Managing Abandoned, Lost or Discarded Fishing Gear and Aquaculture Equipment in the APEC Region

Draft Baseline Report: Best Practice Guide

NRC
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Report Information

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Acronyms used

A-BPF .... Best Practice Framework to Reduce Aquatic Debris from Aquaculture
ALDFG .... Abandoned, Lost or Discarded Fishing Gear
ALDAG .... Abandoned, Lost or Discarded Aquaculture Gear
AIP .... Aquaculture Improvement Project
APEC .... Asia-Pacific Economic Cooperation
BC .... British Colombia
C-BPF .... Best Practice Framework for the Management of Fishing Gear
CPC .... Commission Contracting Party (e.g. of RFMOs)
EC .... European Commission
EEZ .... Exclusive Economic Zone
EMFF .... European Maritime and Fisheries Fund
EPR .... Extended Producer Responsibility
ETP .... Endangered, Threatened or Protected
EU .... European Union
FAD .... Fish aggregating device
FAO .... Food and Agriculture Organization of the United Nations
FIP .... Fisheries Improvement Project
GESAMP .... Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GGGI .... Global Ghost Gear Initiative (known as the “triple GI”).
GPS .... Global Positioning System
GT .... Gross tonnage
HDPE .... High Density Polyethylene (plastic)
IMO .... International Maritime Organisation
IUU .... Illegal, unreported and unregulated (fishing)
OFWG .... Oceans and Fisheries Working Group (of APEC)
OSPAR .... The Convention for the Protection of the Marine Environment of the North-East Atlantic (the ‘OSPAR Convention’)
PA .... Polyamide (Nylon)
PHA .... Polyhydroxyalkanoate
PRF .... Port Reception Facility
RFMO .... Regional Fisheries Management Organisation
SUP .... Single Use Plastic
VGMFG .... Voluntary Guidelines for the Marking of Fishing Gear

1. Background and Purpose

1.1 Background

1.1.1 APEC

The Asia-Pacific Economic Cooperation (APEC) is a regional economic forum established in 1989 to leverage the growing interdependence of the Asia-Pacific. APEC's 21 member economies aim to create greater prosperity for the people of the region by promoting balanced, inclusive, sustainable, innovative and secure growth and by accelerating regional economic integration. APEC's Oceans and Fisheries Working Group (OFWG) was formed in 2011, following a decision to merge the Marine Resource Conservation and the Fisheries working groups (in operation since 1990 and 1991 respectively). The OFWG's mission is to support APEC's goal to foster sustainable economic growth, development and prosperity in the Asia-Pacific region.

Combatting marine debris is an important remit of APEC. In 2019 APEC prepared a *roadmap on marine debris*[1] that:

- encourages a consolidated approach by driving policy development and coordination;
- fosters research and innovation for the development and refinement of new methodologies and solutions for monitoring, preventing, and reducing marine debris;
- promotes sharing of best practices and lessons learned and enhancing cooperation; and
- increases access to financing and facilitates private sector engagement to promote investment, trade and market creation in industries and activities that enable marine debris management and prevention.

Relevant to this document as well is the APEC *roadmap on combatting illegal, unreported and unregulated (IUU) fishing*[2] that will build technical capacities in APEC member economies where appropriate to prevent and combat IUU fishing activities. The IUU roadmap seeks to strengthen institutional capacities and compliance with domestic and international conservation and management measures to address IUU fishing within APEC through enhanced cooperation between member economies. This includes capacity building, technical assistance and, where applicable, enhancement of monitoring, control and surveillance and traceability measures.

1.1.2 Global Ghost Gear Initiative

The ***Global Ghost Gear Initiative*** (GGGI®) is a cross-sectoral alliance committed to driving solutions to the problem of abandoned, lost or discarded fishing gear (ALDFG or 'ghost gear') worldwide. The GGGI aims to improve the health of marine ecosystems, protect marine animals, and safeguard human health and livelihoods.

Founded on the best available science and technology, the GGGI is the first initiative dedicated to tackling the problem of ghost fishing gear on a global scale. The GGGI's strength lies in the diversity of its participants including the fishing industry, the private sector, academia, governments, intergovernmental and non-governmental organizations. Every participant has a

[1] https://www.apec.org/Meeting-Papers/Annual-Ministerial-Meetings/2019/2019_AMM/Annex-B
[2] https://www.apec.org/Meeting-Papers/Annual-Ministerial-Meetings/2019/2019_AMM/Annex-C

critical role to play to mitigate ghost gear locally, regionally and globally. Further information on the GGGI can be found at www.ghostgear.org.

In 2017 the GGGI took a major step forwards by producing their **Best Practice Framework (BPF) for the Management of Fishing Gear (C-BPF)**. providing guidance on preventing and mitigating ghost gear in capture fisheries throughout the seafood supply chain. Following an intensive, six-month global consultation process, the C-BPF was formally launched at the Seattle SeaWeb Seafood Summit in June 2017. Since then, the C-BPF has been downloaded many times and has become an important resource for a wide range of stakeholders, from fishers through to seafood buyers. For instance, Thai Union – one of the world's largest vertically integrated fishing and processing businesses – has committed to implementing the C-BPF within its operations. In addition, the GGGI and United Nations Food and Agriculture Organization (UN FAO) have held four regional workshops in Africa, Asia, Latin America, and the Pacific on implementing the C-BPF to reduce ALDFG (see FAO, 2020a). An updated and revised C-BPF was published in July 2021 (GGGI, 2021a).

Recognizing that aquaculture now produces over half the world's supply of seafood, the GGGI has also recently produced a **Best Practice Framework to Reduce Aquatic Debris from Aquaculture (A-BPF).** The A-BPF provides guidance on preventing leakage of plastics and other debris into the marine environment to stakeholders along the seafood supply chain. Plastics are used extensively in marine fish farming, both in cages (e.g. in the collars and nets themselves, as well as in feeding systems) as well as coastal fishponds (e.g. in pond liners). These plastics are susceptible to loss through mismanagement, deliberate discharge or from extreme weather events, contributing to so-called 'Abandoned, Lost and Discarded Aquaculture Gear (ALDAG). Whilst global losses of plastics from aquaculture to the marine environment are probably lower in volume than from fishing (Huntington, 2019), aquaculture continues to grow worldwide, and it is important that this situation is addressed now. After undergoing extensive stakeholder consultation, the A-BPF was published in 2021 (GGGI, 2021b).

1.2 Approach and Purpose of these Best Practice Guidelines for the APEC region

1.2.1 Purpose

ALDFG, or 'ghost gear', is a significant component of marine litter, with far-reaching impacts on marine ecosystems, fisheries resources and coastal communities. ALDFG negatively affects important marine habitats, such as mangroves and coral reefs, and can present serious safety risks to navigation (Hong *et al*, 2017; Hoeksema *et al*, 2018; Valderrama *et al*, 2018). ALDFG can continue to catch both target and non-target species ('ghost fishing'), entangling and killing marine animals, including threatened, protected, or endangered species as well as commercially harvestable fish species. ALDFG has significant and dire impacts on fisheries across the APEC region, and a 2020 APEC report estimated that the fisheries and aquaculture sector experience US$1.5 billion in direct damages from marine plastics each year (McIlgorm *et al*, 2020). Further, the region relies upon sustainable fisheries for its economic growth and to ensure food security for its growing populations.

Managing Abandoned, Lost or Discarded Fishing Gear and Aquaculture Equipment in the APEC Region

This ALDFG Best Practice Guide for APEC member economies is one component of a wider project that will benefit all APEC member economies, especially developing economies within the APEC region that have a robust fisheries sector and that rely on sea-based protein for food security. In partnership with the GGGI, the project includes this guide, and a companion Compendium of Gear-Marking Schemes. Dissemination and review of these two documents will be accomplished during a workshop for APEC member economies held in September 2021. This workshop is designed to increase awareness among APEC fisheries managers, policymakers, and private sector representatives on the recommendations in the UN FAO Voluntary Guidelines for the Marking of Fishing Gear (VGMFG) and associated best practices outlined in the GGGI C-BPF and A-BPF, the gear-marking compendium, and this APEC-specific best practice guide.

Due to the close linkage between ALDFG and IUU fishing, the project will have additional benefit in a reduction in IUU fishing in the region through more comprehensive fisheries management, including gear-marking, reporting and associated practices and policies. Further, the APEC ALDFG best practices guide developed through the project will serve as a guiding document to inform sustained efforts to continue reducing ALDFG occurrence in future years and will lead to more sustainable fisheries production and greater food security and economic prosperity for the APEC region. The principles as described in both the GGGI BPFs and the VGMFG are assessed on their suitability for implementation in the APEC region and associated case studies of best practice examples relevant to APEC economies have been provided.

The purpose of project is to highlight and explain relevant gear management best practices; and bring them to life through practical real-life examples to inspire APEC member economies and relevant stakeholders to take action. In particular the anticipated outcomes are:

1. **Strengthened ability/capacity to incorporate ALDFG best practices into domestic and regional policy, legislation and industry practice**, including reducing gear loss through effective gear-marking schemes, in APEC member economies.
2. **Dissemination of the project documents to the broader APEC community to strengthen the ability/capacity to undertake and directly conduct ghost gear best practices and gear marking schemes**. The final Best Practices Guide and companion Compendium of Gear-Marking Schemes will provide a step-by-step process to assist practitioners in implementing effective ALDFG best practices, gear marking schemes, and help address gear loss.
3. **Better informed APEC community on the importance of addressing ALDFG as a particularly harmful form of marine debris that has serious economic repercussions at the regional, domestic, and local levels**. Policymakers and private sector stakeholders can use the best practice guide and gear marking compendium to guide the development of new prevention policies and evaluate the effectiveness of existing ALDFG abatement efforts.
4. **Harmonization of gear marking and ALDFG mitigation techniques and policies to enable improved abatement of ALDFG across the APEC region**. The ALDFG Best Practices Guide and Compendium of Gear-Marking Schemes will be available as tools to guide policymakers and the private sector to relevant existing methodologies.

1.2.2 Approach

The two existing GGGI Best Practice Frameworks (C-BPF an A-BPF) provide generic, global frameworks for a stakeholder-focused approach to the management of fishing gear and aquaculture installations to prevent the unnecessary loss of plastic and other materials into the aquatic environment.

This ALDFG Best Practice Guide for APEC member economies is based on both the BPFs, as well as other key guidance such as the VGMFG. This document focuses particularly on the circumstances and current actions in the waters of the APEC member economies to present a summary of the key principles and guidelines appropriate to the region.

1.3 Scope

The **geographic scope** of this ALDFG Best Practice Guide are the waterbodies of APEC member economies around the Pacific Rim. Like the GGGI BPFs, these guidelines are generic in nature, and thus are relevant to the marine waters in the member Exclusive Economic Zones (EEZs), coastal or transitional waters, as well as lakes, rivers and other water bodies in the inland areas. Given the nature of the fisheries and aquaculture activities involved (see **Section 2**) the focus is likely to mirror the effort that mainly takes place in marine waters, although large water bodies such as the Tonlé Sap in Cambodia should not be ignored.

The **technical scope** covers all aspects of seafood production, and thus includes both capture fisheries and aquaculture. However, the focus of this guide will be on capture fisheries rather than aquaculture. Fishing gear marking is also included as a key approach to reducing the loss of fishing gear at sea. Please note that the companion Compendium of Gear-Marking Schemes in APEC member economies provides more detail on this area.

1.4 Users

The project will provide benefit throughout the APEC region to build capacities to more effectively address the problem of sea-based marine debris from fisheries and aquaculture, and its impacts on economies and communities. The benefit will be especially important to APEC developing economies, particularly those in Southeast Asia, that are extremely reliant on healthy fisheries yet face the most significant impacts and costs of marine debris and lack adequate capacity to address the problem.

Users of the project's outputs include officials from across APEC member economies that are responsible for fisheries management and marine debris management. These will be economy representatives from ocean or coastal ministries or environmental ministries or research institution representatives that work with economy ministries responsible for marine debris/fisheries management. The product's main outputs will help guide these officials and improve their ability to undertake gear marking activities and to build capacity to systematically address ALDFG. While the project is focused to benefit APEC member economies primarily, its outputs will also have broader global application and can be used by any entity across the globe to develop their own approach to tackling ALDFG.

1.5 Methodology

The production of this ALDFG Best Practice Guide for APEC member economies included extensive review of existing guidance and best practices documents as well as integration of responses to a short questionnaire provided by APEC member economies. The questionnaire included the five following questions:

- Q1. In your view, what are the main drivers / causes for the production of marine debris from capture fisheries (ALDFG) in the APEC region?
- Q2. In your view, what are the main drivers / causes for the production of marine debris from aquaculture in the APEC region?
- Q3. Is there a gear marking requirement in the regulation or the fishery management plan in your country (or fishing region)?
- Q4. Are you aware of any good examples of schemes or mechanisms to reduce ALDFG / aquaculture-derived debris in the APEC region?
- Q5. According to your knowledge or based on landing data of your country, rank the importance of the following gear types/categories in terms of their landing volume or the number of vessels.

These questions, and the more detailed response requirements, can be found in **Appendix B.**

The questionnaire was launched on 4th June 2021 and closed on 12th July 2021 for this reporting cycle. Responses were received from:

1. Australia
2. Canada
3. Chile
4. Chinese Taipei
5. Hong Kong
6. Indonesia
7. Japan
8. New Zealand
9. Philippines
10. Singapore
11. Thailand
12. Vietnam

These responses have been used to generate quantitative ranking of the drivers for the abandonment, loss or discard of fishing gear and aquaculture equipment (see **Sections 3.1.1** and **3.2.1** respectively for the results) Responses also provided insights into regional perspectives on good practices that already exist in the APEC member economies (**Section 4**).

2. Overview of fisheries and aquaculture in the APEC Region

2.1 Introduction

The APEC region can be considered as the economic powerhouse of the world. The member economies have around 38% of the global population but account for 61% of global gross domestic product (GDP, see table below).

Table 1: APEC Member Economies: GDP, population and importance of the rural economy

Country	GDP, Current USD (in millions)		Total Population (in thousands)		Value Added, Agriculture (% of GDP)
Australia	$ 1,392,681		25,364		2.1%
Brunei Darussalam	$ 13,469		433		1.0%
Canada	$ 1,736,426		37,589		1.9%
Chile	$ 282,318		18,952		3.5%
China	$ 14,342,903		1,397,715		7.1%
Chinese Taipei	$ 610,872		23,596		1.8%
Hong Kong, China	$ 366,030		7,507		0.1%
Indonesia	$ 1,119,191		270,626		12.7%
Japan	$ 5,081,770		126,265		1.2%
Korea	$ 1,642,383		51,709		1.7%
Malaysia	$ 364,702		31,950		7.3%
Mexico	$ 1,258,287		127,576		3.5%
New Zealand	$ 206,929		4,917		5.8%
Papua New Guinea	$ 24,970		8,776		17.6%
Peru	$ 226,848		32,510		6.9%
Russia	$ 1,699,877		144,374		3.4%
Singapore	$ 372,063		5,704		0.0%
Thailand	$ 543,650		69,626		8.0%
The Philippines	$ 376,796		108,117		8.8%
United States	$ 21,374,419		328,240		0.9%
Viet Nam	$ 261,921		96,462		14.0%
APEC	**$53,298,501**	**61%**	**2,918,007**	**38%**	**3.5%**
World	**$ 87,697,519**		**7,673,534**		**4.0%**

Source: APEC Key Indicators Database (http://statistics.apec.org/index.php/key_indicator/index)

The figures above also demonstrate the economic diversity in the region, with the USA, China and Japan between them accounting for over three-quarters of the APEC GDP contribution. Likewise there are a number of countries with relatively low GDPs but with highly important rural (agriculture) sectors, such as Papua New Guinea, Viet Nam and Indonesia. Understanding this diversity in economic strength and focus provides an important background to this work.

2.2 Capture Fisheries

The APEC region accounts for around half the world's capture fisheries production (FAO, 2021a), including marine fish (55%), diadromous fish (60%), crustaceans (50%) and molluscs (57%).

Figure 1 overleaf shows capture fisheries production from the APEC region. The overall catches are dominated by marine fishes (c. 36 million tonnes in 2019). The most striking aspect of this figure is that APEC fisheries landings have plateaued since the late 1980's at between 40 and 50 million tonnes in total.

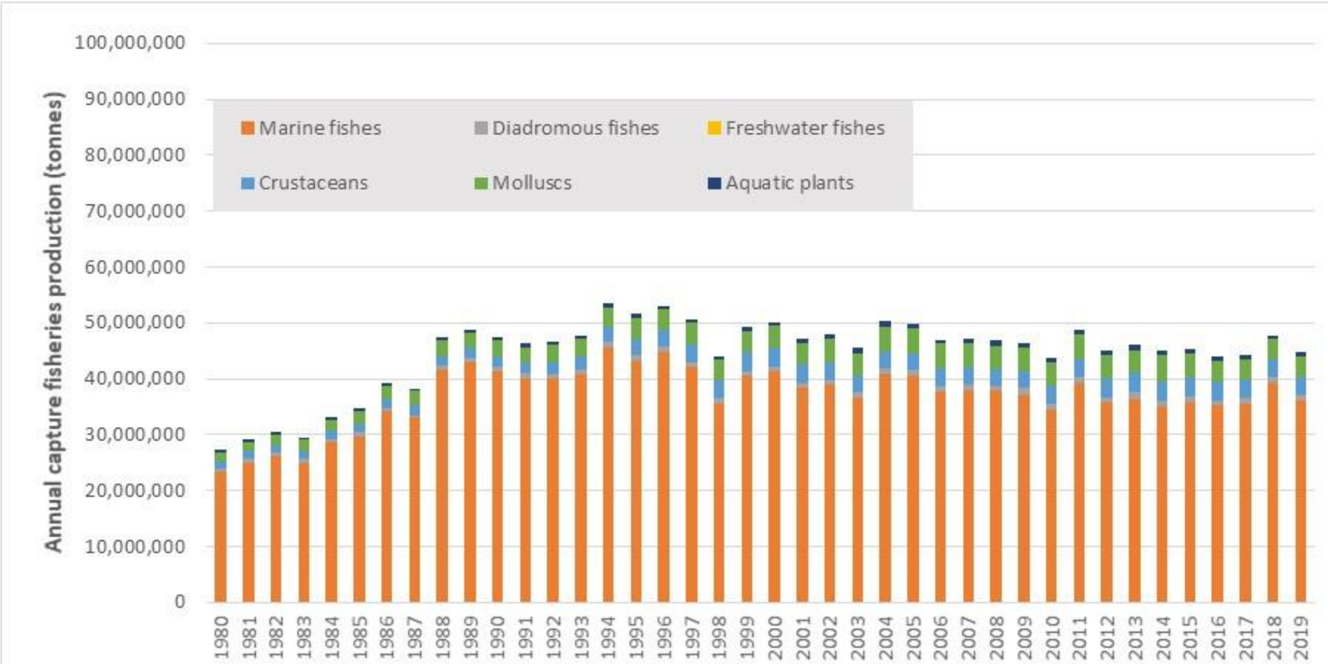
The table below shows the landings by APEC member economy and species group in 2019 (FAO, 2021a). China accounts for around 27% of the region's landings, with Indonesia and Peru both accounting for around 11%. Russia, the USA and Viet Nam are also important catching nations, with 8%, 7% and 7% respectively.

Table 2: Capture fisheries landings by APEC member economy and species group (2019)

Member economy	Landings by species group (tonnes)						
	Marine fishes	Diadromous fishes	Freshwater fishes	Crustaceans	Molluscs	Aquatic plants	Total
Australia	31,868	944		18,003	2,806		53,621
Brunei Darussalam	10,288	795		2,516	91		13,690
Canada	160,011	4,573		11,101	1,613		177,298
Chile	1,781,651	-		31,966	101,765	404,926	2,320,308
China	8,482,220	67,220		1,917,943	1,312,359	174,380	11,954,122
China, Hong Kong SAR	111,974			4,405	6,550	-	122,929
Indonesia	4,214,442	93,290		376,640	192,360	21,500	4,898,232
Japan	2,431,507	100,285		55,700	495,400	66,800	3,149,692
Korea, Republic of	1,022,438	11,361		28,851	173,959	8,710	1,245,319
Malaysia	563,188	11,160		41,562	33,063		648,972
Mexico	974,798	8,904		94,987	51,973	7,326	1,137,988
New Zealand	357,248	-		4,004	47,935	509	409,696
Papua New Guinea	271,960	19		1,109			273,088
Peru	4,098,363			51,704	641,671	36,348	4,828,086
Philippines	1,771,888	2,828		70,581	52,752	365	1,898,414
Russian Federation	2,745,233	468,177	176	88,328	118,562	6,525	3,427,001
Singapore	1,052	46		247	72		1,418
Taiwan Province of China	604,118	53		6,918	11,932	302	623,323
Thailand	832,142	637		96,990	108,093	-	1,037,862
United States of America	2,758,465	380,464		66,897	33,087	1	3,238,914
Viet Nam	2,815,751			66,541	402,677		3,284,969
Grand Total	**36,040,606**	**1,150,756**	**176**	**3,036,994**	**3,788,720**	**727,692**	**44,744,943**

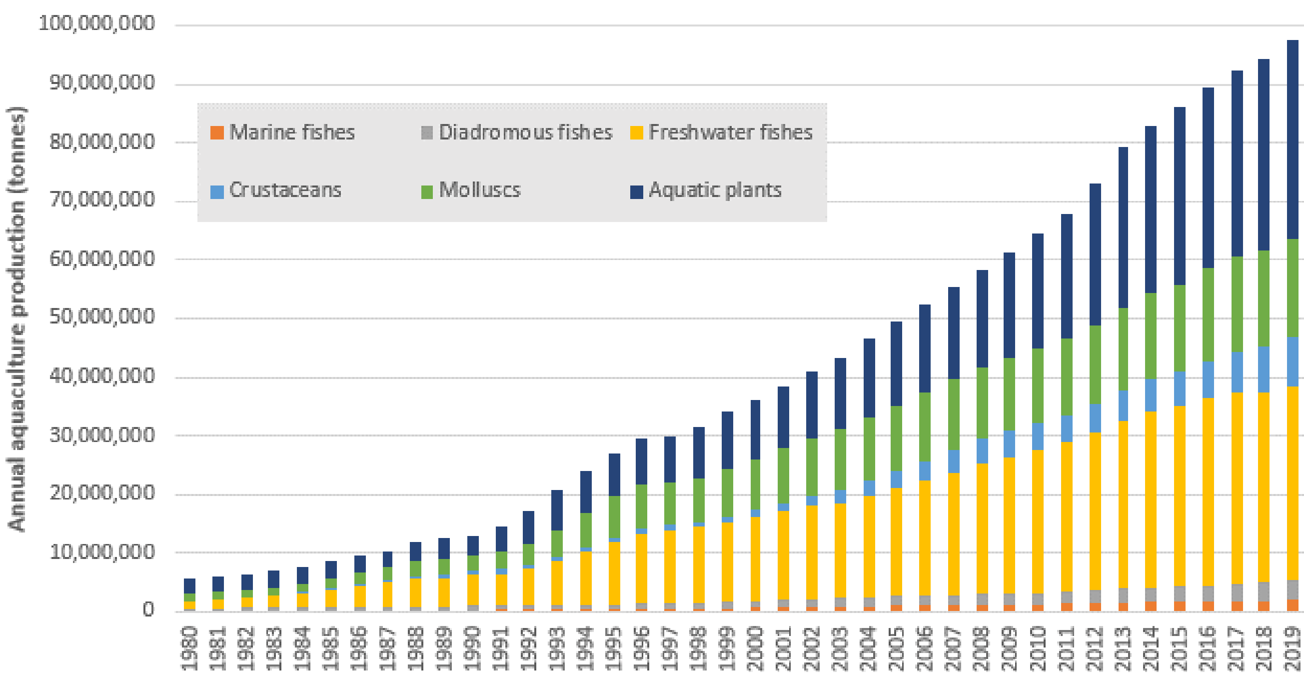
Source: FAO (2021a)

Figure 1: APEC capture fisheries production (1980 – 2019)



Source: FAO (2021a). Excludes marine fisheries outside the Pacific Ocean

Figure 2: APEC aquaculture production (1980 – 2019)



Source: FAO (2021b). Includes inland aquaculture but excludes marine aquaculture outside the Pacific Ocean

2.3 Aquaculture

The APEC region dominates global aquaculture production, accounting for 82% of global aquaculture production in 2018 (FAO, 2021b), including 98% of all aquatic plant production, 94% of all mollusc landings, 81% of all crustacean landings and 64% of all marine fish landings.

Figure 2 on the previous page shows the growth in APEC aquaculture production since 1980. After an initial slow growth until the early 1990s, growth has been continuous, with a compounded annual growth rate (CAGR) of 5.7% over the last ten years (2010 – 2019). The APEC aquaculture production of aquatic animals now stands at around 61 million tonnes, comfortably exceeding the 44 million tonnes from capture fisheries. This gap will only expand in the future. It should also be noted that the APEC regional produces a considerable volume of farmed aquatic plants (mainly seaweeds, currently totaling around 34 million tonnes.

The table below shows the aquaculture production by APEC member economy and species group in 2019 (FAO, 2021b). China dominates APEC aquaculture production, accounting for around 69% of the region's production. Indonesia is the other major aquaculture producer (16%) together with Viet Nam (5%).

Table 3: Aquaculture production by APEC member economy and species group (2019)

Member economy	Production by species group (tonnes)						
	Marine fishes	Diadromous fishes	Freshwater fishes	Crustaceans	Molluscs	Aquatic plants	Total
Australia	-	3,263	902	4,867	3,723		12,756
Brunei Darussalam	228	108	5	592	-		933
Canada	821	97,845	1,432	14	9,684		109,796
Chile	6	989,546	-		395,152	22,582	1,407,286
China	1,615,713	401,864	25,068,485	5,674,350	14,579,369	20,176,992	67,516,773
China, Hong Kong SAR	1,873	-	1,294		620		3,787
Indonesia	31,500	1,076,600	3,804,900	977,800	58,400	9,918,400	15,867,600
Japan	231,200	44,376	2,853	1,400	305,500	345,500	930,829
Korea, Republic of	85,164	15,010	11,950	7,952	442,046	1,812,765	2,374,887
Malaysia	3,497	3,710	104,062	35,002	2,176	188,110	336,557
Mexico	6,964	4,772	63,017	167,750	5,467	10	247,980
New Zealand		14,209			100,373		114,582
Papua New Guinea		150	1,600	-	1	4,300	6,051
Peru	15	50,793	6,095	43,541	53,496	-	153,940
Philippines	1,278	409,906	298,132	87,345	61,615	1,499,961	2,358,238
Russian Federation		2			15,109	10,573	25,684
Singapore	1,296	2,819	593	195	405		5,308
Taiwan Province of China	44,644	81,387	71,485	17,621	73,500	986	289,623
Thailand	563	45,541	383,309	343,021	113,932		886,366
United States of America	1,072	16,588	165,355	72,299	32,847	104	288,264
Viet Nam	14,500	1,500	3,121,200	977,157	315,000	13,300	4,442,657
Grand Total	**2,040,334**	**3,259,989**	**33,106,670**	**8,410,906**	**16,568,415**	**33,993,583**	**97,379,897**

Source: FAO (2021a)

The GGGI A-BPF classifies aquaculture systems into five different types (see table below). There are no quantitative information on the relative usage of these systems by the different APEC member economies, but it is possible to provide a reasonable understanding of how these are distributed around the region (see **Table 5** overleaf).

Table 4: Classification of aquaculture systems in the GGGI A-BPF

System	Location	Description
Open-water pens	Sub-tidal areas (>10 m depth) out to the offshore[3]. Also in lakes & reservoirs.	Plastic, metal or wooden pens with (i) floating collars suspending net enclosures and (ii) deep-water submersible cages, both flexible and rigid. Used for grow-out worldwide for a variety of species (e.g. salmon, yellowtail). Conducted in the open environment.
On & off-bottom culture	Mainly inter-tidal or shallow sub-tidal areas of coast, estuaries and lagoons.	*On bottom* (e.g. sown into or laid upon the substrate) and *off bottom* (e.g. on trestles / poles) culture using mesh bag containment. Mainly shellfish but also used for seaweeds.
Suspended ropes / longlines	Sub-tidal areas. Can be close to the shore, but often placed in deeper waters.	Longlines, suspended from buoys, or rafts with rope droppers, both anchored to the seabed. Used for grow-out of shellfish (e.g. mussels, oysters and scallops often in suspended lantern nets) worldwide. Includes off-bottom seaweed farming on longlines. Conducted in the open environment.
Coastal and inland ponds	Coastal ponds are either tidal-fed or use pumped seawater (up to 20 m above sea level). Inland ponds are mainly adjacent to rivers, irrigation canals or ground water.	Mainly used for grow-out of shrimp and nurseries and grow-out of finfish in tropical areas, as well as carp, trout and other freshwater fish in temperate areas. Some are flow through, others static. Waste / harvest water drains into the open environment. Ponds are either unlined earth, or lined with clay, plastic and other materials.
Tanks (including recirculated aquaculture systems (RAS))	In largely flood-free terrestrial areas, often enclosed, with access to adequate water supplies.	Usually higher density farming of a wide range of species in many different conditions. Usually in an enclosed area with increasing levels of water re-use, covering hatcheries, nurseries and increasingly, grow-out. Full or partial wastewater drainage into the open environment, depending on the level of recirculation / re-use[4].

Source: GGGI (2021b)

[3] Offshore aquaculture can be defined as > 3 km from the coast, often with water > 50 m depth

[4] Re-use can be in other agricultural systems, such as hydroponics.

Table 5 below provides an indication of the wide range of aquaculture systems used in the APEC member economies.

Table 5: Broad distribution of aquaculture systems used by APEC member economies

Member economy	Coastal and inland ponds	On & off-bottom culture	Open-water pens	Suspended ropes / longlines	Tanks (inc. RAS)
Australia	69%	29%	2%	0%	0%
Brunei Darussalam	100%	0%	0%	0%	0%
Canada	0%	9%	90%	1%	0%
Chile	0%	0%	71%	29%	0%
China	45%	22%	2%	30%	1%
China, Hong Kong SAR	100%	0%	0%	0%	0%
Indonesia	37%	1%	0%	62%	0%
Japan	2%	34%	26%	37%	2%
Korea, Republic of	0%	39%	0%	61%	0%
Malaysia	43%	56%	1%	0%	0%
Mexico	100%	0%	0%	0%	0%
New Zealand	0%	2%	12%	86%	0%
Papua New Guinea	29%	0%	0%	71%	0%
Peru	45%	0%	0%	55%	0%
Philippines	31%	0%	0%	69%	0%
Russian Federation	0%	100%	0%	0%	0%
Singapore	100%	0%	0%	0%	0%
Taiwan	93%	5%	2%	0%	0%
Thailand	87%	8%	0%	5%	0%
United States of America	0%	97%	3%	0%	0%
Viet Nam	93%	7%	0%	0%	0%

Source: Estimates generated from FAO (2021b) data

The key characteristics of aquaculture in the APEC member economies are:

- **Coastal and inland ponds**: Around 44% of APEC aquaculture production is from coastal (7%) ponds (mainly shrimp, with some finfish) and inland (37%) ponds (almost all finfish, such as carps and tilapias), especially in SE Asian countries.
- **Suspended ropes and longlines**: around 35% is suspended ropes and longlines, which includes both shellfish (e.g. New Zealand, China and Peru) as well as the majority of seaweed farming (mainly China, Indonesia and the Philippines).
- **On and off bottom farming**: around 17% of APEC aquaculture production is from on and off bottom farming, mainly of shellfish and some seaweed.
- **Open water pens**: around 3% of APEC aquaculture is from open water pens mainly in marine waters farming salmon (e.g. in Chile and Canada) and other finfish species.
- **Tanks**: a relatively small volume (c. 1%) of aquaculture takes place in tanks or RAS systems, mainly high value finfish (eels or sturgeon) or shellfish (e.g. abalone) species.

3. Abandoned, Lost or Discarded Fishing Gear and Aquaculture Gear – Drivers and Impacts relevant to the APEC Region

Thus section examines two main aspects:

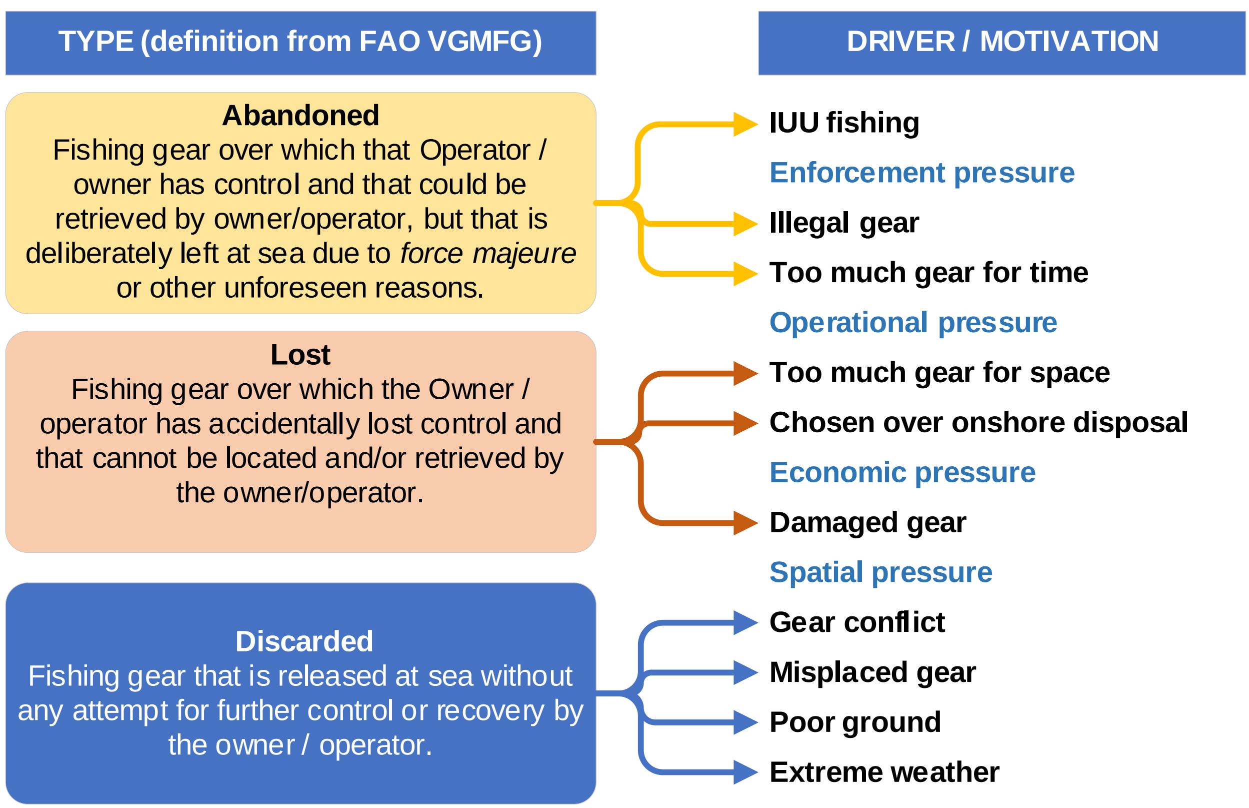
- The **drivers for ALDFG / ALDAG –** the reasons why operators might lose, abandon or deliberately discard fishing or aquaculture gear. These drivers may be operational, economic or because of *force majeure*.
- The **impacts of ALDFG / ALDAG –** the impacts of ALDFG / ALDAG are variable both in nature and scale, having consequences for human personal and food safety, marine biodiversity and over the longer-term, ecosystem functioning.

3.1 Capture Fisheries

3.1.1 Drivers

There have been a number of attempts at identifying the drivers for the abandonment, loss or deliberate discard of fishing gear. The figure below suggests these are mainly due to a number of pressure categories, including (i) enforcement, (ii) operational, (iii) economic and (iv) spatial.

Figure 3: Drivers for abandoning, losing or discarding fishing gear



Source: Adapted from Macfadyen *et al*, 2009

This categorization is echoed by the Organization for Economic Co-operations and Development (OECD) (2021) who suggest the drivers can be grouped into four areas:

- Environmental causes
- Conflicts with gear
- Fisheries management and regulations
- Operational losses and operator error

Viool *et al* (2018) take a slightly different approach, attributing ALDFG to (i) the intentional dumping of ALDFG. (ii) the accidental loss of ALDFG, (iii) there being no appropriate formal waste management and (iv) ALDFG is not easily recyclable.

As part of this study, APEC member economies were asked to rank the reasons why fishing gear might be abandoned, lost or discarded. The responses are provided in **Table 6** overleaf. Whilst the response size was too low to be definitive (see **Section 1.5**), they are illustrative and useful.

The top-ranked cause for ALDFG is ***gear lost due to environmental factors***. Respondents noted the severe weather conditions faced by many of their fishers, both in coastal and offshore waters. Strong currents and unintentional snagging of gear on the sea bottom were also specifically mentioned. In the Philippines the frequency and severity of typhoons was blamed for gear loss, especially for small-scale fisheries. However they also noted that fishers try to locate lost / abandoned gear where possible due to its value, and they are also highly aware of the potential for poor weather to take gear away and plan accordingly. As noted by New Zealand, such gear loss, although usually accidental, is often associated with poor experience.

The ***lack of awareness of the impact of marine debris/litter*** was second highest ranked on average but had a high degree of variability between APEC respondents. In Canada it was ranked low as in recent years there has been a significant public educational push for the recognition of the impacts of plastics in the environment and in general there is a high level of understanding by commercial fish harvesters on the impacts of ALDFG on the environment and harvestable fish stocks. Chinese Taipei and the Philippines also ranked this as ‘low’, but Vietnam and Indonesia both ranked this as ‘high’, saying that environmental awareness is still a challenge and needs to be addressed, especially in small-scale but extensive fisheries. Japan ranked this ‘medium’, stating that awareness has increased due to growing public interest and opinion on the marine plastic/ litter issue.

The ***spatial conflict with other fishing gear or vessel traffic*** was also highly ranked. This tends to be between mobile gears (e.g. trawls) and static gear (e.g. traps or anchored gillnets) but may be caused by other vessel traffic in busy areas. In Canada, whilst spatial conflict is not considered a substantial cause of lost gear, there are locations where there is an increased incidence of gear conflict along the waters that border the United States. In Thailand this was considered a limited cause for ALDFG as it is culturally unacceptable to fish in areas where others have traditionally placed their gear.

Equipment / fishing gear failure was mid-ranked. Most fishers try to maintain fishing gear in good order, and will retrieve broken gear for repair, but some is inevitably lost or in some cases deliberately discarded. Poor maintenance will lead to higher failure rates.

Table 6: Key drivers for ALDFG in respondent APEC member economies

Cause	Canada	Chile	Chinese Taipei	Indonesia	Japan	New Zealand	Philippines	Thailand	Vietnam	Average
Gear lost due to environmental factors	2.0	2.0	2.0	2.0	2.0	3.0	3.0	1.5	3.0	2.28
Lack of awareness of the impact of marine debris/litter	1.0	2.0	1.0	3.0	2.0	3.0	1.0	1.5	3.0	1.94
Spatial conflict with other fishing gear or vessel traffic	2.0	2.0	1.0	3.0	1.0	1.0	2.0	1.5	3.0	1.83
Equipment / fishing gear failure	1.0	2.0	2.0	2.0	1.0	3.0	1.0	1.5	3.0	1.83
Poor gear marking	1.0	3.0	1.0	2.0	1.0	2.0	2.0	2.0	2.0	1.78
IUU fishing activities	2.0	1.0	1.0	2.0	3.0	3.0	2.0	1.0	1.0	1.78
Lack of affordable disposal options	1.0	2.0	1.0	2.0	3.0	3.0	1.0	1.0	2.0	1.78
Theft or sabotage	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	1.0	1.11

Key:	1.0	2.0	3.0
	Low	**Medium**	**High**

Poor gear marking was also mid-ranked, especially where countries did not have gear marking regulations in place, especially for small-scale fisheries, both in coastal and fresh waters. In other countries such as Canada, Japan and Chinese Taipei that do have gear marking regulations for all levels of harvesting, this was considered a less important cause for ALDFG.

In general ***IUU-fishing*** was not seen to be a major driver for abandoning or discarding fishing gear[5], although it is recognized to be a factor, esp. for low cost operations. Only in Indonesia and the Philippines was this considered a 'medium' driver for ALDFG, although it is difficult to quantify this behavior.

[5] For instance a vessel may proactively discard illegal fishing gear if they consider they may become subject to a boarding and inspection. Likewise illegal fishing gear may be abandoned in the water if there is a strong deterrent presence nearby.

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The ***lack of affordable disposal options*** was relatively low ranked as a driver for ALDFG. In some countries there is a good network of free or low-cost disposal facilities whilst in others there tends to be a good, often informal network of fishing gear stripping, re-use and recycling facilities, such as in Indonesia. These both contribute to reducing the temptation to dispose of fishing gear at sea. In contrast in both Japan and New Zealand, where it is often expensive and burdensome to dispose of fishing gears because of their various sizes and complexity, there are limited disposal options that fishers can easily access to, and this may promote ALDFG.

Finally it was recognized that whilst ***theft and sabotage*** does sometimes occur, especially for set nets and pots, it is not a major cause of ALDFG.

3.1.2 Impacts

The impacts of ALDFG are less easy to assess or quantify. ALDFG has a number of ***environmental impacts***, including:

- continued catch of target and non-target species;
- interactions with threatened/endangered species;
- physical impacts on the benthos;
- a role as a vector for invasive species; and
- introduction of synthetic material into the marine food web.

ALDFG also **impacts upon marine users** with marine litter causing, among other things:

- navigational hazards;
- loss of amenity and disruption to enjoyment of beaches and coastal areas
- safety concerns; and
- additional costs resulting from fouling vessels and other gear.

[6] For instance a vessel may proactively discard illegal fishing gear if they consider they may become subject to a boarding and inspection. Likewise illegal fishing gear may be abandoned in the water if there is a strong deterrent presence nearby.

The OECD (2021) reviewed the ***economic damage*** of ALDFG. Antonelis *et al*., (2011) estimated that 178,874 Dungeness crabs were killed annually as ghost catch in derelict crab pots in Washington state in the United States, which represented an economic loss of over USD 744,000. Sullivan *et al*., (2019) estimated a total ghost fishing loss of USD 19,601 or USD 40 in ghost fishing losses per lost blue crab pot in New Jersey, also in the United States.

Most fishing gears are designed to be selective in catching targeted species; however this can result in ***negative impacts to target and non-target species*** when the gear is lost, especially in the case of gillnets and pots. Whether drifting at sea or deposited on the seabed, ALDFG can become a trapping agent for marine organisms, including endangered species. As reported in OECD (2021), Good *et al*., (2010) reported over 100 species in recovered derelict salmon gillnets in the Puget Sound (USA), including mammals, birds, finfish and invertebrates. Abandoned, lost or otherwise discarded pots from the recreational Dungeness crab fishery in the Puget Sound account for the mortality of more than 110,000 harvestable Dungeness crab per year (Antonelis *et al*., 2011). Silliman and Bertness (2002) reported that the keystone species the Malaclemys terrapin, the only entirely estuarine turtle species in the Chesapeake Bay (USA), is at high risk of mortality due to impacts from ALDFG and ghost fishing. Abandoned, lost or otherwise discarded blue crab traps on the east coast of the USA and in the Gulf of Mexico capture and kill not only target species but also a variety of non-target species, several of which are important to regional commercial and recreational fishing.

ALDFG, and in particular gillnets, trawl net panels, ropes and fish aggregating devices (FADs) can ***physically damage sensitive habitats*** such as rocky and coral reefs, sea grass beds and other vulnerable benthic communities. As reported by OECD (2021), in a study examining the impact of ALDFG on corals around Koh Tao, Thailand, 143 ALDFG items were observed to have caused tissue loss, damage and fragmentation for 340 corals underneath and 1,218 corals close to the ALDFG items (Ballesteros *et al*., 2018). Similar ALDFG impacts by other fishing gear types on the coral reefs of the Northwestern Hawaiian Islands were documented by Donohue *et al*., (2001) and Donohue and Schorr (2004).

An understanding of the ***socio-economic impacts*** of ALDFG remains limited (Ten Brink *et al*., 2009). ALDFG negatively impacts people's quality of life by reducing recreational opportunities, loss of aesthetic value of recreational facilities and natural areas, and the loss of non-use values such as clean beaches and coastal areas. Most of the ALDFG-related socio-economic impact studies more broadly cover impacts from a wider range of marine litter items, including ALDFG, to beaches and coastal areas, often with a focus on adverse impacts to coastal tourism. For example, a beach closure due to marine pollution and debris wash up in New York in 1988 resulted in a loss of 379 million to 1.6 billion USD to the tourism industry and 3.6 billion to other associated revenue streams (Ofiara and Brown, 1999).

An extreme example of impacts on ***navigational safety*** comes from the Republic of Korea. In 1993 the propellers of the 110 GT passenger ferry M/*V Seo-Hae* became entangled in a 10 mm nylon rope, which coiled around both propeller shafts and the right propeller, causing the vessel to suddenly turn, capsize and sink, leading to 292 human fatalities (Cho, 2005).

3.2 Aquaculture

3.2.1 Drivers

Much less is known about both the quantity of debris from aquaculture, nor the drivers for its loss. The GGGI A-BPF (GGGI, 2021b) provides a first categorization of the causes as follows:

1. **Low-level losses through routine farming operations**: even with the best run operations there will be the inevitable low-level loss of materials through wear and tear, environmental abrasion and attrition from predators.
2. **Extreme weather**: extreme weather in the form of large storms and extreme temperatures is a major cause of lost debris from aquaculture operations. Large storms are usually accompanied by high winds, large waves and heavy rainfall, all of which can cause equipment failure. In coastal areas, storm surges can overwhelm pond farm areas, washing everything out to sea. Freezing temperatures can also be a major hazard by coating structures with ice, causing them to sink or break apart. Climate change has been implicated in an increase in both the frequency and severity of extreme weather events (Dabbadie *et al*, 2018).
3. **Inadequate planning and management**: the loss of aquaculture equipment through insufficient planning and management can take a number of forms, including:
    a. <u>Poor siting, modelling, layout, installation and maintenance</u>: as can be seen from the previous section, plastics are used extensively in many aquaculture infrastructure components, including cage collars, nets and mooring equipment. These will all be subject to wear and tear, especially in a dynamic offshore environment, and thus the adequacy of the equipment for the environment into which it is placed (see GESAMP, 2001), and the subsequent installation, maintenance and replacement will influence (i) how much plastics will abrade (e.g. leading to secondary microplastic formation) and (ii) the risk of equipment failure and loss of plastics and other components to the aquatic environment.
    b. <u>Poor waste management</u>: considerable plastic and other waste might be generated by aquaculture, including feed sacks, plastic wrapped consumables, disposable equipment (e.g. plastic gloves, cable ties, etc.). These different waste streams need to be disposed of responsibly, requiring safe and secure waste collection (e.g. not vulnerable to informal waste pickers or being blown away by high winds). This can be a challenge, especially when operations are taking place at sea (e.g. on cage sites) or on large, often exposed coastal pond sites.
    c. <u>Limited recycling</u>: many aquaculture components have a finite life (e.g. nets). At present recycling opportunities for plastics from aquaculture gear are limited, and often complicated by both the number of different plastics used and complicating factors like anti-foulant coatings used on nets and mooring gear.

d. Farm decommissioning: farming operations and sites might be closed down for a wide variety of reasons such as poor financial performance or external factors. There are thousands of hectares of abandoned shrimp and finfish ponds sites around the world, with differing levels of decommissioning and clean-up. Abandoned farms are subject to vandalism, natural degradation and storm damage, all of which may result in plastics and other materials being lost into the aquatic environment.

e. Lack of awareness and training: the understanding and capacity of both managers and staff to minimize the risk of plastics loss is key. This implies the need for appropriate policy frameworks, supported by awareness-building and manager and staff training.

4. **Deliberate discharge**: in some cases, equipment and consumables may be deliberately discarded or abandoned, especially if the costs of removal or collection are deemed too high. This suggests that poor waste management in general is likely to be a higher risk in less profitable aquaculture operations (e.g. through the lack of easily accessible waste facilities and poor waste management supervision). Vandalism is also a possible cause of equipment failure, for instance recreational fishers cutting floating cage nets to release fish into the wild.

As with ALDFG, the APEC member economies were asked to rank the reasons why aquaculture equipment might be abandoned, lost or discarded. The responses can be found in **Table 7** overleaf, and these are briefly examined below, together with any specific information provided by the member economy respondents.

As with capture fisheries, ***extreme weather events*** were top-ranked by the eight respondents. In Canada it was acknowledged that inclement weather is a common occurrence and is thought to be a primary contributor to the cause of lost aquaculture gear. They note that in British Colombia (BC) license holders must ensure that all equipment and structures are properly secured and lost or errant gear or equipment must be retrieved immediately. However, there has been documentation of increases in observed marine litter following storm activity in Canadian coastal areas. In the Philippines the placement of fish cages / pens in typhoon corridors is a contributor to marine debris, both inland and at sea. Likewise in Chinese Taipei, until sunken fish cages were adopted typhoons were also a major cause of marine litter. They also noted that offshore oyster farming equipment is particularly vulnerable to bad weather.

The ***lack of awareness of the impact of marine debris/litter*** was also top-ranked as a reason why aquatic debris was lost from aquaculture. This may be because the focus has only recently moved to aquaculture (in contrast there has been concern over ALDFG from capture fisheries for some years now). In countries such as Indonesia where there is the widescale extensive production of seaweed, small-scale producers often use plastic drink bottles as floats. A recent World Bank funded study (Huntington *et al*, unpublished) estimated that a typical one hectare seaweed farm requires around 160 kg of plastic to be replenished each year, most (c. 45 kg / year) of which comes from the used plastic bottles that are utilized as floats, as well as the larger buoys (31 kg/yr.) and replacement longline rope (30 kg/yr.).

Table 7: Key drivers for abandoned, lost or discarded aquaculture equipment in respondent APEC member economies

Cause	Canada	Chile	Chinese Taipei	Indonesia	Japan	New Zealand	Philippines	Thailand	Vietnam	Average
Extreme weather events e.g. storms, floods, etc.	2.0	2.0	3.0	2.0	2.0	2.0	3.0	3.0	3.0	2.44
Lack of awareness of the impact of marine debris/litter	1.0	1.0	3.0	3.0	2.0	1.0	3.0	3.0	3.0	2.22
Lack of planned farm decommissioning	2.0	1.0	3.0	2.0	1.0	1.0	2.0	2.0	2.0	1.78
Inadequate maintenance	1.0	2.0	3.0	2.0	1.0	1.0	2.0	1.0	2.0	1.67
Poor siting and/ or installation	1.0	1.0	3.0	3.0	1.0	1.0	1.0	1.0	2.0	1.56

Key:	1.0	2.0	3.0
	Low	Medium	High

The ***lack of planned farm decommissioning*** was mid-ranked by respondents. In Canada the lack of availability of affordable and practical waste management options to dispose of decommissioned gear has been identified as a possible factor in marine debris from aquaculture, particularly shellfish aquaculture. Farm management plans that include conditions related to farm decommissioning are important backstops to prevent marine debris from aquaculture. Canada's Land Use Operational Policy requires that all decommissioned aquaculture facilities are left in a clean, sanitary and safe manner, including removal of all anchors, cables, and other structures. In cases where clean-up efforts are inadequate, the Provincial government works with the British Columbia Salmon Farmers Association or the British Columbia Shellfish Growers Association to address the outstanding clean up. In Singapore it was not considered a significant contributor as under the Fisheries (Fish Culture Farms) Rules, licensees are required to provide a deposit which will be held by the Authority until all farm structures are completely removed when required. If the licensee fails to comply, the Authority may use the deposit to pay for removal works. In New Zealand, resource consent conditions require farmers to restore the occupied marine area to its original condition if farming stops. If the farmer doesn't comply regional councils can remediate the site at a farmer's expense.

Inadequate maintenance was also mid-ranked. Countries like Canada recognize the role that inspection audits and regular maintenance plans play in preventing escapes and maintaining sound structures in their aquaculture industry. For instance aquaculture license holders in BC must perform regular inspections, maintain records of inspections, and remove and dispose of all debris and degraded floatation materials in a timely manner. These records are inspected and audited by regulatory enforcement staff. In Singapore aquaculture licensees are required to comply with all licensing conditions regarding farm installation, maintenance, reinstatement, waste disposal, etc. In the Philippines the failure to secure mussel and oyster farms, as well as poor maintenance of finfish in cages, is considered an important cause of aquatic debris loss.

Although ranked 'high' by Indonesia and Chinese Taipei, ***poor siting and/ or installation*** received the overall lowest ranking of the five factors considered. In Chinese Taipei this issue was particularly prevalent when investors lacked experience in site selection, and often sited farms either affected by fast currents or exposed to strong winds, thus leading to a higher risk of equipment loss. In the Philippines, where this was ranked 'medium', prospective farmers are often provide technical assistance from local and national government bodies in site selection. Thailand also follows third-party certified Good Aquaculture Practices (GAP) to reduce risk of poor site selection and facility installation. In New Zealand the Resource Management Act (1991) requires an assessment of the environmental, economic, social, and cultural effects of aquaculture necessary to achieve resource consent, which prevents poor siting of farms. Conditions of a resource consent require engineering standards to be met prior to farms being installed.

Overall these results reflect patterns experienced elsewhere in the world. Risk analysis in aquaculture is a specialist subject that has been extensively studied (see Bondad-Reantaso *et al*, 2008) but has rarely covered the specific risks associated with plastics loss and the subsequent impacts. It should be noted that the GGGI A-BPF conducts a useful causal risk analysis for equipment and / or consumable loss from different aquaculture systems for those wishing for more information on the subject.

3.2.2 Impacts

The impact of debris and litter from aquaculture has not been studied to the same extent as that from capture fisheries. According to the GGGI A-BPF, the main impacts are likely to be as follows.

Ghost fishing: The scope of ghost fishing from lost aquaculture equipment is significantly less than from capture fisheries, as most aquaculture debris will not contribute directly to ghost fishing (e.g. most finfish nets are not rigged to catch fish and are usually small-mesh (e.g. up to 2.5 cm / 1"), although some predator nets may be larger mesh (e.g. 2.5 cm / 1" or more, up to around 20 cm / 8") and thus capable of entangling aquatic animals and ghost fishing in some circumstances). That said, the growing production of macroalgae farming systems are using large areas of moorings, lines and floats as a growing substrate which are at risk of being lost (Campbell *et al*, 2019).

Injury and mortality of vulnerable aquatic animals and birds: In addition to 'ghost fishing', lost predator nets and ropes can result in both (i) entanglement, whereby they entangle or entrap animals, including fish, marine turtles and aquatic mammals; and (ii) ingestion, whereby fragments of nets or lines are intentionally or accidentally ingested. Entanglement is far more likely to cause mortality than ingestion (Laist, 1987). Fishing related gear, balloons and plastic bags were estimated to pose the greatest entanglement risk to aquatic fauna (Wilcox *et al*, 2016).

Habitat and benthic community damage: lost nets can impact benthic environments through smothering, abrasion and the integration of benthic organisms into the net mesh and folds as they grow. Lost nets may eventually become incorporated into the seabed. Other heavy aquaculture debris may also sink to the bottom and cause localized benthic damage, especially in vulnerable marine ecosystems (VMEs) such as coral reefs. Eventually large objects may become more stable and integrated into the substrate, but this depends upon local oceanographic conditions.

Social impact of aquatic litter: Both large pieces of debris as well as extensive litter e.g. cable ties and other fastenings, plastic bottles used as floats, pieces of rope are unsightly and can have considerable social costs in relation to the recreational value of coastal waters, beaches and other land-water interfaces (Brouwer *et al*, 2017). This can impact the social licenses afforded to aquaculture in coastal and rural communities. There are also economic costs associated with beach clean-ups.

Aquatic debris as a vector for alien invasive species (AIS): the global spread of non-indigenous species (species that have been transported inadvertently or intentionally across ecological barriers and have established themselves in areas outside their natural range), thus driving biodiversity loss and posing a threat to ecosystems integrity and functions.

Transportation through natural or anthropogenic litter is occurring passively, without control on species, materials and transportation scheme other than hydrodynamics or environmental factors. The transport of biota on litter items is potentially a new problem, because of the recent proliferation of floating particles, which are mostly plastics and have been implicated in dispersing harmful algal bloom (HAB) species (Masó, 2003). Aquatic plastic litter is characterized by its longevity at sea and its surface properties which favor attachment and thus the possibility of transport to new areas of both mobile and sessile species. Consequently, species transported by rafting can alter the composition of ecosystems (Nava & Leoni, 2021) and alter the genetic diversity through breeding with local varieties or species.

Aquaculture-derived debris as an operational or navigation hazard: The presence of aquaculture-derived aquatic debris such as ropes and netting can interfere with both maritime operations such as fishing or sub-sea engineering as well as the safety of navigation (Johnson, 2000). Incidents may create the need to send divers underwater to attempt to clear the debris. Depending on sea state, work in close proximity to a vessel's hull can be dangerous. NOAA's Marine Debris Program demonstrates a wide range of impacts from aquatic debris in general[7].

[7] See https://marinedebris.noaa.gov/discover-issue/impacts

Contribution to, and impact of, aquatic microplastics: Global estimates of plastic litter in the aquatic environment are around 27 to 66.7 million tonnes (EUNOMIA, 2016). Borelle *et al*. (2020) estimate that 19–23 million metric tons of plastics entered the world's ocean from land-based sources in 2016 alone (11% of global plastic waste) and, left unabated, could reach over 90 million tonnes per annum by 2030. Similarly, Eunomia (2016) estimated that 12.2 million tonnes of plastic enter the aquatic environment annually, primarily from land-based sources (74%), fishing litter (9.4%), primary microplastics (7.8%) and shipping litter (4.9%). Of this they estimated:

- 94% ends up on the sea floor (approx. 70 kilograms kg / square kilometer km^2)
- 5% ends up on the shoreline (approx. 2,000 kg / km^2)
- 1% remains on the ocean surface (18 kg / km^2)

Beaumont *et al* (2019) examined the global ecological, social and economic impacts of aquatic plastic (see **Table 8** below for categories and applications of differ plastics) and calculated that the economic costs of aquatic plastic, as related to aquatic natural capital, are conservatively estimated at between USD 3,300 and USD 33,000 per tonne of aquatic plastic per year, based on 2011 ecosystem service values and aquatic plastics stocks. They suggest that the main impacts are on birds (via ingestion), fish (via both entanglement and ingestion) and invertebrates (entanglement and rafting). In terms of impact on services, plant, wild food and aquaculture production are all negatively affected, as are a wide variety of regulatory and cultural services, mainly via invertebrate ingestion of plastics.

Table 8: Types, applications and specific gravity of common plastics

Categories or classes	% of market	Common applications	Specific gravity	
Polyethylene (PE)	29.5%	Plastic bags, bottles, six-pack rings, gear, cages and pipes for fish farming	0.91-0.94	Sinks
Polypropylene (PP)	18.8%	Rope, bottle caps, gear, strapping	0.90-0.92	
Styrene Butadene Rubber (SBR)		Roofing felt and car tyre	0.94	
Polystyrene (expanded) (EPS)		Bait boxes, floats, cups, expanded packaging	0.01-1.05	
Seawater			1.02	
Polystyrene (PS)	7.4%	Utensils, containers, packaging	1.04-1.09	Floats
Acrylonitrile Butadiene Styrene (ABS)		Electronics and electrics, car interior	1.03-1.11	
Acrylic		Paints, packaging	1.09-1.20	
Polyvinyl chloride (PVC)	10.7%	Film, pipe, containers, buoys	1.16-1.30	
Polyamide or nylon (PA)		Gear, fish farming nets, rope	1.13-1.15	
Polyurethane (PUR)	7.3%	Insulation	1.2	
Poly(lactic acid) (PLA)		Packaging, cups, mulch film	1.21-1.43	
Cellulose acetate		Cigarette filters	1.22-1.24	
Polyethylene terephthalate (PET)	6.5%	Bottles, strapping, gear	1.34-1.39	
Polyester resin + glass fibers		Textiles, leisure boats	>1.35	
Polytetrafluorethylene PTFE (aka Teflon)		Personal care products	2.2	

Source: From Sundt *et al*,. 2014

In the context of aquaculture, microplastics (particles < 5mm) are generated from the wear and tear / abrasion of moving couplings, ropes and other dynamic components, as well as through abrasion and environmental degradation of plastic components. They might also be generated through the breakdown of expanded polystyrene (EPS) blocks or fillings, or the loss of bio-media from RAS systems. Lusher *et al* (2017) looked specifically at the contribution of - and impact to - fisheries and aquaculture of microplastics. In terms of the latter, they note that at present there is no evidence that microplastics ingestion has negative effects on populations of wild and farmed aquatic organisms. This is being contested by other more recent authors who consider that microplastics can serve as vector of toxicants to marine organisms (Mei *et al*., 2020, Rodrigues *et al*., 2019) and that microplastics may sorb some hazardous compounds such as persistent organic pollutants (POPs) and metals due to their large surface area-to-volume ratio and hydrophobicity (Rodrigues *et al*., 2019). In humans the risk of microplastic ingestion is reduced by the removal of the gastrointestinal tract in most species of seafood consumed. However, most species of bivalves and several species of small fish are consumed whole, which may lead to microplastic exposure.

Of potentially greater concern are the smallest microplastics (1-100 nm, referred to as 'nanoplastics'), some of which can be absorbed across cell membranes, including gut epithelia. Nanoplastic particles can cross cell membranes and bioaccumulate following transfer across trophic levels (Lusher *et al*, 2017). Furthermore, plastics often contain potentially toxic additives that impart certain desirable qualities to plastic polymers. Nanoplastics are also hydrophobic and will adsorb persistent bioaccumulative toxins, among other compounds, from water. There are large knowledge gaps and uncertainties about the human health risks of plastics in general, and in particular nanoplastics.

4. Sector Responses and Best Practices

This section draws from the GGGI's C-BPF and A-BPF to highlight the main areas where it is possible to prevent, mitigate or recover ALDFG / ALFAG, using APEC case studies and examples where possible. Each of the two following sub-sections (*Capture fisheries* and *Aquaculture*) are divided by the sector's value / management chain into three actor groups:

1. **Primary producers (capture fisheries / aquaculture)**: this group represents the main producers e.g. fishers, aquaculture operators and their representatives e.g. associations and producer organizations. They are considered separately in the text as their risk drivers and management responses are very different.
2. **Governance bodies**: the governance bodies include the main fisheries / aquaculture sector management and licensing authorities (e.g. fisheries and / or aquaculture departments), fisheries control authorities, environmental management authorities and govement research organizations. Capture fisheries and aquaculture governance actors are considered jointly in this section.
3. **Supply chain**: includes the upstream (e.g. net / rope / equipment manufacturers and re-sellers) and downstream (e.g. processors, wholesalers, retailers, NGOs and consumers) involved in seafood supply chains. Capture fisheries and aquaculture supply chain actors are considered jointly in this section.

4.1 Primary producers

4.1.1 Capture fisheries

Both the GGGI C-BPF and A-BPF focus on a combination of measures to prevent ALDFG and ALDAG from getting into the aquatic environment. In capture fisheries these might consist of:

- Good practice in managing fishing gear
- Improved end-of-life fishing gear disposal facilities
- Education, awareness and information on ghost fishing
- Better marking and identification of fishing gear

The first three of these categories are examined in more detail below. The subject of gear marking is covered in a separate, companion document.

Good practice in managing fishing gear

Fishing gear is at risk of being lost through a number of reasons. As noted above, many of these are dependent upon local conditions, including weather currents and through interactions with other sea users. Whilst some of these conditions are *force majeure*, the actual risk of loss can be prevented by good practice, the avoidance of unnecessary risk and working with other sea farers. Some of the key approaches include:

- Instigating and participating in gear zoning initiatives to reduce conflicts between fishers.
- Ensuring good communication between different fishing fleets operating over the same ground to make others aware of set static gear.

- Participating in research collaborative programs to test new fishing gear and FAD designs.
- Limiting the volume of gear used, e.g., limited lengths and depths of gillnet fleets, trap strings, etc., to increase control of fishing gear and reduce the risk of damage or loss.
- Introducing soak time limits for static gear such as gillnets and traps. Longer soak times increase the risk of gear loss, so fishers will aim at a balance of achieving a catch and retrieving gear quickly.
- Considering fishing gear rigging options that minimize gear loss, even if it compromises catch levels. If necessary, the use of alternative gears as dictated by prevailing weather and other conditions.
- Use and sharing of seabed and local current mapping data to reduce risk of snagging and subsequent gear loss.

Improved end-of-life fishing gear disposal facilities

One key driver for the responsible disposal of old or damaged fishing gear is the convenient access to low-cost disposal opportunities. MARPOL Annex V and its amendments, the latest entering into force in 2018 (see IMO, 2017), (i) requires that every ship of above 100 gross register tonnage should follow a written garbage management plan and (ii) prohibits the "*discharge into the sea of synthetic fishing net and line scraps*" and provides a methodology for determining the nature and adequacy of port reception facilities for garbage that is based on the "*number and types of ship that will call at the port*." This latter requirement suggests that fishing ports should have adequate gear reception facilities that reflect the scale and nature of their fisheries. This is relatively straightforward for larger fishing ports but can become problematic for small coastal ports which have limited quayside space or logistical issues with the subsequent responsible disposal of this waste. The MARPOL Convention also recommends separate collection for non-recyclable plastics and plastics mixed with non-plastic garbage, which includes fishing nets and lines, but not necessarily separate collection for fishing gear.

Within this general area of gear disposal, the GGGI C-BPF provides a number of best practices and management options available:

- <u>Involvement of gear manufacturers</u>: With the adequacy of corporate environmental responsibilities and tools such as life cycle analysis, gear manufacturers have a degree of responsibility in facilitating the responsible use and disposal of their products. This should be through a number of different ways, including (i) buy-back of old gear for reconditioning or recycling into new fishing gear (possibly allied to deposit schemes for returned gear) and (ii) sponsorship and/or implementation of responsible gear disposal schemes.
- <u>Recycling and reuse of end-of-life fishing gear</u>: Ideally some degree of recovery of the costs of responsible disposal could be gained through recycling and reuse of fishing gear and its materials. This might require some level of local pre-processing of fishing gear into its constituent components, e.g., rope, net panels, buoys, fastenings, etc., to assist and identify prospective buyers. This approach, when combined with a wider collection system, could also build up sufficient quantities of gear components to make

them further attractive to buyers. This could also be allied with some form of certification or labelling scheme to identify products as recycled fishing gear and thus gain a higher value (see case studies in **Box 1** below).

- Alternative uses of end-of-life fishing gear: In Australia, rangers in northeast Arnhem Land use abandoned, lost or discarded fishing nets found on the coast to harden coastal tracks for vehicles (Kiessling, 2003), while in some countries old nets are recycled at household level into chicken and stock fencing, soccer goals, etc.

Box 1: Recycling of fishing gear – some mini-case studies from APEC member economies

USA: A public-private partnership was established with a recycler in Washington State. The Washington ports, located within an hour or so from the recycler, benefited from providing a service to their fishers and from the free hauling and pickup they received when a recycling container was full (reducing their extremely high waste disposal costs). In Alaska, communities which were dealing with quickly filling landfills, heavy equipment entanglement problems and difficulties in burying nets, benefited from the removal of this bulky, troublesome material.

Philippines: Global synthetic fiber manufacturer Aquafil Group, global carpet tile manufacturer Interface Inc., and the Zoological Society of London (ZSL) partnered to form Net-Works to establish local supply chains for collecting end-of-life fishing gear and recycling it into new yarn for carpet tile production. Now called Coast 4C this has now extended to Indonesia and Cameroon.

Canada: For many years old fishing nets collected at Steveston Harbour just south of Vancouver, British Columbia, were sent to be buried in a landfill with no other viable disposal option. Inspired by the Net-Works project mentioned above, in 2014 Steveston Harbour Authority worked on a pilot project with Aquafil to send nylon6 fishing nets for recycling. After proving the system was viable, and after a successful operation with GGGI in 2016 to recover an older purse net off the coast of Pender Island, they did a short feasibility study to see what it would take to clean recovered ghost gear sufficiently for recycling.

Canada's Ghost Gear Program supports the improvement of end-of-life fishing gear through the Ghost Gear Fund, which provides funding towards establishing responsible disposal options for ADLFG and end-of-life fishing gear for catch and aquaculture fisheries. Through the first year of the Ghost Gear Fund, Canada has been able to improve disposal options for the Pacific coast, including establishing fishing gear recycling depot's in the province of British Columbia.

https://www.dfo-mpo.gc.ca/fisheries-peches/management-gestion/ghostgear-equipementfantome/faq-eng.html

https://www.dfo-mpo.gc.ca/fisheries-peches/management-gestion/ghostgear-equipementfantome/program-programme/projects-projets-eng.html

Education, awareness and information on ghost fishing

Most fishers are aware of their responsibilities towards maintaining the aquatic environment and the resource base on which they depend for their livelihoods. They are also aware of the need to minimize risk to their gear, and to make every effort to recover lost or abandoned gear where possible. As suggested by the ranking conducted or this study (see **Section 3.1.1** above), there are always opportunities for further education and awareness building, both to expand fishers' mindfulness of the consequences of ALDFG in general and ghost fishing in particular, as well as provide additional information on best practice, risk-reduction strategies and new approaches to gear recovery. Various options exist including:

- <u>Development of education and awareness-building material</u>: A number of awareness campaigns – often associated with the wider issue of aquatic litter – already exist such as the NOAA/Ocean Conservancy Council "Keep the Coast Clear Campaign" in the USA. The majority of these current awareness-building initiatives are aimed at the public in general, thus developing consumer awareness of the issue, but not influencing the sector directly. There are several programs working directly with fishers, but many of these are focused on gear removal, e.g., the Marine Debris Location and Removal Program in Virginia. However, there are relatively few that focus on the priority approach of working with fishers to prevent fishing gear being lost in the first place. Such education efforts should focus on practical, high risk areas which, while needing to be defined through a participatory approach, might include such issues as bait box litter management, avoiding gear conflict, reporting of abandoned gear, etc.

  The Northwest Straits Foundation in Puget Sound (USA) implements a multi-faceted education and awareness building campaign aimed at recreational crab fishers, who are responsible for thousands of lost crab pots each year. The campaign includes a central online information hub, instructional videos, outreach at boat launches, online workshops, contests, and point of sale information (see www.catchmorecrab.org).

  There is also a good case to extend education and awareness to include policy makers, port authorities, and fishery managers (NOAA Marine Debris Program, 2015) such as the *Malinis and Masaganang Karagatan* (MMK) program aimed at coastal municipal authorities in the Philippines (see **Box 2** below).

Box 2: Rewarding coastal municipalities for conserving marine environments

In the Philippines, the *Malinis and Masaganang Karagatan* (MMK) program by the Department of Agriculture's Bureau for Fisheries and Aquatic Resources (DA-BFAR) will award coastal municipalities for their efforts in protecting and conserving marine environments. MMK has four general criteria: (1) absence of illegal fishing and observance of fishing closed season, (2) establishment of protected marine sanctuary, (3) clean coastal waters without domestic and industrial wastes and, (4) effective mangrove protection and rehabilitation program. A National Technical Search Committee has been created to specifically evaluate candidates based on the criteria. The National Winner will receive 10 million pesos worth of fisheries equipment.

- Information availability: As also noted by NOAA (NOAA Marine Debris Program, 2015), one major gap in this area is the lack of web-accessible data products regarding ghost fishing information, studies, and projects. Some databases already exist such as GGGI's data portal and StrandNet, an Oracle database that summarizes all records of sick, injured, or dead aquatic wildlife reported to the Department of Environment and Heritage Protection in Queensland, Australia (Department of Environment and Heritage Protection, 2014). This is a powerful tool that centralizes data from known mortalities as compiled by five different agencies across Australia, including those from derelict fishing gear. Having a centralized location with one or more searchable databases would be a significant advancement for educational and outreach purposes, not just locally but globally. There would be a need to have mechanisms in place to oversee management, verification, and distribution of such data.

  Suggestions for data to include are:
  - Spatial zoning of fishing gear regulations searchable by state / region / nation / fishery
  - Mortality of organisms searchable by species/region found
  - Location of found ALDFG with data provided by fishers, scientists, and general public
  - List of initiatives from both governmental and non-governmental organizations to promote collaborations and reduce duplicative research efforts
  - Published literature, including government reports, conference summaries, and links to peer reviewed literature

The establishment of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Pollution (GESAMP) Working Group 43 is another example of efforts to consolidate information about ALDFG causes, impacts, and solutions. The GESAMP Working Group 43 was established by IMO, FAO and UNEP to develop a report of sea-based sources of marine litter identifying extent, causes, impacts, and recommended solutions to the global problem of marine litter from sea-based sources, including ALDFG. The second interim report from the GESAMP Working Group 43 was presented to FAO's Committee on Fisheries (COFI) in June 2020 and included in its recommendation the need for a more robust estimate of global fishing gear loss (Gilardi *et al*., 2020).

4.1.2 Aquaculture

In aquaculture the management levers to reduce aquatic debris for primary producers are very different to those described above for capture fisheries. In aquaculture these might consist of:

- Advance planning and risk assessment
- Good practices in installing, operating and maintaining aquaculture facilities
- Responsible waste management and end of life equipment and facility management
- Education, awareness and information on ghost fishing

These four areas are examined in more detail below.

Advance planning and risk assessment

Given that the major driver for the loss of aquaculture debris is extreme weather (see **Section 3.2.1**), good planning in terms of both site selection as well as contingency planning for forecast or otherwise anticipated events is essential. This can be conducted through a number of approaches, including:

- Aquaculture businesses reduce the risk of aquaculture operations contributing to the aquatic debris load by preparing a **formal risk assessment** examining both low-level risks (e.g. plastic packaging being blown into the water) and high-level risks (e.g. facility vulnerability to extreme weather) and develop management and mitigation measures to reduce these risks. An example is the 'Storm and Hurricane Preparedness' plans for off-bottom oyster aquaculture in the Gulf of Mexico in the USA .
- Where risks are identified, **the development of contingency plans** to reduce or mitigate the risk of facility damage and debris loss. For example in Chinese Taipei many fish cages used to be lost in typhoons. As a result, farmers often use submersible cage systems that can be lowered down the water column in the event of a major storm event being forecast, effectively protecting vulnerable infrastructure. Another example from outside the APEC geographic region is a large coastal shrimp farm in Saudi Arabia whose main supply canal is in the path of periodic flash floods down a *wadi*. They have therefore built sluice gates either side and have a bulldozer on standby. In the event of a flash flood the sluice gates are closed (which provides 2-3 days supply buffer) and the supply canal in between bulldozed to allow the floods to roll through. The canal walls are re-constructed after these rare, short-lived but destructive events have concluded.
- Ensure that **Environmental and Social Impact Assessments** (ESIAs) recognize the potential risks of using plastics in aquaculture, especially in exposed coastal sites. As part of the EIA process, early engagement with relevant communities can help better anticipate issues (siting, hazards, etc.) as well as provide engagement opportunities for the public if concerns are raised.
- Aquaculture businesses prepare **annual waste audits** to analyze the amount and composition of solid waste generated by their operations. This can be used to develop waste management protocols and a waste management plan for the decommissioning, storage and responsible disposal of solid waste (see Aquaculture New Zealand (2015) for an example in shellfish aquaculture).

Good practices in installing, operating and maintaining aquaculture facilities

Although this area scored relatively low on the driver survey (except in Chinese Taipei and Indonesia where both 'Inadequate maintenance' and 'Poor siting and/ or installation' where considered 'high'), this is an area where aquaculture operators can take real steps to reduce the potential for the loss of aquatic debris from their facilities. As described by the GGGI A-BPF, these include:

- **Reducing equipment wear and tear levels by:**
  - Ensuring physical infrastructure components (e.g. anchors, mooring systems, cage collars, longline systems) are appropriate for the physical and chemical environment.
  - Ensuring that any plastic or other waste materials generated by routine maintenance (e.g. net washing) are captured before they can reach the natural environment.
  - Use alternative materials or higher specification plastics e.g. PET or UHMwPE that are resistant to abrasion and are stronger and lighter than materials such as PE. It should be noted that these may be more difficult to recycle than lower grade alternatives.
  - Development and use of aquaculture equipment manufacturing standards such as those in Canada (see **Box 3** below).

Box 3: Use of engineering standards for aquaculture in Canada

In Canada the aquaculture industry operates under federal and provincial government regulatory and management programs in addition to undergoing voluntary audits to demonstrate compliance to of a range of certification standards. Site-specific engineering specifications on net-pen design, installation and anchoring must meet regulatory approval in some Canadian jurisdictions. Licence holders in BC must ensure that installation methods and anchoring systems are adequately designed and that equipment and structures are capable of functioning as intended in the environment where they are located.

- **Reducing the risk of equipment loss or failure by:**
  - Ensuring that maintenance regimes are in place and followed and that equipment and fittings are replaced within their expected lifetime and immediately following any noticeable damage.
  - Monitoring weather forecasts and implementing contingency plans when necessary.
  - Integrating monitoring schemes into the management plans of aquaculture farms and evaluating them on a regular basis. Offer incentives to those farmers who comply with monitoring efforts.
  - Reporting accidental losses of aquaculture equipment and infrastructure to the relevant authority and recording the event in a logbook with all information on the loss.

- Having in place a tracking and labelling system (e.g. serial numbers on key equipment components) to facilitate monitoring, identification and retrieval of lost gear.
- Clearly marking and lighting aquaculture facilities and their inclusion on navigation charts.
- Introducing annual maintenance contracts between the aquaculture farmers, equipment manufacturers and other service providers to carry out regular check-ups of the entire aquaculture infrastructure to maintain, repair and collect any damaged gear and other equipment, and to recover it after a storm (even if located in another country bordering the same sea-basin).
- Creating a communication channel that connects all involved stakeholders with the aim to recover items that have been lost, broken or abandoned by the farmers (see example from New Zealand below).

Box 4: Industry-driven beach cleaning program in New Zealand

The Marine Farming Association (MFA) in the south island of New Zealand has developed a 'Beach Cleaning Programme' that is linked to their environmental certification program. Participating members assigned beach cleaning areas and given beach cleaning targets. These targets are calculated based on the participating members potential 'impact'. MFA also assign beach cleaning areas with frequency targets, based on the amount of debris that washes up in the area, as certain areas are worse than others based on their position, tides, prevailing wind etc. See https://www.marinefarming.co.nz/beach-cleaning-programme/

Responsible waste management and end of life equipment and facility management

Like any productive industry, aquaculture will generate waste, both through the regular use of consumables (e.g. aquafeed) as well as from the replacement of damaged or end of life equipment. It is therefore important to ensure that equipment and consumable procurement, waste management and end of life equipment decommissioning systems are well considered and include both reducing plastic use (esp. single use plastics (SUPs)) and maximizing the re-use / recycling of plastic components where possible. As described by the GGGI A-BPF, these include:

- Plastics used in aquaculture should be designed, manufactured and sold with an environmentally acceptable, affordable and accessible solution available to the user once the equipment has reached end-of-life.
- Maximize re-use of plastics. This may mean buying high specification items rather than cheap SUP alternatives, and possible investment in recovery, cleaning and re-distribution. Engage with equipment suppliers to maximize the use of recyclable plastics in aquaculture equipment. Obtain information on what plastics are used and in what components to assist sorting and recycling. Utilize existing waste recycling systems where possible (see **Box 5** overleaf).

Box 5: Use of 'waste banks' in Indonesia to facilitate and encourage plastic recycling

In Indonesia waste banks – or '*bank sampah*' as they are called in Indonesian – can be found in neighborhoods across the country in Sulawesi, Kalimantan and Java. At waste banks, the waste created is divided into two categories – organic and non-organic. Organic waste gets turned into compost, while non-organic waste is divided further into three categories: plastic, paper, plus bottles and metal. Like a regular commercial bank, individuals can open an account with their local waste bank, with non-organic waste being weighed and given a monetary value based on rates set by waste collectors. These are being used for depositing end of life plastic bottles from Indonesian seaweed aquaculture.

- Practice preventative maintenance where plastic and other components are replaced (i) before the risk of failure starts to increase and (ii) before the component is so damaged by environmental conditions (e.g. UV light, salt, etc.) that recycling is no longer technically or economically possible.
- Ensure there are systems in place to facilitate re-use of plastics and other materials. This could include a sorting system, waste collection points, wash plants, storage and inventory systems. Set up collaborations between farmers, port authorities and gear producers to locate and establish collection points for disposal of aquaculture equipment in port reception facilities.
- Deposit schemes e.g.:
  - <u>Grant a discount on subsequent purchases</u>: the farmer brings back the used items to the seller / manufacturer and gets a discount on the price of the following purchase depending on the weight/volume/quantity returned.
  - <u>Return a deposit</u>: when purchasing equipment the farmer leaves a deposit which will be returned by the seller / manufacturer if the farmer returns the used items.
- Joint responsibility: ensure the responsibility of recycling is extended to the producers and do not leave it the sole responsibility of the farmer.
- Cooperation in handling waste with other industries/neighbor states.
- Develop a recycling policy and associated management systems, e.g.:
  - Develop a plastics inventory to track recyclable plastics and their status on site.
  - Establish facilities and SOPs for decommissioning equipment and recovering plastic (and other) components for recycling.
- Larger companies should consider working with aquaculture small-medium enterprises (SMEs) to collect recyclable waste and add to their own managed waste streams.
- Develop decommissioning plans for farm sites that are closing down to ensure that all plastic elements are disposed of responsibly (e.g. sold to other businesses, recycled, etc.)
- Encourage the inclusion of decommissioning plans, liabilities and responsibilities in operating permits. Some US states require new aquaculture lease holders to establish a bond when beginning their operations. If the farm shuts down, the bond helps to cover removal costs.

Education, awareness and information on the impact of plastic pollution from aquaculture

Whilst there has been growing harvester awareness of the impact of ALDFG on the marine environment, the same issue has not been so well publicized for aquaculture. This is most likely due to the different natures of the catching and farming sectors (the catching sector tends to be more mobile and have more dynamic interactions with the marine environment), but the last five years have seen much more awareness on the potential contribution of aquaculture to plastic litter, both by supply chain actors and primary producers. Best practices suggested by the GGGI A-BPF include:

- Develop and implement staff environmental awareness training to motivate better practices. Develop and implement SOPs for maintenance, contingency and other regimes, again to promote good practice.
- Develop management and staff awareness of the need for re-using (rather than replacing from new) equipment and fittings, even if it requires additional training.
- Include the issue of plastic pollution from aquaculture in industry best practice / codes of conduct. This can be driven by either producer associations or by regulators (see **Box 6** next).

Box 6: Including the plastic issue in Good Aquaculture Practices (GAqP) in the Philippines

The Philippines Bureau of Agriculture and Fisheries Standards (DA-BAFPS) is currently reviewing the Philippine National Standard on Good Aquaculture Practices, particularly for seaweed, in collaboration with other agencies. This will help the Philippines develop and expand its seaweed cultivation. DA-BFAR has also started a campaign to persuade farmers to use less single-use plastic in their seaweed cultivation. This will benefit the ecosystem while also lowering the danger of human consumption of microplastics.

- Support campaigns organized by the public sector to increase customer awareness related to the fact that higher prices (derived from new Extended Producer Responsibility (EPR) systems in place, alternative materials, certification by an independent body such as the Aquaculture Stewardship Council (ASC), etc.) are related to a better environmental quality of the aquaculture product.
- Develop branding or labelling to raise awareness among consumers.
- Introduce a community-reporting system to identify and address gear loss and littering from aquaculture facilities.

4.2 Governance Bodies

Whilst much of the responsibility for managing aquaculture facilities lies with their operators, it is important that there is a firm but facilitatory governance and regulatory framework that firstly guides and facilitates good practice, and if necessary, penalizes poor or willfully negligent behavior. There may be a wide range of regulators involved, including aquaculture and fisheries departments, fisheries control agencies, environmental management organizations, port authorities and waste management bodies. This section looks at some of the common approaches taken and how they have been implemented in the APEC region.

Research and Development

- Conduct a sector-wide analysis to characterize plastic use in aquaculture and to provide strategic approaches to minimizing both plastic loss in particular and plastic water management in general (see **Box 7** below for example from New Zealand).

Box 7: Tackling plastic waste in New Zealand aquaculture

Aquaculture New Zealand and the Ministry for Primary Industries (MPI) and Fisheries New Zealand partnered with the Sustainable Business Network (SBN) to work together to minimise plastic waste in New Zealand aquaculture. They produced a comprehensive document focusing on three key aquaculture products (king salmon, green-shell mussels and Pacific oysters), bringing industry together with experts in plastic manufacturing and recycling to identify areas for improvement by finetuning existing initiatives and implementing new programs. This has provided a shared understanding of the issues, what success would look like and identifies the key opportunities for action. See SBN (2020).

- Examine opportunities for the use of new or rebalanced materials that are both stronger and less damaging to the environment if lost.
- Examine the possibility of developing natural or synthetic biodegradable materials that combine a long active life that can be deactivated (to reduce ghost fishing or other forms of entanglement and habitat smothering) when their management ceases (e.g. if lost).
- Conduct research to better understand the potential impacts of plastics and other materials on the aquatic environment in order to develop approaches to minimize these before loss.
- Develop practical and effective technology for maritime surveillance to better detect and quantify lost or derelict aquaculture equipment in the water column or on the seabed.

Regulating fisheries and aquaculture operations

- Develop national / regional standards for aquaculture site surveys, risk analyses, design, dimensioning, production, installation and operation.
- Use spatio-temporal zoning and planning within a multi-sectoral framework to prioritize and, where appropriate, restrict permitted economic activities (including aquaculture) to maximize the sustainable use of sea areas and reduce the potential for spatial conflicts (see **Box 8** overleaf for examples in Thailand and Canada).

Box 8: Use of spatio-temporal zoning for fisheries and aquaculture (Thailand and Canada)

In **Thailand**, there are fishing zones designated in the coastal (inshore) area and offshore area. The coastal areas include areas out to about three nautical miles from shoreline and are generally used for small scale fisheries using low efficiency fishing gears. Offshore areas include fishing ground beyond 3 nautical miles and are generally used by commercial fisheries using high efficiency fishing gears. All small-scale fishers (using fishing vessels of less than 10 GT) can fish in both areas within 12 nm from the shoreline, while industrial fishers (using fishing vessels of 10 GT and above) can fish in offshore areas only. Some particular fishing gears (trawls, purse seines and anchovy lift/falling nets) can be also operated in offshore areas. There are also limitations on the number of traps as well as length of gillnets for each fisher to operates in both areas to avoid the conflict among fishing gears in the same fishing ground.

Canada's fishery management is partially achieved through a licensing regime that is based on allocations divided by geographical areas. By permitting in this way, fisheries management is able to identify gear conflict issues and adjust management measures as needed to minimize issues. While spatial conflict is not considered a substantial cause of lost gear, there are locations where there is an increased incidence of gear conflict along the waters that border the United States. Focus on lost gear retrieval efforts and Fishery Officer sweeps attempt to target these known areas of ALDFG accumulation. In addition to fisheries management measures, Marine Spatial Planning measures are used in Canada to provide a tailored approach to each unique area to help manage human activities and their impacts on our oceans. Depending on the area, these plans may include areas for potential resource development and areas that require special protection

Monitoring and Reporting ALDFG / ALDAG

- Ensure that policy, management and regulatory authorities implement a practical and robust aquatic debris reporting system that is consistent with the context of different aquaculture operations under their jurisdiction.

Box 9: Lost fishing gear reporting in Canada, Thailand and the US

In Canada the reporting of lost gear is a condition of license for all commercial catch fisheries. Reporting of lost gear is mandatory through conditions of license and the information is maintained in a system to allow for post-season targeted retrieval efforts, which are authorized by the Ghost Gear Program. A reporting system has been established by DFO and monitors lost and retrieved gear and collects all of the recommended information in the FAO VGMFG. Information on lost gear is shared with RFMOs[8].

[8] https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/reporting-declaration-eng.html

In Thailand, the Thai Department of Fisheries (DoF) requires all Thai flagged fishing vessels operating in the area under the Southern Indian Ocean Fisheries Agreement (SIOFA) to mark fishing gear, recover "*fallen, lost or discarded*" fishing gear, notify the DoF of any ALDFG that cannot be recovered and store all plastic waste onboard until it can be safely and responsibly disposed of at adequate port reception facilities[9].

In Puget Sound (USA) reporting of lost fishing nets within 24 hours is mandated by state fisheries managers. A rapid response process is in place to receive and respond to reports, verifying their location. When needed, on-call diver retrieval teams are called out to retrieve nets or vessels of opportunity are engaged if divers are not needed. The reporting program has resulted in the retrieval of 50 newly lost nets since its inception in 2012, effectively preventing their long-term impacts.

- Develop and implement reporting protocols and pathways in cooperation with aquaculture equipment manufacturers, farm operators, producers and supply chain associations, as well as with maritime and other relevant administrations. This can include IT-based approaches such as adopted in Chile (see **Box 10**).

Box 10: Virtual platform for reporting waste generated by salmon farming in Chile

In Chile a virtual platform has been developed by the Technological Institute of Salmon (Intesal) of the Salmon Chile Association to classify and quantify the waste generated in the farming centers of its partners. As of 2014, all aquaculture companies must report annually the type and volumes of waste generated through a declaration system via the web portal, in accordance with the obligations imposed by the Regulation of the Registry of Emissions and Transfers of Pollutants (RETC) Regulation (Art. 26, 27 and 28). With this information, it is possible to estimate the current volumes that are generated in the sector. This information will serve to attract investors or services dedicated to the handling and management of solid waste generated from aquaculture.

- Maintain a record/register of aquaculture-derived aquatic debris reported as being found, lost, abandoned, or disposed of. This record/register should include details of:
    a. Size, nature and characteristics of the debris.
    b. any identification marks or other indicators of origin.
    c. date, time, position of loss or retrieval, depth of water, etc.
    d. reason for loss (if known).
    e. weather conditions; and
    f. any other relevant information.

Harmonize and connect with other registers where possible at regional, national and other levels. Over time, such registers could be merged where appropriate and/or submitted to the GGGI global data portal.

[9] https://www.apsoi.org/sites/default/files/documents/meetings/CC3-Doc11%20Thailand%20Implementation%20Report%20of%20SIOFA%20CMMs%202019.pdf

Facilitating the landing and responsible disposal of damaged / end of life equipment

- Develop regulations clarifying the need for fishers and aquaculture operators to return damaged / end-of-life fishing gear and aquaculture equipment to land for responsible disposal (see **Box 11** below and **Box 12** overleaf).
- Provision of adequate port reception facilities for the disposal of fishing gear in accordance with MARPOL Annex V. and provide waste sorting, cleaning and disposal facilities for debris and litter recovered by third parties, such as fishers and aquatic litter retrieval initiatives.
- Develop agreements with both aquaculture equipment manufacturers and recycling businesses to maximize opportunities for cost-effective and environmentally responsible disposal of landed waste.
- Exchange information with IMO's Port Reception Facility (PRF) database to ensure that specialist reception facilities are easily located.
- Providing a common forum (e.g., notice boards, web fora, other communication) for port users on (i) prevention and mitigation approaches and (ii) relaying gear loss reports to other mariners.

Box 11: Regulations in Chinese Taipei requiring aquaculture equipment to be returned to shore

Chinese Taipei's local governments have formulated autonomous regulations related to oyster culture as below:

1. When the harvest of cultured oysters is completed, all cultured oyster sheds, floats and wastes shall be brought back and placed in the location stated in the application form.
2. The non-systematic abandonment of oyster culture equipment is banned.
3. After the oyster harvest is completed, unusable oyster sheds and buoys should be recovered to the shore.

In addition, there is also a temporary area for placing offshore oyster culture equipment wastes to centralize and process the scrap equipment.

Source: The Regulation of oyster culture in Chiayi County (in Chinese only)[10]

10 https://law.cyhg.gov.tw/LawContent.aspx?id=GL000065&KeyWord=%e5%98%89%e7%be%a9%e7%b8%a3%e7%89%a1%e8%a0%a3%e9%a4%8a%e6%ae%96%e5%8d%80%e5%8a%83%e6%bc%81%e6%a5%ad%e6%ac%8a%e7%ae%a1%e7%90%86%e8%87%aa%e6%b2%bb%e6%a2%9d%e4%be%8b

Box 12: Regulations on solid waste management in Chilean aquaculture

The Chilean Environmental Regulation for Aquaculture (art. 4a and 4b) establishes the adoption of measures to prevent the dumping of solid and liquid residues and wastes, which are caused by the aquaculture. The final disposal of equipment, gear or farming modules or component parts must be carried out in designated and authorised locations. If any aquaculture waste is detected, the owner has ten days to correct it, otherwise a sanctioning process is initiated.

Currently, companies, especially salmon farming, have monitoring and cleaning programs for beach sectors. A public innovation initiative carried out by National Fisheries and Aquaculture Service of Chile (SERNAPESCA) in Coquimbo is notable, aiming at addressing the problem of accumulation of waste from aquaculture, mainly oysters, in the Playa Grande de Tongoy sector. Thanks to this project, involving the 11 owners who carry out aquaculture activities in the area, since 2018 it has been possible to determine the responsibility for 90% of the waste present on the beach, SERNAPESCA collaborates with other public institutions to train companies on cleaning the beaches and coastal areas close to aquaculture farms.

Gear recovery programmes

In Thailand the Net Free Seas project[11] – run by the Environmental Justice Foundation (EJF) and funded by the Norwegian Retailers' Environment Fund – is aiming to rid Thailand's waters of deadly discarded fishing nets. The program employs a project coordinator who will engage with communities, discussing with them the dangers of ghost nets, and how they would like the scheme to work in their area. The coordinator will also provide training for the fishers on how to avoid losing nets themselves. Coastal communities will collect discarded nets which will be sent to make a variety of goods, such as sports and kitchen equipment.

[11] https://ejfoundation.org/news-media/new-project-collecting-and-recycling-ghost-gear-in-thailand

4.3 Supply Chain

The aquaculture supply chain is also an important group of businesses who have a stake in ensuring responsible seafood production from both capture fishers and aquaculture. For the purpose of this document we see this supply chain consisting of upstream equipment designers, manufacturers and sellers, as well as downstream merchants, processors , wholesalers, retailers and consumers. Also included in the supply chain are ancillary organizations, such as sustainable production standard holders, NGOs and consumer advisory groups.

Good gear design

It is increasingly being recognized that there is an important role to be played at the beginning of the seafood production life cycle to ensure that fishing gear and aquaculture equipment is well designed and sensitive to its potential impact if lost, and that there is a degree of gear traceability built into the materials and gear components that allows the potential for the cost-effective identification of gear origin and ownership at different points in the life cycle.

With the advent of corporate environmental responsibilities and tools such as life cycle analysis, fishing gear and equipment manufacturers have a degree of responsibility in facilitating the responsible use and disposal of their products. This should be through a number of different ways, including:

a. **Innovative and practical designs** that (i) ensures that gear / equipment is robust and manageable even under severe conditions, (ii) has mechanisms built in to reduce their impact if lost or abandoned e.g. biodegradable fastenings for pots, (iii) can be easily deconstructed and different plastic types separated if damaged or at end-of-life and (iv) has in-built / easily added traceability to assist waste audits and identify ownership if recovered after being abandoned, lost or discarded.
b. **Buy-back of old gear** for reconditioning or recycling into new fishing gear (possibly allied to deposit schemes for returned gear); and
c. **Sponsorship and/or implementation of responsible gear recalling and disposal / recycling schemes**, possibly through Extended Producer Responsibility (EPR) schemes (see **Box 13**).

Box 13: Canada's EPR scheme development

The Government of Canada has committed to working with provinces and territories to develop consistent, national targets, standards and regulations that will make companies that manufacture plastic products or sell items with plastic packaging, responsible for collecting and recycling them. While there are currently no targeted efforts towards EPR schemes with fishing gear, DFO has flagged this as a priority area to develop and has begun to discuss with stakeholders, to advance extended producer responsibility for fishing gear across Canada.

See: https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/overview-extended-producer-responsibility.html & https://www2.gov.bc.ca/gov/content/environment/waste-management/recycling/extended-producer-responsibility

Responsible sourcing in the supply chain

Seafood businesses, e.g., those companies involved in the purchase, processing and value adding, distribution and sale of seafood, have a considerable role in ensuring that their raw material is procured from responsible and well-managed fisheries that minimize the potential for – and consequences of – ALDFG / ALDAG.

While the predominant sustainability strategy of seafood businesses is to source from fisheries or aquaculture operations that fall under third-party certification schemes, seafood companies are increasingly involved in encouraging fisheries to enter fisheries or aquaculture improvement projects (FIPs / AIPs), providing funding to, and participating in, research and providing consumer information and awareness-building. As described by the GGGI BPFs, these include:

- **Ensure that seafood sourcing avoids high-risk fisheries and aquaculture operations** and participate in relevant initiatives (e.g. equipment recycling where possible, reduced use of SUPs and generally embracing circular economy principles).
- **Require suppliers to conform with best practice** as promoted through the guidance in the GGGI AC-BPF and A-BPF and other relevant guidelines.
- **Ensure that supply chain components also minimize the risk of contributing to both terrestrial and aquatic debris production**.
- **Ensure that any third-party sourcing strategies / policies recognize the impacts of fisheries and aquaculture-derived debris on the aquatic environment** and ensure that these are managed effectively.
- **Ensure that third-party sourcing strategies/policies recognize the efforts of fishers and aquaculture operators to recover their equipment if lost or abandoned**. Where companies have their own sustainable sourcing guidelines, they should favor those operations that participate in recovery programs for aquatic debris.
- **Certification standard holders should develop certification criteria and scoring guideposts that encourage fisheries and aquaculture businesses to follow best practice** in reducing their risk to the aquatic environment throughout the lifetime of seafood harvesting and farming operation.
- **Work both with (i) aspiring fisheries / aquaculture operations that are entering into FIPs and AIPs, as well as (ii) more advanced operations that have or are undergoing the certification process to reduce the risk of generating aquatic debris**.

Awareness-building and promoting best practice

Although the role of fisheries – and to a lesser extent aquaculture – in contributing to marine litter is well known, there is a need to build awanress of the issue throughout the supply chain and to both facilitate best practice and demonstrate the improvements that have been made to date.

In particular non-governmental organizations (NGOs) have proved to be key advocates of good practice and responsible fishing and participate in a wide variety of activities ranging from research and managing FIPs / AIPs to providing seafood consumers and other stakeholders with valuable information and advice.

With regard to fishing gear management and addressing the consequences of ALDFG, NGOs have a particular role in capacity-building, research, developing codes of practice and awareness-raising. As described by the GGGI BPFs, these include:

- **Being advocates for change**, being able to focus on a wide range of actors, including policymakers, seafood producers and fishers.
- **Acting as catalytic partners**, possibly with a particular focus on small-scale fishers and aquaculture operators, developing and facilitating local groupings, assisting with consensus-building and program planning.
- **Providing direct capacity-building and training**, again probably mainly to small-scale fishers and aquaculture operators,, to improve practical skills and ensuring both environmental and financially sustainable businesses.
- **Raising public awareness** in emerging or under-reported issues related to the loss of fishing gear and aquaculture equipment, and the subsequent impact on the aquatic environment.
- **Acting as an independent intermediary and auditor**.
- **Providing research and survey support to mitigatory actions** that either reduce the ability of ghost fishing gear to continue to fish or to directly address the impacts on aquatic animals and birds, habitats and other key components of the aquatic ecosystem.
- **Identify and catalyze funding**, and where appropriate **manage and implement remediation projects** for end-of-life fishing gear and aquaculture equipment removal and related aquatic litter recycling.

5. Checklist of Best Practices

This section briefly summaries the best practices provided in **Section 4** in the form of a checklist. As with the preceding section, this has been divided up into a number of different groups of actors as follows:

- **Primary Producers**
  - ***Capture fisheries (F)***
  - ***Aquaculture (A)***
- **Governance (G)**
- **Supply chain (S)**

These checklists are based on GGGI's C—BPF and A-BPF, as well as drawing on the regional needs and experience that has been described earlier in the report.

5.1 Checklist for Primary Producers

5.1.1 Capture fisheries (F)

Code	Checklist item
F1	Develop and promote codes of practice (voluntary or otherwise) that include fishing gear loss prevention strategies and gear recovery protocols
F2	Support development and follow gear zoning initiatives to reduce conflicts with other fishers.
F3	Set only the size of gear that can be responsibly managed (e.g. limit length and depth when necessary for control)
F4	Limit soak time for static gear to the minimum time needed to achieve catch
F5	Alter fishing methods (gear type, size, etc.) to match ocean fishing conditions
F6	Share information about local conditions and underwater obstructions with others to prevent snagging and gear loss
F7	Mark static gear to make it visible, including with lighting if necessary
F8	Mark gear and components with vessel ownership details
F9	Mark FADs and FAD components with ownership details, equip drifting FADs with position tracking devices & provide FAD position data in real time to relevant authority
F10	Maintain garbage management plans and record book to comply with MARPOL Annex 5 regulations

Code	Checklist item
F11	Train crew on proper gear storage and disposal methods
F12	Recycle and reuse fishing gear components whenever possible
F13	Dispose of end-of-life fishing gear responsibly at on shore facilities
F14	Wherever possible, use fishing gear that becomes disabled if lost at sea (escape mechanisms, biodegradable materials, etc.)
F15	Carry gear retrieval equipment on board and train crew in its use
F16	Immediately retrieve any gear that is lost at sea if possible to do so safely
F17	Communicate location of lost gear to other fishers if it poses a navigation risk
F18	Report all lost fishing gear, including FADs, to appropriate authorities, including date, time and location of and reason for loss

5.1.2 Aquaculture (A)

Code	Checklist item
A1	Develop corporate policies for use and disposal of solid, non-biological waste
A2	Participate in research programs to test novel approaches under commercial conditions.
A3	Use natural or biodegradable synthetic materials where possible, especially for short-term or single use plastic applications.
A4	Establish contingency plans to minimize infrastructure loss in the event of extreme weather or other events threatening farm infrastructure.
A5	Maintain an inventory system and waste audits to manage major plastic components on site.
A6	Participate in debris reporting schemes to ensure that the consequences for environmental damage or safe navigation are minimized.
A7	Participate in equipment / farm decommission plan / bond programs.
A8	Prepare and develop Standard Operating Procedures (SOPs) for the location, tracking and recovery of lost equipment and other debris from farming operations.

Code	Checklist item
A9	Build corporate social responsibility and introduce a community-reporting system to identify and address gear loss and littering from aquaculture facilities.
A10	Aquaculture associations develop codes of practice on behalf of members to facilitate and encourage responsible farming operation, cooperation among members and end-of-life equipment / solid waste management.
A11	Aquaculture associations to work on behalf of members to liaise with other aquatic economic activities as well as conservation initiatives, together with the competent authorities in establishing marine spatial and temporal planning tools to minimize the potential for unwanted interactions.
A12	Aquaculture associations to assist member to identify, map and clear aquaculture-derived aquatic debris 'hotspots' that represent either an operational or navigational hazard to their members and others, or a significant risk to the aquatic environment, including the entangling aquatic mammals, birds or turtles occupying the region.

5.2 Checklist for Governance (G)

Code	Checklist item
G1	Fishing and aquaculture licensing processes should explicitly include specific requirements to mark and identify fishing gear and marine aquaculture facilities consistent with the FAO Voluntary Guidelines for the Marking of Fishing Gear.
G2	Inspections should be conducted at sea and at port to ensure that marking and other requirements relevant to preventing gear/equipment loss are adhered to
G3	Deployed gear/equipment found without required marking should be reported to the relevant authority
G4	Appropriate penalties or other sanctions should be established to prevent and deter non-compliance with gear/equipment marking and other regulations relevant to preventing gear loss
G5	Mandate temporal and/or spatial separation of fishing gear / aquaculture operations to avoid gear loss caused by conflicts
G6	Require the use of biodegradable materials on gear/equipment to minimize ghost fishing
G7	Provide education to build awareness of the harm caused by lost gear/equipment and the practices available to avoid losing gear/equipment
G8	Require on-board lost gear/equipment retrieval tools and crew training where practical
G9	Collaborate on and support the retrieval of lost gear/equipment

Code	Checklist item
G10	Ensure there is an effective system in place to report lost or abandoned gear/equipment
G11	Maintain a lost gear/equipment register that includes the following information: type of gear/equipment lost, identifying marks, date/time/position of loss or retrieval, reason for loss, weather conditions, other relevant information
G12	Coordinate, communicate, and share information about lost gear/equipment with other entities such as RFMOs, and regional and State fisheries managers
G13	Facilitate the reporting of lost gear/equipment by small-scale, artisanal and recreational fisheries and aquaculture operations to appropriate authorities
G14	Researchers should collaborate with fishers, aquaculture operators and their associations designers to test and improve gear/equipment design and materials
G15	Develop cost-effective survey systems to locate and quantify lost gear/equipment at sea
G16	Develop cost-effective lost gear/equipment retrieval techniques
G17	Quantify the causes of gear/equipment loss as well as their impacts and costs
G18	Provide reception of garbage and waste gear/equipment without causing undue delay to ships
G19	Develop onshore waste disposal strategies, including waste segregation, to reduce, reuse, and recycle ship-generated wastes and waste gear/equipment
G20	Provide up-to-date information to authorities for inclusions in the IMO's PRF database to ensure that waste gear/equipment facilities are easily located
G21	Include waste gear/equipment in Port Waste Management Plans

5.3 Checklist for the Supply chain (S)

Code	Checklist item
S1	Design and manufacture gear/equipment to allow for gear traceability and recycling – gear designers, etc.
S2	Design gear / equipment that becomes disabled when lost at sea
S3	Design and manufacture gear/equipment with biodegradable components
S4	Mark key gear/equipment components (ropes, net panels, traps, buoys, pen collars) with manufacturer name, year, type of product and production batch
S5	Include gear/equipment traceability information and ownership in sales record-keeping

Code	Checklist item
S6	Facilitate and promote gear/equipment recycling and responsible disposal schemes including buy-back and EPR schemes
S7	Design and manufacture gear/equipment with end-of-life recycling in mind, reducing use of mixed polymer materials
S8	Seafood buyers source from fisheries or aquaculture operations that employ management practices to prevent harmful impacts from lost fishing gear
S9	Seafood buyers source from fisheries or aquaculture who prioritize recovery of lost gear (when safe and feasible to do so)
S10	Seafood buyers source from fisheries or aquaculture certified by third-party certification schemes that include benchmarks and scoring guidance related to impacts and management of lost fishing gear / aquaculture equipment.
S11	Provide cost effective disposal options for end-of-life or damaged gear / equipment to encourage / facilitate the retrieval of lost fishing gear and aquaculture equipment.
S12	Seafood certification standard holders should include benchmarks and scoring guidance that recognize best practices for preventing gear / equipment loss and for preventing ghost fishing if gear is lost
S13	Regional NGOs should advocate for solutions to the problems posed by lost and abandoned fishing gear or aquaculture debris using objective, evidence-based information
S14	Regional NGOs should build capacity for consensus-driven solutions to the problems of lost fishing gear and / or aquaculture debris, including providing examples of codes of practice
S15	Regional researchers, marine resource development and conservation funding agencies, NGOs and others should coordinate projects establishing innovative solutions to the problems of lost fishing gear / aquaculture debris.

Appendix A: References and Bibliography

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Appendix B: Questionnaire sent to APEC member economies

Introduction:

The **APEC Oceans and Fisheries Working Group** (OFWG), together with the **Global Ghost Gear Initiative** (GGGI), have commissioned a '*APEC Best Practices Framework and Stakeholder Workshop to Address Abandoned, Lost or Discarded Fishing Gear (ALDFG)*'. The purpose of these guidelines is to highlight and explain relevant gear management best practices and bring them to life through practical real-life examples. The expectation is that this will inspire APEC Member Economies and relevant stakeholders to take action and be aware of all the positive progress already being made around the world.

The consultants appointed to the preparing this document - Joan Drinkwin of Natural Resource Consultants, Inc. (NRC), Tim Huntington of Poseidon Aquatic Resource Management Ltd and Pingguo He - have requested that the APEC member economies provide feedback on the specific issues related to ALDFG under their jurisdiction. They would be grateful if this short questionnaire could be filled out in as much detail as possible to ensure that the resulting best practice framework is both targeted and relevant.

We would be grateful if you would return the completed questionnaire to Tim Huntington (tim@consult-poseidon.com) by 25th June 2021.

Details of the respondent:

Name:		**Position:**	
Organisation:			
Location (country):		**Email address:**	

Q1. In your view, what are the main drivers / causes for the production of marine debris from capture fisheries (ALDFG) in the APEC region? *Please put a x in the relevant box in the ranking (H High, M Medium & L Low) & add as much detail as you can for each (esp. high & medium ranked causes). Please add more causes in the empty rows below.*

Cause	Rank H	Rank M	Rank L	Please add detail / comments
Equipment / fishing gear failure				
Gear lost due to environmental factors: weather, currents, bottom obstructions.				
Lack of affordable disposal options				
Theft or sabotage				
Spatial conflict with other fishing gear or vessel traffic				
Poor gear marking				
IUU fishing activities				
Lack of awareness of the impact of marine debris/litter				
Other?				

Q2. In your view, what are the main drivers / causes for the production of marine debris from aquaculture in the APEC region?

Please put a cross (x) in the relevant box in the ranking (H High, M Medium & L Low) and add as much detail as you can for each (esp. high & medium ranked causes). Please add more causes in the empty rows below.

Cause	Rank			Please add detail / comments
	H	M	L	
Extreme weather events e.g. storms, floods, etc.				
Poor siting and/ or installation				
Inadequate maintenance				
Lack of planned farm decommissioning				
Lack of awareness of the impact of marine debris/litter.				
Other?				
Other?				
Other?				

Q3. Is there a gear marking requirement in the regulation or the fishery management plan in your country (or fishing region)?

If so, please attach the relevant text (in English) that is related to gear marking. If an English version is not available, please provide the text in its original language. Please also provide the source or web site if possible.

Q4. Are you aware of any good examples of schemes or mechanisms to reduce ALDFG / aquaculture-derived debris in the APEC region?

If so, please provide details in the table overleaf…..

Action area	Description of scheme	Linkages to web pages / contacts of key proponents (or attach copies).
1. Developing *Extended Producer Responsibility* (EPR) schemes for fishing (e.g. nets, traps, FADs) or aquaculture gear (e.g. fish cages, pond liners) and their components (e.g. rope, buoys, etc)?		
2. Spatial zoning to reduce the potential for conflict between different fishing fleets, aquaculture operations and / or other maritime users		
3. End of life fishing gear / aquaculture equipment collection / disposal solutions		
4. Fisher & aquaculturist awareness building & education programmes related to marine debris and litter.		
5. Lost fishing gear / aquaculture equipment reporting, location and recovery programmes.		
6. Marking of gear for visibility and owner traceability.		
7. Other industry-led solutions to ALDFG or debris from aquaculture.		

Q5. According to your knowledge or based on landing data of your country, rank the importance of the following gear types/categories in terms of their landing volume or the number of vessels.

Please rank the two right-hand columns from 1 to 12. 1 is the highest landing by weight or the greatest number of fishing vessels and 12 is the lowest landing by the weight or the least number of fishing vessels in the list.

Gear category	ISSCFG Code	Rank (1 highest, 12 lowest)	
		Landings by gear (tonnes)	No. of vessels using gear
1. Purse seines	01		
2. Seine nets (incl. Danish/Scottish seine and beach seines)	02		
3. Bottom trawls (all bottom trawls incl. beam trawls)	03.11 - 03.19		
4. Midwater trawls	03.21 - 03.29		
5. Dredges	04		
6. Set gillnets (bottom gillnets)	07.1		
7. Drift gillnets	07.2		
8. Stationary uncovered pound nets (traps/setnets/pound nets)	08.1		
9. Pots (also called traps in some places)	08.2		
10. Stow nets	08.4		
11. Set longlines (bottom longlines)	09.31		
12. Drift longlines	09.32		

Please feel free to add additional gears if they are not listed above.

Thank you for filling in this questionnaire. This will help improve the context and focus of the 'APEC Best Practices Framework and Stakeholder Workshop to Address Abandoned, Lost or Discarded Fishing Gear (ALDFG)' and the accompanying 'Compendium for the marking of fishing gear in APEC countries'.

Please return the completed questionnaire to Tim Huntington (tim@consult-poseidon.com) by 25th June 2021. If you have any questions on any of this questionnaire, please feel free to contact Tim before then.

Notes

Managing Abandoned, Lost or Discarded Fishing Gear and Aquaculture Equipment in the APEC Region