



Status of international monitoring and management of abandoned, lost and discarded fishing gear and ghost fishing



Eric Gilman

Hawaii Pacific University and The Nature Conservancy, 3661 Loulu Street, Honolulu, HI 96822 USA

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ABSTRACT

Abandoned, lost and discarded fishing gear (ALDFG) can pose substantial ecological and socioeconomic problems. Over the past decade there has been increasing international recognition of the need for multilateral efforts to address transboundary problems resulting from ALDFG, including ghost fishing. To benchmark the status of international monitoring and mitigation of ALDFG and ghost fishing, an assessment was made of data collection protocols and management measures to prevent and remediate ALDFG and ghost fishing by 19 global and regional bodies and arrangements with the competence to establish binding controls for marine capture fisheries. Four organizations were explicitly mandated by their convention or agreement text to monitor and control ALDFG and ghost fishing. Modifying mandates of the other organizations might augment members' political will to monitor, prevent and remediate ALDFG and ghost fishing. Ten organizations collected logbook or observer data on ALDFG. Harmonizing data collection protocols where they are in place, and filling gaps where they are lacking, would improve regional monitoring of ALDFG. Twelve organizations have adopted binding measures that contribute to avoiding or remediating ALDFG. The organizations, however, make use of a small subset of available tools: Only half of 18 categories of methods identified as having the potential to prevent and remediate ALDFG and ghost fishing were used by the organizations. Organizations lacking relevant binding measures could begin to fill this gap and organizations can tap a broader suite of complimentary management methods.

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1. Introduction

Abandoned, lost and discarded fishing gear (ALDFG), also called derelict fishing gear, causes substantial ecological and socio-economic problems. An estimated 6.4 million tonnes of marine debris are inputted to global seas annually [1]. ALDFG is estimated to compose less than 10% of total marine debris by volume at a global scale but can be highly variable at small spatial scales [2,3]. The amount, distribution and effects of ALDFG have risen substantially over past decades with the rapid expansion of fishing effort and fishing grounds, and the transition to synthetic, more durable and more buoyant materials used for fishing gears [2,4,5].

There are numerous intentional and unintentional causes for fishing gear from marine capture fisheries to be abandoned, lost or discarded. Fishers may lose gear when there is contact with passing vessels or gear conflicts with active gear (e.g., passive gear is inadvertently, or intentionally, towed away by trawlers or dredgers, or marker buoy moorings are cut) [6–14]. Gear may be lost when tracking systems malfunction. Gear can also be lost and abandoned when the gear becomes snagged on submerged features [2,8,9,12,13,15–17]. Damage by marine organisms can also lead to gear loss (e.g., [18]). Improper gear designs and materials can also

lead to gear loss, such as from not replacing worn gear components. Improper fishing methods can also lead to gear loss, such as new entrants setting passive gear in areas where it is likely to snag bottom features, setting gear at grounds where there is a high probability of interaction with mobile gears, long soak times during which anchored gear moves from its original position, and where strong currents are prevalent (e.g., [9,17]). Gear can also be lost due to inclement weather or strong currents. In addition to causing gear to be lost, bad weather may also result in gear abandonment, if it becomes too dangerous to retrieve the gear. Fishers may also abandon gear when operating illegally and a risk of detection occurs (e.g., [19]). Fishers may opt to abandon gear, or to refrain from attempting to locate and retrieve lost gear, when there is insufficient time, or when it would be too difficult to retrieve it [9,10,17]. Fishers may discard unwanted components of gear at sea when deemed more practical or economical to disposal onshore, especially when port reception facilities are unavailable. Setting excessive gear can also result in discarding gear. For instance, there may be insufficient room onboard for all of the gear, such as when the space used to store nets when starting a trip are subsequently used as the fish hold [2,11].

Ghost fishing, one problem resulting from ALDFG, occurs when ALDFG continues to catch and kill organisms [2,20–26]. Ghost fishing is

Table 1
Preventative methods to avoid and minimize fishing gear from becoming abandoned, lost and discarded, and remedial methods (adapted from [2,61–65]). An asterisk preceding a method indicates measure that are implemented specifically to mitigate ALDFG and ghost fishing; the remaining methods are implemented for a range of fishery management purposes but contribute to avoiding and remediating ALDFG and ghost fishing.

Method	Description
Preventative	
Gear marking to identify ownership and increase visibility	Internationally-agreed systems for marking fishing gear have been developed to enable identifying the owner or user of ALDFG, which can create a disincentive for the deliberate abandonment and discarding of unwanted gear and incentive to report abandoned and lost gear [66–71]. Gear marking to increase the visibility of passive gear has also been required to reduce navigational risks to vessel operators, which could contribute to avoiding accidental gear loss when damaged by passing vessels or active gear [69].
Technology to avoid unwanted gear contact with seabed	Global Positioning System and seabed mapping technology help to reduce the likelihood of gear loss due to unintended contact with the seabed, reducing the probability of accidental gear loss [13].
Technology to track gear position	Attaching radar reflectors and radio buoys to fishing gear reduces the risk of losing gear, avoids interactions with towed gear, and aides in locating lost gear [9,13]. Setting gear used to mark the location of passive gear below the sea surface can reduce the risk of loss due to being cut by passing vessels [2].
Gear technology to reduce gear loss	Changes in fishing gear designs or materials might reduce the incidence of loss (e.g., [72]).
Input controls, including limit on soak time	Limiting the amount of fishing effort or capacity can reduce the quantity of ALDFG. Limiting the length of gear soak time and requiring the retrieval of gear during closed periods can reduce the probability of gear loss [2,70].
Periodic or constant observation of passive gear	Requiring passive gear to be under periodic or constant observation, a recommended practice to increase the probability of sea turtles caught in gear to be released alive [73], can also reduce the probability of gear loss.
Spatial and temporal restrictions on fishing	Separating passive and mobile gears temporally and/or spatially to avoid gear conflicts (i.e., passive gear is towed away by mobile gear), and not using fishing methods in areas where there is a high probability of loss on submerged features, can reduce gear loss [2,9,13]. Gillnets and trammel nets have been banned, in some cases for the explicit purpose of avoiding ghost fishing (e.g., [74,75]).
IUU deterrents	Effective deterrents of illegal, unreported and unregulated (IUU) fishing can reduce incentives for abandoning gear.
* Ban on intentional abandonment and discarding of fishing gear at sea	Measures banning intentional discarding and abandonment of fishing gear at sea (e.g., [76,77]) can be effective if surveillance and enforcement systems elicit strong compliance.
* Economic incentives and disincentives	Economic incentives to reduce the incidence of gear becoming abandoned, lost or discarded include creating a mandatory deposit on new gear, which is returned when unwanted gear is delivered to an appropriate port reception facility, and not subsidizing the cost for fishers to replace ALDFG [9]. Sufficiently onerous penalties for identified infractions of prohibitions on abandoning and discarding gear can create disincentives for noncompliance.
* Port reception facilities for unwanted gear	Providing accessible and affordable port reception facilities for unwanted 'retired' fishing gear can reduce the incentive for at-sea discarding [13,71].
Training for new entrants	Providing training opportunities for new entrants to fisheries with a high probability of gear loss can increase skipper capacity to employ best practice gear designs and fishing methods to reduce the likelihood of gear loss and augment their capacity to recover ALDFG [9].
Remedial	
* ALDFG port reception and recycling facilities	Accessible and affordable port reception facilities can encourage the retrieval and delivery of ALDFG [13,23,70,71,78–80]. There are several programs designed to create incentives for port disposal of unwanted gear and of ALDFG retrieved at sea, such as paying fishers to retrieve marine debris and deliver it to designated seaports [12]. Several ALDFG reception programs provide opportunities for reuse by the fishing industry, recycling, and conversion to energy [23,78–81].
* Detection and removal of ALDFG	Fishing vessels may be required to have onboard equipment to retrieve ALDFG, captains may be required to attempt to retrieve ALDFG, and to report information on lost gear that could not be retrieved [77,82,83]. Mechanisms for fishermen to report ALDFG generated from their vessels or that they encounter at sea, including regulatory frameworks that allow 'no-fault' reporting, eliminating the assessment of penalties for losing gear that would present a disincentive for self-reporting lost gear, can lead to quick identification and retrieval of ALDFG, if a derelict gear removal program exists [38,39]. Several programs periodically survey fishing grounds and sensitive marine habitats in order to locate and remove ALDFG and other marine debris (e.g., [12,39,61,84–87]).
* Disablement of ghost fishing efficiency of ALDFG	Programs periodically use a trawl net or other fishing gear to sweep fishing grounds with unobstructed substrate with known ALDFG in order to remove or otherwise damage derelict gear sufficiently to discontinue its ghost fishing efficiency [9,88].
Gear technology designed for bycatch mitigation in in-use gear that also increases ghost fishing selectivity in ALDFG	Modifications to fishing gear designs to reduce problematic bycatch in in-use gear can also reduce ghost fishing rates of vulnerable species in ALDFG from these fisheries. E.g., reducing net mesh size, reducing gillnet profile (vertical height), and eliminating or reducing the length of anchored gillnet tiedowns have been used to reduce turtle capture in gillnet fisheries [37]. Increasing gillnet filament diameter, modifying

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