Options for Reducing Plastic Leakage to the Marine Environment from Capture Fisheries and Aquaculture

COORDINATING MINISTRY FOR MARITIME AFFAIRS AND INVESTMENTS REPUBLIC OF INDONESIA
THE WORLD BANK IBRD • IDA | WORLD BANK GROUP
ISOP INDONESIA Indonesia Sustainable Oceans Program
OCEANS MDTF

ATTRIBUTION
Suggested Citation: World Bank (2022). Options for Reducing Plastic Leakage to the Marine Environment from Capture Fisheries and Aquaculture. The World Bank, Washington, D.C.

FOR FURTHER INFORMATION
pubrights@worldbank.org

Options for Reducing Plastic Leakage to the Marine Environment from Capture Fisheries and Aquaculture

Acknowledgements

This report was prepared by a World Bank team led by Katelijn Van den Berg and Celine Lim, and a core team comprising of Sapta Ginting and Andrew Harvey. Valuable contributions were received from Ambroise Brenier, David Adeyemi Aromokeye, and Yadranka Farita.

The team would like to thank officials in the Indonesian Ministry of Marine Affairs and Fisheries, particularly from the Directorate General for Marine Spatial Management, Directorate General of Capture Fisheries, Directorate General for Aquaculture, and also officials in the Coordinating Ministry for Maritime and Investment Affairs for their valuable feedback on the study and the finalized report.

Consulting firms Poseidon Aquatic Resource Management and Hatfield Indonesia provided general support for the completion of this report.

The report was funded by the Indonesia Oceans Multi-Donor Trust Fund, established in 2017 at the request of the Government of Indonesia with the support of the Governments of Norway and Denmark. The Oceans Multi-Donor Trust Fund provides technical assistance to implement oceans policy, reduce marine debris, and strengthen coastal resilience.

Contents

Tables and Figures

TABLES

FIGURES

Acronyms and Abbreviations

AIP	Aquaculture improvement project
AIS	Automatic Identification System
ALDAG	Abandoned, Lost and Discarded Aquaculture Gear
ALDFG	Abandoned, Lost and Discarded Fishing Gear
ASC	Aquaculture Stewardship Council
ASEAN	Association of Southeast Asian Nations
ASIC	Asian Seafood Improvement Collaborative
BAP	Best Aquaculture Practices
CMMAI	Coordinating Ministry for Maritime Affairs and Investment
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
EOLFG	End of Life Fishing Gear
EPR	Extended producer responsibility
EPS	Expanded polystyrene
FAO	Food and Agriculture Organization of the United Nations
FSS	Fleet separation scheme
GAQP	Good Aquaculture Practices
GGF	Ghost Gear Fund
GOI	Government of Indonesia
GSA	Global Seafood Alliance
HDPE	High density polyethylene
ICT	Information and communication technology
INDOGAP	Indonesian Good Aquaculture Practices
KEMENHUB	*Kementerian Perhubungan* - Ministry of Transportation
KEMEN-PUPR	*Kementerian Pekerjaan Umum dan Perumahan Rakyat* - Ministry of Public Works and Housing
KLHK	*Kementerian Lingkungan Hidup dan Kehutanan* - Ministry of Environment and Forestry
MARPOL	International Convention for the Prevention of Pollution from Ships
MMAF	Ministry of Marine Affairs and Fisheries
NGO	Non-Government Organization
NPOA-MPD	National Plan of Action on Marine Plastic Debris

PA	Polyamide Nylon 6/Nylon 66
PE	Polyethylene
PP	Polypropylene
PPI	*Pangkalan Pendaratan Ikan* - Fish Landing Quay
PPN	*Pelabuhan Perikanan Nusantara* - Archipelagic Fishing Port
PPP	*Pelabuhan Perikanan Pantai* - Coastal Fishing Port
PPS	*Pelabuhan Perikanan Samudra* - Oceanic Fishing Port
TWG	Technical Working Group
UN	United Nations
VGMFG	Voluntary Guidelines for Marking of Fishing Gear
WPP	*Wilayah Pengelolaan Perikanan* - Fishery Management Area
TKN-PSL	*Tim Koordinasi Nasional Penanganan Sampah Laut* - National Coordination Team for Handling Marine Debris

Executive Summary

The Government of Indonesia's National Plan of Action on Marine Plastic Debris (NPOA-MPD 2017-2025) outlines the ambitious objective to reduce marine plastic debris by 70 percent by 2025. One of the five pillars of this plan is dedicated to "reducing sea-based leakage" that contribute at least 20 percent of all marine plastic debris in Indonesia. Abandoned, Lost and Discarded Fishing Gear (ALDFG) and Abandoned, Lost and Discarded Aquaculture Gear (ALDAG) are major components of sea-based sources of marine debris, and cause significant impacts on the environment, economy, livelihoods and food security. The scale of these impacts on fisheries, marine ecosystems and human users has prompted international action, including under Sustainable Development Goal 14.

ALDFG and ALDAG management and mitigation strategies have the potential to contribute to Indonesia's goals for marine plastic waste management and debris reduction, while also providing economic opportunities. End-of-life fishing gear (EOLFG)—fishing gears and fishing gear components that through wear and tear need to be replaced—can be a major source of material stock for recycling provided such materials are landed ashore and not disposed of or discarded at sea. Many of the materials used in modern fishing gears such as nylon, polyethylene and polypropylene are recyclable materials that can be processed into raw materials for secondary products.

This report aims to enhance the evidence available to support efforts to improve management, retrieval and recycling of EOLFG and ALDFG in Indonesia. It includes details on the development and testing of a methodology to assess gear-specific risk of ALDFG impacts, to establish baselines for the elements relevant to managing EOLFG and ALDFG and, in the longer term, to monitor and evaluate the impacts of prevention, mitigation and/or curative actions.

This report presents options for reducing ALDFG and ALDAG in Indonesia, and improving the management and use of EOLFG. A synthesis of the evidence base is provided, and informs the development of a menu of options in the form of time-bound prioritized actions under six broad categories:

1. Operationalize plastic waste management in the capture fisheries and aquaculture sectors;
2. Prevent ALDFG;
3. Prevent ALDAG;
4. Recover ALDFG and ALDAG;
5. Promote a circular economy for end-of-life fishing and aquaculture equipment; and
6. Improve monitoring and reporting of EOLFG, ALDFG and ALDAG.

Introduction

The Government of Indonesia's (GoI) National Plan of Action on Marine Plastic Debris (NPOA-MPD 2017-2025) outlines the ambitious objective of reducing marine plastic debris by 70 percent by 2025. Sea-based leakage contributes at least 20 percent of all plastic waste that leaks into Indonesia's marine environment (World Bank, 2018). Sea-based leakage includes pollution from maritime activities such as aquaculture, shipping, fisheries and tourism, as well as debris transported by ocean flows. Recognizing the significance of this source, one of the five pillars of the NPOA-MPD 2017-2025 is focused on "reducing sea-based leakage".

Abandoned, Lost and Discarded Fishing Gear (ALDFG) is a major component of sea-based sources of marine debris. ALDFG comprises as much as 50 percent of all marine debris (e.g., Consoli et al., 2021). Global ALDFG leakage is estimated at 1.14 Mt per year (Eunomia, 2016; Gilman et al., 2021), though data limitations may mean that actual quantities are even greater (Richardson et al., 2021b). It is estimated that 5.7 percent of all fishing nets, 8.6 percent of all traps and 29 percent of all lines are abandoned, lost or discarded each year (Richardson et al., 2019).

Abandoned, Lost and Discarded Aquaculture Gear (ALDAG) is another important sea-based source of plastic leakage. The cultivation of marine and aquatic species, including seaweed, uses plastic components such as buoys, ropes, harvest bins and feed sacks. The primary pathways for plastic leakage from aquaculture include mismanagement, deliberate discharge, extreme weather and catastrophic events such as tsunamis (Huntington, 2019). While aquaculture tends to be a more localized source of plastic in comparison to capture fishers, the total volumes are significant (e.g., Skirtun et al., 2022) and are likely to increase given the rapid expansion of the aquaculture sector (Tian et al., 2022).

The impacts of fishery and aquaculture plastic pollution on the environment, economy, livelihoods and food security are significant. ALDFG compromises fisheries sustainability through losses of gear and catch, as well as adverse impacts to marine habitats, target and non-target species, gear efficiency and associated fisheries profits (DelBane et al., 2019; Macfadyen et al., 2009; NOAA, 2016; Scheld et al. 2016). Under certain conditions, ALDFG can travel long distances (Brown et al., 2005) and continue to ensnare and capture marine organisms for years or decades, a phenomenon known as 'ghost fishing' (FAO, 2016; Good et al., 2010; Kaiser et al., 1996; NOAA, 2015). Ingestion of hooks, lines, nets or weights by marine wildlife causes harmful effects (McCauley & Bjorndal, 1999; Moore et al. 2013; Zabka et al., 2006) that can result in population level impacts on marine mammals, seabirds, turtles and other wildlife (e.g. Boren et al., 2006; Franson et al., 2003; Good et al., 2009; Hanni & Pyle, 2000; Orós et al. 2016; van der Hoop et al. 2013), and significant commercial losses from fisheries (Goodman et al., 2021). This potential to entangle, ensnare or be ingested over long distances and timescales results in disproportionately higher impacts to marine wildlife compared to other types of debris (Gilardi et al., 2010; Laist, 1995; Wilcox et al., 2016). Fishery and aquaculture plastic litter can cause significant damage to marine ecosystems and benthic habitats (Gilman, 2015; Macfadyen et al., 2009; NOAA , 2015), present hazards to navigation and safety at sea (Hong et al., 2017), damage marine infrastructure and submarine cables (IPCC, 2021), transport invasive alien species (Enrichetti et al., 2021), reduce the socioeconomic value of coastal areas (English et al., 2019) and transfer toxins and microplastics into marine food webs with associated risks to human health from seafood contamination (Barnes et al., 2009; Foley et al., 2018; GESAMP, 2015; Rochman, 2015).

The scale of these impacts on fisheries, marine ecosystems and human users has prompted international action. The United Nations (UN) has called upon members to take action to reduce ALDFG (FAO, 2016a; UNEA, 2014; 2016; 2018), and to support UN 2030 Agenda for Sustainable Development Goal 14 which asks members to significantly reduce marine pollution (UNSDG, 2018). In addition, the Food and Agriculture Organization of the UN (FAO) has emphasized the need for fishing gear marking and ALDFG reporting and recovery via its Committee on Fisheries, Code of Conduct on Responsible Fisheries and Voluntary Guidelines on the Marking of Fishing Gear (FAO 2016a; 2018; 2019b), and the International Maritime Organization has outlined actions to reduce ALDFG from fishing via vessels (IMO, 2018).

Managing and mitigating plastic pollution from fisheries and aquaculture has the potential to contribute to Indonesia's marine plastic debris targets while also providing economic opportunities. Many of the materials used in modern fishing gears such as nylon (PA), polyethylene (PE) and polypropylene (PP) are recyclable materials that can be processed into raw materials for secondary products (Chen et al., 2020). These circular economy approaches have been tested and proven (e.g., Juan et al., 2021; Charter et al., 2022), and have potential to contribute to Indonesia's goals for marine plastic reduction, while also providing alternative incomes for coastal communities. End-of-life fishing gear (EOLFG)—fishing gears and fishing gear components that through wear and tear need to be replaced—can be a major source of material stock for recycling provided such materials are landed ashore and not disposed of or discarded at sea. Successfully addressing marine plastic debris in Indonesia will require an improved understanding of the life cycle and end-of-life management of Indonesia's fishing and aquaculture gears, and a framework to evaluate the effectiveness of interventions to prevent, minimize and mitigate the generation and effects of plastic leakage from the fishery and aquaculture sector (Kuczenski et al., 2021; Richardson et al., 2021a; Gilman et al. 2021).

This report presents options for reducing ALDFG and ALDAG in Indonesia, and improving the management and use of EOLFG. It draws on the findings of two accompanying reports: (i) Evidence base – Capture fisheries and; (ii) Evidence base – Marine aquaculture. A synthesis of the key findings and recommendations contained in these reports is presented, and developed into a menu of options in the form of time-bound prioritized actions. This report also outlines a proposed process for monitoring and evaluating reductions in sea-based sources of plastic marine debris, including appropriate indicators and methodologies.

Synthesis of the Evidence Base

CAPTURE FISHERIES IN INDONESIA

This section provides an overview of Indonesia's capture fisheries sector, and a synthesis of the evidence available for the sector's generation and leakage of plastic waste—both to the marine environment in the form ALDFG and to the terrestrial environment from accumulation of EOLFG. For additional detail, the reader is directed to the accompanying report Evidence Base – Capture Fisheries.

The capture fisheries sector

The dynamics and distributions of Indonesia's fisheries are an important consideration in identifying priority locations for ALDFG management. The national fishing fleet consists of 171,744 vessels with inboard engines. Of these, 65 percent are smaller than 5 GT, 88 percent are smaller than 10 GT, and 98 percent (168,043 vessels) are smaller than 30 GT. There are a further 181,178 vessels with outboard motors and 190,923 non-motorized vessels. Indonesia has 576 official fishing ports, with eight of these classified as Type A Oceanic Fishing Ports (PPS, *Pelabuhan Perikanan Samudra*), 14 classified as Type B Archipelagic Fishing Ports (PPN, *Pelabuhan Perikanan Nusantara*), 28 as Type C Coastal Fishing Ports (PPP, *Pelabuhan Perikanan Pantai*) and 526 as Type D Fish Landing Quay (PPI, *Pangkalan Pendaratan Ikan*). The majority of fishing ports are concentrated in Fishery Management Area (WPP, *Wilayah Pengelolaan Perikanan*) WPP-712 (174 fishing ports), WPP-572 (159 ports) and WPP-573 (135 ports). Five provinces account for 48.6 percent of Indonesia's annual fish capture production (Jawa Barat 13.0 percent, Aceh 11.3 percent, Jawa Timur 11.2 percent, Jawa Tengah 8.0 percent and Banten 5.1 percent).

Use of plastic

Almost 40 percent of Indonesia's fishing vessels use gillnets and entangling nets. These are predominately drifting gillnets, with a smaller number of set anchored gillnets and trammel nets also in use. Dominant gear types also include hooks and lines (30 percent) and traps and pots (11 percent). Other gears comprise a smaller proportion of the fishing fleet, including seines (6 percent), lift nets (5 percent), surrounding gear (5 percent) and trawls (2 percent).

Encircling nets, gillnets, and entangling nets together account for 90 percent (75,958 tonnes) of the plastic fishing gear material deployed by Indonesia's fishing fleets. The weight of plastic material deployed is a function of both number of vessels and gear type. While encircling gears (e.g., ring nets and purse seines) represent only 5 percent of the fleet, they account for 56 percent (47,212 tonnes) of the total weight of fishing gears deployed. Gillnets and entangling nets represent 34 percent (28,746 tonnes), hooks and lines 4 percent (3,647 tonnes), and traps and pots 2.4 percent (2,015 tonnes) of the total weight of fishing gears deployed by Indonesia's fisheries.

Drivers and risks of ALDFG and EOLFG

Approximately 30 percent of all fishing gears in Indonesia become ALDFG or EOLFG every year. Precise estimates are hindered by the absence of shore-based monitoring of end-of-life and lost gear. Interviews with fishers suggest that about 70 percent of the total weight of deployed fishing gears are retained and reused every year. Around 18 percent of gears are damaged beyond repair or reach their end-of-life, and remain onshore for (i) storage by fishers or fishing companies; (ii) re-sale to waste collectors; or (iii) final disposal in landfill. The remaining 12 percent become ALDFG, with fishers reporting that 11 percent of gears are lost at sea and only 1 percent are deliberately discarded.

Gillnets, entangling nets, encircling nets, pots and traps pose the greatest ALDFG risk. ALDFG risk (Figure 1) is a function of a gear's vulnerability to loss and damage, the total weight of material deployed and replenished annually, and its ecological impacts. While hook and line (pancing) are the most vulnerable fishing gears in Indonesia, with 45 percent discarded and 55 percent lost every year, the total weight of plastic material replenished every year by these fisheries is only 365 tonnes, or 2.2 percent of all fishing gear material replaced in Indonesia. In contrast, gillnet and entangling net fisheries replenish 8,623 tonnes (51.6 percent) and purse seine fisheries 7,080 tonnes (42.4 percent) of material every year. Vulnerability to loss and damage is greatest for gears that: (i) are made of relatively light materials; (ii) operate unattended for extended periods; and (iii) are set on the seabed. These include set anchored gillnets, entangling nets, traps and pots. Indonesia's gillnet fishers report multiple factors that contribute to gear loss, including snagging on submerged obstructions, gear conflict with other vessels, and poor weather. Risk of loss and damage increases when gears are poorly marked, when they are set in areas

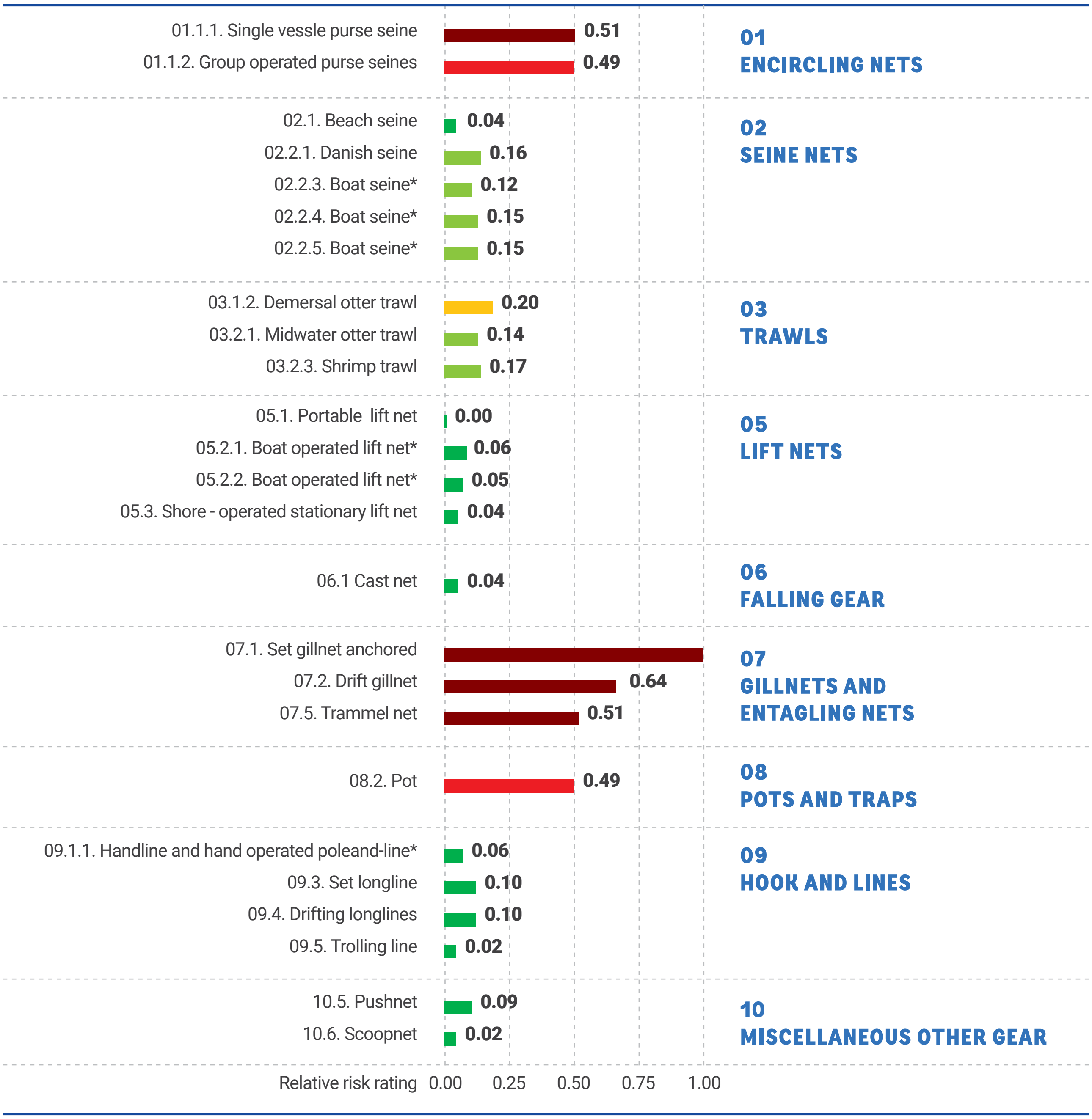


Figure 1. ALDFG risk rating for fishing gears in use in Indonesia.

that do not have adequate fleet separation schemes, and when fishing grounds are overcrowded (i.e., too many licenses per area). The greatest ecological impacts are associated with set anchored gillnets, set anchored trammel nets, plastic pots and drifting gillnets. These impacts include entanglement of marine wildlife, ghost fishing, transport of invasive species, smothering and damage of habitats, and diminished aesthetic and recreational value of coastal resources.

Different strategies are required to address ALDFG and EOLFG. All fishing gears eventually either enter the marine environment as ALDFG, or reach their end of operational life and are disposed of onshore as EOLFG. ALDFG retrieved from the sea is difficult to recycle because the challenges of separating mixed materials (e.g., different types of plastics and metals) are compounded when gears have become entangled and contaminated with marine life and other marine debris. EOLFG has greater potential for repair, reuse or recycling as part of the circular economy. Furthermore, as EOLFG is an inevitable consequence of fishing gear use, the improved collection and management of EOLFG will contribute to reducing rates of ALDFG generation. Purse seine and gillnets are reported to have the highest reuse and recycling rates in Indonesia, due to their construction from nylon.

The lack of an established collection and distribution chain is the main constraint to EOLFG recycling in Indonesia. Strategies for managing fishing related waste vary widely between ports. Most EOLFG is disposed into intermediate waste storage facilities where it is mixed with the general waste stream and eventually transported to landfill. This mixing and contamination affects the condition of EOLFG, and increases costs associated with sorting and cleaning. Contaminated and poor quality EOLFG is unable to compete with the ready supply of good quality waste material from other sectors, contributing to low rates of recycling.

Collection and safe disposal of EOLFG from Indonesia's purse seine and drift gillnet fisheries would account for 51.6 percent of the plastic material replenished annually. These fisheries generate the greatest weight of end-of-life material, with much of this available for landing ashore and recycling. Improved management of purse seine and drift gillnet waste would account for 90 percent (around 76,000 tonnes) of the total weight of fishing gears deployed in Indonesia's fisheries.

MARINE AQUACULTURE

This section provides an overview of Indonesia's marine aquaculture sector, and a synthesis of the evidence available for the sector's generation and leakage of plastic waste to the marine environment.

The marine aquaculture sector

Systems of marine aquaculture production vary enormously in type and scale across Indonesia. The sector is large and rapidly expanding. Around eleven million tonnes of marine and brackish water aquaculture products are produced annually, of which seaweed (mainly Eucheuma spp.) accounts for 82 percent, with milkfish (*Chanos chanos*) and white-leg shrimp (*Litopenaeus vannamei*) accounting for most of the remaining production (7.2 percent and 6.1 percent respectively). The three main production systems are coastal ponds, floating cages and pens, and seaweed lines. Indonesia's extensive and semi-intensive coastal ponds produce around 1.5 million tonnes per annum (predominantly milkfish and white leg shrimp), with intensive ponds producing a further 0.5 million tonnes of shrimp every year. Floating cages and pens are typically constructed using expanded polystyrene (EPS) or high density polyethylene (HDPE) floats, and produce around 20,000 tonnes of grouper, barramundi and other finfish annually. A variety of seaweed production systems are in use, with most using polypropylene ropes. In South Sulawesi and Nusa Tenggara Timur, farmers typically suspend rafts at or near the surface from bamboo frames or plastic floats, in Central Sulawesi off-bottom "long-stake" systems are common whereas in Bali "short-stake" systems predominate.

Use of plastic

The greatest rates of plastic consumption occur in Indonesia's extensive coastal ponds. These farms consume approximately 453 kg of plastic per tonne of product, consisting primarily of plastic seed bags, pipes and aerators. Due to more sophisticated production methods, intensive coastal ponds use only 43 kg of plastic per tonne of product. Floating cages and pens consume on average 144 kg of plastic per tonne of product, primarily in the form of nets. In comparison, seaweed longlines use the least plastic at around 10 kg per tonne of product, and comprised primarily of expanded polystyrene floats, buoys, polypropylene ropes, and plastic bottles.

Drivers and risks of ALDAG

Indonesia's marine aquaculture generates an estimated 865,544 tonnes of plastic waste every year. More than half of this is reused (305,747 tonnes) or sold (196,715 tonnes), bringing risk of future indirect leakage to terrestrial or marine environments. A significant proportion enters landfill (189,347 tonnes) or is otherwise disposed of on land. As much as 82,067 tonnes is estimated to leak to marine environments annually (Figure 2).

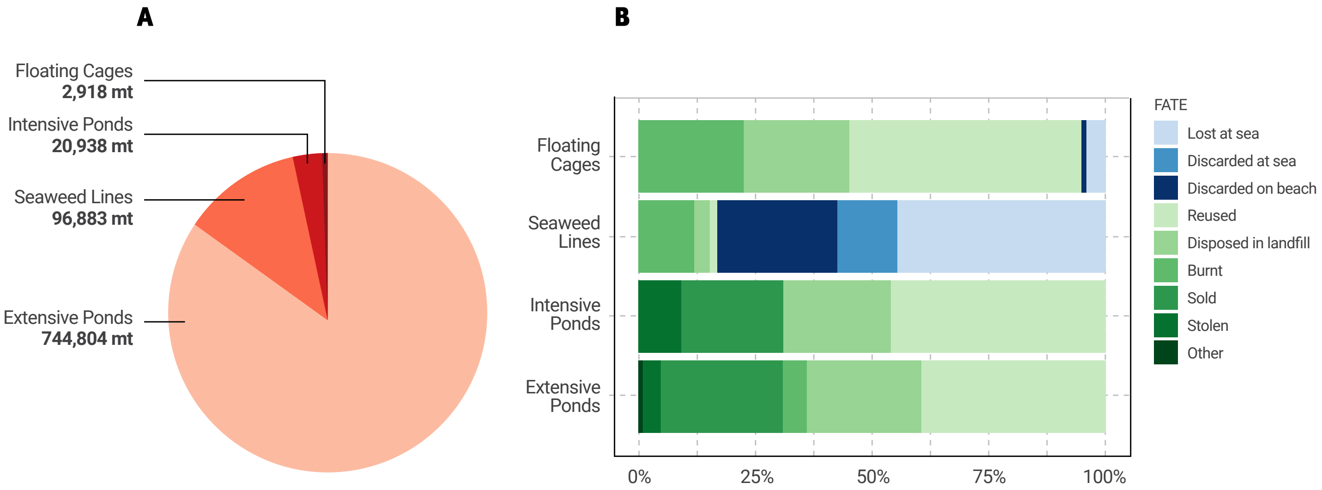


Figure 2. Sources and fates of marine plastic within Indonesia's marine aquaculture sector, indicating (A) total weight of plastic waste generated by different production systems; and (B) the proportion of plastic waste entering terrestrial (green) and marine (blue) pathways.

Seaweed farms pose the greatest risk of plastic leakage. Despite having low rates of plastic consumption per tonne of product, the large number of farms and high total production (c. 9 million tonnes in 2018) results in a large absolute quantity of plastic being consumed. Most of this plastic leaks to marine environments (81,903 tonnes), with only 14,979 tonnes disposed onshore. Seaweed farms tend to be located in shallow coastal areas where they are exposed to wave action. Farms are typically artisanal operations with low profit margins, and consequently many components are homemade, reused or not specifically designed for use in aquaculture (e.g. plastic bottles). These high rates of plastic leakage could be addressed through (i) use of more robust and sustainable materials, especially for floatation; and (ii) improved infrastructure design to increase resilience to strong wind and waves. A key challenge will be identifying cost-effective alternatives to the plastic bottles and expanded polystyrene floats that are in common usage.

Floating cages and pens are also high risk. Cages tend to be located in relatively exposed deeper waters where they depend on water currents to maintain stock health. In these locations they are vulnerable to damage and abrasion from tides and storms, resulting in both periodic losses as well as chronic leakage. An estimated 141 tonnes of plastic material is lost from Indonesia's cage farms annually, with a further 22 tonnes discarded onto nearby beaches and landing sites. Many of these materials have a high risk of ecological impact. Nets contribute to ghost fishing and entanglement, whereas expanded polystyrene floats persist in the water column and contribute to microplastic pollution. Around 2,755 tonnes of plastic material from cages and pens are sold, burnt or enter landfill every year, with most of this being nylon nets. Much like purse seine nets, these materials have high potential for recycling if sufficient quantities and economies of scale can be achieved, and provided that waste nets are separated from general waste streams to minimize contamination and costs of cleaning. Given the high rates of loss from cages and pens, efforts to improve design, construction and resilience are likely to have the most significant impact on reducing plastic leakage.

The risk of plastic leakage from coastal pond aquaculture is low. While extensive coastal ponds generate the greatest proportion of Indonesia's plastic aquaculture waste (744,805 tonnes), direct leakage to marine environments is very low. Ponds are typically located above sea level, and hence the main cause of leakage is infrequent catastrophic events such as storm surge or flooding. Abandoned farms where plastic has been improperly secured or decommissioned may also leak plastic to marine environments. The main sources of plastic material include the fry and seed bags that are sometimes reused to reinforce pond walls, as well as windblown losses during waste incineration and landfill. Improved waste management systems and awareness, rather than improved infrastructure design, are likely to have the greatest impact on reducing plastic leakage from coastal ponds.

Menu of Options and Recommended Actions

This chapter presents a menu of options to address plastic waste leakage from Indonesia's marine capture fisheries and aquaculture sectors. Options are presented in the form of time-bound, prioritized and sequenced actions, that have been identified based on: (i) the risk of leakage and impacts associated with different gears and materials; (ii) the potential for end-of-life fishing and aquaculture materials to contribute to the circular economy; and (iii) the gaps in current data and knowledge that are required to design and implement preventative and curative measures. The proposed actions are broadly separated into six categories:

1. Operationalize plastic waste management in the capture fisheries and aquaculture sectors;
2. Prevent ALDFG;
3. Prevent ALDAG;
4. Recover ALDFG and ALDAG;
5. Promote a circular economy for end-of-life fishing and aquaculture equipment; and
6. Improve monitoring and reporting of EOLFG, ALDFG and ALDAG.

ACTION 1. OPERATIONALIZE PLASTIC WASTE MANAGEMENT IN THE CAPTURE FISHERIES AND AQUACULTURE SECTORS

This action aims to strengthen the enabling environment for operationalizing and accelerating plastic waste management in Indonesia's fisheries and aquaculture sectors. Two sub-groups of actions are proposed: (i) sector-led planning to enhance management of plastic use and loss; and (ii) funding the management of plastic use and loss.

Sector-led planning to enhance management of plastic use and loss

Indonesia's National Plan of Action on Marine Plastic Debris (NPOA-MPD) 2017-2025 outlines the ambitious target to reduce plastic marine debris by 70 percent by 2025. This high-level action plan is implemented primarily via Presidential Regulation 83/PERPRES/2018 on Handling of Marine Waste and under the direction of the National Coordination Team for Handling of Marine Waste (TKN-PSL, *Tim Koordinasi Nasional Penanganan Sampah Laut*)—a cross-sectoral team consisting of 16 Ministries and led by the Coordinating Ministry for Maritime Affairs and Investment (CMMAI) (see Annex 1).

Indonesia's capture fisheries and aquaculture sectors are diverse, complex and make a significant contribution to the nation's marine plastic debris. To support the TKN-PSL and to accelerate progress towards objectives outlined in the NPOA-MPD 2017-2025, specific capacity and capabilities to manage maritime and fisheries plastic waste could be strengthened within the Ministry of Marine Affairs and Fisheries (MMAF). Specific activities could include: (i) Establish a high-level National Task Force to improve management of plastic use and disposal in the fisheries and aquaculture sector; and (ii) Establish a Technical Working Group for ALDFG, EOLFG and ALDAG.

1.01 Establish a high-level National Task Force to improve management of plastic use and disposal in the fisheries and aquaculture sector. This Task Force could facilitate the implementation of actions proposed in this report, including by ensuring that adequate resourcing is available and by coordinating with TKN-PSL and the institutions responsible for implementing specific actions. The Task Force could work in close coordination with TKN-PSL, and be comprised of senior officers from MMAF (e.g., Director of Fishing Vessels and Gears, Director of Ports, and Director of Licensing and Fisher Affairs), Ministry of Public Works (KEMEN-PUPR, *Kementerian Pekerjaan Umum dan Perumahan Rakyat*) (e.g., Director of Sanitation and Solid Waste Management) and Ministry of Transport (KEMENHUB, *Kementerian Perhubungan*) (e.g., Director Maritime Navigation and Director Sea and Coast Guard). Representatives from subnational governments, the fishing and aquaculture industry (including representation of small- and large-scale operations across the various capture fishery and aquaculture subsectors), academia and NGOs could also participate to maximize technical capacity and stakeholder engagement.

1.02 Establish a Technical Working Group for ALDFG, EOLFG and ALDAG. The Technical Working Group (TWG) could support the National Task Force via main functions that could include: (i) advising on policies and strategies necessary to implement the Action Plan; (ii) developing detailed implementation plans, including white papers, terms of reference and work plans; (iii) reviewing and addressing any technical issues associated with implementation of the Action Plan; (iv) targeting the use of funding and other resources; and (v) designing and implementing a monitoring and evaluation framework to measure progress, outcomes and eventual impacts of the Action Plan. The TWG could be composed primarily of MMAF technical officers (e.g., from DG Capture Fisheries, DG Marine Spatial Management, DG Aquaculture, DG Monitoring, Control and Surveillance, and Agency for Research and Human Resources) as well as relevant experts from CMMAI and research organizations.

Funding the management of plastic use and loss

A key issue associated with successful implementation of any plan is raising and allocating the necessary resources. A possible approach to financing the management of plastic use and loss in Indonesia's capture fishery and aquaculture sectors could be the development of a specific funding mechanism. Such a mechanism could support actions that would otherwise be ineligible for or incompatible with state budget or other recurrent funding mechanisms. Specific funding mechanisms have been successfully applied worldwide to address fishing waste, and could provide a model for similar schemes in Indonesia. One such example is the Government of Canada's CAD 8.3 million (c. USD 6.6 million) Sustainable Fisheries Solutions and Retrieval Support Contribution Program, also know as the Ghost Gear Fund.[1]

1.03 Design and implement a Ghost Gear Fund (GGF) for Indonesia. A funding mechanism could be established to provide dedicated financial support to address the management of fishing and aquaculture waste and, where necessary, its retrieval from the marine environment. Use of funds could include: (i) research to map derelict gear hotspots and monitor their recovery; (ii) development and piloting of new technologies and processes to reduce the vulnerability of fishing gear and aquaculture equipment and minimize its impact on the marine environment; (iii) investment into methods for responsible disposal for end-of-life fishing gear and aquaculture equipment, including recycling and waste processing; (iv) improving reporting and monitoring of ALDFG and ALDAG; and (v) enhancing environmental awareness, particularly amongst small-scale fishers, aquaculture producers and coastal communities. The proposed GGF could channel finance from a wide range of sources, including GoI, universities, private companies, NGOs and donors. With careful planning and robust accountability mechanisms, the GGF could also leverage additional finance from both domestic and international lenders and benefactors.

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

ACTION 2.
PREVENT ALDFG

Preventing ALDFG is widely recognized as more cost effective than mitigating its impacts or recovering materials from the marine environment (GGGI, 2021a,b). This action aims to reduce the rate of ALDFG leakage to the marine environment. Six sub-groups of actions are proposed: (i) planning, technical management and coordination; (ii) identifying the economic drivers of fishing gear abandonment and discard; (iii) assessing fishery-specific risks and selecting technical measures; (iv) strengthening policy and regulatory frameworks; (v) evaluating and implementing technical measures; and (vi) enhancing awareness about capture fisheries plastic pollution and its management.

Planning, technical management and coordination

The main reasons why fishing gears are abandoned, lost or otherwise discarded include: (i) inherent weakness of materials making gears vulnerable to damage and loss (especially for some passive gears such as set anchored gillnets and fish/crustacean pots); (ii) interactions between fleets operating on the same fishing grounds (e.g., collision between active gears and passive gears resulting in damage); (iii) inadequate marking of fishing gears which increases the likelihood of passive gears being overrun and makes locating and retrieving lost gears more difficult; and (iv) limited capacity of fisheries authorities to monitor ALDFG at sea due to the large and widely dispersed fishing fleet. Resolving these issues will require ALDFG mitigation measures to be tailored to the specific needs of each fishery.

A wide variety of technical measures are available to prevent ALDFG, differing markedly in their complexity, cost and effectiveness. Furthermore, the introduction of technical measures into a fishery may increase the costs of fishing, resulting in reluctance of license holders to comply. It is therefore critical to invest sufficient time and effort into designing and planning to ensure that technical measures: (i) are proportionate to the scale of the issue being addressed; (ii) have been adequately tested and demonstrated to deliver the desired management objectives; (iii) minimize, as far as possible, the economic burden placed on vessel operators; and (iv) can be effectively monitored to assess levels of compliance. Two main groups of actions are identified: (i) strengthen cross-ministerial capacity to coordinate the development and implementation of technical measures; and (ii) strengthen MMAF's capacity to implement technical measures.

2.01. Strengthen cross-ministerial capacity to coordinate the development and implementation of technical measures. While EOLFG and ALDFG originate within the fisheries sector, developing circular economy solutions will require a multidisciplinary and cross-ministerial approach. The National Task Force could play an important role facilitating these linkages, with technical support provided by the TWG. Given the complexity of the issue and the need for innovative solutions, there is a need to strengthen relevant national expertise as well as to learn from international experience. One option could be an FAO Technical Cooperation Project[2] (FAO Fisheries Division - Fishing Technology and Operations Team, and FAO Development Law Branch) to provide short term (<2 years) technical support that could allow the GOI to take advantage of FAO's international expertise in this area of work, including application of FAO good practices. A series of workshops could enable the work program to de defined, including mapping priorities, setting objectives, identifying technical support and backstopping needs, identifying key team members and experts, and defining roles and responsibilities.

2.02 Strengthen MMAF's capacity to implement technical measures: Preventing ALDFG is a novel area of work that will require multidisciplinary and cross-sectoral thinking and the application of best practices. Technical training is likely to be required to strengthen the capacity and capabilities of MMAF to design and implement technical measures to address ALDFG. The series of workshops discussed above could provide an opportunity to make a preliminary identification of capacity gaps and needs.

---

[2] As an FAO member, GOI has the right to request FAO technical support through an FAO Technical Cooperation Project (TCP). A national TCP (as opposed to regional TCP would provide the necessary focus on technical support to design of technical measures, policy and regulations).

Identifying the economic drivers of fishing gear abandonment and discard

Designing and implementing successful measures to prevent ALDFG will require a good understanding of the factors driving fishing gear abandonment and discard. While factors such as gear design, gear conflicts and monitoring and enforcement capacity are important, it is also critical to consider social and behavioral factors. Most notably, in some cases operational factors may create strong economic incentives to deliberately discard fishing gear, or to abandon gears that have become entangled, damaged, or otherwise difficult to retrieve. For example, when a fisher invests time into recovering gears that have become entangled, they also incur an opportunity cost in the form of foregone fishing. Similarly, if a fisher is to invest resources into gear maintenance — one of the most important factors influence gear longevity — they must perceive a clear return on that investment. Identifying these factors could enable incentive and disincentive structures to be designed and appropriately priced to promote desired behavior changes and to complement technical measures. At the same time, lost fishing gear represents an economic loss to the industry. An improved understanding of these losses and their value could aid in identifying opportunities to enhance stakeholder buy in and engagement with ALDFG reduction efforts.

2.03 Assess the economic drivers of gear abandonment and discard. Building on the information presented in the accompanying Evidence Base reports, analytical studies could be implemented to improve information on the economic drivers of gear abandonment and discard, and to inform the development of appropriate mitigation strategies and incentive structures.

Assessing fishery-specific risks and selecting technical measures

Excellent guidance on conducting robust risk assessments is provided in FAO's Voluntary Guidelines for the Marking of Fishing Gear (VGMFG). While the assessments presented in the accompanying Evidence Base reports provide a preliminary understanding of the nature and severity of risks associated with different fishing gears, further work is required to inform management measures and to obtain input from stakeholders on findings and the design of technical measures. These assessments could help to evaluate the feasibility and affordability of proposed technical measures, and to prioritize and gauge the need for such measures based on best available science.

2.04 Undertake fishery-specific risk assessments. Building on the preliminary assessments described in the accompanying Evidence Base reports, fishery-specific risk assessments could be implemented in priority fisheries identified by MMAF. FAO best practices (as detailed in the VGMFG and its annex on Risk Assessment) could inform the design and implementation of these risk assessments.

2.05 Select technical measures. The baseline data obtained via the fishery-specific risk assessments could assist MMAF to evaluate the benefits and costs of a broad range of ALDFG technical measures. Key considerations could include ensuring that any proposed technical measures (i) are proportional to the scale of the issue being addressed; (ii) represent value for money; and (ii) can be effectively implemented. Candidate technical measures include international examples of good practice such as (i) vessel and gear marking; (ii) collision regulations and amendments; (iii) EOLFG-ALDFG reporting requirements; (iv) fleet separation schemes to reduce vulnerability of fishing gear to loss and damage; and (v) spatial-temporal closure of fishing grounds to reduce interactions between fleets and/or marine fauna. Due consideration could also be given to ensuring that any economic impacts and hardships on affected fishing fleets are clearly identified and understood.

2.06 Survey fishing vessel operators. Fishery-specific surveys of fishing vessel operator is a key part of the risk assessment process. These surveys can help to determine current waste disposal practices and quantify the weights of plastic waste[3] generated by vessels within each fishery. Feedback obtained from the fishing industry could provide critical inputs to the design and implementation of technical measures, and contribute to maximizing levels of compliance from vessel operators. A well designed implementation strategy for vessel operator surveys could assist MMAF to establish dialogue and engagement with the industry on this issue.

[3] MARPOL Annex 5 defines plastic garbage as all plastic waste generated during fishing operations, including fishing gears as well as other types of plastic waste.

Strengthening policy and regulatory frameworks

While international laws to prevent pollution by garbage from ships exist in the form of the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V, these are generally applicable to large fishing vessels (>400 GT) and hence have limited utility to address issues of EOLFG and ALDFG within the specific contexts of Indonesia's fishing fleet. A solution more tailored to Indonesia's specific context and needs could be pursued through national law and regulation, including by establishing reporting obligations according to vessel size and gear type.

2.07 Analyze the policy and regulatory gaps for EOLFG-ALDFG. In parallel with the risk assessments and selection of technical measures described under actions 2.04, 2.05 and 2.06, a policy and legal gap analysis could help to identify the pathways via which regulations could be promulgated (e.g., via amendments to existing regulations or development of new regulations). Proposed regulatory changes could be informed by the results of risk assessments to ensure that changes are proportional to the scale of the issue being addressed. Specific regulatory gaps that could be considered include those relating to (i) requirements for vessel and gear marking; (ii) obligations for reporting of plastic waste (including EOLFG, lost gears, and retrieved ALDFG); (iii) obligations to land and report EOLFG and retrieved ALDFG at designated fishing ports; (iv) the use of de-ghosting technologies to minimize the adverse ecological impacts of ALDFG; and (v) other technical measures identified as a result of fishery-specific analysis (e.g., gear and vessel design, gear marking, fleet separation measures, etc.).

2.08 Evaluate opportunities to link waste reporting obligations to the terms and condition of fishing license. If risk assessments indicate that the nature and severity of risks are sufficient, obligatory reporting of EOLFG, lost gear and retrieved ALDFG may be required. In this case, incentive structures could be established to promote compliance. One option is to link reporting obligations to the terms and conditions of a fishing license. This would require legal analysis to identify how and where existing laws and regulations could be amended. Technical support from FAO Development Law Service could assist MMAF to identify relevant examples of global best practice and to draft regulatory inputs for review and consideration.

2.09 Prepare draft policy and regulatory amendments. Drawing on inputs from the risk assessments and legal gap analysis, draft policies and regulations could be prepared for consideration and inputs from senior officials and other stakeholders.

Evaluating and implementing technical measures

Informed by the findings of fishery-specific risk assessments, appropriate technical measures could be selected to resolve high risk EOLFG and ALDFG issues. The technical measures selected should be proportional to the scale of the issues to be addressed. If a proposed technical measure has a high likelihood of affecting the cost of fishing operations, strategies to minimize economic hardships on affected fishing fleets could be identified. FAO's role as a neutral, evidence-based arbiter could assist MMAF in making difficult decisions with respect to the implementation of new measures. Before any technical measure are rolled out, their satisfactory performance in specific fisheries could be evaluated through pilot testing. Comparative fishing trials aboard commercial fishing vessels provide an effective strategy for evaluating the performance of technical measures, and could be conducted as a pre-condition to wider implementation and roll out.

2.10 Develop and pilot standards for a national gear marking system. Gear marking systems have proven effective at reducing ALDFG in many fisheries worldwide. Fishery-specific risk assessments may indicate the potential utility of gear marking in Indonesia. International experience and best practice—including that detailed in FAO's Voluntary Guidelines on the Marking of Fishing Gear— could provide useful guidance to the development of technical standards for gear marking in Indonesia and to any national-level amendments of international agreements such as the Convention on the International Regulations for Preventing Collisions at Sea (COLREG). When designing gear marking standards, key considerations may include the merits of unique marking to clearly distinguish different fleets and fisheries, and the use of lights or other electronic aids to improve detection of set fishing gears. Where appropriate, measures could be linked to COLREGs and any Indonesia-specific amendments, including through the promulgation of notices to mariners for specific fishing operations and areas. Draft national standards for vessel and gear marking could be piloted within select high risk fisheries to monitor compliance, obtain feedback from stakeholders, and evaluate the effectiveness of the proposed technical standards.

2.11 Select and develop de-ghosting technologies. Fishery-specific risk assessments may indicate a high risk of ecological impact (e.g., ghost fishing) associated with ALDFG from particular fishing fleets (e.g. set anchored gillnets, fish and crustacean pots). To mitigate this risk, de-ghosting technologies could be identified, tailored to local contexts and needs, and piloted aboard commercial fishing vessels via comparative fishing trials.

A wide range of de-ghosting technologies have been successfully deployed in global fisheries, including the use of biodegradable fishing gear, components (e.g., trap door fastenings), and fishing aids (e.g., fish aggregation devices). If comparative fishing trials demonstrate that a de-ghosting technology is effective at reducing ghost fishing, the measure could be considered a candidate for regulation. Indonesia's universities and academic institutions could provide valuable expertise and capacity to develop and evaluate de-ghosting technologies.

2.12 Evaluate Fleet Separation Schemes (FSS). Fishery-specific risk assessments may indicate that ALDFG is exacerbated by interactions with maritime shipping or between different fleets operating on the same fishing grounds. Shipping interactions can be particularly problematic in areas where visibility is restricted and where ships have limited ability to take collision avoidance action (e.g. due to narrow or shallow shipping channels). One solution is mandatory fleet separation via spatial or temporal closure of an area to one or more fishing fleets. However, such closures have the potential to impose significant economic hardships on vessel operators due to restricted access to fishing grounds and fish resources. These impacts should be clearly identified and understood before a FSS is implemented. Moreover, alternative technical measures may be equally effective at reducing interactions while having less economic impact on fishing operations. Such alternatives include amendments to COLREGs, Notices to Mariners, and Vessel Traffic Service over VHF radio. These alternative measures could be evaluated in parallel with FSS to evaluate costs, benefits and trade offs and to identify the most effective options.

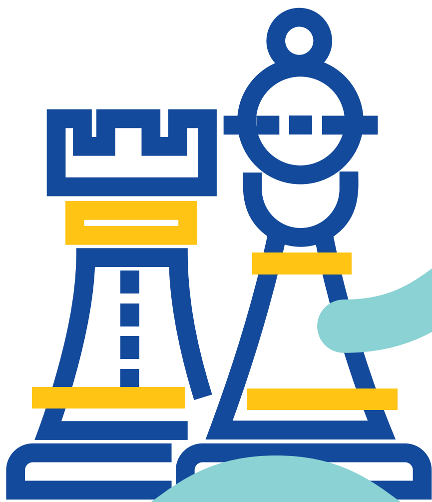
2.13 Roll out technical measures. Before any technical measures are rolled out, their satisfactory performance in specific fisheries should be evaluated and confirmed. Comparative fishing trials aboard commercial fishing vessels are an effective method for evaluating performance, and could be a pre-condition to regulating a technical measure in Indonesia. Once comparative trials have demonstrated that a proposed technical measure is effective at delivering its targeted objectives, MMAF in collaboration with relevant Ministries could prepare the draft policies and regulations necessary to support its implementation. Technical support from FAO's Development Law Service could assist GOI in identifying regulatory amendments and incorporating international experience and best practice.

Enhancing awareness about capture fisheries plastic pollution and its management

Technical measures are likely to affect the behavior of fishers by, for example, influencing where and how they are allowed to fish. Communication with affected fleets will be an important element of successful implementation, not only to demonstrate and disseminate new measures, but also to obtain stakeholder inputs and feedback during planning and evaluation phases.

2.13 Develop Best Practices: Drawing on the outcomes of activities 2.01-2.13, Best Practices could be developed by GOI, with technical assistance from academic institutions and in close consultation with the various sub-sectors of Indonesia's fishing industry. FAO's Fishing Technology and Operations team could be a valuable partner in the drafting of Best Practices, which could be submitted by the GOI to FAO's Committee on Fisheries as an information paper. In addition, the GOI could consider involving the fishing industry as a drafting partner and co-author of the Best Practices, establishing a strong example of industry partnering with government to solve ALDFG issues.

2.14 Develop ALDFG outreach and communication products. A range of communication products (e.g., radio, TV, brochures, etc.) could be developed to raise awareness about ALDFG and to support the implementation of technical measures. These products could include communication related to any specific Notices to Mariners or amendments to Indonesia's regulations and COLREGs.



ACTION 3.
PREVENT ALDAG

ALDAG is similar to ALDFG, in that prevention is more cost effective than mitigating impacts or recovering materials from the marine environment (GGGI, 2021a,b). This action aims to reduce the rates of ALDAG leakage to the marine environment. Seven sub-groups of actions are proposed: (i) improving aquaculture equipment design; (ii) identifying the economic drivers of abandonment and discard; (iii) assessing risks associated with specific production systems; (iv) planning marine aquaculture to minimize spatial conflict; (v) improving fallowing and decommissioning of aquaculture sites; (vi) strengthening capacity to manage plastic use and disposal; (vii) enhancing awareness about marine aquaculture plastic pollution and its management; and (viii) integrating ALDAG into third-party certification schemes.

Improving aquaculture equipment design

One of the key reasons why aquaculture equipment is lost to the marine environment is the use of unsuitable, poorly designed or fragile components. Key examples include the plastic bottles that are widely used as floats and cage collars used in finfish cages.

3.01 Develop technical standards for aquaculture infrastructure. Technical standards could be established for the materials, components and systems (e.g. moorings) used in Indonesia's aquaculture sector. These standards would aim to make aquaculture systems more robust and less vulnerable to equipment failure and plastic loss, including as a result of extreme weather events. Priority focus could be directed towards the subtidal aquaculture production systems (e.g. seaweed longlines and fish cages) that are associated with the highest ALDAG risk.

3.02 Develop technical regulations for aquaculture infrastructure. Once technical standards for aquaculture infrastructure have been established, regulations and enforcement systems could be developed to support their adoption and implementation.

3.03 Research and develop domestically-produced aquaculture components. Research and development could be conducted to identify cost effective alternatives to single use plastics and high risk materials (e.g. plastic bottles or expanded polystyrene floats). These alternatives could be pilot tested to refine designs and determine commercial feasibility.

Identifying the economic drivers of aquaculture gear abandonment and discard

Designing and implementing successful measures to prevent ALDAG will require a good understanding of the factors driving aquaculture gear abandonment and discard. While these include factors such as component design and materials described above, it is also critical to consider social and behavioral factors. Most notably, operational factors may create strong economic incentives to deliberately discard or abandon equipment that has become damaged or worn. For example, if an aquaculture operation is to invest resources into component maintenance — one of the most important factor influencing longevity — a clear return on that investment must be perceived. Identification of these factors will ensure that incentive and disincentive structures can be designed and appropriately priced to promote desired behavior changes. At the same time, lost gears represent an economic loss to the industry. A good understanding of the value of these losses can provide opportunities to enhance stakeholder buy in and engagement with ALDAG reduction efforts.

3.04 Assess the economic drivers of gear abandonment and discard. Building on the information presented in the accompanying Evidence Base reports, analytical studies could be implemented to improve information on the economic drivers of gear abandonment and discard, and to inform the development of appropriate mitigation strategies and incentive structures.

Assessing risks associated with specific production systems

Preliminary risk assessments presented in the accompanying Evidence Base report suggest that two main approaches are available to address ALDAG in Indonesia. For high-risk operations such as cages or seaweed farming, measures should focus on reducing the loss and abandonment of plastic at sea. Strategies could include: (i) providing advice and, where appropriate, minimum specifications for materials and design; (ii) conducting risk assessments as a part of site-level environmental impact assessments to identify and mitigate aquatic debris loss; (iii) ensuring that preemptive maintenance is carried out to repair or replace components before they fail; and (iv) enhancing farmer knowledge and awareness of ALDAG impacts and good practices. For lower risk operations such as coastal ponds, efforts should focus on responsible management and disposal of waste.

3.05 Develop a risk assessment framework for Indonesia's aquaculture sector. Building on the preliminary risk assessments presented in the accompanying Evidence Base report, a comprehensive risk assessment framework could be established for all production systems in Indonesia. This risk assessment could adopt a broad scope by incorporating elements beyond plastic pollution such as biosecurity. However, a modular framework would ensure that risks associated with plastic loss and impact are also adequately considered.

3.06 Develop risk assessment and contingency planning models. Once a risk assessment framework has been established, specific practical risk assessment models and contingency planning approaches could be developed for the various types and scales of aquaculture in Indonesia. These models would identify the potential risk associated with specific operations, and define the responses to be implemented should problems develop. These models could be applied at the site level for large scale aquaculture operations, or at the regional level for clusters of small-scale operations.

3.07 Strengthen capacity for risk assessment and contingency planning. Training and capacity-building on risk assessment and contingency planning could be delivered to small- and large-scale operations. Training could be delivered by the private sector, but could also be integrated into existing academic and vocational training courses in subjects related to aquaculture.

Planning marine aquaculture to minimize spatial conflict

Despite Indonesia being the world's largest archipelagic state, sea spaces are increasingly congested, particularly in inshore areas where competition between aquaculture, tourism, marine traffic and capture fisheries is high. Seaweed aquaculture requires a lot of space, and finfish cage farming often occurs in busy bays close to coastal communities. Both activities are likely to increase in scale over the coming decade. This increasing congestion of coastal areas increases the likelihood of collisions with floating aquaculture facilities and resulting damage and loss of buoys, moorings and other equipment.

3.08 Minimize spatial conflict with other marine users. Marine spatial planning and zoning can be used to segregate marine activities and minimize the risk of spatial interactions such as accidental collision with fish cages or seaweed farms. Indonesia has already established a robust marine spatial planning framework that delineates major zones such as general use and conservation areas. General use areas could be further zoned to clearly delineate and segregate different activities, and further minimize interaction risks.

3.09 Improve marking of aquaculture facilities. Technical standards could be established for the marking and illumination of floating aquaculture facilities to minimize the risk of collision and damage. This could include marking of individual facilities, as well as marking the boundaries surrounding intensive aquaculture zones. The development of technical standards could be informed by risk assessments to ensure that the most vulnerable and high risk facilities are prioritized. Technical standards could address marking for the purposes of both identification (e.g., to enable the owner of buoys, floats or other major components to be identified) and detection (e.g., radar reflectors, lighting, etc.). For larger facilities, automatic identification system (AIS) transmitters or other locator beacons could be considered.

Improving fallowing and decommissioning of aquaculture sites

Like many other countries, Indonesia has a high turnover of aquaculture sites. Reasons include the temporary fallowing of sites as part of a site rotation strategy, as well as the permanent cessation of activities if the site proves unsuitable or operators go out of business. While some decommissioning is conducted systematically, it is often haphazard and incomplete, resulting in equipment and plastic materials being abandoned, unmanaged and at high risk of leakage to the marine environment. This applies to both subtidal and supralittoral sites, with the majority of plastic lost from coastal ponds resulting from incomplete or inadequate decommissioning plans.

3.10 Ensure responsible decommissioning of redundant aquaculture sites. The system for aquaculture permitting and licensing could be adapted to require decommissioning plans to be clearly defined prior to the granting of license. While the Directorate General of Aquaculture has overall authority for aquaculture licensing, decommissioning requirements could be implemented at both national and provincial levels depending on the scale of aquaculture operation involved.

3.11 Apply fiscal instruments to ensure responsible decommissioning. In addition to incorporating decommission plans into the aquaculture licensing process, GOI could consider applying financial bonds or withholding taxes to ensure that the costs of responsible disposal (e.g. re-purposing, recycling or approved disposal methods) are built into the cost of operation. Fiscal instruments may not be appropriate for all types and scales of aquaculture in Indonesia, and their design could be informed by the results of risk assessments to ensure that productions systems with the highest risk are considered.

Strengthening capacity to manage plastic use and disposal

Training and capacity building at the aquaculture sector level would enhance awareness of operators and farmers about their environmental responsibilities and the consequences of non-action.

3.12 Develop technical guidelines for plastic waste management within the aquaculture industry. Guidelines could be developed to promote good waste management practices throughout the aquaculture value chain. These could include specific guidance on: (i) developing and maintaining inventories of the plastics in use by installations; (ii) reducing the use of high risk materials such as EPS; (iii) technical standards to minimize risks, such as by enclosing friable materials such as EPS in rigid, durable, non-toxic HDPE shells to minimize leakage; (iv) ensuring plastic materials are recyclable, including by ensuring that mixed material components can be disassembled and separated; and (v) adopting and implementing solid waste logbooks. Guidelines could be developed by GOI, with technical assistance from research and academic institution and strong consultation with the various sub-sectors of Indonesia aquaculture industry. These could then be developed into specific codes of practice or guidelines for each production system, and embedded within in an updated version of the Indonesian Good Aquaculture Practices (IndoGAP).

3.13 Develop specific codes of practice for different production systems. While the technical guidelines described above are likely to be generic across the different types and scales of aquaculture, they could be further developed into specific codes of practice for each production system. Codes of practice could be developed in consultation with industry producer associations to obtain stakeholder feedback and inputs, and to promote stakeholder cooperation and engagement. Existing good practice guidelines could provide a useful starting point (e.g., WWF-Indonesia, 2014).

Enhancing awareness about marine aquaculture plastic pollution and its management

Reducing plastic pollution from aquaculture will require stakeholder awareness about the issue, including the consequences of plastic pollution on ecosystem functioning and human wellbeing. This is particularly important for small-scale aquaculture operators and their dependent coastal communities who may be both a source of plastic waste as well as impacted by its downstream affects.

3.14 Enhance awareness amongst aquaculture famers and coastal communities. Local awareness campaigns could be developed targeting aquaculture operators and coastal communities. Development of key messages could be informed by risk assessments to address priority issues.

Integrating ALDAG into third-party certification schemes

The ecolabelling of seafood, mainly though the third-party certification and assessments of individual aquaculture sites and businesses, creates an important market driver for responsible aquaculture. Producers in Indonesia have adopted a number of certification schemes, including the Aquaculture Stewardship Council (ASC), Global Seafood Alliance Best Aquaculture Practices (GSA-BAP) and Asian Seafood Improvement Collaborative (ASIC). MMAF has established the Indonesian Good Aquaculture Practice (IndoGAP) with consideration of the FAO Technical Guidelines on Aquaculture Certification and the Association of Southeast Asian Nations of Shrimp Good Aquaculture Practices (ASEAN Shrimp GAqP). To date, most aquaculture certification schemes have focused on issues associated with biological waste (e.g. the release of metabolic waste, pathogens and genetic material), but have yet to fully address non-biological wastes. The ASC is currently considering how to incorporate waste management into its standard (e.g., Huntington, 2019). Actions could be taken to more fully integrate plastic waste management into aquaculture improvement projects (AIPs) and certification in Indonesia.

3.15 Evaluate the feasibility of upgrading MMAF's IndoGAP certification to include risk assessment, management and recovery of plastic waste. If there is potential to expand the IndoGAP certification, these actions could be integrated alongside other actions such the development of technical standards for aquaculture equipment (Action 3.01), risk assessment (Action 3.05) and capacity-building (Action 3.12).

3.16 Facilitate aquaculture producers to engage in improvement and certification programs. International certification schemes are increasingly considering how to implement ALDAG and solid waste management principles into their certification standards. Aquaculture operations could be encouraged to engage in AIPs and to undergo third-party certifications that include best management practices for plastic use and disposal. Ultimately, market demand will have the greatest influence on a producer's interest in certification schemes. However, support programs could be established—including technical guidance and training schemes—to assist producers to meet certification standards.

ACTION 4.
RECOVER ALDFG AND ALDAG

While preventing ALDFG and ALDAG is preferable to remedial actions, nonetheless efforts to recover derelict gear can play an important role in an overall strategy by (i) reduce the impact of derelict fishing and aquaculture gear on the environment; (ii) contributing to the wider issue of marine plastic debris; and (iii) increasing stakeholder awareness and engagement.

Different recovery strategies will be required for different size and types of vessels and gears. A tiered strategy could be adopted, with selected vessels that have the appropriate equipment and expertise undertaking ALDFG recovery missions in offshore locations, and coastal communities engaging in fishing for litter schemes to recover derelict fishing gear and other marine debris in inshore locations. The action aims to enhance the recovery of ALDFG and ALDAG from the marine environment. Three subgroups of actions are proposed: (i) operationalizing ALDFG and ALDAG recovery; (ii) implementing fishing-for-litter schemes; and (iii) establishing fit-for-purpose port reception facilities.

Operationalizing ALDFG Recovery

As a short-term action to mitigate the current problem and accumulation of ALDFG in the environment, a task force could be established to coordinate recovery actions. If risk assessments demonstrate that the preventative measures described above (Actions 2 and 3) are effective, remedial measures will eventually become unnecessary and the Task Force could be disbanded.

4.01 Establish a Ghost Gear Recovery Task Force. A Ghost Gear Recovery Task Force could be established to coordinate recovery missions. The Task Force could be led by MMAF, and include other Ministries and organizations. The Ministry of Environment and Forestry (KLHK, *Kementerian Lingkungan Hidup dan Kehutanan*) could be a valuable member due to its waste management mandate, while NGOs could contribute valuable technical capacity and resources.

4.02: Identify ALDFG and ALDAG hotspots. To prioritize recovery efforts and resources efficiently, ALDFG and ALDAG hotspot locations could be identified. The risk assessment process could provide an entry point for MMAF to engage with the fishing industry, which is likely to have valuable information and intelligence that could help identify hotspots. This activity could generate a list of prioritized provinces and sites, including an understanding of the types of ALDFG and ALDAG that are likely to be encountered, to enable targeted recovery operations to be implemented.

4.03: Plan recovery missions. At the hotspots identified, the Task Force could commission vessels that are fit for purpose (i.e., of sufficient scale and with suitable equipment) for the type of ALDFG likely to be encountered. For example, in some locations nets and traps could be recovered by dragging grapnels, while at more sensitive sites such as shallow coral reefs, recovery by trained teams of divers may help to avoid further habitat damage. The Task Force could determine suitable rates to pay recovery vessels, which could be tendered via a competitive bidding process to ensure value for money. Mission planning could include the preparation of recovery plans that promote best practice and safety in recovery, handling, landing and treatment of retrieved material.

4.04: Implement recovery missions. Once plans are agreed, recovery missions could be carried out and brief post-mission reports provided to the Task Force detailing the location, resources used, the weight and type of material retrieved, and the onshore collection and treatment of recovered material. The Task Force could regularly review planning and implementation processes to ensure that best practices are applied and to capture lessons learned in order to optimize future missions.

Implementing Fishing-for-Litter schemes

Fishing-for-Litter schemes are well established in many countries, where they support the recovery of marine litter by small- and large-scale fishing operators. Such schemes could be particularly relevant in Indonesia where a significant component of fishing and aquaculture waste is plastic bottles that may be indistinguishable from other post-consumer waste that contributes to marine litter.

4.05 Design and implement a Fishing-for-Litter scheme. Fishing-for-Litter schemes can encourage fishers to land all waste generated and recovered during fishing operations. Designing a scheme could involve providing fishers with reusable sacks, establishing incentive structures (e.g., payments for verified weight of waste landed), collecting waste in port reception facilities, and monitoring and reporting. A pilot scheme could be established in selected priority ports before wider roll-out. Risk assessments could help to identify priority ports, such as those with trawl fleets that regularly bring marine litter onto deck during hauling. Following successful pilots, the scheme could be scaled up, with a network of collection systems established to encourage wider participation in marine litter collection.

4.06 Promote Fishing-for-Litter schemes. Fishing-for-Litter schemes could be promoted alongside wider marine litter awareness campaigns to fishers and coastal communities—this could include integrating with existing marine litter awareness-raising efforts under the MPOA-MPD. Adequate communication and promotion of Fishing-for-Litter schemes will be critical to maximize stakeholder awareness and engagement. Schemes could help to drive behavior changes regarding marine litter, including storage and onshore disposal of waste generated onboard (e.g., food packaging) or recovered during fishing.

Establishing fit-for-purpose port reception facilities

4.07 Install fit-for-purpose port reception facilities. In the ports where Fishing-for-Litter schemes are established, waste reception facilities could be installed to receive the waste landed by Fishing-for-Litter participants. A network of waste reception and collection systems could be established connecting small landing sites to larger ports that could function as waste collection hubs. Incentives and waste collection must be managed and monitored carefully by port operators to ensure it is only dealing with marine litter collected by fishers as part of the Fishing-for-Litter scheme, and not general municipal waste.

ACTION 5.
PROMOTE A CIRCULAR ECONOMY FOR END-OF-LIFE FISHING AND AQUACULTURE EQUIPMENT

A circular economy is restorative and regenerative by design, keeping resources in use for as long as possible, extracting the maximum value from them whilst in use, and then recovering and regenerating products and materials at the end of their service life. Consequently a circular economy offers a way to improve competitiveness and resource efficiency. The Action aims to enhance the circularity of end-of-life fishing gear and aquaculture equipment. Two sub-groups of actions are proposed: (i) establishing EOLFG value chains; and (ii) improving fishing gear circular design.

Establishing EOLFG Value Chains

A circular economy could be developed for EOLFG to make it less likely this material becomes ALDFG. At the end-of-life, materials should have clearly defined directions to follow before they become waste, including repair, reuse, refurbishment, recycling for secondary materials, or up-cycling/ down-cycling to alternative use.

To sustain a circular economy, sufficient value and volume of material is required to maintain economic viability. Where this is not achieved by the private sector alone, public sector interventions may be required to address constraints or stimulate investment. An important consideration is the opportunity cost associated with engaging in fishing gear waste processing rather than other waste streams. Purse seine and gillnets are the fishing gears with the highest reuse and recycling rates as these gears are often constructed from Nylon, a medium value material. Initial pilots could prioritize these fisheries.

Several enterprises and pilot initiatives in Indonesia (see accompanying Evidence Base reports) demonstrate that fishing gear recycling businesses are viable, but margins are tight and support is needed to scale up existing operations. In particular, the unpredictable supply and variety of plastic types associated with fishing gear waste highlight the importance of integrating approaches into wider circular economy initiatives to enhance viability and economies of scale.

An active informal waste collection sector and plastic recycling enterprises are well-established in Indonesia. These tend to focus on the simplest and most plentiful waste streams from municipal waste and industry. The collection and recycling of fishing gear is comparatively difficult and so must be facilitated with collection points (for volumes to be transported efficiently) and material handling (to separate and clean material). The informal sector plays an important role in the circular economy through the collection and segregation of waste plastic and other materials. Policies that recognize and protect the livelihoods and human safety of informal waste collectors are essential. The informal waste collection sector could be engaged in recycling initiatives as key participants in the EOLFG value chain.

While Extended Producer Responsibility (EPR) schemes can be effective at encouraging waste recovery in some sectors, there could be challenges implementing such schemes in the fishing sector. These challenges include a high reliance on imported fishing gear, and the highly dispersed and low value nature of fishing waste. Improvement in ALDFG monitoring, waste collection systems and recycling markets are likely to be essential prerequisites to effective EPR schemes. As an alternative, gear buy-back schemes could be established for relatively large capital gear items such as trawl and seine nets. Collection of waste could be facilitated through the installation of fit-for-purpose port reception facilities that are able to receive different waste streams and maintain separation.

5.01 Implement EOLFG value chain pilots. Pilots could be established at key ports where risk assessments have identified sufficient volumes and rates of EOLFG generation. Gillnet and seine net fisheries could be prioritized, as these gears are constructed from materials that have the highest reuse and recycling value. Pilots could be implemented in coordination with local port and waste management operators in order to develop fit-for-purpose EOLFG collection facilities and treatment systems, and to establish the incentive structures needed to sustain fishing gear waste value chains. Pilots should consider all key steps and stakeholders in the value chain, including (i) deposit of EOLFG by fishers; (ii) collection, sorting, cleaning and drying by waste collectors; (iii) pickup and transport by recyclers or middlemen; (iv) crushing, washing and pelletizing by recyclers; and (v) transport of plastic pellets to plastic manufacturers.

5.02 Scale up recycling and treatment initiatives. Based on lessons learned from the pilot value chains, incentives could be introduced at a wider scale to facilitate EOLFG collection and treatment systems. Incentives could be direct (e.g., subsidies) or indirect (e.g., tax relief on sales resulting from EOLFG material). Subsidies could be used to, for example, ensure a minimum price for recycled materials that covers the cost of production, helping to de-risk the venture and encourage waste operators to receive EOLFG. Incentive schemes require careful design to ensure that levels of support are appropriate and good oversight to ensure schemes are not exploited. Once value chains with sufficient economies of scale are established, it may be feasible to reduce or remove incentive structures. Currently, Indonesia's EOLFG collectors are neither organized nor registered. Initiatives could support waste collectors to organize more effectively, for example through co-operation schemes with local authorities, and improve linkages between informal waste collectors, recyclers, plastics manufacturers and other stakeholders along the EOLFG value chain.

5.03 Implement EOLFG buy-back schemes. A buy-back scheme is a form of EPR that incentivizes suppliers to develop ongoing relations with their customers through the promotion of return, repair and replacement services. Such arrangements are commonplace amongst fishing and aquaculture net suppliers in many countries, for example the Government of South Korea has implemented a purchase scheme for EOLFG and marine litter received at port collection points[4]. While in Europe, private sector buy-back schemes are common for large and relatively high-value gear items such as purse seines and trawl nets, with net suppliers offering discounts on repaired and new nets when EOLFG are returned. In this way buy back schemes can encourage customer loyalty while also ensuring that EOLFG is returned for reuse or recycling. Consultation could be initiated with gear suppliers to define how a buy-back scheme could function in Indonesia. In the short-term it may be most feasible to implement a government buy-back scheme that could be introduced relatively quickly and include smaller items such as gillnet and handline, while simultaneously facilitating the longer-term development of viable, private sector EPR schemes.

5.04 Establish fit-for-purpose EOLFG port reception facilities. Port reception facilities are already being progressed by GOI as part of MARPOL Annex V implementation. Port facilities are required for:

- Net repair areas FAO guidance recommends that small- and medium-sized fishing ports have dedicated net repair facilities, with 500m2 allocated in artisanal ports and 1,000m2 part-covered areas allocated in coastal and offshore fishing ports (Sciortino, 2010).
- ALDFG and 'Fishing for Litter' waste: Port reception facilities could be installed to receive material from Fishing for Litter schemes and ALDFG recovery missions. This material is likely to be mixed and often contaminated (e.g., with oil or marine growth), difficult to clean and separate, and therefore may need to be disposed of through incineration. If waste is paid for as (e.g., via a scheme similar to that implemented by the Government of South Korea), reception facilities could be established at larger ports that are adequate for the volumes of waste anticipated. Cement reception facilities are ideal, and indeed several ports identified in the accompanying Evidence Base report already have cement areas for waste reception that are not currently in use. Assessments could be implemented on a port-by-port basis to determine the relative scale of material and adequacy of existing facilities before new facilities are constructed. At smaller ports where volumes of waste will be less, or when there is no need to distinguish who has deposited the waste, dedicated skips with secure lids would suffice, though ideally these could be separate from general waste to enable better monitoring of the volumes received.
- EOLFG collection facilities: Separate, dedicated EOLFG collection facilities could be installed at key fishing ports where significant volumes of EOLFG have been identified. Prioritization could be given to ports that are home to significant purse seine and trawl fleets. Fit-for-purpose facilities include skips with secure lids that could enable waste EOLFG to be transported to treatment centers. EOLFG reception facilities could be moved between ports as EOLFG accumulated over many years is cleared and volumes settle down to annual replacement rates. The installation of dedicated EOLFG collection facilities would improve separation of these materials from general waste streams, and facilitate the development of EOLFG value chains. Particular consideration could be given to larger ports that receive foreign fishing vessels, and that are required to have and promote facilities for process-

[4] NOWPAP MERRAC, 2015: http://merrac.nowpap.org/merrac/publication/select_marineLitter_list

ing EOLFG and recovered marine litter from these vessels. In particular, the Port State Measures Agreement ratified via Presidential Regulation 43/PERPRES/2016 specifically identified PPS Nizam Zachman Jakarta, PPS Bitung, PPS Bungus, and Benoa Sea Port.

- Village-level facilities: In addition to port reception facilities in larger fishing ports, PPI and smaller landing facilities in coastal villages may also require infrastructure to collect, store and process EOLFG, recovered ALDFG and other recovered plastic litter. FAO guidelines (Sciortino, 2010) recommend a small (50 m²) platform with integrated stores (e.g. 2 x 6 m²).

Improving fishing gear circular design

A key challenge to enhancing circularity in fishing gear design is to develop products that use a less diverse range of material types. Mixed materials within fishing gears (whether associated with different components, or where two materials are interweaved together) inherently reduce the likelihood and feasibility of materials being re-used or recycled.

5.05 Promote research and development of fishing gear circular design. Research and development programs could be established to identify fishing gear designs suitable for a circular economy, including through the use of a high proportion of reused or recycled materials and gradual elimination of all virgin plastics. Particular emphasis could be placed on designs that do not reduce performance, durability or product lifetime. Potential areas of research identified in the accompanying Evidence Base reports include: (i) developing new nets and/or ropes from EOLFG trawl and seine nets; (ii) designing floats and weights from EOLFG that could provide a viable alternative to the plastic bottles and other materials commonly used in fishing and aquaculture; and (iii) developing new products from EOLFG materials such as plastic decking, chairs or tables. Research and design programs are likely to require the involvement of diverse stakeholders from industry and academia in order to address the challenges associated with EOLFG. A fund could be established and promoted to encourage innovation and partnerships, with funding made available through open calls for proposals thar are evaluated by an assessment panel.

ACTION 6. IMPROVE MONITORING AND REPORTING OF EOLFG, ALDFG AND ALDAG

While an international framework exists for reporting of waste by fishing vessels in the form of MARPOL Annex V, these apply primarily to large-scale vessels (>400 GT) and are not sufficiently tailored to the contexts and needs of Indonesia's fishing operations. Similarly, international frameworks for reporting of waste from aquaculture are not yet well developed.

To address plastic leakage from capture fishery and aquaculture sectors, Indonesia could establish national regulations that go beyond the minimum standards outlined in MARPOL Annex V to establish waste reporting requirements for all vessels operating within its maritime jurisdiction, as well as for aquaculture installations. This action aims to enhance monitoring and reporting of plastic use and disposal by the capture fishery and aquaculture sectors. Four sub-groups of activities are proposes: (i) planning, technical management and coordination; (ii) developing e-reporting and e-monitoring prototype systems; (iii) piloting e-reporting and e-monitoring for capture fisheries; and (iv) evaluating reporting for aquaculture.

Planning, technical management and coordination

Monitoring and reporting of EOLFG and ADLFG in Indonesia could be based on a mass balance approach, with checks and balances built into various stages of the fishing gear lifecycle (Annex 2). Such a system would require information on gear replenishment rates obtained from suppliers and/or vessel operators, and a fishery independent system to monitor the weight of plastic materials landed by large-scale (>30 GT) fishing vessels. Estimates could be further improved if (i) a system is put in place for monitoring and reporting lost fishing gears, and (ii) vessel operators are required (e.g., through linkages to the terms and conditions of a fishing licensing) to report landed plastic weights an lost gears. Electronic reporting (e-reporting) and electronic monitoring (e-monitoring) offer potential opportunities for efficient and effective data capture, provided they are designed with consideration of stakeholder needs and supporting regulatory frameworks.

6.01 Improve information sharing and coordination for e-reporting and e-monitoring. The effective management, monitoring, reporting and safe disposal or recycling of EOLFG and ALDFG requires synergy between sectors and line ministries. The TWG, supported by representatives from academia and industry, could bring together the diverse range of expertise that resides in Indonesia. By facilitating information sharing, dialog and coordination, the TWG could increase the likelihood that e-reporting and e-monitoring system designs are fit for purpose and able to tackle a range of concerns that can arise from the fishing, licensing, port authority, fisherfolk, coast guard, maritime affairs, waste management domains.

6.02 Strengthen capacity for e-reporting and e-monitoring. In order to prepare for piloting, a series of targeted training workshops could be implemented to ensure that each sector has a clear understanding of their roles and responsibilities in developing and implementing e-reporting and e-monitoring. Training could be made available for personnel directly involved in e-reporting and e-monitoring pilots (which may include MMAF, KEMEN-PUPR, fishing gear companies and fishing license holders). The National Task Force could oversee this process, including by e.g., integrating plastic waste e-reporting and e-monitoring into existing catch documentation and traceability processes.

6.03 Analyze the policy and regulatory gaps for e-reporting and e-monitoring. To ensure effective implementation of an e-reporting / e-monitoring system, a gap analysis could be carried out of the policy and legal frameworks via which plastic waste and plastic pollution is managed. A particularly focus could be the limitations of MARPOL Annex V for waste management of fishing vessels, and consideration of the national legislation needed to improve waste monitoring and reporting for vessels 30-400 GT. Programmatic approaches could be identified for vessels to (i) report offloading of their EOLFG, retrieved ALDFG and other types of plastic garbage (see IMO definition) prior to arrival, (ii) report lost fishing gear at the time of loss, indicating time, location, depth and the cause of loss, and (iii) transmit information to the relevant authorities, including the design of appropriate forms. The gap analysis could inform the draft of legislation and regulations for consideration by senior management. Technical assistance from FAO Development Law Branch could assist MMAF to incorporate international best practice and lessons learned.

Developing e-reporting and e-monitoring prototype systems

E-reporting of plastic waste from fishing involves the electronic recording of information by vessel captains and crew and fisheries managers according to pre-determined data collection protocols and forms. It includes the reporting of: (i) EOLFG and retrieved ALDFG; and (ii) all other plastic waste that is generated during fishing operations and considered as plastic garbage. E-monitoring, on the other hand, is the use of electronic equipment to automatically record information on plastic waste generated by fishing activities and to track trends in disposal behavior such as the quantities disposed onshore or discarded at sea. E-reporting is typically used to collect data on plastic waste disposal by high-risk fishing fleets, while e-monitoring is typically used to address compliance with fisheries regulations. Effective e-reporting and e-monitoring strategies depend on information and communication technology (ICT) systems and processes that minimize the burden on data reporters, including through use of flexible and easy-to-use "off the shelf" technologies.

6.04 Establish baseline data to support e-reporting and e-monitoring: Reliable baseline data will be required to inform the selection of priority fisheries and ports for pilot implementation, and to evaluate progress. The accompanying Evidence Base reports identify data gaps that currently constrain the ability to quantify and identify the main ports and fleets generating waste. Baseline data could be improved, including by (i) improving disaggregated data on fishing vessel size and number and fishing gears per port; (ii) updating Indonesia's catalogue of fishing gears, with a focus on updating information on material types and quantities to provide a more robust estimate of the weight of plastic material deployed in Indonesia's fisheries; and (iii) select priority ports and fisheries for monitoring and e-reporting pilots informed by risk assessments.

6.05 Develop, pilot and evaluate e-reporting and e-monitoring systems. Informed by risk assessments and other outputs of Actions 2.01-2.12, a shore-based monitoring and reporting system could be designed, costed, procured and evaluated in selected ports and fisheries. The design phase could define data models, reporting form templates, and software specifications for desktop, tablet or mobile phone platforms. Given the technical nature of this activity, inputs may be required from the TWG as well as an ICT specialist for technical oversight, preparation of terms of reference and procurement specifications. Critical milestones and outputs could include: (i) procurement of key infrastructure and equipment for pilot evaluations in selected ports and fisheries; (ii) design and procurement of e-reporting and e-monitoring systems; (iii) development of standard operating procedures, including operating manuals for end users and clearly defined roles and responsibilities for key actors; (iv) initial testing and evaluation (dry run) of hardware and software systems; (v) pilot implementation and field evaluation in selected ports and commercial fishing vessels for a period of two years; (vi) periodic progress reporting on pilots by TWG to the national task force; (vii) preparation of a plan for national roll out, including identification of long-term staffing, operation and maintenance resources. If risk assessments and pilots identify that specific reporting requirements are needed for gear loss (only one aspect of ALDFG), specific subroutines could be incorporated into the e-reporting system, with consideration given to any applicable provisions under MARPOL Annex V Regulation 10.6 to ensure that coastal State responsibilities to report gear loss to the International Maritime Organization are adequately addressed.

Piloting e-reporting and e-monitoring for capture fisheries

A decision to roll out an e-reporting and e-monitoring system for plastics in the fisheries sector is likely to have economic consequences for fishing operators as well as for the work program of government officers in fisheries, compliance, marine transportation and solid waste management, amongst others who will be required to operate and maintain the systems.

6.06 Evaluate and approve national rollout. Information obtained during the development, and piloting of e-reporting and e-monitoring systems (Actions 6.01-6.05) could provide decision makers with the evidence base and supporting information (e.g., costs) to evaluate the potential of these systems to be deployed at national scales.

6.07 Develop communication strategy and products. National role out of e-reporting and e-monitoring systems could be supported by a communication strategy targeting the affected private sector and wider general public and affected private sector. Communications could include information on the requirements and obligations for e-reporting and e-monitoring.

Evaluating reporting for aquaculture

The challenges of monitoring debris from aquaculture are quite different from that of capture fisheries. This is mainly due to the different nature of loss—primarily persistent, low-level leakage of single use plastics with intermittent catastrophic losses of material due to storms or flooding. As a result reporting and tracking are likely to be more expensive and less cost-effective than for the capture fisheries. However, aquaculture debris is likely to more localized than ALDFG, as most of Indonesia's marine aquaculture occurs in coastal areas. The challenges of monitoring plastic leakage from aquaculture could be addressed via two different strategies:

1. **Routine reporting and monitoring of aquaculture-derived debris within priority locations.** Risk assessments could be used to identify locations that have high levels of aquaculture activity, or are particularly vulnerable to plastic pollution (e.g., sites of biological significance such as marine protected areas). Using a standard protocol, monitoring could be implemented by subnational governments, private sector, NGOs or other stakeholders.
2. **Short-term monitoring following catastrophic events** that could generate losses and discharge of aquaculture debris to the marine environment (e.g., following coastal flooding, storms or tsunamis).

There is limited global experience designing and implementing systems for reporting and tracking aquaculture debris. This, combined with the continuous low-level and largely coastal nature of loss, suggests that a step-wise approach could be taken to ensure that strategies adopted in Indonesia are appropriate and cost-effective.

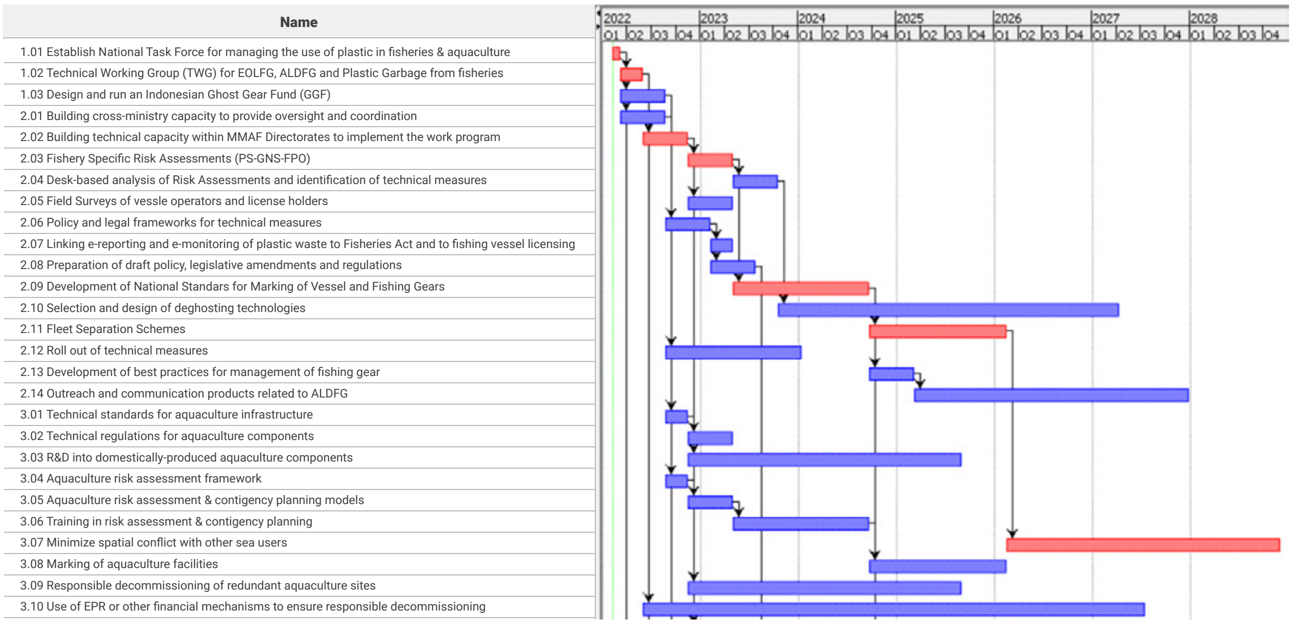
6.08 Undertake a feasibility study for aquaculture debris reporting. Studies could be implemented to evaluate the feasibility of a national aquaculture debris reporting system. Such a system could be integrated with or deployed alongside other marine debris monitoring systems (e.g. from capture fisheries).

6.09 Implement aquaculture debris reporting. Voluntary or mandatory reporting system could be implemented, with a priority focus on capturing information about aquaculture infrastructure failure and major loss of equipment to the marine environment. Reporting could include details about the date, circumstances of loss, nature of the equipment or debris, and potential risk it might pose to other maritime users or the environment.

6.10 Develop community-based reporting of ALDAG. A community-based framework could be established involving local stakeholders and aquaculture operations to monitor ALDAG at the local level. Communities could be enabled to monitor and report marine pollution or other problems that affect them as a result of local aquaculture production, and systems could be established to ensure an adequate response from the aquaculture industry. A community e-reporting system could be developed, with representatives from the aquaculture industry providing valuable inputs into the design of such a system.

Indicative implementation timeline

An indicative implementation timetable is presented in Figure 3 including of the sequencing of precursor activities and critical paths.



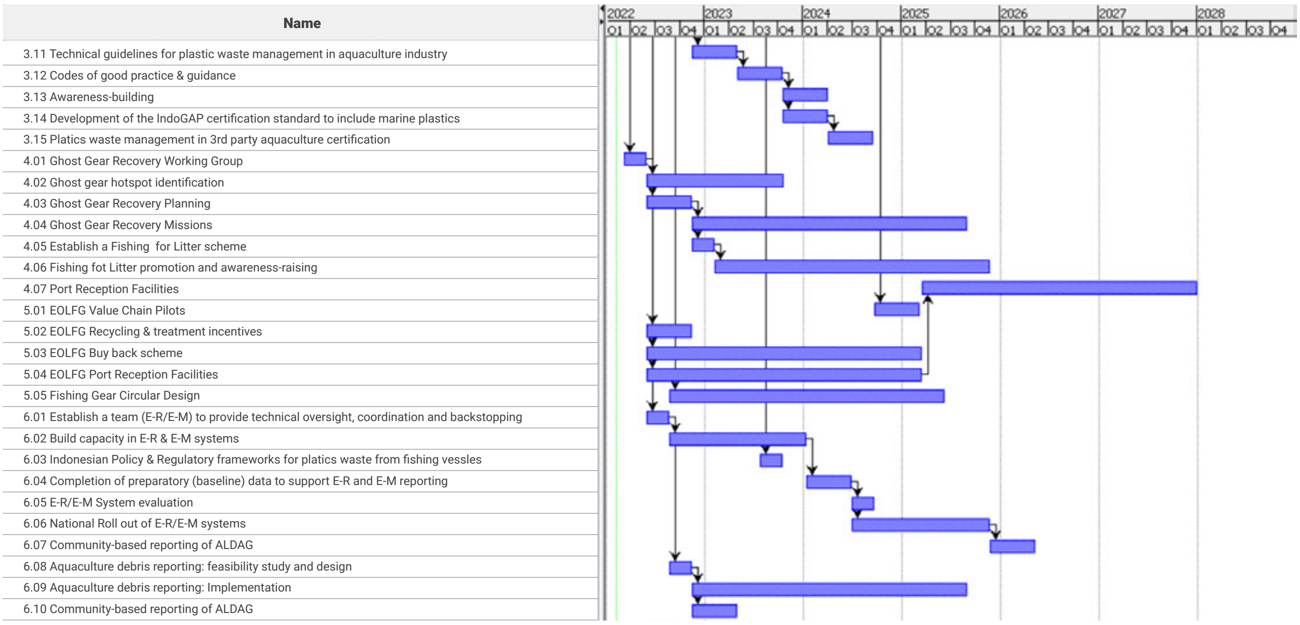


Figure 3. Indicative timetable for implementing the proposed actions.

References

Barnes, D.K., Galgani, F., Thompson, R.C. & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. Philos Trans R Soc Lond B Biol Sci 364(1526): 1985-1998. doi:10.1098/rstb.2008.0205

Boren, L.J., Morrissey, M., Muller, C.G. & Gemmell, N.J. (2006). Entanglement of New Zealand fur seals in man-made debris at Kaikoura, New Zealand. Mar Pollut Bull 52(4): 442-446. doi:10.1016/j.marpolbul.2005.12.003

Brown, J., Macfadyen, G., Huntington, T., M.J. \& Tumilty, J. (2005). Ghost Fishing by Lost Fishing Gear. Final Report to DG Fisheries and Maritime Affairs of the European Commission (Fish/2004/20). Institute for European Environmental Policy \& Poseidon Aquatic Resource Management Ltd.

Burgess, H.K., Herring C.E., Lippiatt S., Lowe S., & Uhrin A.V. (2021). NOAA Marine Debris Monitoring and Assessment Project Shoreline Survey Guide. National Oceanic and Atmospheric Administration Marine Debris Program.

Charter, M. & Carruthers, R. (2022). Products from waste fishing nets: accessories, clothing, footwear, home ware and recreation. Centre for Sustainable Design (CfSD)

Chen, W.-Q., Ciacci, L., Sun, N.-N., & Yoshioka, T. (2020). Sustainable cycles and management of plastics: A brief review of RCR publications in 2019 and early 2020. Resources, Conservation and Recycling 159; 104822. doi:10.1016/j.resconrec.2020.104822

Consoli, P., Sinopoli, M., Deidun, A., Canese, S., Berti, C., Andaloro, F. & Romeo, T. (2021). The impact of marine litter from fish aggregation devices on vulnerable marine benthic habitats of the central Mediterranean Sea. Mar Pollut Bull, 152, 110928. doi:10.1016/j.marpolbul.2020.110928

DelBene, J.A., Bilkovic, D.M. & Scheld, A.M. (2019) Examining derelict pot impacts on harvest in a commercial blue crab Callinectes sapidus fishery. Mar. Pollut. Bull. 139, pp. 150-156. doi:10.1016/j.marpolbul.2018.12.014

EC (2013). Guidance on Monitoring of Marine Litter in European Seas. Marine Strategy Framework Directive Technical Subgroup on Marine Litter. 117 pp. https://op.europa.eu/en/publication-detail/-/publication/76da424f-8144-45c6-9c5b-78c6a5f69c5d/language-en https://www.iucn.org/sites/dev/files/content/documents/2021/beach_debris_mornitoring_2020_report_english-_1_july_2021.pdf

English, E., Wagner, C. & Holmes, J. (2019). The Effects of Marine Debris on Beach Recreation and Regional Economies in Four Coastal Communities: A Regional Pilot Study. National Oceanic and Atmospheric Administration, Silver Spring, USA.

Enrichetti, F., Bavestrello, G., Betti, F., Rindi, F., Tregrosso, A. & Bo, M. (2021). Fate of lost fishing gears: Experimental evidence of biofouling colonization patterns from the northwestern Mediterranean Sea. Environ Pollut 268: 115746. doi:10.1016/j.envpol.2020.115746

Eunomia (2016). Plastics in the Marine Environment. Eunomia Research and Consulting, Bristol, UK

FAO (2016a). Abandoned, lost and discarded gillnets and trammel nets: methods to estimate ghost fishing mortality, and the status of regional monitoring and management> Written by Eric Gilman, Francis Chopin, Petri Suuronen and Blaise Kuemlangan. FAO Fisheries and Aquaculture Technical Paper No. 600. Rome. Italy. 79 pp. ISBN 978-92-5-108917-0. http://www.fao.org/3/a-i5051e.pdf

FAO (2016b). Report of the Expert Consultation on the Marking of Fishing Gear, Rome, Italy, 4–7 April 2016. FAO Fisheries and Aquaculture Report No. 1157. Rome, Italy. http://www.fao.org/3/a-i5729e.pdf

FAO (2018). Voluntary guidelines on the marking of fishing gear. Rome. 88 pp. Licence: CC BY-NC-SA 3.0 IGO. http://www.fao.org/3/ca3546t/ca3546t.pdf

Foley, C.J., Feiner, Z.S., Malinich, T.D. & Höök, T.O. (2018). A meta-analysis of the effects of exposure to microplastics on fish and aquatic invertebrates. Sci Total Environ 631-632: 550-559. doi:10.1016/j.scitotenv.2018.03.046

Franson, J.C., Hansen, S.P., Creekmore, T.E., Brand, C.J., Evers, D.C., Duerr, A.E. & DeStefano, S. (2003). Lead Fishing Weights and Other Fishing Tackle in Selected Waterbirds. Waterbirds 26(3): 345-352. doi:10.1675/1524-4695(2003)026[0345:lfwaof]2.0.co;2

GESAMP (2015). Sources, fate and effects of microplastics in the marine environment: a global assessment. Rep. Stud. GESAMP No. 90. IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, pp. 96.

Gilardi, K. V., Carlson-Bremer, D., June, J. A., Antonelis, K., Broadhurst, G., & Cowan, T. (2010). Marine species mortality in derelict fishing nets in Puget Sound, WA and the cost/benefits of derelict net removal. Mar Poll Bull 60: 376–382. doi: 10.1016/j.marpolbul.2009.10.016

Gilman, E. (2015). Status of international monitoring and management of abandoned, lost and discarded fishing gear and ghost fishing. Mar Policy 60: 225-239. doi:10.1016/j.marpol.2015.06.016

Gilman, E., Musyl, M., Suuronen, P., Chaloupka, M., Gorgin, S., Wilson, J. & Kuczenski, B. (2021). Highest risk abandoned, lost and discarded fishing gear. Nature Scientific Reports 11: 7195 . doi: 10.1038/s41598-021-86123-3

Global Ghost Gear Initiative (2021a). Best Practice Framework for the Management of Fishing Gear. 2nd Edition. Prepared by Huntington, T of Poseidon Aquatic Resources Management Ltd. In press.

Global Ghost Gear Initiative (2021b). Best Practice Framework to Reduce Aquatic Debris from Aquaculture (A-BPF). Prepared by Tim Huntington of Poseidon Aquatic Resource Management Ltd for GGGI. In press.

Good, T.P., June, J.A., Etnier, M.A. & Broadhurst, G. (2009). Ghosts of the Salish Sea: threats to marine birds in Puget Sound and the Northwest Straits from derelict fishing gear. \textit{Mar Ornithol}, \textit{37}, 67-76.

Good, T.P., June, J.A., Etnier, M.A. & Broadhurst, G. (2010). Derelict fishing nets in Puget Sound and the Northwest Straits: patterns and threats to marine fauna. Mar. Pollut. Bull. 60, 39-50. doi:10.1016/j.marpolbul.2009.09.005

Goodman, A.J., McIntyre, J., Smith, A., Fulton, L., Walker, T.R. \& Brown, C.J. (2021). Retrieval of abandoned, lost, and discarded fishing gear in Southwest Nova Scotia, Canada: Preliminary environmental and economic impacts to the commercial lobster industry. Mar Pollut Bull 171: 112766. doi:10.1016/j.marpolbul.2021.112766.

Hanni, K.D. & Pyle, P. (2000). Entanglement of Pinnipeds in Synthetic Materials at South-east Farallon Island, California, 1976--1998. Mar Pollut Bull 40(12): 1076-1081. doi:10.1016/s0025-326x(00)00050-3

Hong, S., Lee, J. & Lim, S. (2017). Navigational threats by derelict fishing gear to navy ships in the Korean seas. Mar Pollut Bull

119(2): 100-105. doi:10.1016/j.marpolbul.2017.04.006

Huntington, T (2019). Marine Litter and Aquaculture Gear –White Paper. Report produced by Poseidon Aquatic Resources Management Ltd for the Aquaculture Stewardship Council. 20 pp. https://www.asc-aqua.org/what-we-do/programme-improvements/gear-management/#marine-litter-and-aquaculture-gear-asc-white-paper

ICPC (2021). Fish Aggregation Devices: Risks to Submarine Cable Deployment and Operations: An Annex to Government Best Practices for Protecting and Promoting Resilience of Submarine Telecommunications Cables. International Cable Protection Committee, Portsmouth, UK.

IMO (2018) Action Plan to Address Marine Litter from Ships, Resolution MEPC.310(73), 26 October 2018. International Maritime Organization Marine Environmental Protection Committee. http://www.imo.org/en/MediaCentre/HotTopics/marinelitter/Documents/IMO%20marine%20litter%20action%20plan%20MEPC%2073–19-Add-1.pdf

Juan, R., Domínguez, C., Robledo, N., Paredes, B., Galera, S., \& García-Muñoz, R. A. (2021). Challenges and Opportunities for Recycled Polyethylene Fishing Nets: Towards a Circular Economy. Polymers 13(18): 3155. doi:10.3390/polym13183155

Kaiser, M., Bullimore, B., Newman, P., Lock, K., Gilbert, S. (1996) Catches in 'ghost fishing' set nets. Mar. Ecol. Prog. Ser. 145, 11-16. doi:10.3354/meps145011

Kuczenski, B., Vargas, C., Gilman, E., Musyl, M., Geyer, R. & Wilson, J. (2021). Plastic gear loss estimates from remote observation of industrial fishing activity. Fish., 23: 22-33. doi: 10.1111/faf.12596

Laist, D.W. (1995). Marine debris entanglement and ghost fishing: a cryptic and significant type of bycatch. Proceedings from Solving Bycatch: Considerations for Today and Tomorrow, September 25-27, 1995, Seattle, Washington.

Macfadyen, G., Huntington, T., and Cappell, R. (2009). Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. ISBN 978–92-5–106196-1. United Nations Environment Programme and Food and Agriculture Organization of the United Nations, Nairobi and Rome.

McCauley, S., Bjorndal, K. (1999) Conservation implications of dietary dilution from debris ingestion: sublethal effects in post-hatchling loggerhead sea turtles. Conserv. Biol., 13(4): 925-929. doi: 10.1046/j.1523-1739.1999.98264.x

Moore, M.J., van der Hoop, J., Barco, S.G., Costidis, A.M., Gulland, F.M., Jepson, P.D., Moore, K.T., Raverty, S. & McLellan, W.A. (2013). Criteria and case definitions for serious injury and death of pinnipeds and cetaceans caused by anthropogenic trauma. Dis Aquat Org 103(3): 229-264. doi:10.3354/dao02566

NOAA (2015). Report on the Impacts of "Ghost Fishing" Via Derelict Fishing Gear. NOAA Marine Debris Program, Silver Spring, MD

NOAA (2016). Report on Marine Debris Impacts on Coastal and Benthic Habitats. National Oceanic and Atmospheric Administration Marine Debris Program, Silver Spring, MD

Orós, J., Montesdeoca, N., Camacho, M., Arencibia, A. & Calabuig, P. (2016). Causes of Stranding and Mortality, and Final Disposition of Loggerhead Sea Turtles (Caretta caretta) Admitted to a Wildlife Rehabilitation Center in Gran Canaria Island, Spain (1998-2014): A Long-Term Retrospective Study. PLOS ONE 11(2): e0149398. doi:10.1371/journal.pone.0149398

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

Richardson, K., Hardesty, B., Vince, J., Wilcox, C. (2021a) Global causes, drivers, and prevention measures for lost fishing gear.

Front. Mar. Sci. 8, 690447. doi: 10.3389/fmars.2021.6900447

Richardson, K., Wilcox, C., Vince, J., & Hardesty, B. D. (2021b). Challenges and misperceptions around global fishing gear loss estimates. Marine Policy 129: 104522. doi: 10.1016/j.marpol.2021.104522

Rochman, C.M. (2015). The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment. In M. Bergmann, L. Gutow,\& M. Klages (Eds.), Marine Anthropogenic Litter (pp. 117-140). Springer International Publishing, Cham. doi:10.1007/978-3-319-16510-3_5

Scheld, A.M., D.M. Bilkovic, and K.J. Havens, K.J. (2016). The Dilemma of Derelict Gear. Scientific Reports 6, Article Number 19671. 7 pp.. http://www.nature.com/articles/srep19671

Sciortino, J.A. (2010). Fishing harbour planning, construction and management. FAO Fisheries and Aquaculture Technical Paper. No. 539. Rome, FAO. 2010. 337p.

Skirtun, M., Sandra, M., Strietman, W.J., van den Burg, S.W.K., De Raedemaecker, F. & Devriese, L.I. (2022). Plastic pollution pathways from marine aquaculture practices and potential solutions for the North-East Atlantic region. Mar Pollut Bull, 174, 113178. doi:10.1016/j.marpolbul.2021.113178

Tian, Y., Yang, Z., Yu, X., Jia, Z., Rosso, M., Dedman, S., Zhu, J., Xia, Y., Zhang, G., Yang, J. & Wang, J. (2022). Can we quantify the aquatic environmental plastic load from aquaculture. Water Res, 219, 118551. doi:10.1016/j.watres.2022.118551

UNEA (2014). Resolution 1/6 Marine plastic debris and microplastics. Resolutions and decisions adopted by the United Nations Environment Assembly of the United Nations Environment Programme at its first session on 27 June 2014, Nairobi, Kenya. http://wedocs.unep.org/bitstream/handle/20.500.11822/17285/K1402364.pdf

UNEA (2016). Resolution 2/11 Marine litter and microplastics. Resolutions and decisions adopted by the United Nations Environment Assembly of the United Nations Environment Programme at its second session on 23-27 May 2016, Nairobi, Kenya. http://wedocs.unep.org/bitstream/handle/20.500.11822/11186/K1607228_UNEPEA2_RES11E.pdf

UNEA (2018). Resolution 3/7 Marine litter and microplastics. Resolutions and decisions adopted by the United Nations Environment Assembly of the United Nations Environment Programme at its third session on 4-16 December 2017, Nairobi, Kenya. https://wedocs.unep.org/bitstream/handle/20.500.11822/22773/K1800210%20-%20UNEP-EA-3-RES-7%20-%20Advance.pdf

UNSDG (2018). Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. Targets and Indicators of the United Nations Sustainable Development Goals. https://sustainabledevelopment.un.org/sdg14

van der Hoop, J.M., Moore, M.J., Barco, S.G., Cole, T.V.N., Daoust, P., Henry, A.G., Mcalpine, D.F., Mclellan, W.A., Wimmer, T. \& Solow, A.R. (2013). Assessment of Management to Mitigate Anthropogenic Effects on Large Whales. Conserv Biol 27(1): 121-133. doi:10.1111/j.1523-1739.2012.01934.x

Wilcox, C., Mallos, N.J., Leonard, G.H., Rodriguez, A. \& Hardesty, B.D. (2016). Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife. Mar Policy 65: 107-114. doi:10.1016/j.marpol.2015.10.014

World Bank (2018). Indonesia Marine Debris Hotspot Rapid Assessment: Synthesis Report. World Bank Group and Coordinating Ministry of Marine Affairs, Government of Indonesia. https://documents1.worldbank.org/curated/en/983771527663689822/pdf/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report.pdf

WWF-Indonesia (2014). Better Management Practices - Manual for Small Scale Fishery. Seaweed Farming - Cottonii

(Kappaphycus alvarezii), Sacol (Kappaphycus striatum) and Spinosum (Eucheuma denticulatum). World Wide Fund for Nature - Indonesia.

Zabka, T.S., Haulena, M., Puschner, B., Gulland, F.M.D., Conrad, P.A. \& Lowenstine, L.J. (2006). Acute Lead Toxicosis in a Harbor Seal (Phoca vitulina richardsi) Consequent to Ingestion of a Lead Fishing Sinker. J Wildl Dis 42(3): 651-657. doi:10.7589/0090-3558-42.3.651

ANNEX

Members of the National Coordination Team for Handling Marine Debris

Via Presidential regulation 83/PERPRES/2014 on Marine Debris Management, the Government of Indonesia has established a National Coordination Team for Handling Marine Debris (TKN-PSL, *Tim Koordinasi Nasional Penanganan Sampah Laut*). The various members of the TKN-PSL are listed in the table below, together with a summary of roles and responsibilities relevant for the management of EOLFG, ALDFG and ALDAG.

POSITION / INSTITUTION	KEY ROLE(S)
Minister of **Coordinating Ministry for Maritime and Investments Affairs (CMMAI)** or *Kementerian Koordinator Bidang Kemaritiman dan Investasi* (**KEMENKO-MARVES**)	The Lead of National Task Force of TKN PSL - Submits a report on the implementation of the Action Plan to the President at least once a year or at any time if necessary
Minister of **Ministry of Environment and Forestry (MEF)** or *Kementerian Lingkungan Hidup dan Kehutanan* (**KLHK**)	Daily Chief Executive of TKN PSL together with the leaders of national task force of TKN PSL to submit a report on the implementation of the Action Plan to the President at least once a year or at any time if necessary
• Director-General of Waste Management, Hazardous Waste and Toxic Materials or *Direktur Jenderal Pengelolaan Sampah, Limbah, dan Bahan Beracun Berbahaya* (KLHK)	Secretary of TKN PSL and lead of the implementing team of the national task force
• Director-General of Pollution Control and Environmental Damage or *Direktur Jenderal Pengendalian Pencemaran dan Kerusakan Lingkungan* (KLHK)	Advisor of implementing team of the national task force
• Assistant Deputy for **Empowerment of Science and Maritime Technology** or *Asisten Deputi Pendayagunaan Ilmu Pengetahuan dan Teknologi Maritim* (KEMENKO-MARVES)	Assistant Secretary of TKN PSL and Assistant of Lead for the implementing team

POSITION / INSTITUTION	KEY ROLE(S)
• Director of **Waste Management** or *Direktur Pengelolaan Sampah* (KLHK)	Coordinator of working groups 2 for land-based waste management And secretary-I of implementing team
• Director of **Pollution and Damage Control of Coastal and Marine** or *Direktur Pengendalian Pencemaran dan Kerusakan Pesisir dan Laut* (KLHK)	Secretary II of implementing team
• Deputy for **Coordination of Human Resources, Science and Maritime Culture** or *Deputi Bidang Koordinasi SDM, IPTEK dan Budaya Maritim* (KEMENKO-MARVES)	Advisor of implementing team of the national task force
Minister of **Ministry of Home Affairs (MHA)** or *Kementerian dalam Negeri* (**KEMENDAGRI**)	Member of TKN PSL
Minister of **Ministry of Foreign Affairs (MFA)** or *Kementerian Luar Negeri* (**KEMENLU**)	Member of TKN PSL
Minister of **Ministry of Finance (MF)** or *Kementrian Keuangan* (**KEMENKEU**)	Member of TKN PSL
• Head of **Center of State Revenue Policy** or *Kepala Pusat Kebijakan Pendapatan Negara* (KEMENKEU)	Coordinator of working groups 4 for mechanisms for strengthening institutions, supervision, and legal entities
Minister of **Ministry of Industry (MI)** or *Kementerian Perindustrian* (**KEMENPARIN**)	Member of TKN PSL
Minister of **Ministry of Transportation** or *Kementerian Perhubungan* (**KEMENHUB**)	Member of TKN PSL
Minister of **Ministry of Marine Affairs and Fisheries (MMAF)** or *Kementerian Kelautan dan Perikanan* (KKP)	Member of TKN PSL
• Director of Coastal and Small Island Utilization or *Direktur Pendayagunaan Pesisir dan Pulau-Pulau Kecil* (KKP)	Coordinator of Working Groups 3 for waste management in coastal and marine
Minister of **Ministry of Public Works and Housing** (MPWH) or *Kementerian Pekerjaan Umum dan Perumahan Rakyat* (**KEMEN-PUPR**)	Member of TKN PSL
Ministry of Health (MH) or *Kementerian Kesehatan* (KEMENKES)	Member of TKN PSL
Minister of **Ministry of Education and Culture** or *Kementerian Pendidikan dan Kebudayaan* (KEMENDIKBUD)	Member of TKN PSL
• Director of **Elementary School Development** or *Direktur Pembinaan Sekolah Dasar* (KEMENDIKBUD)	Coordinator of Working Groups 1 for National Movement to Raise Awareness of Stakeholders

POSITION / INSTITUTION	KEY ROLE(S)
Minister of **Ministry of Research, Technology and Higher Education (MRTHE)** or *Kementerian Riset, Teknologi, dan Pendidikan Tinggi*	Member of TKN PSL
• Director of Research and Development System - **Ministry of Research, Technology and Higher Education** Direktur Sistem Riset dan Pengembangan – Kementerian Riset, Teknologi dan Pendidikan Tinggi	Coordinator of working group 5 – Research and Development
Minister of **Ministry of Communication and Informatics (MCI)** or *Kementerian Komunikasi dan Informatika* (**KEMENKOMINFO**)	Member of TKN PSL
Minister of **National Development Planning Agency (NDPA)** (*Badan Perencanaan dan Pembangunan Nasional* / **BAPPENAS**)	Member of TKN PSL
Minister of **Ministry of Cooperatives and Small and Medium Enterprises (MCSME)** or Kementerian Koperasi dan Usaha Kecil Menengah (**KEMENKOP-UKM**)	Member of TKN PSL
Minister of **Ministry of Tourism and Creative Economy (MTCE)** or Kementerian Pariwisata dan Ekonomi Kreatif (**KEMENPAREKRAF**)	Member of TKN PSL
Cabinet Secretariat (CS) of the Republic of Indonesia	Member of TKN PSL
Head of **Indonesian Maritime Security Agency (IMSA)** or *Badan Keamanan Laut Republik Indonesia* (**BAKAMLA**)	Member of TKN PSL

Monitoring progress in reducing plastic marine debris from fisheries and aquaculture

The Evidence Base from Capture Fisheries report that accompany this Options Paper has attempted to quantify the leakage of marine debris to the marine environment from fisheries and aquaculture, as well as the amount of plastic material being landed as EOLFG. These estimates were hindered by the current limited availability of data on plastic usage and disposal. This section provides an overview of proposed methodologies to improve the data available to establish baselines and to monitor progress over time. For additional detail, the reader is directed to the accompanying reports Evidence Base – Capture Fisheries.

CAPTURE FISHERIES

A 'mass balance approach' is proposed to estimate EOLFG and ALDFG weights and monitor changes over time. This approach requires information on the quantity of new material entering the fishery (replenishment rate), the quantity of material exiting the fishery as EOLFG, and the remaining quantity which represents ALDFG (Table 1, Figure 4).

Table 1. Key elements of a mass balance approach to monitoring ALDFG.

[Total Wt. FG Deployed] = [Wt. Baseline FG] + [Wt Replenished FG]

[Wt Replenished FG] = [Wt. of EOLFG] + [Wt. ALDFG]

ELEMENT OF MASS BALANCE	DESCRIPTION
[Wt. Baseline FG]	Weights of floats, netting and ropes - calculated from fishing gear plans
[Wt Replenished FG]	Approximate weights of floats, netting and ropes replenished – available from surveys of fishing vessel operators. More precise weights for replenishment can be obtained from gear suppliers reporting replenishment to a vessel
EOLFG	Can be obtained from monitoring of offloaded weights of floats, netting and ropes reported by individual vessels
[Wt. ALDFG]	A proxy value for ALDFG can derived from: [Wt. Baseline FG] + [Wt Replenished FG] - [Wt. of EOLFG]

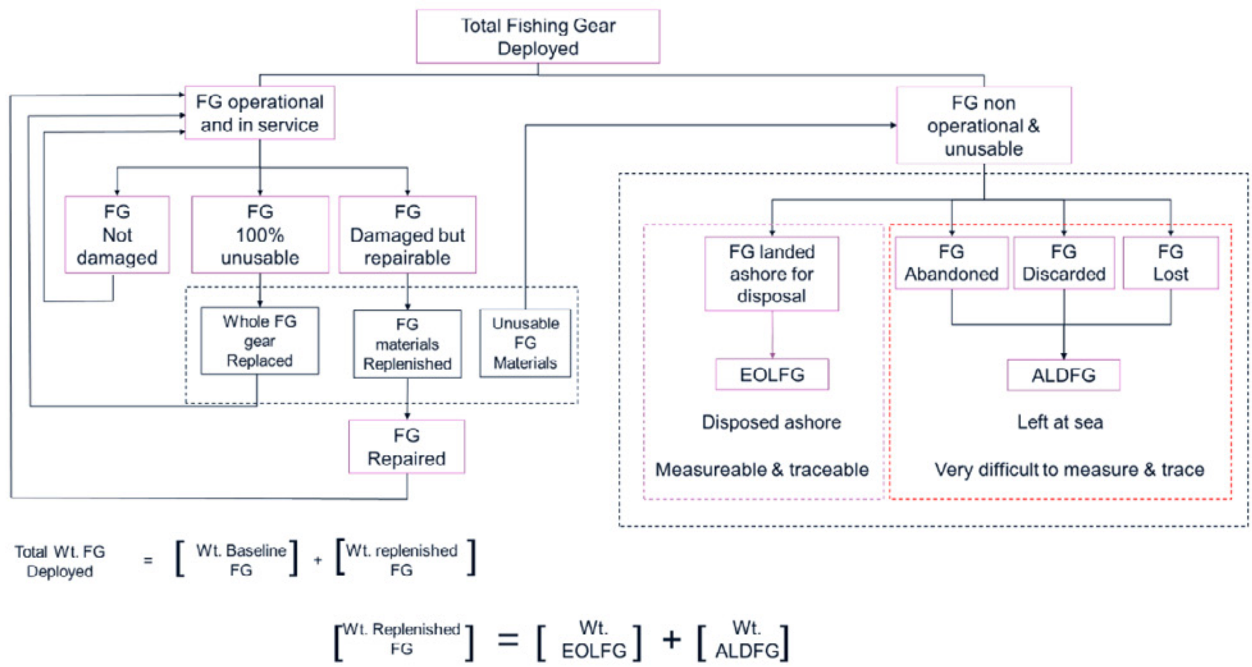


Figure 4. Components of fishing gear contributing to the mass balance method

The approach aims to:

1. Establish a single fishing unit (e.g. a single vessel, or group of vessels) whose inputs (new gear) and outputs (EOLFG) are fully traceable.
2. Establish the current baseline in terms of the total weight of fishing gear held by the fishing unit (X).
3. Record fishing gear weights (mass) purchased by each vessel, tracked via its license number (Z)
4. Record weights of EOLFG landed ashore after each trip and recorded in an official port reception facility (Y).
5. Record estimated weights of fishing gear "reported as lost" by vessel operators (tracked via its license number).
6. Record estimated weights of abandoned, lost or discarded fishing gears that were retrieved at sea by each trip and submitted to an official port reception facility.
7. Annual mass balance calculations can then be conducted for each vessel to estimate the ALDFG (i.e., ALDFG =(X+Y) - Z). Risk-based audits could be carried out to verify gear inventories and cross-check records reported in connection with Y and Z.

Initially, the system records will be dominated by weights of fishing gears deployed by vessels and weights of replacement fishing gears added to the vessel. Over time, as vessels land their EOLFG ashore and weights recorded at port reception facilities, the model will start to estimate the weights of ALDFG at the vessel and fleet levels. It is anticipated that EOLFG reporting rates for individual vessels within a fleet will be distributed around a mean. EOLFG non-reporting vessels and vessels with very low EOLFG weight reporting vessels indicate potential risk of at-sea disposal behavior and could help to identify vessels for follow up investigations by compliance officers. On the other hand, very high EOLFG reporting may highlight specific problems with gear loss in the fishery. Accordingly, *post factum* analysis of mass balance data records can provide detailed vessel and gear plastic disposal patterns.

Given the potential complexities of this system, it is suggested that (i) it is rolled out slowly, focusing on the high-risk gears (e.g. gillnets and traps) and those with a large mass of EOLFG (e.g. ring nets and purse seines) as identified by this study and (ii) undergoes extensive design and piloting (see Actions 5.08 – 5.14). These pilots could focus on well-established fishing units (e.g. fishing gear / vessel size class / target species) where the inputs (e.g. new gear), outputs (e.g. end of life gear) and gear inventories (e.g. fishing gear held on board or on shore) can be monitored and verified relatively easily.

AQUACULTURE

The challenges of monitoring debris from aquaculture are quite different from that of capture fisheries. This is mainly due to the different nature of loss – the mainly persistent low-level leakage, largely of SUPs with the occasional pulse of material from intermittent catastrophic losses (e.g. through storms or coastal flooding) – means that both reporting and tracking will be expensive and possibly less cost-effective. ALDAG is likely to be less widespread than capture fisheries ALDFG, as in Indonesia the vast majority of marine aquaculture activities take place on the coast or in inshore waters, rather than offshore.

As a result, no single indicator or approach is proposed for the monitoring of marine plastic loss from aquaculture. Instead, there are several different approaches that could be taken (Table 2).

Table 2. Approaches, indicators, scope and methodologies for monitoring aquatic debris from aquaculture

APPROACH	INDICATOR	SCOPE	METHODOLOGY
Bay-level aquaculture litter surveys	Actual weight of aquaculture-derived plastic debris & litter per 100 m shoreline (kg per 100 m) at time of survey.	Semi-enclosed bay areas or shoreline areas with historical deposition patterns of aquaculture-derived debris.	Burgess *et al* 2021; Cuong et al (2021)
Mass balance estimates	Estimates of weight of abandoned, lost, discarded aquaculture gear (kg per year[5]).	Defined aquaculture production units e.g. 1 mt seaweed production from a longline system; 1 mt biomass from a coastal fish/shrimp pond.	To be developed, but similar to the mass balance approach for ALDFG (see **S 8.1**)
At sea debris monitoring via seabed trawl surveys	Actual weight of aquaculture-derived plastic debris and litter in seabed trawl surveys ((kg) per swept square kilometer recovered (by location, vessel type as well as other parameters such as substrate & gear type).	Located in known / modelled debris deposition 'hotspots'. Could be as part of wider marine plastic monitoring, or specifically for aquaculture in known problem areas, or after a major loss (e.g. after coastal flooding / storms).	Galgani & Pihi, 2010; Cheshire et al, 2009

[5] Could be per 'aquaculture unit' e.g. one mt wet weight production or 1 hectare of coastal pond area

Bay-level intertidal litter surveys

Bay level marine litter surveys could be developed in either semi-enclosed bays where there are concentrations of either inter-tidal / sub-tidal seaweed or finfish cage aquaculture, or where there are historical accumulations of aquaculture-derived debris, including from shrimp / fish coastal pond farms.

The scope of survey and monitoring is limited to high-tide and intertidal zones. A 100m section of shoreline is selected, of which three cross-sections are randomly selected. Each cross-section is 5m wide and extends from the high water mark to the water. Surveys are ideally carried out at low tide. Waste is collected from each selected section.

Following Burgess et al., (2021), the waste collected will include a range size of 2.5 cm and above, which can then be classified into 42 categories: plastic (18 types), glass (4 types), metal (4 types), rubber (5 types), paper (4 types), fabric (6 types) and mixed waste.[6] From this survey, it is possible to estimate (i) the proportion of marine litter by types and/or sources of plastic waste discharged, (ii) the average density / abundance of marine litter (kg per 100 m²) and (iii) the total volume of plastic litter by categories/types in the given area. Categorization could be tailored for specific aquaculture debris and litter survey. Survey results would (i) improve understanding of the overall trends in shoreline marine litter deposition; and (ii) identify the relative contribution of aquaculture to this debris load.

This approach has several advantages. The methodology is well established, cheap, easy to implement and can provide useful information on long-term trends in marine debris abundance and deposition levels. A disadvantage is that it will not provide absolute quantification of aquaculture debris loss.

The methodology is also suitable for delegation to and/or adoption by local communities who may have concerns about the level of aquaculture-derived debris, other affected blue economy sectors such as tourism, as well as local aquaculture companies who are considering their social license to operate.

Farm-level and sector-wide mass balance estimates

A mass balance approach could be implemented similar to that proposed for Capture Fisheries. Quantities of unaccounted plastic would be estimated through quantifying (i) baseline plastic stocks held by a farming unit (X); (ii) weights of new plastic brought onto the farm (in terms of both equipment as well as single-use plastics e.g. feed sacks) (Z); and (iii) weights of plastics disposed of in the form of end-of-life equipment and single-use plastics (Y). Any unaccounted for plastic is presumed to be lost to the marine environment, and can be calculated as (X+Y)-Z.
This approach is best used for discrete aquaculture units where some degree of traceability of inputs and outputs can be effectively and cost-efficiently maintained. Unlike in capture fisheries where large-scale, semi-automated data collection (e.g. via electronic monitoring) could be applied, for aquaculture a stratified sampling framework could be applied across different types and scales of aquaculture production, thus allowing the results to be extrapolated up to regional or national levels.

The advantage of this approach is that it has the potential to provide information on the quantities of plastic leaking to the marine environment. Its main disadvantage is the cost of implementation.

At-sea marine debris monitoring

This approach will detect and quantify the relative abundance of aquaculture and other types of marine litter on the seabed. It could be implemented via:

1. **Fishing for Litter programs**. Fishing for Litter marine debris recovery programs have been successfully implemented in several countries to encourage fishers and other marine users to retrieve marine litter encountered or caught in fishing gears. The retrieved litter is landed ashore for analysis and responsible disposal. One of the longest running and most documented programs is the European 'Fishing for Litter' initiative. The European Union (EU) Marine Strategy Framework Directive specifically addresses marine litter, and it is therefore included in EU Member State monitoring programs for marine waters. The EU Directorate-General for the Environment established a Technical Subgroup on Marine Litter to identify and develop methodologies for marine litter assessment including 'Guidance on Monitoring of Marine Litter in European Seas' (EC, 2013).
2. **Observational or scientific studies**. At-sea scientific observation has been implemented by several countries, and provides a degree of precision, survey replicability and data standardization. In the EU, the International Bottom Trawl Survey (IBTS) conducts regular surveys of fishery stocks. The survey has been extended to incorporate marine litter variables. At-sea scientific surveys can be costly, and the IBTS has enabled these costs to be minimized by combining data collection with other surveys.

In Indonesia there are currently no regular scientific trawl surveys being carried out that could be adopted for marine litter sampling. Options for scientific marine litter sampling are either to (i) charter a dedicated fishing vessel with a fishing master and a standardized fishing rig to conduct non-commercial marine litter surveys in different locations; or (ii) deploy trained observers onboard commercial fishing boats to collect and analyze marine litter caught during commercial fishing hauls. The second option, though likely to deliver more variable results due to the wide variety of vessels and gear configurations, is also likely to be most cost-effective.

[6] See NOAA Marine Debris Monitoring and Assessment Project Item Categorization Guide. https://marinedebris.noaa.gov/mdmap-protocol-documents-and-field-datasheets

ANNEX 3

Action Plan

Tables presented in this Annex summarize the actions described in Chapter 3. These tables have the following fields:

- **Action code:** A two-part numerical code identifying the specific actions. The first part indicates the category,[7] and the second part indicates the sequencing of activities.
- **Precursor action(s):** The action code for any immediate precursor activity (i.e., an action that must be in place before the current action can be implemented).
- **Action title:** The name and brief description of the action.
- **Investment type:** categorization of the action into the following four types:
  a. Institutions & systems — investment into institutional development and associated governance / management systems.
  b. Infrastructure & equipment — investment into physical infrastructure and / or equipment.
  c. Capacity-building — investments in training or other awareness-building, including the development of good practices and other capacity-building measures.
  d. Other — other types of investment that do not fall into the three categories above.
- **Lead agency:** the institution or organization responsible for leading an action.
- **Partner agencies (x2)**: the institutions or agencies working with the lead to implement an action.
- **Timing:** the timing of the action implementation over the following three time periods:
  a. Short-term (less than (<) two years)
  b. Medium-term (two to five years)
  c. Long-term (six to ten years and beyond)
- **Priority**: Irrespective of the timing of the action implementation (see above) the priority in terms of high, medium or low. Priority is assigned based on a combination of the urgency, feasibility, chance of success and estimated effort.
- **Cost:** the estimated cost band according to the following three categories:
  a. High (> USD 5 mill.)
  b. Medium (USD 500K - 5mill.)
  c. Low (< USD 500K)

OPERATIONALIZE PLASTIC WASTE MANAGEMENT IN INDONESIA'S FISHERIES SECTOR

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
1.01		**Establish a high level National Task Force for managing the use of plastic in fisheries & aquaculture**	1. Institutions & systems	KKP	TKN PSL		Short-term (< 2 yrs)	1. High	Low (< USD 500K)
1.02	1.01	**Technical Working Group (TWG) for EOLFG, ALDFG and Plastic Garbage from fisheries**	1. Institutions & systems	KEMENKO-MARVES	TKN PSL		Long-term (6-10 yrs)	1. High	Low (< USD 500K)
1.03	1.01	**Design and run an Indonesian Ghost Gear Fund (GGF)**	1. Institutions & systems	KEMENKEU	KKP		Short-term (< 2 yrs)	1. High	High (> USD 5 mill.)

[7] 1. Operationalize plastic waste management in Indonesia's fisheries sector; 2. Prevent ALDFG; 3. Prevent ALDAG; 4. Recover ALDFG and ALDAG; 5. Promote a circular economy for end-of-life fishing and aquaculture equipment; and 6. Improve monitoring and reporting of EOLFG, ALDFG and ALDAG.

PREVENT ALDFG

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
2.01	1.01	**Building cross-ministry capacity to provide oversight and coordination to development and implementation of technical measures**	3. Capacity-building	KKP	FAO	Academia	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.02	1.02	**Building technical capacity within MMAF Directorates to implement the work program**	3. Capacity-building	KKP	FAO	Academia	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.03	2.01, 2.02	**Fishery Specific Risk Assessments (PS-GNS-FPO)**	1. Institutions & systems	KKP	FAO	Academia	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.04	2.03	**Desk-based analysis of Risk Assessments and identification of technical measures**	1. Institutions & systems	KKP	TKN PSL	KEMENHUB	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.05	2.02	**Field Surveys of vessel operators and license holders**	3. Capacity-building	KKP	TKN PSL	KEMENHUB	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.06	2.01	**Policy and legal frameworks for technical measures**	1. Institutions & systems	KKP	FAO	Academia	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
2.07	2.06	**Linking e-reporting and e-monitoring of plastic waste to Fisheries Act and to fishing vessel licensing**	5. Other	KKP	KEMENHUB	FAO	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.08	2.06	**Preparation of draft policy, legislative amendments and regulations**	1. Institutions & systems	KKP	KEMENHUB	FAO	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
2.09	2.03	**Development of National Standards for Marking of Vessels and Fishing Gears**	1. Institutions & systems	KKP	KEMENHUB	Academia	Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
2.10	2.04	**Selection and design of deghosting technologies**	1. Institutions & systems	KKP	Academia	FAO	Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
2.11	2.09	**Fleet Separation Schemes**	1. Institutions & systems	KKP	Academia	FAO	Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
2.12	2.01, 2.10	**Roll out of technical measures**	1. Institutions & systems	KKP	Academia	FAO	Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
2.13	2.02, 2.05, 2.09	**Development of best practices for management of fishing gear**	3. Capacity-building	KKP	Academia	FAO	Medium-term (2-5 yrs)	2. Medium	Low (< USD 500K)
2.14	2.13	**Outreach and communication products related to ALDFG**	4. Other	KKP	Academia	FAO	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)

PREVENT ALDAG

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
3.01	2.01	**Technical standards for aquaculture infrastructure**	1. Institutions & systems	KKP	MRTHE	Academia	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
3.02	3.02	**Technical regulations for aquaculture infrastructure**	1. Institutions & systems	KKP	MRTHE	Academia	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
3.03	2.01, 2.02	**R&D into domestically-produced aquaculture components**	1. Institutions & systems	KKP	MRTHE	Academia	Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
3.04	2.01	**Aquaculture risk assessment framework**	1. Institutions & systems	KKP	KEMENKO-MARVES	BAPPENAS	Medium-term (2-5 yrs)	2. Medium	Low (< USD 500K)
3.05	3.04	**Aquaculture risk assessment & contingency planning models**	1. Institutions & systems	KKP	Academia		Medium-term (2-5 yrs)	2. Medium	Low (< USD 500K)
3.06	3.05	**Training in risk assessment & contingency planning**	3. Capacity-building	KKP	KEMENDIKBUD	Academia	Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
3.07	2.11	Minimize spatial conflict with other sea users	1. Institutions & systems	KKP	TKN PSL		Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
3.08	2.09	Marking of aquaculture facilities	1. Institutions & systems	KKP	DJPL	FAO	Short-term (< 2 yrs)	2. Medium	Medium (USD 500K - 5mill.)
3.09	3.01	**Responsible decommissioning of redundant aquaculture sites**	1. Institutions & systems	KKP	NGOs		Medium-term (2-5 yrs)	3. Low	Low (< USD 500K)
3.10	1.02	Use of EPR or other financial mechanisms to ensure responsible decommissioning	1. Institutions & systems	KKP	KEMENKEU		Medium-term (2-5 yrs)	3. Low	Medium (USD 500K - 5mill.)
3.11	3.04	**Technical guidelines for plastic waste management in aquaculture industry**	1. Institutions & systems	KKP	KLHK	TKN PSL	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
3.12	3.11	**Codes of good practice & guidance**	3. Capacity-building	KKP	NGOs		Short-term (< 2 yrs)	1. High	Low (< USD 500K)
3.13	3.12	**Awareness-building**	3. Capacity-building	KKP	NGOs	KEMENDIK BUD	Short-term (< 2 yrs)	1. High	Medium (USD 500K - 5mill.)
3.14	3.12	**Development of the IndoGAP certification standard to include marine plastics**	1. Institutions & systems	KKP	KAN		Short-term (< 2 yrs)	1. High	Low (< USD 500K)
3.15	3.14	**Plastic waste management in 3rd party aquaculture certification**	1. Institutions & systems	KKP	NGOs		Short-term (< 2 yrs)	1. High	Low (< USD 500K)

RECOVER ALDFG AND ALDAG

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
4.01	1.01	**Ghost Gear Recovery Working Group**	1. Institutions & systems	KKP	KLHK	NGOs	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
4.02	4.01	**Ghost gear hotspot identification**	4. Other	KKP	KLHK	NGOs	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
4.03	4.01	**Ghost Gear Recovery Planning**	1. Institutions & systems	KKP	NGOs		Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
4.04	4.03	**Ghost Gear Recovery Missions**	3. Capacity-building	KKP	NGOs		Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)
4.05	4.03	**Establish a Fishing for Litter scheme**	1. Institutions & systems	KKP	NGOs		Short-term (< 2 yrs)	1. High	Medium (USD 500K - 5mill.)
4.06	4.05	**Fishing for Litter promotion and awareness-raising**	3. Capacity-building	KKP	TKN PSL		Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
4.07	5.04	**Port Reception Facilities**	2. Infrastructure & equipment	KKP	TKN PSL		Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)

PROMOTE A CIRCULAR ECONOMY FOR END-OF-LIFE FISHING AND AQUACULTURE EQUIPMENT

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
5.01	3.06	**EOLFG Value Chain Pilots**	1. Institutions & systems	KKP	KEMENPARIN	TKN PSL	Short-term (< 2 yrs)	1. High	Medium (USD 500K - 5mill.)
5.02	4.01	**EOLFG Recycling & treatment incentives**	2. Infrastructure & equipment	KKP	KEMENPARIN	TKN PSL	Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
5.03	4.01	**EOLFG Buy back scheme**	1. Institutions & systems	KKP	KEMENPARIN	TKN PSL	Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
5.04	4.01	**EOLFG Port Reception Facilities**	2. Infrastructure & equipment	KKP	TKN PSL		Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
5.05	1.03	**Fishing Gear Circular Design**	4. Other	KKP	MRTHE	TKN PSL	Medium-term (2-5 yrs)	1. High	Medium (USD 500K - 5mill.)

IMPROVE MONITORING AND REPORTING OF EOLFG, ALDFG AND ALDAG

Action code	Precursor action(s)	Action title	Investment type	Lead agency	Partner agency (1)	Partner agency (2)	Timing	Priority	Cost
6.01	1.02	**Establish a team (E-R / E-M) to provide technical oversight, coordination and backstopping**	1. Institutions & systems	KKP	KEMEN-PUPR	Academia	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
6.02	6.01	**Build capacity in E-R & E-M systems**	1. Institutions & systems	KKP	KEMEN-PUPR	Academia	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
6.03	2.08	**Indonesian Policy & Regulatory frameworks for plastic waste from fishing vessels**	4. Other	KKP	KEMENHUB	DJPL	Short-term (< 2 yrs)	1. High	Low (< USD 500K)
6.04	6.02	**Completion of preparatory (baseline) data to support E-R and E-M reporting**	1. Institutions & systems	KKP	BPS	Academia	Short-term (< 2 yrs)	1. High	Medium (USD 500K - 5mill.)
6.05	6.04	E-R / E-M System evaluation	1. Institutions & systems	KKP	KEMEN-PUPR	Academia	Medium-term (2-5 yrs)	1. High	Low (< USD 500K)
6.06	6.04	**National Roll out of E-R / E-M systems**	1. Institutions & systems	KKP	KEMEN-PUPR	Academia	Long-term (6-10 yrs)	2. Medium	Medium (USD 500K - 5mill.)
6.07	6.06	Communication products	3. Capacity-building	KKP	NGOs		Short-term (< 2 yrs)	1. High	Low (< USD 500K)
6.08	6.01	Aquaculture debris reporting: feasibility study and design	2. Infrastructure & equipment	KKP	KLHK	TKN PSL	Short-term (< 2 yrs)	2. Medium	Low (< USD 500K)
6.09	6.08	Aquaculture debris reporting: Implementation	2. Infrastructure & equipment	KKP	KLHK	TKN PSL	Medium-term (2-5 yrs)	2. Medium	Medium (USD 500K - 5mill.)
6.10	6.08	Community-based reporting of ALDAG	3. Capacity-building	KKP	Academia	NGOs	Short-term (< 2 yrs)	1. High	Low (< USD 500K)

COORDINATING MINISTRY
FOR MARITIME AFFAIRS AND INVESTMENTS
REPUBLIC OF INDONESIA

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

ISOP INDONESIA
Indonesia Sustainable Oceans Program

OCEANS MDTF