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Report on good practices to prevent and reduce marine plastic litter from fishing activities

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Preparation of this document

This report is the result of a desktop study to gather data and information on existing projects that address marine plastic litter from fisheries. The report outlines the main achievements of these projects and highlights areas that should be the subject of future research. The publication is a product of the Food and Agriculture Organization of the United Nations (FAO) Activity 1.1.2 under the GloLitter Partnerships project (UNJP/GLO/051/IMO) (hereafter, "GloLitter") and will be used for knowledge sharing purposes.

GloLitter is implemented by the International Maritime Organization (IMO) and FAO, thanks to initial funding from the Government of Norway via the Norwegian Agency for Development Cooperation (Norad). The project's overall objective is to assist developing countries to reduce marine plastic litter from its maritime transport and fishing sectors. To this end, the project strengthens government and port management institutional capacities to address marine plastic litter (MPL), and supports legal, policy and institutional reforms at the country level. GloLitter achieves its aims by focusing on several areas identified in the recently adopted IMO Action Plan to address MPL from ships, as well as in complementary actions identified by FAO. The latter include, in particular, the provisions laid out in the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG).

This report is based on work conducted by Ms Ingrid Giskes, Mr Joel Baziuk and Ms Hannah Pragnell-Raasch, of the Global Ghost Gear Initiative® (GGGI), Ocean Conservancy and Ms Amparo Perez Roda, project coordinator for the FAO component of GloLitter. Technical supervision was carried out by Mr Jon Lansley, FAO Lead Technical Officer. The final manuscript was reviewed by Ms Tamara Barabaze, IMO GloLitter project manager, and Mr Edward Kleverlaan, IMO international consultant.

The GGGI is one of GloLitter's strategic partners. As an initiative it supports the project's goals and objectives by working to tackle the global threat of abandoned, lost and otherwise discarded fishing gear. The GGGI was formed in 2015 as the first and only global alliance dedicated to developing holistic solutions for ghost gear around the world.

Abstract

While the quantity of abandoned, lost or otherwise discarded fishing gear (ALDFG) entering the ocean remains the subject of conjecture, ALDFG is nonetheless recognized as the most harmful form of marine plastic litter. Irrespective of whether it has been intentionally discarded or accidentally lost, ALDFG harms vulnerable species, damages fragile habitats, creates navigational hazards and depletes fish stocks. Furthermore, if left unmanaged, ALDFG can threaten food security, livelihoods and human health.

In order to determine good practices to manage and ultimately prevent ALDFG, it is essential to understand the context of the current situation, including the sources, drivers and impacts of ALDFG. The present report provides an overview of the fishing related marine plastic litter problem and its current status. More specifically, it focuses on ALDFG or "ghost gear", situating its impact and contribution to the broader issue of sea-based plastic litter.

A key component in the successful management of ALDFG involves heeding the lessons learned from existing projects around the world, while acknowledging that management strategies vary significantly across geographies. The application of new strategies must therefore be evaluated in light of local circumstances and/or needs. Using the good practice categories identified by the Global Ghost Gear Initiative's Best Practice Framework for the Management of Fishing Gear for Capture Fisheries, this report presents ten case studies that exemplify key good practices for the prevention, mitigation and remediation of ALDFG. Based on the good practices identified in the case studies, as well as the broader global context of the ALDFG problem, the report then offers a series of recommendations. The latter include mechanisms and elements that can be implemented by GloLitter participating countries and all those aiming to prevent, mitigate and remediate fishing-related marine plastic litter.

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Abbreviations and acronyms

ALDFG	abandoned, lost or otherwise discarded fishing gear
APEC	Asia-Pacific Economic Cooperation Council
A-BPF	Best Practices Framework for the Management of Aquaculture Gear
C-BPF	Best Practice Framework for the Management of Fishing Gear (for wild capture fisheries)
CFP	Common fisheries policy
CMMs	conservation and management measures
COFI	United Nations Committee on Fisheries
DFD	dive-for-data
DoF	Department of Fisheries, Canada
EJF	Environmental Justice Foundation
EOL	end-of-life
FAD	fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
FFI	Fauna and Flora International-Myanmar
FIPs	Fishery Improvement Projects
FNG	Fishing Net Gains
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GGGI	Global Ghost Gear Initiative
HDPE	high density polyethylene
IMO	International Maritime Organization
IUU	illegal, unreported and unregulated (fishing)
LPC	Lead partnering country
MARPOL	International Convention for the Prevention of Pollution from Ships
MoHT	Ministry of Hotel and Tourism
MOP	Myanmar Ocean Project
MPL	marine plastic litter
NFS	Net Free Seas

NOAA	National Oceanic and Atmospheric Administration
NRC	Natural Resources Consultants
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PC	Partnering country
PE	polyethylene
PP	polypropylene
RFMO	Regional fisheries management organization
SDGs	Sustainable Development Goals
SEAFDEC	Southeast Asian Fisheries Development Center
SOFER	Stand Out for Environment Restoration
UNCLOS	United Nations Convention of the Law of the Sea
VESS	Vanuatu Environmental Science Society
VFD	Vanuatu Fisheries Department
VGMFG	Voluntary Guidelines on the Marking of Fishing Gear
VSLA	Village Savings and Loan Association
ZSL	Zoological Society of London

Executive summary

This report provides an overview of the status of fishing-related marine plastic litter, focusing specifically on abandoned, lost or otherwise discarded fishing gear (ALDFG or "ghost gear") and evaluating its impact and contribution to the broader marine plastic litter issue. In particular, the preparation of this report supports phase I of the Food and Agriculture Organization of the United Nations (FAO) component of the UNJP/GLO/051/IMO project, Activity 1.1.2, under the GloLitter partnership (hereafter "GloLitter"). GloLitter is implemented by the International Maritime Organization (IMO) and FAO thanks to initial funding from the Government of Norway via the Norwegian Agency for Development Cooperation (Norad).

While the quantity of plastic waste from the fishing sector entering the ocean, and in particular ALDFG, is still the subject of conjecture, ALDFG is recognized as the most harmful form of marine litter (Wilcox *et al.*, 2016) irrespective of whether it has been intentionally discarded or accidentally lost. Focusing on the scientific aspects of the ALDFG problem is part of the mandate for the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) Working Group 43 on sea-based sources of marine plastic litter (GESAMP, 2021).

In order to determine good practices to prevent, mitigate and remediate ALDFG, it is essential to understand the context of the current situation: this includes the sources, drivers and impacts of ALDFG. Section one of this report therefore provides an overview of ALDFG and its contribution to the broader marine plastic litter issue. Additionally, it summarizes key governance instruments currently in operation to manage and prevent marine plastic litter from fisheries. With this mind, it particularly focus on the two international guidelines that address fishing gear management: the Global Ghost Gear Initiative's (GGGI) Best Practice Framework for the Management of Fishing Gear for wild capture fisheries (C-BPF), and the FAO Voluntary Guidelines on the Marking of Fishing Gear (VGMFG).

Section two presents a series of case studies exemplifying existing good practices to prevent, mitigate or remediate fishing-related marine plastic litter, with a particular focus on ALDFG. As per the GGGI (2021) the categories are defined as:

- **prevention**: avoiding the occurrence of ALDFG in the environment
- **mitigation**: reducing the impact of ALDFG in the environment

- **remediation**: removing ALDFG from the environment.

The good practices highlighted provide tried-and-tested measures that can be applied to the design and implementation of viable solution projects in other countries around the world.

As well as identifying good practices, section three captures key information gaps, challenges and limitations in addressing ALDFG; these have been informed by the analysis of existing projects and literature review. Based on the case study analysis and the literature review of the broader global context, the final section also offers a series of recommendations that can be incorporated into the development of projects that deal with marine plastic litter from the fishing sector.

1. Sources, drivers, impacts and governance of fishing-related marine plastic litter

1.1 Overview of marine plastic litter

Exponential increase in production has made plastics present across the globe. The production of plastics has increased by an average of 8.4 percent annually since the 1950s (Geyer, Jambeck and Law, 2017). Coupled with other factors such as inappropriate and/or uncontrolled disposal practices, inadequate waste management infrastructure and insufficient recycling technologies, along with a lack of public awareness and incentives (Hahladakis, 2020), this has resulted in plastic litter being universally present in the environment. Compared to the amount produced, only a small proportion of plastic materials enter waste management processes such as recycling or incineration (Lebreton *et al.*, 2018), including fishing gear. The majority goes to landfill or is discarded in the environment where it can leak into waterways and the ocean (Figure 1, Geyer, Jambeck and Law, 2017).

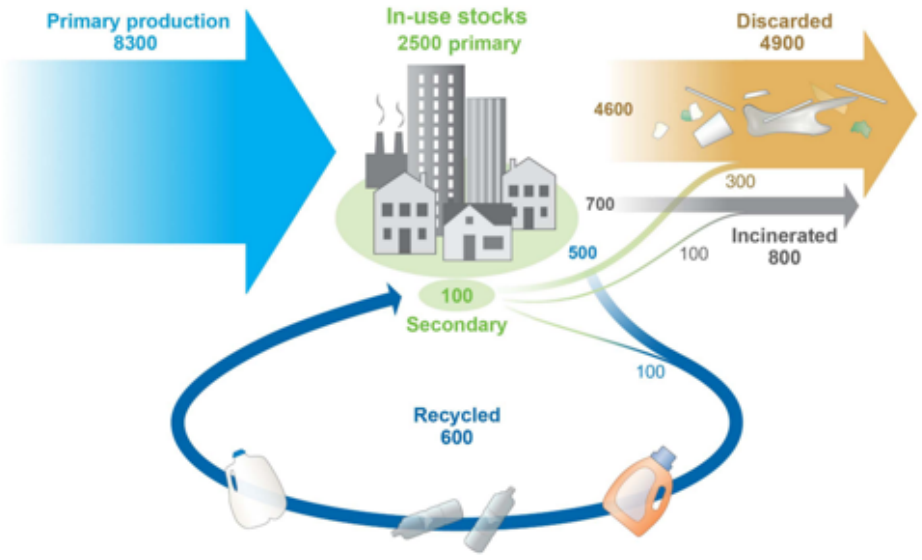

Figure 1. Global production, use and fate of polymer resins, synthetic fibres and additives (1950 to 2015; in million metric tonnes) (Geyer, Jambeck and Law, 2017).

As a consequence, marine debris, or marine plastic litter is considered the most pervasive form of pollution impacting the ocean (Jambeck *et al.,* 2001) and poses significant environmental as well as socio-economic impacts. The National Oceanic and Atmospheric Administration (NOAA) of the United States of America defines marine litter as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes". This includes consumer items such as beverage containers and plastic shopping bags, through to industrial waste, including waste produced in marine-based activities.

Plastics are the predominant form of marine litter, accounting for three-quarters of the global quantity (Secretariat of the Convention on Biological Diversity, 2016). As a result, marine litter and marine plastic litter are terms that are commonly used interchangeably. Owing to the strength and durability that plastics exhibit in the marine environment, the use of synthetic fibres marked an important technological advance in fishing and aquaculture gears (Lebreton *et al.*, 2018). As a consequence, gear that is accidentally lost or intentionally discarded in the marine environment has become the most impactful form of marine plastic litter. Accounting for 40–70 percent of floating macro-plastics in the ocean gyres by weight (Eriksen *et al.*, 2014; Lebreton *et al.*, 2018), these plastics endanger numerous marine species including turtles, sea mammals and seabirds, all of which can become ensnared in discarded fishing gear. Entanglement by ALDFG also threatens commercial fish stocks and thus food security, as well as presenting a navigational hazard to vessels. In this report, the use of the term marine plastic litter includes ALDFG unless otherwise specified.

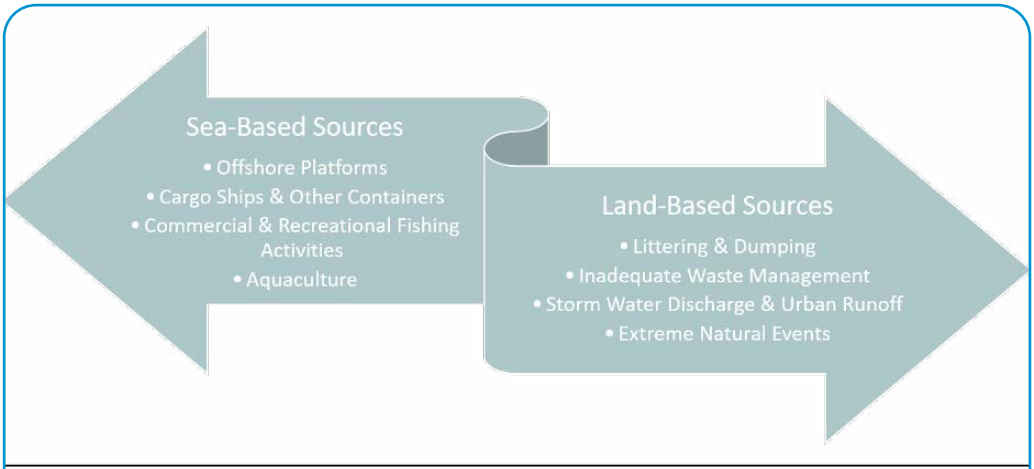

Figure 2. Sea-based and land-based sources of marine litter

1.2 Sources of marine plastic litter

Marine plastic litter is a transboundary issue with multiple sources, inputs and drivers (Hardesty *et al.*, 2016) though the origin of marine litter can be broadly categorized into sea-based and land-based sources (Figure 2). Plastics enter the ocean via various transport mechanisms including rivers and waterways, whether they are blown or swept out to sea, intentionally dumped or accidentally lost. It is generally believed that the majority of marine litter comes from land-based sources. However, the amount of marine litter generated from sea-based sources such as fishing, shipping and aquaculture has not been quantified; the contribution of sea-based sources to global marine litter is thus poorly understood (Gilardi et al., 2020).

Moreover, most general waste items derived from sea-based activities cannot necessarily be distinguished from similar general waste derived from land-based sources. As such, they can rarely be attributed directly to sea-based activities. By contrast, ALDFG can be definitively attributed solely to fishing activities.

Box 1: Definition of sea-based marine litter

"Sea-based marine litter" is any form of man-made, synthetic (non-natural) debris deposited directly into seawater from a vessel, facility or activity that is situated in or on, or is taking place entirely on or within, the ocean, from the intertidal to pelagic zones, and encompassing open ocean-adjacent seawater bodies including harbors, bays, estuaries and lagoons. The following types of marine litter would not be considered sea-based, because they represent marine litter resulting from land-based sources: input from freshwater systems (e.g. rivers); marine litter washing from beaches after high tides or storm surges and catastrophic damage to coastal infrastructure resulting in marine debris deposited in the ocean.

GESAMP WG 43 (Gilardi et al., 2020)

Figure 3 provides a thematic representation of the relationship between sources of marine litter and the mechanisms by which debris is transported to and within the marine environment. It is commonly noted that land-based sources account for 80 percent of marine litter in the global ocean and sea-based sources account for 20 percent; however, the source of these figures is not traceable in the scientific literature, nor have the figures been verified (Gilardi *et al.*, 2020). This being said, a recent analysis on global marine litter conducted by Morales-Caselles *et al.*, (2021) reported that 22 percent of litter items analysed (by count) originate from sea-based sources, thereby supporting the aforementioned 80:20 ratio of land- to sea- based sources.

This highlights an implicit need to yield empirical data to develop a more representative and substantiated understanding of marine litter sources. Despite the conjecture, whether from land-based or sea-based sources, it is unanimously accepted that marine litter is ubiquitous across the global ocean (Gall and Thompson, 2015): it is found in all ocean basins, including the most remote locations from the poles to the equator, from the coastline to the open ocean, and from the sea surface to the depths of the seafloor (Thompson et al., 2009).

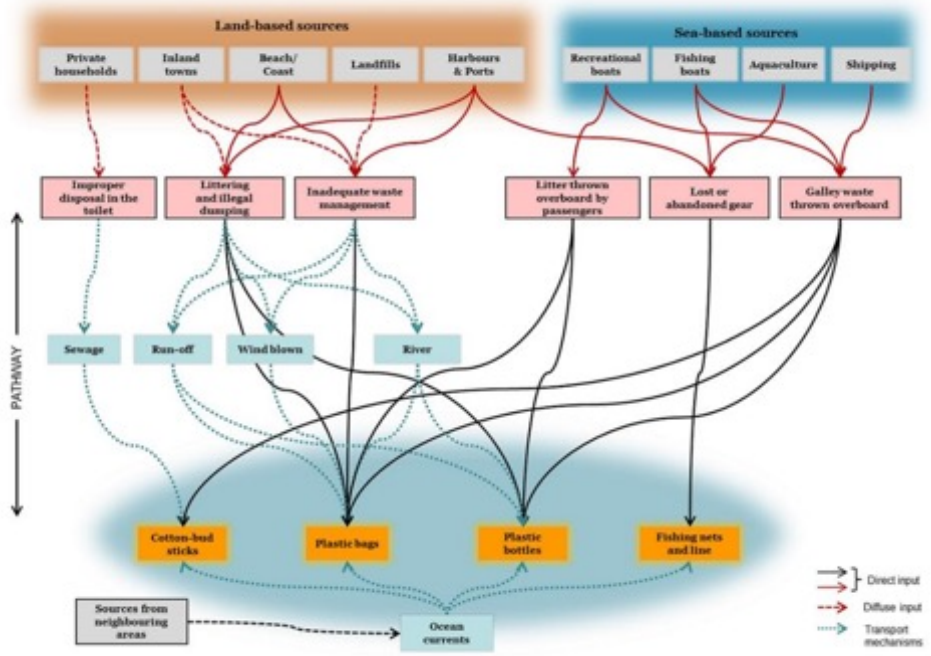

Figure 3. Multiple sea- and land-based sources (grey boxes) of four common items of marine plastic litter and their potential pathways of entrance (blue boxes) into the marine environment. (Note: the size of the boxes does not reflect their relative importance) (Veiga et al., 2016).

It remains a challenge to determine the respective proportions of different forms of marine litter accurately, including ALDFG types, as proportions vary depending on geographic region and the physical features of the ocean. This is further complicated by the various metrics used (e.g. weight versus count data) as well as the influence of socio-economic factors. For example, there is a global mismatch between the types of debris that dominate shorelines and beaches versus those that dominate the seafloor, when analysed using empirical field data (Roman *et al.*, 2020). Some evidence suggests that fishing gear dominates seabed habitats, while consumer products dominate coastlines.

1.2.1 Fishing gear contribution to sea-based sources

Though there is still debate about the proportions of sea-based versus land-based sources of marine plastic litter, ALDFG is recognized as its most harmful form (Wilcox *et al.*, 2016), be it accidentally lost or intentionally discarded. Crude, dated estimates suggest that ALDFG accounts for almost 10 percent of all global marine litter by volume and is one of the main sources of plastic pollution in the marine environment (Macfadyen, Huntington and Cappell, 2009).

As with the difficulties associated with substantively determining the relative contribution of sea- and land-based sources, similar challenges apply when attempting to identify the fishing industry's relative contribution to total marine plastic litter, and specifically ALDFG. For example, it has been reported that ALDFG accounted for 77 percent of total marine litter items (by count) in the western Mediterranean (Consoli *et al.*, 2019). Other studies, meanwhile, have identified fishing-related items as accounting for as much as 95 percent of litter (by weight) in critical wetland reserves in Oman (van Hoytema *et al.*, 2020).

Although it is commonly cited that 640 000 tonnes of ALDFG enters the ocean each year, this figure remains difficult to substantiate (Richardson *et al.*, 2021). Determining an updated global estimate of annual fishing gear loss is therefore part of the mandate for the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) Working Group 43 on Sea-based Sources of Marine Litter.

The loss of gear varies significantly across different gear types (Figure 4), with recent estimates of overall loss suggesting 29 percent of all fishing lines, 8.6 percent of all traps and pots, and 5.7 percent of all fishing nets used globally are lost or discarded into the aquatic environment every year (Richardson, Hardesty and Wilcox, 2019). It is worth noting that the predicted percentages of gear loss across the subcategories for all fishing lines was 23 percent for handlines, 65 percent for pole-lines, and 20 percent for longlines. However, the authors acknowledge that the available data and studies geographically over-represent the commercial fisheries of Europe and North America.

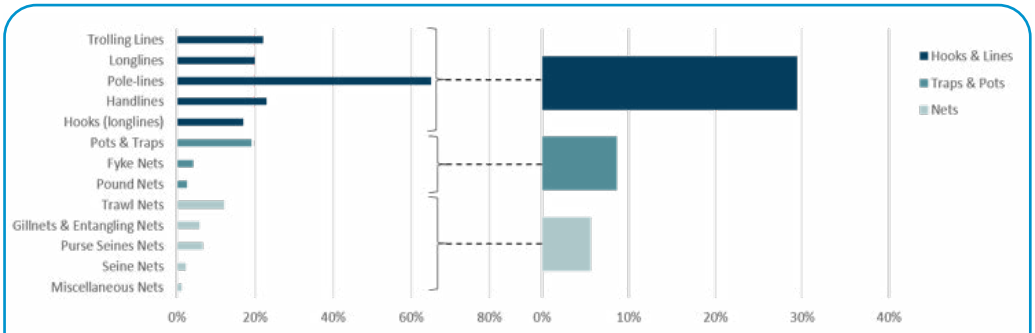

Figure 4. Average proportion per gear type lost annually (Richardson, Hardesty and Wilcox, 2019).

1.3 Drivers of abandoned, lost or otherwise discarded fishing gear

In order to manage fishing-related litter effectively, it is essential to understand the drivers that lead to fishing gear loss in the first place (Gilardi *et al.*, 2020; Macfadyen, Huntington and Cappell, 2009). A variety of drivers can cause the accidental loss or intentional dumping of fishing gear in the marine environment, and gear loss is often the result of a combination of factors (Figure 5). These may include environmental, spatial, operational/economic and enforcement pressures with varying degrees of occurrence and magnitude across different fisheries (Gilardi *et al.*, 2020). For example, a combination of vessel–gear interactions coupled with storms have been identified as the most frequently reported drivers for the loss of pots and traps (Antonelis et al., 2011; Richardson, Hardesty and Wilcox, 2019).

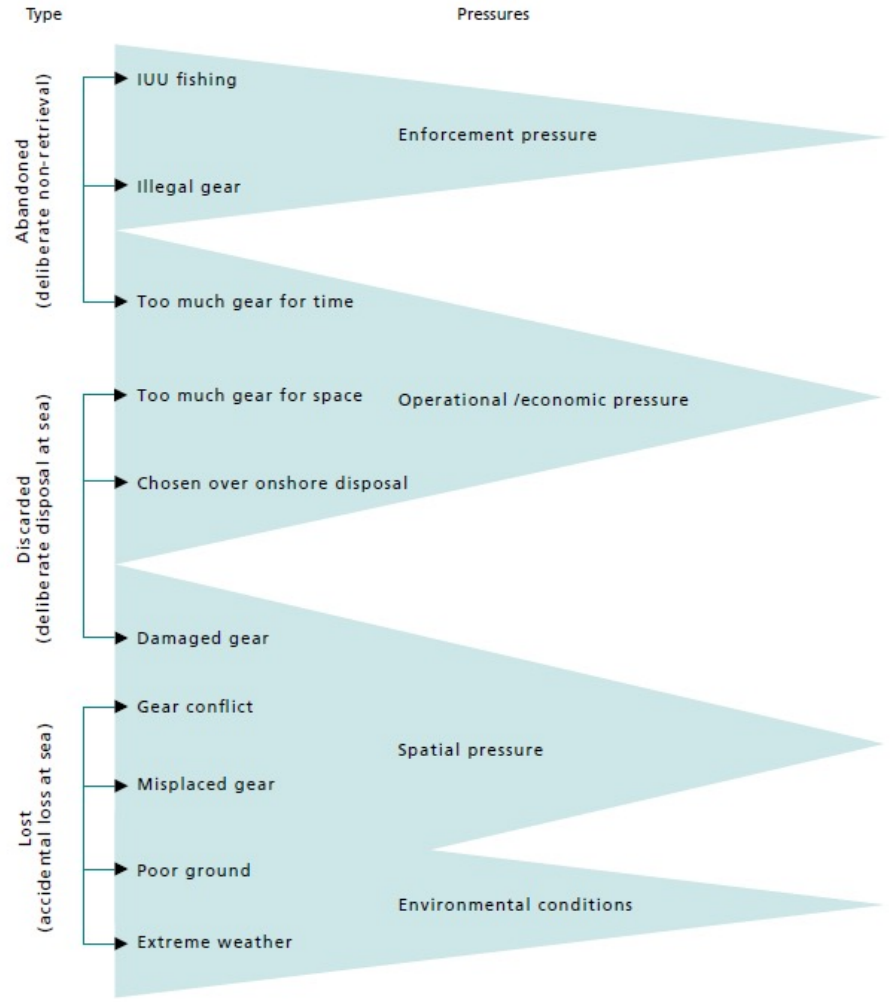

Figure 5. Drivers resulting in gear becoming abandoned, lost or otherwise discarded (Macfadyen, Huntington and Cappell, 2009)

Natural drivers include seabed topography, whereby gear may become snagged; strong currents, which can result in gear becoming entangled on itself or with other gear; and adverse weather conditions, which may result in gear being damaged and/or lost. It may not be possible for fishers to retrieve gear in cases where it may be too difficult, costly or dangerous to do so. Tides, currents, waves and winds can also dislodge gear, carrying it away from its deployed location (Gilardi *et al.*, 2020; Gilman, 2015; Macfadyen, Huntington and Cappell, 2009).

Accidental loss of gear may be a result of gear conflict or operator error/ gear malfunction.

Fishers don't typically want to lose their fishing gear as lost gear is expensive to replace, results in the loss of valuable fishing time, and can impact stocks which could otherwise be harvested in the future. Fishing gear is typically only intentionally abandoned/discarded at sea in emergency situations or when fishers don't have access to adequate port reception and disposal facilities.

Fishing gear may be intentionally discarded to hide evidence of illegal, unregulated and unreported (IUU) fishing activity. Under these circumstances, fishers may abandon or intentionally discard their gear to evade capture.

1.4 Impacts of abandoned, lost or otherwise discarded fishing gear (ALDFG)

The impacts of marine plastic litter, although most frequently cited for environmental reasons, also has significant social and economic consequences. Not only does it lead to aesthetic degradation, economic losses and human health hazards (Islam and Tanaka, 2004), ALDFG also presents significant threats to coastal communities, fisher livelihoods, the maritime industry (presenting navigational hazards) and global food security. The environmental and socio-economic impacts are summarized in Table 1 in section 1.4.2 Socio-economic.

1.4.1 Environmental

Marine plastic litter poses significant harm to marine life and threatens fragile habitats (Gall and Thompson, 2015). Over 800 different species are believed to have been impacted by marine plastic litter through ingestion or entanglement (Secretariat of the Convention on Biological Diversity, 2016) and the impacts of ALDFG on marine life has been widely documented, notably on vulnerable species of whales, dolphins and sea turtles (Allen *et al.,* 2012; Brad *et al.*, 2004; Moore *et al.*, 2009; Sancho *et al.*, 2003; Santos, Bellini Tamar-Icmbio and Bortolon, 2012; Stelfox, Hudgins and Sweet, 2016; Wilcox *et al.*, 2015). It could also be contributing to the threat of extinction for some species (Dulvy *et al.*, 2016). Werner *et al.*(2016) reported that 45 percent of all marine mammals on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species have been impacted by marine plastic litter through ingestion and/or entanglement.

Fishing gear is designed to catch target species; once lost, it can continue to catch and/or smother sensitive habitats indiscriminately. In the Gulf of Carpentaria, Australia, it is estimated that up to 15 000 sea turtles have been killed as a direct result of ALDFG (Wilcox et al., 2015).

The impacts of ALDFG also threaten the health and future of fisheries. For example, a study carried out in Oman found that 94 percent of non-target species trapped in ALDFG were of commercial value (Al-Masroori *et al.*, 2004). Elsewhere, ALDFG causes extensive habitat damage from areas including fragile coral reefs (Beneli *et al.*, 2020; Lamb *et al.*, 2015; Mangi and Roberts, 2006; Valderrama Ballesteros, Matthews and Hoeksema, 2018) to benthic marine habitats (Consoli *et al.*, 2020b, 2020a; Wilcox *et al.*, 2015) and mangroves, which serve as critical nursery grounds.

1.4.2 Socio-economic

The marine environment is essential for global economic prosperity: it is estimated to have provided USD 1.5 trillion in economic activity and 31 million direct jobs in 2010 (OECD, 2016). Sustainable fish stocks are also essential for our food security – fish are a critical source of animal protein and essential nutrients, especially for coastal communities in developing countries (FAO,

2020a). However, anthropogenic stressors continue to put the health and productivity of the marine environment at risk, and with that our economic prosperity and food security, particularly as the human population increases. In addition to the environmental ramifications of marine litter, plastics alone cost marine ecosystems approximately USD 13 billion a year in environmental damage (UNEP, 2014). The socio-economic ramifications associated with ALDFG include the direct cost to fishers associated with gear replacement, but also the indirect cost of lost fishing potential. A recent study evaluating derelict blue crab pots in Virginia, in the United States of America, found that the removal of ALDFG resulted in 22.4 percent more crab per pot and 34.7 percent more crab per trip. This translates to an 18 percent annual increase in productive hauls, which results in approximately USD 3 million in annual net benefits (Scheld, Bilkovic and Havens, 2021).

Table 1. Economic and social costs of ALDFG (Macfadyen, Huntington and Cappell, 2009)

Economic costs
Direct: • cost of lost gear/vessels because of entanglement as well as cost of replacement; • cost of emergency rescue operations because of entanglement of gear/vessels; • cost of time and fuel searching for and recovering vessels because of gear loss, which results in reduced fishing time; and • cost (to fishers or administrations) of retrieval programmes/ activities to remove lost/discarded gear, or other management measures, e.g. cost of time required for better communication, cost of better marked gear, cost of monitoring regulations intended to reduce ALDFG. Indirect: • reduced income/value-added resulting from ghost fishing mortality, which means fish are lost from the fishery; • reduced multiplier effects from reduced fishing income; • cost of research into reducing ALDFG; and • potential impact on buying because of consumer fears/concerns about ghost fishing and ALDFG.
Social costs
• reduced employment in fishing communities resulting from decreased catch levels associated with unintended fish mortality; • reduced recreational, tourism and diving benefits from lost gear on beaches and at sea; and • safety risks for fishers and vessels if vessel manoeuvrability is compromised by entanglement or navigational hazards.

1.5 Governance of fishing-related marine plastic litter

In order to manage fishing-related marine plastic litter effectively, international as well as local governance is essential (Hardesty *et al.*, 2016). The most effective measures also differ depending on whether the gear is lost, abandoned, or discarded as illustrated in Figure 6. Here we summarise the two governance tools predominantly used to manage fishing-related marine plastic litter, and specifically ALDFG: the GGGI's C-BPF and FAO's

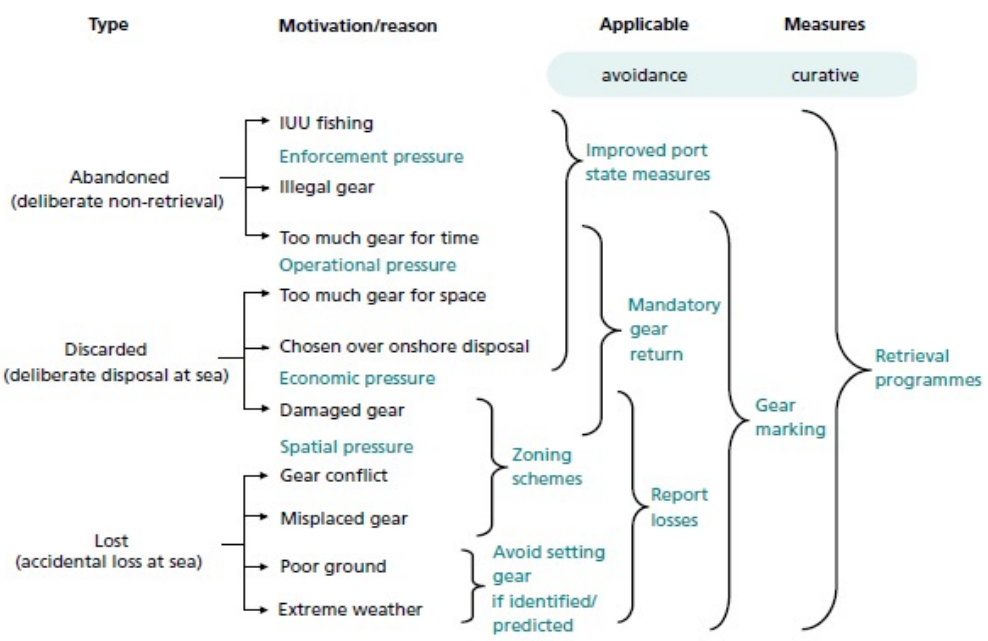

Figure 6. Motivation and measures for addressing lost, discarded or abandoned fishing gear (Macfadyen et al., 2009)

1.5.1 Advancing the United Nations' Sustainable Development Goals

In order to manage fishing-related marine plastic litter effectively, international as well as local governance is essential (Hardesty *et al.*, 2016). The most effective measures also differ depending on whether the gear is lost, abandoned, or discarded as illustrated in Figure 6. Here we summarise the two governance tools predominantly used to manage fishing-related marine plastic litter, and specifically ALDFG: the GGGI's C-BPF and FAO The 2030 Agenda for Sustainable Development (United Nations, 2021), adopted by all United Nations Member States in 2015, provides a common vision for peace and prosperity for people and the planet. Of the 17 goals that outline priority areas to achieve sustainability, SDG 14: Life Below Water, specifically identifies the need for action to conserve and sustainably use the oceans, seas and marine resources for sustainable development. Target 14.1 directly calls for a significant reduction in marine pollution of all kinds, which includes marine plastic litter.

In addition to supporting SDG 14, the successful management of marine plastic litter, and specifically ALDFG, also contributes to other SDGs. Addressing the adverse impacts of ghost fishing upon potential catch contributes to people's livelihoods (SDG 1: No poverty) and food security (SDG 2: Zero hunger). From a supply chain perspective, implementing good practices, circular economy principles and innovative gear design to mitigate the impact of fishing gear when it gets abandoned, lost or discarded will continue to support both SDG 12: Responsible Consumption and Production; and SDG 9: Innovation and Infrastructure.

As the custodian UN Agency of SDG 14, FAO developed the Voluntary Guidelines for the Marking of Fishing Gear (VGMFG), which were endorsed by FAO's Committee on Fisheries at its Thirty-third Session in 2018. The VGMFG are voluntary and global in scope, and they apply to all types of fishing gear in all types of fishing activities, in all oceans and seas. They are intended as a tool to contribute to sustainable fisheries and to improve the state of the marine environment by combatting, minimizing and eliminating ALDFG, as well as facilitating the identification and recovery of such gear. More details on the guidelines are provided in section 1.5.4.

The IMO Marine Environment Protection Committee (MEPC) also recognized the importance of continued action to manage the marine plastic litter issue, with the development of an Action Plan to Address Marine Plastic Litter from Ships (IMO, 2018) at its Seventy-third session in October 2018 (IMO, 2018). The action plan builds on existing policy and regulatory frameworks, identifying opportunities to enhance them. It also seeks to introduce new supporting measures to address the issue of marine plastic litter from shipping, fisheries, dumping of wastes at sea, as well as land-based sources of marine litter. Finally, it identifies opportunities to synergize its efforts with the actions undertaken by FAO and promotes a joint implementation of the action plan, in particular those elements related to fisheries.

1.5.2 Policy instruments and guidelines

There are a number of existing instruments pertaining to the governance of marine plastic litter and/or ALDFG including agreements, conventions, voluntary guidelines and resolutions (WWF, 2020; Hodgson, 2022). The "Ghost Gear Legislation Analysis" report (WWF, 2020), prepared by Ocean Outcomes with support from the Global Ghost Gear Initiative, together with a study on the legal aspects of ALDFG (Hodgson, forthcoming),[1] jointly provide an extensive analysis of existing ALDFG governance instruments. The key international and regional instruments are summarized in Table 2, although it should be noted that those listed here predominantly address ALDFG through fisheries management.

There are a number of other legal and regulatory options that serve to address the issue of ALDFG, which fall beyond the confines of traditional fishery management regimes (WWF, 2020; Hodgson, 2022). These include

instruments that promote a circular plastics economy, e.g. extended producer responsibility (EPR) throughout the entire life cycle of fishing gear, or voluntary approaches such as industry-sponsored codes of conduct, and certification and eco-labelling schemes, among others.

The WWF report with the GGGI and Ocean Outcomes (2020), and Hodgson's study on the legal aspects of ALDFG (2022), also offer a comprehensive overview of current legislation. The two publications include international instruments and conventions, non-binding guidelines and resolutions, and the conservation and management measures (CMMs) adopted by regional fisheries management organizations (RFMOs). They also illustrate the legal and institutional arrangements in selected case-study jurisdictions such as Australia, Canada, the European Union, Norway and the United States of America.

[1] FAO commissioned a study on the legal aspects of ALDFG (Hodgson, 2022) which examines the legal responses to ALDFG in the context of marine fisheries and looks at the ways in which law can or should be used to address ALDFG. The study will be published during the second half of 2021 under the auspices of the GloLitter Project.

Table 2. International and regional governance instruments currently in place to help prevent and mitigate the impacts of marine plastic litter from fisheries (Adapted from WWF, 2020 and Hodgson, 2022)

International instruments	Key components
International Convention for the Prevention of Pollution from Ships (1973) as modified by the Protocol of 1978 (MARPOL 73/78), Annex V (Regulations for the Prevention of Pollution by Garbage from Ships)	► Administered by the International Maritime Organization (IMO). ► The Convention includes regulations aimed at preventing and minimizing pollution from ships – both accidental pollution and that from routine operations – and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes. ► MARPOL Annex V generally prohibits the discharge of all plastics and other garbage into the sea, including but not limited to synthetic ropes, synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products.
United Nations Convention of the Law of the Sea of 10 December 1982 (UNCLOS)	► The basic objective of UNCLOS is to establish a universally accepted, just and equitable legal order, or "Constitution" for the oceans, which lessens the risk of international conflict and enhances peace and stability in the international community. ► UNCLOS is relevant to ALDFG because it confers the right upon States to regulate the issue of ALDFG within their national legislation.
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. The 2005 United Nations Fish Stocks Agreement (UNFSA).	► UNFSA is one of two implementing agreements adopted pursuant to UNCLOS; it is concerned with the conservation and exploitation of highly migratory fish species and straddling stocks. ► It contains a reference to "lost or abandoned gear" in its article 5, which sets out general principles for coastal States and States fishing in the high seas.

International instruments	Key components
Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, 2009 (PSMA).	► To prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing through the adoption and implementation of effective port state measures. ► Does not refer to ALDFG, but includes fishing gear and their markings as an element of the Port State inspections procedures
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention), modernized as the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol).	► London Convention: • promotes the effective control of all sources of marine pollution; • take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. This includes the (deliberate) disposal at sea of "persistent plastics and other persistent synthetic materials" (e.g. netting and ropes). ► London Protocol: • all dumping is prohibited, except for possibly acceptable wastes on the "reverse list".
FAO Code of Conduct for Responsible Fisheries, 1995 (CCRF) .	► Voluntary guidelines ► Sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. ► Contains a number of references to ALDFG within sections 7.2 on Management Objectives, 7.6 Management Measures and 8.4 Fishing Operations.

International instruments	Key components
International Guidelines on Bycatch Management and Reduction of Discards, 2011.	► Voluntary guidelines providing a reference instrument to help States and RFMO/As formulate and implement appropriate measures for the management of bycatch, and reduce discards in all fisheries and regions of the world. ► Contain a number of references to ghost fishing.
FAO Voluntary Guidelines on the Marking of Fishing Gear, 2019 (VGMFG)	► Voluntary guidelines to contribute to sustainable fisheries, improve the state of the marine environment, and enhance safety at sea by combatting, minimizing and eliminating abandoned, lost or otherwise discarded fishing gear (ALDFG) and facilitating the identification and recovery of such gear.

Regional instruments	Key components
Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, 2009 (PSMA).	► Legislation governing the management of fishing fleets and the conservation of fish stocks in the European Union. ► Policies are translated into associated mandates in the form of EC Council Regulations (binding) and directives (goals that countries must achieve). ► Directive on Port Reception Facilities for the Delivery of Waste from Ships (2019/883; PRF Directive), which requires that all European Union ports provide reception facilities for the waste generated by all seagoing vessels. Follows MARPOL requirements but focuses more on ports than vessels. Upon adoption of the directive, Member States have two years to ensure their national laws comply.
Regional fishery bodies (RFBs) - regional fisheries managemen organisations (RFMOs) - regional fisheries advisory bodies (RFABs)	► International bodies consisting of nations that share a practical and/or financial interest in managing fish stocks in a specific geographic area. ► RFMOs can adopt resolutions, recommendations and conservation and management measures (CMMs) that obligate parties to consider or take implementing actions. ► RFABs are purely advisory, providing advice to members on fisheries conservation and management. In contrast with RFMOs, RFABs do not have the authority to adopt binding measures

Regional instruments	Key components
UNEP's Regional Seas Programme	► Has played an increasingly important role in recent years, developing programmes and action plans to combat marine litter, including ALDFG.

1.5.3 The Global Ghost Gear Initiative's Best Practice Framework for the Management of Fishing Gear (C-BPF)

To help tackle the global threat of ALDFG, the GGGI was formed in 2015 as the first and only global alliance dedicated to driving holistic solutions to ghost gear at scale around the world. Along with 18 government signatories, the GGGI is comprised of 125 members from around the world, which represent civil society, the private sector, the fishing industry, public agencies, academia, and intergovernmental organizations. The GGGI has worked with partners worldwide since its founding to conduct projects on a range of solutions; these include: collecting data, removing gear from the sea, recycling end-of-life gear, testing innovative technologies to improve gear tracking and prevent future gear loss, and building local capacity to implement best practices and solutions on the ground. The GGGI has also been selected as a strategic partner for GloLitter, supporting the project's goals and objectives to assist developing countries in reducing marine plastic litter from the maritime transport and fisheries sectors.

In 2017, following a six-month global consultation process, the GGGI launched the C-BPF. The C-BPF is the world's only guidance document directed at all actors in the seafood supply chain, with recommendations to prevent, mitigate and remediate ALDFG. As developments continue to be made in ALDFG related research, technology, solutions and case studies, the C-BPF will be updated periodically to ensure its information remains relevant and promotes the latest best practices as they develop. The latest iteration of the C-BPF was launched in June 2021 and incorporates research, technology and data produced since its initial release, including:

- adreworking the gear type risk assessment based on feedback from industry and the latest research;
- added guidance for two new stakeholder groups: international development and funding agencies, and Municipal councils and authorities;
- improved gear categorization in the C-BPF risk assessment, making a clear distinction between longlines and other forms of line fishing e.g. handlines, pole-and-line, and troll lines.

The C-BPF provides practical, comprehensive guidance to minimize lost gear and its impacts across the entire seafood supply chain. The document was created with inputs and consultation from all actors in the seafood industry in order to ensure the recommendations it contains are practical, applicable and feasible. It recognizes the diverse roles and responsibilities of different stakeholders (gear manufacturers, fishers, port authorities, fisheries management authorities, seafood companies, retailers and other interested parties) in managing fishing gear, and provides examples of best practice relevant to each stakeholder group.

The framework is currently the only comprehensive guide on strategies for gear loss prevention, mitigation, and remediation. Preventative measures that avoid the occurrence of ALDFG in the environment are the default, preferred approach, because they prevent ALDFG from getting into the aquatic environment in the first place. Improving end-of-life fishing gear disposal facilities is one example. Effective gear disposal involves providing adequate, convenient, and low or no-cost port-side reception facilities for fishers to dispose of gear responsibly. It also involves fishing gear manufacturers designing gear with disassembly, recyclability, reuse or re-purposing in mind once the gear has reached the end of its useful life. Businesses should, where possible, support efforts to provide less costly or cost-free means of end-of-life fishing gear disposal. For example, this could be by supporting harbours/ports providing disposal facilities, supporting buy-back schemes or developing reuse/recycling initiatives through their supply chain (GGGI, 2021).
Mitigation measures are those put in place to minimize the damage caused by fishing gear if and when it does become ALDFG. Gear design, for example, can help reduce the incidence and duration of ghost fishing should gear become lost. This could include biodegradable escape hatches on crab and lobster pots or biodegradable escape cords (rot cords) which, depending on the design, can be effective at disabling derelict traps. The use of biodegradable plastics in fishing gear is a rapidly emerging area that has the potential to help mitigate the impacts of lost gear.

Remedial measures are those taken to report and assist the recovery of ALDFG. Gear recovery can often be an expensive exercise and is therefore less of a focus than prevention. However, it may be appropriate in some circumstances, particularly in critically sensitive habitats or when gear is interacting with endangered, threatened or protected (ETP) species. One important management tool that has often been suggested, though it is still rarely employed, is the reporting of lost or abandoned fishing gear (it is presumed that deliberately discarded fishing gear will not be reported for obvious reasons). Other remedial measures include the location and identification of ALDFG – for example, sea-based surveys can be used to locate lost fishing gear that may still be ghost fishing or damaging habitats – or ALDFG recovery efforts that remove ALDFG from the aquatic environment. The latter typically employs customized grapnels for the retrieval of lost fishing gear; or, alternatively through specially trained scuba divers and free divers.

To date, multiple leading retailers such as Nomad Foods, Sainsbury's, Aldi, Co-op UK and Waitrose – to name only a few – are GGGI members who have committed to addressing ALDFG. Thai Union, one of the world's largest vertically integrated fishing and processing businesses, is also committed to implementing the C-BPF into its operations. In addition, the GGGI and FAO have held a number of regional workshops on implementing the C-BPF and the VGMFG to reduce ALDFG (FAO, 2020b).

1.5.4 Food and Agriculture Organization's Voluntary Guidelines on the Marking of Fishing Gear (VGMFG)

At the Thirty-first Session of the Committee on Fisheries (COFI) held in 2014, concern was expressed about ghost fishing by ALDFG. The Committee recommended that Members and regional fishery bodies (RFBs) – which include both regional fisheries management organizations (RFMOs) and regional fisheries advisory bodies (RFABs) – increase their attention on mitigating ALDFG impacts, noting that cost-effective technologies and practices were available. In response, FAO convened an Expert Consultation on the Marking of Fishing Gear in 2016[2] (FAO, 2016) which resulted in the development of Draft Guidelines for the Application of a System on the Marking of Fishing Gear. Having considered the Expert Consultation's recommendations, COFI encouraged FAO to support the implementation of the Draft Guidelines at their Thirty-second Session in 2016, urging the Organization to conduct pilot projects on fishing gear marking (see case study 2.1.2). COFI also supported the further development of the Draft Guidelines via a Technical Consultation on the Marking of Fishing Gear, convened in February 2018. The consultation saw the participation of representatives from 35 FAO Members, 1 Associate Member and 3 observers from international NGOs.

The Technical Consultation (FAO, 2018) reviewed and finalized the scope of the guidelines, agreeing that supporting technical documents could be developed separately by the Secretariat. The Technical Consultation considered how **gear marking systems** should be implemented, controlled and monitored. Moreover, it identified the importance of gear marking in combating ALDFG, as well as the role that gear marking could play in reducing or eliminating illegal, unreported and unregulated (IUU) fishing. The Guidelines agreed by the Technical Consultation also addressed the commercial traceability of fishing gear marking, the reporting and recovery of ALDFG, and provided for special considerations when marking and reporting fish aggregating devices (FADs). Special consideration was also given to developing States and small-scale fisheries when implementing the guidelines in these contexts. The Technical Consultation highlighted several key areas for research and development on gear marking and related issues, and provided guidance on communication and capacity development.
The resulting text from the Technical Consultation was endorsed by the Thirty-third FAO Committee on Fisheries in July 2018 and published in 2019 as the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG).

[2] Expert Consultations are held to gather the best available knowledge on a particular subject in order to provide FAO with guidance and inputs on developing major studies or international instruments. Experts are invited in a personal capacity, while in the Technical Consultations government representatives are invited to revise and endorse texts produced by the independent experts.

2. Case studies: Solution projects to prevent, mitigate and remediate ALDFG

The case studies presented in this section are selected examples of projects dealing with marine plastic litter from the fishing sector, in particular ALDFG. However, this is not an exhaustive list: other examples of projects in place to address sea-based marine plastic litter and/or ALDFG are listed in Table 3. The information contained in this table is the result of survey conducted with the GloLitter focal points of participating countries (see the Appendix for a complete list of GloLitter participating countries) in order to determine what projects, if any, were being undertaken to address marine plastic litter from the fisheries sector.

Table 3. GloLitter participating countries that currently have projects in place dedicated to addressing ALDFG (based on survey results received from GloLitter national focal points)

Project Name	Country	Overview
"Addressing waste management in coastal towns. Education as a tool to reduce plastic waste entering the ocean"	Argentina	- Strengthen the capacities of local government and relevant civil society organizations regarding plastic waste separation and recycling. - Raise awareness and train artisanal fishermen in good practices associated with their activity. - Raise awareness among tourists and the resident population about the value of marine ecosystems to prevent plastic waste from entering the sea and promoting circular economy models.

Project Name	Country	Overview
"Implementation of a programme for the reduction of ghost fishing in Panama through the application of specific measures and gear tracking"	Panama	The programme has three stages: - The first one consists of the creation of a diving unit with the skills, equipment and training to remove ghost nets, as well as the execution of the ghost net removal plan; this stage began in 2009 and continues to this day. - The second stage is scheduled to start in 2022 and will consist of the development of a pilot plan for gear tracking: first in artisanal fishing and later in industrial fishing. However, this stage is still in the development and budget allocation phase, due to delays caused by the ongoing COVID-19 pandemic. - The third stage consists of using the data and information gathered from the previous stages to generate a legal framework that regulates the import and use of fishing gear, allowing the reduction of ghost fishing in Panama. The programme is being implemented with the participation of coastal communities, artisanal fishermen, private companies and government institutions.

Project Name	Country	Overview
"Pesca sin plástico" (No plastic fishing)	Peru	- Raise awareness among fishers about the importance of not discarding plastic products such as bottles, bags, fishing gear and other related plastics during fishing operations at sea. - Equip fishers with bags to store the plastic waste produced during their fishing activities on board; these bags are then returned at the end of fishing. - Implement reception facilities for plastic waste and fishing gears in ports so that fishers can dispose of marine plastic litter and fishing gears responsibly.
Seabed Cleaning Project	Senegal	- Awareness raising and education among coastal communities and other stakeholders on actions to protect the environment. - Annual seabed clean-ups are organized. - Collection and recycling efforts promoted among coastal populations in order to help reduce marine pollution in Senegal.

Project Name	Country	Overview
The Impact of Ghost Fisheries on Fisheries Resources in Thai Waters Project	Thailand	This project will assess the state of fisheries resources and establish guidelines to reduce the impacts of ALDFG: - investigate the number, length, and types of ALDFG; - survey to quantify the number of species entangled in ALDFG; - conduct interviews with fishers to gain an understanding as to why gear is lost, experience with non-target species; - inform guidelines to reduce the impacts of ALDFG.
Ekipa Tasi Mos Atauro (Clean Ocean Team, Atauro)	Timor-Leste	- Remove marine debris from the waters and beaches that surround Atauro and record data via the Australian Marine Debris Initiative Database (AMDI). (The marine debris is sorted, separated and counted and any items that are recyclable are washed and stored for recycling.) - Assist the community, businesses and government to reduce their use of single-use plastics. - Build a community recycling plant to process marine debris items; the project currently has a work shed with four recycling machines (shredder, compression, injection mould, and extruder machines).

Project Name	Country	Overview
Ekipa Tasi Mos Atauro (Clean Ocean Team, Atauro)	Timor-Leste	These enable the production of a variety of products including baskets, tiles and bar coasters.
Development of the National Plan for Managing Plastic Litter from the Fisheries and Aquaculture (NPMPL)	Viet Nam	The project will assess the status of fisheries and aquaculture and develop a national plan of action for managing plastic litter and ALDFG: - investigate the volume, source and character of plastic litter from capture fisheries and aquaculture in Viet Nam; - investigate methods that facilitate the collection and processing of plastic litter at fishing communities and aquaculture farms; - develop and implement the NPMPL in Viet Nam by 2030.

Due to the complex nature of marine plastic litter and ALDFG, effective solutions and good practices must adopt a multidimensional approach, incorporating collaboration across all stakeholder groups. In alignment with the GGGI's C-BPF, good practices can be categorized based on their focus on preventative, mitigative or remedial measures; however, it should be noted that a number of case studies cover elements of more than one category. The categories are defined as:

- **prevention**: avoiding the occurrence of ALDFG in the environment
- **mitigation**: reducing the impact of ALDFG in the environment
- **remediation**: removing ALDFG from the environment.

2.1 Prevention

2.1.1 Coast 4C (formerly Net-Works™), Philippines

Coast 4C is an social enterprise that builds on the award-winning Net-Works™ project co-created in 2012 by the Zoological Society of London (ZSL) and global carpet tile manufacturer Interface Inc. Coast 4C provides a simple, scalable and holistic business model (figure 7) to divert end-of-life fishing nets from the ocean in marginalized small-scale fishing communities across Southeast Asia. Coast 4C's main operations are focused in central Philippines where their prototype inclusive value chain model was developed around discarded fishing nets that are processed and exported for recycling. The model has been successfully replicated to Cameroon and Indonesia through local implementing partners. Fishers now sell their end-of-life nets directly to Coast 4C, preventing gear from being discarded in the ocean in the first place.

The Coast 4C's business model for end-of-life fishing nets includes 6 steps (Figure 7): 1) Collecting & Cleaning: Local communities collect, aggregate and clean discarded Nylon 6 fishing nets; 2) Buying: The nets are bought by community banks established by Coast 4C or their local implementing partners, providing participants with supplemental income; 3) Baling: Coast 4C buy the nets from the community banks, and then process them for export using a mechanical baling machine which compresses and packs the nets without using electricity; 4) Shipping: The nets are exported to responsible recyclers; 5) Recycling: Nets are recycled, and 6) New products: the recycled material is integrated into new products.

Figure 7. Coast 4C's six-step business model for end-of-life fishing nets.

Coast 4C engages local communities in the responsible management of end-of-life monofilament and multifilament nets and lines. Local communities collect end-of-life nets, cleaning them before selling them through local community banks to Coast 4C. Mechanical baling machines that compress and pack the nets without the use of electricity were designed by the original Net-Works™ partners; this makes the process more economically viable and environmentally friendly, and keeps the value local. Once nets are baled, they are exported to recycling companies.

Good practices on end-of-life fishing gear recycling

- ✓ inclusive business model that engages local community through end-of-life (EOL) fishing gear collection and the development of community banks;
- ✓ provision of training on FG recycling to the local community;
- ✓ provision of economic incentives to encourage fishers to participate and dispose of EOL fishing gear responsibly to prevent it becoming lost or abandoned;
- ✓ publication of business model and results on the internet;
- ✓ collaboration across the public and private sectors.

Coast 4C provides training and support on the ground to ensure nets are correctly identified and cleaned for recycling. The largest fishing gear component processed is monofilament gillnets, mostly the crab nets (pukot pang lambay) used to catch blue swimming crabs, which have a very high turnover (they are replaced every 2–6 weeks depending on season and location). Any gear element that is not suitable for recycling, such as lead lines, is typically retained by the fishers and reused, as they are far more durable and valuable than the nets themselves. To manage local supply chains for Nylon 6, Coast 4C sets up community banks, bringing communities together in specially purposed cooperatives and providing much-needed access to financial services. For this, they primarily use the globally recognized and proven Village Savings and Loan Association (VSLA) model (Brannen and Sheehan-Connor, 2016). Community banks (particularly the VSLA model) were selected because they respond to broader needs within the community (financial inclusion), are gender equitable and have a high level of sustainability (on average 85 percent of VSLAs that are set up remain active 5 years after external support is removed). They also provide a platform for increasing social capital and implementing social marketing campaigns to implement pro-environmental behaviour change.

Key government authority project partners are the local government units (LGUs). They are involved at both the barangay (village) level and municipal

level. Coast 4C have agreements with LGUs for various aspects of their work. As Coast 4C help them to deliver a component of their obligations under the Solid Waste Management Act (GOVPH, 2001), LGUs are extremely supportive; they also constitute the first stage of for scoping out and accessing new sites. With specific reference to net recycling work, LGUs have less of an active role once the system is set up beyond collaboration, coordination and permissions etc – because most of the work is done by VSLAs (the community banks).

To date Coast 4C has diverted 297 tonnes of ocean-bound fishing nets in the Philippines to recycling, generating around PhP 4 150 000 (~USD 82 300) of supplemental income for the small-scale fishing communities. Through the VSLAs 2 500 households have benefited from financial inclusion, and 60 000 people in 35 partners villages have benefited from an average 60 percent reduction in coastal fishing net pollution, as well as a 40 percent reduction in other plastic pollution (N. Hill, personal communication, August 2021).

2.1.2 Gear marking methods in Indonesian small-scale fisheries, Indonesia

The Thirty-second Committee on Fisheries (COFI) instructed FAO to conduct a number of pilot projects to explore the feasibility of fishing gear marking methods, particularly in developing countries. Indonesia was put forward as a suitable country for a pilot project given: a) the abundance of ALDFG and increasing threat of illegal, unregulated and unreported (IUU) fishing in Indonesian territorial waters; and b) the Indonesian government's strong commitment to addressing both issues (Dixon et al., 2018).

Gillnets were selected as the project's primary focus due to their prevalence and impact as ALDFG. Two pilot sites were selected in Java, Indonesia, to test gear marking methods as outlined in the then draft VGMFG. Low rates of gear loss were reported in Pekalongan, due to favourable weather conditions and a sandy, muddy substrate that reduces the possibility of snagging. Higher rates of gear loss were reported in the second pilot site in Sadeng however, where the fishers operate in deeper waters in the Indian Ocean in less favourable weather conditions.

In 2017–2018, a pilot project was led by the Indonesian Ministry of Marine Affairs and Fisheries together with the GGGI under World Animal Protection, and supported by FAO and the government of the Netherlands. Work on the ground has been led by a team led by Dr Fayakun Satria from the Indonesian Ministry of Marine Affairs and Fisheries.

The pilot project aimed to:

- provide a practical case study to facilitate how FAO's Draft Guidelines on the Marking of Fishing Gear could be implemented on gillnets and gather feedback on the practical application of the proposed marking techniques;
- enhance technical understanding of Indonesian fisheries for how both static and drifting gillnets can be marked and tracked;
- raise awareness of ALDFG in Indonesian fisheries at the local and national level.

Prior to field testing of gear marking methods, interviews and focus group discussions were conducted in the pilot sites. The aim was to collect information related to attitudes, behaviour, current marking practices, causes of gear loss, practical challenges to the retrieval of lost gear and women's engagement in the fishery.

The gillnet marking methods were tested using low-cost tags made of readily available materials. Six different types of marker were tested in the trials: plastic, wood, coconut, bamboo, metal and a tag similar to a barcode that utilizes Septillion FibreCode technology (Figure 8), and which provides user-level identification upon scanning with a mobile phone device.

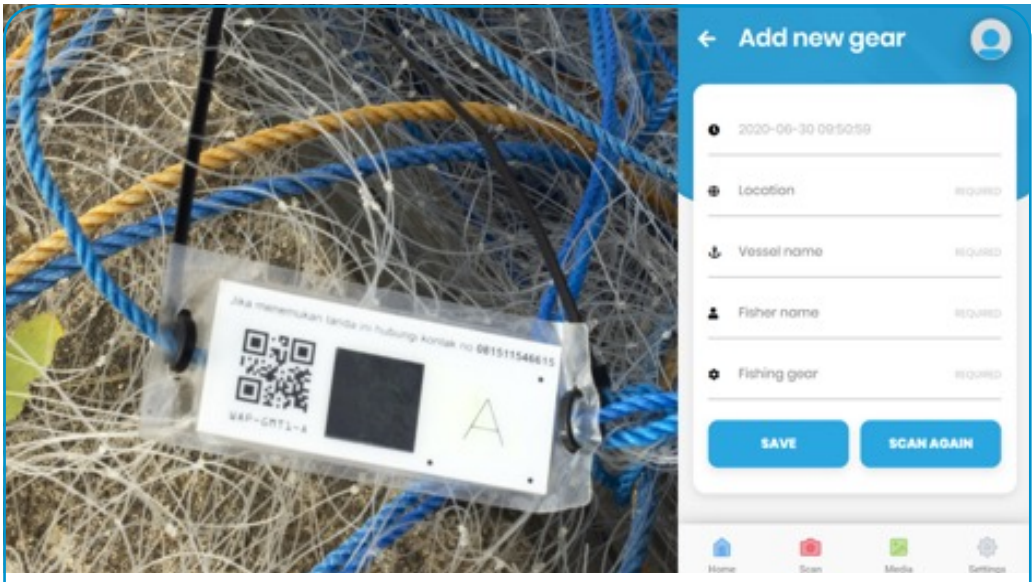

Figure 8. Net with tag using Septillion FibreCode technology (left) and gearmarker app (right)

Table 4. Twelve criteria used in the tag assessments and the scoring system used to determine effectiveness

No	Criteria	Score			
		1	2	3	4
1	Pollution effect	Very high	High	Middle	Low
2	Easy to unravel	Very difficult	Difficult	Middle	Easy
3	Cost of tag	Expensive	Cheap	Very cheap	
4	Availability of tag	Available in certain places	Order	Limited	Plenty
5	Manufacture	Difficult	Middle	Easy	
6	Practical installation	Very long	Long	Fast	Very fast
7	Durability of tag	fragile	Strong	Very strong	
8	Impact for net operation (disturb/annoying)	Very disturb	Disturb	Rather	Not
9	Safe for fishers	Low	Middle	High	Very high
10	Safe for fish catch	Not safe	Safe		
11	Accepted by fisher	Not accept	Accept		
12	Easy to monitor	Not visible	Not clear	Clear	Very clear

Good practices on piloting gear marking methods

- ✓ study on current practices by fishers and the role of women, prior to the implementation of gear marking trials;
- ✓ raising awareness of the project and the subject around it, with fishers in the pilot areas;
- ✓ gear marking trial using a participatory approach;
- ✓ use of low-cost and easy to apply marking methods;
- ✓ public - private partnership to trial high technology marking method;
- ✓ project report publicly available.

Based on the field trials and a participatory workshop with fishers – where results of field trials were discussed – bamboo and wooden tags were preferable for Pekalongan fishers and Septillion FibreCode technology tags were favourable for Sadeng fishers. However, one suggestion proposed replacing the plastic material used in the Septillion tags with a biodegradable material (on which the same code could be printed).

Some of the challenges identified during the gear marking trials included the availability of environmentally friendly materials for markers and their attachments, and fisher safety when operating physically marked gear.

The trials also concluded that it might be challenging to apply certain types of technology in the context of both small-scale fisheries in general, and gillnet fisheries in particular, owing to the high cost of more technical marking options and the comparative low value of the gear itself. Marking at manufacture and adding value to end-of-life gear could thus offer potential approaches to these issues.

Lessons learnt and conclusions from this pilot study were incorporated into the final version of the VGMFG.

A second phase of the project has continued under the GGGI with the support of Ocean Conservancy and Bumble Bee Seafoods. The current project will run from 2021 to the end of 2023 and see the delivery of activities for the reduction of ALDFG. The retrieval, reuse and recycling of marine litter in ghost fishing gear will explore a circular economy model to be developed and applied in Indonesia. The key components and associated outcomes are detailed in Table 5.

Table 5. The key components and outcomes associated with phase two of Indonesia's gear marking pilot project (2021–2024)

Component 1 - Reduce ALDFG	
Identify evidence around ghost fishing through reduction and mitigation measures by adopting best practice framework solutions from GGGI at scale	**Outcome 1.1** Identify causes and find solutions to reduce ALDFG
	Outcome 1.2 Deliver best technical approach through gear marking pilot project using new technology (including bamboo tags and degradable la-tex/bio-plastic material)
Component 2 - Retrieve ALDFG	
Stakeholder collaboration initiatives to remove/ recover ghost fishing gear with improved port waste reception facilities	**Outcome 2.1** Identify methods and techniques to locate ALDFG
	Outcome 2.2 Stakeholder engagement and initiatives collaborative works for recovery/ mitigation the occurrence impact of ALDFG
Component 3 - Reuse and recycle	
Explore innovative approaches to recycling ALDFG into the implementation of circular economy concepts	**Outcome 3.1** Conduct focus group discussions for handling waste management and, in particular, "waste fishing gear" including disposal, sorting, storage and packaging for recycling.
	Outcome 3.2 Direct economic incentives that empower the community to manage end-of-life and ghost fishing gear.

2.1.3 Net Positiva, Peru, Chile, Argentina (Latin America)

Recognizing that there were no environmentally sound options for end-of-life gear, Bureo's Net Positiva programme has spent the last eight years implementing positive solutions to end-of-life fishing nets in South America. Bureo is a Benefits Corporation focused on creating a net positive solution to end-of-life fishing gear. Through Net Positiva, Bureo works with fishing industry and fishing communities across Chile, Argentina and Peru to transform this once harmful marine debris into a fully traceable, innovative raw material supply known as NetPlus. Bureo's NetPlus material is utilized in a growing number of like-minded brands. Seed funding to implement Net Positiva in Peru and Argentina comes from the US State Department, while the Chilean government provided the funding to initiate the project in Chile through their start-up programme.

Net Positiva mainly focuses on the collection of two types of fishing nets: monofilament nylon, multifilament nylon (both polyamide-6) and high density polyethylene (HDPE). The fishing nets are collected and recycled into a range of products with a variety of applications (Figure 9 outlines the process). Bureo provides fishers with the infrastructure to collect end-of-life nets, while also raising awareness of ALDFG and investing in community-led education programmes. Bureo trains and employs teams of local workers to clean and pack the fishing nets through local facilities that Bureo sets up.

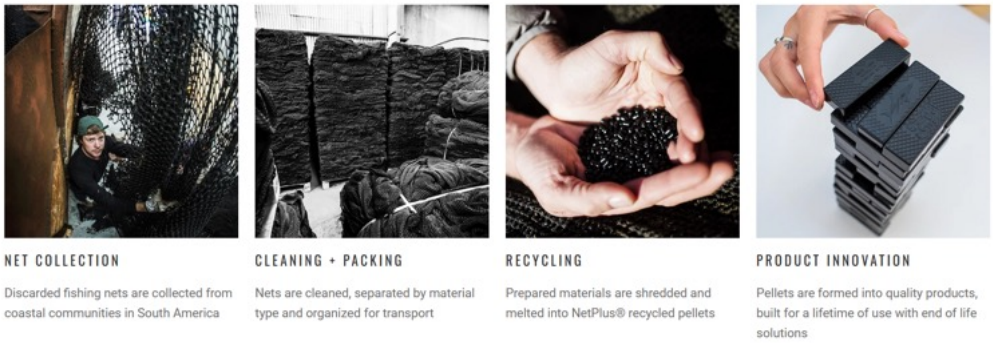

Figure 9. Bureo's Net Positiva process for recovering and recycling end-of-life fishing nets into innovative products and applications (Bureo, 2021)

Good practices on end-of-life fishing gear recycling

- ✓ direct engagement with fishing industry (fishers and shipowners), local NGOs, net manufacturers and fisheries authorities;
- ✓ development of a material traceability database;
- ✓ provision of training on FG recycling to local communities and raising awareness of ALDFG;
- ✓ provision of economically viable options for fishers to dispose of their end-of-life fishing gear responsibly (infrastructure and collection services);
- ✓ promoting a closed-loop circular economy;
- ✓ investment in environmental, community-led projects.

With their partners WWF Peru, Bureo is working with the anchoveta industry in Peru – the second-largest fishery in the world – to engage the fishing industry in a circular economy model for their gears. In Argentina, Bureo works with the Whale Conservation Institute (Instituto de Conservación de Ballenas) and the Tree Foundation (Fundación el Árbol) in Chile to engage with the fishing industry and implement environmental projects with the funds generated from the recycled fishing nets.

Working directly with net manufacturers - FIMAR in Chile and Peru, and Moscuzza in Argentina, the largest domestic fishing net manufacturers in each country – Bureo have convinced these companies to donate their end-of-life fishing nets for recycling. This action has directly prevented gear becoming lost or discarded in the environment. Bureo has also developed a material traceability database, which tracks the movement of all fishing nets through their programme. This is all backed by invoices, inspection reports, transport records and government-endorsed end-of-life certification for fishing nets. Bureo has agreements in place with net manufacturers to ensure that when new nets are delivered by the fishing net manufacturer and end-of-life (EOL) fishing gear is returned, the fishers/shipowners are paid per kilogram for their EOL nets. These are then taken back on the same truck which delivered the new nets. Bureo then pays the net manufacturer for the service of delivering them to one of their recycling facilities.

While the programme has encountered some key challenges, as listed below, Bureo continues to develop the programme to ensure its longevity into the future.

Key challenges have included:

- Limited supply of fishing nets during certain times of the year can cause high costs for the operation due to low productivity.

- Fishing nets are contaminated or produced with more than one type of plastic fibre, which compromises the recycling process.
- High costs of transport from remote fishing villages and high-volume, low-density fishing nets resulting in a small quantity of nets per kilogram being transported per truckload.
- Engaging fishermen and providing the right incentives to have them return their end-of-life fishing nets responsibly.

Despite the challenges, Bureo's Net Positiva programme has now engaged 58 partners including fishers, shipowners, gear manufacturers and fisheries authorities. Essentially, Bureo engages with anyone in need of an end-of-life solution for fishing nets in order to prevent fishing nets becoming a harmful source of plastic pollution. To date, they have collected over 1.2 million kg of end-of-life fishing nets and implemented 18 community projects. Fishers also receive a free disposal service for their end-of-life nets through the programme. For each kilogram of fishing net received, Bureo rewards the fishing community with funds to implement new projects within their community, contracting a local NGO to invite the community's leaders to co-create an environmental project that meets the community's specific needs. These projects range from composting systems and environmental education programmes, to the installation of solar photovoltaic systems and improved waste management infrastructure.

2.1.4 Derelict Gear Program, Puget Sound, United States of America

The Northwest Straits Foundation (NWSF) is a marine conservation organization that raises funds to support locally driven marine restoration, stewardship and education programmes in the Salish Sea – also known as Puget Sound. Their remit includes the removal of ALDFG, habitat restoration, research, as well as outreach and education. More specifically, the NWSF works to combat ALDFG through:

- derelict fishing gear (ALDFG) removal (crab pots, shrimp pots, and gillnets);
- the Newly Lost Net Reporting, Response & Retrieval Program;
- development and implementation of the Puget Sound Lost Crab Pot Prevention Plan;
- research to better understand causes, impacts and solutions; and
- outreach and education to prevent gear loss.

Since 2002, the NWSF has removed 5 811 derelict fishing nets (predominantly monofilament gillnets) and 6 102 derelict crab pots from the marine waters

of Puget Sound through its derelict fishing gear removal programme. The programme also included a no-fault, no-penalty reporting mechanismthrough which fishers could report their lost fishing gear. Lost gear is also located using side-scan sonars, drop cameras and dive surveys. Removed gillnets are landfilled but lead lines are usually removed and recycled, while pots are recycled as metal.

Good Practices on FG reporting and retrieval

- ✓ fishers, local fishing authorities, private sector and CSO engagement;
- ✓ engagement across commercial and recreational fishers and different government agencies;
- ✓ no-fault, no-penalty programme gear loss reporting programme;
- ✓ ALDFG retrieval by professional scuba divers and harvest divers;
- ✓ development and implementation of an strategic action plan to prevent and reduce gear loss with a participatory approach;
- ✓ strategic action plan is publicly available;
- ✓ research, capacity building and awareness raising to prevent gear loss among fishers.

The removal of derelict fishing gear eliminates the present and future threat of entanglement to marine birds, fish, mammals and invertebrates, while also restoring the full ecosystem-service benefits of the marine habitat it has degraded. A post-derelict gear removal monitoring project showed that marine habitat dominated by kelp achieved a 90 percent recovery over one growing season without further management actions (June and Antonelis, 2018). By removing 5 811 derelict nets the initiative has restored more than 860 acres of marine habitat.

In order to promote prevention of ALDFG further, the Newly Lost Net Reporting, Response and Retrieval Program was made mandatory in 2012 to allow fishers to report their lost nets through a no-fault, no-penalty programme. Working with the Washington Department of Fish & Wildlife and Puget Sound Treaty Tribes, the programme helps to ensure that newly lost nets are located and removed before they become ALDFG and cause continued harm through ghost fishing. The response and retrieval components are contracted out to a private company (Natural Resources Consultants – NRC), while retrieval operations are usually conducted by subcontracted commercial dive teams, most of whom are harvest divers (sea urchin and sea cucumber harvesters). Since the programme's inception in June 2012, 132 reports of lost nets have been investigated and 87 newly lost nets have been removed.

The Puget Sound Lost Crab Pot Prevention Plan was developed as a strategic action plan to prevent the accumulation and minimize the impacts of lost crab pots in Puget Sound. The plan identifies the causes of pot loss, its negative impacts and implementable solutions. An Advisory Committee was formed with stakeholders throughout Puget Sound to guide the development of this strategic plan collaboratively. The Advisory Committee includes individuals from state and tribal commercial fisheries, recreational fishers, fisheries resource managers, vessel traffic authorities, the marine industry, county advisory groups, non-governmental organizations, and government agencies. The details of the Prevention Plan are publicly available on the NWSF website (Drinkwin, 2016).

Implementation of the plan has been extensive, with regular pot removal operations, increased inspec-tions, focused outreach to sport crabbers, and regulatory changes. Regulatory changes currently in discussion include changes to size of escape cord and refining crab pot design requirements.

Challenges encountered during the plan's implementation include the capacity needs to implement some of the recommendations, the ongoing need for crabber outreach, and the continued use of crab pot designs that do not allow full crab escape when lost.

NRC is currently updating the estimates of crab pot loss and the consequent economic impacts and a report will be published soon.

Research, outreach and education are key components to the NWSF's Derelict Fishing Gear Program. They have conducted research projects to learn what the impacts, causes and solutions to derelict fishing gear are and to better understand how to create effective outreach and education campaigns. The NWSF has studied species and habitat impacts, as well as gear modifications; it reaches over 300 000 individuals an-nually through its outreach campaign.

2.1.5 Thai Union's SeaChange® Strategy, Thailand

As one of the world's largest seafood companies, Thai Union is committed to addressing the issue of ALDFG in their supply chains and working to find solutions to remove and prevent plastic pollution from entering the oceans. Thai Union's global sustainability programme, SeaChange®, strives to drive meaningful improvements across the entire global seafood industry through: a) safe and legal labour; b) responsible sourcing; c) responsible operations and d) people and communities. Since 2018, Thai Union has been part of the Global Ghost Gear Initiative (GGGI), working together to identify ways to tackle this problem. Since joining with the GGGI, the two organizations have worked together to identify suitable projects, which are captured in the Thai Union Ghost Gear Work Plan (Thai Union, 2018). This case study focuses on component number 4 of the work plan: "Improved management practices for ALDFG in Thailand to reduce and prevent pollution into the marine environment".

Good Practices on Understanding ALDFG

- ✓ work plan to address ALDFG is publicly available;
- ✓ vessel owner surveys to understand the reasons why gear is lost, the barriers to retrieval, access to EOL reception facilities, etc;
- ✓ survey results are publicly available;
- ✓ liaison with port authorities to implement more surveys;
- ✓ awareness raising among seafood suppliers and retailers.

Recognizing that Thailand has one of the world's largest commercial fishing fleets, and has been ranked among the top ten countries in the world responsible for plastic entering the ocean, Thai Union has pledged a commitment to improve the management of ALDFG in Thailand. To support this, Thai Union conducted a Thailand Commercial Fishing Sector Survey and Assessment of Abandoned, Lost and Discarded Fishing Gear (Thai Union, 2021).

With from some guidance provided by FAO, Thai Union created a survey to gather relevant data from fishing vessels that supply Thai Union, focusing on gear loss rates and causes. The survey aimed to help Thai Union achieve greater clarity on how they could work with suppliers to reduce the amount of gear loss, recycling equipment once it reached the end of its life.

The survey was conducted between May 2020 and November 2020 and involved interviews with 10 suppliers who owned a total of 36 vessels. These vessels consisted of 6 trawlers and 30 purse seiners, of which the trawlers were smaller in size and weight than the purse seiners. The survey was

designed to gain a better understanding of how the suppliers operate, how gear is lost, how much gear they lose over time and what happens to end-of-life gear.

Survey results indicated that the main causes of gear being lost were poor weather conditions, ocean currents and operator error.

Respondents also noted that when gear is lost it is always reported by the owners of the vessel, who also underlined that attempts are always made to retrieve lost gear. The success of these attempts varied between respondents, but a majority – 60 percent – stated that they were frequently successful, while 30 percent stated that the gear was always retrieved and the remaining 10 percent failed to recover the lost gear. Overall, there was a lack of understanding and awareness among 70 percent of respondents regarding national laws/regulations covering the loss or disposal of fishing gear.

The survey reported that the weight of lost gear retrieved and returned to port ranges from 10 kg to 200 kg of gear per vessel per year, with 50 percent of respondents stating that only 50 kg of lost or damaged gear is brought back per vessel. Meanwhile, 90 percent of respondents stated that there was a container/reception facility available to facilitate the recycling of damaged gear and netting. Fishers also reported that they receive payment to recycle the damaged or end-of-life gear they bring into port. Finally, 70 percent of respondents reported that they lose an average of one unit of gear per year. It was assumed that this "unit" referred to the whole unit of the gear rather than a portion of it; however, this was not made explicitly clear and requires more information to gain a quantitative measure of gear loss.

The answers provided indicated that respondents are aware of the high costs of gear and do attempt to recover it when it is lost at sea or damaged. Similarly, the high cost of gear provides an incentive for fishers to do what they can to extend its life, which includes repairing damaged nets. It was encouraging to discover that some commercial fishers already have access to collection and recycling facilities for their end-of-life gear.

Going forward, Thai Union hopes to see greater cooperation between fishers and recycling facilities, including the addition of more incentives to encourage fishers to use the latter. Based on the results and gaps identified, Thai Union will focus its future work on:

- Continued work with vessel owners and captains to prevent gear becoming lost in the first place. As environmental conditions were

shown to be the main cause of gear loss, there may be scope to examine whether the vessels are taking risks when fishing in certain areas in poor weather. It is understood that vessels do have the technology on board to assess weather and underwater obstacles.

- Liaise with Thai Port In – Port Out (PIPO) Control Centres to implement more surveys on ALDFG.
- Having identified that one unit of gear is lost per vessel per year, further investigation of vessels should be conducted to see if modifications can be made to vessels (e.g. winches, small cranes) or additional crew training provided to facilitate a higher rate of gear recovery.
- Engage with Environmental Justice Foundation (see case study 2.3.3) to promote cooperation between fishers and recycling facilities. Additional research is needed to identify the companies operating these facilities, identify areas for improvement, and improve fishers' access to these facilities. Essentially this type of disposal needs to be incentivized and made as easy as possible for fishers.
- Training on gear disposal and ALDFG-related regulation in Thailand could be undertaken to facilitate greater understanding of the regulatory framework among fishers.
- Provision of additional financial incentives and funding for the recovery and responsible disposal of end-of-life gear should be investigated.

2.1.6 Developing an Asia-Pacific Economic Cooperation (APEC) Best Practice Framework to Address Abandoned, Lost or Discarded Fishing Gear Project, (Thailand, Malaysia, United States)

Good Practices to prevent and reduce ALDFG at regional level

- ✓ capacity building on effective management of fishing gear to prevent gear loss;
- ✓ awareness raising on the impacts of ALDFG;
- ✓ reduction in the incidence of ghost fishing through policy-making and field work;
- ✓ regional cooperation to address the ALDFG issue;
- ✓ combining gear marking systems with complementary best practices to manage fishing and aquaculture gear;
- ✓ engaging fisheries managers, policy-makers, private sector representatives to find/share solutions to address ALDFG.

Begun in 2020, this project identifies key challenges and capacity development needs associated with addressing ALDFG and illegal, unreported and unregulated (IUU) fishing across the Asia-Pacific Economic Cooperation (APEC) region. Specifically, this effort has been applauded and supported economically by Malaysia, Thailand and the United States of America. The project aims to build the APEC economies' capacity to address both issues effectively, by increasing regional uptake of FAO's VGMFG and the GGGI's C-BPF and Best Practices for the Management of Aquaculture Gear (A-BPF). To do so, it engages fishery management and industry stakeholders through a capacity building workshop in Thailand. Owing to the challenges presented by the COVID-19 pandemic, the workshop will be hosted as an online event. The project aims to:

- Build the capacity of APEC fisheries managers, policymakers and key private sector representatives to manage fishing gear more effectively and improve fishing practices to prevent gear loss.
- Reduce the incidence of ALDFG and marine plastic litter, which affect both capture fisheries (e.g. unintentional reduction of fish stocks) and aquaculture operations in the APEC region, through policymaking and by encouraging field work.
- Share lessons learned, best practices and mechanisms for managing fishing gear to minimize the impact of ALDFG. This will be achieved through one virtual workshop for APEC delegates in 2021, sharing the documents produced under this project with

APEC economies, presentations in the APEC Ocean and Fisheries Working Group and potentially further implementation work.
- Provide clear guidance and next steps to members of APEC, multilateral organizations and the private sector on how to implement solutions to strengthen capacity on fishing gear management in APEC economies.

To achieve the objectives outlined, the project is structured around three core outputs:

Output 1) ALDFG Best Practices Guide for the APEC region

The ALDFG Best Practices Guide (hereafter, the Guide) will build on the foundations of the GGGI's C-BPF, as well as their recently launched Best Practices for the Management of Aquaculture Gear (A-BPF) and FAO's VGMFG. The principles, as described in both the BPFs and the VGMFG, will be assessed on their suitability for implementation in the APEC region; associated case studies of best practice examples relevant to APEC member economies will also be provided. The Guide will first describe the relevant principles and the research behind them, followed by case studies on how they have been implemented in projects, policy, fisheries and corporate management. The Guide may also include the workshop report (see Output 3 below) and a comparative analysis of the pre- and post-workshop surveys. The purpose of this Guide is to point out and explain relevant gear management best practices; it brings them to life through practical, real-life examples that inspire stakeholders and APEC member economies to take action and be aware of all the positive progress already being made around the world.

Output 2) APEC Regional Compendium of Gear-Marking Schemes

The APEC-specific Gear Marking Compendium aims to elaborate on the guidance provided in the VGMFG. The compendium will provide more detailed descriptions of the various gear tracking techniques and elements of gear marking systems mentioned in the VGMFG, as well as case study examples of how these techniques have been piloted or implemented. The Compendium will also provide a description of how gear marking needs to work in conjunction with gear (loss) reporting mechanisms, supply chain traceability schemes and potential fishing gear licensing and EPR requirements.

Output 3) Regional stakeholder workshop on ALDFG

The purpose of this workshop is to bring together regional stakeholders to share knowledge and strengthen capacity to incorporate ALDFG best practices into member economies' regional policy, legislation and industry practice — including reducing gear loss through effective gear marking schemes. Participants will include: public and private sector stakeholders from APEC member economies; experts from FAO, regional fisheries management organizations (RFMOs) and research institutes such as the Southeast Asian Fisheries Development Center (SEAFDEC); while the organizers will be from the Malaysia Department of Fisheries, Thailand Department of Fisheries, U.S. Department of State, U.S. National Oceanic and Atmospheric Administration (NOAA) and Ocean Conservancy/GGGI.

The workshop will focus on: building an understanding of ALDFG (causes, impacts, drivers, volume) within the APEC region; educating participants on the various approaches to prevent, mitigate and remediate ALDFG; and putting all the learning into practice during the final session on strategy planning and building action plans. One of the key success factors from previous workshops is that stakeholders were able to interact and learn from each other throughout.

Due to the challenges presented by the COVID-19 pandemic and the inability for stakeholders to travel safely, the workshop will be hosted as online in January 2022. The development of the ALDFG Best Practices Guide and the APEC Regional Compendium of Gear Marking Schemes have also been delayed and will be published after the workshop in 2022.

The setbacks caused by the pandemic have pushed the project timeline back to June 2022, but two new outputs have been incorporated in response to the challenges encountered: Output 4) the APEC Private Sector Stakeholder Roundtable; and Output 5) the APEC Gear Marking Training Tool. Both outputs are designed to be delivered virtually. These new outputs reflect changes to the project based on the need to reprogramme funds initially slated for travel and other costs associated with hosting a three-day workshop in Phuket, Thailand. The decision has been made to convene the workshop virtually owing to the ongoing global pandemic and resultant impacts on travel and events.

2.2 Mitigation

2.2.1 Marking of anchored fish aggregating devices (aFADs) and gear loss modelling, Vanuatu

In partnership with the Vanuatu Fisheries Department (VFD) and with funding from Canada's Sustainable Fisheries Solutions and Retrieval Support Contribution Program (Ghost Gear Fund), GGGI continues work in Vanuatu, building on previous efforts to identify effective tools to track the position of fish aggregating devices (FADs) and locate and remove ALDFG. A previous project phase was supported by the governments of Belgium and the United Kingdom of Great Britain and Northern Ireland and contributed to the development of the FADs section of the Voluntary Guidelines on the Marking of Fishing Gear. The project's other implementing partners include the Vanuatu Environmental Science Society (VESS), and Natural Resources Consultants (NRC). Local fishermen are engaged in the deployment of the tracking devices for anchored fish aggregating devices (aFADs). The current phase has been named "Best Practices to Prevent ALDFG, Preserve Fisheries and Protect Ecosystems in the South Pacific" and involves:

- monitoring and locating the aFADs should they become detached, using innovative technology;
- providing capacity building and training for local authorities to incorporate the new technology in fisheries management monitoring and surveillance activities;
- snorkel, scuba and beach surveys of ALDFG to ground-truth areas of probable gear loss, and thus refine the predictive ALDFG model for all types of gear developed in the previous phase;
- conducting in-water gear removal of ALDFG; and
- collecting and reporting data on removed ALDFG to the GGGI data portal.

The VFD uses a non-entangling FAD design, the "Vatuika" FAD, for the anchored FADs they deploy – this includes a flag on its end buoy to increase visibility of the aFAD (Figure 10).

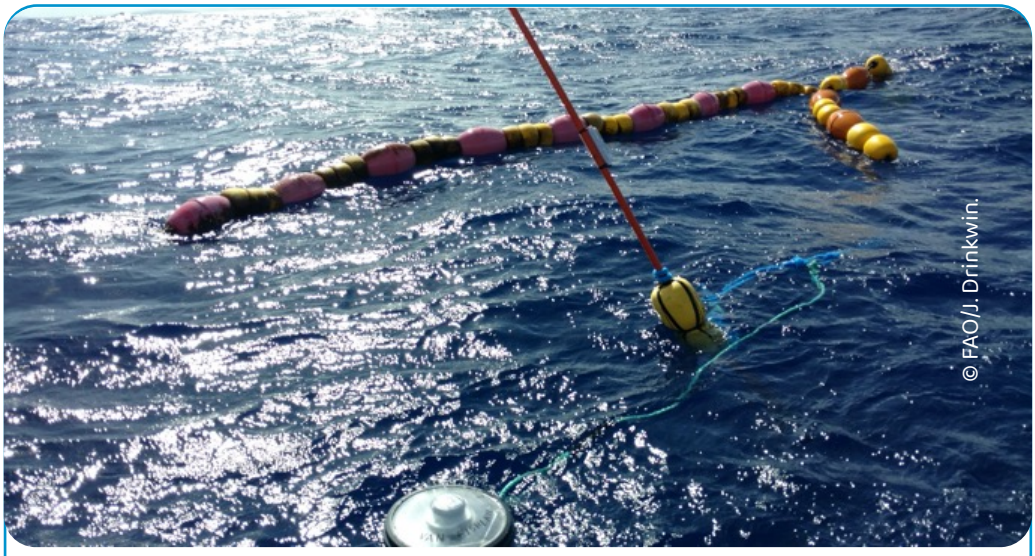

Figure 10. Deployed Vatuika a FAD.

Good practices on aFAD marking and ALDFG prevention and remediation

- ✓ public–private partnership to trial tracking technologies for aFADs;
- ✓ testing of different tracking technologies for aFADs to ensure they suit local conditions/requirements;
- ✓ fisheries authorities trained on the use of the tracking technologies trialled;
- ✓ fishers are engaged in the testing of the aFAD tracking technologies;
- ✓ gear loss modelling to predict where gear is lost;
- ✓ validation/refining of the model through onsite surveys;
- ✓ retrieval of ALDFG identified through the model;
- ✓ data collection and recording of retrieved ALDFG.

The initial phase of the project (2017–2019) resulted in a predictive model that identified where ALDFG of all types (nets, lines, traps, FADs etc.) were likely to occur in Vanuatu. High probability areas covered large expanses around almost every island, with the largest continuous areas around Malekula, southern Espiritu Santo and Efate. Two kinds of tracking devices were also deployed during the initial phase of the project at five Vatuika aFAD locations and trialled – namely Pelagic Data Systems VTS units and SatLink satellite buoys with echosounders. A key challenge encountered during the initial phase was that the tracking devices tested were not specifically designed for anchored fishing gear; they therefore did not withstand periods of submersion at depth, which occur with aFADs. This was a primary consideration when identifying suitable tracking devices to be trialled in phase two.

The project's second phase (2020–2022) involves: a) refining the predictive model through ground-truthing snorkel, SCUBA and beach surveys at areas identified as high probability for ALDFG loss or accu-mulation; b) retrieving identified ALDFG of all kinds; and c) piloting new gear marking/tracking technolo-gies for Vanuatu's aFADs.

As Vanuatu's aFADs are exposed to submersion periods of varying duration and depth, three tracking devices able to withstand such periods of submersion were selected for piloting during phase two: Blue Ocean Gear's (BOG) Farallon Smart Buoy system, Collecte Localisation Satellites' (CLS) marine mammal tag and CLS E-Gear GearTracker. Dedicated training sessions were facilitated by BOG and CLS (separately) to train VFD personnel in the preparation, deployment and monitoring of the respective gear tracking de-vices.

During this second phase, VESS is conducting surveys at 10–15 sites to update and refine the ALDFG predictive model developed during the project's earlier phase; they will also conduct ALDFG retrieval operations of identified lost gear. Retrieval operations will follow the Vanuatu ALDFG Removal Planning and Protocols prepared for this project, which outline a stepwise approach for the safe removal of ALDFG once it has been identified in Vanuatu.

2.3 Remediation

2.3.1 Fishing Net Gains Project, Nigeria

Fishing Net Gains (FNG) is a programme run by the Stand Out for Environment Restoration (SOFER) Initiative (SOFER Initiative, 2021) which works to address ghost fishing and other related threats to marine life in Nigeria and the west coast of Africa. Funding received through the Joanna Toole Foundation, GGGI and Ocean Conservancy provided support for the Nigerian arm of the FNG programme – referred to as Fishing Net Gains Nigeria (F-NGN). The Department of Fisheries and Oceans, Canada also provided funding to support the West African branch of the FNG programme – Fishing Net Gains West Africa (FNG-WA). Depending on funding and capacity, the FNG programme intends to expand into Cameroon and other parts of Africa, as well as other countries around the world. By fostering collaboration between government and other stakeholders, and by applying best practices for addressing ALDFG in the region from a prevention and remediation point of view, FNG seeks to create economic opportunities for coastal communities, including women and young people. The programme's current community outreach efforts cover five coastal communities in Nigeria – Ibeno (Akwa Ibom State), Ikot Abasi (Akwa Ibom State), Badagry (Lagos State), Brass (Bayelsa State) and Escravos (Delta State), in addition to Limbe in Cameroon, which amounts to a total of six communities.

SOFER is supporting the six coastal communities across Nigeria and Cameroon through the construction of HubNets (Figure 11), semi-permanent structures which serve as collection sites for end-of-life fishing gear and recovered ghost gear that would otherwise be thrown away. The programme thus promotes the effective recycling of fishing gear and end-of-life gear disposal, including buying-back old equipment for recycling and supporting the implementation of responsible end-of-life gear disposal options. Fishers are asked to bring end-of-life or damaged gears to the HubNets

Figure 11. "HubNet" collection site for ALDFG in Nigeria (image courtesy of Fishing Net Gains Nigeria). © FAO/Cyril Austin Akpan.

so they can be repurposed into crafts by community women after being weighed and cleaned at the HubNet by the HubNet Data Collectors. Treated nets are currently distributed free of charge to encourage the women to develop their crafts with free resources, but this will change once they start making money from their output. When that happens, the women will then have to buy nets from the HubNets, which will then be used as economic incentives for fishers to recover their own lost fishing gears and promote the recovery of ALDFG encountered while fishing.

HubNets are designed to receive all types of gears but predominantly they receive gillnets and cast nets as these are the most common in the region. What is collected in the HubNets serves as raw material for women and youth in the community, whom SOFER train to create handicrafts like baskets and mats out of end-of-life or damaged gears, which they can sell to supplement their income. To facilitate a closed loop system, SOFER is working on a zero-waste approach, using all elements of the fishing gear recovered by engaging crafters and artists. Any remaining waste materials are used to create art that can also be sold on SOFER's market platforms; to this end, the organization is also working on a digital marketplace to supplement the physical market to exhibit and sell the products created.

Good Practices to prevent and remediate ALDFG

- ✓ local community and government engagement and participation to address ALDFG;
- ✓ implementation of reception facilities and recycling options for end-of-life gear and retrieved ALDFG;
- ✓ reuse and recycle ALDFG;
- ✓ supplementary income created for local women and young people through recycling of ALDFG;
- ✓ community women and youth are trained on recycling and upcycling end-of-life gear and retrieved ALDFG;
- ✓ ALDFG and EOL fishing gear data collection;
- ✓ awareness raising on impacts of ALDFG with fishers, local communities and scuba divers;
- ✓ community stakeholder workshops to discuss issues related to ALDFG and generate consensus across communities;
- ✓ engagement of trained scuba divers in ALDFG retrieval.

Phase one saw the implementation of a recruitment process to select the project team. After proper screening and evaluation, seven members of staff, one intern, seven volunteers and six HubNet data collectors (for the Ibeno and Ikot-Abasi locations) were recruited. In total, 59 persons have been recruited through the FNG programme. They are currently working

on recruiting an additional seven junior staff at the head office; with new locations in Escravos (Nigeria) and Limbe (Cameroon), they expect to have six additional HubNet Data Collectors.

The team promotes awareness raising around the impacts of ALDFG, as well as the generation of ALDFG data on the West African coast, which SOFER hopes to expand to other regions as they work on creating a scalable and replicable programme. HubNet Data Collectors are community youths employed through SOFER's Youth Volunteer Corp (YVC) programme. The collectors are stationed at the HubNets to gather relevant information and data regarding end-of-life and ALDFGs delivered to the Hubnets, as well as sightings of ALDFG. After recovery of an ALDFG, fishers proceed to the HubNet where their vital information is registered, including basic contact information, and the gears are weighed and recorded before treatment. Any further analysis after treatment and distribution are also recorded; data is uploaded to the GGGI ghost gear reporter app and also stored in SOFER's database. Through the implementation of the HubNets, FNG provides a sound project that promotes community integration and participation. Additionally, the project works to help fishers avoid hazardous zones during fishing activities through education and awareness raising: this helps prevent gear being lost in the first place.

During phase one, 315 artisanal fishers were engaged across Ibeno, Ikot-Abasi, Badagry and Brass locations. There were some challenges, with some fishers being unwelcoming and reluctant to participate, as well as communication difficulties owing to language barriers. In order to further integrate community in the FNG programme, a two-day community stakeholder workshop was conducted by SOFER to bring together fishers, community leaders, youth groups and other relevant stakeholders. The workshop provided an opportunity to assemble members of host communities and stakeholders to discuss issues related to ALDFG and generate consensus across communities.

The FNG community stakeholder workshops have so far engaged a total of 653 attendees ranging from government officials, community leaders, young people and women's groups in the four project locations of Ibeno, Ikot-Abasi, Badagry and Brass. Government representatives from the Ministry of Environment and Ministry of Agriculture (under which the Federal Department of Fisheries and Aquaculture operates) shared the fishers' concerns regarding piracy, illegal fishing by trawlers and lack of basic facilities in the communities including general waste management as well as reception facilities.

Consensus was reached to a) report lost fishing nets at the HubNet; b) dispose of nets that had elapsed their lifespan at the HubNet; and c) form an organized body of fishermen in order to have a voice.

Building on the initial phase of FNG, phase two (October 2020–March 2021) focused on engaging the local scuba diving community and building an awareness campaign called "Dive-For-Data" (DFD). The campaign aimed to educate local divers on ghost gear and encourage them to report it when they encounter it. SOFER also created a dedicated offshore recovery campaign aimed at retrieving ghost gear from the ocean; this will build on the DFD campaign and ensure that only skilled and trained scuba divers perform gear removal. Due to funding limitations, only two DFD workshops where held, one for Badagry and a joint workshop covering the Ibeno and Ikot-Abasi project sites. Despite the challenges, 42 local scuba divers were engaged through the DFD workshops organized in Ibeno and Badagry locations and an action plan was drafted detailing five resolutions on the management of ALDFG.

Sadly, the HubNet facility at Mkpanak, Ibeno was flooded, leading to a significant decline in gear recovery as well as the loss of HubNet records, recovered gear and data. The capacity for storage of recovered gear is small and expansion is needed to accommodate more of it. The team were able to reconstruct another HubNet with reinforced foundations. To date, SOFER has recovered almost 900 kg of ALDFG and documented 535 visits to the HubNets. With the planned expansion of the FNG programme to other areas across Africa and other regions, the team hope to continue increasing those numbers.

2.3.2 ALDFG Removal in the Myeik Archipelago, Myanmar

The Myanmar Ocean Project (MOP), a non-profit organization and member of the GGGI, is undertaking fundamental work to understand the state of Myanmar's underwater world, put the issue of ALDFG on the public and policy agendas, and work collaboratively with fishing communities to conserve local biodiversity. In 2019–2020, as part of a GGGI-sponsored effort, a project was implemented to shed light on the scale of the ALDFG issue in Myanmar's remote Myeik Archipelago. Investigating potential causes/drivers of ALDFG, it recommends measures to prevent, mitigate and remediate the issue. The project was sponsored by GGGI, Ocean Conservancy and National Geographic Society. In addition, the Department of Fisheries (DoF), Fauna and Flora International-Myanmar (FFI), Istituto Oikos and the Ministry of Hotel and Tourism (MoHT) provided support and assistance in granting the MOP team the necessary permits and ancillary staff to conduct survey and retrieval work in remote locations in the Myeik Archipelago.

In order to gather information and build a baseline of ALDFG data in the Myeik Archipelago, three components were carried out:

1. Information gathering about ALDFG from local fishers, scuba divers and other ocean users in and on the water, to establish potential causes and hotspots for gear loss and discarding.
2. Systematic underwater surveys conducted by scuba divers to determine exact locations where ALDFG accumulates and assess the scope of pollution and different gear types.
3. Gear recovery operations conducted by trained scuba divers equipped with cutting instruments and lift bags to safely remove and lift retrieved gear.

In doing so, 87 systematic surveys were conducted by professionally trained scuba divers so as to build a baseline assessment of the state of the problem; the data was collected using the GGGI's Ghost Gear Reporter App and housed in the GGGI ghost gear data portal. During the first phase of the project, it became clear that 95 percent of surveyed locations had incidences of ALDFG harming local marine life, with almost one- third of those locations identified as ALDFG hotspots (accumulation). Gillnets were found to be the predominant type of ALDFG encountered. Through interviews conducted with local stakeholders it was determined that most ALDFG resulted from deliberate discarding. The intention behind it was to save space on the boat and fuel before returning to port, and because of conflict with other gear types.

Good practices on assessing, reporting and recovering ALDFG

- ✓ identify potential causes and hotspots for gear loss and discarding by surveying fishers and other ocean users;
- ✓ underwater surveys to determine where gear is being lost/abandoned/discarded and the scale of the problem;
- ✓ train professional scuba divers to conduct ALDFG retrieval;
- ✓ ALDFG retrieval;
- ✓ data collection on retrieved ALDFG.
- ✓ engagement of different public administrations;
- ✓ project report is publicly available.

The MOP has facilitated the successful training of highly skilled and experienced scuba divers. Engaging in safe and effective gear recovery, this approach has led to almost 2000kg of ALDFG, mainly gillnets, being removed from the Myeik Archipelago. The project has also resulted in MOP publishing the first quantitative and qualitative analysis of ALDFG in Myanmar (Myanmar Ocean Project, 2020).

Building on the information gathered from the first phase of the project, the MOP will continue to work with local fishers on the ground in one of the key hotspot locations identified in the first phase. They will conduct outreach and education with local fishing communities on the dangers of lost gear, explore options for end-of-life gear disposal in the region, and perform gear removal operations in some previously identified hotspot areas. The latter has been put on hold, however, owing to the challenges currently facing Myanmar in the wake of the military coup and the COVID-19 pandemic.

2.3.3 Net Free Seas, Thailand

The Net Free Seas (NFS) project was launched in early 2020 by the Environmental Justice Foundation (EJF), with the aim of ridding Thailand's waters of discarded fishing nets. Funded by the Norwegian Retailers' Environment Fund (Handelens Miljøfond) and Rufford Foundation, the project supports coastal communities collect discarded nets, which are used to make a variety of goods such as sports and kitchen equipment. This project aims to protect ocean wildlife and support local villages simultaneously, providing a sustainable and environmentally friendly alternative way of disposing of used nets rather than burning or sending them to landfill. The NFS project works with the private sector – Ranong Recycle for Environment (a social enterprise operated by the Jan & Oscar Foundation), NatureMind-ED, Qualy (a Thai recycling and an end-user product company) – local NGOs like Save Andaman Network, and associations of artisanal fishers in both the

Gulf of Thailand and the Andaman Sea. The project is also supported by the Department of Fisheries, Department of Marine and Coastal Resources and the Department of National Parks, Wildlife, and Plant Conservation.
The project seeks to:

- provide an innovative solution to reducing the occurrence of fishing nets entering marine ecosys-tems;
- contribute to Thailand's effort in tackling marine litter issues, which poses a risk to marine ecosystems and resources, as well as the long-term economic and environmental sustainability of the country's fisheries sector;
- introduce a circular economy management system that increases the economic value of used nylon (PA6) fishing gear and creates a sustainable recycling market, as well as increasing demand for recycled materials in manufacturing;
- educate local coastal communities on the importance of addressing marine litter issues and help integrate recycling and waste management practices into their day-to-day lives.

Good practices on fishing gear recycling:

✓ local community, government, research institutions and private sector engagement;
✓ promote gear recycling and responsible disposal of end-of-life gear;
✓ recycle ALDFG and EOL fishing gear;
✓ create a market for recycled plastic from fishing gear;
✓ create supplementary income for local communities through the recycling of ALDFG;
✓ awareness raising and capacity building on good practices to prevent and reduce MPL, including the publication of a "handbook for fishers" in English and Thai;
✓ dedicated retrieval of ALDFG.

The EJF has already produced a line of prototype products with Qualy. These products include a variety of household items, face shields (to protect healthcare volunteers while combatting COVID-19) and Push Sticks (to prevent the transmission of COVID-19). Under NFS, Qualy purchases discarded nets from communities participating in the project. The money from these purchases goes directly to communities either in the form of direct payments, or in the form of a community fund which can be used for supporting future community-based activities or projects. Qualy then brings the nets to their factory, where they are shredded and injected into moulds, ready to be transformed into new products – introducing

a circular economy management system for fishing nets. More details on how the project operates to connect small-scale fishing communities with local recycling companies are provided in their Net Free Seas Handbook 2021 (Environmental Justice Foundation, 2021).

Since the start of the project over 16 tonnes of fishing nets have been collected and recycled from 76 participating communities across Thailand, engaging over 1 500 fishers (D. Thomson, personal communication, August 2021) through dedicated, community-led clean-ups and dive retrievals. These nets have been turned into over 50 000 product pieces sold both in Thailand and internationally. Apart from Qualy, EJF is also working with two other recycling/manufacturing companies – namely Teamplas and Micro Precision – to expand the range of product applications. What is more, they are also working with Thai research institutions to conduct further tests on netting samples to ensure their quality and usability in future product lines.

The Bo Son community in Chana district, Songkhla province, provides an impressive example of how communities are embracing the project and tailoring it to their local circumstances. In just 3 months, the community collected almost 5 tonnes of fishing nets and decided to build their own cleaning station, where they can clean and dry the nets in preparation for recycling (D. Thomson, personal communication, 2021).

The example of the Bo Son community highlights one of the most pressing challenges facing the NFS project: cleaning the nets so that they are ready to be recycled. Twigs, stones or other organic matter can clog plastic melting machines and reduce the overall quality of the resulting plastic. It is therefore vital but currently very time consuming to remove these foreign contaminants before sending the nets to the factory for processing.

Another challenge has of course been the ongoing COVID-19 pandemic and severe movement restrictions imposed across Thailand since March 2021. This has severely limited EJF's ability to meet face-to-face with communities and continue to grow the project or engage in community training. During this difficult time, EJF works with local partners to keep the project running.

3. Good practices and recommendations

3.1 Identified good practices and analysis of case studies

The case studies presented in this document present good practices for preventing, mitigating and remediating the impacts of ALDFG. They provide working examples that could be applied to other locations around the world in order to address ALDFG issues. Nevertheless, there is no one-size-fits-all solution when it comes to managing ALDFG and a suite of good practices under the three categories (prevention, mitigation, and remediation) are needed to find locally viable solutions. Table 6 provides a summary of the good practices outlined in the case studies applied for the prevention, mitigation, and remediation of ALDFG, as well as good practices that can be adopted at all stages of intervention.

Table 6. Good practices on prevention, mitigation and remediation of ALDFG identified from the case studies included

Prevention
- Implementation of baseline studies on the causes and spatial distribution of ALDFG, as well as current practices to prevent ALDFG, through direct engagement with fishers (surveys, workshops, etc.) - Supporting the development and implementation of local reception facilities and collection points (infrastructure and collection services) for fishers to dispose of and recycle ALDFG and end-of-life fishing gear responsibly. - Where reception facilities exist, engaging directly with fishers to understand why and where gear is lost and determine the local barriers to retrieving lost gear and/or disposing of EOL gear. - Coupling the provision of reception facilities/collection points with incentives for fishers to dispose of EOL fishing gear in order to provide viable alternatives to discarding at sea. - Facilitating circular economy practices including the efficient and cost effective recycling of gears, as well as providing training to fishing communities on fishing gear recycling. - Development and implementation of plastic material traceability mechanisms for fishing gear. - Testing of fishing gear marking technologies that enable the owner/operator to be identified through a participatory approach in local contexts. - Use of environmentally friendly fishing gear marking tags. - Raising awareness among fishing communities on the impacts of ALDFG and the project objective to prevent ALDFG.

Mitigation

- Provide training to local communities with regards to reporting of ALDFG.
- Support "no-fault" lost gear reporting systems for fishers to encourage them to report the loss of any gear at the time of loss, thereby maximizing the incidence of recovery.
- Raising awareness among fishing communities on the impacts of ALDFG and the project objective to prevent ALDFG.
- Testing fishing gear tracking technologies, thereby enabling the location of fishing gear and FADs after they get lost, abandoned or discarded in local contexts.

Remediation

- Specialized training provided for the safe retrieval of ALDFG.
- Development of mechanisms to undertake dedicated and coordinated retrieval operations to remove ALDFG, including incentives to promote retrieval and data collection.
- Development of statistical models, surveys and/or in-the-field hotspot analysis to determine where gear is being lost.

General good practices

- Engage all relevant stakeholders to foster collaboration and drive positive solutions across the entire seafood supply chain, from fishers and local community members through to government regulators, gear designers and manufacturers.
- Provide economic incentives to the relevant stakeholders to participate in the initiative.
- Foster the development of public–private partnerships in order to engage the private sector in finding innovative and cost-effective solutions that address ALDFG at all stages of the fishing gear life cycle (design, responsible use, proper disposal and processing at EOL).
- Raise awareness of ALDFG and its impacts as an issue, as well as the measures/solutions taken through the relevant project to prevent/mitigate/remediate them.
- Develop and integrate fishing gear marking systems into fisheries management frameworks.
- Gather knowledge and conduct data collection prior to and during a project's implementation.
- Develop strategies or action plans based on evidence (ALDFG baseline studies).
- Share knowledge, making project results and the non-confidential data collected publicly available.

Projects addressing ALDFG are focused and defined in accordance with the interests and priorities of the lead implementing entity. In the case studies we can differentiate between three categories of implementing entities:

1. Private companies: Coast 4C (2.1.1), Bureo (2.1.3) and Thai Union (2.1.5);
2. Government agencies: the Indonesian Ministry of Marine Affairs and Fisheries (2.1.2), APEC representatives of Malaysia, Thailand and the United States of America (2.1.6) and Vanuatu Fisheries Department (2.2.1); and
3. NGOs: Northwest Straits Foundation (2.1.4), SOFER Initiative (2.3.1), Myanmar Ocean Project (2.3.2) and Environmental Justice Foundation (2.3.3).

Based on these case studies, projects led by **private companies** are more focused on preventive measures that can avoid or reduce ALDFG by providing the reception facilities and technical capacity to dispose and recycle EOL fishing gear. This is the case in the Coast 4C and Net Positiva projects, where lead companies provide fishermen and their local communities with the services, incentives and training to recover EOL fishing gear. The gear is subsequently sent for the necessary treatment, before being shipped to recycling/plastic producer companies. Furthermore, Net Positiva has developed a material traceability mechanism that allows them to track fishing nets entering their project circuit.

Preventive projects focused on providing reception facilities and the technical capacity to dispose of and recycle EOL fishing gear are also implemented by **NGOs** like the Derelict Gear Program in the United States of America, Fishing Net Gains Project in Nigeria and Net Free Seas in Thailand. The difference with the solutions offered by private companies is that these projects also include ALDFG recovery activities (remediation). Another example of a 'solution project' focused on remediation is the MOP ALDFG Removal in Myanmar, which trained experienced scuba divers to engage in safe and effective gear recovery operations in the Myeik Archipelago (Myanmar). The project also included surveys with local fishers and other ocean users to establish potential causes and hotspots for gear loss. Finally, the trained scuba divers conducted discarding and underwater surveys prior to the removals to determine the exact locations where ghost gear accumulates and assess the scope of pollution and different gear types. All data and information collected through the project is publicly available through its online report.

Government agencies have more capacity to lead cross-cutting solution projects as they can interact with all categories of stakeholders (private sector, NGOs, civil society organizations) and cover the policy and regulatory dimension that the other stakeholders cannot address. The present study provides examples of government led projects covering different aspects of the ALDFG problem.

The gear marking technology pilot project in Indonesia, led by the Indonesian Ministry of Marine Affairs and Fisheries, focuses on testing gear marking technologies that can be applied to local gillnet fisheries. The project is a first step towards the implementation of gear marking systems to prevent, mitigate and remediate the problem of ALDFG and the increasing threat of illegal, unregulated and unreported (IUU) fishing in Indonesian territorial waters. In its second phase, the project includes activities to promote the responsible disposal of EOL fishing gear, promote fishing gear recycling and identify methods and techniques to locate and recover ALDFG.

The Marking of aFADs and gear loss modelling project led by the Vanuatu Fisheries Department is an example of mitigation with two components. One of them focuses on testing tracking technology for aFADs that will facilitate monitoring and their recovery should they become detached. This component also includes training activities for local authorities to incorporate the trialled technology in fisheries management monitoring and surveillance. The other component includes the refinement of a gear loss modelling tool that will allow the identification of areas where gear loss is most likely to occur. Under this component, ALDFG retrieval activities are conducted on the areas identified by the model and retrieval data is collected and recorded in the GGGI ghost gear data portal.

The last example of a government agency led project is the Development of an Asia-Pacific Economic Cooperation (APEC) Best Practice Framework to Address ALDFG. This project is an example of regional cooperation to address the ALDFG problem in areas where the fisheries sector in particular – and ocean resources in general – are an important economic resource for their people. The project aims to build the capacity of APEC member economies to manage ALDFG effectively, based on the principles outlined in the VGMFG, the C-BPF and A-BPF. This is achieved through policymaking and encouraging field work to find local solutions.

An essential component of successful solution projects to address ALDFG is ensuring representative **stakeholder engagement** is pursued. All of the case studies presented in this report engage a number of different stakeholder groups – the number and composition of which vary depending

on the nature of the project. The GGGI's C-BPF (2021) identifies 12 primary stakeholder groups that are recognized as key players when looking at good practices to prevent, mitigate and remediate ALDFG. Table 7 summarized the stakeholder groups as defined in the C-BPF that each case-study has engaged to help ensure the success of the project.

Table 7. Summary of stakeholder groups engaged across each of the case studies. Stakeholder groups are as defined in the GGGI's C-BPF (GGGI, 2021).

Stakeholder Group	Coast 4C, Philippines	Gear marking, Indonesia	Net Positiva, Latin America	Derelict Gear Program, United States of America	Thai Union, Thailand	APEC best practice framework, APEC	Marking of aFADs, Vanuatu	APEC best practice framework, APEC region	Fishing Net Gains Nigeria	ALDFG removal, Myanmar	Net Free Seas, Thailand
Gear designers and manufacturers	✓	✓	✓		✓		✓				
Fishers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fleet operators and fisheries organizations			✓	✓	✓	✓		✓			
Port operators			✓			✓		✓			
Fisheries managers and regulators		✓	✓	✓		✓	✓	✓	✓	✓	
Fisheries control agencies		✓	✓	✓	✓						

Stakeholder Group	Coast 4C, Philippines	Gear marking, Indonesia	Net Positiva, Latin America	Derelict Gear Program, United States of America	Thai Union, Thailand	APEC best practice framework, APEC	Marking of aFADs, Vanuatu	APEC best practice framework, APEC region	Fishing Net Gains Nigeria	ALDFG removal, Myanmar	Net Free Seas, Thailand
Fisheries and aquatic environment research		✓		✓	✓						✓
Seafood ecolabel standard and certificate holders					✓						
Post-harvest seafood companies					✓						
NGOs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
International development and funding agencies	✓	✓	✓			✓	✓	✓	✓	✓	✓
Municipality councils and authorities	✓	✓					✓				✓

All case studies included in this document have actively engaged fishers in their respective projects (see Table 7). Engaging fishers and the broader fishing community in the design and implementation of projects is key to the successful management of ALDFG for obvious reasons: fishers are fishing gear users and the application of the measures proposed in the projects depend on them and uptake from the broader fishing community. Examples of how fishers and the broader fishing community have been actively engaged and benefited from solution projects are: Coast 4C, through their inclusive business model that engages local community through EOL fishing gear collection and the development of community banks; Net Positiva and Net Free Seas, where fishers/shipowners are paid per kilogram of their EOL nets and, in some cases, the money is invested in community projects; and Fishing Net Gains project, where the ALDFG and EOL fishing gear collected serves as raw material for women and youth in the local community who SOFER train in creating crafts they can sell to supplement their income.

While engaging private sector entities can support a project's sustainability through different actions, NGOs have a greater capacity to engage fishers and their local communities in solution projects (see the three case studies under remediation and local NGO engagement in Net Positiva). Private sector entities can facilitate cost-effective disposal solutions for ALDFG/EOL fishing gear by creating a business model for fishing gear recycling, as in the case of Coast 4C, Net Positiva and Net Free Seas. Specialized companies can also provide the technology and the research and development component of prevention and mitigation solutions, such as fishing gear marking technologies (see gear marking project in Indonesia) and tracking devices (see marking of aFADs project in Vanuatu).

Another cross-cutting good practice identified in all ten case studies is **awareness raising** and **capacity building** activities on the impacts of, and solutions to, ALDFG. As shown in the case studies, this can be done through the organization of dedicated workshops that aim to create consensus across fishing communities and/or the fishing industry, as well as the delivery of training on the specific measures proposed, e.g. fishing gear recycling, fishing gear recovery, etc.

Determining the root cause of the problem in a particular context will help identify effective measures. Moreover, establishing a baseline is essential to measuring the impact(s) of the proposed measures. **Knowledge gathering and data collection** is therefore a key good practice, one to be implemented in any type of solution, both during the development of a project and its implementation. Examples of surveys or studies and/or data collection to understand the local characteristics of the ALDFG problem (causes, spatial

distribution, current practices to prevent/mitigate it, etc.) can be found in the gear marking methods project in Indonesia, the derelict gear programme in the United States of America, Thai Union's sea change strategy, APEC project, Fishing Net Gains Nigeria and the ALDFG removal project in Myanmar.

The last good practice identified in many of the case studies relates to **knowledge sharing**. Making a project report and/or their results publicly available helps put forward solutions to the ALDFG problem. Almost all of the case study projects in this document have shared their results and/or methods publicly, online.

3.2 Recommendations for developing projects addressing ALDFG

As indicated in the introduction to Section 2, many of the case studies presented involve elements that tackle ALDFG from different angles. For example, Fishing Net Gains and Net Free Seas are under the section "remediation" because both projects were designed to eliminate the existing problem of ALDFG in Thai and Nigerian waters. However, both also provide fishing gear reception facilities and processing options (recycling) that can help prevent fishing gear being abandoned or discarded at sea. Another example is Vanuatu's project on FAD tracking and gear loss modelling, which includes elements of mitigation (aFAD tracking devices follow its location should they become detached) and remediation (ALDFG removal activities to validate the gear loss model).

RECOMMENDATION: When formulating projects that aim to address ALDFG, we recommend that, in order to be successful, projects follow the consistent pathway shown in Figure 12. First and foremost, they should prioritize the implementation of good practices for the prevention of ALDFG, although it is essential that projects take a step-by-step approach to determine locally viable solutions.

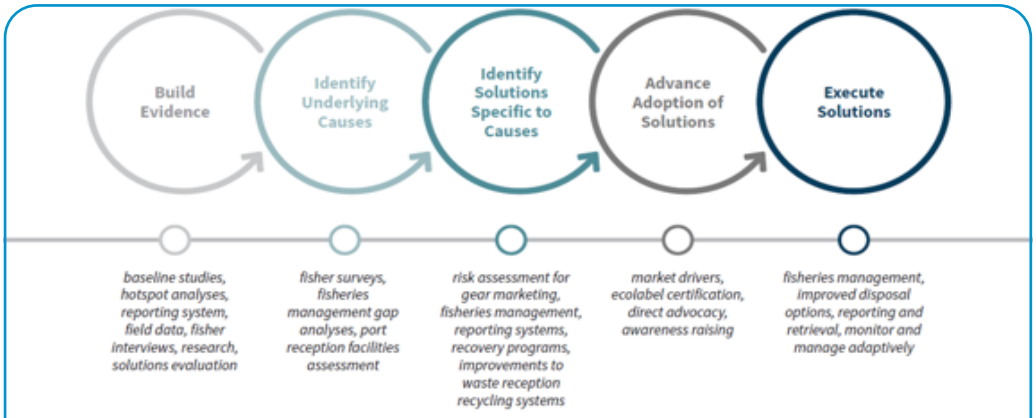

Figure 12. Pathway to ALDFG management solutions (Ocean Conservancy, Global Ghost Gear Initiative and World Wildlife Fund, 2020)

Build evidence and identify underlying causes

Conducting **research activities** to discover the impacts and causes of ALDFG, and current practices to address the problem in a particular context, are both essential to identifying proper solutions.

Concrete examples of research activities from the case studies include: the gear marking project in Indonesia, where interviews and focus group discussions were conducted at the pilot sites to collect information relating to attitudes, behaviour, current marking practices, causes of gear loss, practical challenges to the retrieval of lost gear and women's engagement in the fishery; NWSF research to understand the causes, impacts and solutions to the loss of crab pots; Thai Union's survey of vessel owners, which gained a better understanding of how the latter operate, how gear is lost, how much gear they lose over time and what happens to end-of-life gear; the development of a gear loss model by VFD and its implementing partners; and MOP surveys with fishers, scuba divers and other ocean users to establish potential causes and hotspots for gear loss and discarding.

RECOMMENDATION: The first step when developing a project/programme to address ALDFG should be conducting research activities to understand where, when, how and why fishing gear is lost, abandoned or discarded at sea. Engaging specialists in the issue, whether drawn from **academia** (i.e. university, research institutes, etc.) or **knowledge organizations and technical personnel** within **relevant government authorities**, will ensure data collection is conducted in accordance with scientific methods so as to inform relevant policies/regulations.

As presented in Section 1 of this report, geographic disparities continue to exist with regard to the state
of knowledge on ALDFG and its impacts, owing to the lack of data reporting and monitoring. Additionally, there is no empirical evidence of the scope and magnitude of ALDFG in many geographical locations and fisheries; this demonstrates a pertinent need to have dedicated reporting efforts to quantify the types and amounts of ALDFG.

RECOMMENDATION: Based on recommendations set out by GESAMP WG 43 (Gilardi et al., 2020), Table 8 proposes some specific **knowledge and data** gaps that projects could incorporate in order to build evidence of the ALDFG problem at a local/national level.

Table 8. Knowledge and data gaps identified by GESAMP WG 43 regrading fishing related marine litter (Gilardi et al., 2020).

Knowledge Gap	Requirements
ALDFG categories and differentiation among sub-gear types	Future studies need to make clearer distinctions between sub-gear types; sub-gears classified under the same overarching category may have very different impacts following loss. Future research that aims to gain a better understanding of losses from both high risk sub-gear types (e.g. gillnets), and provide evidence for types that are likely lower risk (e.g. hooks and line gear), is important because it will allow for a more nuanced and informed discussion across fisheries.
Distinguishing between actively deployed gear and ALDFG as causes of wild life entanglements	At present it is extremely difficult to distinguish marine wildlife entanglements caused by actively deployed gear from those caused by ALDFG. Very often, marine entanglements in actively deployed gear (especially those concerning cetaceans) are reported as marine litter entanglement events. Entanglement rates in ALDFG may be exaggerated if it is assumed that all entanglements, including those in actively deployed fishing gear, are due to ALDFG as marine litter. Better data around this question is important because management and fishery interventions to prevent entanglements will necessarily vary depending on the status of the gear causing the entanglement.
Impacts of ALDFG on target and non-target species	Population-scale impacts on both target and non-target resources are largely unknown and understudied. Research on the impacts of ALDFG to specific fisheries and related target species are limited. There is almost no information on the impacts of ALDFG on major fisheries. Moreover, ALDFG wildlife entanglement is circumstantial and opportunistic, precluding any kind of global assessment of impact.

Knowledge Gap	Requirements
Geographic gaps	Future research on the quantity and impact of ALDFG should focus on geographic areas for which there is very little to no information, notably in Africa, Asia, South America and Antarctica. Research should focus on developing countries, where large numbers of small-scale fishing vessels and large-scale artisanal fisheries operate, and should be undertaken in regions where large-scale/industrial fishing vessels deploy large volumes of gear. This is true of purse seine fisheries using dFADs and some pelagic longline fisheries, and anywhere there may be greater chances for the introduction and accumulation of ALDFG.
Quantifying ALDFG contributions from recreational fisheries	There is a lack of quantitative information regarding the amount of ALDFG from the recreational fishing sector. The primary challenge in gaining ALDFG-related information from this area on a global scale lies in the general paucity of oversight, reporting and documentation of participation and effort when compared to commercial fisheries. This is important because recreational gear has been documented as the dominant type of ALDFG present in some water bodies, compared to ALDFG from commercial fisheries. At present, it is unknown if this is the case in other parts of the world where there is a high level of recreational fishing.
FADs as sources of marine litter	Quantities, degradation and impacts from anchored and drifting FADs are documented but limited. Further research for this gear type should be prioritized to identify the scale and scope of FADS' contribution to marine litter.
Aquaculture operations as sources of marine litter	A lack of reporting on the loss, abandonment or discard of plastic materials from aquaculture operations by the majority of producing countries prevents comprehensive assessments of the scope and scale of marine litter generated by aquaculture. Given the growth of aquaculture worldwide, this must be addressed with future studies.

To assist countries build evidence and identify the causes of ALDFG in their jurisdictions, **FAO**[3] has developed a set of **survey questionnaires on ALDFG**. The survey is designed to provide the following benefits:

- Scientific, evidence based and defensible global estimates of the amount of ALDFG, as well as the temporal and spatial distribution of gear loss across fisheries, geographical locations and gear types.
- An understanding of the reasons for gear loss and disposal, which benefits future efforts in the development of technology, management strategies, and educational and awareness programmes to reduce ALDFG and its impact at the national level.
- Development of effective mitigation strategies to reduce ALDFG and its impact in the marine environment globally, particularly in key hotspot areas. These result in positive socio-economic and food security benefits to coastal communities, including reduced incidences of gear loss, food loss through 'ghost fishing', and the entanglement of threatened or protected species and non-target species in general.
- Improved management of fishing gear in use and end-of-life gear disposal.

RECOMMENDATION: The implementation of FAO surveys is highly recommended given the transboundary nature of the issue[4]. The **FAO ALDFG survey** provides standardized forms and methodology at the regional and global levels that will contribute to achieving a reliable baseline of ALDFG. The latter can then be used for evaluating strategies and efforts at the regional and global levels and to meet goals and targets for reduction marine litter, especially SDG 14.1. Data collected will be entered into the FAO ALDFG database contributing to improving global understanding of both the quantities and root causes of ALDFG.

Identify solutions specific to causes

RECOMMENDATION: After identifying the scale of the problem and their causes, the next step is to develop a **plan of action** or **strategy** that will direct

[3] For updates on FAO activities addressing ALDFG visit the FAO website for Responsible Fishing Practices for Sustainable Fisheries at https://www.fao.org/responsible-fishing/en/

[4] Organizations/institutions interested in implementing FAO ALDFG surveys are invited to contact the FAO responsible fishing operations team at Responsible-Fishing@FAO.org.

suitable solutions or good practices to the specific context. An effective plan of action should include:

- ✓ A list of priority actions and objectives based on the gaps identified during the data collection process.
- ✓ Ensure all dimensions of the problem are identified and covered, including policy/regulations in place to allow the implementation of the identified priority actions; these should also be linked to relevant national/regional/global governance frameworks (see Section 1.5), infrastructure, human capacity and funding.
- ✓ Mapping the relevant stakeholders that need to be included in the project and identifying their roles/responsibilities.
- ✓ Establishing a feasible timeframe to implement priority actions and a monitoring system with proper indicators. Indicators and monitoring can help to adjust the action plan and its priority objectives to address gaps/weaknesses identified during its implementation.

Some examples of action planning can be found within the case studies presented in this document: the Puget Sound Lost Crab Pot Prevention Plan (2.1.4), the Thai Union Ghost Gear Work Plan (2.2.1).

Besides the good practices proposed through the case studies like ALDFG reporting and recovery systems, fishing gear recycling, fishing gear marking, etc., other solutions can be targeted at an earlier stage of the fishing gear life cycle, as indicated in the "Research and development" section of the VGMFG and in the C-BPF.

Gear innovation to promote a **circular economy** across the fishing gear life cycle and **mitigate the impacts of ALDFG ghost fishing** is an expanding area of work that is gaining significant traction. Some examples can be found in the report on circular business opportunities for end-of-life fishing gear (Charter, Sherry and O'Connor, 2020) published by the Centre for Sustainable Design at the University for the Creative Arts in the United Kingdom of Great Britain and Northern Ireland, the report of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) on redesign recommendations for fishing gear in the European Union (OSPAR, 2020), and the Study on Circular Design of the Fishing Gear for Reduction of Environmental Impacts (MRAG *et al.*, 2020) commissioned by the European Commission and the recent creation of the Centre for Research Based Innovation – Biodegradable Plastics for Marine Applications "Dsolve" (UiT, 2021), hosted by the Arctic University of Norway (UiT). The Dsolve Centre aims

to reduce marine plastic litter in the marine environment caused by fishing and aquaculture industries by replacing the traditional plastics used in gears and gear components with new biodegradable materials.

However, as shown in the relevant case studies, nowadays only specific types of plastic components used in fishing gear are recyclable: monofilament nylon, multifilament nylon (both polyamide-6) and high density polyethylene (HDPE). Moreover, fishing gears are produced with more than one type of plastic fibre which can compromise the recycling process.

RECOMMENDATION: In order to progress towards the integration of fishing gears into circular economy models and the mitigation of ALDFG impacts, the engagement of **fishing gear manufacturers** and **specialized companies on Electronic Monitoring Systems and satellite telecommunications** is recommended. This will ensure proposed solutions from research studies are truly functional and cost-effective for commercial fishing activities at all scales.

Advance adoption of solutions

The implementation of **awareness raising** activities on the impacts of ALDFG and the provision of a clear purpose and rationale as to why the proposed measures/solutions are necessary will facilitate their adoption by the target fishing communities and other key stakeholders.

The provision of adequate **education and training** to fishers and their extended local communities can facilitate the implementation of the proposed solutions – as demonstrated in many of the case studies. Some examples include Coast 4C, Net Positiva and Fishing Net Gains providing training on fishing gear recycling to local communities; fisheries authorities training to incorporate the FAD tracking technology in fisheries management monitoring and surveillance activities; and MOP training of scuba divers on safe and effective fishing gear recovery. Awareness raising campaigns/activities on the impacts of ALDFG and good practices to prevent and reduce them are implemented by almost all case studies presented here.

RECOMMENDATION: All solution projects should include awareness raising and training activities that aim to inform the relevant stakeholders on the causes and impacts of ALDFG and the range of possible solutions that can be applied to the local context.

Besides awareness raising and training, proposed measures/solutions should be coupled with **incentives** that can facilitate the adoption of proposed measures. Two clear examples from the case studies are the development

of social banks by Coast 4C in the Philippines and Fishing Net Gains "schools" for craft making based on end-of-life or damaged gears.

RECOMMENDATION: All solution projects should identify and implement the necessary incentives to facilitate the adoption of the measures proposed.

Execute solutions

A common challenge highlighted in this report is the access to ongoing funding to sustain projects in the long term. For ALDFG solutions to be amenable, they must be cost-effective. Especially in developing countries, the cost associated with prevention, mitigation or remediation actions can create a barrier to implementing action locally, something which has been highlighted in the case studies presented (e.g. SOFER Initiative in Nigeria and Myanmar Ocean Project in Myanmar). However, funding and resource mobilization can be a challenge for developed countries as well as developing countries, as illustrated in the example provided in Box 2.

Box 2. Costly nature of ghost gear retrieval operations – Emerald Sea Protection Society (EPS)

The costly nature of recovery work and the need for expensive technical equipment to survey and recover ALDFG properly, in often demanding conditions, presented the most significant challenges to Emerald Sea Protection Society (ESPS). Based in British Columbia, this not-for-profit organization has set up a project entitled "Restoring the Emerald Sea: Collaboratively Tackling Lost Fishing Gear in the Canadian Salish Sea". However, given the significant investment required to purchase proper technical equipment, ESPS's projects have previously relied on fundraising for gear rental or in-kind support from organizations that could supply the equipment. Thanks to a grant received from the Government of Canada's Sustainable Fisheries Solutions & Retrieval Support Contribution Program, ESPS have been able to purchase the tools and equipment required for secure gear recovery operations, using commercial diving standards for surface supply gear recoveries. This has drastically increased their team's safety while operating, as well as the range of conditions, depths and scenarios with which they can engage. The organization has also been able to establish a budget to hire fishing vessels during seasonal downtime to assist in recovery work. Fishers have some of the best knowledge of local waters, insight into both regions known for high levels of gear loss, and the equipment and know-how to pull gear out of the water safely and effectively.

Engaging the private sector in project implementation has been a successful strategy employed by many of the case studies in this report: Coast 4C in Philippines, Net Positiva in Latin America, Net Free Seas in Thailand, Gear marking project in Indonesia and Marking of aFADs project in Vanuatu. Developing public–private partnerships can provide important seed funding to initiate projects as well as promoting innovation and circularity to address ALDFG across the whole fishing gear life cycle.

RECOMMENDATION: Engaging the private sector in projects addressing ALDFG is highly recommended. Depending on the focus of the project, private sector stakeholders may include: fishing gear manufacturers, specialized companies on vessel monitoring systems and satellite telecommunications, recycling companies, end-user plastic products producers, seafood companies, etc.

Facilitating access to the latest developments in terms of **knowledge** and **technology** that address marine plastic litter will help put forward solutions to the ALDFG problem. Reaching consensus at the regional and global level on measures/good practices to be applied is essential owing to the transboundary nature of the problem.

RECOMMENDATION: Joining international initiatives that aim to connect the global community (both individuals and entities) working on the issue of marine plastic litter such as the Global Partnership on Marine Litter (GPML) and the GGGI is highly recommended. These initiatives bring together groups who share a common concern about marine plastic litter. Their members share their experience, learn from others and are aware of the latest developments in terms of knowledge and technology to address marine plastic litter in general, through the GPML, and ALDFG in particular through the GGGI. Being a member of these initiatives may also help to reach out to potential project partners and donors.

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5. Appendix

GloLitter Lead partnering countries (LPC) and partnering countries (PC)

	Asia	Africa	Caribbean & Central America	Latin America	Pacific
Lead partnering country (LPC)	Indonesia India	Côte d'Ivoire Kenya Madagascar Nigeria	Costa Rica Jamaica	Brazil	Vanuatu
Partnering country (PC)	Timor-Leste Philippines (the) Sri Lanka Thailand Viet Nam	Cabo Verde Mozambique Senegal Sudan (the) United Republic of Tanzania (the) Togo the Gambia	Nicaragua Panama	Argentina Colombia Ecuador Peru	Tonga Solomon Islands

GloLitter partnerships

This document is part of the GloLitter Partnerships Phase I Knowledge Products Series. The GloLitter Partnerships project is implemented by the International Maritime Organization (IMO) and the Food and Agriculture Organization of the United Nations (FAO). GloLitter assists developing countries in reducing marine plastic litter from the maritime transport and fisheries sectors.

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