retrieved, only one respondent stated to have insufficient space to store non-usable fishing gear. Overall, maintenance and repair present a '**Likely'** Likelihood score. If ALDFG does occur here, it is considered to have a '**Major'** Impact risk score. Combined, this resulted in an Inherent score of '**High'.**

FADs undergo regular maintenance in varying degrees across ocean regions in line with requirements for design and tracking along with the nature of each ocean region. This should ensure the required level of functionality and durability. This involves repairing replacing worn components, and ensuring FADs are properly marked and trackable. Gear maintenance must comply with regulatory requirements, such as marking FADs with unique identifiers, as mandated by WCPFC, in CMM 2017-04 and 2018-01.

Seven stakeholders demonstrated using specific gear modifications that reduce ecological impacts, amongst these trialing bioFADs, use of non-entangling gear, and following ISSF requirements, were mentioned. These factors have also included added resilience to DFAD design requiring fewer interventions for DFAD maintenance.

Given the predominance of WCPO in the supplies of FAD caught tuna to Bumble Bee the risk estimates here are scored with a weighting towards this fishery. Therefore, the likelihood and impact scores are higher than for example in the Indian Ocean where the predominantly EU based fleet comply to a more recent and higher required standard outlined in the most recent DFAD

Resolution (IOTC 24/02) that includes provisions for a FAD record, including limits on the number of active DFADs, DFAD design including biodegradable materials, reporting, marking, a prohibition on vessels from deliberately discarding DFADs or associated instrumented buoys and instruct ions that all vessels should to take “all reasonable precautions to prevent accidental loss of DFADs and instrumented buoys” including that when a vessel retrieves an instrumented buoy attached to a DFAD from the sea, that the vessel cannot leave the DFAD without an active instrumented buoy and it must be removed.

The IOTC situation can be regarded as the next wave of measures that will be gradually introduced across all ocean regions and RFMOs in the future.

Taking this into account, the maintenance and repair measures are scored ‘**Medium’** for Mitigation. With the current low-level effectiveness in preventing ALDFG from FAD fisheries, the Residual risk is calculated ‘**Medium’.**

4.3.1.4 Existence of EOL Processes

The main driver for gear loss, according to stakeholder input, is FADs drifting to locations that are not reachable by fishing vessels for retrieval and would be considered abandoned, resulting in a Likelihood score of ‘**Likely’**. Five fishers and Fong XXX Company confirmed that they have measures in place to recover lost fishing gear. In contrast, FCF, Grupomar, and Unicord were uncertain about the existence of such measures, while one fisher stated that no such measures were in place on their vessel. The responses came from stakeholders operating purse seine fisheries using FADs and it is unclear whether the responses were relating specifically to the purse seine gear element or FAD. However, stakeholders commented that the general measures to recover lost gear include using a crane to retrieve the net, checking if the buoy signal is still traceable, and retrieving and storing the gear on board until it can be offloaded at the port for proper disposal. These measures are relevant to both FAD and purse seine elements of the gear, though it is important to note here that responses received may reflect a combination of both gear components. When asked if there was sufficient space onboard to store damaged gear, Tri Marine responded, “*Typically yes. Useful to have a crane onboard to lift old FADs out of the water onto the boat*.” This indicates that there is a degree of gear (FAD) recovery occurring on their vessels.

Some stakeholders and supplier vessels participate in FAD recovery initiatives to mitigate the environmental impacts of ghost gear, but many will have no EOL procedures resulting in a ‘**Major’** impact. Examples mentioned across respondents include The Nature Conservancy (TNC’s) Palmyra project,[24] the Iniciativa Cuidando with TUNACONS, and the SPC lost FAD data collection and retrieval project, (Escalle *et al*. 2021) which encourages the retrieval of lost or abandoned gear.

At port, stakeholders revealed inconsistencies in the availability and awareness of infrastructure for handling EOL fishing gear at ports. While some ports have designated disposal and recycling facilities, others lack formal waste management systems. The home ports of vessels included Taiwan, Nauru, Manila (Philippines), and Sultan Qaboos (Oman), with operations extending to

[24] TNC Announces Expansion of the FAD WATCH project in Palmyra Atoll .

ports in Majuro (Marshall Islands), Pohnpei (FSM), Noro (Solomon Islands), Tarawa (Kiribati), Funafuti (Tuvalu), Rabaul (PNG) and Manta (Ecuador). Four fishers confirmed they would offload fishing gear that is no longer useful at Majuro, where two fishers confirmed the fishing gear would be collected in containers and one fisher confirmed they would deliver their EOL fishing gear to their agent. Beyond the collection of the gear, most fishers were uncertain of the final disposal process, with only one fisher stating that the port authorities would “put it in the ground.”

With regards to the fishing companies and seafood supplier stakeholders, Unicord confirmed the existence of designated disposal ports but did not specify them, while Tri Marine identified Noro (Solomon Islands) as a location where they are reportedly collaborating with net recycling companies to manage EOL fishing gear. Fong XXX Company listed Majuro and Pohnpei, noting that while Majuro has PRF to handle EOL, Pohnpei does not, requiring gear to be shipped to a fishing agent for disposal. In addition, many stakeholders were uncertain about the processes involved in the disposal of gear at EOL. The Impact score was therefore designated as ‘**Major’,** and combined with the Likelihood score, resulted in an Inherent score of ‘**High’.**

Stakeholders reported mixed experiences with PRFs, with some ports offering designated gear disposal facilities and waste management systems, while others lack formal structures to provide proper collection, disposal or recycling of FADs. This is seen across survey responses leading to inconsistent management of unusable FADs and less strong incentives and motives for fishers to adhere to disposal recommendations. From stakeholder responses, four stakeholders stated their vessels had access to PRFs, but only during business hours, while others were unsure, and one fisher reported access beyond these hours. One fisher explained they had to contact the fishing agent to gain access to the PRF and no training is provided on how to use the facilities. Most respondents noted that using these facilities required at least one day's advance notice, with no apparent incentives for vessels to make use of them. The limits on the amount of fishing gear or plastic that can be disposed of were uncertain, with most stakeholders unaware of any such restrictions. In terms of vessel reporting, an anonymous stakeholder with a home port in Nauru noted that ship managers will report waste brought from fishing operations to port officials, and multiple stakeholders mentioned the use of delivery receipts to document gear disposal.

To reduce ALDFG, stakeholders recommended a few EOL-related measures, including in-person skipper training, procedural guidelines for PRF use, and increased support, resources, and assistance from port authorities. However, disposal infrastructure remains inconsistent across ports, leading to uncertainty and reduced compliance with best practices. Awareness of EOL gear management is generally low, with many stakeholders unaware of available facilities or waste management protocols. Access to PRFs is often restricted, requiring advance notice with no clear incentives for vessel participation. Although mitigation measures are in place, they lack uniform enforcement, contributing to continued challenges in reducing ALDFG. As a result, Mitigation was therefore scored ‘**Moderate’,** producing a Residual score of ‘**High’.**

4.3.2 Skipjack and Yellowfin Tuna Purse Seine Fishery (Free School)

From the stakeholder surveys, it was revealed that all fishers will target free-swimming schools of tuna, along with five using FADs. However, for the purpose of this assessment, only responses from one fishing company (Grupomar) and one fisher, both exclusively targeting free-swimming schools, are be used in the analysis.

Risk factor	Likelihood	Impact	Inherent	Mitigation	Residual
Geographic Distribution	Unlikely	Major	Medium	Moderate	Medium
Fishing Practices	Unlikely	Major	Medium	Moderate	Medium
Fishing Gear Maintenance and Repair	Unlikely	Moderate	Medium	Strong	Low
Existence of EOL Processes	Unlikely	Moderate	Medium	Moderate	Medium

4.3.2.1 Geographic Distribution of Use

Findings from the survey reveal the fisher based in the Philippines operates in FAO area 71, WCPFC convention area, and reported that fishing does not take place in the high seas. The fisher conducts 10-12 trips per year, each fishing trip lasting 10-20 days. Gear is deployed for approximately two hours. The fisher mentioned they avoided areas where other fisheries or gear types are in use simultaneously and does not operate in regions with strong currents. The respondent noted that while poor weather conditions and unexpected swells can occasionally cause gear loss, such instances are rare.

In contrast, Grupomar operates in IATTC convention area in Mexico EEZ, also deploying gear in the high seas. Their vessels are active for 210 days per year, operating at a depth of 200 m. Unlike the previous fisher, Grupomar's vessels do operate in areas where other fisheries or gear types are present, suggesting a potential risk of gears interacting but as fishing gear is attached to the vessel at all times, this is unlikely. Grupomar's vessels do operate in areas with strong currents, indicating that poor weather conditions rarely result in gear loss in this area.

Due to the pelagic nature of purse seine nets, fishing gear does not encounter the seabed and therefore the likelihood of damaged or lost gear caused by snagging on seabed is low. No stakeholder specifically mentioned encountering Marine Protected Areas (MPAs) or other sensitive environmental features within their fishing areas. However, the diverse ecosystems in these tropical and subtropical regions could still be adversely affected by ALDFG and it is likely the fisheries may overlap with MPAs.

Based on the stakeholders' descriptions of their fishing operations and the pelagic nature of the target species and gear, the Likelihood of gear interacting with the seabed is considered '**Unlikely'**.

In the event that fishing gear is abandoned, lost or discarded, the impact on aquatic life and the environment could be significant**.** If a purse seine net is lost with its flotation buoys intact, the

mesh net, designed to target pelagic fish, could continue to entangle marine life, as it functions passively without mechanical operation. If purse seines are lost without their flotation devices, they are likely to settle on the seabed relatively quickly, resulting in more localized damage and limiting broader environmental impacts. As a result, the impact of derelict gear on the ecosystem is scored as major, particularly where local conditions, such as strong currents, could potentially move derelict gear, increasing their range and severity of impact on the seabed and marine life. Therefore, the Impact score has been allocated '**High'**, resulting in a '**Medium'** Inherent score.

For WCPFC, IOTC and ICCAT measures in the applicable geographic regions, please see Section 4.3.1 'Skipjack and Yellowfin Tuna Purse Seine Fishery (FAD Associated)' on 'Geographic Distribution of Use'. A number of mitigation measures are in place, though they are more focused on FAD fisheries, and challenges exist around their enforcement. Therefore, a Mitigation score of '**Moderate'** has been assigned.

At this level, specific regulations relating to Mexico that would be applicable to Grupomar vessels have not been found.

Given these considerations, the Residual risk is **'Medium'**.

4.3.2.2 Fishing Practices

Most stakeholders mentioned that main nets and float lines are never lost, while Grupomar indicated these are rarely lost. Grupomar stated that this may be because of faulty or damaged gear, or operator error, but even these occurrences take place rarely. Both stated that entire purse seine nets are never lost. This is supported by Richardson (2022) stating that while purse seines account for a large amount of fishing efforts, actual incidences of whole gear loss is rare. When purse seines are lost, it is typically only a small portion of the net (~19%) that occurs, compared to gillnets and trawl gears (43% and 41% of nets lost respectively). An anonymous stakeholder with Taiwan-flagged vessels however challenged this, and though mentioned that main nets are never lost, float lines were indicated as often lost, and entire nets were sometimes lost. As such, Likelihood has been given an **'Unlikely'** score since purse seine gear is infrequently lost**,** Impact has been given a '**Major'** risk score due to the large net size and subsequent environmental impacts, and the resulting Inherent risk of gear loss occurring within this fishery is '**Medium'**.

To mitigate the impact of ALDFG on the wider environment, Unicord PCL mentioned that they exclusively target free-swimming schools, avoid fishing in areas where gear might be snagged and avoid fishing in bad weather and areas of high vessel activity. Unicord claims that they communicate with other vessels, always mark gear, trains crew in gear management, maintains and / or replaces old and / or damaged gear, in order to minimize or prevent fishing gear loss.

Similarly, Grupomar avoids fishing in bad weather and ensures to always employ gear use limits to reduce the risk of damaged or lost gear, trains crew in gear management, maintains and/or replaces old and/or damaged gear, in order to minimize or prevent fishing gear loss. Specific preventative or mitigation measures stated by Grupomar to minimize or prevent gear loss, includes *"Good maintenance of all the fishing gear specially the cables".*

Though the purse seine nets themselves are typically not lost, gear loss is a common concern, and nets can drift across large ocean areas, harming marine life and washing up on shores, impacting benthos ecosystems. The vastness of areas covered presents challenges as there are also limited resources for monitoring and enforcement, and varying levels of commitment to regulations among flag States. While WCPFC requires 100% observer coverage for FAD associated purse seine vessels operating between 20°N and 20°S, this requirement is less strict for free school vessels. However, both types of purse seine fishing require VMS tracking that helps provide confidence that set types are appropriately reported.

Both the Fisher and Grupomar do not receive or provide education or awareness training sessions to reduce fishing gear loss, and neither has fishery observers to report lost or discarded gear. The Fisher marks gear with a unique identifier, such as an IMO number, and buoys are marked with the corresponding vessel name, allowing authorities to identify the responsible party. In contrast, Grupomar does not mark their gear with such identifiers. When it comes to lost gear, the Fisher has no specific measures in place to recover it onboard, though lost gear is sometimes successfully retrieved. Grupomar's respondent was unsure if such measures exist on their vessels, but lost gear is reported internally to the vessel owner or company. Neither respondent indicated any specific gear modifications or designs implemented to reduce the ecological impact of lost gear on marine life. For these reasons, the Mitigation risk is '**Moderate'**, and therefore the residual risk is calculated as '**Medium'**.

4.3.2.3 Fishing Gear Maintenance and Repair

Both the respondents for the fisher and Grupomar conduct gear repairs at sea, with damaged parts or repair fragments always stored onboard for later disposal. These fragments are either saved for future net repairs or disposed of when the vessel returns to port, and neither discards gear overboard. Gear replacement is provided in the home port if needed, and both respondents indicated that vessels have sufficient space to stow non-usable fishing gear. The Fisher reports lost gear to the Integrated Fisheries Information Management System (iFIMS), while Grupomar vessels report lost fishing gear internally to the vessel owner or company. Grupomar also noted that gear lasts 3-4 years before needing replacement and that gear loss is very rare, with no instances known by the respondent during their time with the company. Grupomar also mentioned that while initial repairs are done at sea, final repairs are completed at their fishing gear repair shop upon the vessel's return to port. Neither stakeholder mentioned the use of biodegradable components. However, purse seine nets themselves are expensive, and use buoys to float, meaning gear loss of this equipment is generally low, resulting in an '**Unlikely'** Likelihood risk score. Though, if ALDFG does occur here, it is considered to have a '**Moderate'** Impact risk score. Combined, this resulted in an Inherent score of '**Medium.**

Purse seine gears undergo regular maintenance to ensure functionality and durability. This involves repairing damaged nets and replacing worn components. Gear maintenance must comply with regulatory requirements, as mandated by WCPFC, in CMM 2017-04 and 2018-01. Considering maintenance and repair measures, Mitigation has been scored '**Strong'.** For these reasons, the residual risk is calculated as '**Low'.**

4.3.2.4 Existence of EOL Processes

The port used by two anonymous fishers is located in Manila, Philippines, serving as a location where gear that is no longer useful is discarded or offloaded. Although transshipment or discharge occurs out of Rabaul, gear is ultimately disposed of in Manila. This port offers facilities to bring gear for repair and reuse, as well as waste reception facilities that accept the disposal of fishing gear. Separate bins are provided for different types of fishing gear and there are no pre-processing requirements before waste materials can be accepted. However, a pre-notification document must be completed prior to disposal. There is also a fee to use the facility, and no incentive for the fisher to make use of this waste reception. One fisher suggested that a "physical training and procedure guideline" would be helpful in assisting companies to reduce ALDFG. Stakeholders did not include any additional port-specific facilities.

The port used by Grupomar is at Manzanillo, Mexico, where waste reception facilities are available for the disposal of fishing gear. Gear is collected in bins and containers, with separate bins for different types of fishing gear. There are no pre-processing requirements before waste material can be accepted. The facility is accessible and unlocked out of business hours, and no advance notice is required. The facility is free to use, and there is no limit on the amount of gear that can be disposed of.

The nature of purse seine gear operating with a more simple, more controlled and lower-risk gear warrants a low score across both Likelihood of gear loss score and consequential Impacts, in spite of gaps in formal disposal procedures and protocols. These have therefore been scored '**Unlikely'** and '**Moderate'**, respectively. This results in an Inherent score of '**Medium'.** Overall, the ports have varying degrees of reception facilities, however as a minimum, ports have accessible facilities with general bins where gear can be disposed of, and therefore Mitigation has been scored '**Moderate'.** For these reasons, the residual risk is calculated as '**Medium'.**

4.3.3 Albacore Tuna Longline Fishery

Survey responses from stakeholders involved in albacore supply chains included one fisher operating a China-flagged vessels from Cape Town, two fishing companies (Fue Shin Fishery Ltd based in Donggang, Taiwan, and FFIA based in Fiji), and three seafood supply companies (Unicord, FCF, and Tropical Canning (Thailand) Public Company Limited, based in Thailand).

Risk factor	Likelihood	Impact	Inherent	Mitigation	Residual
Geographic distribution	Unlikely	Minor	Low	Weak	Low
Fishing practices	Almost certain	Minor	Medium	Weak	Medium
Fishing Gear Maintenance and Repair	Unlikely	Moderate	Medium	Strong	Medium
Existence of EOL Processes	Unlikely	Moderate	Medium	Moderate	Medium

4.3.3.1 Geographic Distribution of Use

The stakeholder survey revealed that fishing activity primarily takes place offshore under the jurisdiction of four tuna RFMOs: WCPFC, ICCAT, IOTC and IATTC. FFIA confirmed their vessels will also fish within the Fijian EEZ within FAO area 71. On average, vessels within the Fue Shin Fishery Ltd will operate at depths of 100 m while a depth range of 150 – 300 m was reported by the FFIA. Where effort in these fisheries is largely concentrated in waters off the continental shelf, the likelihood of pelagic longline fishing gears interacting with the seabed is assumed to be low and therefore, the Likelihood score is deemed to be '**Unlikely'**.

Local conditions specific to the site of fishing are not expected to increase the likelihood of ALDFG production, with only one respondent citing strong currents and tides, no respondents encountering seabed contact, or a high density of fishing effort from different gears in the area. Although Fue Shin Fishery Ltd did state that they fish in areas where other fishing gears are deployed, potentially increasing the risk of ALDFG via gear interference. However, the stakeholder confirmed that they always communicate with other vessels and deliberately avoided fishing in overcrowded areas. In addition to these measures, the fisher and FFIA confirmed that they always avoid areas with high vessel traffic, such as shipping lanes, mitigating the risk of gear damage or loss due to vessels accidentally towing it away. Consequently, the geographic distribution of albacore longline supply fisheries would have a '**Minor'** impact on both the likelihood of gear becoming ALDFG and on its impact on marine ecosystems, wildlife and sensitive habitats. As a result, the Inherent score was determined to be **'Low'.**

Measures to mitigate ALDFG are implemented both at the fishery-specific level and through national fisheries regimes and RFMO CMMs. In 2017, WCPFC adopted CMM 2017-04[25] which prohibits vessels from discharging any plastics, except for fishing gear; encourages vessels to retrieve and retain ALDFG, recording position, type, and size of ALDFG if it cannot be retrieved; and encourages crew training on the impacts of marine pollution caused by fishing vessels. WCPFC also requires that all fishing gear utilized in its convention area is clearly marked prior to deployment (Andreassen, 2024).

Despite Provision 2 of CCM 2017-04 prohibiting vessels from discharging plastics with the exclusion of fishing gears, Provision 3 encourages contracting parties to prohibit vessels from discharging garbage into the sea. Footnote 1 of the CMM further defines garbage to include fishing gear that is released into the water without the intention of later retrieval, meaning that deliberate discharging of ALDFG would fall under this definition. As a result, WCPFC encourages or enforces its members to prohibit discharging of ALDFG, establish suitable port reception facilities for its disposal, enforce marking of fishing gears, and encourage retrieval and reporting of ALDFG (Andreassen, 2024). However, where measures are only "encouraged" rather than "required," they remain voluntary and lack enforceability, significantly limiting their effectiveness in preventing ALDFG from being discarded at sea.

[25] WCPFC, CMM 2017–04 - Conservation and Management Measure on Marine Pollution, 2017.

The most relevant current resolution to ALDFG reduction in albacore longline fisheries is Resolution 19/04[26]. This requires all Contracting Parties and Non-Contracting Parties to clearly mark all fishing gears with flags or radar reflector buoys for the daytime, and light buoys for nighttime to help indicate their position. Resolution 19/04 also requires that marker buoys or similar objects floating on the surface, intended to demarcate fishing gears, be clearly marked with the letters and/or numbers of the vessel to which they belong. Despite this, no resolutions are set out prohibiting the dumping of damaged fishing gear, and Resolution 15/02[27] on mandatory statistical reporting requirements does not stipulate any gear loss reporting requirements for longline, or any other fisheries. To date, mandatory marking of gear remains the only measure enforced on longline vessels in the IOTC convention area to reduce the impacts ALDFG (Andreassen, 2024).

ICCAT currently enforces measures on intentional discharging of fishing gear at sea, marking of fishing gear, and retrieval and reporting of ALDFG where it is produced. These are all outlined in Recommendation 19-11[28], a legally binding set of measures which came into effect in 2019 and represents one of the most comprehensive RFMO obligations regarding ALDFG. This obliges Contracting Parties to “ensure that its fishing vessels authorized to fish species managed by ICCAT in the Convention area are prohibited from abandoning and discarding fishing gear except for safety reasons,” thereby establishing a clear prohibition on the discarding of fishing gear in line with MARPOL 73/78[29] Annex V. In the event of gear loss, vessel operators are required to notify their flag Contracting Party (CPC) within 24 hours if fishing gear is lost and cannot be retrieved. Similarly, any retrieved gear must also be reported. The flag CPC is then responsible for notifying the ICCAT Secretariat and including this data in its annual report.

Recommendation 19-11 sets a critical precedent for the mandatory reporting and management of ALDFG. In October 2024, Canada proposed an amendment to build on the reporting requirements outlined in Recommendation 19-11 by introducing observer requirements for ALDFG.[41] The proposal mandates observers to record instances of ALDFG and report them to the flag CPC and ICCAT’s Executive Secretary within 24 hours of the vessel’s return to port. If adopted, this measure would further solidify ICCAT’s leadership in ALDFG monitoring and reporting, reinforcing its role in advancing global best practices. Recommendation 19-11 defines fishing gear as “understood to mean fishing gear that poses a significant risk of ghost fishing when abandoned, lost, or discarded in ICCAT Convention area”. However, the Recommendation additionally states that “the provisions of this Recommendation do not apply to longline gear”. As such, longline fishing gear may be legally discarded into the seas in ICCAT Convention area.

---

[26] IOTC, Resolution 19/04: Concerning IOTC Record of Vessels Authorised to Operate in IOTC Area of Competence, 2019

[27] IOTC, Resolution 15/02: Mandatory Statistical Reporting for IOTC Contracting Partis and Cooperating Non-Contracting Parties (CPCs), 2015

[28] ICCAT, Recommendation 19–11: Recommendation by ICCAT on Abandoned, Lost or Otherwise Discarded Fishing Gear, 2019.

[29] See the International Convention for the Prevention of Pollution from Ships, 1973, 1340 UNTS 184, as modified by MARPOL 73/78 Annex V, Regulation 3.2.

IATTC promotes best practices around gear management and recovery, for example through programs such as the “Common Oceans Tuna Project II”[30], which aims to reduce the environmental impacts of fishing activities, address IUU fishing, and improve biodiversity contributions. However, as of December 2024, IATTC has not adopted specific measures to manage or mitigate the effects of ALDFG through monitoring or reporting requirements, and moreover it also does not have pollution prevention measures in place, nor measures prohibiting the disposal of damaged gear. However, in September 2024, Canada proposed a new resolution on managing marine pollution in the Eastern Pacific Ocean, drawing on existing measures from WCPFC and ICCAT.[42] This proposal aims to ensure effective management of fishing gear and plastics onboard vessels to reduce and prevent marine pollution, including a prohibition on the abandonment and discard of fishing gear and plastics; requirements for appropriate retention, storage, and disposal of gear and marine pollutants; capacity building initiatives; and encourages retrieval programs. It also includes detailed reporting requirements for lost gear, urging vessels to notify relevant authorities within 48 hours of gear loss or retrieval. The proposal advocates for the development of a standardized reporting template for adoption by the Commission in 2026.

It is crucial to note the low enforceability of such measures, particularly due to the low observer coverage of worldwide tuna longline fleets (Richardson *et al.,*2022). Additionally, the mitigation measures described have a limited scope and show regulatory gaps. For example, key issues include exemptions allowing the disposal of gear at sea (WCPFC and ICCAT) and non-mandatory gear loss reporting (WCPFC and IOTC) and crew training is not mandated. Most RFMO regulations focus on FAD fisheries, leaving longline gear with inadequate ALDFG mitigation measures, which collectively result in a high risk of gear loss, therefore Mitigation of the fisheries in these geographic areas has been scored **‘Weak’.**

Among tuna RFMOs, ICCAT's Resolution 19-11 remains the benchmark for ALDFG reporting. While WCPFC has taken steps with CMM 2017-04, its voluntary nature limits its utility. Notably, Canada's proposal to IATTC aims to set a new standard, surpassing ICCAT's requirements by requesting additional data collection through observer reporting and offering a longer notification period (48 hours vs. 24 hours). These efforts provide a foundation for advocating similar measures across all RFMOs.

Bumble Bee could collaborate with organizations such as the ISSF to advance ALDFG monitoring and reporting across RFMOs. Advocacy should focus on introducing explicit ALDFG-related requirements in tuna fisheries and aligning these with broader conservation priorities. Given the regional importance of tuna landings from the Western Pacific and Indian Ocean, Bumble Bee should prioritize efforts on RFMOs such as WCPFC and IOTC to adopt or reinforce comprehensive monitoring and reporting standards. For instance, advocate for mandatory reporting under WCPFC’s CMM 2017-04 and encourage the adoption of robust ALDFG protocols in IOTC and IATTC regions.

[30] https://www.fao.org/in-action/commonoceans/en/

Given the combination of low impacts of local conditions on the production of ALDFG, relatively low gear interference levels expected in the areas fished by survey respondents, and the weak ALDFG-related enforcement measures for longline fisheries, the residual risk of longline-produced ALDFG occurring in this region is '**Low'.**

4.3.3.2 Fishing Practices

No survey respondents indicated the number of vessels fishing in their fleet; however, tuna pelagic longline fisheries are associated with high levels of fishing effort on a very large industrial scale. Given the geographic coverage stated in survey responses, this is likely to be the case for pelagic longline fisheries supplying Bumble Bee. Vessels operating in these fisheries vary in size but are typically large, ocean-going vessels. Stakeholders relevant to albacore longline fisheries gave no information on the number of longlines or hooks deployed per vessel or fishing trip, however the two fishing companies stated that their vessels were in continued operation at sea for long periods (300 and 240 days per year). For the fisher, one fishing trip will take 8 months and they will only conduct one deployment each year. These long continuous fishing trips would be facilitated by bunkering with tankers and supply vessels for fuel, vessel supplies, and crew change, as well as offloading of catch onto Reefers for catch transshipment. The very large scale of pelagic longline fisheries, paired with long periods of almost continuous fishing effort, make them a potential high-risk source of ALDFG.

Gear loss in pelagic longline fisheries occurs through several means. The most common of these gear loss causes is "bite-off" events. Here, a hooked fish or bycatch species (e.g. shark) bites through the monofilament snood connecting the hook to the mainline (ACAP, 2021). As the snood is ripped it may release any sliding weights or hookpods threaded onto it, releasing them into the water column. The baited hook and the attached leader would most likely remain in the fish or shark's mouth, resulting in little to no ALDFG production. Another potential cause of gear loss is interference by other fishing gears and/or other vessels. The coexistence of both longlines and general vessel traffic along with other types of fishing operations have the potential to cause gear loss. Vessels may accidentally sail over longlines, causing the propeller and hull of the vessel to tangle or tear the mainline such that baited hooks are released into the water column. Severe weather events may also have the same effect, either tearing the mainline or causing buoys to sink, making some or all of the mainline irretrievable. Typically, pelagic longline gear is not lost through the mainline being unlocatable as the buoys at either end of the mainline contain GPS beacons. Should these malfunction the fishing vessel may struggle to relocate the mainline, causing the gear to be left drifting on the water's surface. Despite this, the high cost of longlines, paired with the incentive of retrieving gear to harvest the fish they may have caught, means vessels will make every attempt to retrieve lost gears (Sieben *et al.,* 2023).

Gear loss rates were only reported by Fue Shin Fishery Ltd based in Donggang, Taiwan. The respondent noted that roughly 300 hooks were lost per fishing trip, with trips lasting roughly four to six months. No other gear loss rates were quoted, however other stakeholders responded that snoods and hooks were most commonly lost gear components, with marker buoys rarely being lost. This is supported by the literature, where longline gear loss rates are thought to be among the highest of any fishing gear excluding FADs. Richardson *et al.* (2022) carried out a study, conducting interviews with fishers around the world, to estimate fishing gear loss into the ocean

worldwide. They estimated that 3.33% (±0.59%) of all longline mainlines were lost each year, with 3.58% (±0.78%) of all longline branch lines and 2.86% (±0.55%) of all longline hooks lost around the world per year.

Stakeholder responses reported several mechanisms through which longline gear loss occurs. A respondent from the albacore longline fishery stated that the main reason for gear loss was that gear was "*not tied properly*", likely referring to the knots connecting swivels on the mainline to branch lines (snoods). The fisher also cited other vessel activity as a cause of gear loss. The fisher reported that mainline and whole sets were never lost, this is consistent with other responses. In contrast, FCF reported sharks to be the main cause of gear loss in their fishery, presumably via bite-off events. Stakeholders also responded that damaged or faulty fishing gear often caused gear loss, with operator error, loss of marker buoys, and poor weather were the least common causes. As a result, the loss of gear is '**Almost Certain'** within this fishery.

Once lost, longline gear is thought to present a relatively short window for active ghost fishing while bait, or caught fish, remain on hooks. These are likely to fall off or be stripped off, leaving the bare hooks and the line behind. Once at this stage the longline poses a low risk of catching fish or other marine fauna (Macfadyen *et al.,* 2009) but may still sink and snag on habitats. Longline ALDFG therefore tends to have the greatest impact directly after the gear loss event, with potential for ghost fishing expected to decrease with time after the gear loss event. Considering the small size of the gear components that are lost posing minimal risk to marine life, and their limited capacity for sustained ghost fishing, longline gear loss is considered to have a **'Minor'** Impact. The Inherent score was subsequently determined to be **'Medium'**.

Mitigation measures reported by stakeholders included the marking of gear (by some operations), avoiding crowded waters, reducing soak times, hauling gear before severe weather, and maintaining and replacing damaged or faulty gear. Four of the five stakeholders stated that they conducted gear management training for crews, with FCF stating their own gear management form for fishers to record the usage and loss of gear and using their FIP to improve outreach to their skippers working in the fishery. FCF also mentioned the use of the ISSF Skipper Guidelines for training. Where gear is lost, stakeholders reported varying rates of retrieval. Unicord and FFIA responded that fishing gear is sometimes successfully recovered, while Fue Shin Fishery Ltd stated that successful gear retrieval is rare. Stakeholders explicitly stated that gear loss due to longline movement or a lost marker buoy is very rare.

No stakeholder responses referred to formal reporting of gear loss, except for skippers keeping a record of it in logbooks for requesting replacement gear to their fishing company. Furthermore, while observers are required to report on whether a vessel has abandoned fishing gear overboard in some RFMO observer programmes (Gilman, 2015), observer coverage on pelagic longline fisheries is generally low (Richardson *et al.,* 2017).

Mitigation measures in place to reduce the likelihood of gear loss from the longline fisheries supplying Bumble Bee mostly include avoidance of crowded waters, reduced soak times and hauling gear before severe weather. However, once the gear is lost there are no measures that can be taken to reduce its impact on the marine environment, aside from retrieval which does not seem to be commonplace amongst stakeholders. As a result, the mitigation measures for fishing

practices in the skipjack longline fishery are considered '**Moderate'** and present a '**Medium'** Residual risk for ALDFG.

4.3.3.3 Fishing Gear Maintenance and Repair

Gear maintenance appears to be routinely completed throughout albacore longline supply fisheries. All but one stakeholder, that did not provide a response, stated that damaged gear is repaired, and that gear maintenance is common onboard vessels. No further details were given about what maintenance protocols were undertaken, but responses cited crew training in proper gear management and maintenance, likely addressing usage and storage requirements. Some stakeholders responded that damaged gear was repaired at sea by vessels, with others stating that it is typically returned to shore and exchanged for undamaged gear. Other sources of replacement gear were transshipments, replacement in home port, and supply vessels (likely during crew change and restocking of vessel supplies). Likelihood was therefore scored **'Unlikely'**.

In most cases, stakeholder responses stated that vessels store damaged longline gear onboard until they can be disposed of once the vessel is in port. The FCF respondent stated, "*they usually put unwanted gear on the upper deck because it doesn't interfere with fishing activities and there's more space*". Similarly, the FFIA response detailed how longline fishing gear does not take up much space when in storage, stating that "*damaged ones [longlines] are often stacked in available storage rooms*". However, Fue Shin Fishery Ltd did respond that gear is often discarded overboard, presenting direct evidence of used gears becoming ALDFG. In addition, a respondent from MIMRA raised concerns, stating, *"Sometimes the crew could just throw away their tangled-up line into the water causing risk to mammals."* Although this does not confirm the behavior, it highlights the need to address fisher practices.

Given this gear is expected to be disposed of without hooks being baited, the likelihood of ghost fishing seems low, although its potential impacts on habitats and on microplastics pollution are expected to be the same as any other longline ALDFG. While vessels have the capacity to repair and store damaged gear, these practices do not reduce the subsequent environmental impact of gear once lost. Gear, even without hooks, can result in damage or loss of further gear where active fishing gear can snag on abandoned lines, compounding the risk of environmental harm and eventual degradation into microplastics. This justifies a **'Moderate'** Impact score, and subsequent **'Medium'** Inherent score. Based on stakeholder responses, longline fishing gear life depends on catches and fishing conditions, however respondents replaced their gear as often as every six months. The FFIA response gave a detailed breakdown of expected gear life of each longline component (Table 20).

With the exception of the reports of discarding of gear overboard by vessels within the Fue Shin Fishery Ltd fleet, respondents take precautions to store damaged or unwanted gear before replacing it via their home port, transshipments, or supply vessels. Therefore, Mitigation has been scored **'Strong',** and the overall Residual risk of ALDFG is '**Low'.**

Table 20. Expected lifespan of each longline component.

Longline Component	Expected Gear Lifetime
Mainline	1 year
Branch line	3 months
Hooks	2 years (where not lost)
Buoys	5 years
Snaps	1 year
Radio Beacon	1 year
Ropes	5 years
Swivels	1 year

Source: FFIA survey response)

4.3.3.4 Existence of EOL Processes

The stakeholder responses for the albacore longline supply fleet have a relatively small number of home ports. These include Cape Town for the fisher, Majuro (Marshall Islands), Tarawa (Kiribati), Funafiti (Tuvalu), Rabaul (PNG) for Unicord; Donggang (Taiwan) and Pago Pago (American Samoa) for Fue Shin Fishery Ltd; Kaohsiung (Taiwan), Suva and Levuka (Fiji), and Mauritius for FCF; and Suva and Levuka for FFIA. The fisher stated that port reception facilities require a week's notice, custom release forms, and a fee required to use the facilities. Unicord's response on the port reception facilities across the quoted WCPFC countries simply states that each port has them, with no further comment. The respondent for Fue Shin Fishery Ltd stated that their home ports accept EOL fishing gear through general waste disposal but lack separate bins for fishing gear. These reception facilities do not have any reporting requirements associated with them. FCF's response pertained to Taiwanese ports, "*The TFA (Taiwan Fisheries Agency), in collaboration with local authorities, has set up temporary marine waste storage areas at primary and secondary fishing ports. By the end of 2021, a total of 84 temporary storage areas were established. These areas handle waste within the ports, receive assistance from environmental fleets to collect marine waste and abandoned fishing gear, and manage the sorting, packaging, recycling, and disposal of these materials*". Based on the wording from the survey response, the term "*temporary*" can be inferred as their designation as non-permanent structures. They also reported a fee for use and some form of incentive around ALDFG, however no further details were provided. Finally, the FFIA responded that there is currently no dedicated bin for the disposal of damaged fishing gear. Instead, all waste from vessels is dumped into general waste disposal bins.

The absence of port reception facilities in one of the main longline ports Pohnpei., FSM, directly leads to the Recommendation for the establishment of such facilities by Bumble Bee in Pohnpei (see Recommendation 3).

While port reception facilities may not be specific to gear type or provide recycling, the availability of waste bins is adequate to warrant an **'Unlikely'** Likelihood score, with potential ALDFG Impacts at this stage considered to be **'Moderate',** resulting in a **'Medium'** Inherent risk score.

Regarding mitigation measures, though three of the four RFMOs utilized (WCPFC, IOTC, and ICCAT) have resolutions pertaining to waste disposal by longline fisheries, there is a lack of clear

guidelines and infrastructure for the proper disposal or recycling of gear. At this level, there are insufficient mitigation measures and a lack of standardized EOL procedures. However, stakeholders have demonstrated fishery-specific measures and provided adequate descriptions of available port facilities. Therefore, Mitigation has been scored **'Moderate'.**

While in most cases, Bumble Bee's skipjack longline fisheries generally have access to port reception facilities, they are not tailored to receive ALDFG or damaged fishing gear, with fishing gear being disposed of in general waste bins. Regardless, the residual risk of ALDFG with respect to gear end of life processes, is **'Medium'**.

4.3.4 Yellowfin Tuna Longline Fishery

The survey responses for the yellowfin longline fishery are the same as can be found in the albacore longline risk assessment, with the addition of one survey response from a fisher based in Sultan Qaboos Port in Oman solely targeting yellowfin. As a result, this risk assessment largely mirrors the risk assessment for albacore.

Risk factor	Likelihood	Impact	Inherent	Mitigation	Residual
Geographic distribution	Unlikely	Minor	Low	Weak	Low
Fishing practices	Almost certain	Minor	Medium	Moderate	Medium
Fishing Gear Maintenance and Repair	Unlikely	Moderate	Medium	Strong	Low
Existence of EOL Processes	Unlikely	Moderate	Medium	Moderate	Medium

4.3.4.1 Geographic Distribution of Use

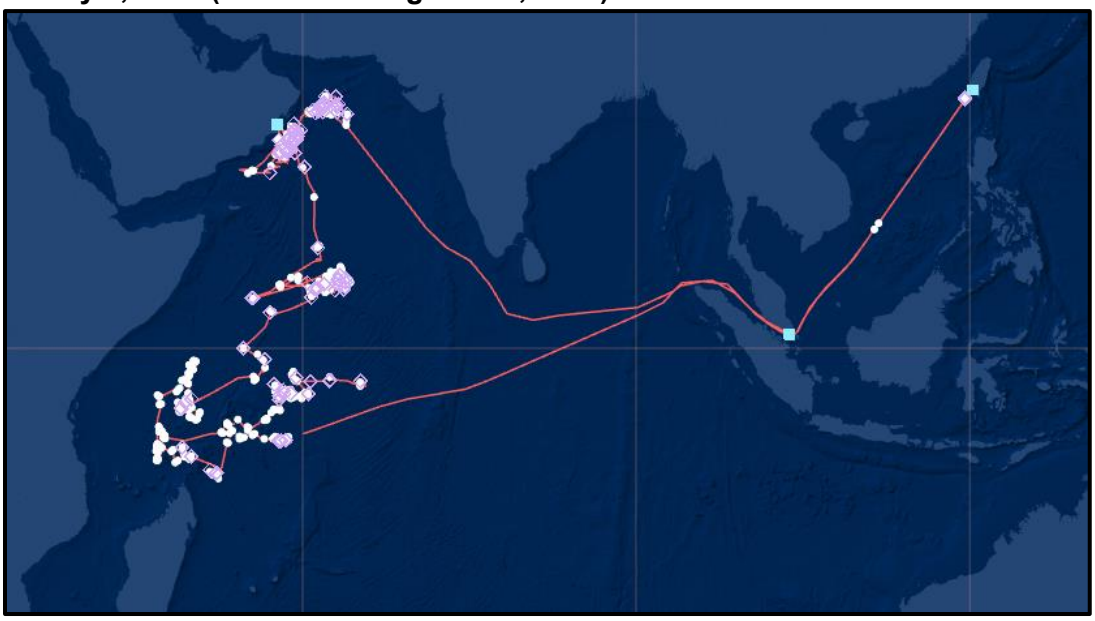
In addition to the description given under Section 4.3.3 Albacore Tuna Longline Fishery, the fisher based in Sultan Qaboos Port in Oman also confirmed operating in the EEZs of the Seychelles and Oman and the wider IOTC area.

To better understand the typical movements of a vessel in these fisheries, the vessel tracking data of the fisher respondent's vessel, Arwa, was assessed using Global Fishing Watch's Vessel Viewer tool. As shown in Figure 14, the fishing vessel Arwa spent most the year either off the Gulf of Oman, in the northeastern waters of IOTC Commission Area, or in port in either Singapore or Kaohsiung, Taiwan. Arwa spent the majority of 2023 at sea, docking briefly at the end of April and again in mid-July, before docking in Kaohsiung for August and September, before steaming out to fishing grounds off the northwest of Madagascar where she likely resumed fishing in mid-November. This vessel behavior is typical of an ocean-going longline vessel, providing a picture of how other vessels belonging to fishing company stakeholders might behave.

As mentioned in Section 4.3.3 Albacore Tuna Longline Fishery risk assessment rationale, the Likelihood of pelagic longline gear interacting with the seabed is considered low and has been therefore scored **'Unlikely'.** The geographic distribution is expected to play a **'Minor'** role in the Impact of ALDFG gear and subsequent environmental effects, resulting in a **'Low'** Inherent score.

As described in , mitigation measures are weak, with regulatory gaps and procedures that are not standardized across RFMOs, leading to a high risk of gear loss. As such, Mitigation has been scored **'Weak'**, and the Residual score has been determined to be **'Low'.**

Figure 14. Vessel tracks of yellowfin longline fishing vessel Arwa between January 1, 2023 and January 1, 2024 (Global Fishing Watch, 2024).



4.3.4.2 Fishing Practices

In addition to the description given under Section 4.3.3 Albacore Tuna Longline Fishery, Arwa's fishing trips are reported to last three to five months. When the vessel is actively fishing, gear is deployed in the water for six hours at a time.

The respondent confirmed that "*vandalism*" was the main cause of gear loss, as well as faulty or damaged gear. The fisher stated that, "*when operating in Omani territorial waters between April and June each year, whenever you get too close to other small boats, you will be clipped by them for floats, outriggers, sticks etc. fishing gears are cut by small boats if they get too close to other boats*".

To minimize the risk of gear loss, the fisher confirmed they would reduce soak times, train crew in gear management, repair and replace old or damaged gear and retrieve gear before storm events. Fishing gear is rarely marked and despite the fisher confirming vandalism to be the main cause of gear loss, the vessel will only sometimes avoid fishing in overcrowded areas or communicate with other vessels. In the event of gear loss, the fisher confirmed it is never recovered.

As a result, the fishing practices in the yellowfin longline fishery are considered to present a '**Medium'** Residual risk of ALDFG, following the same Likelihood, Impact, Inherent, and Mitigation scores described in the Albacore Tuna Longline Fishery assessment.

4.3.4.3 Fishing Gear Maintenance and Repair

Like the description given under Section 4.3.3 Albacore Tuna Longline Fishery, Arwa operators stated gear repair occurs on the vessel. Based on this, the residual risk of ALDFG is '**Low',** based on the same rationales for Likelihood, Impact, Inherent, and Mitigation as described in the Albacore Tuna Longline Fishery assessment **.**

4.3.4.4 Existence of EOL Processes

In addition to the description given under Section 4.3.3 Albacore Tuna Longline Fishery, Arwa operators state that Sultan Qaboos Port does have port reception facilities that accept the disposal of fishing gear, and that there is a fee associated with their use. Based on stakeholder responses, the overall risk of ALDFG from yellowfin longline fisheries, relating to EOL processes, is '**Medium',** following the same rationales for Likelihood, Impact, Inherent, and Mitigation as described in the Albacore Tuna Longline Fishery.

4.3.5 Tuna Pole and Line Fishery

Pole and line fisheries primarily target skipjack, yellowfin, and albacore tuna across the Atlantic, Pacific, and Indian Oceans. Within Bumble Bee's supply chain, the main stock areas are the Indian Ocean for albacore and skipjack; the Western Pacific for skipjack and yellowfin; and the North and South Pacific and the South Atlantic for albacore. It is also worth noting that some tuna is sourced from MCS certified fisheries, primarily the MSC Maldives pole and line skipjack tuna.

Despite the limited spatial overlap between these tropical tunas and albacore, stakeholder engagement has provided little distinction between the fisheries. Currently, Pahala Bahari Nusantara (PBN) and Unicord Public Company Limited (Unicord) are the only suppliers providing skipjack, yellowfin, and albacore tuna caught using pole and line and handline methods. As this risk assessment focuses on the fishing gear used across all pole and line tuna fisheries, and the best practices employed to mitigate gear loss within the fisheries sourcing to PBN and Unicord, all species will be evaluated under a single assessment. This approach allows for a comprehensive analysis of the sustainability and management practices within these fisheries, ensuring that the risk of gear loss is minimized, and best practices are uniformly applied.

Risk factor	Likelihood	Impact	Inherent	Mitigation	Residual
Geographic distribution	Moderate	Minor	Medium	Moderate	Medium
Fishing practices	Moderate	Moderate	Medium	Moderate	Medium
Fishing Gear Maintenance and Repair	Moderate	Minor	Medium	Moderate	Medium
Existence of EOL Processes	Moderate	Moderate	Medium	Moderate	Medium

4.3.5.1 Geographic Distribution of Use

From the stakeholder responses, only Unicord provided specific geographic information about where their fisheries primarily operate. These fisheries are under the jurisdiction of four RFMOs and within an unspecified EEZ. The RFMOs include IOTC, IATTC, ICCAT, and WCPFC. Unicord also listed the primary source ports for their fish, identifying Majuro (Marshall Islands), Tarawa (Kiribati), Funafuti (Tuvalu), and Rabaul (PNG). All of these ports are located within the Pacific Ocean and fall under the jurisdiction of WCPFC.

While stakeholder responses did not include information on average depth or fleet activity locations, pole and line tuna fisheries have been extensively studied worldwide (Grande *et al.,* 2014; Lopez and Scott, 2014). Pole and line fisheries typically operate at surface levels, high in the water column, where active gear interactions with the seabed and habitat structures are rare. However, the prevalent use of both drifting and anchored FADs to increase fishing efficiency poses several risks. FADs disrupt ecosystems by altering the natural behavior and distribution of marine species and have the potential to contribute to ghost fishing when they are constructed with entangling nets. Additionally, unrecovered non-biodegradable FADs contribute to marine macro and microplastic pollution. With regards to ALDFG, conditions such as strong currents and tides in the Atlantic, Indian, and Pacific Oceans are likely to increase the occurrence of gear loss and even ghost fishing and can damage habitats when they ground on coral reefs or atolls. Derelict FADs can also blemish coastal habitats and have disproportionate impacts on communities that are not able to manage the additional waste.

Although it is typically anchored FADs that are used to catch tuna in pole and line fisheries, drifting FADs are also used, with FAD type usage rates varying by fishery area and scale (Lopez and Scott, 2014). The possibility of larger AFADs becoming detached, lost or unrecovered depends on environmental conditions or other context-specific circumstances.

Given the broad geographic distribution of pole and line fisheries targeting skipjack, yellowfin, and albacore, vessels are unlikely to operate in areas tightly overlapping with other fisheries and this lack of overlap decreases the potential for gear conflicts.

The common practice of using AFADs with pole and line fisheries contributes to a '**Moderate'** Likelihood for loss of gear, and thus the occurrence of ALDFG. The Impact of ALDFG from pole and line fisheries targeting skipjack, yellowfin, and albacore on marine ecosystems, wildlife, and sensitive habitats is scored '**Minor'** with the potential use of either AFADs or DFADs in these fisheries which increases the level risk. Therefore, a '**Medium'** inherent risk for ALDFG was assigned.

While all deliberate, non-emergency, disposal of synthetic plastics at sea contravenes Annex V of MARPOL conventions[31], fishing gear is excluded provided it was released with the intent to retrieve it. Each RFMO implements unique Recommendations, Resolutions and CMMs to address ALDFG from pole and line fisheries to varying extents. While IOTC, IATTC, ICCAT, and WCPFC

[31] International Convention for the Prevention of Pollution from Ships (MARPOL) (imo.org)

implement limited policies which directly address ALDFG resulting from tuna pole and line fisheries, as these issues are more relevant to gear-intensive methods like purse seining, the RFMOs have implemented broader measures that indirectly help reduce the risk of ALDFG in pole and line fisheries. For example, IOTC has implemented Port State Measures since March 2011[32] which provides mechanisms for regulating and monitoring vessel activities through port state controls. These measures would apply to pole and line fishing vessels targeting skipjack, yellowfin and albacore, and aid compliance with gear management regulation. Within their jurisdiction, IATTC promotes best practices which encompass gear management and the recovery of lost gear under programs such as the "Common Oceans Tuna Project II"[33], which aims to "lower environmental impacts of fishing operations by advocating the adoption of ocean-friendly fishing devices". Though these IATTC practices are in reference to DFAD management, many of these principles will also be applicable to AFADs.

Based on the ports provided by Unicord, fisheries for this supplier would likely operate under the jurisdiction of WCPFC, where CMM 2023-01 is currently enforced[34]. This measure states that "the use of mesh net shall be prohibited for any part of a FAD. If the raft is covered, only non-entangling material and designs shall be used and that the subsurface structure shall only be made using non-entangling materials." In line with global initiatives to reduce synthetic debris, vessels are encouraged to "use, or transition towards using, non-plastic and biodegradable materials in the construction of FADs." Additionally, by no later than 2026, WCPFC will make a decision regarding the requirement for all FADs to be biodegradable. The Scientific Committee is currently reviewing research results on the use of biodegradable material on FADs and is expected to provide specific recommendations to the Commission no later than 2026. These recommendations are anticipated to provide a timeline for the stepwise introduction of biodegradable FADs, potential gaps or needs and any other relevant information. In the latest correspondence from the FAD Management Options Intersessional Working Group (FADMO-IWG) Chair (WCPFC Circular 2024-09),[35] the Scientific Committee noted that trials for biodegradable FADs are still ongoing, and for some Commission members, starting the transition to biodegradable FADs may not be viable in 2025. In addition, the Scientific Committee has already taken note of IATTC's biodegradable FAD implementation program, which includes a phased timeline for the mandatory use of FADs of biodegradability Category I (made of fully biodegradable materials) or Category II FAD is made of fully biodegradable materials except for plastic-based flotation components (e.g. plastic buoys, foam, purse-seine corks) by 2029, which could be reviewed for consideration in the WCPO. While these management measures are expected to mitigate the environmental impact of FAD-related ALDFG events, the potential for negative effects on the marine environment currently persists until a decision has been made.

[32] Procedures for the implementation of the Indian Ocean Tuna Commission Port State Measures (fao.org)

[33] https://www.fao.org/in-action/commonoceans/en/

[34] CMM 2023-01 - Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the Western and Central Pacific Ocean

[35] WCPFC Circular 2024-09 Letter from the FADMO-IWG Chair

The guidelines and regulations which govern gear marking requirements again vary by fishery and RFMO. However, general, area wide governance is often in place rather than those specifically focused on tuna pole and line fisheries, for example under IOTC Resolution 19/04[36], "each gear used by [...] fishing vessels authorized to fish in IOTC area of competence is marked appropriately" and that "fish aggregating devices shall be clearly marked at all time with the letter(s) and / or number(s) of the vessel to which they belong." All the RFMOs highlighted in stakeholder responses conform to common themes in the FAO VGMFG, revolving around established and internationally recognized gear marking requirements to ensure traceability and incentivize gear retention aiming to reduce the likelihood of ALDFG events (He and Suuronen, 2018).

Overall, the mitigation measures in place were scored as '**Moderate'** as they reduce the likelihood and magnitude of possible ALDFG events, resulting in a '**Medium'** residual risk score.

4.3.5.2 Fishing Practices

Globally, the number of fisheries employing pole and line techniques to target tuna has been in decline, historically replaced in favor of purse seine methods. Consequently, pole and line fisheries now contribute less than 10% to the global tuna catch (Gillet, 2016). However, international efforts to promote environmentally sustainable seafood sources are beginning to reverse this trend, with pole and line fisheries garnering support due to their lower bycatch and discard rates (Pham *et al.,* 2021) and the increasing prevalence of certifications, such as in the Maldives pole and line skipjack tuna.[37]

A recent study using observer data from pole and line fisheries in the Azores and the Maldives estimated relatively low rates of ALDFG: approximately 1.4% of monofilament line per lost angler, with the average length of lost line measuring 0.1 m (Pham *et al.,* 2021). These results suggested that globally pole and line fisheries contribute 96 kg (± 42.6 kg) of ALDFG per year, with the study concluding that pole and line fishery contribution towards ALDFG is relatively minor when compared to other tuna fishing methods. This contrasts sharply with an earlier study by Richardson *et al*. (2019) which estimated pole and line fisheries experience gear loss rates of 65%. However, this study is based on historic data from the 1990s and is now considered outdated due to improvements in crew training, operational practices and advances in gear technology, all of which have likely contributed to reduced gear loss in recent decades. Nevertheless, when both active (poles and lines) and passive (FAD) gear classes are taken into consideration, the risk of gear becoming ALDFG is considered '**Moderate'**.

With that said, no stakeholders who targeted skipjack, yellowfin and albacore using pole and line methods detailed the use, type or management of FADs in their fisheries and the potential impact of these was not fully assessed by Pham *et al.* (2021). Both anchored and drifting FADS are known to be commonly used when targeting tuna (Lopez and Scott, 2014) with FAD usage in the Indian Ocean contributing to 25-28% of the total tropical tuna catch (mainly skipjack; Zudaire *et*

[36] IOTC, Resolution 19/04: Concerning IOTC record of vessels authorised to operate in IOTC area of competence.

[37] Maldives pole & line skipjack tuna - MSC Fisheries

al., 2018). The consequences of abandoned FADs are well researched, with ecological consequences including the alteration of natural behaviors and migration patterns of tuna, disruption of population dynamics through concentrating juvenile fish (Widyatmoko *et al.,* 2021), and physical damage to sensitive habitats like coral reefs.

Additionally, FADs may entangle non-target species such as sharks, turtles, and seabirds, leading to injury or mortality. FADs are often comprised of non-biodegradable material which can contribute towards marine pollution. Although regional differences are acknowledged, the occurrence of gear loss and ghost fishing directly from pole and line fishing can be notably low, as the relatively short lengths of line lost in these fisheries may pose only a minimal risk of ghost fishing, however, due to the prevalence of AFAD use in pole and line fisheries to aggregate fish, the impact of ALDFG was found to be **'Moderate'**, and the Inherent score was assigned as **'Medium'**.

The instances of AFADs becoming ALDFG differ greatly by region with accurate estimates difficult to establish (Gilman *et al.,* 2021), with both Widodo *et al.* (2016) and Proctor *et al.* (2019) finding that inaccurate AFAD data was prevalent in the Pacific Ocean due to poor registration and monitoring systems, along with the desire for fisher confidentiality. Proctor *et al.* (2019) estimated that between 5,000-10,000 anchored FADs were in use in Indonesian tuna fisheries, with high loss rates stemming from storms, currents, vandalism, collisions, and wear. Gilman *et al.* (2021) therefore estimated that an annual loss rate of 51% more likely reflected the rate that AFADs become ALDFG in pole and line fisheries. If an AFAD becomes detached from its mooring and subsequently begins to drift, it would have the same or more serious impact than one or more lost DFADs. Therefore, the maintenance and repair of AFADs (see below) is one of the more important mitigation measures for pole and line fisheries.

The reasons for gear loss described by Proctor *et al.,* (2019) can be compared with the stakeholder survey response by one fish processing company, Pahala Bahari Nusantara (PBN). Findings from the survey show the main causes of gear loss were most likely caused by poor weather, with the same supplier additionally commenting that *"[bad weather conditions damage or wash away fishing gear].*" Unexpected swells, gear snagging, loss of marker buoys, gear becoming inaccessible due to drifting, and conflicts with other vessels were all included as rare reasons for gear loss. The stakeholder did not cite vandalism or faulty/damaged gear as reasons for gear loss, with this being reported as never occurring.

Of the two stakeholders who responded, only Unicord reported that their procurement policy included preventive or mitigative measures to ensure that the fisheries they sourced from implemented actions to minimize or prevent fishing gear loss. These measures included avoiding fishing in areas prone to gear snagging, modifying gear configurations to suit bottom conditions, reduced soak times, avoidance of overcrowded fishing areas, training crew members in gear management, and maintaining or replacing old or damaged gear. The question concerning gear marking, identification, or tracking was left blank, and a comment of "*Don't know*" was included for whether each fishery enforces a gear marking system. Unicord subsequently noted that some unspecified gear was marked. With regards to gear identified as lost, it was indicated that while unknown if vessels report lost gear, fisheries observers were present to report lost or discarded fishing gear. However, it was unknown if recovery measures were in place and that only

"*sometimes*" lost gear was recovered. Education and training sessions aimed at reducing gear loss, and policies to mitigate the ecological impact of lost gear on marine life were reported as implemented, though specific details were not provided.

While the above procurement procedures were not included by PBN, they commented that "*supplier ships take precautions by taking back damaged fishing gear to be repaired on land or thrown away on land if it can no longer be used*" to minimize or prevent fishing gear loss. This processor indicated that not all fishing gear was marked, but that if gear was identified as lost, or encountered while fishing, there are measures in place to recover the fishing gear onboard the vessel. PBN did not indicate specific implementation of policies related to mitigating ALDFG to reduce the ecological impact of lost gear. Information regarding the frequency of gear recovery, the delivery of education and awareness or training sessions, and gear modifications to reduce gear loss, was not provided. Additionally, details regarding the presence of fisheries observers onboard or systems for reporting ALDFG were not included.

Stakeholder responses revealed varying approaches to managing fishing gear. Unicord reported only some gear markings and attempted recovery of lost gear, with detailed specifics lacking regarding the effectiveness and implementation of these measures. PBN had no comparable preventive procedures, but highlighted that damaged gear was either repaired or discarded on land. They did not implement gear marking or specific ALDFG mitigation policies and provided limited information on the recovery of lost gear, education or training efforts, and systems for reporting ALDFG.

Overall, while pole and line fisheries targeting tuna are regarded as highly selective with low comparable rates of gear loss, the responses result in a '**Moderate'** score for mitigation and highlight a need for more consistent and detailed policies across stakeholders to effectively assess, manage and mitigate against the risks associated with ALDFG, largely stemming from association with FAD use. Considering the RFMO requirements, limited potential scope for impact, limited accurate reporting estimates and limited responses, the residual risk of ALDFG is '**Medium'.**

4.3.5.3 Fishing Gear Maintenance and Repair

Both stakeholders stated that there is sufficient space for non-usable fishing gear to be stowed within vessels, with PBN confirming that unusable gear was taken ashore for repair or disposal, while Unicord did not include stowage details. Neither stakeholder responses detailed processes for how or where pole and line gears or FADs are maintained or repaired, how often maintenance or disposal is required, or at what frequency gear is disposed of.

4.3.5.3.1 Active Gear – Poles and Lines

In tuna pole and line fisheries, the lifespan of active equipment varies based on quality, usage frequency, maintenance, and environmental conditions. High quality poles can last over a decade, while more economical options may only endure a few seasons. Higher quality poles are typically made from fiberglass, and are becoming increasingly favored, while materials such as wood (bamboo or split cane) are commonly used as more economical alternatives. Frequent use and

exposure to saltwater shortens equipment lifespan, increasing the requirements for regular cleaning, drying, correct storage and repair or replacement. For the monofilament fishing lines commonly used, these typically require season replacement due to UV damage and wear.

The impact of fishing pole ALDFG events would vary depending on the materials used in construction. Wooden poles, being biodegradable, would degrade and become unusable faster than alternative materials in marine environments, leading to more frequent replacement and potential loss. However, they pose minimal long term environmental risk if lost at sea, as they decompose naturally. In contrast, fiberglass poles, while durable and long lasting, are not biodegradable and, if snapped or lost, persist in the marine environment, releasing harmful microparticles (Ciocan *et al.,* 2020). Although their durability decreases the frequency of loss, this advantage is offset by a comparatively higher long-term risk to marine ecosystems compared to the more environmentally friendly but potentially less durable wooden poles.

4.3.5.3.2 Passive Gear - AFADs

The average lifespan of AFADs was considered to be two years in Indonesia (Proctor *et al.,* 2019), with ownership patterns varying by region. Typically, AFADs used by pole and line fishers will be owned by the vessels, with the vessel owners bearing responsibility for their maintenance. Within Indonesian waters, there are also several government-owned and operated AFADs, however these tend to typically be used by hand or troll line vessels. While monitoring, maintenance and repair of government owned AFADs is likely to occur at higher rates, AFADs deployed and owned by vessels may be subject to less stringent protocols.

In the Maldives, pole and line fishing is a prevalent technique accounting for over 60% of tuna caught (Zelasney *et al.,* 2020). Fishers target free swimming schools or those associated with AFADs. All registered pole and line vessels have equal access to over 55 anchored FADs within the EEZ (Jauharee *et al.,* 2021), which are deployed and maintained by the Maldivian government, decreasing the likelihood of AFAD associated ALDGF events occurring (Zelasney *et al.,* 2020; Jauharee *et al.,* 2021).

Based on these findings for Fishing Gear Maintenance and Repair, a '**Medium'** Inherent risk is scored, due to a combination of the '**Moderate'** likelihood gear would become lost due to poor maintenance or neglect, and lost gear having a **'Minor'** level of impact.

Whilst stakeholder responses did not detail maintenance and repair protocols, PBN indicated that faulty or damaged gear was never a reason for gear loss. This suggests that maintenance of gear used within their fleets is effective. As such, the '**Moderate'** mitigation measures in place result in a '**Medium'** residual risk.

One aspect not yet considered is the ALDFG risks posed during the capture of bait fish. This could be considered as pole and line fisheries typically require substantial quantities of bait to attract and hold schools.[38] Bait fishing gear differs by region and is often performed in coastal areas targeting small pelagics for use as live bait. 'Bagans', commonly used in Indonesia, are anchored

[38] pl-guidebookipnlfissffinal.pdf

floating platforms which use lights to attract and capture baitfish at night with fine mesh nets. Alternatively, pole and line vessels will directly capture bait, also using lights and fine mesh nets.[39] These methods have minimal habitat impacts as they are conducted in waters deeper than 20 m, away from coral reefs, with 'bagans' anchored over loose substrates in deep water. Due to environmental constraints, unsuitable areas for 'bagan' deployment include those with strong currents, high winds, or complex reef structures minimizing the risk of their contribution towards ALDGF.

4.3.5.4 Existence of EOL Processes

Overall, little information was provided on the EOL processes for the disposal of fishing gear within stakeholder responses. Only Unicord provided a concise list of supplier ports (Majuro, Tarawa, Funafuti and Rabaul) and confirmed that the vessels they source fish from have specific ports designated for the discarding or offloading of unwanted fishing gear, with no further details provided.

PBN confirmed the presence of waste reception facilities available at the ports where their vessels typically operate from and that these did accept fishing gear, describing reception facilities as "*rubbish dump(s) at the harbor*" with the port authorities responsible for managing the collection of fishing gear brought in. However, there are no designated areas for different types of fishing gear, nor are there pre-processing requirements before waste material can be accepted. The facilities are accessible only during business hours, free of charge, and there is no limit on the amount of fishing gear or plastic that can be disposed of per user. After using the waste reception facilities their "*ship managers will report waste brought from fishing operations to port officials*".

Although facilities to dispose of unwanted fishing gear are available, the stakeholders stated use a number of ports and information specific to each port was not provided. While facilities to dispose fishing gear do exist, with the data collected it is uncertain whether this is a consistent practice across all ports accessed by vessels. A precautionary scoring approach has therefore been used, with a Likelihood score of **'Moderate'**. The responses indicate that while the availability of onshore waste disposal facilities helps lower the risk of gear being discarded at sea, the resulting Impact is still considered '**Moderate'**, and consequently the Inherent score is **'Medium'.** The overall effectiveness of EOL processes in mitigating environmental impacts may be undermined by insufficient access, resulting in a **'Moderate'** score, and a **'Medium'** residual risk.

4.4 Risk Assessment Summary

The risk assessment results, broken down by their likelihood, impact, inherent risk, mitigation and residual risk scores can be found in the following section, illustrated in rose plots. In these plots, each "petal" corresponds to a specific fishery (defined by species and gear class), with the size of the petal indicating the magnitude of the risk. To enhance clarity, a color-coding scheme is applied, ranging from green (low risk) to deep red (very high risk), as outlined in the corresponding

[39] Assessments Solomon Islands skipjack and yellowfin tuna purse seine and pole and line - MSC Fisheries

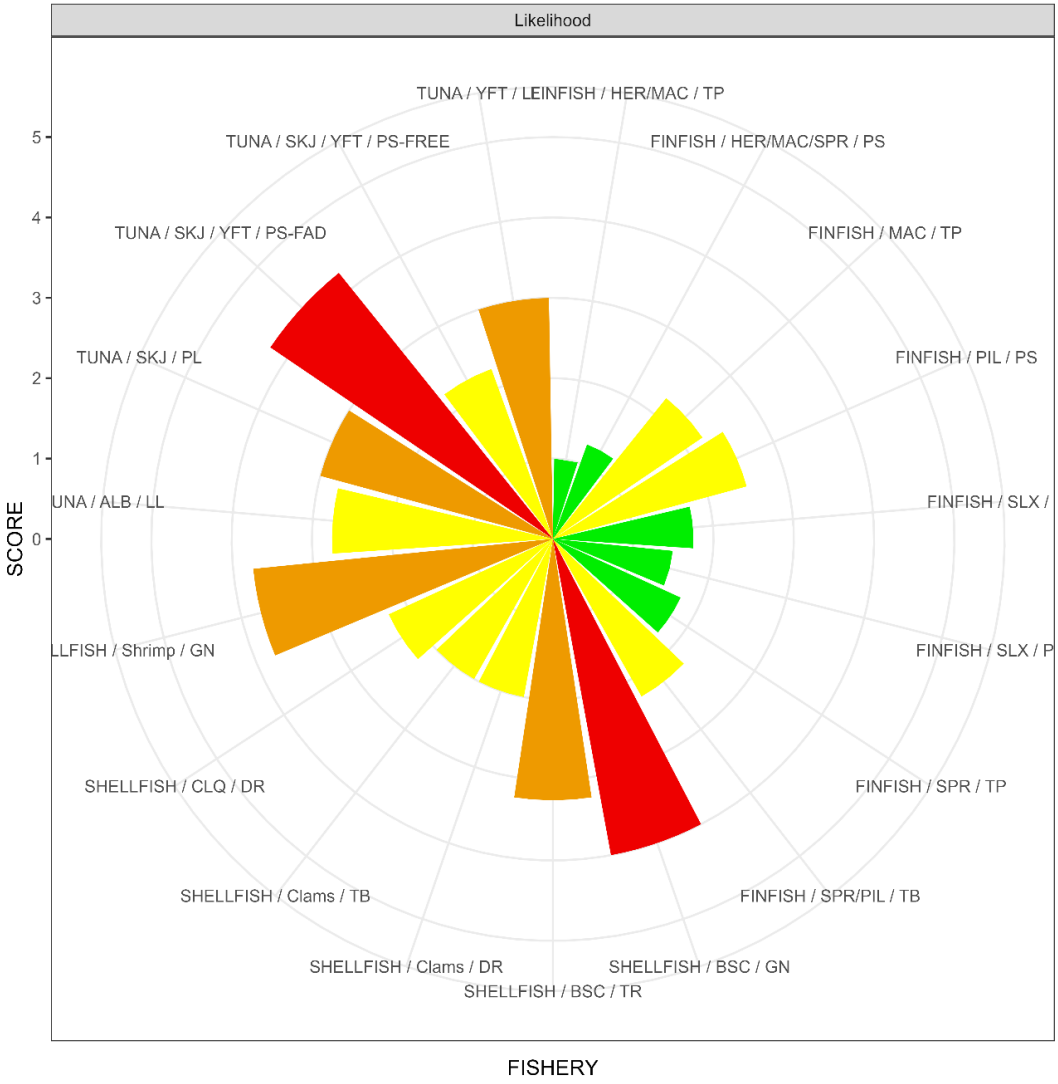
tables. Individual plots for each of the four risk factors that contributed to the aggregated data can be found in the detailed Annexes to this report.

4.4.1 Likelihood of ALDFG

An examination of the likelihood of ALDFG across all source fisheries (Figure 15) reveals three distinct groupings.

- **Low Likelihood Fisheries (Green Petals):** These fisheries are predominantly well-managed finfish fisheries, such as those targeting herring, mackerel, and sprat in Europe and North America.
- **Moderate Likelihood Fisheries (Yellow and Orange Petals):** Tropical and temperate tuna fisheries, such as those using purse seines (FAD-free) and longlines, exhibit moderate risk levels. This suggests that gear loss is less frequent but still notable compared to well-managed fisheries. Similarly, shellfish fisheries, including those targeting clams, demonstrate moderate likelihoods of ALDFG.
- **High Likelihood Fisheries (Red and Dark Orange Petals):** Purse seine tuna fisheries using FADs exhibit the highest likelihood of ALDFG. The red petals highlight the significant risks associated with FAD loss due to their operational nature. Shrimp gillnet fisheries also show elevated likelihoods of gear loss, as indicated by the darker orange petals, suggesting challenges related to this gear type, including the combination of high inherent risk and low mitigation measures in place.

Figure 15. Likelihood assessment by fishery.

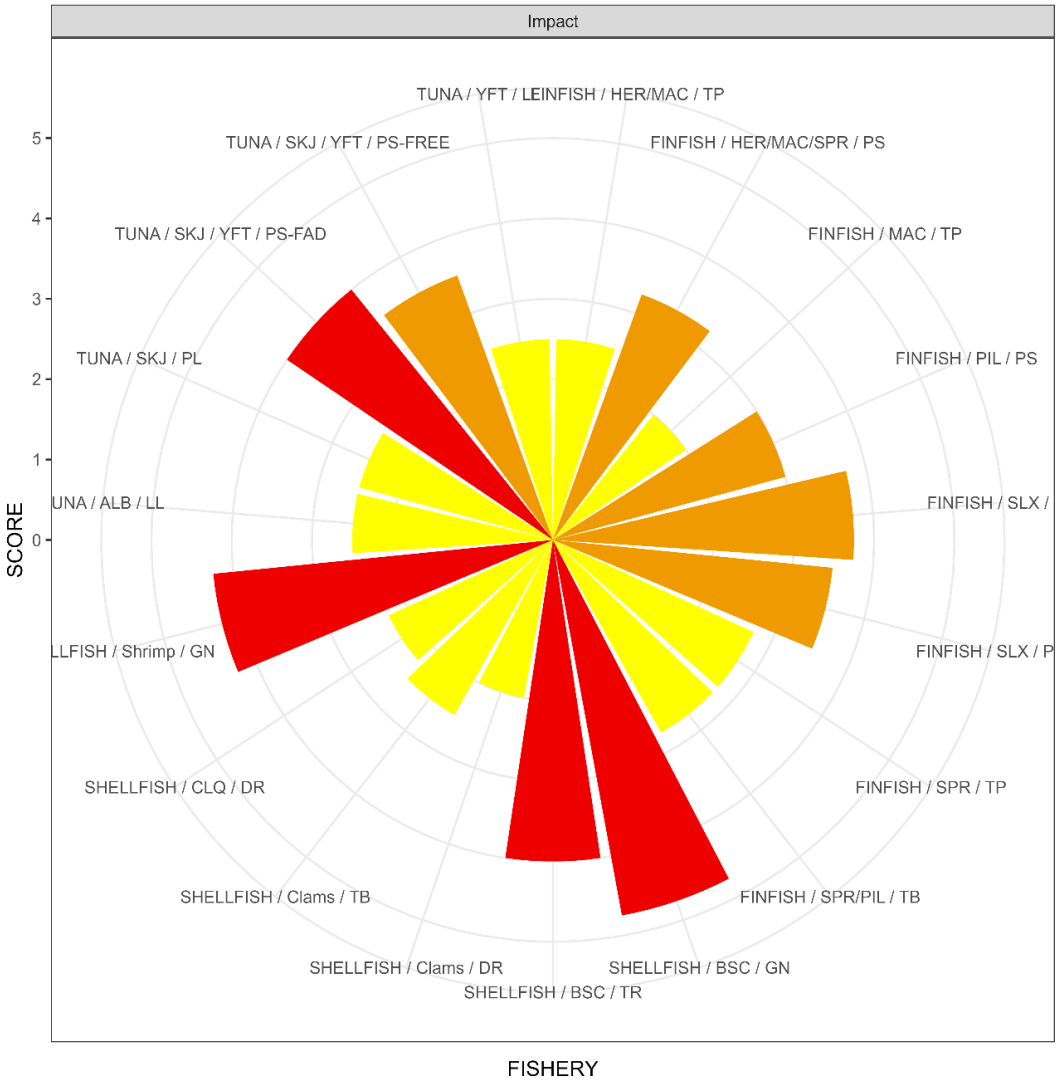


4.4.2 Impacts of ALDFG

Figure 16 highlights the potential impact of ALDFG across fisheries, with results similar to those seen in the likelihood illustration above. Non-tuna finfish fisheries generally exhibit low to moderate levels of potential impact, with the salmon gillnet fishery standing out as having the highest impact within this group. Tuna fisheries display a low to moderate level of impact across all species and gear types, with the exception of tuna FAD fisheries, which demonstrate a high impact level due to DFAD use.

The shellfish fisheries show the highest potential impacts overall, with the gillnet fisheries targeting blue swimming crab and shrimp exhibiting the most significant levels of impact. These are closely followed by the trap fishery for blue swimming crab, which also shows elevated potential impacts.

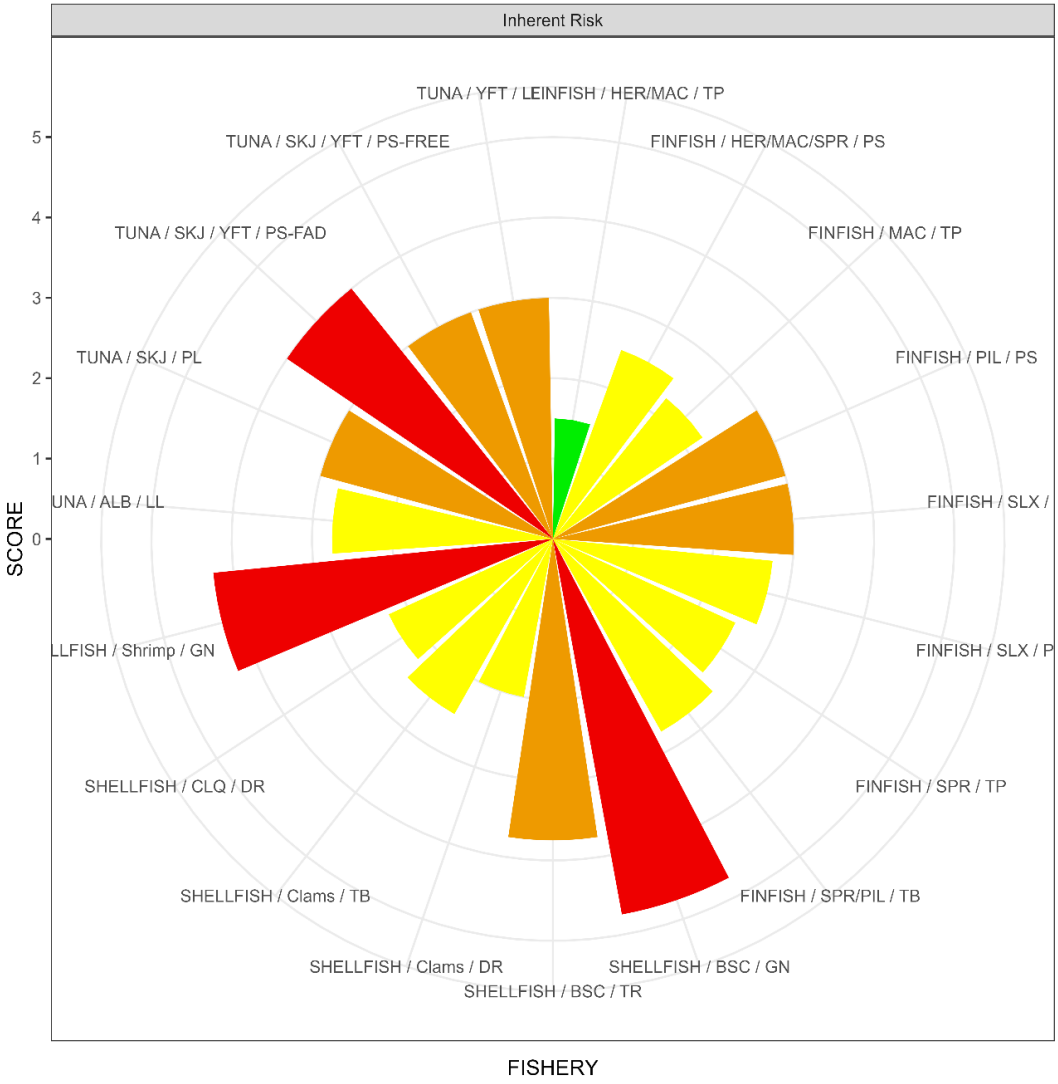
Figure 16. Impact assessment by fishery.



4.4.3 Inherent Risk

When the likelihood and impact are combined to describe the level of inherent risk for each fishery source (see Figure 17), the non-tuna finfish fisheries show the lowest level of risk with all ranked very low to moderate. The tuna fisheries all exhibit a moderate level of risk except for the FAD-associated fisheries that show a high level of risk. The shellfish risks range from low for the clam fisheries to moderate for the blue swimming crab trap fisheries to a high risk for the blue swimming crab and shrimp gillnet fisheries.

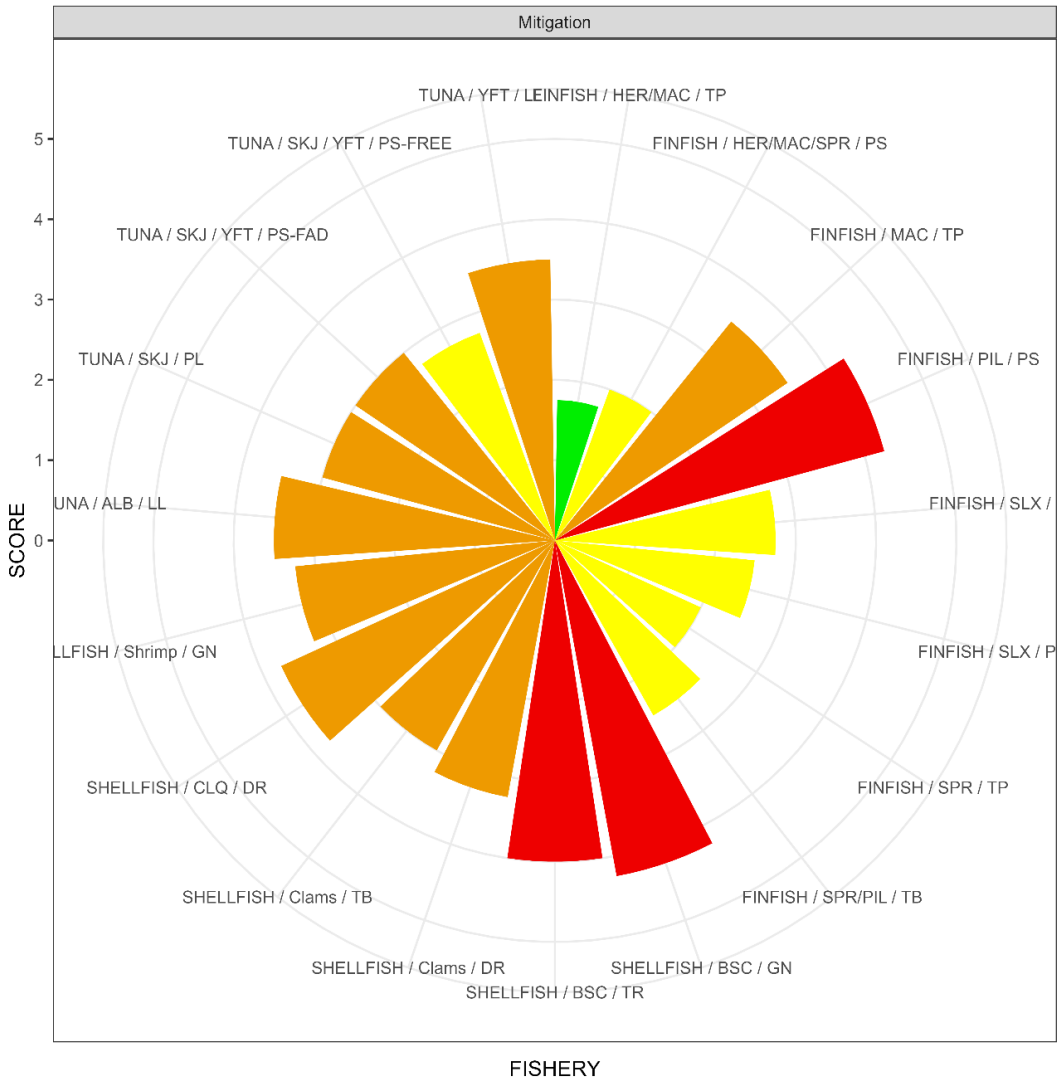
Figure 17. Inherent risk assessment by fishery.



4.4.4 Mitigation Measures

The extent of mitigation measures implemented across fisheries exhibits considerable variation (see 18). Within the finfish fisheries, mitigation levels range from very high (green) in the herring pelagic trawl fisheries to relatively low (red) in the pilchard pelagic trawl fisheries. Tuna fisheries, managed under the frameworks of RFMOs, demonstrate moderate to low mitigation scores across all species and gear types, reflecting a consistent regulatory approach across these fisheries. In contrast, shellfish fisheries generally exhibit low to medium levels of mitigation. Notably, fisheries targeting blue swimming crab and shrimp perform poorly in terms of mitigation measures, highlighting the need for enhanced management interventions to address these vulnerabilities effectively.

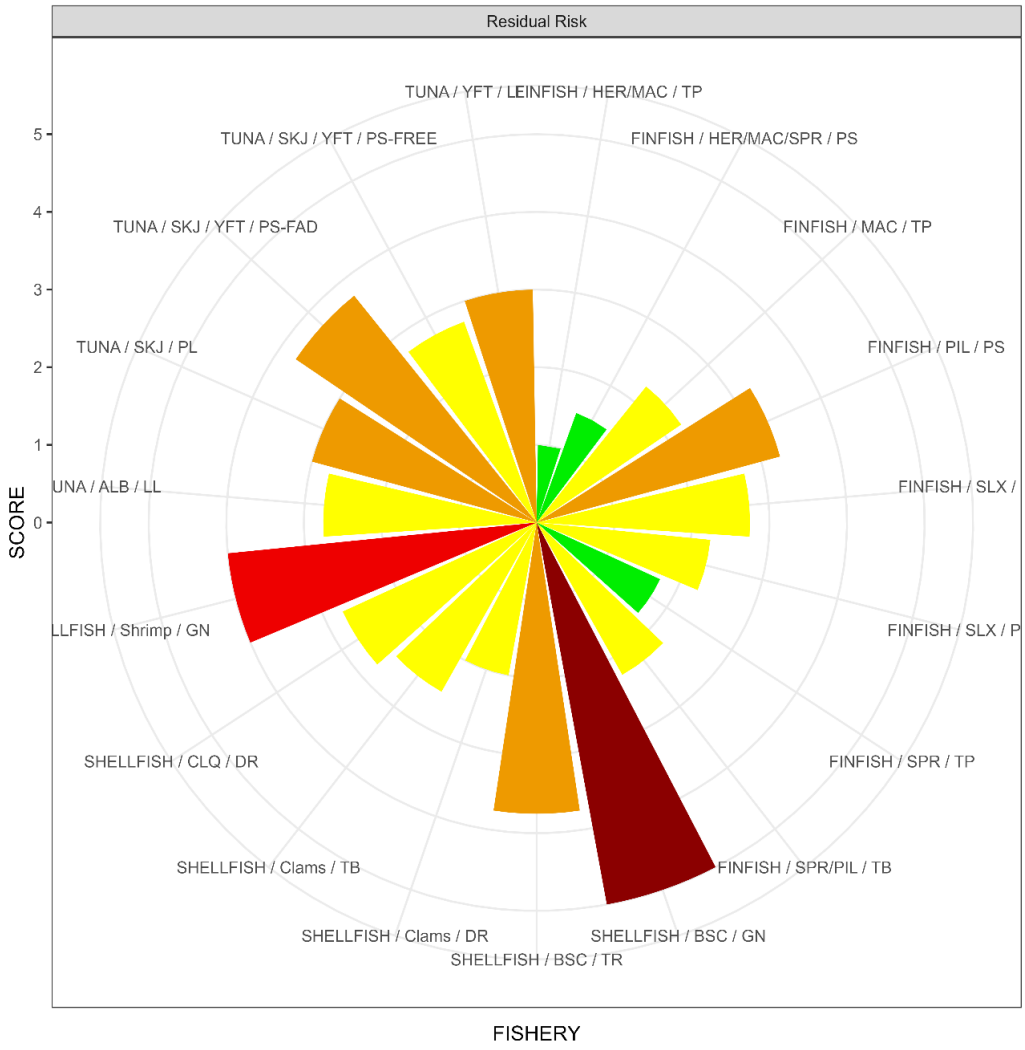
Figure 18. Mitigation by fishery.



4.4.5 Residual Risk

The final residual risk scores for each fishery source are presented in Figure 19. The highest risk scores are observed in the blue swimming crab and shrimp gillnet fisheries, followed by the blue swimming crab trap fishery, which also demonstrates a relatively high risk. The tuna fisheries typically exhibit low to moderate risk levels, with the highest risks associated with purse seine fisheries. Within this category, FAD-associated fisheries are characterized by higher risks compared to those targeting free-swimming schools. Non-tuna finfish fisheries generally display low-risk levels, with the exception of the pilchard purse seine fishery, which is classified as exhibiting a moderate level of risk.

Figure 19. Residual risk assessment by fishery.



4.4.6 Risk Exposure

When assessing risk in terms of exposure across various sources and supply chains, it is crucial to also consider the relative volume of each source. Ideally, high-volume fisheries should exhibit low residual risk to minimize overall exposure. High-volume, high-risk fisheries present the greatest risk to Bumble Bee, while low-volume, low-risk fisheries pose minimal threat. Fisheries with moderate or high risk and low to medium volumes present intermediate levels of exposure.

For tuna species, residual risk remains relatively consistent across all species, gears, and sources, ranging from 2.75 to 4.00, despite considerable variations in volume. This indicates that efforts to reduce ALDFG in tuna fisheries should be applied uniformly across the sector, emphasizing actions such as RFMO conservation initiatives, engagement with key flag States, and collaboration with port States. Specific interventions should prioritize high-volume species and gears, particularly purse seine fisheries targeting skipjack tuna (and associated yellowfin and bigeye tuna) as well as albacore longline fisheries. In contrast, risk patterns for non-tuna species are more diverse. High-volume fisheries supplying Bumble Bee, such as pelagic trawl fisheries for sprat, herring, and mackerel, and purse seine fisheries for herring, mackerel, and sardine, exhibit low residual risk and therefore result in low exposure. However, three shellfish sources – blue swimming crab gillnet and trap fisheries, along with shrimp gillnet fisheries – are characterized by very low volumes and high residual risk.

5 Deep-Dive Analysis

The deep dive analysis seeks to further explore the mechanisms and drivers of ALDFG in fisheries, aiming to achieve a more detailed and comprehensive understanding of their operational practices, associated challenges, and external factors contributing to gear loss.

Three case studies were selected for this analysis: skipjack and yellowfin tuna purse seine fisheries (FAD-associated), albacore tuna longline fisheries, and blue swimming crab fisheries. These fisheries were identified as high-risk based on the risk assessment results, underscoring their importance as focal areas for targeted recommendations.

Further stakeholder consultation was conducted for each case study; however, only the purse seine and blue swimming crab case studies received responses. No additional information was obtained for the longline fleet, underscoring the need for further research, as limited data was also gathered during the initial ALDFG survey for this fishery. A summary of the key insights from the in-depth analysis is provided below, while the full case study details (including methods) can be found in Annex 10 (tuna purse seine and longline fisheries) and Annex 11 (blue swimming crab trap and gillnet fisheries).

5.1 Skipjack and Yellowfin Purse Seine Fisheries

5.1.1 Main Causes of ALDFG

The results of the risk assessment identified the main causes of ALDFG in purse seine fisheries were attributed to fishing practices, geographic distribution, gear maintenance and EOL processes. While purse seine nets themselves are rarely lost, FADs (particularly DFADs) pose significant challenges. DFADs can drift over vast oceans making them difficult to monitor and retrieve and are then susceptible to theft. Stakeholder responses indicated that gear loss is more likely to occur when DFADs drift out of accessible areas, overlap with other fishing operations and vessels or encounter extreme weather events. Efforts mentioned to mitigate ALDFG occurrences include reducing soak times, gear marking, adopting non-entangling and biodegradable FAD designs and avoiding overcrowded waters. However, survey responses showed that retrieval rates remain inconsistent. Geographic distribution was another key area of concern, with the operational areas spanning large distances meaning that lost FADs can drift far from their point of deployment, potentially drifting to affect sensitive ecosystems. Despite efforts to mitigate these consequences, such as non-entangling FADs and RFMO regulations, weak enforcement and inconsistent compliance across regions can undermine these measures.

Gear maintenance and EOL processes also revealed that the main challenges of ALDFG arise due to improper gear storage and inadequate port facilities and disposal infrastructure. One stakeholder mentioned gear is discarded overboard rather than being repaired or brought to land. In general, the ports across the Pacific Ocean lack organized waste collection facilities with no gear-specific disposal available. This can lead to improper discarding or reuse of gear, exacerbating ALDFG risks.

5.1.2 Further Stakeholder Consultation

One response was received from the purse seine department at FCF. The respondent identified severe weather conditions as the leading cause of gear loss within their fleet of four tuna purse seine vessels, with additional factors reported to 'often' result in gear loss, including faulty or damaged fishing gear, vandalism, and difficulties in locating lost gear components. Notably, the respondent initially stated that damaged gear was frequently discarded intentionally, highlighting a high priority area for targeted interventions to change fisher behavior. However, this statement was later contradicted when the respondent claimed that damaged gear was always stored onboard for proper disposal onshore and never discarded at sea. This inconsistency highlights the need for further investigation into actual disposal practices within the fleet.

Furthermore, the respondent confirmed that no crew training was provided on gear management, revealing a critical gap in best practices for gear maintenance, retrieval and handling of EOL fishing gear onboard purse seine vessels. Addressing this issue could significantly reduce gear loss and improper disposal. A recommendation would be the implementation of comprehensive crew training on FCF-associated vessels, ensuring all crew members are educated on safe gear retrieval and onboard storage procedures. Equipping vessels with appropriate retrieval tools and collaborating with the ISSF to develop and enforce a standardized gear maintenance schedule for purse seine vessels would further enhance responsible fishing practices (see Recommendations: 'Encourage crew training on safe retrieval of lost or abandoned fishing gear' and Annex 12 for 'Work with ISSF to develop a gear maintenance schedule to implement for longline and purse seine vessels').

5.1.3 Spatial Analysis of Fisheries Activity Data

Using fisheries activity data from the Global Fishing Watch Vessel Viewer, the top 20 most active tuna purse seine vessels in Bumble Bee's supply chain were identified from Bumble Bee's procurement data and mapped to visually represent the spatial distribution of the fleet between 2018 – 2023 The spatial analysis provided trends on vessel activity, such as heavily fished areas and key port locations. These insights contributed to a more comprehensive understanding of Bumble Bee's tuna supply chain vessels, providing a foundation for the development of sustainable practices.

The top 20 tuna purse seine vessels cumulatively account for 18,838 fishing days between 2018 and 2023 in the WCPO (Table 9; Annex 10). Among these, the Pacific Islands accounted for 55% of vessels, reflecting the importance of Pacific Island nations in the tuna supply chain. Furthermore, 25% were Taiwan-flagged vessels, highlighting Taiwan's significant role in global tuna fishing and the potential ALDFG risks associated with its operations. Of the top 20 vessels, 40% used FADs, with highest activity levels amongst FSM and Nauru flagged vessels. Fishing effort was varied, with only a 32% difference between the highest and lowest fishing days, indicating differences in vessel capacity, fishing efforts and operational practices.

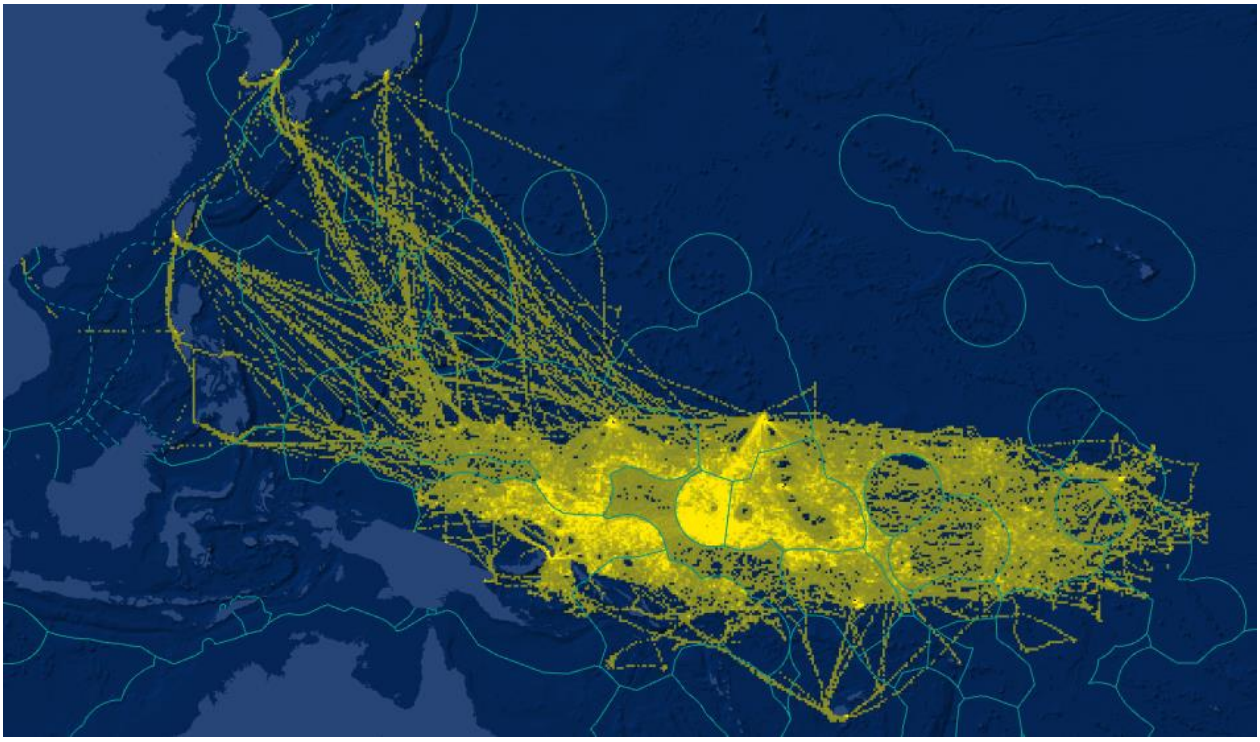
Figure 20 is a visualization of purse seine vessel activity, which shows operational practices heavily concentrated in the WCPO. This region, which accounts for roughly 60% of global tuna catches (Schiller *et al.,* 2023), is geographically dominated by small island developing states

(SIDS), of which fishing activity is notably high in and around the EEZs of FSM, Nauru and Kiribati, members of the PNA- a sub-regional coalition formed to manage and leverage access to some of the world's most productive tuna fishing grounds (Schiller *et al.,* 2023).

The brighter areas of vessel activity denoted in yellow represent key ports and hubs of vessel activity, such as transshipment or unloading of catch. These areas are most clustered around island nations such as Nauru, Kiribati, Marshall Islands, FSM and PNG. The dense network of routes indicates hotspots of fishing operations, as well as pathways connecting fishing grounds and for vessels returning to port.

Based on this visualization of fishing activity, the high density of operations in the WCPO reinforce this area as an important fishing ground for tuna fisheries. However, with increased fishing activity comes heightened risks of gear loss, particularly for vessels using FADs. Additionally, overlapping fishing activity increase the likelihood of vessel interference, a major cause of ALDFG incidences as found by the stakeholder survey responses.

Figure 20. Spatial distribution of the top 20 purse seine tuna vessel activity and port visits between 2018 – 2023. (Source: Global Fishing Watch Vessel Viewer – public data).



5.1.4 Location of Port Visits

The ports visited are presented in Table 21. Based on the frequency of port visits, Majuro (Marshall Islands), Tarawa (Kiribati), Rabual (PNG) and Pohnpei (FSM) are highlighted as the most important ports for the 20 identified tuna purse seine vessels. Within Bumble Bee's procurement data, port information for direct landings was only available for albacore tuna, while most skipjack and yellowfin landings were reported as transshipped at various ports. This analysis offers

valuable insight into where fishing vessels are docking, regardless of where they are unloading their catches, identifying ports which may serve as disposal points for damaged or EOL fishing gear, emphasizing the importance of ensuring PRF are available for vessel use when needed.

Survey results indicate PRF are available in Majuro, yet Rabaul and Pohnpei do not have any PRF, and vessels must ship any EOL fishing gear to their fishing agent. Insufficient information on PRF availability at Tarawa was gained from the survey; however, a respondent from FCF later confirmed no PRFs exist at this port. The respondent noted, "*Some small island countries lack capacity to handle waste nets, so normal practice will be* [for a] *sister vessel to bring back to Taiwan or through carrier to deliver to discharging port.*" This response highlights the logistical challenges of managing EOL fishing gear in regions with limited waste management infrastructure.

Given the high volume of vessel activity at these ports, access to PRF will have an important influence on sustainable fishery practices and therefore are key to improving ALDFG management and mitigation. Investments in port infrastructure, such as facilities specific to EOL gear or enhanced monitoring systems, can significantly reduce gear loss in these locations. Additionally, robust regulations by the relevant RFMOs, combined with collaborative initiatives amongst flag States and local stakeholders, can further help manage ALDFG in tuna fisheries and associated key ports. These measures will help address the environmental impacts of intensive purse seine fishing while supporting sustainable industry practices.

Table 21. Total number of port visits made by the top 20 tuna purse seine vessels between 2018 – 2023. (Source: Global Fishing Watch Vessel Viewer).

EEZ	Port Name	Total Port Visits
Marshall Islands	Majuro	275
Kiribati	Tarawa	191
Papua New Guinea	Rabaul	189
Federated States of Micronesia	Pohnpei	143
Tuvalu	Funafuti	74
Taiwan	Kaohsiung	73
Korea	Busan	43
Japan	Yaizu	31
Solomon Islands	Honiara	16
Fiji	Suva	13
Japan	Yamagawa	11
Japan	Makurazkai	6
Philippines	General Santos	5
Papua New Guinea	Wewak	5
Solomon Islands	Noro Anchorage	3
Federated States of Micronesia	Kosrae	1

5.1.5 Conclusion

Overall, the results from the spatial analysis corroborate stakeholder responses from the ALDFG survey. Notably, the analysis confirmed the high concentration of purse seine vessels operating in the WCPO, particularly around Nauru, Kiribati and PNG, as well as identifying key regional ports. Additionally, stakeholder feedback from FCF highlighted a critical gap in gear management, specifically the lack of crew training in gear maintenance, which can contribute to potential gear loss. A summary of the main findings, and associated recommendations to reduce ALDFG risks, is provided below.

1. **High risk of DFAD abandonment** raised as a major concern in WCPO as DFADs can drift out of accessible areas. Interventions should focus on advocating for standardized gear regulations on FAD use across tuna RFMOs. This will align regulatory frameworks regarding the use of non-entangling and biodegradable FADs, vessel participation in FAD retrieval initiatives, and support consistent data reporting requirements across RFMOs to inform decision-making.

   Recommendation(s) in main report: 'Support participation in existing FAD retrieval initiatives' and 'Support expanded vessel participation in FAD trials'.

   Recommendation(s) in Annex 12: **'**Broad Standardization of FAD Management in Tuna RFMO CMMs' and 'Advocate to RFMOs for broader industry adoption of biodegradable FAD trials'.

2. **Lack of gear maintenance and crew training in gear management** emerged as a frequent cause of gear loss, with faulty or damaged fishing gear often leading to ALDFG. FCF reported that no crew training was provided. An easy solution here would be to train crew in best practices to maintain and handle damaged gear onboard. Interventions should focus on exploring the potential for new or enhanced maintenance schedules onboard vessels to reduce the risk of deploying damaged or faulty gear which are more susceptible to breakage and becoming ALDFG. Such a protocol could include regular inspections and repairs, with intervals based on gear type, expected lifespan and operational conditions.

   Recommendation(s) in main report: 'Encourage crew training on safe retrieval of lost or abandoned fishing gear'.

   Recommendation(s) in Annex 12: 'Work with ISSF to develop a gear maintenance schedule to implement for longline and purse seine vessels' and 'Advocate to RFMOs on gear maintenance standards'.

3. **Lack of PRFs and EOL gear management** in major landing ports, such as Tarawa, Rabaul and Pohnpei. Interventions should focus on improving access to PRFs that can handle EOL fishing gear.

   Recommendation(s) in main report: ''Support research and increase access to Port Reception Facilities' and 'Support the establishment of an EOL collection point in Pohnpei, FSM'.

   Recommendation(s) in Annex 12: 'Advocate to RFMOs on PRF standards and gear disposal'.

5.2 Albacore Longline Fisheries

5.2.1 Main Causes of ALDFG

In longline fisheries, the risk assessment identified the configuration, handling and operational procedures of the gear as the main concern regarding the likelihood of ALDFG occurrences, as the extensive size and method of deployment make it particularly vulnerable to loss. Longline gear spans vast distances making it difficult to monitor and retrieve. It is also prone to tangling or breakage, especially during extreme weather. Stakeholders highlighted operational challenges such as severe weather and vessels crossing over gear can tear mainlines or sink buoys making gear irretrievable. Other causes of ALDFG were GPS tracking errors and shark “bite-off” events, where sharks break monofilament snoods. Efforts to mitigate ALDFG occurrences include gear marking, avoiding crowded waters, reducing soak times, and hauling gear when severe weather approaches. Unicord and FFIA responded that fishing gear is sometimes successfully recovered, while Fue Shin Fishery Ltd stated that successful gear retrieval is rare.

Four of the five stakeholders stated that they conducted gear management training for crews. FCF highlighted use of their own gear management form for fishers to record the usage and loss of fishing gear and skipper outreach under their FIP. FCF also mentioned the use of the ISSF Skipper Guidelines for training.

Another area of concern is the insufficient EOL processes for old or damaged gear. Taiwanese ports managed by FCF have organized waste collection and recycling systems, but other ports lack such facilities, with general waste bins and no gear-specific disposal or reporting available. Inconsistencies in disposal processes can lead to improper discarding or reuse of gear, contributing to ALDFG occurrences. The geographic distribution factor, and its subsequent impacts, is of less concern, as effective best practices and conservation measures help mitigate risks here, and environmental factors are less likely to contribute to ALDFG. However, across each factor, mitigations are weak or at most, moderate. This shows that while systems may be in place with the intention to manage ALDFG, there are issues around enforcement and compliance, highlighting the need for improved mitigation strategies and stakeholder collaboration.

5.2.2 Further Stakeholder Consultation

No further information was obtained during the second stakeholder consultation phase.

5.2.3 Spatial Analysis of Fisheries Activity Data

Using fisheries activity data from the Global Fishing Watch Vessel Viewer, the top 20 most active tuna longline vessels were identified using Bumble Bee procurement data. These vessels were mapped to visually represent the spatial distribution of the fleet between 2019 – 2022. The spatial analysis provided trends on vessel activity, such as heavily fished areas and key port locations. These insights contributed to a more comprehensive understanding of Bumble Bee’s tuna supply chain vessels, providing a foundation for the development of sustainable practices

The top 20 tuna longline vessels with the highest fishing effort cumulatively account for 30,993 fishing days between 2019 and 2022 in the WCPO and the Indian Ocean (Table 11; Annex 10).

Among these top 20 vessels, 13 were Chinese-flagged, highlighting China's significant role in this fishery and the potential ALDFG risks associated with its operations. The main Chinese fishing companies were CNFC Overseas Fisheries Co. Ltd and Rongcheng Ocean Fishery Co. Ltd, indicating two key companies to work with for any future work on reducing ALDFG within the longline fleet.

The remaining seven vessels were Fijian- and Taiwanese- flagged. The main Fijian fishing company was Rising Fisheries Pte Ltd (three vessels) and Sunshine Fisheries Pte Ltd (one vessel). No fishing companies were associated with the vessel information for the Taiwanese-flagged vessels. However, from the procurement data, it can be seen that all vessels landed their raw material in Port Louis and the main vendor supplying the processed tuna to Bumble Bee was under the name “Mauritius”, assumed to be a subsidiary site for FCF. [40]

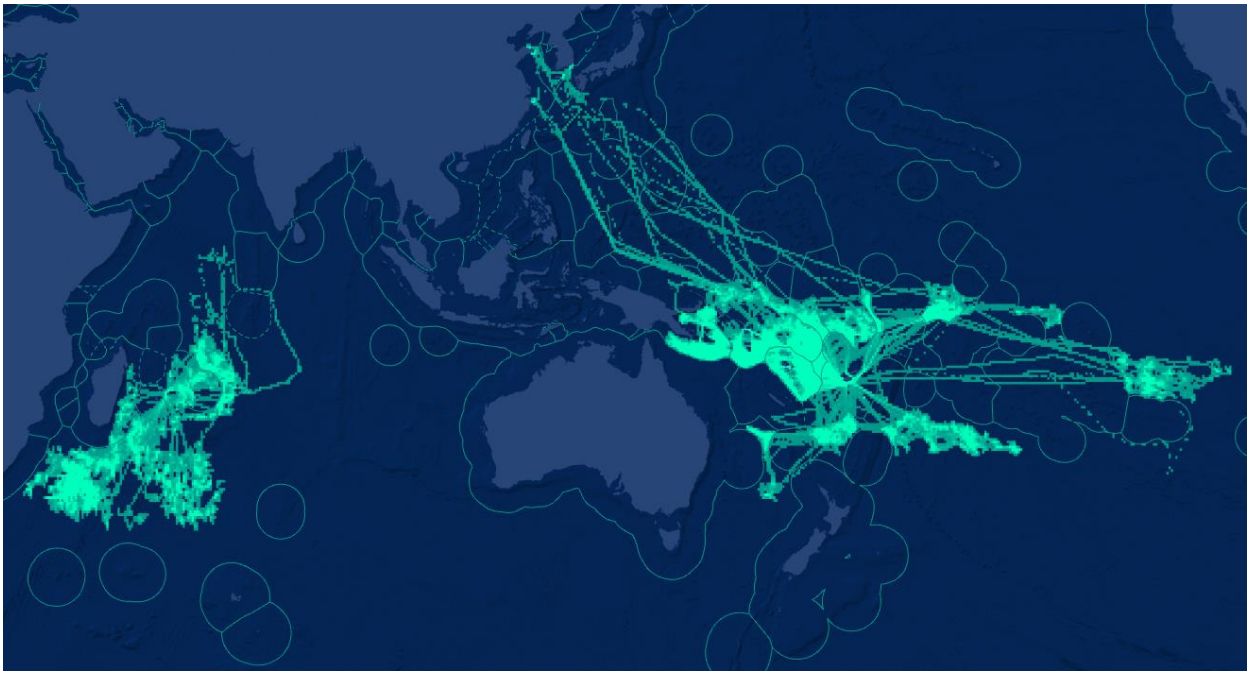
It is interesting to note that all four fishing companies operating in the WCPO predominately supply their raw material to the Pacific Fishing Company Ltd for processing, a direct vendor to Bumble Bee.

Figure 21 provides a visualization of longline tuna vessel activity and their associated port visits. The densest activity can be seen in the WCPO, with hotspots of activity in Pacific Island nation EEZs, both areas of which are known as important tuna fishing areas. The Indian Ocean also shows considerable fishing activity, mostly in the west and south. These patterns may represent both fishing activity and port visits for transshipments or unloading of catches. Bright spots on the map indicate highly frequented ports, likely corresponding to important hubs in tuna-processing countries or transshipment locations, such as ports in Fiji, Mauritius, China, and the Solomon Islands.

The higher concentration of fishing activity in the WCPO aligns with its global importance for tuna fishing grounds, with fishing activity indicated to be most clustered in the high seas and EEZs of island nations such as the Solomon Islands, Vanuatu, PNG and Fiji. In the Indian Ocean, fishing activity appears to be more localized, with a high fishing effort in the high seas south of Madagascar and Réunion, as well as on the border of the Mauritian EEZ. The overlap of fishing effort in high-seas areas and within EEZs reinforces the need for cooperation between RFMOs and individual nations to monitor and regulate fishing activities to manage ALDFG risks. The more concentrated routes and areas of high fishing activities are likely to be prone to ALDFG issues, as vessel interference was identified as a key factor contributing to damaged, and subsequently abandoned and lost, gear according to the stakeholder survey results. This further emphasizes the need for targeted interventions, such as improved gear marking, retrieval incentives, and enhanced monitoring of gear loss incidents.

[40] https://fcf.com.tw/our-subsidiaries-and-other-locations/indian-ocean/

Figure 21. Spatial distribution of top 20 longline tuna vessel activity and port visits between 2019 – 2022. (Source: Global Fishing Watch – public data).



5.2.4 Location of Port Visits

The most frequently visited ports are detailed in Table 22, where Suva, Fiji, emerges as the primary hub for tuna longline vessels, with 17 of the 20 most active longline vessels landing at this port. This aligns with the analysis of Bumble Bee's procurement data, highlighting Suva as the most significant port in terms of landed catch. However, stakeholder feedback from the survey revealed there were no dedicated bins to dispose of damaged gears in Suva or Levuka, and EOL fishing gear is currently discarded into general disposal bins alongside other vessel waste. This is also the case for Port Louis. Despite the lack of specific EOL management, the presence of PRFs which accept EOL fishing gear is positive.

In contrast, Shidao harbor does have PRF which accepts the disposal of EOL fishing gear. Stakeholder feedback explained there are designated areas with containers for the collection of different types of fishing gear and recycling companies will come and collect derelict fishing gear. No pre-processing requirements are enforced before waste material can be accepted, and there is no fee to use the facilities. Given China's significant role in global tuna fishing and prominence of Chinese flagged vessels in the top 20 active vessels in Bumble Bee's supply chain, the presence of PRFs which accept EOL fishing gear is positive.

Investing in the construction of waste reception facilities at ports in accordance with MARPOL Annex V, particularly in Suva, could facilitate proper EOL gear disposal, reducing the risk of ALDFG and support responsible fisheries practices. This should include specific designated areas for the collection and storage of end-of-life fishing gear. Specific collection bins for gear components should also be considered and incorporated, where possible, to assist in subsequent collection or recycling schemes. This aligns with a recommendation from the Fiji Fishing Industry

Association which suggested implementing "*specific recycling bins for damaged or retired fishing gear*", as well as providing "*guidelines to assist vessel operators to ensure all damaged and old gears are discarded appropriately in port*."

Table 22. Total number of port visits made by the top 20 tuna longline vessels between 2019 – 2022. (Source: Global Fishing Watch Vessel Viewer).

EEZ	Port Name	Total Port Visits
Fiji	Suva	241
Fiji	Levuka	47
Mauritius	Port Louis	35
China	Shidao	20
Solomon Islands	Honiara	15
Korea	Busan	9
Vanuatu	Port Villa	9
China	Rongcheng	5
China	Zhoushan	4
China	Ningbo	4
China	Yantai	4
Solomon Islands	Noro Anchorage	4
China	Lanshan	1
Tongo	Nuku Alofa	1

5.2.5 Conclusion

Overall, the extent of ALDFG occurrence in albacore longline fisheries is not clear. The absence of quantitative data limits evidence-based decision-making. The limited stakeholder engagement in both stakeholder consultation phases highlights the challenges of reaching vessels participating in the fishery and emphases the need for additional data collection and the potential use of alternative methods of data gathering, for example fisheries observers and REM.

The spatial analysis of the top 20 longline vessels within Bumble Bee procurement data confirmed the high concentration of longline vessels in the Pacific and Indian Ocean, with Suva highlighted as the most significant port in terms of the frequency and number of vessels visiting this port. A summary of the main findings, and associated recommendations, to reduce ALDFG risks is provided below.

1. **Limited information on causes of ALDFG in the longline fleet** was obtained during both stakeholder consultation phases, underscoring the need for further research and engagement with longline vessels. Due to the data limitations, an understanding of the prevalence of ALDFG from longline fisheries was not possible. In the absence of such data, specific research questions were not able to be developed. A deeper understanding of gear loss rates, contributing factors, existing prevention and reporting mechanisms is essential. Interventions should prioritize collaboration with FCF to assess longline gear loss on FCF-associated vessels, including outreach to vessels participating in the four tuna FIPs (Atlantic Ocean tuna

- longline (FCF), Indian Ocean tuna - longline (FCF), Pacific Ocean tuna - longline (FCF Co. Ltd), and Pacific Ocean albacore tuna - longline (Taiwan Tuna Association)). This could involve documenting gear loss frequency using GGGI's Reporter App or trialing REM onboard longline vessels to track ALDFG occurrence and its drivers. Additionally, Bumble Bee should explore partnerships with CNFC Overseas Fisheries Co. Ltd and Rongcheng Ocean Fishery Co. Ltd, the two companies managing the most active longliners in its supply chain, to enhance monitoring and reporting of ALDFG incidents.

Recommendation(s) in main report: 'Review of tuna FIP workplans and provision of feedback', 'Support trialing GGGI Reporter App on Connors Bros Herring Fleet' and 'Trial Remote Electronic Monitoring (REM) systems'.

Recommendation(s) in Annex 12: 'Advocate to RFMOs for ALDFG inclusion in monitoring standards'

2. **Lack of PRFs and EOL gear management in major ports of landing**. Spatial analysis of fishing effort corroborates findings that Suva is a significant hub for longliners within the Bumble Bee supply chain, though further research on the type and location of PRFs is required. This should be conducted in conjunction with the appropriate RFMOs. Stakeholders, for example, have indicated that Suva lacks EOL gear disposal infrastructure. Investing in the construction of gear collection sites would be an effective solution to facilitate the responsible disposal of EOL fishing gear and reduce the risk of fishing being discarded at sea. It has been proposed that a receptive site for an EOL PRF would be Pohnpei, FSM. Although not on the list of top longline ports, the potential to test such a facility in a receptive port is considered an important factor. This could then be followed by expansion to ports with higher prevalence of longline vessel use, for example Suva.

   Recommendation(s) in main report: 'Support research and increase access to Port Reception Facilities' and 'Support the establishment of an EOL collection point in Pohnpei, FSM'

   Recommendation(s) in Annex 12: 'Advocate to RFMOs on PRF standards and gear disposal'.

5.3 Blue Swimming Crab

5.3.1 Main Causes of ALDFG

Within Bumble Bee's supply chain, the Indonesian BSC fishery presents a high risk for ALDFG, particularly in gillnet and crab trap fisheries. Although this fishery represents only 0.8% of Bumble Bee's supply chain, it poses significant ecological and socio-economic challenges due to gear loss. Through a combination of literature and qualitative data collected during key informant interviews, ten primary drivers of ALDFG were categorized as either abandonment, loss, or intentional discarding. In most cases, drivers are linked to unintentional gear loss. These drivers are primarily influenced by environmental (bad weather and strong currents), social (low public awareness or concern, gear conflict, theft, and vandalism) and governance-related factors (insufficient MCS, inadequate gear marking, and absence of waste reception facilities). Stakeholder perceptions differed regarding the primary causes of gear loss. Seafood suppliers emphasized bad weather, while fisher interviews within the literature highlight gear conflict, indicating contrasting perspectives on the challenges faced within the fishery. To gain a deeper understanding of the drivers of gear loss, this deep-dive analysis engaged with stakeholders working closely within the fishery to confirm the root causes of gear loss and inform the development of practical solutions to help reduce the potential for ALDFG in the BSC fishery. The full methodology and scope of deep-dive analysis can be found in Annex 10.

5.3.2 Further Stakeholder Consultation

A stakeholder mapping exercise was conducted to identify key players within the BSC fishery. Based on the knowledge that PT Rex Canning, Bumble Bee's main supplier, sources its crab meat from fishers participating in the Indonesia Blue Swimming Trap and Gillnet FIP, the main stakeholders involved in the management of the FIP were contacted via email. In total, six key informant interviews were conducted, however, the leading partner implementing the FIP, Asosiasi Pengelolaan Rajungan Indonesia (APRI), did not respond.

Gear conflict between fishers emerged as a central issue in five interviews, driven in part by declining crab stocks, which have led many fishers to switch their gear to the now illegal mini trawls. These trawls frequently tow away or crush gillnets and crab traps, either accidentally or intentionally, when operating in the same area. Conflicts also arise among fishers using the same type of gear, particularly when one cuts another's buoy lines or nets to expedite the hauling process and prevent any damage to their own gear. Stakeholders noted that such incidents often go unreported, leaving fishers unable to find their gear.

Inadequate gear marking further exacerbates these conflicts. Fishers typically use marker buoys, jerry cans, or other readily available materials to mark their gear and do not include any clear identifiers to detail ownership. However, while these markers may be recognizable within local fishing communities, they are less visible to vessels towing mini trawls, which often operate at night to avoid detection. As a result, the risk of unintentional gear loss increases, and better methods of marking gear should be implemented by fishers.

Stakeholders also provided insights into the frequency of gear loss which is limited within the literature. Analysis reveals that within the crab trap fishery, buoys and individual traps are the most frequently lost, with three respondents reporting occasional loss of entire trap sets. In the gillnet fishery, five respondents indicated that main net losses occur “sometimes,” while floats and weights are lost less frequently. Given the lack of data, improving reporting mechanisms is essential for assessing the scale of gear loss. The GGGI Reporter App was suggested as a valuable tool for this purpose.

5.3.1 Spatial Analysis of Fisheries Activity Data

Due to the small-scale nature of the BSC fishery, no vessel information was available to support an analysis of fishing activity. However, further analysis on the status of the fishery and current ALDFG mitigation efforts by the Indonesian government and APRI as part of the Indonesian BSC crab trap and gillnet FIP is provided in Annex 11.

5.3.1 Conclusion

Through partnerships with organizations such as the FAO and GGGI, it is evident there is already work underway to address the causes of ALDFG and improve the management of small-scale fisheries. The Indonesian trap and gillnet FIP has taken important steps to raise community awareness of ALDFG impacts, discourage harmful practices like gear-cutting, launch local campaigns for ghost gear collection and reporting, and pilot more selective gear designs that reduce environmental impacts. However, the current scale of these initiatives is limited and needs to be expanded to effectively address the issue across the BSC fishery. A summary of the main findings, and recommendations to reduce ALDFG risks, is provided below.

1. **Inadequate gear marking** to visually indicate the location and extent of deployed fishing gear or the vessel owner. Collaborating with the NFI Crab Council, Sustainable Fishery Partnership and partners in the Indonesian BSC crab trap and gillnet FIP (e.g. APRI) to include gear marking measures as an action goal within the FIP.

   Recommendation(s) in main report: ‘Review of tuna FIP workplans and provision of feedback’,

2. **Improve reporting of gear loss**. There is a need to enhance gear loss reporting. A trial of the GGGI Report App could help facilitate accurate documentation of gear loss.

   Recommendation(s) in main report: ‘Support trialing GGGI Reporter App on Connors Bros Herring Fleet’.

6 Validation and Recommendations

Following completion of a risk assessment of Bumble Bee's entire wild capture seafood supply chain - including three in-depth case studies - and a comprehensive literature review, an analysis of actual identified gear loss drivers revealed the areas of highest ALDFG risk. These results led to a set of specific recommendations of additional activities beyond standard practice to drive feasible and lasting solutions to the problem of ALDFG, further solidifying Bumble Bee's leadership on the issue.

6.1 Validation Workshop

A Validation Workshop was held to present MRAG's characterization of Bumble Bee's supply chain as well as findings from the ALDFG risk assessment, followed by a discussion of proposed recommendations to corroborate and refine those recommendations with Bumble Bee and GGGI.

The workshop was held in-person in Santa Cruz, California, on Thursday November 21, 2024, with representatives from Bumble Bee, GGGI and MRAG attending. Additional participants joined remotely from these organizations. Workshop objectives included:

1. Presentation of data on Bumble Bee's supply chain, key findings from the ALDFG questionnaire, and risk assessment;
2. Insights from the deep-dive analysis into high-risk fisheries and priority action areas for ALDFG mitigation;
3. Discussion of MRAG's recommendations, focusing on their feasibility, effectiveness, and applicability for Bumble Bee; and
4. Receive feedback from Bumble Bee to further refine recommendations and ensure their feasibility and strategic value to the organization.

Following the workshop, the preliminary recommendations were refined to incorporate feedback received during our discussion. Recommendations include a description of each activity's relevance, based on the results of the risk assessment and factoring in the Bumble Bee team's guidance, and are followed by an implementation pathway section that provides explicit directions toward effectuating the activity. Each implementation pathway includes an "indicator section" which contains descriptions of "indicator," "personnel," "target," and "performance."

For each recommendation, the anticipated timeline to implement the recommendation's activity was provided. Based on expert judgement, this timeline indicates the time required to accomplish each activity from start to completion, with clear distinction between near-term, mid-term, and long-term actions. For recommendations with longer timeframes, activity has been broken down into actionable steps across multiple years. Bumble Bee's current workplan runs through 2026, with the next plan scheduled for 2027–2032. Therefore, with the exception of activities requiring immediate action and Phase 1 of "Support research and increase access to Port Reception Facilities," all recommended timelines are intended for implementation after 2026.

For ease of further dissemination, each recommended activity and corresponding implementation pathway are formatted such that they can be printed as a single page with text on both front and back, meaning that each recommendation is contained on its own stand-alone sheet.

The implementation pathway for each proposed activity includes the following elements:

Activity:	Concise title
Implementation:	When the activity should be started
Next steps:	Time-based, step-by-step description of how and when the activity should be implemented, including details on the key personnel responsible for accomplishing each activity
Stakeholders:	Stakeholders involved in and/or responsible for activity implementation
Cost estimate:	Low, low-medium, medium or high cost
Ease of Implementation:	An assessment of how easily the recommendation can be implemented. For example, ease may be higher when Bumble Bee has direct control over the activity compared to scenarios requiring action through an RFMO. (Easy, Medium or Difficult)
Opportunities and Incentives	Identified opportunities for how each recommendation can support Bumble Bee meet its sustainability goals.
Anticipated challenges	Anticipated challenges or barriers to implementation that need to be accounted for.
Timeframe:	Anticipated timeline for activity implementation (from start to completion)
Indicators:	SMART indicator(s) with targets, responsible stakeholders, and method of verification

6.2 Development of SMART Indicators

In the recommendations presented, we have used SMART indicators to clearly define objectives and enable GGGI and Bumble Bee to track progress and results against targets and baselines. SMART indicators are used as standard within management frameworks to establish objectives that are Specific, Measurable, Achievable, Relevant, and Time-bound. While some variations of these terms are occasionally used, such as *attainable*, *realistic*, or *timely*, the core principles of SMART remain consistent.

These five criteria provide a structured and transparent approach for setting and evaluating goals and objectives. They help ensure that progress can be tracked effectively against defined targets.

- **Specific**: Indicators should clearly address a particular issue or topic.
- **Measurable**: It should be evident how each indicator will be assessed in relation to baseline data and ongoing progress.
- **Achievable**: Indicators must be realistic and attainable within the scope of the overall plan.
- **Relevant**: Objectives should respond directly to a recognized need or priority.
- **Time-bound**: Each indicator should include a clear timeframe for completion or specify the expected duration of associated activities.

In the framework we propose for the recommendations, each of these five criteria is addressed. The following section illustrates how they are applied, with examples drawn from the nine recommendations.

Table 23. Examples from recommendations of the SMART indicator criteria.

Criteria	Framework	Examples
Specific	Activity and Stakeholder	Clear activity specified with phases where needed. *"Investigate opportunities to increase access to port reception facilities (PRFs) at strategically important ports of landing (Phase 1), including the establishment of an EOL fishing gear collection point in Pohnpei, FSM, (Phase 2) and other identified ports (Phase 3)."* Clear identification of stakeholders. *"Bumble Bee (VP of Responsible Sourcing & Sustainability and FIP Steering Committee), GGGI (Partnerships Manager) and industry partners"*
Measurable	Indicator and Timeframe	Clearly defined indicators *"EOL fishing gear collection facility established at Port of Pohnpei."* Clearly defined timeline *"1-2 year"*
Achievable	Cost, Anticipated Challenges and Timeframe	Cost estimates for cost for each recommendation according to clear scale. Challenges outlined. *"Vessel access for audits may be difficult to organize and implement. At the simplest level, this could be implemented through online self-declare forms."*
Relevant	Impact and Priority	Impact and strategic alignment outlined. *"Enhances Bumble Bee's commitment to responsible sourcing by ensuring all FIPs align with MSC Fisheries Standard Version 3.0 on ghost gear management."*
Time-bound	Implementation and Timeframe	Implementation and time frame both outlined. Implementation: *Immediate* Time Frame: *Completion expected within 1 – 2 years"*

6.3 Development of Priority Recommendations

Prioritization is a complex process that requires consideration of multiple factors, including impact, ease of implementation, cost, and strategic importance. For this analysis, priority will be based on a combination of these factors, initially focusing on the impact of each activity to reduce the potential occurrence and subsequent environmental impact of ALDFG relative to cost and ease

of implementation to identify activities that can be implemented quickly with low costs but have high potential impact. Other recommendations may be of high priority due to their strategic importance or volume/risk considerations but may require a longer timeline to execute due to higher costs or more complex implementation.

Recommendations will be categorized by their temporal scale, such as short-term (1–2 years), mid-term (3–4 years), and long-term (up to or over 5 years), as well as by priority. This approach helps to clearly distinguish activities that can be accomplished straight away from those that require long-term commitment and more significant resources.

Impact refers to the potential reduction in ALDFG through successful implementation, considering factors such as the efficacy in preventing ghost fishing, scalability (e.g. influencing CMMs across multiple RFMOs), or shaping EOL pathways at high-volume ports of landing.

Ease/complexity of implementation assesses the availability of partnerships and clear pathways for action, helping to determine the anticipated timeline for each activity. This includes assessing whether the activity can leverage existing relationships, or if new partnerships need to be developed. It also considers whether the activity is within Bumble Bee's direct control or requires external support, such as action through an RFMO. The complexity of these factors influences the timeline, with simpler, more self-contained activities likely to have shorter timelines.

Cost of implementation estimates the resources required to carry out each activity, factoring in internal capacity, potential need for external consultants, and investments in projects or capacity-building initiatives. Costs are categorized into four levels, as outlined in Table 24 to guide internal planning and resource management, distinguishing activities that can be implemented immediately from those requiring additional funding.

Table 24. Cost estimate brackets for activity.

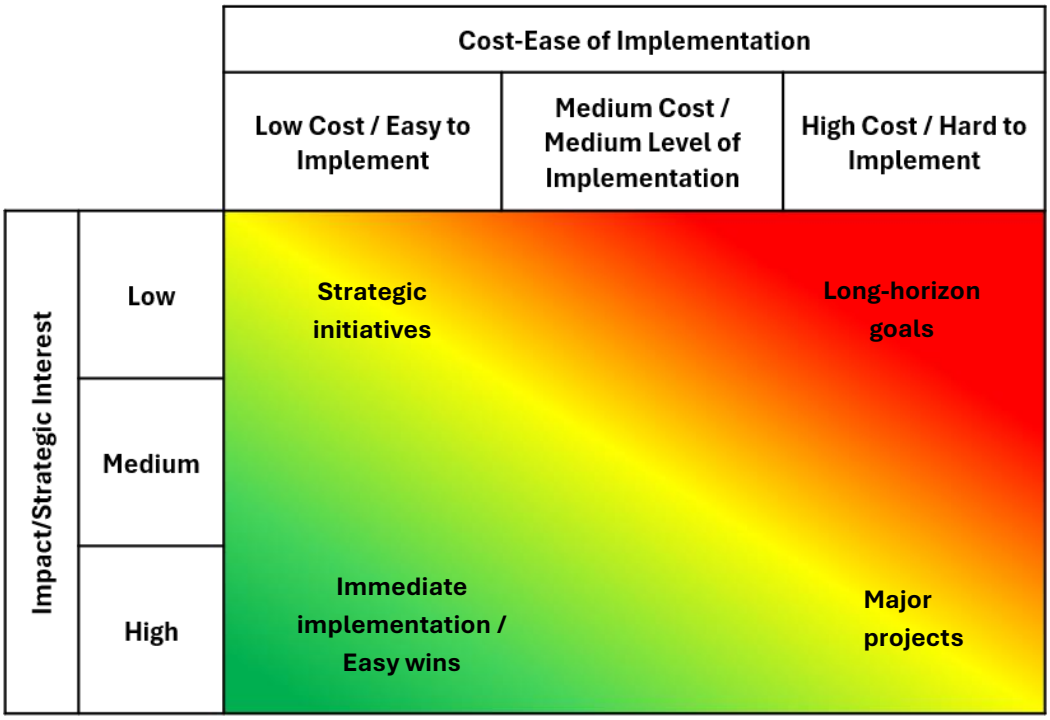
Cost	Description	Estimated Value
Low ($)	e.g. Procedural actions implemented using existing organizational structures and processes	<$5,000
Low-Medium ($$)	e.g. Additional company procedural actions, internal training, procurement of low-cost equipment	$5,000 - $10,000
Medium ($$$)	e.g. Additional company procedural actions, external training, procurement of low-cost equipment on a larger scale	$10,000 - $50,000
High ($$$$)	e.g. Procurement of high-cost equipment or investment into research projects/gear modification or gear marking trials.	$50,000 - $100,000

Strategic interests align with Bumble Bee's commitments to sustainability and its influential industry leadership, as informed by the input gathered during the Validation Workshop. Priority should be given to areas where Bumble Bee has established business interests, influence, and partnerships, particularly in specific ports (e.g. Suva) or through FCF connections. Targeting high-volume and high-risk fisheries in critical geographies presents substantial opportunities for addressing ALDFG. Notably, tuna purse seine and longline fisheries in WCPFC RFMO area offer a strategic focus, enabling Bumble Bee to leverage its position at RFMO meetings and collaborate with organizations like ISSF and GGGI to advocate for ALDFG-specific regulations, thereby driving systemic industry-wide change.

6.4 Identification of Priority Recommendations

Following the development of each recommendation and consideration of all four factors, these factors can be viewed against each other in a matrix, as shown in Figure 22, to determine their level of priority. Cost and ease of implementation are combined along the x-axis with regards to the associated resources and time required to accomplish each activity. The level of impact and strategic interest to Bumble Bee are indicated on the y-axis, with regards to the potential for ALDFG reduction in high volume and or high-risk fisheries. The intersection of these four parameters provide a way forward for the implementation sequence of each action.

Figure 22. Prioritization Matrix.



Recommendations with a high impact / strategic interest and low cost / easy to implement are the most straightforward decisions. Some of these recommended actions are categorized for '**Immediate implementation**' as they could be implemented as part of existing operational procedures and organizational structures. '**Easy wins**' also represent opportunities that are low cost but high priority. They are typically easy to implement and offer significant benefits, making them an attractive option for prioritization using additional operational procedures or organizational structures, often termed 'low-hanging fruit'. Within the same realm of high impact and strategic interest, recommendations with a high combined cost and low ease of implementation are classified as '**Major projects**'. These are large-scale actions that may require greater financial commitments and a longer timeframe to execute them.

On the other hand, recommendations with low impacts would have a lower initial priority unless of strategic importance. Low impact solutions with a low cost and that are easy to implement

would be considered for implementation as '**Strategic initiatives**', as these can be initiated based on the availability of resources and personnel and could prove beneficial, especially when combined with other higher impact measures (medium-low priority). Conversely, activities that are of low-impact, high-cost, and difficult-to-implement solutions would be classified as '**Long-horizon goals**' and should be scrutinized carefully to determine whether they justify implementation, considering the high capital expenditure for minimal return.

Based on the findings of this study, a set of recommendations has been developed, of which nine have been selected for inclusion in this report (Table 25). These recommendations align with the current priorities of GGGI and Bumble Bee and are categorized by priority level and proposed implementation timeline in the following section. Additional recommendations for future consideration are provided in Annex 12.

Table 25. Summary of Recommendations.

Implementation	Activity	Impact	Cost	Ease of Implementation	Strategic Interest	Timeline to accomplish (Years)				
						1	2	3	4	5
Activities for Immediate Implementation	Review of tuna FIP workplans and provision of feedback, including review of BSC FIP workplan.	Medium	Low	Easy	✓					
	Support trialing GGGI Reporter App on vessels that supply to Bumble Bee	High	Low	Easy	✓					
Easy Wins: High Priority Activities with Short Timeframe	Support research to increase access to PRFs	High	Medium	Medium	✓					
	Explore potential for enhanced gear marking	Medium	Low	Easy	✓					
Major Projects: Medium Priority Activities with Long Timeframe	Advocate to RFMOs on gear marking	Medium	Low	Difficult	✓					
	Trial Remote Electronic Monitoring (REM) systems	High	High	Difficult	×					
Long Horizon Goals: Medium to Low Priority Activities	Support participation in existing FAD retrieval initiatives	High	High	Difficult	✓					
	Support expanded vessel participation in FAD trials	High	High	Medium	✓					
	Encourage crew training on safe retrieval of lost or abandoned fishing gear	Medium	Medium	Medium	✓					

6.5 Activities for Immediate Implementation

High priority activities that have the potential be implemented straight away as part of existing internal procedures and can be accomplished within the next 1-2 years. Given the short timeline, a detailed schedule has been provided within the next steps to outline when specific actions should be executed and accomplished.

Recommendation 1: Review of Tuna FIP Workplans and Provision of Feedback

Specific Action:	Review the workplan of all tuna FIPs FCF participants in (Phase 1). Expand review process to include all tuna FIPs vessels supplying Bumble Bee engage with (Phase 2) and the Indonesia BSC trap and gillnet FIP (Phase 3)
Impact:	FIPs that have incorporated best practices to address ALDFG will attain a high score against the latest MSC Fisheries Standard Version 3.1. Importantly, having actions in place which directly address ghost gear can actively minimize the environmental impacts associated with gear loss and ghost fishing.
Target:	Atlantic Ocean tuna - longline (FCF) Indian Ocean tuna - longline (FCF) Pacific Ocean tuna - longline (FCF Co., Ltd) Pacific Ocean albacore tuna - longline (Taiwan Tuna Association; TTA)
Implementation:	**Immediate**
Timeframe:	**Completion expected within 1 – 2 years**

Relevance:

- FIPs working toward MSC certification can benefit from additional measures or activities to prevent, mitigate and remediate ALDFG.
- Bumble Bee can advocate for and support the inclusion of ghost gear management practices in the FIPs where FCF or Bumble Bee are participants.

Evidence:

- FCF participates in four tuna longline FIPs, serving as the FIP lead for three of them. It is agreed that all four FIP workplans should be included in the review; however, based on available information on FisheryProgress.org, none currently include specific measures reduce gear loss.
- With MSC assessments approaching (2025–2026), time is limited and potential amendments to the workplans could include crew training in gear maintenance, safe retrieval methods and protocols on proper storage of EOL fishing gear prior to disposal at PRFs, potentially building on operational practices and Codes of Conduct already in place.
- Procurement data indicates Bumble Bee sources tuna from additional FIPs e.g. Indonesia Southeast Sulawesi yellowfin tuna and skipjack tuna - purse seine FIP, where Tri Marine International is listed as a participant. Opportunity for Bumble Bee to collaborate with industry suppliers on FIPs beyond FCF/Bumble Bee's programmes.
- Bumble Bee also sources non-tuna products from FIPs, including high-risk BSC fisheries, and could review the Indonesian BSC trap and gillnet FIP workplan.

Implementation Pathway(s)

PHASE 1	
Activity:	Bumble Bee to collaborate with FCF to review all tuna FIP workplans.
Implementation:	**Immediate**
Next steps:	Preparation and Initial Review *(Months 1 - 6)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to work with the Partnerships Manager at GGGI and the Primary Contact from FCF for each FIP to review existing workplans and assess how they can integrate measures to minimize gear loss and its environmental impacts to meet MSC requirements. Update FIP Workplans *(Months 7 – 12)* 2. The Primary Contact from FCF to work with the other FIP leads (responsible for workplan) to update workplans with a ghost gear management strategy. Monitoring of Performance *(ad hoc)* 3. The FIP Steering Committee at Bumble Bee to monitor the completion of the reviews of each of the four active FIPs and update leadership if there have been any changes made.
Stakeholders:	Bumble Bee (VP of Responsible Sourcing & Sustainability & FIP Steering Committee), GGGI (Partnerships Manager), FCF (primary contact listed for each tuna FIP) and FIP leads (organization/individual responsible for Action Plan)
Cost estimate:	Low
Ease of Implementation:	Easy
Opportunities & Incentives	1. Enhances Bumble Bee's commitment to responsible sourcing by ensuring all FIPs align with MSC Fisheries Standard Version 3.0 on ghost gear management.
Anticipated challenges	1. FCF and other FIP stakeholders may have competing priorities, leading to delays in integrating ghost gear management into workplans.
Timeframe:	**Completion expected within 1 - 2 years**
Indicator:	**Indicator:** Number of tuna FIPs with a ghost gear management strategy **Personnel:** Bumble Bee, FCF, GGGI and FIP lead. **Target**: 100% of FIPs aligned with MSC Fisheries Standard Version 3.0 where it pertains to ghost gear. **Performance:** Annual FIP progress reports and audits.

PHASE 2	
Activity:	Collaborate with industry suppliers to ensure all tuna FIP workplans include actions addressing ghost gear
Implementation:	**Mid-term (2 – 4 years)**
Next steps:	Preparation and Engagement *(Months 1 - 6)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to engage with industry suppliers involved in Bumble Bee's supply chain that participate in tuna FIPs, including: a. Eastern Atlantic tuna - purse seine (Participant: Thai Union Europe) *b.* Indian Ocean tuna - purse seine (SIOTI); (Participant: Thai Union Europe) c. Indonesia Southeast Sulawesi yellowfin tuna and skipjack tuna - purse seine; (Participant: PBN - PT Pahala Bahari Nusantara, Tri Marine International) d. Pacific Ocean tuna - longline (Participant: StarKist) 2. The Partnerships Manager at GGGI to identify and assess additional GGGI members actively working to prevent ALDFG in their supply chains. Initial engagement opportunities include reaching out to Thai Union Europe, Tri Marine and StarKist. *3.* The VP of Responsible Sourcing & Sustainability at Bumble Bee to initiate strategic discussions with these companies to evaluate potential areas for collaboration. Update FIP Workplans *(Months 7 – 12)* 4. Collaborate with industry partners to review and propose updates to FIP workplans. Monitoring of Performance *(ad hoc*) 5. The FIP Steering Committee at Bumble Bee to monitor the completion of the reviews and update leadership if there have been any changes made.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability and FIP Steering Committee), GGGI (Partnerships Manager) and industry partners
Cost estimate:	Low
Ease of Implementation:	Medium – Industry suppliers and relevant FIPs already identified. However, due to lack of indirect involvement in FIP programmes and thereby lack of influence to change or update FIP workplans to include ghost gear management strategy.
Opportunities & Incentives	1. Expands industry-wide collaboration, leveraging collective influence to implement ghost gear management across multiple FIPs.
Anticipated challenges	1. Limited direct influence over FIPs led by other industry suppliers may make it challenging to push for workplan updates.
Timeframe:	**Completion expected within 2 - 4 years**
Indicator:	**Indicator:** Number of tuna FIPs with a ghost gear management strategy **Personnel:** Bumble Bee, industry partners and FIP lead (aka coordinator). **Target**: 100% of FIPs aligned with MSC Fisheries Standard Version 3.0 where it pertains to ghost gear. **Performance:** Annual FIP progress reports and audits.

PHASE 3	
Activity:	Bumble Bee to review the Indonesia BSC trap and gillnet FIP
Implementation:	**Long-term (anytime during 3 – 5 years)**
Next steps:	Preparation and Engagement *(Months 1 - 9)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee and Partnerships Manager at GGGI to collaborate with the NFI Crab Council, Sustainable Fisheries Partnership and APRI to review the Indonesia BSC trap and gillnet FIP workplan and propose updated, including mandatory gear marking. Liaise with P.T Rex Canning (participant) to help advocate updated measures. Update FIP Workplans *(Months 10 – 18)* 2. Work with FIP partners to integrate agreed changes into their operational framework. Update FIP Workplans *(ad hoc)* 3. Where necessary, the VP of Responsible Sourcing & Sustainability at Bumble Bee to work with FIP leads to update the workplan with a ghost gear management strategy. Monitoring of Performance *(ad hoc*) 4. The FIP Steering Committee at Bumble Bee to monitor the completion of the reviews of each of the FIPs and update leadership if there have been any changes made.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability and FIP Steering Committee) and industry/FIP partners
Cost estimate:	Low
Ease of Implementation:	Easy/Medium – Bumble Bee is already involved in the NFI Crab Council
Opportunities & Incentives	1. Strengthens partnerships with NFI Crab Council, SFP, and APRI, fostering collaboration on sustainable fishing practices.
Anticipated challenges	
Timeframe:	**Completion expected anytime up to 5 years**
Indicator:	**Indicator:** of the FIP has a ghost gear management strategy **Personnel:** Bumble Bee, industry partners and FIP lead. **Target**: FIP aligns with MSC Fisheries Standard Version 3.0 where it pertains to ghost gear. **Performance:** Annual FIP progress reports and audits.

Recommendation 2: Support Trialing GGGI Reporter App on Connors Bros Fleet

Specific Action:	Trial the GGGI Reporter App on Connors Bros Herring Fleet (Phase 1) and consider expanding to other fisheries (e.g. FCF-associated vessels) (Phase 2)
Impact:	Opportunity to trial the GGGI Reporter App to test its efficacy and user-friendliness in a commercial fleet prior to expanding to high-risk tuna fleets. This would provide Bumble Bee/FCF with a unified reporting system to understand trends in ALDFG and enable anonymized data sharing with regulatory bodies, RFMOs, and national authorities to inform evidence-based prevention strategies.
Target:	Connors Bros herring fleet (initially one or two vessels and expanding later to cover all vessels)
Implementation:	**Immediate**
Timeframe:	**Completion expected within 1 – 2 years**

Relevance:

- Digital reporting tools, such as the GGGI Reporter App, can standardize and formalize ALDFG data collection across Bumble Bee's supply chain.
- Transitioning from logbook entries to structured digital reporting enhances transparency.

Evidence:

- Within tuna fisheries, survey results indicate logbooks are used for gear loss reporting, but data are not standardized and rarely shared beyond vessel owners or fishing companies.
- To address this, the GGGI Reporter App offers a readily available solution for standardized, real-time gear loss and recovery reporting, and has the potential for adoption in FCF's fleet.
- Bumble Bee can pilot the App on Connors Bros vessels to gather feedback on user-friendliness and assess data utility to understand ALDFG drivers and inform management.

Implementation Pathway(s)

PHASE 1	
Activity:	Bumble Bee to collaborate with GGGI to implement the GGGI Reporter App with Connors Bros herring fleet vessels.
Implementation:	**Immediate**
Next steps:	Preparation and Engagement *(Months 1 - 2)* 1. The Partnerships Manager at GGGI to engage with the Director of Marine Operation at Connors Bros to introduce the GGGI Reporter App and distribute a briefing package/training materials for the vessel operators. Pilot Implementation *(Months 3 – 6, during the herring season)* 2. GGGI to provide real-time assistance to operating vessels and gather user feedback. Midpoint Evaluation *(Month 7 – 12)* The VP of Responsible Sourcing & Sustainability at Bumble Bee to review post-season results with GGGI and any fisher feedback received from the Connors Bros pilot study. Second Pilot Implementation, if needed *(Second herring season)* 3. GGGI to provide real-time assistance to operating vessels (assumed to be the same pilot vessels) and gather user feedback. 4. The VP of Responsible Sourcing & Sustainability at Bumble Bee to assess the feasibility of expanding the App to other fisheries, such FCF-associated vessels.
Stakeholder:	GGGI (Partnerships Manager), Connors Bros (TBC), and Bumble Bee (VP of Responsible Sourcing & Sustainability).
Cost estimate:	Low
Ease of Implementation:	Easy – Readily available solution and GGGI already has the materials lined up to be shared with Connors Bros.
Opportunities & Incentives	1. Real-time data entry reduces reliance on informal reporting, improves traceability in the supply chain, and enhances ALDFG data for broader use.
Anticipated challenges	1. Operators may find app usage cumbersome or time-consuming.
Timeframe:	**Completion expected within 1 - 2 years; evaluation over 2 years**
Indicator:	**Indicator:** Number of vessels providing positive feedback on the GGGI Reporter App **Personnel:** Bumble Bee, GGGI. **Target**: 100% satisfaction among vessels using the GGGI Reporter App. **Performance:** Feedback from fishers.

PHASE 2	
Activity:	Advocate for expansion to FCF-associated vessels (purse seine and longline)
Implementation:	**Mid-term (2 – 3 years)**
Next steps:	*Feasibility Assessment (Months 1–6)* 1. VP of Responsible Sourcing & Sustainability at Bumble Bee to initiate discussions with FCF to discuss the feasibility of FCF-associated vessels using the GGGI Reporter App. 2. The Partnerships Manager at GGGI to collaborate with FCF to introduce the App and distribute a briefing package/training materials for vessel operators. 3. Key personnel from the FCF purse seine and longline department to determine which FCF-associated vessels will participate in the initial rollout of the App. *Pilot implementation (Months 7 – 18)* 4. GGGI to monitor App usage and provide real-time assistance to operating vessels. *Midpoint Evaluation (Month 19 – 24)* 5. FCF and Bumble Bee to review the performance of the GGGI Reporter App (e.g. level of engagement from vessel operators and type of information submitted) with GGGI, identifying trends in ALDFG reporting. *Full implementation (Month 25 – 48)* 6. FCF to expand App adoption beyond pilot vessels, targeting full-scale implementation across all FCF-associated longline and purse seine vessels.
Stakeholder:	GGGI (Partnerships Manager), FCF (TBC), Bumble Bee (VP of Responsible Sourcing & Sustainability).
Cost estimate:	Low
Ease of Implementation:	Medium- Difficult to train and onboard all vessel operators due to differing schedules of fishing trips and time spent at sea. Engagement will need to be flexible and on an *ad hoc* basis to distribute briefing package/training materials.
Opportunities & Incentives	1. Expands traceability efforts across a broader segment of the tuna supply chain and positions FCF and Bumble Bee as industry leaders in proactive ALDFG reporting.
Anticipated challenges	1. Some operators may be hesitant to adopt new reporting tools or may operate in areas with limited connectivity, affecting real-time data uploads.
Timeframe:	**Completion expected within 2 – 4 years**
Indicator:	**Indicator:** Number of FCF-associated vessels actively using the GGGI Reporter App. **Personnel:** Bumble Bee, FCF, GGGI. **Target**: Comprehensive data collected for high-risk tuna vessels. **Performance:** Level of engagement from vessel operators and type of information submitted

6.6 Easy Wins: High Priority Activities with Short Timeframe

High priority activities that can be started quickly (within one year) due to minimal cost or complexity and be accomplished within 2 years. Given the short timeline, a detailed schedule has been provided within the next steps to outline when specific actions should be executed and accomplished.

Recommendation 3: Support Research and Increase Access to Port Reception Facilities

Specific Action:	Investigate opportunities to increase access to port reception facilities (PRFs) at strategically important ports of landing (Phase 1), including the establishment of an EOL fishing gear collection point in Pohnpei, FSM, (Phase 2) and other identified ports (Phase 3).
Impact:	Expanding vessel access to port reception facilities would enable EOL fishing gear to be returned to port where it can be disposed of responsibly to ensure that it does not make its way back into the marine environment.
Target:	Suva (Fiji), Port Louis (Mauritius) and Levuka (Fiji)
Implementation:	**Near-term (within one year)**
Timeframe:	**Completion expected within 2 - 4 years**

Relevance:

- Strategic development of PRFs at key ports of landing can significantly reduce ALDFG and support Bumble Bee's sustainability goals.
- Leveraging existing PRF infrastructure by enhancing disposal options, extending operating hours, and minimizing fees can encourage responsible EOL gear management.
- Identifying high-usage ports is crucial for exploring recycling opportunities and developing strategic partnerships.

Evidence:

- Stakeholder analysis highlighted longline gear as having a significant potential to become ALDFG. Procurement data shows longline fisheries contribute 34% of total tuna landings, yet important ports of landing for this gear type lack adequate facilities for EOL gear disposal.

Ports with inadequate PRFs include Port of Suva (Fiji), Port Louis (Mauritius), Port of Levuka (Fiji), Port of Tarawa (Kiribati), Port of Pohnpei (FSM), Port of Funafuti (Tuvalu), Port of Kosrae (FSM), Port of Rabaul (PNG) and Port of Spain (Trinidad and Tobago). A full list of ports analysed is available in

- Table 12.
- A situation analysis is required to assess disposal requirements and identify appropriate management strategies for collected EOL fishing gear at each port.
- Particular focus should be given to the Port of Pohnpei, where Bumble Bee has an existing relationship and confirmed support for a new disposal facility in the Validation Workshop.

Implementation Pathway(s)

PHASE 1	
Activity:	Research the potential to improve access to PRF in strategically important ports of landing
Implementation:	**Near-term (within one year)**
Next steps:	Initial Engagement and Feasibility Assessment *(Months 1- 6)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to collaborate with FCF to engage port authorities at strategically important ports of landing (Longline: Suva, Port Louis, Levuka; Purse Seine: Tarawa, Rabaul, Pohnpei and Funafuti) and advocate for improved PRF access and facilities to handle EOL fishing gear. Port Situation Analysis *(Months 7 – 12)* 2. The Port Authority at Suva, Port Louis and Levuka to undertake a situation analysis to evaluate current PRF capabilities and identify opportunities for enhancement, such as extended hours, reduced fees, and dedicated EOL gear disposal bins. Assess potential value chains for recycling or repurposing collected gear. Generate roadmap for next steps. Evaluation *(Months 13 – 24)* 3. The VP of Responsible Sourcing & Sustainability at Bumble Bee to review the findings of each port situation analysis and engage in discussions with the relevant port authority and GGGI on how Bumble Bee can support the improvement of current PRFs to handle EOL fishing gear.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (TBC) and port authorities
Cost estimate:	Low
Ease of Implementation:	Easy – collaboration with existing contacts and FCF connections to consult port authorities and develop an action plan.
Opportunities & Incentives	1. Bumble Bee, through its partnerships with port authorities and FCF connections, is well-positioned to drive improvements in PRF accessibility and EOL gear disposal processes.
Anticipated challenges	1. Regulatory and logistical challenges in expanding PRF access, such as extending hours or reducing fees. 2. Potential lack of engagement from fishers if PRF facilities are not easily accessible or properly managed.
Timeframe:	**Completion expected within 2 years**
Indicator:	**Indicator:** Number of strategically important ports contacted, and situation analysis completed and reviewed by Bumble Bee **Personnel:** Bumble Bee, FCF, GGGI and port authorities **Target**: 100% of strategically important ports equipped with a road map to improve PRFs. **Performance:** Annual progress reviews completed by port authorities.

PHASE 2	
Activity:	Support the establishment of a EOL fishing gear collection point in Pohnpei, FSM
Implementation:	**Near-term (1-2 years)**
Next steps:	Initial Engagement and Feasibility Assessment *(Months 1–6)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee (or their designee) to engage the Pohnpei Port Authority to initiate discussions on how Bumble Bee can support the establishment of an EOL fishing gear collection facility. 2. The Pohnpei Port Authority to conduct a site assessment, develop cost estimate for construction and send to Bumble Bee for review. Operational Planning and Infrastructure Development *(Months 7–12)* 3. The Pohnpei Port Authority begin the procurement and installation of required infrastructure (e.g. waste bins, storage containers, security measures, signage, etc.). 4. The Partnerships Manager at GGGI to support the development of operational guidelines for gear collection, processing and disposal of EOL fishing gear. Establishment of EOL collection point (*Month 13 – TBC*) 5. Pohnpei Port Authority to supervise the establishment of EOL collection point. Training for Fishers and Vessel Operators *(dependent on completion of facility)* 6. The Partnerships Manager at GGGI to support the development of training materials and guidelines for fishers/vessel operators on how to use the PRFs. 7. The Port Authority to engage with shipping agents to distribute the guidelines to their vessels to ensure all ALDFG are disposed of properly.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), GGGI (Partnerships Manager) and Port Authority in Pohnpei.
Cost estimate:	Medium
Ease of Implementation:	Medium - leverage existing relationships with the Pohnpei Port Authority.
Opportunities & Incentives	1. Pohnpei currently lacks a PRF, making this initiative a high-impact intervention to reduce ALDFG.
Anticipated challenges	1. Reliance on the port authority to execute the establishment of the facility, with the potential for external funding if needed.
Timeframe:	**Completion expected within 2 years**
Indicator:	**Indicator:** EOL fishing gear collection facility established at Port of Pohnpei. **Personnel:** Bumble Bee and Pohnpei port authority. **Target**: Vessels responsibly dispose of EOL fishing gear at the collection facility **Performance:** Annual progress reviews completed by port authority.

PHASE 3	
Activity:	Support the establishment of a EOL fishing gear collection points in strategically important ports of landing identifed in Phase 1
Implementation:	**Mid-term (2 – 4 years)**
Next steps:	Operational Planning and Infrastructure Development *(Months 1 – 12)* 1. Port Authorities to conduct site assessments and develop infrastructure needs for collection points (e.g., storage, signage, waste management), send to Bumble Bee to review and confirm how they will support development. 2. The Partnerships Manager at GGGI to work with Bumble Bee to support the development of operational guidelines for gear collection and management e.g. subsequent responsible disposal / potential value chain if recycling opportunities have been identified during the research. Establishment of an enhanced EOL collection point *(Months 13 – TBC)* 3. Port Authority to supervise the establishment of an enhanced EOL collection point. Training for Fishers and Vessel Operators *(dependent on completion of facility)* 4. The Partnerships Manager at GGGI to work with Bumble Bee to create and distribute training materials for vessel operators on proper usage of PRFs.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), GGGI (Partnerships Manager) and Port Authority in Pohnpei.
Cost estimate:	Medium
Ease of Implementation:	Medium - leverage existing relationships with port authority to facilitate coordination and implementation of an EOL fishing gear collection facility
Opportunities & Incentives	1. Expands responsible disposal options at frequently visited fishing ports, reducing ALDFG risks. 2. FCF and other partners shown to tbe driving systemic improvements in PRF access.
Anticipated challenges	1. Unknown capacity for ports to manage EOL fishing gear once collected.
Timeframe:	**Completion expected within 2 – 4 years**
Indicator:	**Indicator:** Number of ports equipped to handle EOL fishing gear disposal. **Personnel:** Bumble Bee, FCF, port authorities and GGGI. **Target**: Establish PRFs in 100% of identified high-volume ports (e.g. Suva, Levuka, Port Louis, Tarawa, Rabaul, & Kosrae). **Performance:** Annual progress reviews completed by port authorities.

Recommendation 4: Explore Potential for Enhanced Gear Marking

Specific Action:	Perform audit of FCF-associated vessels / gear and ensure gear marking is implemented where possible.
Impact:	All components of fishing gear that require marking , as defined by relevant RFMOs or other regulatory bodies, clearly identifiable as belonging to a particular vessel, thereby reducing ALDFG risks and enhancing accountability.
Target:	FCF-associated vessels
Implementation:	**Near-term (1-2 years)**
Timeframe:	**Completion expected within 2 - 3 years**

Relevance:

- Gear marking is a fundamental best practice to reduce the likelihood of gear loss and increase subsequent recovery of ALDFG.
- All vessels should employ a standardized gear marking system to indicate the position, nature and extent of fishing gear, as well as marked with an “identifier” (e.g. IMO number).
- This practice increases gear visibility, reduces any dangers to navigation or collisions at sea associated with unattended fishing gear and aids in the recovery and identification of lost gear.

Evidence:

- All fisher respondents were representatives of FCF and there was clear alignment in their gear marking practices, with most fishers marking the name of the vessel on the buoy.
- However, FCF only responded “some gear” was marked (e.g. for purse seine vessels) and did not provide any details to describe how longline vessels mark their gear (see Annex 13).
- Bumble Bee should work closely with FCF to assess current gear marking practices on FCF-associated vessels to identify gaps and implement improvements.

Implementation Pathway(s)

Activity:	Perform audit of FCF-associated vessels / gear and ensure gear marking is implemented where possible.
Implementation:	**Near-term (1 – 2 years)**
Next steps:	Initial Engagement and Data Collection *(Months 1 – 3)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to work with key personnel at FCF to engage with vessel operators supplying raw materials to FCF and collect information on their current gear marking practices. Situation Analysis and Compliance Review *(Months 4 – 6)* 2. FCF to conduct a situation analysis to ensure gear marking is implemented and identify any vessels not adhering to international standards, as outlined in RFMO CMMs such as WCPFC CMMs 2017-04 and 2018-01, and best practice outlined in GGGI's C-BPF and FAO VGMFG. Vessel Outreach *(Months 7 – 12)* 3. FCF to engage with vessel operators and either conduct training workshops or distribute training materials to ensure crew are trained in effective gear marking. 4. The VP of Responsible Sourcing & Sustainability at Bumble Bee to work with
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (TBC) and GGGI (Partnerships Manager)
Cost estimate:	Low
Ease of Implementation:	Easy – collaborate with FCF to reach out to all vessels
Opportunities & Incentives	1. FCF, as a major tuna supplier in WCPFC region, serves as a significant example to other fisheries and RFMO delegates, demonstrating leadership in sustainable practices. This aligns with Bumble Bee's broader goals of advocating for standardized practices in the tuna industry, setting a precedent for others to follow.
Anticipated challenges	1. Vessel access for audits may be difficult to organize and implement. At the simplest level, this could be implemented through online self-declare forms.
Timeframe:	**Completion expected within 2 years**
Indicator:	**Indicator:** Percentage of vessels reported to follow gear marking protocols. **Personnel:** Bumble Bee, FCF and GGGI. **Target**: 100% of FCF-associated vessels report gear marking in place. **Performance:** Supplier audit and documentation review. Repeat the same process every two years to document progress over time.

6.7 Major Projects: Medium Priority Activities with Long Timeframe

High-priority, large-scale actions that require significant resourcing or financial commitments. These projects should begin within 1-2 years, but given their complexity and scope, they may take 5+ years to complete. At this stage, only an estimated timeline is provided.

Recommendation 5: Advocate to RFMOs on Gear Marking

Specific Action:	Bumble Bee to partner with ISSF to advocate for mandatory gear marking standards in RFMOs, ensuring alignment with ISSF and FAO's VGMFG.
Impact:	Improved regulatory consistency across tuna fisheries. All fishing gear clearly identifiable and abandonment and discarding of fishing gear is reduced.
Target:	Tuna fisheries in WCPFC, IOTC, IATTC, and ICCAT regions (e.g. longline fishery and FAD associated fisheries) Non-tuna fisheries using mobile fishing gear in relevant RFMOs (e.g. NEAFC for herring, sprat and mackerel).
Implementation:	**Near-term (1-2 years)**
Timeframe:	**Full adoption may take 5+ years.**

Relevance:

- Fishing gear should be marked in accordance with national and international legislation in order to identify the owner of fishing gear, in particular ALDFG.
- Promoting standardized gear marking at the RFMO level would improve compliance, facilitating better gear reporting, tracking and retrieval in Bumble Bee's supply chain.
- Advocating for uniform gear marking promotes broader industry participation beyond Bumble Bee's direct control, reducing oversight burden on Bumble Bee while ensuring consistent implementation across their supply chain.

Evidence:

- Survey results highlight inconsistent gear marking practices e.g. Grupomar (IATTC) and Rongcheng Chuangxin Foodstuffs (WCPFC) and Denholm Seafoods (NEAFC) which reported no gear marking. A summary of gear marking systems is presented in Annex 13.
- While some RFMOs exempt pelagic trawls from gear marking (e.g. under Article 7 of the NEAFC's Scheme of Control and Enforcement)[41] some companies, including Interfish Limited and NorthBay Pelagic, voluntarily mark their gear with vessel PLNs. Additionally, Thai Union / King Oscar follows ISSF and FAO marking guidelines for their pelagic trawl and purse seine fisheries in the NEAFC region, indicating an industry willingness to comply with mandatory gear marking requirements.

[41] NEAFC Scheme of Control and Enforcement

Implementation Pathway(s)

Activity:	Advocate for mandatory gear marking standards in RFMOs
Implementation:	**Near-term (1-2 years)**
Next steps:	Collaborate with GGGI and ISSF *(Months 1 – 24)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to collaborate with GGGI and ISSF to put forward and promote mandatory gear marking standards at various tuna RFMO meetings, with a particular focus on WCPFC. 2. The Partnerships Manager at GGGI to help generate support with other GGGI members to support the notion for mandatory gear marking standards at various tuna RFMO meetings.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), ISSF (TBC) and GGGI (Partnerships Manager)
Cost estimate:	Low
Ease of Implementation:	Medium – needs to be advocated through national delegations or like-minded NGOs active in specific RFMOs
Opportunities & Incentives	1. By leveraging ISSF's established relationships with tuna RFMOs and their position as a leading advocate for sustainable fishing practices, Bumble Bee can effectively amplify their influence to drive this change to ensure that the fisheries they source from are obligated to enforce gear marking.
Anticipated challenges	1. Time to push through each of the RFMOs will increase difficulty.
Timeframe:	**Full adoption may take 5+ years.**
Indicator:	**Indicator:** Number of RFMOs adopting gear marking standards. **Personnel:** Bumble Bee, like-minded NGOs, RFMOs, and key industry stakeholders. **Target**: 100% alignment of key RFMOs with FAO gear marking guidelines. **Performance:** Regular reviews of RFMO policies and ISSF advocacy outcomes.

Recommendation 6: Trial Remote Electronic Monitoring Systems

Specific Action:	Bumble Bee to collaborate with FCF to promote and provide support for trial remote electronic monitoring (REM) onboard FCF-associated vessels, preferably in conjunction with IOTC or WCPFC, to monitor and record ALDFG occurrence and drivers.
Impact:	Better monitoring and estimation of rates of ALDFG.
Target:	FCF-associated vessels operating tuna longline vessels
Implementation:	**Near-term (1-2 years)**
Timeframe:	**Trial for 5 years.**

Relevance:

- REM systems offer in the long-term a potentially cost-effective and scalable solution to monitor fishing activities, identify the frequency and causes of gear loss, and enhance compliance with best practices.
- Advances in data recording, AI integration, and encrypted storage have improved REM's usability, making it a viable tool for monitoring at sea activities.
- REM data can complement observer programmes, support RFMO compliance, and inform gear management policies in Bumble Bee's supply chain.

Evidence:

- Longline tuna fisheries, identified as high-risk, high-volume fisheries, operate predominantly in the Western Pacific and Indian Ocean, where longline observer coverage remains low (5%)
- No RFMO currently mandates REM, but trialing REM on FCF-associated vessels presents an opportunity to bridge observer coverage gaps and enhance ALDFG monitoring.
- Bumble Bee has requested FCF to initiate REM trials on longline fleets to improve data collection where observer coverage is low.
- Bumble Bee could explore potential partnerships with technology providers to trial REM and ensure systems align with RFMO standards and provide robust, reliable data.

Implementation Pathway(s)

Activity:	Trial REM systems onboard FCF-associated longline vessels for detection and quantification of ALDFG
Implementation:	**Near-term (1-2 years)**
Next steps:	Development of feasibility of REM trials with FCF and other partners (*Months 1 - 6*) 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to continue discussions with FCF leadership on the feasibility of trialing REM systems onboard FCF-associated vessels. Assess technical requirements, cost-sharing opportunities, and logistical considerations for REM deployment. 2. The VP of Responsible Sourcing & Sustainability at Bumble Bee and FCF leadership to collaborate with the Partnerships Manager at GGGI to identify and engage with technology providers to ensure their systems operate onboard longline vessels, ensuring systems align with RFMO standards. Pilot stage (*Months 7 - 42*) 3. During the data collection of pilot stage, select a representative subset of longline vessels for initial REM installation. Trial the REM systems for three years. When the data has been collected from the longline vessels (variable depending on trip length), conduct a comparative analysis of REM data against observer-reported ALDFG occurrences to assess accuracy and reliability. Development strategy and best practice guidelines (*Months 42-60*) 4. If the pilot is successful, refine deployment strategy and expand REM coverage across a broader share of FCF's fleet. 5. Alongside GGGI, develop best practice guidelines for REM-based ALDFG monitoring to support future RFMO regulations.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (TBC), ISSF (TBC), GGGI (Partnerships Manager) and EM provider
Cost estimate:	High
Ease of Implementation:	Difficult – Needs to work across various regions and varied REM systems and fleets
Opportunities & Incentives	1. Strengthens Bumble Bee's ability to document gear loss and ensure best practices are followed. 2. Provides robust evidence to advocate for stronger ALDFG monitoring regulations.
Anticipated challenges	1. Significant upfront costs for equipment, installation, and training. 2. Fishers may be hesitant to adopt REM due to concerns over surveillance and operational changes. 3. Variability in REM system capabilities and regional fleet operations may complicate standardization. 4. Lack of current REM mandates may slow adoption and regulatory acceptance. 5. Requires secure storage, review mechanisms, and trained personnel to handle large REM datasets.
Timeframe:	**Completion expected in 5 years**
Indicator:	**Indicator:** Number of successful detections of ALDFG during trial period- **Personnel:** Bumble Bee, FCF, ISSF, GGGI and EM provider. **Target**: Trials onboard longline vessels demonstrate the ability to detect and quantify ALDFG through REM **Performance:** Annual evaluation of REM deployment and reporting of ALDFG.

6.8 Long Horizon Goals: Medium to Low Priority Activities

Medium to low priority activities are those that may require more resources or external partnerships, and may take a long time to implement (e.g. up to five or more, especially if there is a requirement for agreement through RFMOs). The timescale may be improved through collaborative partnerships, sharing resource burdens or increasing pressure for change. Cooperation could be with industry bodies (e.g. ISSF), like-minded NGOs (e.g. WWF or through GGGI), or other commercial companies that share the same view and direction on specific topics. At this stage, only estimated timelines are provided.

Recommendation 7: Support Participation in Existing FAD Retrieval Initiatives

Specific Action:	Collaborate with FCF to expand participation among fishers operating in the Pacific Ocean with FAD retrieval programmes in the Pacific Ocean.
Impact:	Reduced FAD beaching and ghost fishing incidents in key tuna fisheries, particularly in the Pacific Ocean where FAD use is high in purse seine fisheries.
Target:	Tropical tuna purse seine fisheries targeting skipjack and yellowfin tuna (FCF-associated vessels and other supplier fishing companies)
Implementation:	**Near-term (1-2 years)**
Timeframe:	**Long-term (3-5 years)**

Relevance:

- Current FAD recovery programmes include FAD Watch in the Indian Ocean, TNC's Palmyra project and Iniciativa Cuidando, with TUNACONS, in the Pacific Ocean and Satlink's Project ReCon engaging with fleets targeting tuna in the Pacific, Indian and Atlantic Ocean.
- Participation in FAD recovery programmes is in adherence to CMM 2023-03 in the Eastern Pacific Ocean (IATTC), and CMM 23-03 in the Western Pacific Ocean (WCPFC). This may best be achieved through industry bodies such as ISSF.

Evidence:

- Stakeholders highlight logistical and economic barriers to recovering lost FADs, particularly when they drift to inaccessible areas. It was noted that the high fuel costs and loss of fishing opportunities often result in abandonment.
- Some tuna companies are engaged in FAD recovery initiatives, such as Satlink ReCon, TNC's Palmyra Project, Iniciativa Cuidando, and the SPC lost FAD retrieval project.
- Three fishers and one tuna longline company reported a lack of existing retrieval measures, particularly within WCPFC region under FCF's fleet, signaling an opportunity for improvement.
- Bumble Bee should collaborate with FCF to engage more fishers in retrieval trials, focusing on initiatives like TNC's Palmyra Project and Satlink's ReCon, which operate in the Pacific Ocean.
- Beyond FCF's fleet, Bumble Bee could engage with other tuna fishing companies using FADs, as identified in the deep-dive assessment. These companies include Caroline Fisheries Corp., Inc., Ocean Conquest (Nauru) Limited, Ocean Encounter (Nauru) Limited, Taijin Gyogyo Kabushiki Kaisha, and Searich Seafood Co., Ltd (see Table 9; Annex 10).

Implementation Pathway(s)

Activity:	Support participation of FCF-associated vessels in existing FAD retrieval initiatives.
Implementation:	**Near-term (1-2 years)**
Next steps:	Coordination with FCF *(Months 1 - 12)* 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to work with FCF to assess the feasibility of FCF-associated vessels participating in FAD retrieval programmes. Focusing on initiatives operating in the Pacific Ocean, including TNC's Palmyra Project, Iniciativa Cuidando, and Satlink's Project ReCon. 2. Key personnel at FCF to engage with vessel operators to understand their willingness to participate. Implementation (*Months 13+)* 3. The VP of Responsible Sourcing & Sustainability at Bumble Bee to engage with FCF, expanding out to Tri Marine and other fishing companies using DFADs, to encourage vessels to provide position data as required under the relevant RFMO CMM, and the company which owns the FAD ensures retrieval before it reaches shallow waters, and retaining recovered DFADs for appropriate disposal.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (TBC), Tri Marine (TBC), and other fishing companies (as identified above)
Cost estimate:	Low
Ease of Implementation:	Medium – Requires industry collaboration
Opportunities & Incentives	1. Increasing participation in retrieval programmes aligns with WCPFC's CMM 23-03, which sets FAD recovery and data-sharing obligations in the Western Pacific.
Anticipated challenges	1. Some vessels may be reluctant to participate due to increased operational costs and logistical challenges.
Timeframe:	**Completion expected within 3 - 5 years**
Indicator:	**Indicator:** Number of FCF vessels participating in FAD retrieval programmes. **Personnel:** Bumble Bee, FCF **Target**: Increase FCF vessel participation by 10% annually . **Performance:** Annual progress reports to Bumble Bee from FAD retrieval partners.

Recommendation 8: Support Expanded Vessel Participation in FAD Trials

Specific Action:	Expand participation in FAD modification trials that promote the use of biodegradable materials in DFAD construction
Impact:	Contribute to the advancement of biodegradable gear design for FAD construction, developing more ecologically sustainable FADs to reduce the lifespan and subsequent impact of FADs on marine animals and ecosystems reducing the potential of ghost fishing.
Target:	Tropical tuna purse seine fisheries targeting skipjack and yellowfin tuna (FCF-associated vessels and other supplier fishing companies)
Implementation:	**Near-term (1-2 years)**
Timeframe:	**Long-term (3 - 5 years)**

Relevance:

- Biodegradable FAD trials are essential to demonstrate effectiveness without impacting catch volume and value.
- Participation in FAD trials not only strengthens industry support for sustainable practices but also aligns Bumble Bee with emerging standards and innovations in responsible gear management.

Evidence:

- Survey responses from five fishers and three suppliers indicate they already use DFADs with non-entangling mesh and biodegradable components, primarily in WCPFC RFMO area, and vessels are already trialing biodegradable FAD designs.
- ISSF-led initiatives, such as Jelly FAD trials, have been instrumental in advancing biodegradable gear development.
- Efforts should concentrate on fisheries within the WCPFC region, which represents the highest fishing effort and is a key supply area for Bumble Bee.
- The deep-dive assessment identified fishing companies with the highest fishing effort which would be potential trial candidates due to increased ALDFG risks (see Annex 9).

Implementation Pathway(s)

Activity:	Support and expand vessel participation in biodegradable FAD trials
Implementation:	**Near-term (1-2 years)**
Next steps:	Coordinate with ISSF (*Months 1-3*) 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to collaborate with ISSF to support and invest in Jelly FAD testing, and trials of other biodegradable FAD materials, including existing and emerging options within strategically important fisheries. Fisheries where implementation is most feasible, impactful, or urgently needed. The main focus should be on tropical tuna purse seine fisheries targeting skipjack and yellowfin tuna in the WCPFC region. Engagement with vessel operators (*Months 4 – 24)* 2. The VP of Responsible Sourcing & Sustainability at Bumble Bee to work closely with key personnel at FCF and Tri Marine to engage with vessel operators and increase vessel participation in FAD-trialing projects (such as ISSF Jelly FADs). 3. The VP of Responsible Sourcing & Sustainability to lead outreach efforts targeting additional tuna fishing companies identified in the deep-dive assessment to encourage and facilitate participation in biodegradable FAD trials. Companies including Caroline Fisheries Corp., Inc., Ocean Conquest (Nauru) Limited, Ocean Encounter (Nauru) Limited, Taijin Gyogyo Kabushiki Kaisha, and Searich Seafood Co., Ltd. .
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (TBC), Tri Marine (Amanda Hamilton) and other fishing companies (as identified above)
Cost estimate:	High
Ease of Implementation:	Medium – Requires industry collaboration to scale trials effectively.
Opportunities & Incentives	1. Tri Marine's existing trials provide a foundation for expanding participation. 2. Growing industry momentum towards adopting biodegradable gear across multiple RFMO regions, with significant opportunities to expand participation and trial efforts in strategic fisheries.
Anticipated challenges	1. Some vessels may be reluctant to participate due to potentially increased operational costs and logistical challenges. 2. Expanding Bumble Bee's involvement in FAD trials will require collaboration with regional stakeholders and industry bodies to scale efforts effectively.
Timeframe:	**Completion expected within 3-5 years.**
Indicator:	**Indicator:** Number of vessels participating in ISSF Jelly FAD trials **Personnel:** Bumble Bee, ISSF **Target**: A cost-effective biodegradable FAD design **Performance:** Quarterly progress reports from ISSF. **Indicator:** Number of vessels supplying Bumble Bee (e.g. FCF-associated vessels) participating biodegradable FAD trials, such as the ISSF Jelly FAD trials **Personnel:** Bumble Bee, ISSF, FCF, **Target**: 50% of FCF company-owned vessels participating in trials (check with FCF to determine baseline number) **Performance:** Quarterly progress reports from ISSF. **Indicator:** Number of Bumble Bee suppliers participating in biodegradable FAD trials **Personnel:** Bumble Bee, ISSF **Target**: 100% of key suppliers engaged in trials within the next 3 years. **Performance:** Supplier audit and documentation review.

Recommendation 9: Encourage Crew Training on Safe Retrieval of Lost or Abandoned Fishing Gear

Specific Action:	Ensure all FCF-associated vessels are equipped with appropriate retrieval tools and whilst ensuring crew members receive training on best practices and safety procedures associated with retrieving lost fishing gear.
Impact:	Increased retrieval rates of lost fishing gear reducing ALDFG occurrence. Improved crew knowledge and adherence to safe retrieval protocols.
Target:	FCF-associated vessels operating tuna longline and purse seine vessels
Implementation:	**Mid-term (2 – 4 years)**
Timeframe:	**Long-term (3 - 5 years)**

Relevance:

- Equipping vessels with appropriate gear retrieval tools and training crew in retrieval protocols is critical to reducing ALDFG**.**
- Aligns with RFMO requirements, such as ICCAT Recommendation 19-11, which mandates vessels over 12 m to have retrieval equipment onboard.
- Proper onboard stowage of ALDFG ensures responsible disposal at designated PRF.
- Training will increase crew capacity to retrieve lost gear safely and effectively, improving overall gear management.

Evidence:

- Several fishers and seafood suppliers involved in tuna fisheries reported challenges in retrieving lost gear due to a lack of proper equipment or unclear retrieval protocols, with one fisher noting that successful retrieval was rare.
- Tuna fishing companies expressed uncertainty about onboard gear recovery protocols, revealing a critical gap in operational procedures.
- Potential to leverage ISSF Skipper Training Guidelines and existing training programmes to improve retrieval and storage practices industry wide. By building upon existing resources, this initiative can be scaled effectively while leveraging an established framework that is already familiar to many fishers.

Implementation Pathway(s)

Activity:	Ensure all FCF-associated vessels that supply Bumble Bee are equipped with appropriate retrieval tools and crew are trained in retrieval protocols.
Implementation:	**Mid-term (2-4 years)**
Next steps:	Cooperation with FCF (*Months 1-6*) 1. The VP of Responsible Sourcing & Sustainability at Bumble Bee to initiate discussions with FCF to conduct an internal assessment of FCF-associated vessels, identifying available retrieval tools, any gaps in availability, and crew training needs. 2. FCF personnel to liaise with vessel owners to ensure all vessels are equipped with appropriate retrieval tools to facilitate immediate gear recovery and conduct an audit of crew training schedules to ensure regular assessment in safe and effective retrieval methods. Development of training materials (*Months 7-12*) 3. Assistance can be provided by GGGI to develop training materials for purse seine, longline, and pole-and-line tuna vessels to incorporate specific guidelines for safe retrieval and storage of damaged and EOL fishing gear onboard. Delivery of training (*Months 13+)* 4. FCF to partner with ISSF to deliver Skipper Training to crew members of Bumble Bee and FCF owned vessels, with a focus on vessels lacking prior training in gear retrieval best practice.
Stakeholder:	Bumble Bee (VP of Responsible Sourcing & Sustainability), FCF (Sustainability & Compliance Teams, Vessel Owners), GGGI (Partnership Manager), ISSF (Training & Compliance Teams)
Cost estimate:	Low
Ease of Implementation:	Medium –Bumble Bee or FCF to check vessels have the appropriate tools and collaborate with ISSF on training. May be more difficult without direct control over vessels.
Opportunities & Incentives	1. Ensures all vessels that supply Bumble Bee are equipped with retrieval tools and crews trained in best practice protocols to safely retrieve gear. 2. Expanding these training materials, which are already widely available and utilized by the fishing industry, presents a strategic opportunity to comprehensively improve gear management practices.
Anticipated challenges	1. Frequent personnel changes may require ongoing training efforts. 2. Varying levels of onboard storage capacity – some vessels may struggle to store retrieved gear until proper disposal at port.
Timeframe:	**Completion expected within 3 - 5 years**
Indicator:	**Indicator:** Percentage of FCF-associated vessels equipped with retrieval tools. **Personnel:** Bumble Bee and FCF **Target**: 100% of vessels equipped within 4 years. **Performance:** Annual audit of company vessel equipment or self-declaration. **Indicator:** Percentage of skippers have received ISSF Skipper Training **Personnel:** Bumble Bee collaborate with ISSF **Target**: 100% of skippers have received ISSF Skipper Training **Performance:** Annual audit and documentation review.

7 References

Agreement on the Conservation of Albatrosses and Petrels (ACAP). (2021). ACAP Advice on Improving Safety when Hauling Branch lines during Pelagic Longline Fishing Operations. *Twelfth Meeting of the Advisory Committee Virtual Meeting, 31 August – 2 September 2021*. www.acap.aq/en/bycatch-mitigation/mitigation-advice

Alatorre-Ramirez, V.G., Galvan-Magaria, F., Torres-Rojas, Y.E., & Olson, R.J. (2017). Trophic segregation of mixed schools of yellow fin tuna (*Thunnus albacares*) and skipjack tuna (*Katsuwonus pelamis*) caught in the eastern tropical Pacific Ocean. *Fishery Bulletin*, *115*(2), 252-269.

Andreassen, I.S. (2024). The role of tuna-RFMOs in combating 'ghost fishing': Where is the Catch? *Marine Policy*, Volume 167, September 2024, 106239, ISSN 0308-597X, https://doi.org/10.1016/j.marpol.2024.106239

Asosiasi Pengelolaan Rajungan Indonesia (APRI). (2023). Pre-liminary Results of Net with Improved Mesh Size Program March 2024.

Banks, R., & Zaharia, M. (2020). Characterization of the costs and benefits related to lost and/or abandoned Fish Aggregating Devices in the Western and Central Pacific Ocean. *Report Produced by Poseidon Aquatic Resources Management Ltd for The Pew Charitable Trusts*.

California Environmental Associates (CEA). (2018) Trends in Marine Resources and Fisheries Management in Indonesia. A 2018 Review. 13pp. Available here: https://www.ceaconsulting.com/wp-content/uploads/Indonesia-Report-2018_Executive-Summary-compressed.pdf

Ciocan, C., Kristova, P., Annels, C., Derjean, M., & Hopkinson, L. (2020). Glass reinforced plastic (GRP) a new emerging contaminant-First evidence of GRP impact on aquatic organisms. *Marine Pollution Bulletin*, *160*, 111559.

Escalle, L., Scutt Phillips, J., Brownjohn, M., Brouwer, S., Sen Gupta, A., Van Sebille, E., Hampton, J., & Pilling, G. (2019). Environmental versus operational drivers of drifting FAD beaching in the Western and Central Pacific Ocean. *Scientific Reports*, *9*(1), 14005. https://doi.org/10.1038/s41598-019-50364-0

Escalle, L. Hare, S., Hamer, P. & Pilling G. (2021). Pacific dFAD retrieval feasibility study. WCPFC- SC17-2021/EB-IP-17.11pp. https://meetings.wcpfc.int/node/12852

Food and Agriculture Organisation (FAO). (2024a). FishStat: Global capture production 1950-2022. [Accessed on 29 August 2024]. In: FishStatJ. Available at www.fao.org/fishery/en/statistics/software/fishstatj. Licence: CC-BY-4.0.

Food and Agriculture Organisation (FAO). (2024b). Fishing Techniques. Tuna purse seining. Technology Fact Sheets. Text by J. Majkowski. In: Fisheries and Aquaculture. Rome. https://www.fao.org/fishery/en/fishtech/40

Fonteneau, A. (2014). On the movements and stock structure of skipjack (Katsuwonus pelamis) in the Indian ocean. *Document IOTC TTWG*.

Forum Fisheries Agency (FFA). (2019). Fishing for tuna in the Western and Central Pacific Ocean: Purse Seine and Longline Fishing [Fact Sheet]. Forum Fisheries Agency.

Gillett, R. (2016). *Pole-and-line Tuna Fishing in the World: Status and Trends*. IPNLF Technical Report No.6. The International Pole & Line Foundation, London. 17 pp.

Gilman, E. (2015). Status of international monitoring and management of abandoned, lost and discarded fishing gear and ghost fishing. *Marine Policy*, *60*, 225-239.

Gilman, E., Musyl, M., Suuronen, P., Chaloupka, M., Gorgin, S., Wilson, J., & Kuczenski, B. (2021). Highest risk abandoned, lost and discarded fishing gear. *Scientific Reports*, *11*(1), 7195.

Grande, M., Murua, H., Zudaire, I., Goni, N., & Bodin, N. (2014). Reproductive timing and reproductive capacity of the Skipjack Tuna (Katsuwonus pelamis) in the western Indian Ocean. *Fisheries Research*, *156*, 14-22.

He, P., & Suuronen, P. (2018). Technologies for the marking of fishing gear to identify gear components entangled on marine animals and to reduce abandoned, lost or otherwise discarded fishing gear. *Marine Pollution Bulletin*, *129*(1), 253-261.

Herrera, M., & García Horcajuelo, M. (2018). Assessing the Contribution of Purse Seine Fisheries to Overall Levels of Bycatch in the Indian Ocean. IOTC-2018-WPDCS14-26 95 pp.

International Seafood Sustainability Foundation (ISSF). (2024). Status of the world fisheries for tuna. Mar. 2024. ISSF Technical Report 2024-02. International Seafood Sustainability Foundation, Pittsburgh, PA, USA

Jauharee, A. R., Capello, M., Simier, M., Forget, F., Adam, M. S., & Dagorn, L. (2021). Tuna behaviour at anchored FADs inferred from Local Ecological Knowledge (LEK) of pole-and-line tuna fishers in the Maldives. *PLoS One*, *16*(7), e0254617.

Lebreton, L., Royer, S. J., Peytavin, A., Strietman, W. J., Smeding-Zuurendonk, I., & Egger, M. (2022). Industrialised fishing nations largely contribute to floating plastic pollution in the North Pacific subtropical gyre. *Scientific Reports*, *12*(1), 12666.

Lopez, Jon & Scott, G. (2014). The use of FADs in tuna fisheries. European Parliament. Policy Department B: Structural and Cohesion Policies: Fisheries. https://www.researchgate.net/publication/260257723_The_use_of_FADs_in_tuna_fisheries

Macfadyen, G., Huntington, T., & Cappell, R. (2009). Abandoned, lost or otherwise discarded fishing gear. *UNEP Regional Seas Reports and Studies* No.185; *FAO Fisheries and Aquaculture Technical Paper,* No. 523. Rome, UNEP/FAO. 2009. 115pp. https://www.fao.org/4/i0620e/i0620e00.htm

Matsumoto, W. M., Skillman, R. A., & Dizon, A. E. (1984). *Synopsis of biological data on skipjack tuna, Katsuwonus pelamis* (No. 136). US Department of Commerce, National Oceanic and

Atmospheric Administration, National Marine Fisheries Services. NOAA Technical Report NMFS Circular 451. 94 pp.

MRAG Asia Pacific (2018). PNA FAD Management Scheme: Executive Summary. Available from: https://www.pnatuna.com/sites/default/files/ZN2469%20-%20PNA%20FAD%20Reports%20Consolidated.pdf

National Academy of Sciences (1975). Assessing potential ocean pollutants: A report of the study panel on assessing potential ocean pollutants to the Ocean Affairs Board. Commission on Natural Resources, National Research Council. National Academy of Sciences, Washington DC 1975, 440pp.

Nikolic, N., Morandeau, G., Hoarau, L., West, W., Arrizabalaga, H., Hoyle, S., Nicol, S. J., Bourjea, J., Puech, A., Farley, J. H., Williams, A. J., & Fonteneau, A. (2016). Review of albacore tuna, Thunnus alalunga, biology, fisheries and management. *Reviews in Fish Biology and Fisheries*, *27*(4), 775–810. https://doi.org/10.1007/s11160-016-9453-y

Nimit, K., Masuluri, N. K., Berger, A. M., Bright, R. P., Prakash, S., TVS, U., T, S. K., Rohit, P., A, T., Ghosh, S., & Varghese, S.P. (2020). Oceanographic preferences of yellowfin tuna (Thunnus albacares) in warm stratified oceans: A remote sensing approach. *International Journal of Remote Sensing*, 41(15), 5785–5805. https://doi.org/10.1080/01431161.2019.1707903

Pham, C.K., Machete, M., Edwards, Z., Adam, S., Bealey, R., Rodríguez, Y., Pereira, J.M., Saneeh, I & Nadheeh, I. (2021). Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG) in Tuna Pole-and-Line Fisheries. 17 pp. DOI: https://doi.org/10.21203/rs.3.rs-1170070/v1

Pecoraro, C., Zudaire, I., Bodin, N., Murua, H., Taconet, P., Díaz-Jaimes, P., Cariani, A., Tinti, F., & Chassot, E. (2017). Putting all the pieces together: Integrating current knowledge of the biology, ecology, fisheries status, stock structure and management of yellowfin tuna (Thunnus albacares). Reviews in Fish Biology and Fisheries, 27(4), 811–841. https://doi.org/10.1007/s11160-016-9460-z

Pecoraro, C., Babbucci, M., Franch, R., Rico, C., Papetti, C., Chassot, E., Bodin, N., Cariani, A., Bargelloni, L., & Tinti, F. (2018). The population genomics of yellowfin tuna (Thunnus albacares) at global geographic scale challenges current stock delineation. *Scientific Reports*, *8*(1), 13890.

Richardson, K., Haynes, D., Talouli, A., & Donoghue, M. (2017). Marine pollution originating from purse seine and longline fishing vessel operations in the Western and Central Pacific Ocean, 2003–2015. *Ambio*, *46*(2), 190-200.

Richardson, K., Gunn, R., Wilcox, C., & Hardesty, B. D. (2018). Understanding causes of gear loss provides a sound basis for fisheries management. *Marine Policy*, 96, 278–284. https://doi.org/10.1016/j.marpol.2018.02.021

Richardson, K., Hardesty, B. D., & Wilcox, C. (2019). Estimates of fishing gear loss rates at a global scale: A literature review and meta-analysis. *Fish and Fisheries*, 20(6), 1218–1231. https://doi.org/10.1111/faf.12407

Richardson, K., Hardesty, B. D., Vince, J. Z., & Wilcox, C. (2021). Global causes, drivers, and prevention measures for Lost Fishing Gear. *Frontiers in Marine Science*, 8. https://doi.org/10.3389/fmars.2021.690447.

Schiller, L., Auld, G., Hanich, Q., & Bailey, M. (2023). Increasing industry involvement in international tuna fishery negotiations. *One Earth*, *6*(1), 41-54.

Sieben, C., Gascoigne, J., & Watt, P. (2023). American Samoa EEZ tuna longline fishery On Behalf of StarKist. Marine Stewardship Council (MSC) Public Certification Report (PCR). Prepared by Control Union. Lymington, UK.

Stelfox, M., Hudgins, J., & Sweet, M. (2016). A review of ghost gear entanglement amongst marine mammals, reptiles and elasmobranchs. Marine Pollution Bulletin, 111(1–2), 6–17.

United Nations Environment Programme (UNEP). (2016). Regional Survey on abandoned, lost or discarded fishing gear & ghost nets in the Mediterranean Sea. Available at: https://mio-ecsde.org/wp-content/uploads/2016/12/ALDFG-in-the-MED.pdf

Wain, G., Guéry, L., Kaplan, D. M., & Gaertner, D. (2021). Quantifying the increase in fishing efficiency due to the use of drifting FADs equipped with echosounders in tropical tuna purse seine fisheries. *ICES Journal of Marine Science*, *78*(1), 235–245. https://doi.org/10.1093/icesjms/fsaa216

Widodo, A. A., Wudianto, W., & Satria, F. (2016). Current status of the pole-and-line fishery in eastern part of Indonesia. *Indonesian Fisheries Research Journal*, *22*(1), 43-52.

Williams, A. J., Allain, V., Nicol, S. J., Evans, K. J., Hoyle, S. D., Dupoux, C., Vourey, E., & Dubosc, J. (2015). Vertical behavior and diet of albacore tuna (*Thunnus alalunga*) vary with latitude in the South Pacific Ocean. *Deep Sea Research Part II: Topical Studies in Oceanography*, *113*, 154–169. https://doi.org/10.1016/j.dsr2.2014.03.010

Widyatmoko, A. C., Hardesty, B. D., & Wilcox, C. (2021). Detecting anchored fish aggregating devices (AFADs) and estimating use patterns from vessel tracking data in small-scale fisheries. *Scientific reports*, *11*(1), 17909.

Yellow Sea Large Marine Ecosystem (YSLME). (2020). *Plastic and Microplastics: Understanding and Managing Marine Litter in the Yellow Sea | SEA Knowledge Bank*. 10 pp. https://www.seaknowledgebank.net/e-library/plastic-and-microplastics-understanding-and-managing-marine-litter-yellow-sea

Zairion, Boer, M., Wardiatno, Y., & Fahrudin, A., (2014). Composition and size of the blue swimming crab (Portunus pelagicus) caught at several bathymetric stratifications in East Lampung waters. Jurnal Penelitian Perikanan Indonesia 20(4), 199–206 [in Bahasa Indonesia].

Zelasney, J., Ford, A., Westlund, L., Ward, A., & Riego Peñarubia, O. (2020). *Securing sustainable small-scale fisheries: Showcasing applied practices in value chains, post-harvest operations and trade* (Vol. 652). Food and Agriculture Organization of the United Nations.

Ziegler, F., & Hilborn, R. (2023). Fished or farmed: life cycle impacts of salmon consumer decisions and opportunities for reducing impacts. *Science of the Total Environment*, *854*, 158591.

Zudaire, I., Santiago, J., Grande, M., Murua, H., Adam, P.A., Nogués, P., Collier, T., Morgan, M., Khan, N., Baguette, F & Moron, J., (2018). FAD Watch: a collaborative initiative to minimize the impact of FADs in coastal ecosystems. *A paper submitted to the 14th IOTC Working Party on Ecosystems and Bycatch, Cape Town, South Africa*. IOTC-2018-WPEB14-12.