

The work area onboard for fishers has also seen significant change. After the boat reconfiguration, the 72-m² living area is now shared by only 17 fishers (excluding the skipper), hence each fisher now has 4.23 m² of workspace versus the 2.48 m² before. This means that the fishers no longer work in such a crowded space, which has been notoriously dangerous in the fishing industry, this means safer work conditions.

Fuel costs are largely unchanged after the reconfiguration. The vessel owner however noted that any increases in fuel usage due to the installation of the crane are offset by the reduction in the number of fishers onboard. SEAFDEC is planning to change the configuration of the refrigeration system starting in late-2019 as the engineering team believes that such changes could lead to reduced energy costs. With regards to engines used in the fishing industry, certain more efficient fuel-injection engines have been in use elsewhere, but these are not available in Thailand and are three times more costly than the traditional engines. As a result, most vessel owners in Thailand have reportedly shown little interest in the lower-carbon types of engines. Meanwhile, the owner of the pilot fishing vessel and SEAFDEC had estimated that the resale value of the vessel after the reconfiguration is about USD 330,000 an increase of about two-thirds of its USD 200,000–230,000 value before the changes.

Improvements in their working conditions had led to reduced turnover rate of fishers from 30 percent to effectively zero in the months after the reconfiguration. This demonstrates that the installation of basic power-hauling equipment on purse seiners can help alleviate labor shortages and improve the conditions of those working and living onboard the vessels. The total cost of the comprehensive reconfiguration carried out on the pilot fishing vessel (excluding the cost of acquiring new nets) is USD 58,330. This includes the central cooling system, refrigeration system, other installations, and the core reconfiguration: crane, power block, and hydraulic system. The investment cost for the vessel's reconfiguration is relatively high as far as the owners of even the smallest commercial fishing companies that own one or two fishing vessels. However, SEAFDEC is of the view that the investment costs could be reduced if only the core equipment are changed, *i.e.* crane, power block, and hydraulic system. The central cooling system, the refrigeration system, and the purchase of new purse seine nets are not necessary for the core reconfiguration, as vessel owners can make such additional improvements over time. Assuming that a ten percent increase in revenue per trip due to the enhanced cooling and refrigeration systems, from an average of USD 15,833 per trip to USD 17,416 per trip, at 30 trips per year, the increase in annual revenue during the second year after the reconfiguration is estimated at USD 47,500. Adding the savings from the labor cost of USD 29,138 per year, the total amount could easily cover the investment cost for the reconfiguration and installations in less than one year. The summary of the cost of the vessel reconfiguration and benefits gained is shown in **Table 67**.

Table 67. Summary of reconfiguration cost and benefits

Comprehensive Reconfiguration Cost (excluding new nets)	USD 58,333
Estimated increase in revenue per year after reconfiguration	USD 47,500
Savings from labor cost per year after reconfiguration	USD 29,000
Return on investment (estimated period)	Less than 1 year

Way Forward

Currently, SEAFDEC/TD is undertaking this activity under the Japanese Trust Fund Project “Responsible Fishing Technologies and Practices” that includes 1) marine engineering technologies (*i.e.* fuel efficiency, greenhouse gas reduction, and safety of fishing operation at sea) at the national and regional level; and 2) the development of fish handling techniques onboard fishing vessels. The R&D on the development of appropriate technologies to reduce carbon emissions to the environment at a low level in response to the issues of global crisis by climate change and reduce labor onboard by applying appropriate hauling devices to contribute to improving the national economies and fishers’ well-being onboard fishing vessels, would be enhanced and continued. The results of such activities would be shared by SEAFDEC/TD with the AMSs through the production of information and training materials/models that would be introduced through the training courses of SEAFDEC/TD on the improvement of appropriate fishing vessel technology in terms of marine engineering, and also through the SEAFDEC website. Capacity-building programs through online workshops and demonstrations, as well as hands-on practical sessions, could also be organized.

4.1.3 Abandoned, Lost or Otherwise Discarded Fishing Gear

Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a collective term for the various causes of loss of fishing gear as identified by Macfadyen, *et al.* (2009). The term “abandoned fishing gear” means fishing gear over which the operator or owner, although has the control, is unable to retrieve and deliberately leave the gear at sea due to force majeure or other unforeseen reasons. Meanwhile, “lost fishing gear” refers to fishing gear over which the owner or operator has accidentally lost control and can no longer be located and/or retrieved by the owner or operator. The term “discarded fishing gear” refers to fishing gear that is released at sea without any attempt by the owner or operator for further retrieval or recovery. Unless un-retrievable, fishing gear is deliberately abandoned by fishers at sea and becomes ALDFG because of bad weather, or injury of fishers, or mechanical failure of the fishing vessel, and finally the gear could no longer be retrieved. Fishers engaged in IUU fishing may also abandon their gears when at risk of being inspected or arrested, and in order to escape quickly, have to dispose of any evidence.

Gear is often lost due to snagging on obstructions in or on the water, the interaction between gears snagging on each other, and when it is impossible to retrieve even after all efforts are made. Discarded gear is usually a gear that had been damaged beyond repair and the vessel has nowhere to dispose of it properly and thus, is intentionally left at sea. Subsequently, ghost fishing is a related issue and easily occurs when ALDFG continues to efficiently catch and kill aquatic animals. There are various factors that affect the ability, efficiency, and duration of ALDFG to ghost fish. Aquatic animals could be caught in derelict nets and traps, while other gear types could attract scavenging aquatic animals and are subsequently caught, and thus, causing redundant loop and long-term ghost fishing due to their self-baiting mechanism.

The FAO-UNEP had undertaken few attempts since 2009 to quantify the approximate scale of the source of marine litter that includes ALDFG which contributes approximately 10 percent (640,000 mt) of global marine litter by volume (Macfadyen *et al.*, 2009), with land-based sources being the majority cause of marine debris in coastal areas. The Global Ghost Gear Initiative (GGGI) reported in 2018 that The Ocean Cleanup28 found ALDFG constituting 46 % of surface debris and 70 % of macro plastics. The large scale of fishing operations across the Asia-Pacific region generates ALDFG, but this is so far un-quantified because ALDFG is usually hidden under the water and is seldom seen as a threat until some marine mammals (*e.g.*, dugong, dolphin) or sea turtles wash up on a beach entangled in fishing gear or has died due to ingestion of plastic or fishing gear. Consistent data on ALDFG in Asia-Pacific fisheries operation is limited. Currently, the data is aggregated to marine litter information with no existing standardized and updated figures on ALDFG in fisheries. In 2021, a global marine pollution assessment conducted by the Alfred Wegener Institute for Polar and Marine Research estimated that fisheries-related wastes constituted a total of about 13.8 percent (**Figure 95**) of the total marine litter types (AWI Litterbase, 2021).

Among the marine debris pollutions, ALDFG is a problem that is an increasing concern in the Southeast Asian region as it leads widely to health-threatening of the ocean diversity, fisheries industries, and fisheries communities. ALDFG is a source of marine plastics and has a category on its own as the fishing industry in the Southeast Asian region had been largely dependent on such gear (Lyons *et al.*, 2019). It is difficult to exactly estimate the number of fishing activity that makes different contributions to the total marine litter based on locality, but it is clear that the majority of fishing takes place not only in marine environments but also in freshwater environments, and thus the latter, which also host major capture fisheries in some countries, could have facilitated some contributions to the litter.

Apparently, ALDFG contributes huge impacts on navigational hazards and associated safety issues, yet the ability of ALDFG to ghost fish has detrimental impacts on the fish stocks, with no means of generating economic benefits and with potential impacts on the vulnerable or threatened species and the benthic and intertidal environments. The extent and impacts of the problem are thought to have increased significantly over the last 50 years with the increasing levels of fishing capacity and activity in the world's oceans. The impact of fishing gear on the environment has been intensified by the utilization of non-biodegradable materials for fishing gear, primarily plastics, which are generally more persistent in the environment than materials sourced from nature. Therefore, without proper measures and management to address ALDFG, the amount of fishing gear remaining in the marine environment will continue to accumulate.

Fishing Gear Marking: A tool to cope with ALDFG issues

Globally, gillnets and trap fisheries have the most impacts as the highest risk of ghost fishing compared with other gear types such as fish aggregating devices (FADs), hooks and lines, bottom trawls, mid-water trawls, and seine nets that are found to have lesser impacts than the two fishing gears previously mentioned. This is likely to have the same tendency in the Southeast Asian region since gillnets and traps are widely used by fishers along the coastal areas. To mitigate the opportunity and risk of ghost fishing and ALDFG, properly marked gear can help identify the ownership and location of the gear and ascertain its legality. This has been an integral requirement of the Code of Conduct for Responsible Fisheries, which intends to create a disincentive for intentional abandonment or discarding of gear, increase the visibility of passive gear, which could reduce gear conflicts and damage by passing vessels, and reduce accidental gear loss. Remedial methods to mitigate ghost fishing include, for example, programs to detect and remove ALDFG, and the use of less durable and biodegradable materials for fishing gear to reduce their capability and duration in ghost fishing.

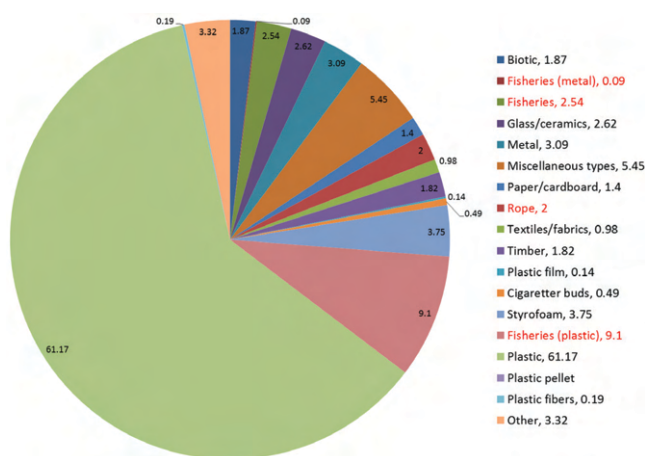


Figure 95. Global distribution of marine litter types in 2021 (%)
 Source: adapted from AWI Litterbase (2021)

In 2016, FAO published the “Abandoned, lost and discarded gillnets and trammel nets: Methods to estimate ghost fishing mortality, and the status of regional monitoring and management,” in order to focus on the issue of ALDFG contributing to marine litter. However, the marking of fishing gear as one of the measures to minimize ALDFG is still not universally applied. It has been recognized that properly marking fishing gear with gear tracking technology and an associated reporting system can reduce ALDFG and its impacts, including ghost fishing. Gear marking and tracking is an important tool for recovery of lost gear and to facilitate management measures for such actions as inappropriate disposal, as well as provide incentives for the proper management of fishing gear, including its disposal and recycling.

In 2018, FAO hosted the Technical Consultation for the Marking of Fishing Gear in Rome, Italy, which led to the publication of “The Voluntary Guidelines for the Marking of Fishing Gear” in 2019. FAO is now working at the global level with various partners to address ALDFG and microplastics. Consistent application of an approved gear marking system may also assist the application of measures to identify and prevent IUU fishing, which in turn should reduce gear abandonment and disposal at sea.

ASEAN Resolutions on Marine Debris

In November 2017, the ASEAN Conference on Reducing Marine Debris held in Thailand recommended an integrated land-to-sea policy approach by developing and implementing the Regional Action Plan for Combating Marine Debris in the Southeast Asian Region. Subsequently, the 34th ASEAN Summit in June 2019 adopted both the Bangkok Declaration on Combating Marine Debris in the ASEAN Region and the ASEAN Framework of Action on Marine Debris. These efforts demonstrate the commitment of the ASEAN to advance the concrete action on environmental protection.

As a follow-up, the ASEAN Regional Action Plan for Combating Marine Debris was developed from October 2019 to July 2020 through extensive consultations with relevant experts and stakeholders. Led by Thailand and with support from the World Bank, this Regional Action Plan proposes the phased implementation of a systematic and integrated response to guide regional actions in addressing the issue of marine plastic pollution in the ASEAN over the next five years (2021–2025). The Regional Action Plan for Combating Marine Debris will play an important role in helping the ASEAN to tackle plastic wastes and protect the vital marine environments that sustain the region for generations to come.

Regional and International Cooperation to Combat ALDFG in Southeast Asia

International recognition of marine litter is demonstrated by large numbers of international organizations and agreements that now focus specifically on ALDFG, in addition to numerous national and local-level initiatives that are being implemented around the world and in the Southeast Asian region. Recently, research on marine plastics, especially identification of their types and distribution, have been increasingly carried out and the results had been published by many environmental concerned authorities in the Southeast Asian region, but there are no published results of research studies on the ecological and environmental impacts of marine plastics. Moreover, there is a very limited number of published research studies on ALDFG in the Southeast Asian region.

In addressing the ALDFG issues, the concerned SEAFDEC Technical Departments, *i.e.* SEAFDEC Training Department (SEAFDEC/TD), Marine Fishery Resources Development and Management Department (SEAFDEC/MFRDMD), and Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDMD) embarked on some initiatives to acquire the necessary baseline information on some major types of fishing gear used in the region. Specifically, SEAFDEC/TD conducted a survey on gillnets, traps, and pots which are possibly the major types of ALDFG in the coastal areas. Results of the surveys and research works have identified the quantities and types of fishing gear that contribute to the ALDFG. Such initiatives would be beneficial to and the lessons learned and methodology on how to collect the primary information of the ALDFG would encourage the SEAFDEC Member Countries to commence research studies in their respective countries. The following are the initiatives carried out by the concerned SEAFDEC Technical Departments in cooperation with collaborating partners (**Box 12**).

National Initiatives/Activities on ALDFG and Marking of Fishing Gear

Recognizing the adverse impacts of ALDFG on the marine resources and environment, the Southeast Asian countries have attempted to address the issues on ALDFG at their respective national levels. Although it is not mandatory to adopt the Marking of Fishing Gear to primarily mitigate the quantity of the ALDFG discharged into the oceans, some Southeast Asian countries (**Box 13**) have already commenced some research works to demonstrate the rationale for Marking of Fishing Gear such as gillnets and pots in close collaboration with international agencies, *e.g.*, FAO or GGGI, by carrying out trials on various types of markings. Additionally, however, the application of the Marking of Fishing Gear is compulsory for some specific fishing gear and fishing grounds in some regions, such as

Box 12. Initiatives of concerned SEAFDEC Departments in addressing issues on ALDFG

<p>SEAFDEC/TD</p> <ul style="list-style-type: none"> • In 2020, SEAFDEC/TD has embarked on a 5-year project “Responsible Fishing Technology and Practices,” supported by the Japanese Trust Fund 6 Phase II. Considering that ALDFG is one of the emerging concerns and issues identified by SEAFDEC Member Countries at an Inception Meeting organized in late 2020, a series of ALDFG surveys had been conducted intensively in the Gulf of Thailand and the Andaman Sea through interviews using specific-designed questionnaire focusing on gillnets and traps (pots) fishing gears. Results of the surveys will be analyzed and shared with the SEAFDEC Member Countries to develop and apply the methodology to assess the quantity and measures to prevent the occurrence of ALDFG and its impacts in the region. While it is recognized that Fishing Gear Marking is one of the tools to mitigate the ALDFG, SEAFDEC/TD will simultaneously conduct a study on the suitable marking of fishing gear to be applied at the national and regional levels. • SEAFDEC/TD collaborated with the Food and Agriculture Organization (FAO) for the conduct of the ‘Survey to Estimate Levels of Abandoned, Lost or Otherwise Discarded Fishing Gear in Thailand: Gillnets and Trap Fisheries in 2021,’ using a preliminary questionnaire designed by FAO to collect information on ALDFG, e.g., gillnets and traps fisheries through face-to-face interview with fishers in Thailand. Results of this survey will be used as part of the ALDFG assessment at the global level and will be possibly applied for monitoring and reporting of ALDFG at national and regional levels. Moreover, in an upcoming collaborative activity between SEAFDEC/TD and the Bay of Bengal Large Marine Ecosystem (BOBLME) Phase II, SEAFDEC/TD will conduct a study on fishing gear marking in the Andaman Sea during 2022-2023. • SEAFDEC/TD carried out the Preliminary Investigation to Estimate the Abandoned, Lost and Discarded Traps (Pots) and Gillnets along the Coasts of Thailand, under the Project Responsible Fishing Technology and Practice, supported by the Japanese Trust Fund (JTF 6 Phase II) of the Government of Japan in 2020-2024
<p>SEAFDEC/TD- MFRDMD-IFRDMD Collaboration</p> <ul style="list-style-type: none"> • SEAFDEC/TD, SEAFDEC/MFRDMD, and SEAFDEC/IFRDMD had collaboratively initiated the Project “Regional Collaborative Research and Capacity Building for Monitoring and Reducing Marine Debris from Fisheries in Southeast Asia,” through the ASEAN Cooperation Project (Japan-ASEAN Integrated Fund or JAIF) during 2021-2023
<p>SEAFDEC/TD-BOBLME Phase II Collaboration</p> <ul style="list-style-type: none"> • SEAFDEC/TD-BOBLME Phase II (Bay of Bengal Large Marine Ecosystem) launched the 3-year Project “Sustainable Management of Fisheries, Marine Living Resources and their Habitats in the Bay of Bengal Region for the Benefit of Coastal States and Communities: Support to SEAFDEC Member Countries” with support from FAO/GEF

Box 13. Initiatives of some Southeast Asian countries to address the issues on ALDFG

<p>Malaysia: data collection and monitoring of ALDFG in artificial reefs by SCUBA diving undertaken by the Department of Fisheries (DOF) Malaysia, and implementation of the Marking of Fishing Gear targeting tuna long liners undertaken by DOF Malaysia in Penang, Malaysia</p>
<p>Philippines: implementation of the Marking of Fishing Gear for gillnets and pots undertaken by the Department of Agriculture - Bureau of Fisheries and Aquatic Resources (DA-BFAR) in collaboration with the FAO/IMO in Visayan Sea, Philippines</p>
<p>Thailand: experiment on Marking of Fishing Gear undertaken by the Department of Fisheries (DOF Thailand) on some commercial fishing gear, e.g. trawlers, purse seines and falling nets and entangling nets, of which the application of the marking of fishing gear is compulsory for some permitted fishing gear (e.g. gillnets, tuna purse seines operated in association with fish aggregating devices (FADs)) operated in the Indian Ocean to comply with the requirements of the Southern Indian Ocean Fisheries Agreement (SIOFA)</p>
<p>Myanmar: research survey on ALDFG undertaken by the Department of Fisheries of Myanmar in collaboration with the Fauna and Flora International (FFI) and Marine Ocean Project (MOP) in Myeik Archipelago in 2018, where gillnets were found as the most common type of gear used by small-scale fishers and now performing as ALDFG, although Marking of Fishing Gear is not yet implemented</p>
<p>Indonesia: implementation of a field project that focused on the practical application of marking of fishing gear (in general) undertaken by Ministry of Marine Affairs and Fisheries (MMAF) in collaboration with Global Ghost Gear Initiative (GGGI)</p>

those required by the regulations of the Southern Indian Ocean Fisheries Agreement (SIOFA).

Way forward

In addressing the issues on ALDFG and promotion of the Marking of Fishing Gear concept at the national and regional levels, some AMSs are progressively exerting their efforts in exploring the means and methods by implementing pilot projects and eventually coming up with some scopes, lessons learned, and valuable recommendations which could productively pave the way for future development of regional actions. Studies and trials on the Marking of Fishing Gear have been made recently by some AMSs (e.g., Indonesia (Dixon *et al.*, 2018), Thailand (Chumchuen &

Krueajun, 2021), and the results and recommendations are briefly summarized as follows:

- Marking of fishing gear can make use of great varieties of materials, namely: metal, plastic, bamboo, coconut shell, and others as they are affordable and available locally. An advance innovation, “FibreCode” tags similar to a barcode, provides user-level identification upon scanning through a mobile device, and could also be applied as an option which will then be assessed using a multi-criteria analysis to determine the preferred method
- Further studies and development efforts should be carried out to improve the suitable materials used for gear marking, the appropriate installation methods, and the effective cost for fishing gear marking, and

to explore the possibility of embedding the fibers into appropriate non-plastic materials to ensure eco-friendliness and readability of information in the fibers using an electronic device

- Gear marking study must be implemented in the context of broader measures for managing fishing gear and wider fisheries management measures as gear marking alone is unlikely to address the issues related to ALDFG and ghost fishing which are apparent in small scale-scale fisheries and probably in other similar fisheries particularly practiced in developing countries
- o Awareness building on the benefits of gear marking can lead to fishers' voluntary application provided they are incentivized, for rigid legislative control and enforcement may not be appropriate for small-scale fisheries
- The government's support is anticipated by most fishers for the application of fishing gear marking practice, especially the cost of producing the markers
- Developing a system of reporting lost gear is necessary to help retrieve lost gear and to enable data collection and increase the chances of lost gear retrieval, although incentives and benefits should also be incorporated with the reporting system
- Strengthening fishers' education and awareness building, capacity building, in general, should be promoted together with spatial management of fishing effort and circular economy approach to managing of the end-of-life gear

Lessons learned from the aforesaid initiatives should be analyzed and considered in developing the appropriate guidelines or standard operating procedures (SOPs) for the marking of fishing gear in the Southeast Asian region. Nevertheless, in the development of the guidelines or SOPs, the concerns of small-scale fishers should be taken into consideration since most of the gear involved in the ALDFG issues are being operated by small-scale fisheries in the region.

4.2 Challenges and Future Direction

A wide range of commercial fishing technologies has been utilized by the fishing industry of the AMSs with a view to maximizing fish catch (including those of other aquatic animals) to meet the increasing demand for food. Nonetheless, excessive fishing including the practice of adopting irresponsible technologies and practices have led to the deterioration of fishery resources, *e.g.* increased catch of juveniles and low-value fish by non-selective gears such as trawls, use of fish aggregating devices/techniques (*e.g.* luring light) in purse seine operations without appropriate regulation and management, use of bottom tow gears such as dredges that impact on the environment especially the benthic communities and habitats, losing or discarding gears that continue to fish and create negative impacts on marine organisms and the ecosystems. Understanding the impacts

as well as the development of appropriate technologies and practices are therefore necessary to mitigate such possible impacts from fishing operations. Also, the adoption of novel technologies is also crucial for fishing operations to be undertaken in a responsible manner toward the sustainability of the resources, minimizing the impacts of fishing on the environment, and reducing greenhouse gas (GHG) emission and the impacts of fishing on the climate in the future. Thus, the AMSs and relevant institutions and organizations should consider the following aspects in their efforts toward enhancing the promotion of responsible fishing practices toward sustainable utilization of fishery resources:

Understanding the impacts of fishing gears on resources/habitats

- The AMSs, relevant organizations, and institutions to consider undertaking research studies on the impacts of fishing gears on the fishery resources (*e.g.* target species, associated and dependent species, marine mammals) and the habitats; and on the development of appropriate mitigations of the impacts. Research studies should also be undertaken to establish the technical measures for reducing the unintentional mortality of non-target marine resources including the endangered, threatened, and protected (ETP) aquatic species. Catching of such species should be avoided while their escape and release at certain fishing depths should be facilitated as well as discarding the individual resources in live conditions. Moreover, the technical measures to reduce the impacts of fishing on the seabed and sensitive habitats should also be studied, including the development of spatial and temporal management, improvement of fishing gears and methods to reduce their destruction on the seabed, and replacement of intrusive fishing gears with more habitat-friendly gears.
- The AMSs, relevant organizations, and institutions to regularly monitor the development and modification of fishing gears and techniques by fishers, undertake necessary research studies on the efficiency and impacts of such gears and techniques on fishery resources and the habitats, and come up with the regulatory measures as appropriate and necessary.
- The AMSs, relevant organizations, and institutions to strengthen the Regional Network for the Reduction of the Impacts of Fishing on Coastal and Marine Environments in Southeast Asia (IFCOME Network) and facilitate the sharing and dissemination of information on programs and initiatives related to the reduction of the impacts of fishing and monitor the developments to be used as the basis for improving the design of fishing gears and promotion of responsible fishing practices.