

Operationalisation of FAO Voluntary Guidelines for the Marking of Fishing Gear in the IOTC Area of Competence

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Acronyms

aFAD.....	Anchored fish aggregating device
AIS	Automatic Identification System
ALDFG	Abandoned, Lost or Discarded Fishing Gear
CCSBT.....	Commission for Conservation of Southern Bluefin Tuna
COLREG.....	International Regulations for Preventing Collisions at Sea
COFI	Committee on Fisheries (FAO)
CPC	Members and Cooperating non-Contracting Parties
CWT.....	Coded wire tag
dFAD.....	Drifting fish aggregating device
DFO	Department of Fisheries and Oceans (Canada)
EEZ.....	Exclusive Economic Zone
ETP.....	Endangered, Threatened or Protected (species)
EU.....	European Union
FAD.....	Fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (UN)
GGGI	Global Ghost Gear Initiative
GPS	Global Positioning System
GT.....	Gross tonnage
HDPE.....	High Density Polyethylene (plastic)
IMO	International Maritime Organisation
ISSCFG	International Standard Statistical Classification of Fishing Gear
IOTC	Indian Ocean Tuna Commission
IUU.....	Illegal, unreported and unregulated (fishing)
MARPOL.....	International Convention for the Prevention of Pollution from Ships
MCS.....	Monitoring, Control and Surveillance
MEPC	Marine Environmental Protection Committee (IMO)
NOAA.....	National Oceanic and Atmospheric Administration (USA)
PRF	Port Reception Facility
RFID	Radio frequency identification
RFMO/A.....	Regional Fisheries Management Organisation/Arrangement
SIOFA.....	South Indian Ocean Fisheries Agreement
SWIOFC	South Indian Ocean Fisheries Commission
VGMFG.....	Voluntary Guidelines on the Marking of Fishing Gear
UNGA	United Nations General Assembly

Plastic materials

EVA..... Ethylene vinyl acetate

PA Polyamide (Nylon)

PE Polyethylene

PES..... Polyester

PP Polypropylene

PUR Polyurethane

PVA..... Polyvinyl alcohol

PVC Polyvinyl chloride

Abstract

A system for the marking of fishing gear should be an integral component of fisheries management. Fishing gear marking is an important tool to reduce gear loss and aid recovery, as well as in determining ownership, assisting in fishing effort management and control, facilitating monitoring, control and surveillance, and deterring IUU fishing. Fishing gear marking is also an important means for safe navigation. This document evaluated major fishing gears in use in the Indian Ocean Tuna Commission (IOTC) area of competence targeting IOTC managed species through a risk assessment to determine the level of complexity for implementing a system of fishing gear marking. Five fishing gear types, which represent 90% of fish landings in the IOTC area of competence and two types of fish aggregating device (FAD) are included in the analysis. Purse seines, drift gillnets, and drifting FADs are considered as having “high” or “very high” overall risks, anchored FADs having medium risks, while handline and pole-and-line, and trolling lines having “very low” overall risks. Accordingly, a framework for marking these fishing gears and FADs was proposed based on principles provided in the FAO Voluntary Guidelines on the Marking of Fishing Gear. Some economic assessment for implementing a system for the marking of fishing gear in the IOTC area was provided based on responsibilities between IOTC Secretariat, the Contracting Parties and Cooperating non-Contracting Parties (CPCs), and fishing operator (fishers, fisher organisations, or corporations). Implementing a system of gear marking requires extensive effort in awareness raising and communication by IOTC Secretariat and CPCs. Considering the diversity of CPCs, predominately Developing States, implementing a system for the marking of fishing gear in the IOTC area will require careful consideration regarding capacity building requirements and financial assistance, especially for Least Developed States and Small Island Developing States. As requested, a draft resolution for implementing a system of fishing gear marking for the IOTC area of competence has been prepared.

1. Introduction

1.1 Background

Fishing gears may be marked for a variety of purposes, such as to establish ownership and legality of their use, to indicate position to aid for navigation, and to reduce conflicts between gears. More recently, fishing gears may also be marked to inform the origin of the gear when they are entangled on marine animals or drifting at sea or deposited on beaches as marine litter. Gear marking has been considered as an important tool to reduce abandoned, lost, or otherwise discarded fishing gear (ALDFG) and to fight illegal, unreported, and unregulated (IUU) fishing (FAO, 2016; 2019).

Fishing gear marking intends to contribute to more sustainable fisheries through prompt reporting and facilitate retrieval of ALDFG to minimize their impact on the environment through the reduction of marine litter and the minimization of their impact on living marine resources of the ocean through the reduction of ghostfishing. Establishing a system for the marking of fishing gear is also intended to provide means of identifying the ownership and location of fishing gears and should be considered in the context of broader fisheries management measures which support sustainable fisheries and healthy oceans, including effort control, legality of fishing, and measures against IUU fishing.

1.1.1 The Voluntary Guidelines on the Marking of Fishing Gear

The Food and Agriculture Organization of the United Nations (FAO) started to develop a guideline for the marking of fishing gears in the early 1990s. The Voluntary Guidelines on the Marking of Fishing Gear (VGMFG, FAO, 2019) was endorsed by FAO members at its 33rd Session of the Committee on Fisheries in July 2018.

A guiding principle of the Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) is that a system for the marking of fishing gear should be put in place for all gear types unless the relevant authority, as a result of risk assessment or other appropriate means, deems otherwise. The VGMFG stresses that a system of the marking of fishing gear should be considered and implemented in the context of broad fisheries management measures that support sustainable fisheries and healthy oceans, including reduction, minimisation and elimination of ALDFG. The VGMFG envisages that marking of fishing gear should be a condition of fishing authorisation or license, when appropriate.

The VGMFG not only stipulates that fishing gear should be marked, it also provides guidance on the reporting of gear loss, recovery of ALDFG and disposal of end-of-life gear.

1.1.2 IOTC's work towards the implementation of fishing gear marking

In 2019, the European Union, a Member of Indian Ocean Tuna Commission (IOTC), put forward a proposal for a resolution on the marking of fishing gear following the adoption of the FAO's Voluntary Guidelines on the Marking of Fishing Gear and with regard to Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) that prohibits the discharge of all garbage including those from fishing vessels (IOTC, 2019). The proposal called for the Members and Cooperating non-Contracting Parties (hereafter referred to as "CPCs") to implement measures to ensure that all fishing gears used by vessels flying their flags and fishing for tuna and tuna-like species in the IOTC Area of Competence are clearly

marked. However, the proposal did not receive the required support to pass into a resolution, but the Commission tasked the IOTC Secretariat to develop standards for the marking scheme for consideration and adoption by the Commission, taking into account the FAO Voluntary Guidelines on the Marking of Fishing Gear. This report is in response to the 2019 decision of the Commission regarding fishing gear marking.

1.2 Purpose and Scope

The purpose of this report is to devise a framework to operationalize the FAO Voluntary Guidelines on the Marking of Fishing Gear for gears that target tuna and tuna-like species in the IOTC Area of Competence and applicable to CPCs. The primary focus of gear marking for IOTC is to prevent and reduce marine pollution caused by ALDFG, but gear marking also serves for other conservation and management purposes. The report outlines a process and framework for implementing a system of gear marking including priority and complexity of gear marking for different gears based on a risk assessment as recommended by the VGMFG. The report will also examine current relevant conservation measures established by IOTC and how the measures may be enhanced. The report will also outline potential financial implication of implementing a system of gear marking for IOTC Secretariat and CPCs under different implementation scenarios. Due to diverse economic development stages and fishery management levels of CPCs, means for raising awareness and capacity building for CPCs, especially Developing States are outlined. The Terms of Reference is attached as Appendix I.

2. Major Fishing Gears of Interests to IOTC

This chapter will provide an overview of major fishing gears in use in the IOTC area. The gears will be described in relation to the revised International Standard Statistical Classification of Fishing Gear (ISSCFG). The description also takes into account of the characteristics of gear with regards to gear loss, capacity control, and other related characteristics, including types of plastic materials commonly used in these gears. In this document, the definition of fishing gear as provided in Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) is adopted:

*A **fishing gear** is any physical device or part thereof, or combination of items that may be placed on or in the water or on the seabed with the intended purpose of capturing or controlling for subsequent capture or harvesting marine or freshwater organisms.*

From IOTC catch database, the following five gear types are identified as major gears that land IOTC-managed species in the IOTC Area of Competence: purse seines, drift gillnets, handlines and hand-operated pole-and-line, drift longlines, and trolling lines. Their landings for 2019 is provided in Table 1.

Table 1. Landing (tons) for major gear types of IOTC-managed species in 2019 (Source: IOTC catch database, <https://iotc.org/oqs>) and relative importance (scaled to 1 – 5). The relative importance of aFAD and dFAD is assigned based on catch related to FADs and number of FADs in use

Gear	ISSCFG code*	Catch (tons)	Comments	Relative importance
Purse seine	PS	553,210	Purse seines only	5
Drift gillnet	GND	583,775	All gillnets, presumably majority are drift gillnets	5
Handline/pole-and-line	LHP	238,914	Handlines and bait boat (assuming pole-and-lines)	2
Drift longline	LLD	290,567	All longlines (drift longlines)	3
Trolling line	LTL	75,589	Including troll line, trolling non-mechanized, handline and troll line, trolling mechanized	1
Anchored FAD	aFAD		Handline, pole-and-line, and trolling line	3
Drifting FAD	dFAD		Purse seine	5

*For FADs, aFAD and dFAD are not ISSCFG code, but common abbreviations

Fish aggregating devices (FADs) are not strictly fishing gears, but an auxiliary gear that may increase fishing efficiency for the main gear they are associated with (He *et al.*, 2021). Due to the importance and the quantity of FADs used in tuna purse seine and other fisheries, the description and marking of FADs are included as if they were a type of fishing gear. In this document, definition of FAD as provided by IOTC (2019) is adopted:

***Fish Aggregating Device (FAD)** is a permanent, semi-permanent or temporary object, structure or device of any material, man-made or natural, which is*

deployed and/or tracked, for the purpose of aggregating target tuna species for consequent capture.

Drifting Fish Aggregating Devices (dFADs) is a FAD not tethered to the bottom of the ocean. A dFAD typically has a floating structure (such as bamboo or metal raft with buoyancy provided by buoys, corks, etc.) and a submerged structure (made of old netting, canvass, ropes, etc.).

Anchored Fish Aggregating Devices (aFADs) is a FAD tethered to the bottom of the ocean. It usually consists of a very large buoy and anchored to the bottom of the ocean with a chain.

In the IOTC Area of Competence, aFADs are mostly used within EEZs of CPCs and mostly associated with handlines, pole-and-line, and trolling lines. As in other oceanic tuna fisheries, dFADs are associated with purse seines, mostly in high seas, but they can drift into CPCs' EEZs; and in some cases, grounded in shallow coastal areas.

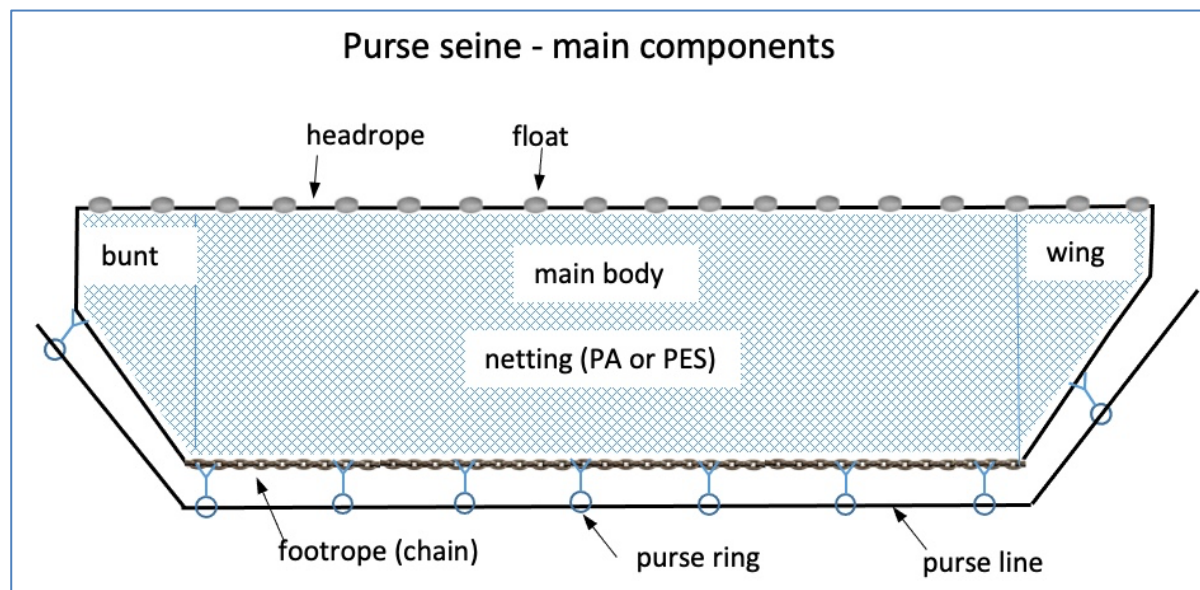
2.1 Purse seines and FADs

2.1.1 Purse seines

A purse seine (standard alphanumerical codes: PS 01.1) is a wall of netting designed to encircle a school of pelagic fish near the surface and use a purse line to close the bottom of the net. The purse lines may be made of steel wire, but can also be PP or PE ropes, especially in small operations. Purse rings are made of iron, steel, or polyvinyl alcohol (PVA).

Purse seines use weights, lead lines or chain attached to the footrope, and dense netting materials such as PA or PES, to increase the sinking velocity of the net to prevent fish from escaping horizontally. The purse seine is characterized by a purse line threaded through purse rings spaced along the bottom edge of the net, through which the purse line can be drawn tight – hence “purse seine”. The middle sections of the netting are deepest and gradually taper towards the wing and the bunt where fish finally accumulate (Figure 1). The bunt can also be at the middle of the net; in this case, hauling starts from both wings.

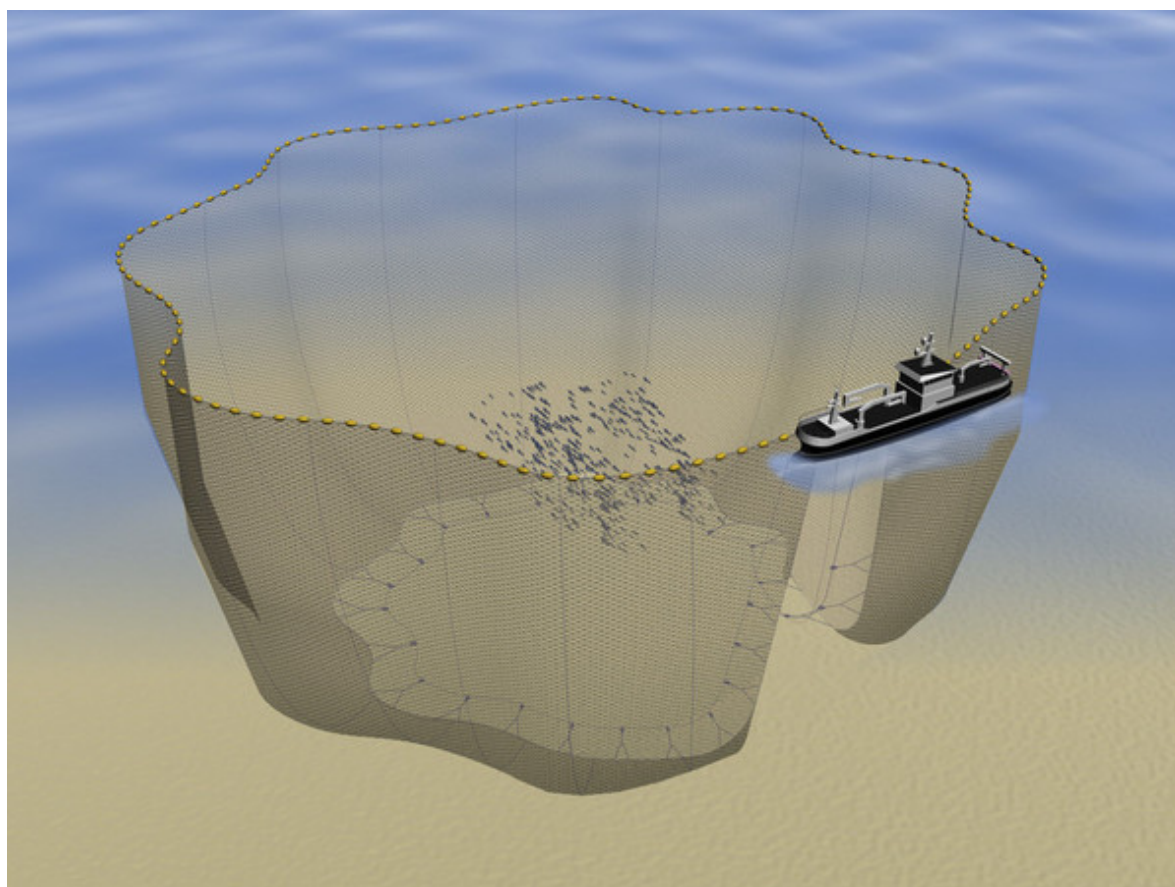
Figure 1. The anatomy and components of a purse seine for which the bunt is at the wing. Drawing not to scale



Source: He *et al.* (2021)

When a target fish school is identified, the vessel manoeuvres into a favourable position and the seine net is prepared for deployment. The vessel follows a course around the edge of the school, attempting to encircle it. With the net fully deployed, ropes attached to the ends of the net are hauled in order to close the seine around the school. At the same time, the purse line is drawn to close the seine net beneath the school. Typically, the headrope is longer than the footrope so as to reduce tension and prevent it from submerging, which can result in fish escaping over it.

A modern tuna purse seine, as illustrated in Figure 2, can be very large, measuring 2000 m or more in length, and 250 m or more in depth. Purse seines can be operated by one vessel, one main vessel with the assistance of auxiliary vessels, or two main vessels. Purse seines are often operated with assistance of artificial lights at night to concentrate fish, around fish aggregating devices (FADs), or by targeting free-swimming fish schools. The purse seine is the most important fishing gear in marine capture fisheries in terms of the quantity of fish landed. According to recent FAO statistics, purse seines account for about a third of total marine landings. Technologies that enhance the catch efficiency of modern purse seines include solar-powered, satellite-linked buoys for drifting fish aggregating devices (dFADs) equipped with an echo-sounder, bird radar and spotter planes/helicopters for locating surface schools, high-speed boats for deflecting fast-moving schools towards the net, and high density purse seine netting to ensure the net sinks rapidly and prevents fish from escaping (Scott and Lopez, 2014; Lopez *et al.*, 2014; Torres-Irineo *et al.*, 2014).

Figure 2. Modern purse seine encircling a free-swimming fish school

Source: Seafish (www.seafish.org)

2.1.2 Fish aggregating devices

A fish aggregating device (FAD) is a permanent, semi-permanent or temporary structure, which is deployed and/or tracked, and used to aggregate fish for subsequent capture (IOTC, 2019; FAO, 2019). Fish aggregating devices (FADs) are not strictly fishing gears, but auxiliary gears that may increase fishing efficiency for the main gear they are associated with.

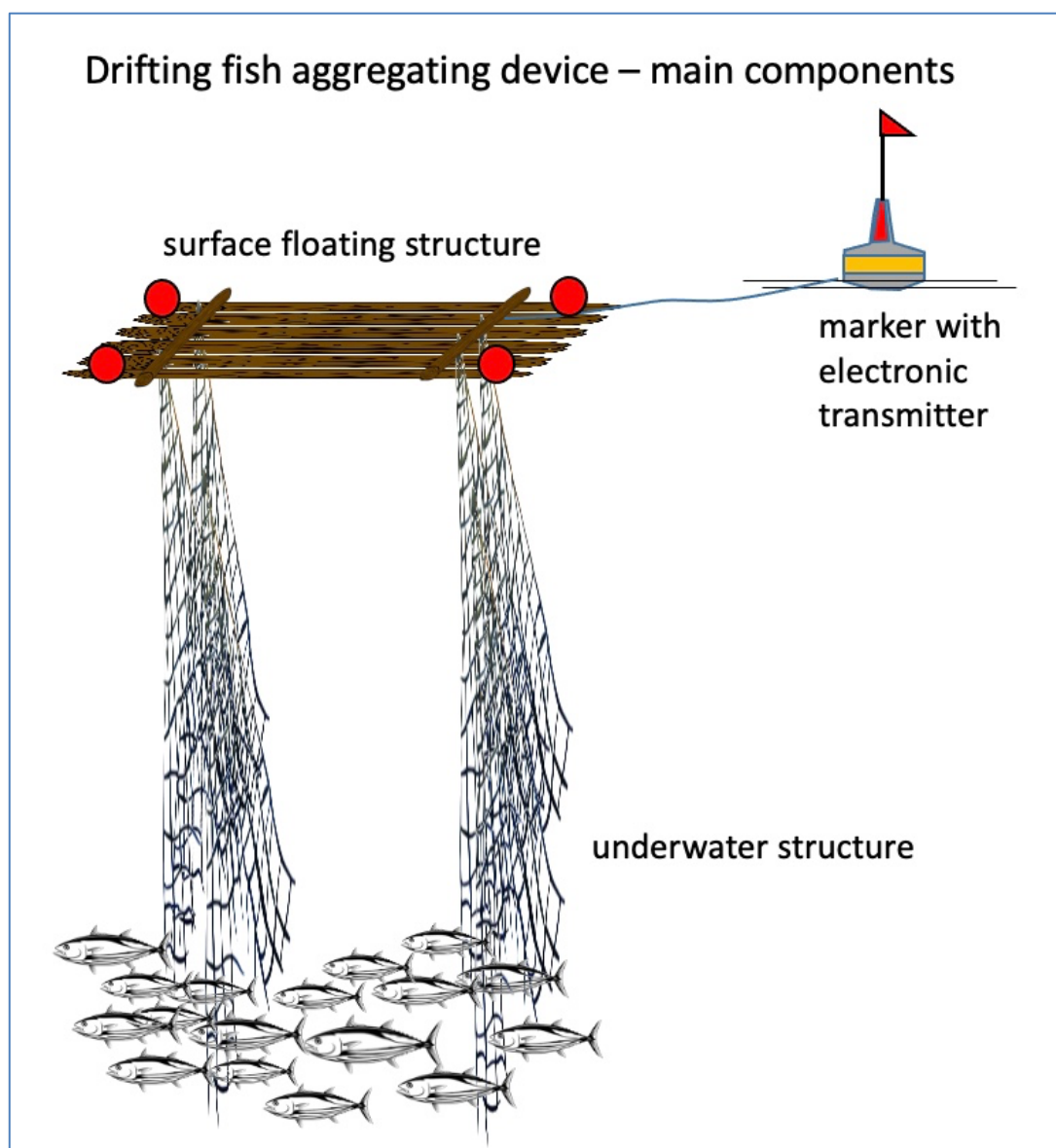
A FAD can be either anchored (aFAD; or called moored) which is often deployed within a nation's EEZ, or drifting (dFAD), which is often deployed in the high seas. AFADs are mainly used by handline, pole-and-line, trolling line, and vertical line vessels, but sometimes by purse seine, and dFADs are utilized predominately by large industrial tuna purse seine vessels. Today, about half of tuna catches are from FAD-associated operations (Miyake *et al.*, 2010). Anchored FADs are often set in coastal areas but can be set in archipelagic and/or offshore waters at depths greater than 2000 m.

FADs typically consist of surface components (rafts), underwater components (appendages) and a marker to indicate or report its position (Figure 3). Drifting FADs often have a marker with an electronic transmitter, sometimes linked to satellite communication. Anchored FADs have a rope leading to an anchor or weight on the seabed. Both anchored and drifting FADs can be marked for ownership, and position, and for dFADs for real-time tracking of position.

While earlier FADs were mostly made from natural degradable materials, such as bamboo, wood, tree branches, most FADs used today are primarily made of synthetic materials for both surface raft and appendage, with less than 2% made totally from natural materials in the western and central Pacific Ocean (Escalle *et al.*, 2018; Hanich *et al.*, 2019). The raft may be made from drums (metal or plastic), floats (PVC, EVA and EPS) and buoys (PVA, PUR), pipes (PVC) and netting (usually old netting from purse seines and nets, likely PA and PES). Some FADs bundle the netting so that they are less entangling to reduce unintentional meshing of fish and other animals. Electronic and/or satellite buoys used with dFADs contain metal and plastics (mostly PVC).

The large numbers of dFADs deployed by industrial purse seine vessels operating within EEZs and on the high seas have resulted in numerous FADs becoming abandoned, lost or otherwise discarded. Furthermore, without a clear requirement to identify the ownership of dFADs, it is not easy to ascertain the vessel to which responsibility and/or obligation for retrieval can be attributed (Gilman *et al.*, 2018). Drifting FADs deployed by purse seine vessels may drift for several years, raising concerns as to whether the boat operator has any intention of retrieving the gear. Moreover, concerns have also been expressed regarding the possibility that dFADs set by a vessel in one location may drift hundreds or thousands of kilometres, aggregating highly migratory tuna as they go, within and across multiple maritime boundaries (Hanich *et al.*, 2019; Toonen and Bush, 2020).

Drifting FADs are usually marked for real-time tracking of position. The use of sophisticated satellite buoys significantly increased the number of FADs that a vessel can handle, and speed of detection. While there are no recent reliable assessments, it was estimated by Baske *et al.* (2012) that about 105,000 drifting FADs are in use by the world's tuna fisheries, primarily tuna purse seines. Commercial dFAD buoy manufacturers produce 47,500–70,000 dFAD satellite buoys per year, primarily for European Union purse seine fleets (Scott and Lopez, 2014), indicating that many dFADs are not recovered, but left at sea.

Figure 3. A simplified drawing representing a drifting fish aggregating device (dFAD)

Source: He *et al.* (2021)

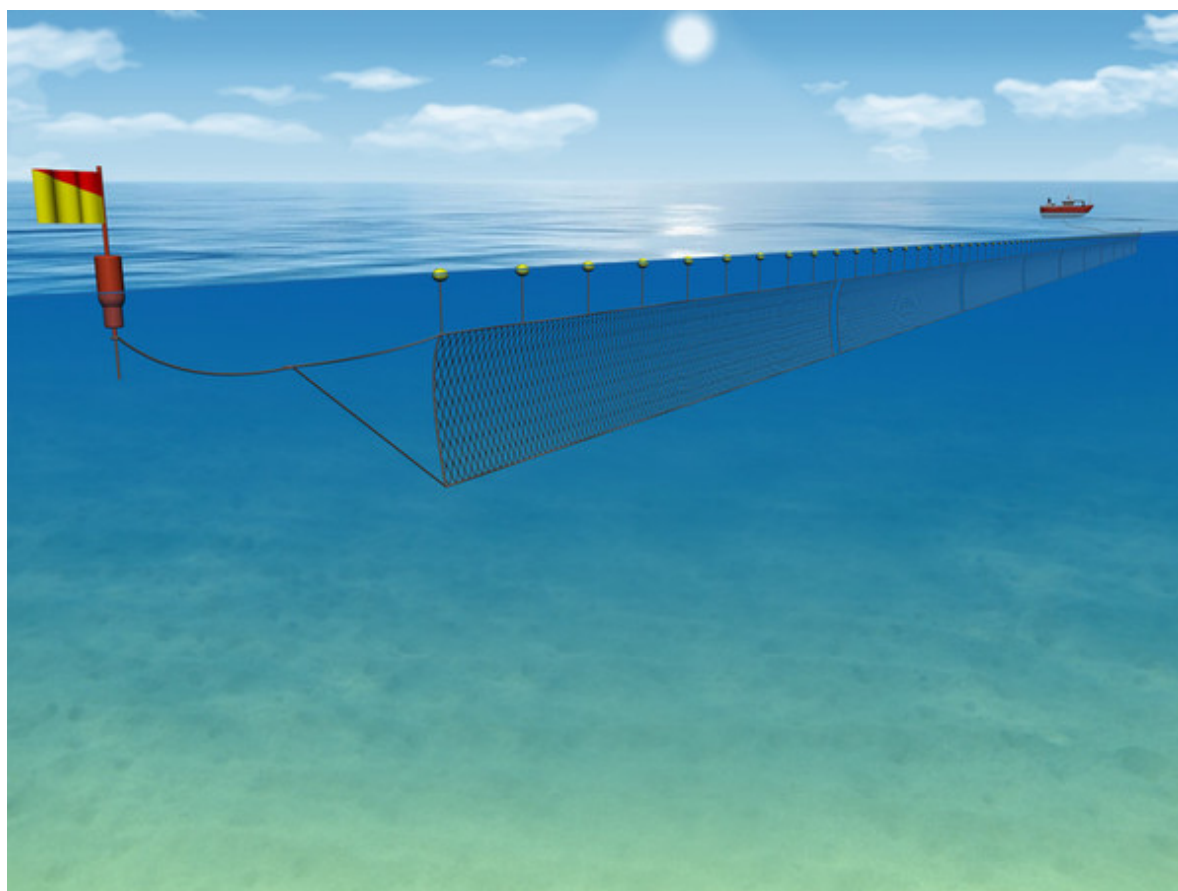
2.2 Drift gillnets

Drift gillnet (or driftnet, Figure 4) is a type of gillnet that is not fixed to the seabed but allowed to drift with the current. Drift gillnets are usually fished in a fleet which can extend over a great distance in open waters. Drift gillnets typically use PP ropes as headrope and PA or lead sleeved PP rope as footrope. Netting is typically made of monofilament PA. floats made of PVC or EVA are typically used on the headrope. Surface buoys may be made of PVC or PUR. Drift gillnets usually fish on or near the surface but can be in midwater, with the length of buoy ropes controlling the depth of the net below the surface. The net is typically adrift with the vessel or markers (buoy and highflyer) attached to the end of the gear (Figure 4). In large operations, the marker may be equipped with radio or satellite transmitters or transponders for easy location. A fleet of drift gillnets can be over 10 km long and several fleets may be

fished by a vessel; the total length of the net fished by one vessel may therefore stretch to tens of kilometres.

Drift gillnets have been reported as a concern for non-target species including ETP species such as marine mammals, seabirds and turtles (Northridge, 1991). As a consequence, the United Nations adopted a resolution banning the use of large-scale driftnets over 2.5 kilometres long in high seas in 1991 (UNGA RES 44/225; UN, 1989). Subsequently, some regional and national authorities have implemented similar bans in their jurisdictions, such as the IOTC, the European Union and other Regional Fisheries Management Organisations. However, the ban did not apply to drift gillnets of less than 2.5 km, which are commonly used in various small-scale fisheries in the IOTC area.

Figure 4. A fleet of drift gillnets near the surface



Source: Seafish (www.seafish.org)

2.3 Hook and lines

2.3.1 Handlines and pole-and-lines

Handlines and hand-operated pole-and-lines include all hook-and-line gears that are operated and/or tended by a fisher. Handlining is carried out with one or more baited (natural or artificial) hooks attached to a single line. Fish must take the bait to be captured. Hand-operated pole-and-lines use similar lines and hooks, but with a pole.

While pole-and-lines are the most important recreational fishing gears operated in most riverine, lacustrine and estuarine waters, they are also important commercial fishing gears in oceanic waters. One important commercial pole-and-line fishing practice in IOTC area is the tuna pole-and-line fishing for skipjack tuna (*Katsuwonus pelamis*). Skipjack pole-and-line fishing typically use live bait (chum), enhanced with water spray to induce an elevated feeding response (Ben Yami, 1980; Gillet, 2006). In this fishery, barbless hooks with or without feather lures are fished from the deck of the vessel, as illustrated in Figure 5. Live baitfish are typically captured by a boat-operated lift net such as the Japanese-style stick-held lift net (*bouke ami*) in coastal waters the night before (Lewis, 1990). Purse seines are also used for catching live baitfish, which may be held in cages for days before they are used with pole-and-lines.

Figure 5. Hand-operated pole-and-lines (LHP 09.1) fishing for skipjack tuna (*Katsuwonus pelamis*) with live bait chum and water jets. Water jets come from the stern of the boat (underneath the fishers)



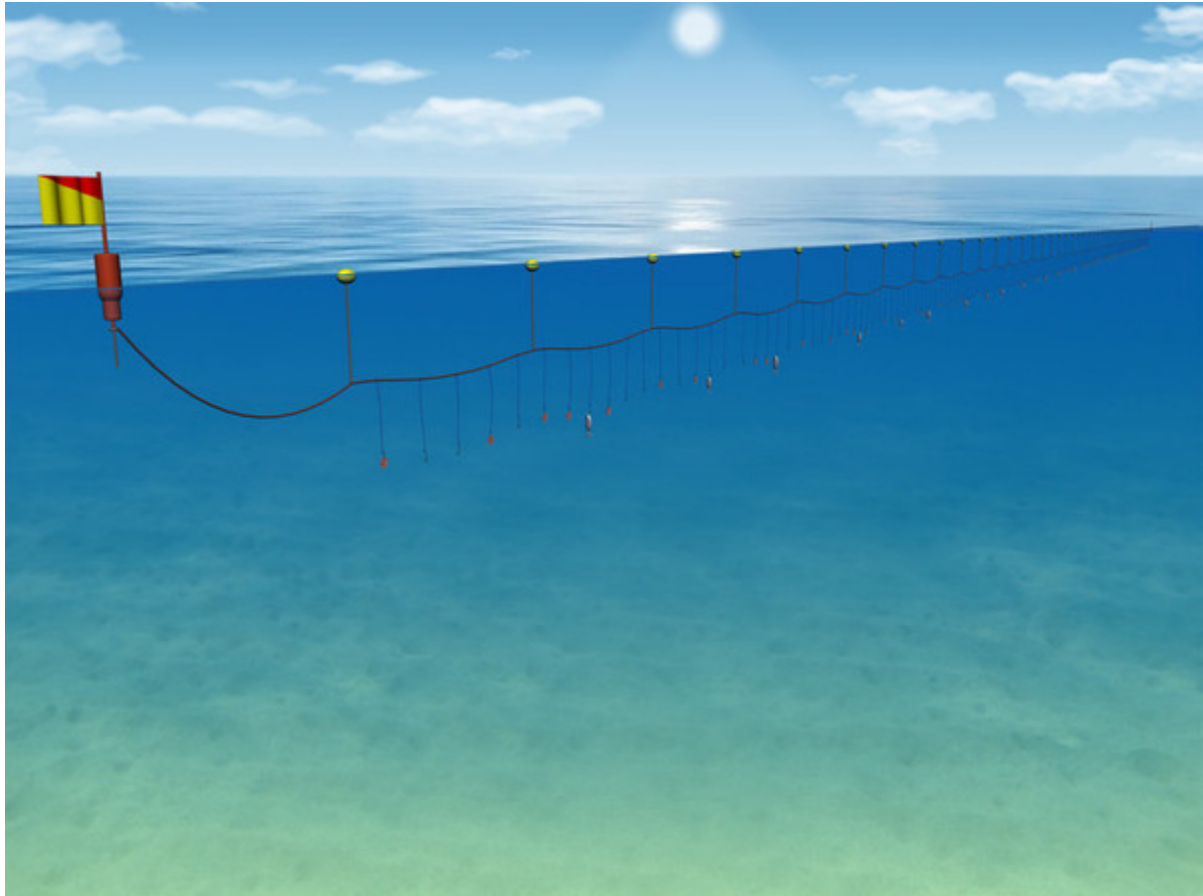
Source: He *et al.* (2021)

2.3.2 Drift longlines

A drift longline is a type of longline that is not fixed to the seabed and drifts passively with the current, or with the boat (also drifting) attached at one end of the longline (Figure 6). These longlines often fish in open water or high seas targeting tuna or tuna-like species, and are often large in scale with mainline (PP, PA or PES) lengths up to 80 km. Snoods, which are often called branch lines in drift longlines, are often more than 10 m long, and may include a clip, one or more swivels and a weight (Figure 7). Monofilament PA is usually used in the terminal section of the branch line, but steel wires are sometimes used in shark longlines. In large-scale operations in open oceans and archipelagic seas, radio or satellite buoys are often

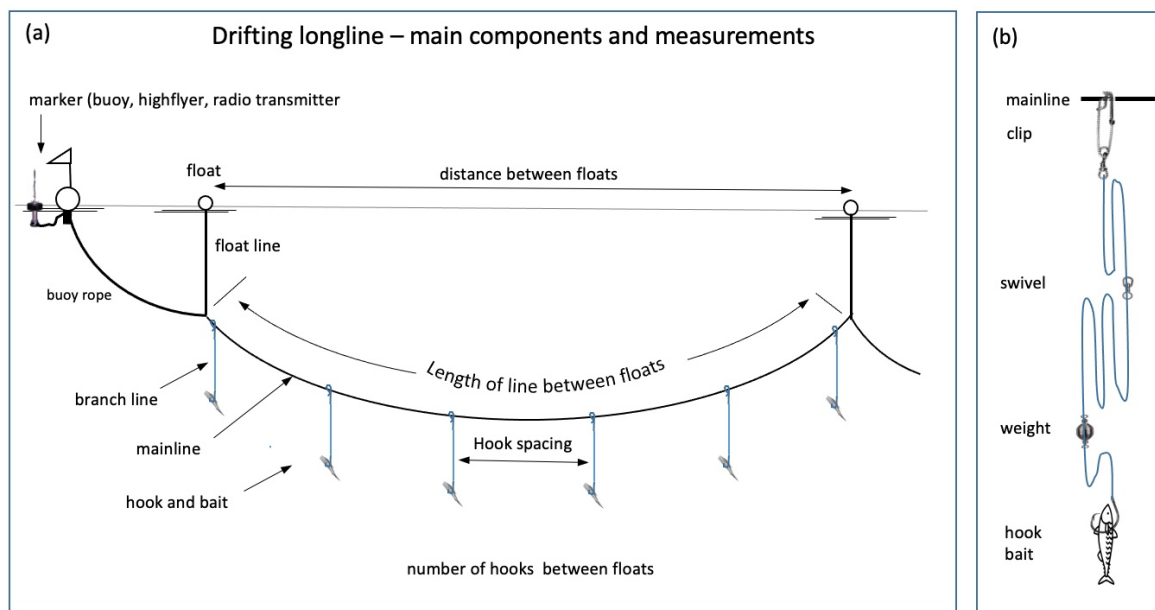
attached to end buoys (PVC or PUR) or intermediate floats to monitor and locate the position of the gear.

Figure 6. A fleet of drift longlines (LLD 09.32) set near the surface



Source: Seafish (www.seafish.org)

Figure 7. Basic components and terms used to describe a drift longline (LLD 09.32)



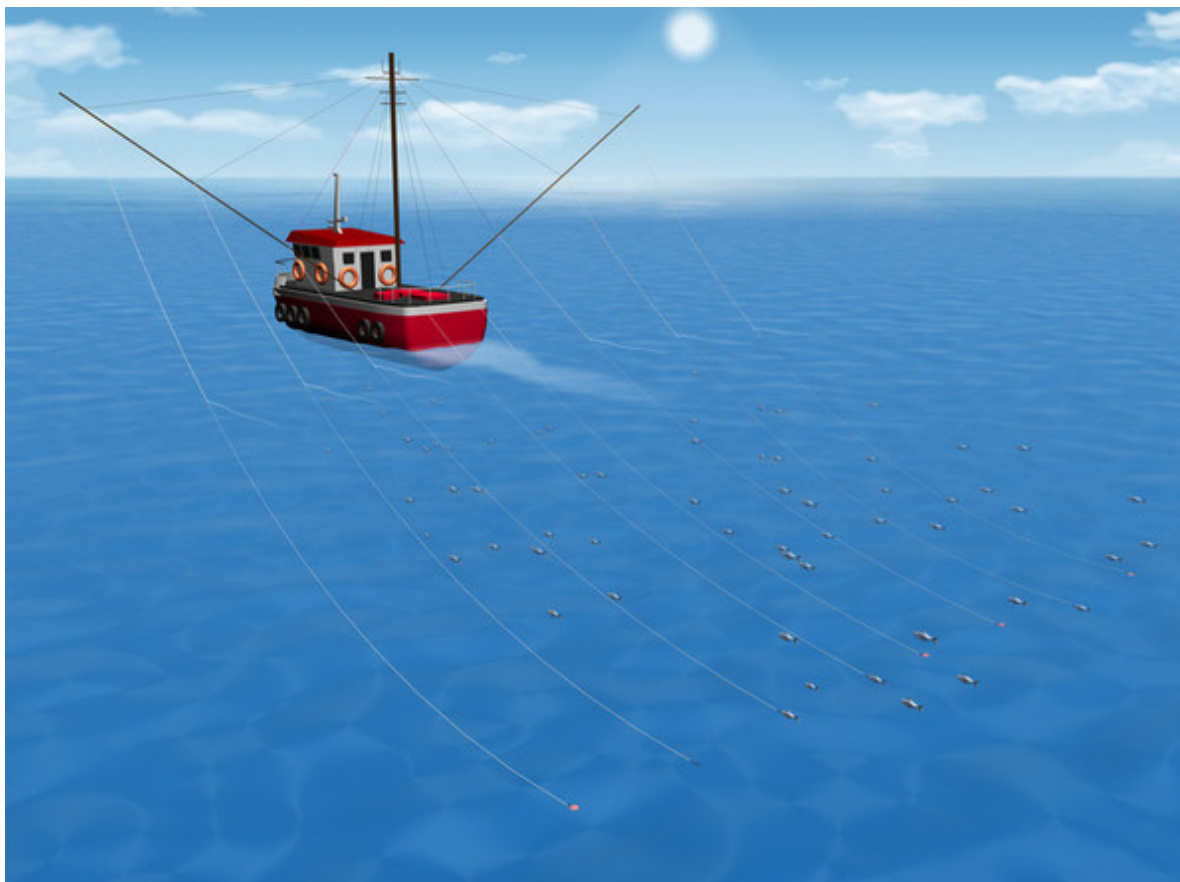
Source: He *et al.* (2021)

2.3.3 Trolling lines

A trolling line is a line with one or more baited hooks (or lures) towed behind a boat. The boat may tow many lines, often from outriggers (

Figure 8) or a single line hand-tended by a small crew in a dinghy (Preston *et. al.*, 1987). Outrigger poles extending from the sides of the boat may be used to increase the number of lines that can be trolled simultaneously. The towing (or trolling) speed depends on the target species.

Figure 8. Trolling lines (LTL 09.5) towed behind a boat using outriggers



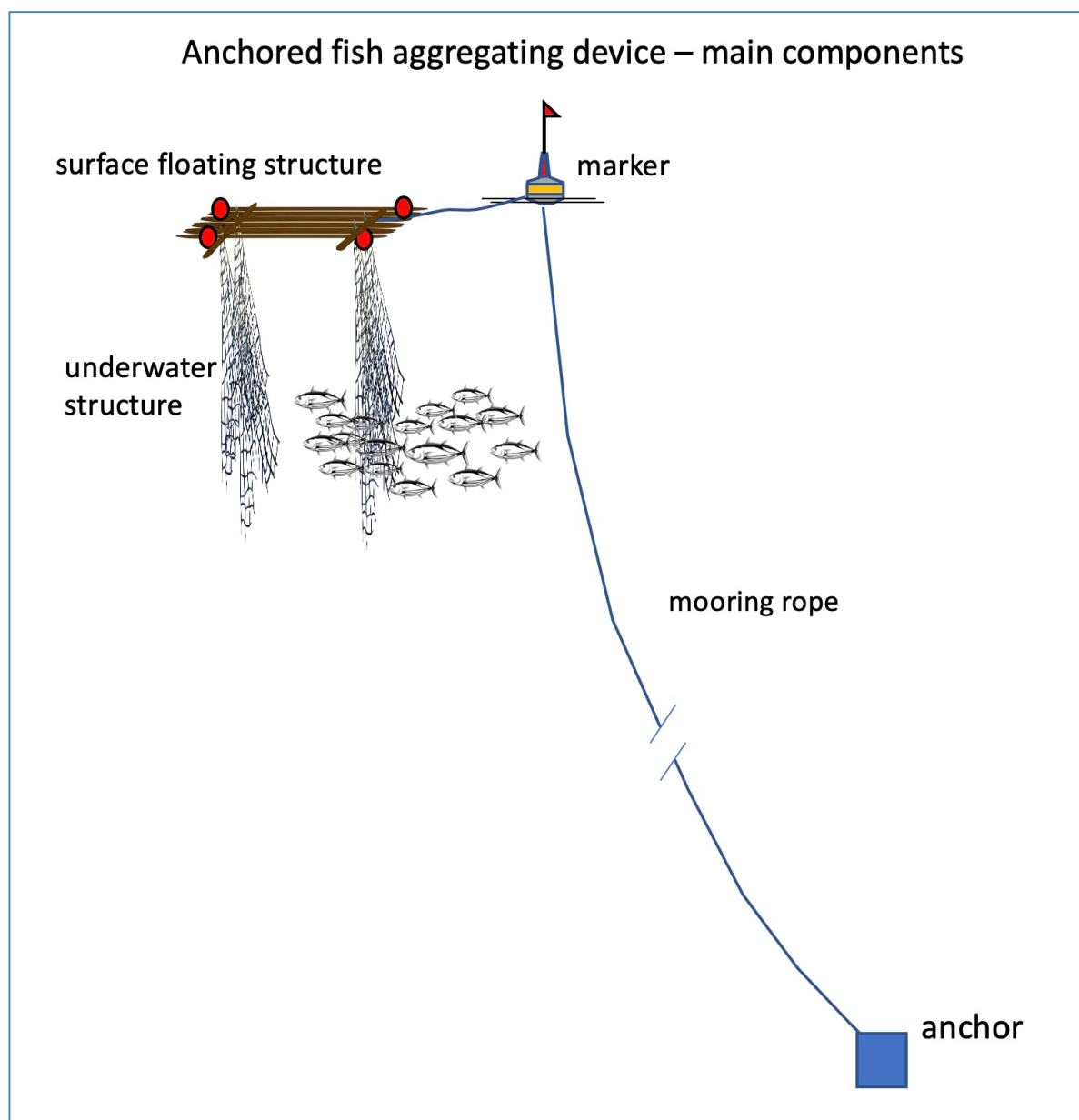
Source: Seafish (www.seafish.org)

2.3.4 Anchored fish aggregating devices

Anchored fish aggregating devices (aFADs) have similar surface structure as drifting FADs, except they are anchored or otherwise fixed to the seabed with a mooring rope, weights or anchors (

Figure 9). As their position is fixed, satellite buoys are not used. Big spar buoys, usually with a light are used to indicate position and aid to navigation.

Handlines, pole-and-line, trolling lines, vertical lines and small purse seines are often fishing near aFADs to take advantage of fish accumulated near the FAD.

Figure 9. A simplified drawing representing an anchored fish aggregating device (aFAD)

2.4 Relative importance and plastic materials

The relative importance of different gear types for IOTC area was evaluated by the volume of fish landing in Table 1. The importance of gear was broadly scaled from 1 (least important, less usage, small landing) to 5 (most important, large landing). The scores of relative importance of gear types are used to estimate the overall plastic amount for the gear type (Table 2), and the impact of the gear use, which will be discussed in later sections.

Knowledge on the composition of plastic in each fisher gear is important. Plastic components of fishing gear do not readily degrade and for that reason may remain in the water or on the seabed for a long period of time as marine debris and some may continue to catch fish, i.e., ghostfishing. A summary of relative scale of the amount of plastic material used and the types

of plastic material for netting, rope and floatation and surface marking (buoys) for different gear types is provided in Table 2. The type of materials used in fishing gears provide information about their buoyancy and risk to navigation and or fouling of seabed habitats.

Plastic amount in the gear implies the relative size (and number of units) and plastic contents of the gear operated by a fishing vessel or vessels at a given time. When a fishing vessel operates more than one unit of gear (e.g., one gillnet), the amount is multiplied. The scale of plastic amount is estimated based on typical operation of the gear, as an indicative of the gear type.

Table 2. IOTC fishing gear and FADs, their relative importance for fish capture in IOTC, and plastic materials. See Table 1 for ISSCFG gear code.

Gear type	Relative importance (1-5)	Plastic materials			Plastic amount * (1 - 5)	Overall plastic amount (scaled to 1 - 5)**
		Netting	Rope/line	Float/buoy		
PS	5	PA, PES	PA,PP	PVC, EVA	5	5
GND	5	PA	PA,PP	PVC, EVA, PUR	5	5
LHP	2	-	PA	PVC	1	1
LLD	3	-	PA	PVC,PUR	5	3
LTL	1	-	PA,PP	PVC	1	1
aFAD	3	PE, PA	PP	PVC,EVA,PUR	2	2
dFAD	5	PE, PA	PP	PVC,EVA,PUR	5	5

Note: *scale of plastic amount for the gear typically operated by a vessel, ** overall scale of plastic for the type of gear considering the importance of the gear in the area.

3. Gear Marking Technologies and Practices

There are varieties of fishing gear marking technologies and practices, from the earliest carving and painting on buoys to mark ownership, to flags for easy location, to modern electronic devices for real-time tracking. The VGMFG (FAO, 2019) defined a “mark” as:

- i) *an identifier, that allows the relevant authority to discern the person or entity ultimately responsible for the use of the fishing gear; and/or*
- ii) *a means of providing an understanding of the presence, scale and nature of fishing gear in the water.*

The types of fishing gear marking may include physical, chemical, electronic and virtual. The purposes of fishing gear marking may include ownership and legality, capacity control, position to aid navigation, identification of the origin of ALDFG, to track and locate the gear for easy recovery and prevention of loss. New technologies for subsea electronic and/or virtual gear will also be examined. Some of information described below are drawn from He and Suuronen (2018) paper “Technologies for the marking of fishing gear to identify gear components entangled on marine animals and to reduce abandoned, lost or otherwise discarded fishing gear”.

3.1 Types of Fishing Gear Marking

3.1.1 Physical marking

Traditionally physical marking, which can include inscription, writing, colour, shape, and tags have been used for ownership, legality and capacity control purposes, and buoys, lights, flags, and radar reflectors are used for marking of position and as an aid to navigation. Physical marking is still the primary fishing gear marking means today.

3.1.2 Chemical marking

Chemical elements that are embedded during the process of fishing gear material manufacturing may be used to identify the owner of the gear if loss and subsequently recovered, providing that a good book-keeping of sale and resale of the materials and gears are practiced. Chemical markings cannot be easily removed and provide a permanent “signature” of the material or the gear. The entire gear or some specific components of the gear may be identifiable through the analysis of chemical contents, which allow for retracing of the owner and the manufacturer of the material with good bookkeeping. Chemical content of material cannot be easily identified on site and need laboratory analysis to obtain information.

3.1.3 Electronic tags, marks and transmitters

Electronic tags may contain more information about the gear and its owner, and can be read by special devices, for example, through near-field communication (NFC) protocol. Electronic devices including radio and satellite transmitters have been used in some fisheries, especially large industrial operations in open seas, for easier location from a distance or for real time tracking from the vessel and from the land. These electronic devices provide much more temporal and spatial information of the gear, as well as biological and environmental

information of the sea if additional sensors such as temperature, depth or other sensors are attached to the same buoy. Modern satellite buoys associated with dFADs are also equipped with echo sounders which provide information on the amount of fish near a dFAD.

3.2 Gear Marking for Different Purposes

3.2.1 Gear marking to indicate position and for location tracking and surveillance

Gear marking for position aids in the quicker positioning of the gear by its owner, and also aids to navigation for other ocean users. Proper gear marking can reduce gear conflicts between fishers and between gear sectors (e.g., fixed and mobile gear sectors), thereby reducing the probability of gear loss. Gear marking for position also aids to navigation for other ocean users, thereby reducing gear damage and improving navigation safety.

Flags, lights, and radar reflectors

Flags, lights, and radar reflectors are the main position markers for coastal fisheries. Gear marking for location provides quicker retrieval of the gear, thereby reduces gear loss and gear conflicts, and improves safety at sea. Modern electronic devices allow accurate marking of set position of stationary gears on an electronic chart, allowing for quick and efficient recovery of the gear. Specific requirements for surface marking of fixed gears are stipulated in IMO COLREG, which was further developed by FAO in 1996 (Appendix III). FAO is currently developing a more comprehensive gear marking manual as required in the VGMFG.

Active RFID tags

Active radio frequency identification (RFID) tags are battery-powered radio transmitters. If they are attached to fishing gears such as buoys or highflyers, they can be detected by the vessel from a distance even in poor weather and sea conditions. This device can also be detected by a low-flying airplane or a drone, greatly increase the area of monitoring and surveillance, providing enhanced means for enforcement and combating IUU fishing.

The Automatic Identification System

The Automatic Identification System (AIS) is primarily used by ocean-going shipping vessels, and increasingly used by fishing vessels. While AIS is primarily for safety at sea and for port security, there is a potential for using AIS as fisheries monitoring system for combating IUU fishing (Robards *et al.*, 2016). Currently there is no known implementation or formal discussion of using AIS systems for the marking of fishing gear. However, there are advantages of using AIS-based transponders as fishing gear markers as many vessels already have AIS receivers, therefore, no additional onboard equipment is necessary. There are several versions of AIS buoys that are marketed as “fishing net tracking buoys” or other similar names. The potential use of AIS devices as fishing gear markers needs substantial national and regional elaborations and international agreements.

Radio and satellite buoys

Radio and satellite buoys are used by drift gillnetters, pelagic longliners and purse seiners (marking dFADs). As drift gillnets and pelagic longlines are not attached to the bottom, surface buoys and markers are thus very important for locating the “drift” gear. Purse seiners use dFADs to congregate fish for subsequent capture. Anchored FADs are marked for ownership

and position, while dFADs are also marked for real-time tracking of position using satellite buoys. The use of sophisticated marking systems significantly increases the number of dFADs a vessel can handle, and speed of detection.

Virtual marking

Due to increasing challenges of entanglement of megafauna species in vertical buoy lines of pots and other unattended gears, pot fishing without buoy ropes and surface marks are being developed and tested in several fisheries. “Ropeless” fishing intends to eliminate buoy ropes and surface markers when the gear is fishing. Virtual marking technology is being discussed and tested to reduce gear conflict and to facilitate enforcement. The technology requires virtual marking that can be “seen” by different levels of stakeholders, e.g., the gear owner, other fishers operating in the same fishery, fishers and mariners passing by, and authorities including fishery managers and MCS entities. Virtual marks may be incorporated into electronic navigation charts. The technology is still under development and will require major technological advancement and legal and institutional approval (Baumgartner *et al.*, 2018).

3.2.2 Gear marking for the identification of origin

There is a need to identify the origin of fishing gear or its components when they become lost and/or entangled with marine animals. Knowing the area, fishery and gear type that the gear was originally used provides valuable information for fishing gear modifications to reduce loss and entanglement, for area/season closure, and other management measures to reduce entanglement and potential mortality of vulnerable animals (Wilcox *et al.*, 2015).

Colours and tracers

Coloured ropes or tracers are being implemented in the north-eastern water of the United States (NOAA, 2015) and Eastern Canada (DFO, 2020) to aid tracing ropes that are entangled in endangered North Atlantic right whales. There are limited colour shades that can easily be distinguished after rugged use in the sea. Colours may fade under extended exposure under sun. Tracer yarns or strips may be woven into ropes or twines which would preserve the colour for a longer period. The tracer may have different colours, and information such as manufacturer, batch number, and/or material specification that can be printed on to the tracer before it is woven into the rope or twine. Fisheries and regions may require specific information to be printed and ordered specially.

Coded wire tags

Coded wire tags (CWT) have been tested for possible inclusion in fishing ropes to provide additional information. Only one study has tested the feasibility of using CWTs for marking the origin of fishing rope, specifically ropes for use in fixed gears (pots, gillnet and longlines).

Radio frequency identification tags

Radio frequency identification tags (RFID) have been tested for possible inclusion in the components of fishing gear. One problem of using RFID tags is the readability, and ease of reading when ALDFG is recovered. RFID tags can potentially provide a large amount of information about the gear and the fishery that was used, and potentially the time of last deployment and environmental conditions. Applying RFID tags to some gear is less challenging than others. For example, incorporating RFID tags in fishing ropes still face great

challenges in terms of durability of the tags and the ropes they imbedded, but attaching an RFID tag to a pot does not normally present any technical issues.

3.2.3 Gear marking for ownership, capacity management and monitoring.

Gear marking for ownership, legality, and capacity management is especially important in capacity-controlled fisheries such as pots, gillnet and longline fisheries. Traditionally, various physical tags have been used, usually inscribed with the permit number of its owner. In some fisheries, tags are fixed in the gear itself (e.g., gillnets) or attached to its surface markers (e.g., buoy of a pot), or both. These physical tags can only contain limited information (e.g., license number). More advanced tags that contain static information (e.g., license number, owner, vessel, etc.) as well as dynamic information (such as time in water, location deployed, etc.) would have advantages both for fishers and for management. Advanced tags that can be detected over a longer distance would help fishery enforcement in combating IUU fishing.

Physical tags

Physical tags have traditionally been used, usually inscribed with the permit number or name of its owner. In some fisheries, the tags are fixed to the gear itself, while in others, the tags are attached to the surface buoys, and while still others, both underwater and surface components of the gear are tagged or marked. Printed tags with bar code or QR code can contain more information about the gear and other information.

RFID tags

RFID tags are being tested and used for ownership and capacity control. These systems not only serve as permit tags, but they are also designed to reduce the theft of gear and catch (NWIFC, 2015).

3.2.4 Gear marking to aid recovery of lost gear

Technologies that allow for relocating lost fishing gear will aid speedy recovery of lost gear and reduce ALDFG. Gear relocation devices typically use acoustic technology, taking advantage of superior sound transmission property in the sea water. There are two types of technologies: active pingers and transponders, and passive sonar reflectors. The first method is based on detecting specific frequencies of sound from the locator tag using a receiver hydrophone, and the second is based on enhanced target strength of the locator using an echo sounder or a sonar.

Pingers

Pingers (also called beacons) continuously emit acoustic signals at certain frequencies once in the water. A hydrophone is used to listen to the acoustic signals from the pinger to home in its position.

Transponders

Transponders listen to the acoustic signal from a command unit via a hydrophone. Once it has detected a certain signal, the transponder sends an acoustic signal back to the hydrophone, so that the location of the transponder can be determined.

Passive sonar reflectors

Passive sonar reflectors enhance acoustic reflectivity of objects underwater so that they can be easily detected by echo sounders or other acoustic equipment. Measures to enhance reflectivity of objects include the size, shape, material, and other features (Islas-Cital *et al.*, 2013).

3.3 Examples of gear marking requirements in selected jurisdictions

It has long been recognized that passive (unattended) fishing gears, such as set gillnets, drift gillnets, longlines and pots, should be marked to facilitate retrieval, establish ownership and to reduce interactions with other vessels for safe navigation or avoiding gear conflicts. The need for a uniform marking scheme across management boundaries and in high seas resulted in the 1967 Convention on the Conduct of Fishing Operations in the North Atlantic. This Convention (Article 5) and its Annexes (Annex II and IV) have become the basis for many fishing gear marking legislations and recommendations for many nations and regions, including Annex IV “Proposal for the Application of Standard System of Lights and Shapes for the Identification and Location of Fishing Gear” of FAO Technical Guidelines for Responsible Fisheries 1. Fishing Operations (FAO, 1996), which is attached as Appendix 3.

Selected national and regional fishing gear marking requirements are described below. Only parts of regulations and/or laws that are relevant to markings for IOTC gears are included.

3.3.1 Norway

There is a general requirement that fishing gear shall be marked in its fisheries law (FOR-2015-02-23-152. Chapter XVI. Marking of fishing gears). The requirements generally reflect those in the 1967 Convention with some additional requirements. Specific requirements are as follows.

(1) Marking requirements

- i. All stationary or drifting fishing gear in use in the Norwegian EEZ must be clearly marked with vessel’s district registration number. If vessel is not registered, then with the owner’s name and address. At least one of the buoys attached to the gear must be marked.
- ii. All aquaculture cages must be marked as in i, but at least two buoys must be correctly marked.
- iii. Anchors and mooring ropes must be marked as described in i.
- iv. Marking must be on the fishing gear if no buoys are used.
- v. Pots used for snow crab fishery must be marked even used outside of the region mention in i. Pots fished in a fleet of more than one pots must be marked with vessel registration number, and on the float attached to the pot.

(2) Special marking rules outside 4 NM

Gillnets and longlines used in the Norwegian EEZ outside of 4 NM from shore baseline must be marked as follows:

- i. At daytime the fishing gear must have both ends a highflyer with a radar reflector or a flag. After sunset both ends must have a buoy with reflector (see section f) and with light (see section g) so that both end buoys show the location of the fishing gear and its extent.
- ii. At daytime, the west end (accord to compass south through west into and with north) buoy must have two flags, one over the other. Distance between those two flags must be at least 25 cm. Radar reflector can be replaced by the upper flag. After sunset the buoy must have two lights. Distance between the lights must be at least 50 cm.
- iii. At daytime the east end (accord to compass north through east to and with south) buoy must have one flag. Radar reflector can be used instead of the flag. After sunset the buoy must have one light.
- iv. Distance between buoy on anchored fishing gear may not be more than 1 nm. If fishing gear is longer than 1 nm, it must have one or more intermediate buoys between the end buoys. Intermediate buoys shall be marked as described in iii. After sunset those middle buoys can be without lights, but only if distance between light on the fishing gear is not more than 2 NM.
- v. Distance between marking buoys on drifting fishing gear may not be more than 2 nm. Fishing gear with length over 2 nm, must have one or more intermediate buoys between the end buoys. The intermediate buoys must be marked as explained in iii.
- vi. Driftnets in fleet of many connected nets with total length over 1 NM must have one or more buoys with light reflectors to assist in visual relocation.
- vii. If the topography of the bottom and/or the current strength make it impossible to have buoy on both ends, the length of the fishing gear may not be longer than 1 NM.
- viii. When one end of the drifting fishing gear is attached to the vessel, the marking is not needed at that end.
- ix. The poles on highflyer must be at least 2 m high above the surface. Marker, poles or the top marker must have a light reflector, capable to reflect light from all directions.
- x. The light on the highflyer must be yellow and visible from a distance of at least 2 NM in clear visibility in darkness. Constant lights which are on all the time or flashing lights may be used. However, it is not allowed to have both constant and flashing light on the same marker. Flashing lights must flash at a rate of 20 to 25 flash per minute. If two flashing lights are used on the same pole or marker, they must be synchronized, so that they blink in rhythm.

3.3.2 European Union

The European Union laid out detailed rules for the implementation of the Common Fisheries Policy (EC No. 1224/2009) with specific details on the marking of fishing gear and related reporting requirements that took effect in 2011. Below are some excerpts from EC No. 1224/2009:

- (1) General rules for passive gear and beam trawls
 - i. The provisions contained in Articles 9 to 12 of this Regulation shall apply to EU fishing vessels fishing in all EU waters and the provisions contained in Articles 13 to 17 of this Regulation to EU waters outside 12 NM measured from the baselines of the coastal Member States.
 - ii. It shall be prohibited in EU waters as set down in paragraph 1 to carry out fishing activities with passive gear, buoys, and beam trawls, which are not marked and identifiable in accordance with the provisions of Articles 10 to 17 of this Regulation.
 - iii. It shall be prohibited in EU waters as set down in paragraph 1 to carry on board:
 - (a) beams of a beam trawl which do not display the external registration letters and numbers in accordance with Article 10 of this Regulation,
 - (b) passive gear which is not labelled in accordance with Article 11(2) of this Regulation,
 - (c) buoys which are not marked in accordance with Article 13(2) of this Regulation.
- (2) Rules for beam trawls (text omitted due to irrelevance to IOTC),
1. (3) Rules for passive gear
 - i. The master of an EU fishing vessel or his representative shall ensure that each passive gear carried on board or used for fishing is clearly marked and identifiable in accordance with the provisions of this Article.
 - ii. Each passive gear used for fishing shall permanently display the external registration letters and numbers displayed on the hull of the fishing vessel to which it belongs:
 - (a) for nets, on a label attached to the upper first row,
 - (b) for lines and long lines, on a label at the point of contact with the mooring buoy,
 - (c) for pots and traps, on a label attached to the ground rope,
 - iii. for passive gear extending more than 1 nautical mile, on labels attached in accordance with (a), (b) and (c) at regular intervals not exceeding 1 nautical mile so that no part of the passive gear extending more than 1 nautical mile shall be left unmarked.

The same EU Regulation also specified in detail the “Rules for labels”, “Rules for buoys”, rule for intermediate and end marker buoys and how they should be fixed, “Rule for cords” which refer to buoy ropes, and reporting requirements. The regulation also has detailed requirements for marking of FADs, and electronic and satellite tracking devices.

3.3.3 Canada

(1) General provisions

Regulations for gear marking in Canada are contained in the Fisheries Act (SOR/93-53). The main provisions are as follows:

- i. No person shall set, operate or leave unattended in the water any fishing gear other than mobile gear or handlines unless the gear is marked with the vessel registration

number as set out in the license authorizing the use of that gear or in any other case, the name of the person who owns the gear.

- ii. The vessel registration number or name shall be painted on or otherwise securely affixed to a tag, float or buoy attached to the gear and be legible and readily visible at all times without the necessity of raising the gear from the water or, where the water is ice covered, without the necessity of removing any snow or ice.
- iii. The numerals in a vessel registration number shall be solid block Arabic numerals without ornamentation; not less than 75 mm in height; and in a colour that contrasts with their background. In the case of an owner's name, block capital letters in Roman characters should be used.
- iv. In tidal waters where one end of the fishing gear is fastened to the shore, a buoy shall be affixed to the end of the gear farthest from the shore; and in any other cases, be affixed to each end of the gear.
- v. No person shall display any number, name or validation tab on fishing gear or on a tag, float or buoy attached to fishing gear that is so similar to a number or name required as to be capable of being mistaken for any such number, name or validation tab.

(2) Specific provisions for gillnets used to target Pacific salmon and roe herring

- i. For Pacific salmon gillnets, buoys shall be orange in colour and at least 125 cm in circumference. The end of the gillnet not attached to the vessel shall be marked with a light that gives a steady white light during night.
- ii. For the roe herring gillnet fishery, buoys shall be at least 125 cm in circumference and of the same colour. The validation tab issued with the licence under which the gillnet is being used shall be attached to a buoy that is attached at one end of the gillnet.

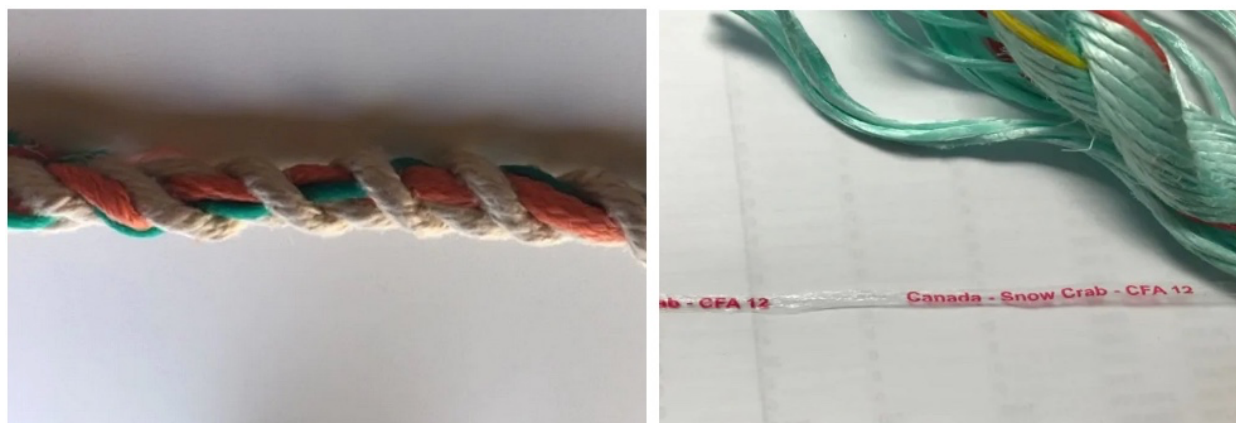
(3) Gear marking to trace origin in Eastern Canadian fixed gear fisheries

Canadian Fisheries and Oceans implemented mandatory gear marking to all unattended fixed gear fisheries in 2020 in Eastern Canada, including the Gulf, Maritimes, Newfoundland & Labrador, and Quebec Regions (DFO, 2020). The new requirements are part of the Canada's efforts to improve tracking of gear when lost, address ghostgear and further identify management measures to reduce threats to marine mammals, in particular North Atlantic Right Whales. They are implemented to trace gear origin, specifically country, region, target species, as well as lobster and snow crab fishing areas. The gear marking requirements consists of interlacing different strands of coloured twine within an existing rope.

- i. Colour combination using two different strands of twine interlaced on the same segment (Figure 10):
 - (a) One colour to identify specific Region – to be interlaced on the same segment of rope as the second colour.
 - (b) A second colour to identify target Species – to be interlaced on the same segment of rope as the first colour. Each species will be attributed the same colour across all Regions in Eastern Canada (i.e., yellow for lobster).

- ii. For lobster and snow crab fisheries only, a third colour is used to mark different fishing areas. The third colour is added to a subsequent segment of rope immediately after the segment of rope with the first two colours
- iii. Gear marking is mandatory for ropes attaching the fishing gear to the primary buoy (vertical line). It could also be included on other rope segments when applicable, at the discretion of fish harvesters, such as on the rope from the primary buoy to the secondary buoy, and on the ground lines.
- iv. At a minimum, gear marking is required at the top, middle and bottom of the vertical line or every 27.4 m throughout the length of the rope.
- v. Use of a “tracer” as an alternative to colour coding requirements is permitted (Figure 10). The tracer, a silver transparent tape inside the full length of the rope, must have a visible inscription identifying country, regions, species and fishing area.

Figure 10. Colour combination using two or more different strands of twine interlaced on the same segment to indicate the fishery and region (left), and tracer with visible inscription identifying country, region, species and fishing area (right)



Source: Canada Department of Fisheries and Oceans

3.3.4 Taiwan, China

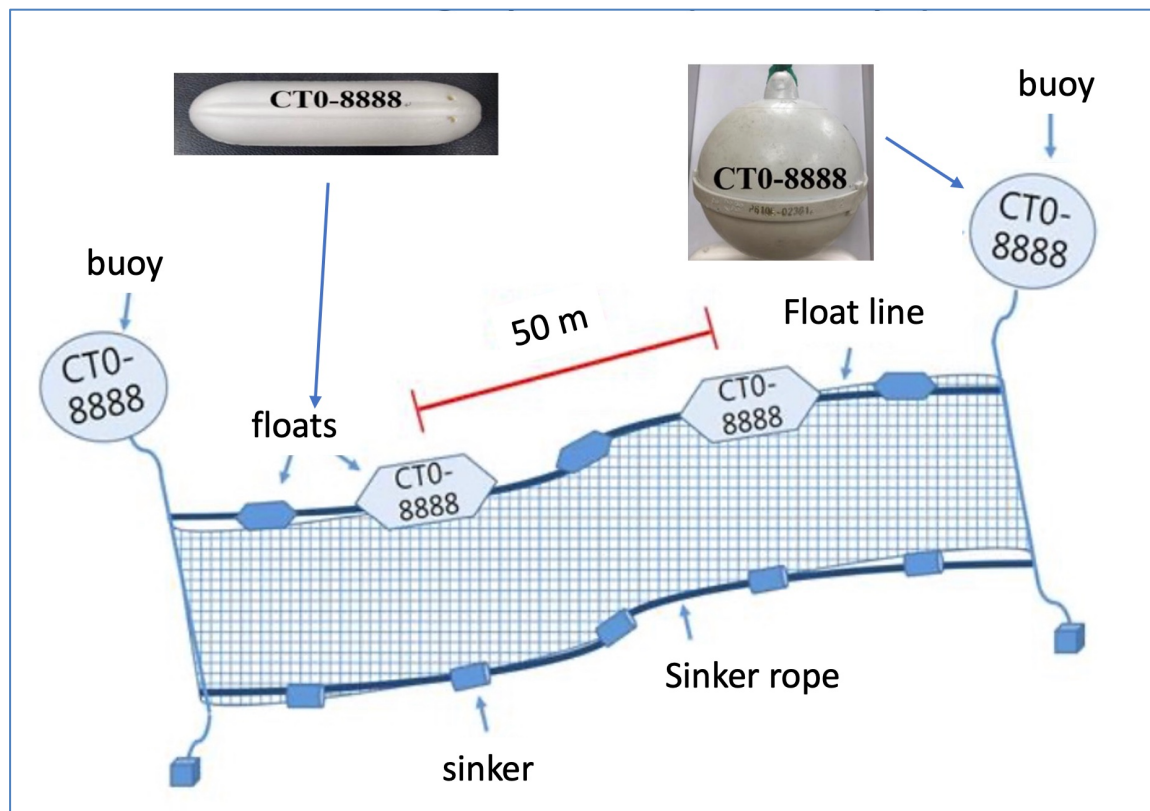
Taiwan, China recently implemented marking for gillnets, as published in "Gillnet Net Fisheries Fishing Gear Marking Measures" which took effect in 2018 (CoA, 2018).

Before a fishery person is authorized to engage in gillnet fisheries, his fishing gear shall be marked in accordance with the following prescribed methods, contents, and locations (as shown in Figure 11) and shall maintain a clear and identifiable state at any time:

- (1) The manner and content of the marking:
 - i. to write, paint, engraving, tie label or other manners that are not easy to remove (or peel off).
 - ii. should be marked with the vessel identification number, with legible font sizes.
- (2) Location of marking:
 - i. on the buoys or flags at both ends of the float line of the gillnet.
 - ii. For floats longer than 8 cm, on floats at an interval of 50 m. For float shorter than 8 cm, or no floats on the float line, on the buoy at both ends of the gillnet.

When a fishing vessel is unable to bring back the gillnets due to adverse sea conditions, entanglement, navigation safety or other reasons, the fisher shall, orally or in writing, notify the Taiwan Fisheries Communication Radio, the county (city) municipalities, or local fisheries associations, who should in turn record the notification according to the format prescribed by the authority.

Figure 11. Gillnet marking requirements stipulated by Council of Agriculture (Taiwan, China)



Source: Modified from CoA (2018)

3.3.5 The United States of America

Under the Magnusson-Stevens Fisheries Management and Conservation Act of 1996, and subsequent renewals, the US marine fisheries are managed by NOAA Fisheries in cooperation with eight regional fishery management councils. Many specific management requirements, including fishing gear marking requirements, are region-specific. Some examples are given below.

(1) Surface marking requirements for Northeast multispecies and monkfish fisheries.

- i. Bottom-tending fixed gear, including, but not limited to, gillnets and longlines designed for, capable of, or fishing for NE multispecies or monkfish, must have the name of the owner or vessel or the official number of that vessel permanently affixed to any buoys, gillnets, longlines, or other appropriate gear so that the name of the owner or vessel or the official number of the vessel is visible on the surface of the water.
- ii. Bottom-tending fixed gear, including, but not limited to gillnets or longline gear, must be marked so that the westernmost end of the gear displays a standard 12-inch (30.5-cm) tetrahedral corner radar reflector and a pennant positioned on a staff at least 6 ft

(1.8 m) above the buoy. The easternmost end of the gear need display only the standard 12-inch (30.5-cm) tetrahedral radar reflector positioned in the same way.

- iii. In the Gulf of Maine and Georges Bank regulated mesh area specified, gillnet gear set in an irregular pattern or in any way that deviates more than 30° from the original course of the set must be marked at the extremity of the deviation with an additional marker, which must display two or more visible streamers and may either be attached to or independent of the gear.

(2) Tagging requirements

- i. Roundfish gillnet. Roundfish nets must be tagged with two tags per net, with one tag secured to each bridle of every net, within a string of nets
- ii. Flatfish gillnet. Flatfish nets must have one tag per net, with one tag secured to every other bridle of every net within a string of nets. Gillnet vessels must also abide by the tagging requirements in paragraph (a)(3)(iv)(C) of this section.
- iii. Tags. Tags must be obtained as described in § 648.4(c)(2)(iii), and vessels must have on board written confirmation issued by the Regional Administrator, indicating that the vessel is a Day gillnet vessel or a Trip gillnet vessel. The vessel operator must produce all net tags upon request by an authorized officer. A vessel may have tags on board in excess of the number of tags corresponding to the allowable number of nets, provided such tags are onboard the vessel and can be made available for inspection.
- iv. Lost tags. Vessel owners or operators are required to report lost, destroyed, and missing tag numbers as soon as feasible after tags have been discovered lost, destroyed or missing, by letter or fax to the Regional Administrator.
- v. Replacement tags. Vessel owners or operators seeking replacement of lost, destroyed, or missing tags must request replacement of tags by letter or fax to the Regional Administrator. A check for the cost of the replacement tags must be received by the Regional Administrator before tags will be re- issued.

3.3.6 The Southern Indian Ocean Fisheries Agreement

The Southern Indian Ocean Fisheries Agreement's (SIOFA) Conservation and Management Measure for Control of Fishing Activities in the Agreement Area (CMM 2018/09) has gear marking, reporting and retrieval provisions. Below are some excerpts from CMM 2018/09:

(1) Marking of fixed gear

- i. Fixed gear used by vessels flying its flag is marked as follows:
 - (a) the ends of nets, lines and gear anchored to the seabed shall be fitted with flag or radar reflector buoys by day, and light buoys by night, sufficient to indicate their position and extent. Such lights should be visible at a distance of at least 2 NM in good visibility.
 - (b) Marker buoys and similar objects floating on the surface and intended to indicate the location and/or origin of fixed fishing gear, and where possible, the gear itself shall be clearly marked with the vessel's name and International Radio Call Sign.
- ii. Notify without delay the Secretariat of the information regarding the marking of fixed gear used by vessels flying its flag. This notification does not need to be repeated unless there are changes to be reported.

4. Current IOTC Measures Related Gear Marking

4.1 Current IOTC measures and requirements related to gear marking

The following IOTC resolutions are relevant to the marking of fishing gear:

IOTC (2001). Resolution 01/02. Relating to control of fishing activities

The India Ocean tropical Tuna Commission (IOTC) adopts

4. a) Each Contracting Party and Non-Contracting Party Cooperating with the IOTC shall ensure that gear used by its fishing vessels authorised to fish in the IOTC Area is marked appropriately, such as, the ends of nets, lines and gear in the sea, shall be fitted with flag or radar reflector buoys by day and light buoys by night sufficient to indicate their position and extent
- b) Marker buoys and similar objects floating and on the surface, and intended to indicate the location of fixed fishing gear, shall be clearly marked at all time with the letter(s) and/or number(s) of the vessel to which they belong
- c) Fish aggregating devices shall be clearly marked at all time with the letter(s) and / or number(s) of the vessel to which they belong

(Note: Resolution 01/02 remains binding on all Members until 13 November 2013 and which will remain binding on: India)

Resolution 01/02 was superseded by a number of other resolutions, and the most current version is 19/04:

IOTC (2019). Resolution 19/04. Concerning the IOTC Record of Vessels Authorised to Operate in the IOTC Area of Competence

The India Ocean tropical Tuna Commission (IOTC) adopts

19. Each Contracting Party and Cooperating Non-Contracting Party with the IOTC shall ensure that:

- a) Each gear used by its fishing vessels authorised to fish in the IOTC area of competence is marked appropriately, e.g., the ends of nets, lines and gear in the sea, shall be fitted with flag or radar reflector buoys by day and light buoys by night sufficient to indicate their position and extent;
- b) Marker buoys and similar objects floating and on the surface, and intended to indicate the location of fixed fishing gear, shall be clearly marked at all time with the letter(s) and/or number(s) of the vessel to which they belong;
- c) Fish aggregating devices shall be clearly marked at all time with the letter(s) and / or number(s) of the vessel to which they belong.

IOTC (2019). Resolution 19/02. Procedures on a fish aggregating devices (fads) management plan

The India Ocean tropical Tuna Commission (IOTC) adopt the following:

2. This Resolution shall apply to CPCs having purse seine vessels and fishing on Drifting Fish Aggregating Devices (DFADs), equipped with instrumented buoys for the purpose of aggregating target tuna species, in the IOTC area of competence. Only purse seiners and associated supply or support vessels are allowed to deploy DFADs in the IOTC Area of Competence.
3. This resolution requires the use of instrumented buoy, as per the above definition, on all DFADs and prohibits the use of any other buoys, such as radio buoys, not meeting this definition.
10. CPCs shall require vessels flying their flag and fishing on DFADs to annually submit the number of operational buoys followed by vessel, lost and transferred (total number of DFADs tagged at sea, by deploying an instrumented buoy on a log or another vessel DFAD already in the water) by 1° by 1° grid area and month strata and DFAD type under the confidentiality rules set by [Resolution 12/02](#) (or any subsequent superseding Resolution).

FAD Marking

20. A new marking scheme shall be developed by the ad-hoc FAD working group and shall be considered by the Commission at its regular annual session in 2020.
21. Until the marking scheme referred to in paragraph 20 is adopted, CPCs shall ensure that the instrumented buoy attached to the DFAD contain a physical, unique reference number marking (ID provided by the manufacturer of the instrumented buoy) and the vessel unique IOTC registration number clearly visible.

4.2 Proposals related to gear marking

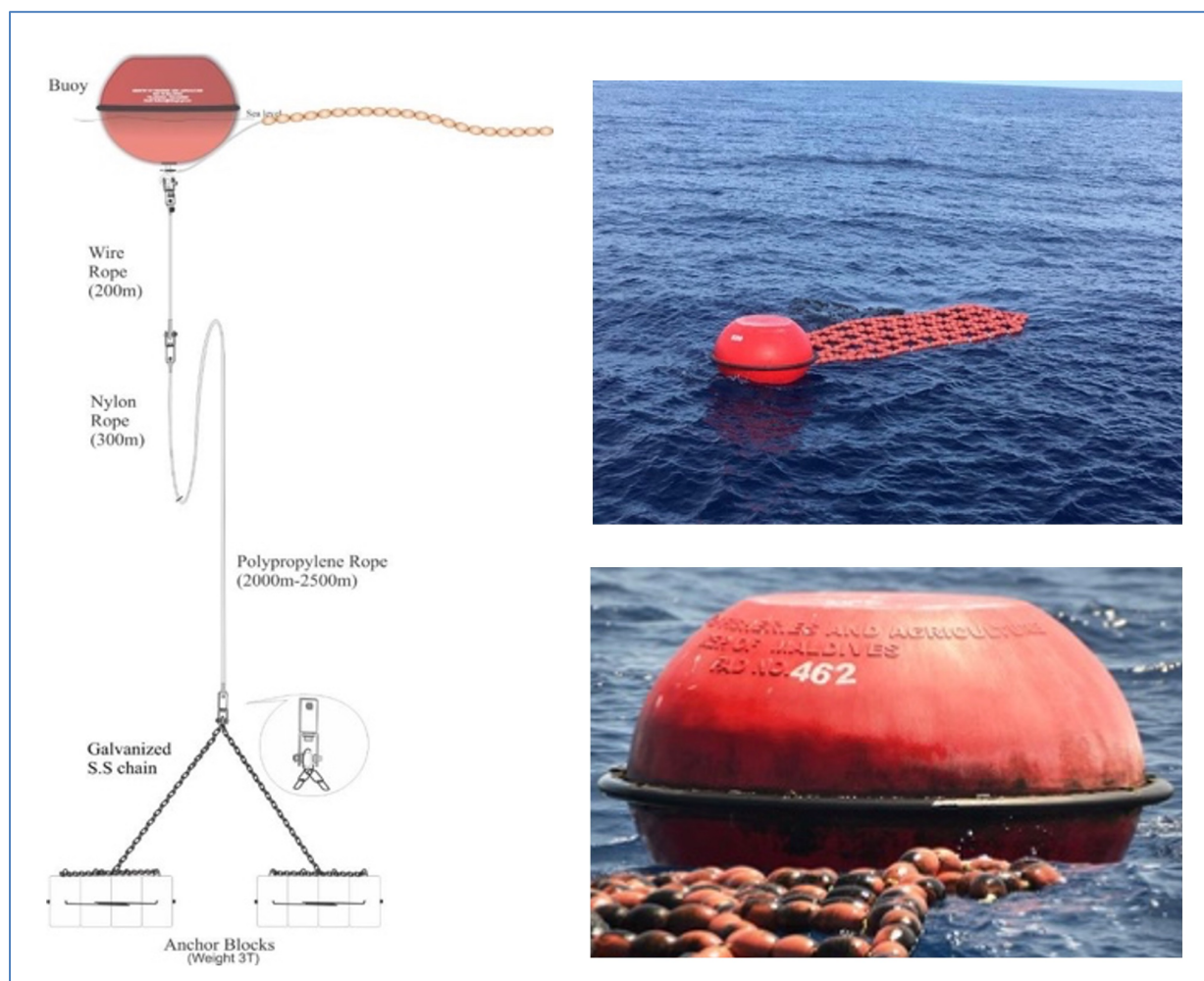
The proposal “On marking of fishing gear and prevention of marine pollution” (IOTC-2019-S23-PropL[E]) was submitted by European Union in 2019, but was not adopted into a resolution. The proposal set out general principles and detailed measures on marking, reporting, and recovery or retrieval of ALDFG and means for prevention of marine pollution.

The proposal “On management of fish aggregating devices in the IOTC area of competence” was drafted by Kenya and other countries in 2021 (IOTC-2021-SS4PropD_rev1) and has not yet been finalized. The proposal was to strengthen Resolution 19/02 to “mitigate the ecological impacts associated with drifting FADs, especially its stranding, damage to coral reefs, and inshore habitats and its contribution to marine debris”.

4.3 Examples of marking measures of CPCs

As reported in Adam *et al.* (2019), all anchored FADs have been deployed by Maldives government. The buoys are clearly marked with “Ministry of Fisheries and Agriculture, Rep of Maldives” embossed on the buoy (Figure 12). This was done during fabrication of the FRP buoy. The unique number of the FAD was printed prior to deployment.

Figure 12. Maldives Anchored FAD with marking on its buoy.



Source: Modified from Adam *et al.* (2021)

5. Risk Assessment for the Marking of Fishing Gear

The purpose of conducting a risk assessment is to facilitate prioritization of actions and guide additional phased mitigation approaches. These would be based on the level of severity and likelihood of potential impacts of different fisheries, using the best available information at the time of the assessment (FAO, 2019).

The risk assessment methodology described below was first piloted for Grenada fisheries (He, Lansley *et al.*, in preparation), which will result in a framework for conducting risk assessment for the implementation of a gear-marking system. The methodology was further improved considering geographic and management scopes, and fishing gears used in the IOTC area.

5.1 Principles of risk assessment

5.1.1 General principles

Based on the Voluntary Guidelines on the Marking of Fishing Gear (FAO, 2019), the determination of risk levels involves four primary steps:

- Estimation of the consequence (impact) of the lack of a gear marking system (on an inadequate marking system) in the fishery under consideration
- Estimation of the likelihood of occurrence (probability) of the identified impacts/risk, occurring as a result of the lack of a gear marking system (on an inadequate marking system) in the fishery under consideration
- Scoring of the impact, which may be determined by the nature of and design of the gear and modified by the perceived importance of impact by stakeholders
- Categorization of the risk

A risk assessment should take into consideration risk associated with both actively fished gear as well as lost, abandoned or otherwise discarded fishing gear (ALDFG). Before a full risk assessment is undertaken, a simple yes/no assessment may be conducted based on the type of fishing gear, marking methods and techniques and the area of operation as suggested in the VGMFG. This will allow simple small-scale methods, usually hand-held fishing gears, to be assessed without the need for a full risk assessment. The parameters that need to be considered for consequences and impacts should include, but not limit to:

- Ecological risks (plastic pollution, status of species impacted, e.g., ghostfishing, impact on endangered, threatened, and protected (ETP) species, habitats vulnerability and fragility)
- Economic risks (gear theft; replacement cost of lost gear; level of fishing effort; value of the fishery; economic nature of the fishery (e.g., subsistence, artisanal, small-scale, industrial), IUU fishing, and cost of implementation)
- Technological risks (Gear types, numbers of gear units, numbers of vessels, method of operation)
- Safety and navigational risks (risks to the vessel operating the gear, other fishing vessels, and non-fishing vessels)

- Implementation risks (different users, language, level of organization, availability of information and the quality of information, international, regional and local expert support).

Determining a risk level requires estimates of the consequences and likelihood based on best available science and local ecological knowledge and stakeholder input. To be able to defend estimates, a clear rationale should be provided on how estimated levels were chosen, so that the determination can be traced and verified. Regional standardization is desirable, but fishery- or location-specific criteria are possible if justifiable. Clear rationale also provides a basis from which future assessments can be made. The information, data and expert and fishers' opinion collected and consolidated through the initial scoping exercise form the basis for that rationale, with additional information being provided where appropriate and necessary.

5.1.2 Technology readiness

There are a variety of fishing gear marking technologies, and new technologies are being developed and or introduced with advance of electronics and communication technologies and infrastructure (He and Suuronen, 2018). However, there are great disparities among regions and nations. A risk assessment should thus include an assessment of the feasibility of implementing a system for the marking of gear with regard to fisheries or nations that the system that is to be implemented. Accordingly, the risk assessment should address the following basic questions:

- Is the technology associated with the system feasible?
- Will the technology mature (or become obsolete) over time?
- Are there any technical barriers to integrating the capability within the system?

5.1.3 Economic consideration

For the economic consideration, the following questions may be asked:

- Is the technology (and associated costs) fit for the required purpose?
- Do the countries, regions and/or Regional Fishery Body in question have the administrative capacity and financial resource to implement and monitor the system?
- What capacity building needs should be considered (both in terms of administrations and fishery operators)?

5.1.4 Transparency and stakeholder involvement

Risk assessments and associated decision-making should be carried out in a transparent fashion and following written rules of procedure. Arrangements for conducting risk assessments and associated decisions should be carried out with balanced participation by independent technical experts and representatives of interested parties in system development, revision and approval processes. Stakeholders for risk assessment, and the development of gear marking systems that follows, may include:

- Representatives of fishery management and enforcement authorities
- The fishing industry and fisher organization
- Scientific and research community
- Nongovernmental organizations

- Fish processors, traders and retailers
- Consumer associations and seafood certification bodies

5.2 Fishing gear and risks

The process for conducting risk assessment for the marking of fishing gear should start with the identification of scope, area, fishery, and gear to be assessed, and existing gear marking requirements in national and regional fishery regulations or laws, and any recommendations for gear marking relevant to the fisheries being assessed (i.e., non-binding measures of RFBs)¹. This should be followed by collection of fishing gear and fishery data and gear loss data, and where and when loss had often occurred (hot spot identification). The process should involve diverse stakeholders, often through stakeholder surveys, workshops of other similar mechanism. Stakeholders identify, using scientific, technical and fishers' knowledge, and through consensus to categorize risks and to score risks if the gear is not marked or not properly marked for different fishing gears. One important aspect of stakeholder input and consensus is valuing the reduction of specific risks associated with specific gears relevant to the area, or the importance of reducing different types of risks. This is partly based on geographic location, ocean environment, economic condition, and personal or community perception. For example, stakeholders in different regions may value differently the importance between economic loss of gear and ghostfishing resulted from the gear loss. Risk assessment for the marking of fishing gear involves the following steps.

5.2.1 Scoring likelihood and impact of risks of gears in normal fishing conditions

Fishing gears and risks associated with not marking, or not properly marking, depend on the type of gear, the fishery, fishery management regimes in place, sea conditions and other activities being conducted in the same area. Scoring of likelihood of occurrences of risks for different gear types was done on each specific gear type. The following risks were identified when the gear is in normal fishing conditions:

- Gear loss
- Ownership dispute and theft
- Capacity control and overcapacity
- Illegal fishing
- Gear conflict
- Navigation hazard

One of the primary purposes of gear marking at surface is for positioning of the gear for subsequent retrieval by its owner and for guiding other fishers not to set or to tow their gears at the same location. Proper gear marking reduces gear loss as a result of the inability to find their gear, and damage and entanglement caused by gear conflicts. Good gear marking also aid other mariners to stay away from the gear for safe navigation, especially in areas with heavy vessel traffic.

¹ Recommendation WECAFC/17/2019/17 "On the marking of fishing gear" https://www.fao.org/fi/static-media/MeetingDocuments/WECAFC/WECAFC2019/17/RecWECAFCXVII2019_17.pdf

The likelihood of occurrence of various risks may vary with intrinsic characteristics of the gear and how they are operated, as well as other factors, including:

- Intrinsic characteristics of the gear
- Scale (size) and number of gear units being fished
- Sea and weather conditions
- Area being fished, including water depth, seabed type and distance from the port
- Catch amount
- Operator skill
- Machinery malfunction
- Legality of fishing; illegal fishing operators often abandon gear when approached by monitoring and enforcement agencies.

Typically, unattended gears have higher likelihood of loss than attended gears, but partial loss of attended gears is also possible, especially in incremental weather and sea conditions. Determining the likelihood of occurrence requires a combination of specialized knowledge of fishing technologists on fishing gear design and operation, and local knowledge on how the gear is being used by fishers in the area concerned.

Fishing gear loss

Effective surface gear marking facilitates location of previously deployed unattended fishing gear, thereby reducing probability of gear loss. Gear marking for capacity control also limits excessive amount of gear that leads to abandonment in incremental weather and sea conditions. Good surface gear marking also reduces gear conflicts between stationary and mobile fishing gears, and between stationary gears setting on top of each other, causing gear loss.

Generally speaking, unattended gears have higher risk of loss if not marked or not properly marked. This includes inability of the fisher to find the gear previously deployed, or due to gear conflicts and inability to avoid unmarked or improperly marked gear. However, unattended gears set in a short duration with the vessel monitoring nearby would reduce the likelihood of loss.

Ownership dispute

Many unattended gears are marked on the surface and sometime also on the gear from the earliest times to ascertain ownership to deter theft and to avoid accidentally retrieving the gear not belonging to them. Surface buoys of pots, gillnets and longlines are often inscribed with names and/or unique numbers. Attended gear, and unattended gears with active monitoring have lower likelihoods of ownership dispute and theft, while unattended gears set overnight without active monitoring by the owner vessel have higher likelihoods of the risk.

Overcapacity and effort control

One of the measures to control fishing effort, e.g., number of nets or pots that can be possessed or used by a fisher, is through the issuance and apply of marks or tags to the gear. More and more management regimes set limits on the number of gear units that can be used by fishers/vessels to control fishing capacity and to avoid overcapacity to protect resources. A corresponding number of marks/tags, often issued by legal authority, are assigned to a fishing unit or a corporation, and are attached to each unit of gear.

Illegal fishing

While fishing gear marking cannot stop illegal fishing, a system of gear marking facilitates monitoring, control and surveillance (MCS) authority for ascertaining legality of fishing operation and compliance of the fishing gear. Unmarked or insufficiently marked fishing gear that cannot be linked to its owner or authorization to fish in a specific area may indicate IUU fishing operations (FAO, 2019). Gear marking should therefore be considered as an important mechanism for assisting in the prevention and deterring of IUU fishing.

Gear conflicts

Gear marking plays an essential role in reducing and preventing gear conflicts between stationary gears, and between stationary and mobile gears. Properly marked gear indicates position, direction and extent of the gear. Attended gear, and unattended gears with active monitoring have lower likelihoods of gear conflict, while unattended gears without active monitoring by the owner vessel have higher likelihoods of the risk. Fishing around coastal aFADs may be popular for small scale fishers and can cause gear conflict.

Navigation hazards

One of the primary purposes of gear marking at surface is for positioning of the gear. Good gear marking also aid other mariners to stay away from the gear for safe navigation, especially in areas with heavy vessel traffic. The hazards of not properly marking on the surface are therefore dependent on location, and sometimes, season.

Table 3. Scores of likelihoods of occurrence (1 – lowest, 5 – highest) of different risks for fishing gears when they are in normal fishing conditions, if they are not marked or not adequately marked, based on their characteristics of design, fishing mechanism, and operation. See Table 1 for ISSCFG gear code and abbreviations.

Gear type (ISSCFG code)	Fished gear in normal fishing - Likelihood of Occurrence (1 - 5)						Mean likelihood score*
	Gear loss	Owner. Dispute	Over capacity	Illegal fishing	Gear conflict	Nav. hazard	
PS	1	1	1	5	1	1	1
GND	5	5	5	5	5	5	5
LHP	1	1	3	3	1	1	1
LLD	5	5	5	5	5	5	5
LTL	2	1	3	3	1	1	1
aFAD	3	2	2	1	2	2	1
dFAD	5	5	5	5	2	4	4

* Rescaled to 1 – 5.

5.2.2 Scoring of impacts or consequences

Types of impacts or consequences should ideally be verified and scored by stakeholders taking into account the type of fishery operating in the region. Characterization or scoring of impact may also consider the primary purpose of gear marking as determined by the authority, the fishing industry, and other stakeholders. This should ideally be done through stakeholder workshops where characterisation and scoring can be determined through consensus or calculated from individual or group response.

In this study, the importance of reducing the categorized impact or consequence for the IOTC Area of Competence was communicated with IOTC Secretariat. The following questions were provided to the IOTC Secretariat, and scores (1 to 5) were obtained (Table 4):

- Gear loss - How important is gear marking in preventing gear loss?
- Ownership disputer/theft - How important is gear marking in preventing or resolving ownership disputes?
- Over capacity/fishing effort control - How important or useful is gear marking in limiting fishing effort?
- Illegal fishing - How important or useful is gear marking in fighting illegal fishing?
- Gear conflict - How important is gear marking in resolving or avoiding gear conflicts?
- Navigation hazard - How important is gear marking in aiding navigation safety?

Table 4. Impact scores of different risks (1 – lowest, 5 – highest), as represented by perceived importance by stakeholders, when the gear is in normal fishing conditions.

	Impact score - Perceived importance by stakeholders (1 - 5)					
Risk type	Gear loss	Ownership dispute	Over capacity	Illegal fishing	Gear conflict	Navigation hazard
Scores	4.5	5.0	5.0	5.0	2.5	4.0

The impact scores in Table 4 are weighed by the importance of the gear as provided in Table 2 to result in weighted impact scores of different risks for relevant fishing gears, as shown in Table 5. The mean impact scores are rescaled to values from 1 (lowest) to 5 (highest).

Table 5. Scoring the impact of different risk types, when the gear is in normal fishing conditions, considering the gear's importance as provided in Table 2. See Table 1 for ISSCFG gear code.

Gear type (ISSCFG code)	Gear in normal fishing conditions – impact score (1 - 5)						Mean impact score*
	Gear loss	Owner. Dispute	Over capacity	Illegal fishing	Gear conflict	Nav. hazard	
PS	4.5	5.0	5.0	5.0	2.5	4.0	5
GND	4.5	5.0	5.0	5.0	2.5	4.0	5
LHP	1.8	2.0	2.0	2.0	1.0	1.6	2
LLD	2.7	3.0	3.0	3.0	1.5	2.4	3
LTL	0.9	1.0	1.0	1.0	0.5	0.8	1
aFAD	2.7	3.0	3.0	3.0	1.5	2.4	3
dFAD	4.5	5.0	5.0	5.0	2.5	4.0	5

* Rescaled to 1 – 5.

5.2.3 Scoring likelihood and the impact and consequences of ALDFG

Once fishing gears become abandoned, lost or otherwise discarded, there are consequences to the environment, ecosystem and other ocean users, in addition to the costs for replacement of the gear for fishers. The severity of consequences (level of impact) is partially related to

gear design, operation, and intrinsic nature of the gear, as described below, and modified by recognized importance of the impact by stakeholders.

Plastic pollution

One of the most damaging outcomes of gear loss, abandonment and discarding is marine plastic pollution. While gear marking does not reduce marine plastic pollution after the gears have become ALDFG, marking do provide information about the fishery and region that ALDFG had come from, helping prioritizing areas and gears that need to implement measures to reduce gear loss and abandonment, and prohibition of discarding.

The score for plastic pollution for each gear type is related to the amount of plastic material in the gear that is operated by a fishing unit at any one time.

Ghostfishing

Another negative outcome of ALDFG is ghostfishing. Some gears are more likely to ghostfish after becoming ALDFG, negatively impacting the target fishery resource and dependent species. Gillnets and entangling nets are of particular concern.

Both actively fished gear and ALDFG can impact endangered, threatened and protected (ETP) species, but their degree of impact may be species and gear specific. The major differences between actively fished gear and ALDFG is that the former can be managed to reduce their impact through spatial and temporal closure, effort control, and gear modification, while the later cannot be controlled once they become ALDFG, unless some design features can be incorporated before they become ALDFG (de-hosting technology).

Traceability of ALDFG

Proper and effective marking of fishing gear is essential for tracing the region and fishery of the origin of the gear before they became ALDFG. The design of marking of fishing gear should take into consideration any national or regional recommended or mandatory ALDFG reporting requirements. This is especially important on gear that are entangled on large megafauna species, as identification of its origin can shed lights on measures to reduce entanglement and mortality of the animals. Traceability of ALDFG also informs measures for specific fisheries for proper management of gear to reduce loss and abandonment. The score of traceability is related to mobility of ALDFG of specific gear types – floating ALDFG is more likely to be carried by current to distance locations from where they were lost or abandoned.

Fouling seabed

Abandoned, lost or otherwise discarded fishing gears can foul seabed if they remain in the seabed or sink to the seabed. The likelihood this risk is related to the type of gear and density of fishing gear materials. Heavier materials such as PA and PES netting and ropes are likely to foul seabed while floating materials such as PE and PP are less likely doing so.

Economic loss

The immediate consequence of fishing gear loss is the replacement costs of the gear, from purchase costs to the lost fishing time. This risk is related to the size and scale of operation and gear characteristics. Loss of some fishing gear, e.g., large-scale fish traps, may mean loss of fishing for the entire season as construction and deployment usually take a long time. Seasonal nature of many such traps also make replacement unfeasible. Economic risk may

be more important in small-scale fisheries in developing countries where ability to purchase additional gear may be limited.

Navigation hazards

Navigational hazards of ALDFG are largely dependent on the material of the gear. Floating gear materials such as PP and PE netting and ropes often floats on the surface of water when they become ALDFG. Netting and ropes with functional floats and buoys also pose greater hazards to navigation, thus have higher risk scores. Navigation risk scores are also related to their area of operation; higher risks when they are operated in coastal, heavy vessel traffic areas and lower risk in the high seas.

Table 6 provides scores of likelihoods of gears when they become lost, abandoned or discard if they are not marked or not properly marked based on their scale (size) of the gear, material, and characteristics of design and operation. The scores of risks can vary greatly in different fisheries and should be determined through stakeholder inputs based on regional conditions, local ecological knowledge, and fishers' experience. The mean likelihood scores are rescaled to values from 1 (lowest) to 5 (highest).

Table 6. Scores of likelihoods of ALDFG risks (1 – lowest, 5 – highest) based on their characteristics of gear design and amount of plastic material.

Gear type (ISSCFG code)	ALDFG - Likelihood score (1 - 5)						Mean likelihood score*
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling seabed	Economic loss	
PS	5	3	3	2	5	5	4
GND	5	5	5	2	5	5	5
LHP	1	1	2	1	2	1	1
LLD	3	1	5	2	2	5	3
LTL	1	1	2	1	2	2	1
aFAD	2	3	3	3	5	2	3
dFAD	5	3	5	3	5	2	4

* Rescaled to 1 – 5.

5.3 Value and importance of reducing or eliminating impacts

Similarly, the importance or the value of eliminating or reducing each of identified impact or risks after the gear become ALDFG was communicated with IOTC Secretariat and scored were provided (

Table 7). The following questions were asked for each of the identified risks of ALDFG:

- Plastic pollution - How important or significant is ALDFG in contributing to marine plastic pollution in your region?
- Ghostfishing - How important or significant is ALDFG in ghostfishing?
- Traceability of ALDFG - How important is gear marking in tracing the origin of ALDFG in the sea (where it originate)?
- Navigation hazards - How significant is ADLFG in impacting navigation in your area?
- Fouling seabed - How significant is ADLFG in fouling seabed such as coral reefs in your area?
- Economic loss - How significant is the financial or economic impact of gear loss?

Table 7. Scores of impacts (or importance) of different ALDFG risks (1 – lowest, 5 – highest).

	ALDFG impact score - Perceived importance of stakeholders (1 - 5)					
Risk type	Plastic pollution	Ghostfishing capacity	Traceability of ALDFG	Navigation hazard	Fouling seabed	Economic loss
Scores	5.0	5.0	5.0	2.0	5.0	5.0

The impact scores in

Table 7 are weighed by the importance of gear as provided in Table 2 to result in weighted impact scores of different risks as shown in Table 8. The mean impact scores are rescaled to values from 1 (lowest) to 5 (highest).

Table 8. Impact scores of ALDFG risks (1 – lowest, 5 – highest) for different gear types considering scores from Table 7 and the gear's importance scores from Table 2. See Table 1 for ISSCFG gear code.

Gear type	ALDFG - impact score (1 - 5)						Mean impact score*
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling seabed	Economic loss	
PS	5.0	5.0	5.0	2.0	5.0	5.0	5
GND	5.0	5.0	5.0	2.0	5.0	5.0	5
LHP	2.0	2.0	2.0	0.8	2.0	2.0	2
LLD	3.0	3.0	3.0	1.2	3.0	3.0	3
LTL	1.0	1.0	1.0	0.4	1.0	1.0	1
aFAD	3.0	3.0	3.0	1.2	3.0	3.0	3
dFAD	5.0	5.0	5.0	2.0	5.0	5.0	5

* Rescaled to 1 – 5.

5.4 Categorization of risk

Categorization of risk involves assigning different gears in a likelihood - impact table for a specific impact (or consequence) or combined overall impact, either for the fishing gear that are in normal fishing conditions or after they become ALDFG, or the combined risk of both.

5.4.1 Fishing gear in normal fishing conditions

The likelihoods of occurrence for certain risks associated with fishing gears in normal fishing conditions as shown in Table 3, and their impact as shown in Table 5 can be used to construct likelihood - impact tables for a specific risk (e.g., gear loss, Table 9) or combined overall impact (

Table 10).

Table 9. Likelihood - impact table for the risk of gear loss when the gear is in normal fishing conditions. See Table 1 for ISSCFG gear code. Colour shade:



Potential Impact	5	PS				GND, dFAD
	4					
	3			aFAD		LLD
	2	LHP				
	1		LTL			
		1	2	3	4	5
Likelihood of occurrence						

Table 10. Likelihood - impact table for combined risks when the gear is in normal fishing conditions.

Potential Impact	5			PS	aFAD	GND
	4					
	3		aFAD		LLD	
	2	LHP				
	1	LTL				
		1	2	3	4	5
Likelihood of occurrence						

The risk of specific impact or combined overall impact can also be calculated with the following formulae:

$$\text{Risk} = \text{Likelihood of occurrence} \times \text{Impact}$$

The risk of specific impact or combined overall impact they may be ranked, as shown in Table 11 for combined overall risk. It can be seen that drift gillnet and drifting FADs have the highest overall risk scores, while trolling line has the lowest risk scores, when they are in normal fishing conditions

Table 11. Risk scores for different gear types when they are in normal fishing conditions.

Gear type	Actively fished gear – risk score						Mean risk score
	Gear loss	Owner. Dispute	Over capacity	Illegal fishing	Gear conflict	Nav. hazard	
PS	4.5	5.0	5.0	25.0	2.5	4.0	8.3
GND	22.5	25.0	25.0	25.0	12.5	20.0	21.5
LHP	1.8	2.0	6.0	6.0	1.0	1.6	3.3
LLD	13.5	15.0	15.0	15.0	7.5	12.0	12.9
LTL	1.8	1.0	3.0	3.0	0.5	0.8	1.7
aFAD	8.1	6.0	6.0	3.0	3.0	4.8	4.6
dFAD	22.5	25.0	25.0	25.0	5.0	16.0	19.2

5.4.2 Abandoned, lost or otherwise discarded fishing gear

The likelihoods of occurrence for certain risks associated with ALDFG as shown in Table 6 and their impact as shown in Table 8 can be used to construct likelihood - impact tables for a specific risk (e.g., plastic pollution, Table 12) or combined overall impact (Table 13).

Table 12. Likelihood - impact table for the risk of plastic pollution when the gear became ALDFG.

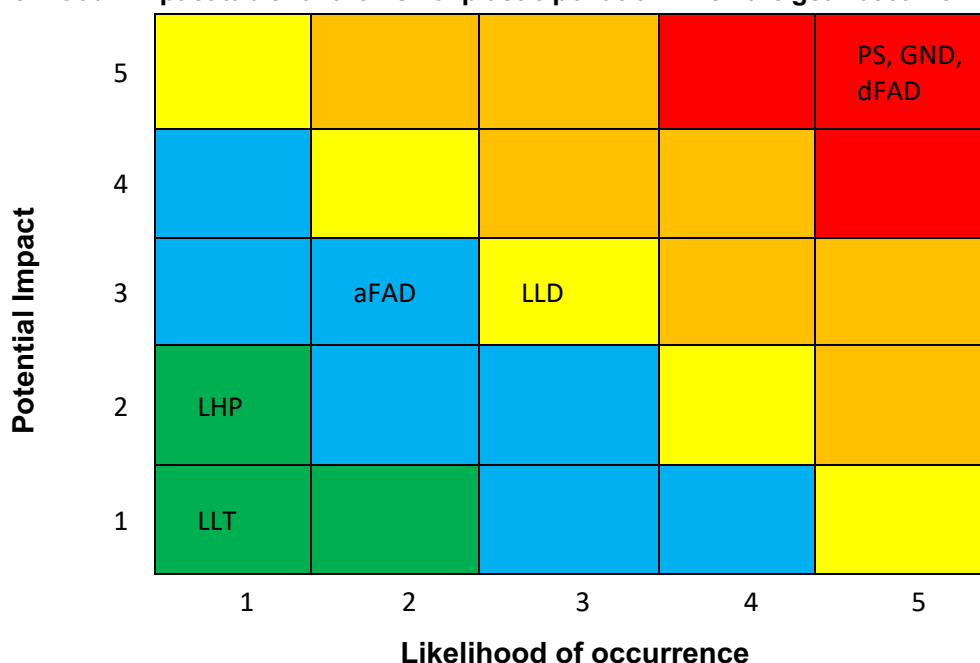


Table 13. Likelihood - impact table for combined risks when the gear became ALDFG.

Potential Impact	5				PS, dFAD	GND
	4					
	3			LLD, aFAD		
	2	LHP				
	1	LTL				
		1	2	3	4	5
		Likelihood of occurrence				

The risk of specific impact or combined overall impact can also be calculated using the same formula as for gears in normal fishing conditions, so that they may be ranked, as shown in Table 14. It can be seen that purse seines, drift gillnets and drifting FADs have the highest overall risk scores when the gear have become ALDFG, while trolling lines and handlines/pole-and-lines have the lowest risk scores.

Table 14. Risk scores for different gear types when they are lost or abandoned.

Gear type	ALDFG – risk score						Mean risk score
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling seabed	Economic loss	
PS	25.0	15.0	15.0	4.0	25.0	25.0	16.8
GND	25.0	25.0	25.0	4.0	25.0	25.0	20.8
LHP	2.3	2.0	4.0	0.8	4.0	2.0	2.6
LLD	10.0	3.0	15.0	2.4	6.0	15.0	8.3
LTL	1.0	1.0	2.0	0.4	2.0	2.0	1.5
aFAD	5.5	9.0	9.0	3.6	15.0	6.0	8.5
dFAD	25.0	15.0	25.0	6.0	25.0	10.0	16.2

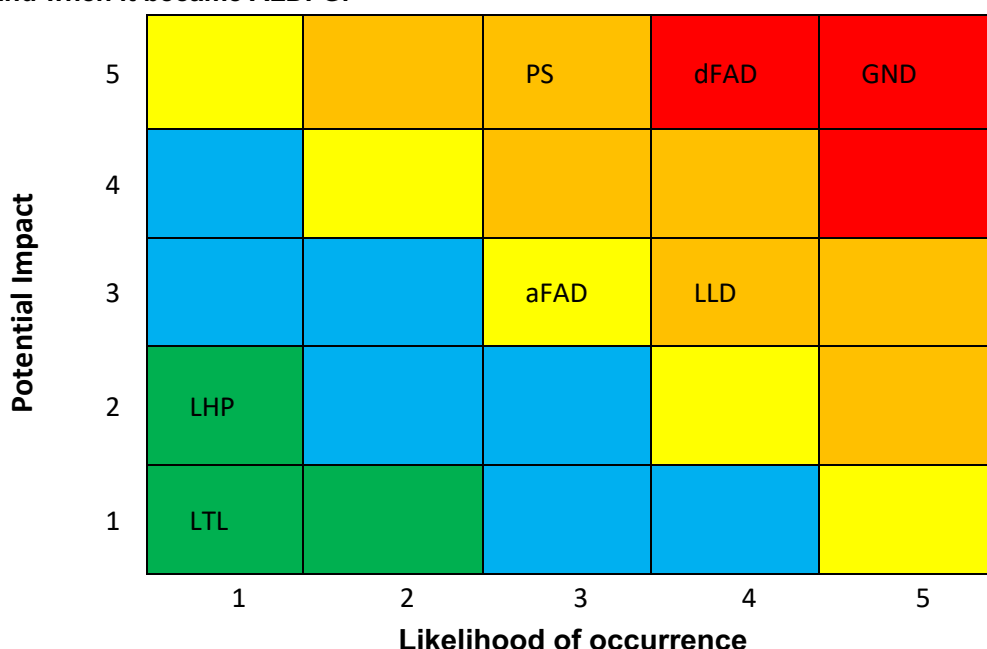
5.4.3 Overall risk

The overall risk of a fishing gear considering both when it is in normal fishing condition and after they became ALDFG may be evaluated by combining all likelihood scores and all impact scores for the gear type, as shown in Table 15. It can be seen that drift gillnet and aFAD has highest risk (red, the highest likelihood of occurrence and highest potential impact), while trolling line has the lowest risk (green) (Table 16).

Table 15. Overall risks considering both when the gear is fishing in normal conditions (Normal) and after they become ALDFG.

Gear type	Normal		ALDFG		Overall		
	Likelihood	Impact	Likelihood	Impact	Likelihood	Impact	Risk
PS	1.0	5.0	4.2	5.0	2.6	5.0	12.9
GND	5.0	5.0	5.0	5.0	5.0	5.0	25.0
LHP	1.0	2.0	1.0	2.0	1.0	2.0	2.0
LLD	5.0	3.0	3.2	3.0	4.1	3.0	12.2
LTL	1.2	1.0	1.2	1.0	1.2	1.0	1.2
aFAD	1.4	3.0	3.1	3.0	2.2	3.0	6.7
dFAD	4.2	5.0	4.2	5.0	4.2	5.0	20.9

Table 16. Likelihood - impact table for combined risks when the gear is in normal fishing conditions and when it became ALDFG.



5.5 Prioritization and complexity

Based on the risk categories and scores for IOTC fishing gears when they are in normal fishing conditions and after they become ALDFG, drift gillnets, dFADs, purse seines and drift longlines are ranked as “very high” or “high” risks, while aFADs have “medium” risks. These gears should be marked with sufficient details to indicate authorization to fish, ownership, and traceability once lost or abandoned. Handlines and pole-and-line, trolling lines are ranked to have “very low” overall risks. Accordingly, the high priority for gear marking should be assigned to drift gillnets, aFAD, purse seines, drift longlines and aFADs, while handlines and pole-and-line, and trolling line may be marked with less complexity, for example, to provide ownership and license to fish.

6. A Gear Marking Scheme for the IOTC Area of Competence

6.1 General principles

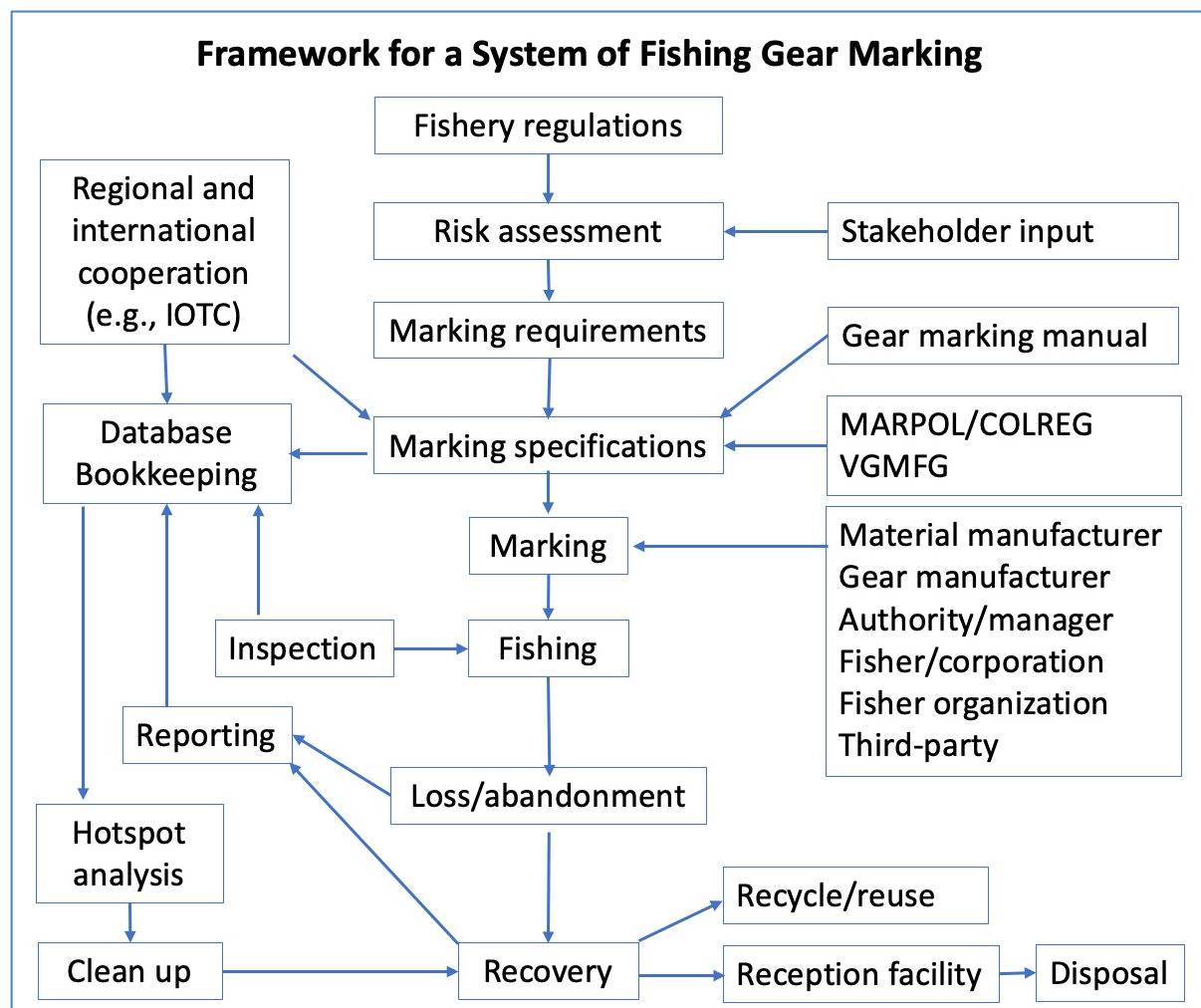
A system of fishing gear marking should be an integral component of and serves as an important tool for fisheries management. It should be compatible with existing international laws and rules, including, but not limited to MARPOL Annex V, and COLREG with special reference to marking of fishing gear on the surface to prevent collision. The priority, complexity and level of gear marking should be based on the outcome of risk assessments as described in Chapter 5. In addition, a system of gear marking should have the following function and characteristics as suggested by the VGMFG:

- provide a simple, affordable and verifiable means of identifying the ownership and position of fishing gear,
- be compatible with related traceability and certification systems,
- be supported by a monitoring process for compliance,
- meet obligations in applicable international conventions and agreements,
- link with fishing authorization or license, and to vessel, its owner or operator engaged in fishing, and
- have minimal environmental risk, e.g., plastic pollution.

6.2 A framework for fishing gear marking

As system of fishing gear marking should include risk assessment (as illustrated in Section 5), gear specific marking requirements, reporting, recording and data management system, application of data for monitoring control and surveillance, and for mitigating the impact of ALDFG including the retrieval of ALDDFG, and collection, reuse and recycle of end-of-life gear. A framework for a system of fishing gear marking synthesizing the VGMFG is shown in Figure 13.

Figure 13. Flowchart synthesizing a system of fishing gear marking, and its components



6.3 Areas and fisheries

The IOTC area of competence includes EEZs of CPCs and international waters beyond national jurisdiction in the entire Indian Ocean. The fisheries persecuting the species managed by IOTC consists large scale industrial operations such as purse seines and drift longlines and small scale and artisanal fisheries using handline and trolling lines. However, there is no current agreement of what constitutes artisanal, coastal and semi-industrial fisheries in terms of applying gear marking measures to fishing gears and FADs. In addition, vessels may also fish both in national waters and international waters. Therefore, it may not be feasible to separate fisheries and areas when implementing a system of fishing gear marking. However, through a risk assessment, certain gear types that are commonly considered small scale or artisanal may in fact result in minimal risk and therefore minimal requirements for gear marking.

6.4 Infrastructure, authorities and stakeholders

6.4.1 Database

A system of gear marking should include a good book-keeping system on production, issuance, replacement, and termination of marking or markers, which usually involves a database linked to vessel records, fishing licenses and permits, gear regulations, as well as commercial tracing of manufacture, sale, resale and disposal of fishing gear or its major components. The database may have functionality for user input and query in controlled manners with different levels of user access based on authority, relevance and necessity.

6.4.2 Authorities

Fisheries management entities should be the principal bodies for designing, establishing, managing, and implementing a system of gear marking. For gear-marking implementation in IOTC area of competence, the Commission should be the primary body for designing and coordinating the implementation for the gear marking, while competent agencies of CPCs should be the primary bodies for implementing and enforcing CPC flagged vessels conducting fishing for species under IOTC management.

6.4.3 Stakeholders

Gear marking design and implementation should be done in collaboration with a diverse stakeholder group. The Global Ghost Gear Initiative's Best Practice Framework for Managing Fishing Gear (GGGI, 2021) lists twelve entities that are considered as stakeholders. Specifically, for IOTC gear marking implementation, stakeholders may include:

- Fishing gear designers and manufacturers
- Fishers and fishing company managers and owners
- Fisheries organizations
- Port operators of CPCs
- Fisheries managers and regulators of CPCs
- Fisheries control agencies of CPCs
- Fisheries and ocean researchers conducting research in the IOTC area
- Seafood ecolabel standard and certificate holders
- Post-harvest seafood companies
- NGOs
- International development and funding agencies
- Coastal municipality councils and authorities

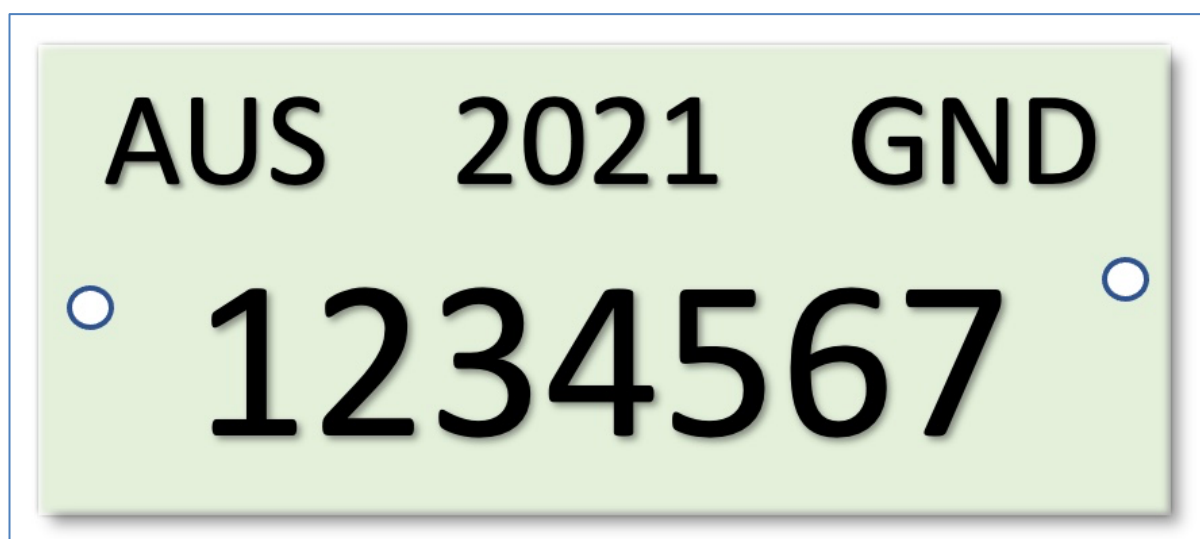
6.5 Recommended marks or marking for IOTC gears

6.5.1 Recommended information on marks and markings

As a minimum, information on marks should contain country the fishing vessel is flagged (Flag State) as represented by three-letter ISO codes, the fishing gear type as represented by two or three letter codes in the revised International Standard Statistical Classification of Fishing

Gear (ISSCFG), and a unique letter or number (or a combination of them), which may be license/permit number, IMO number of the vessel, or any identifiable number. It may also be useful to contain the year when the mark is issued. An example of a mark that may be attached to the headline of a gillnet is shown in Figure 14. In addition, a bar code and/or QR code may be printed to the tag with additional information. However, Bar codes and QR codes can lose all information.

Figure 14. Recommended minimum information on a mark. AUS – three-letter ISO country code for Australia, 2021 – year the tag is issued, GND – ISSCFG code for drift gillnet, 1234567 – licence number, IMO number of a unique number that identifies the mark and its owner.



6.5.2 Different types of marks relevant to IOTC gears

Floats and buoys may be printed with marking information post purchase such as shown in Figure 15. Marked floats and buoys can easily be incorporated into gillnets, purse seines, drift longlines and FADs.

Ropes may be marked with engraved or stamped rope clips or “bird rings” as shown in Figure 16. These rope marks can be used for headrope and footrope of purse seines and gillnets, and the mainline of longlines, and buoy ropes of gillnets, longlines and anchored FADs. Additionally ropes with external coloured-coded tracers or an internal printed tracer may be used to identify a fishery or a region.

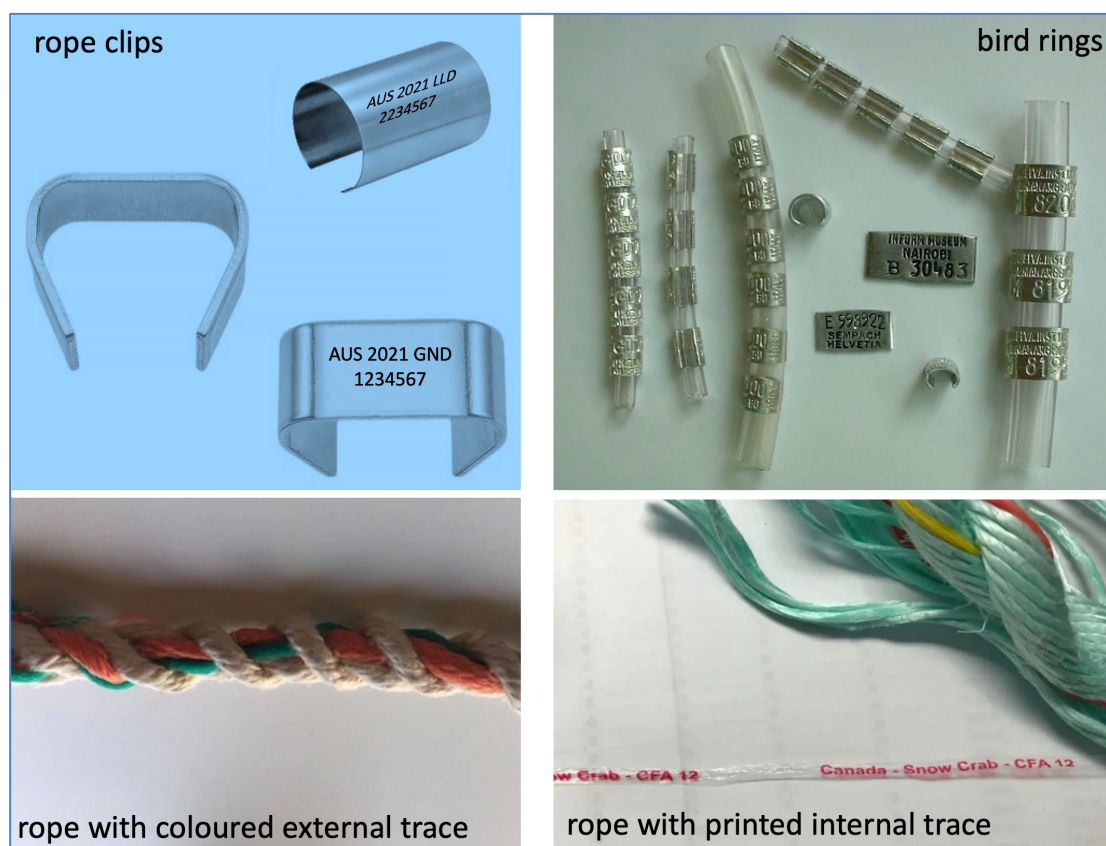
There is currently no desirable means for marking netting used in fishing gears. A label made of hard plastic, or fabric may be attached to netting, if it would not affect the operation or fishing efficiency of the gear. In most cases, these labels or marks are attached to ropes rather than netting itself. Use of plastics as tags and marks should also be restricted as these marks or tags may add additional plastic debris to the marine environment.

Large hooks may be stamped or engraved with serial numbers, so that they remain identifiable when lost. However, information that can be borne on a hook is very limited, and can also be cost-prohibitive. Value of such marking may also be very limited.

Figure 15. Example of marking for floats and buoys.



Figure 16. Example of marking for attaching to ropes.



Sources: Top left: modified from internet. Top right: I.O. Mekaniska AB. www.birdringing.se/alliten.jpg. Bottom left and right: Canadian Department of Fisheries and Oceans.

6.6 Recommended gear marking requirements in the IOTC Area of Competence

Generally speaking, attended gears (purse seine, handline and pole-and-line, and trolling line) have lower risks of loss and low risks to safe navigation. Marking on attended gear should focus on:

- Legality of the gear or its components, such as minimum codend mesh size, approved bycatch reduction device
- Capacity control, if multiple gear units are used, or if the size of gear is limited by regulation

Some attended gears are large in scale and contain a large amount of plastic material. components that are prone to loss should be marked.

Unattended gears (drift gillnet, drift longlines, aFAD and dFAD) are left in the sea for a period of time before being hauled and are more likely to lose. They can also pose risks to navigation if not properly marked. Marking of unattended gears should focus on:

- Surface marking for locating the gear, for avoiding gear conflicts and as an aid to navigation should follow guidelines in Appendix III
- Capacity control as many of unattended gears contain multiple gear units, which often subjects to limits
- Ownership and ownership dispute
- Legality, and illegal fishing

It is ideal and sometimes imperative that ALDFG can be traced back to the original fishery, location, and sometimes to the owner to help devising measures to reduce loss. In the case of entanglement of megafauna species on ALDFG or actively fished gear, tracing to the gear type, fishery and location can help devise technical and management measure to reduce such entanglement.

6.6.1 Purse seines

While there are usually no ownership issues with these attended and actively operated gears, there are concerns on their legality of use, and/or confirming to management regulations, e.g., minimum mesh size.

Purse seines should have at least one mark on its headline (float line) to indicate legality for use in certain areas, seasons, and maybe target species, and linked to the vessel (e.g., IMO number if available), permit and/or license numbers. At least another mark should be attached to the bunt of purse seines. Preferably, floats with printed/painted information as shown in Figure 15 should be spaced at 50 m apart.

6.6.2 Drift gillnets

Drift gillnets should be marked with at least one tag or mark to each unit of gillnet (typically 100 m or 50 fathoms (91 m)). At least 3 floats with printed information as shown in Figure 15 should be used on each net – one on each end and the third at the middle. All intermediate buoys, if used, should bear the marking information. Surface markers at the end should bear

similar numbers/codes, in addition to surface marker requirements as stipulated for navigation safety.

6.6.3 Drift longlines

Drift longlines should be marked at certain length intervals on the mainline, with marks similar to those in Figure 16. Each intermediate floats should be marked with required information as shown in Figure 15 that is linked to its owner or license number. Surface markers at each end should bear similar numbers/codes, in addition to surface marker requirements as stipulated for navigation safety. If electronic buoys are used, the minimum information for marks should be printed on the outside of the electronic buoys.

6.6.4 Handlines and pole-and-lines

Vessels operating handlines or pole-and-lines should display on the deck mark with information similar to required information, with vessel ID (IMO number), country code and year the mark is issued. Information on the maximum number of lines or poles that are permitted to use on the vessel, if it is restricted, should also be included in the displayed mark.

6.6.5 Trolling lines

Vessels operating trolling line should have a similar mark as in handline and pole-and-line vessel in Section 6.6.4.

6.6.6 Anchored FADs

Anchored FADs should be marked with ownership, which may be government of community, and license or permit to deploy the aFADs. The mark should also contain the date of deployment and a sequential number. At least one mark should be attached to the structure and another mark on the buoy. AFAD should be marked with surface marker for positioning and for aid to navigation.

6.6.7 Drifting FADs

All drifting FADs should be attached with an instrumented buoy that can transmit position via a satellite. In addition, drifting AFDs should be marked on the structure/raft of the FAD with information about the owner that first deployed the aFAD, year deployed, and license (or IMO) number. The letters on the marking should be large enough and with sufficient contrast to their background so that they are readable from a vessel at least 50 m away. Reflective material that is used on highway signs is recommended.

The instrumented buoy should also be physically marked with information printed or painted on the outside of the buoy. In addition to the minimum information for other gears, an instrumented buoys should also be marked with the buoy ID provided by its manufacturer.

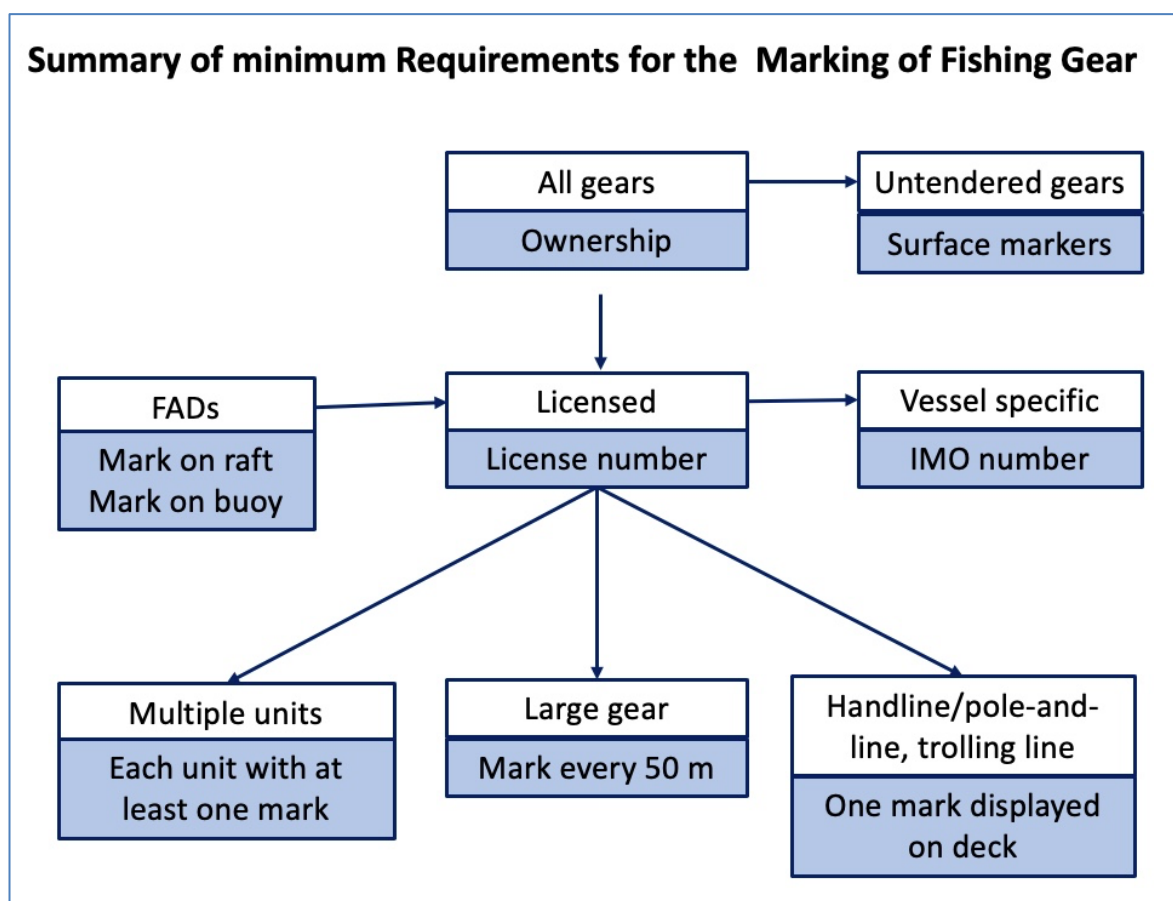
6.6.8 Marking for navigation and safety

The general requirement for surface marking of unattended gear should follow Annex 4 of the FAO Technical Guidelines for Responsible Fisheries, 1. Fishing Operations (FAO, 1996), which is being updated by FAO. The existing version of that annex is attached as Appendix III of this report.

6.6.9 Summary of the minimum requirements for the marking of fishing gear

The proposed minimum requirements for relevant fishing gears and FADs in the IOTC area of competence is provided in Figure 17.

Figure 17. Minimum requirement for the marking of fishing gear



6.7 Retrieval and reporting of lost, abandoned and recovered gear

6.7.1 Fishing gear

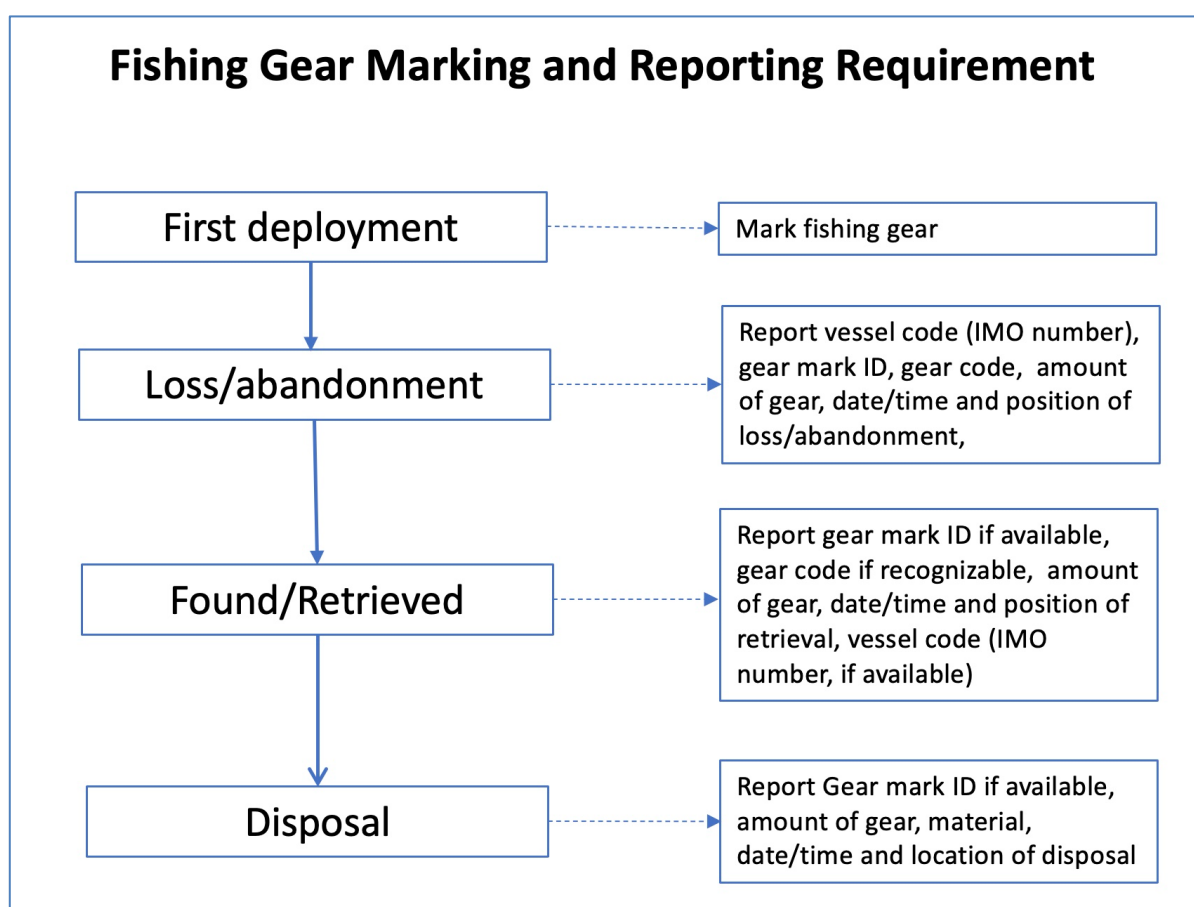
Fishing gear that are lost or abandoned should be recorded and reported to authorities or their designated parties, to warn other fishers for safe fishing operation, other mariners for safe navigation and to facilitate future recovery (Figure 18). As a minimum, the following information should be reported when the gear is lost or abandoned:

- Vessel identifier (IMO number, IOTC number)
- Gear mark ID
- Gear code
- Amount of gear
- Date/time and position of loss/abandonment
- Reason for loss/abandonment (e.g., weather, equipment failure)

Vessels that encounter previously lost/abandoned gear (either by itself or by other vessels) should retrieve the derelict gear (if allowed by law) and report the recovered gear to authorities or their designated parties. As a minimum, the following information should be reported when the gear is lost or abandoned:

- Gear mark ID if available
- Gear code if recognizable
- Amount of gear, especially amount of plastic materials
- Date/time and position of retrieval
- Vessel code (IMO number) or vessel name that report the recovery

Figure 18. Summary of reporting requirements for fishing gears and anchored fish aggregating devices.



Anchored FADs should be treated the same as a fishing gear when reporting loss and recovery/retrieval.

6.7.2 Drifting fish aggregating devices

Drifting FADs that are to be first deployed, should be marked as described above. When they are deployed and activated, the following information should be reported to authority:

- Deploying vessel code (IMO number)
- FAD structure code (Mark information on structure)
- Instrumented buoy code
- Date/time and position of first deployment
- Type of FAD design (regular, non-entangling, biodegradable etc.)
- Estimated amount of plastic material

When a dFAD is deactivated, the following information should be reported:

- Vessel code (IMO number) tracking the FAD
- FAD structure code (Mark information on structure)
- Manufacturer's code of the instrumented buoy that is deactivated
- Date/time of deactivation
- The last known position

When an instrumented buoy is switched, the following information should be reported:

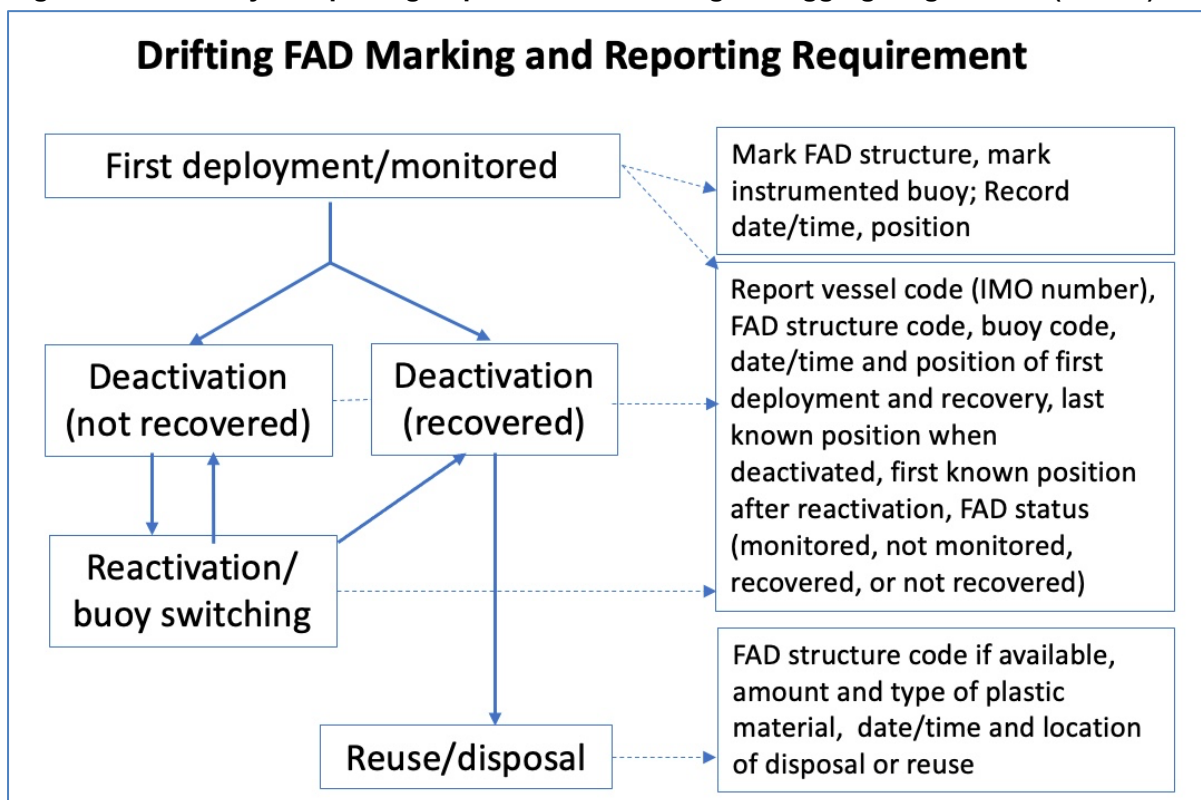
- Vessel code (IMO number)
- FAD structure code (mark information on structure)
- Instrumented buoy code that was attached to the raft (if available)
- Instrumented buoy code that is to be attached to the raft
- Date/time and position of switching

Drifting FADs that are recovered and no longer to be used should also reported. The following information that should be recorded and reported:

- FAD structure code
- Instrumented buoy code
- Date/time and position of the FAD when it is retrieved
- Amount and type of plastic materials retrieved
- Vessel ID (IMO code if available) that retrieved the FAD
- Final deposition (reused, disposed)

Figure 19 summarises reporting requirement for drifting FADs.

Figure 19. Summary of reporting requirement for drifting fish aggregating devices (dFADs).



6.8 End-of-life fishing gear

Fishing gears, including FADs, should be reused, or disposed of properly when it accomplished its intended use or reached its end of life. Fishing harbours should provide adequate port reception facilities for disposal of end-of-life gears and FADs in accordance with MARPOL Annex V. Vessels disposing used fishing gear materials should report to authorities or their designated parties with the following information:

- Gear mark ID if available,
- Amount and type of plastic materials
- Date/time and location of disposal
- Vessel code (IMO number) or vessel name that disposed the material

longlines will require more marks or markings, while smaller scale operations such as handline, and pole-and-lines, and trolling lines require less and simple marks or markings.

7.2 Costs to the CPCs

The costs to CPC can be substantial due to its responsibilities in making gear marking requirement into their own fisheries regulations and laws, and creation and maintaining databases on gear marking and reporting, and enforcement of gear marking. CPC's port authorities should also establish port reception facilities for accepting end-of-life gears for recycle and/or disposal. It is also recommended that CPC would also be in charge of "clean up" operations in their own EEZ following "hotspot" analysis of ALDFG by IOTC Secretariat or CPCs.

From the CPCs' point of view, implementation of a gear marking system, may not be limited to gears that catch IOTC managed species, but all gears operated in all regions by vessels of their flags. In this case, additional risk assessments may need to be carried out to determine prioritisation, complexity and exemptions.

Due to diverse economic and fishery development conditions, many CPCs may find the cost to implement a system of gear marking excessive. International financial and technological assistance may be necessary to implement such a system.

7.3 Costs to IOTC Secretariat

IOTC Secretariat is responsible for conducting risk assessment for the marking of fishing gear for gears that catch and land IOTC managed species, and define marking specifications so that they can be incorporated into CPCs' fisheries laws and regulations. IOTC Secretariat is also responsible for establishing and maintaining a database of gear marking and gear loss/abandonment and retrieval as reported by CPCs. IOTC Secretariat should also conduct "hot spot" analysis of ALDFG, especially for area beyond national jurisdiction.

As IOTC Secretariat already has a database for catch reporting related to species, gear, location etc., it may be feasible to expand the database to include gear marking and gear loss/abandonment and retrieval. It may be desirable to include the information of gear marking in the IOTC Record of Authorised Vessels, in which case it may be required to add a new field to this database. Additional costs to IOTC Secretariat may be minimal, however, substantial efforts may be required to encourage and assist CPCs to establish their national systems of recording and reporting, as well as awareness raising and capacity building.

8. Awareness raising and capacity building for the implementation of gear marking

8.1 Awareness raising and communication

IOTC Secretariat and CPCs should jointly or separately make effort to raise awareness on the detrimental impact of fishing gear loss as a result of unmarked or poorly marked fishing gear and FADs, including plastic pollution, ghostfishing, and impact to protected species. There are many entities that should be engaged in raising awareness and improving communication for implementation of the marking of fishing gear. These include the global organizations such as FAO, IMO, regional organizations such as IOTC, CCSBT, SIOFA, and SWIOFC, national governments (CPCs), NGOs, and fishers and fisher organisations. For the implementation of fishing gear marking in the IOTC area of competence, IOTC Secretariat should play a leading role together with CPCs in awareness rising and communication.

8.1.1 The IOTC Secretariat

The IOTC Secretariat should:

- Collect and share data and information on gear loss, including analysis of “hotspots, estimate of gear loss rate, ghostfishing of ALDFG to increase urgency to implement fishing gear marking and to reduce ALDFG,
- Design outreach materials regarding the benefit of fishing gear marking and made available to CPCs and other stakeholders.
- Facilitate the development of best-practice approaches to reducing gear loss and plastic pollution,
- Organise workshops and training sessions for fishery managers, enforcement personnel and fishers on gear marking and best practice for the management of fishing gear,
- Establish and support working groups or similar teams to provide scientific and technical advice on gear marking specifications, technologies, data reporting, and management,
- Developing standards and harmonized measures to reduce gear loss, abandonment in IOTC managed fisheries,

8.1.2 CPCs

IOTC Members and Cooperating non-Contracting Parties (CPCs) should:

- Ensure that all information used for communication and awareness-building is accurate, up-to-date and appropriate for the target audiences,
- Adapt outreach, education and awareness materials to locally relevant scenarios and in appropriate formats, including websites and social media platforms,
- Ensure that outreach materials are translated to local languages when necessary

- Identify and ensure appropriate training needs are met for managers, fishing technologists, gear manufacturers, and fishers with regard to the implementation and enforcement of fishing gear marking,
- Collate and share best practice methods relevant to local fisheries for:
 - Reducing plastic waste during fishing
 - Preventing of gear loss,
 - Employing tools and means for effective retrieval of lost gear,
 - Properly disposing end-of-life gear,
 - Reusing and repurposing used gear,
- Collaborate with IOTC Secretariat and other regional bodies, and non-governmental organisations (NGOs) in outreaching and communicating benefits of gear marking, including reduction of plastic pollution in the sea,
- Take fishers' opinions, suggestions and experiences on effective measures to reduce gear loss and recovery of lost gear, and make them available to fishers in other regions and other countries, when appropriate,
- Coordinate and strengthen activities and programmes of fishers' cooperatives and other similar organizations on gear marking, gear loss prevention, and reduction of marine plastic pollution.

8.1.3 International organizations

International organizations such as FAO and the IMO should play a role in facilitating awareness raising and communication related to gear marking and the reduction of plastic pollution in fisheries. Specific examples include:

- Advocating the importance of fishing gear marking and reduction of marine plastic pollution in high-level meetings, such as UN General Assembly, FAO Committee of Fisheries (COFI) meeting, and IMO Council meetings and Marine Environmental Protection Committee (MEPC) meetings,
- Producing fishing gear marking manuals and specifications,
- Facilitating the development of best-practice approaches to manage fishing gear to reducing gear loss and plastic pollution,
- Promoting these best practices on various platforms and venues to raise awareness of the issue,
- Collecting, collating and sharing information and raising awareness of ALDFG with Member States on plastic pollution issues, and the measures to address them,
- Identifying opportunities for cooperative planning to harmonize standards and measures and reduce inconsistencies between management frameworks at a global level.

8.1.4 Non-governmental organizations (NGOs)

Both IOTC Secretariat and CPCs should recognise that NGOs also have an important role in facilitating effective awareness raising and communication related to the best practice measure for conducting of fishing, including reduction of gear loss and plastic pollution in capture fisheries. NGOs are often good at effective communication and promotion of certain issues. One prominent organisation in this area is the Ocean Conservancy's Global Ghost Gear Initiative (GGGI), but many other organisations exist. IOTC Secretariat and CPCs should collaborate with reputable NGOs to raise awareness. Specific areas that NGOs should be invited to participate may include:

- Helping produce materials for communication and awareness-raising,
- Developing platforms for sharing information and raising awareness, including websites and social media,
- Collating and sharing best practice methods for reducing impacts of plastic debris on animals and the environment,

8.2 Capacity-building measures

8.2.1 The IOTC Secretariat

The IOTC Secretariat should:

- Assist CPCs in adoption of a system of fishing gear marking legally, financially and technically
- Establish a working group or similar team to provide scientific and technical advice on gear marking specifications, technologies, data reporting, and management,
- Organise specialized workshops in setting up recording, reporting and data management framework for CPCs,
- Provide appropriate funding for programmes designed to implementation of a system of gear marking, especially for Developing States, and Least Developed States, and Small Island Developing States.

8.2.2 CPCs

IOTC Members and Cooperating non-Contracting Parties (CPCs) should:

- Organise and sponsor capacity-building workshops for managers, enforcement personals, gear manufacturers and fishers
- Collaborate with IOTC Secretariat, and other regional and international organisations to enhance capacity in implementation and maintain a system of gear marking
- Encourage management and technical staff to participate in training courses offered by IOTC Secretariat and other regional and international bodies

8.2.3 International organizations

International organizations such as FAO and the IMO also have a role to play in capacity building related to the reduction of plastic pollution in fisheries. Specific examples include:

- Providing funding and technical assistance to States in implementing fishing gear marking and measures to reduce ALDFG,
- Sponsoring technical meetings and training workshops for implementation of gear marking,
- Collating and sharing best practice methods for estimating gear loss, hotspot identification, reporting and retrieval of lost gear

8.2.4 Non-governmental organizations (NGOs)

IOTC Secretariat and CPCs should collaborate with reputable NGOs to enhance capacity for the implementation of fishing gear marking and other measures to reduce negative impact of ALDFG, including:

- Co-sponsoring capacity building workshops and training sessions for fishery managers of CPCs,
- Supporting, advocating, lobbying for, and providing funding for programmes to improve awareness, communication, training and capacity building across all issues concerning marine plastic pollution from fishing.

8.3 Special requirements of Developing States

IOTC should fully recognize the special requirements of Developing States (DS), notably the Least Developed States (LDS) and Small Island Developing States (SIDS). Such requirements should be understood in terms of the capacity of these States to implement gear marking measures consistent with agreed gear marking scheme for the IOTC area, including the assessment of risk and feasibility.

Small-scale and non-industrial fisheries constitute a large portion of fisheries in Developing States, especially in Least Developed States and Small Island Developing States. A greater emphasis on identifying practical approaches and challenges in these fisheries is critical if we were to succeed in reduction in marine pollution in fisheries.

In particular, States, international and regional organizations, international financial institutions and other entities should consider offering financial and technical assistance to DS, especially LDS and SIDS to enhance the capacity to implement gear marking in their fisheries. This assistance should be provided on voluntary and mutually agreed terms, in conformity with relevant international law, the FAO Code of Conduct for Responsible Fisheries and FAO Voluntary Guidelines on the Marking of Fishing Gear. Particular focus areas may include the following:

- The development of management, legal and regulatory frameworks and infrastructure for the marking of fishing gear,

- Development of effective action plan for the reduction of marine plastic pollution, at national and regional scales,
- Data collection and assessment of gear loss and hot spots,
- Gear loss recording and reporting,
- Development and implementation of low-cost, low-tech measures for gear marking that is consistent with the nature of small scale, artisanal nature of fisheries,
- Development of effective Monitoring, Control and Surveillance (MCS),
- Carrying out socio-economic studies on the effects of gear marking and marine plastic reduction measures,
- Technology transfer and training,
- Enhanced awareness raising, communication and capacity-building measures,
- Providing support to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing, particularly as it pertains to gear marking.

9. Draft Resolution for a System of Fishing Gear Marking in the IOTC Area of Competence

A draft resolution for the implementation of a system of fishing gear marking in accordance with the FAO Voluntary Guidelines on the Marking of Fishing Gear is attached as Annex I. Preamble to the draft resolution is omitted. Surface marking for location and navigation of unattended gears should follow the proposed guidelines Annex 4 of the FAO Technical Guidelines for Responsible Fisheries, 1. Fishing Operations (FAO, 1996), attached as Appendix III of this report.

10. Summary

A system of fishing gear marking should be an integral component of and serves as an important tool for fisheries management. It is recognized that gear marking is an important tool to reduce gear loss and aid recovery, as well as in determining ownership, assisting in fishing effort management and control, facilitating monitoring, control and surveillance, and deterring IUU fishing. Fishing gear marking is also an important means for safe navigation. Fishing gear marking can be physical, chemical, electronic, and virtual. They can bear various types of information, and should be linked to its owner or license and/or permit to fish.

In accordance with the VGMFG (FAO, 2019), development of a system of fishing gear marking should include risk assessment. A system for the marking of fishing gear should include:

- gear specific marking requirements,
- a reporting, recording and data management system,
- mechanism for the application of data for monitoring control and surveillance,
- mechanism for mitigating the negative impact of ALDFG (including retrieval of ALDFG),
- provision of adequate port reception facilities for the disposal of ALDFG and end-of-life fishing gear, and
- reuse and recycle of end-of-life fishing gear.

A system of gear marking should provide a simple, affordable and verifiable means of identifying the ownership and position of fishing gear, be compatible with related traceability and certification systems, be supported by a monitoring process for compliance, link with fishing authorization or license, and to vessel, its owner or operator engaged in fishing, and have minimal environmental risk.

This document provided an example on how major fishing gears harvesting species managed by IOTC may be evaluated through a risk assessment to determine the level of complexity for implementing a system of fishing gear marking for the IOTC Area of Competence. Five fishing gear types, which represent landing of 90% of managed species in the IOTC area and two FAD types were included in the analysis.

When implementing a system of fishing gear marking, a risk assessment should be carried out to evaluate available data and information on both the fishery utilizing the gear and the ecological and economic characteristics of the fishery. The determination of risk levels involves the estimation of the consequence (impact) of the lack of a gear marking system in the fishery, an estimation of the likelihood of occurrence of the identified impacts, a score of the risk, and categorization of the risk, for both fishing gear in normal fishing conditions and after they become ALDFG. The consequences and impacts analysed include ecological risks (plastic pollution; ghostfishing (fishery resource and ETP species), habitat impact, economic risks (including loss due to IUU fishing, cost of implementation, and economic loss due to gear loss and theft), operational risks (gear conflict, ownership dispute), and navigational risks. Risk resulted in priority for gear marking and level of complexity. For gears harvesting IOTC managed species, purse seines, drift gillnets, and drifting FADs are considered as having “high” or “very high” overall risks, anchored FADs having medium risks, while handline and pole-and-line, and trolling lines having low overall risks.

While anchored FADs can be considered as a type of unattended gear, drifting FADs have special considerations regarding marking, reporting and recovery. Consequently, procedures for marking, reporting and recovery for dFADs are provided for consideration.

As requested, draft texts for a resolution for implementing a system of fishing gear marking for the IOTC area of competence has been provided (Annex I). The general requirement for surface marking of unattended gear should follow Annex 4 of the FAO Technical Guidelines for Responsible Fisheries, 1. Fishing Operations (FAO, 1996), which is attached as Appendix III of this report.

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Annex I. Draft Resolution for a System of Fishing Gear Marking in the IOTC Area of Competence

Preamble

(Omitted)

Application

2. This resolution shall apply to all CPCs within the IOTC area of competence.
3. This resolution will be effective from XXXX.

Database and data management

4. CPCs should establish a data recording system with associated human resources, compatible or linked with their licensing system for recording and reporting for:
 - a. issuance and/or replacement of gear marks;
 - b. receive and record the reporting of gear loss from fishers;
 - c. receive and record the reporting of recovery of gear and/or marks from fishers and others;
 - d. receive and record infringement of gear marking requirement from enforcement parties.
5. CPCs should report annually the loss or abandonment of fishing gear to the Secretariat.
6. The Secretariat should establish a gear marking database to:
 - a. Record and consolidate data reported from CPCs on gear loss and abandonment;
 - b. Conduct analysis on where fishing gears are lost for possible identification of “hotspot” of ALDFG.

Marking of fishing gear

7. CPCs should ensure that all fishing gears used by vessels flying their flag and fishing for the IOTC managed species and in the area of competence are clearly marked.
8. The minimum information on marks should contain information of the flag country (represented by three-letter ISO codes), the type of fishing gear (represented by two or three letter codes in ISSCFG), the year the tag/mark was issued, and a unique letter or number (or a combination of them), which may be linked to the owner of the gear (license/permit number, IMO number of the vessel, or any identifiable number).

Gear loss, abandonment and discard

9. No fishers shall deliberately abandon fishing gear, except for safety reasons.

10. CPCs shall require vessels flying their flags make all reasonable efforts to reduce, minimise and eliminate abandoned, lost or otherwise discarded fishing gear (ALDFG) while operating in the area of competence.
11. CPCs shall require vessels flying their flag not to discard fishing gear with plastic materials in accordance with MARPOL Annex V.
12. CPCs shall require vessels flying their flag to report gear loss or abandonment within 24 hours to its competent authority of the following information:
 - a. vessel name, IMO number, or call sign of the vessel, if available;
 - b. gear type and amount (or quantity) of gear lost or abandoned;
 - c. the time when the gear was lost or abandoned;
 - d. the position (longitude/latitude) where the gear was lost or abandoned
 - e. measures taken by the vessel to retrieve lost or abandoned gear;
 - f. the circumstances that led to the gear being lost or abandoned (e.g., for safety).

Recovery, retrieval and disposal

13. CPCs shall require vessel of their flag fishing with any gear to have appropriate equipment on board to retrieve ALDFG linked to those vessels.
14. CPCs shall require vessels flying their flag to make every reasonable effort to retrieve the gear they lost or abandoned as soon as possible.
15. CPCs should encourage vessels flying their flag to retrieve ALDFG not linked to their vessel, if it can be certain the gear is ALDFG, and report the following information to competent authority:
 - a. vessel name, IMO number, or call sign of the vessel, if available, that retrieved the gear;
 - b. details of marks that indicate the vessel that lost or abandoned the gear (if known)
 - c. the type of gear retrieved;
 - d. the quantity of gear retrieved;
 - e. the time when the gear was retrieved;
 - f. the position (longitude/latitude) where the gear was retrieved;
 - g. if possible, photographs of the gear retrieved;
16. CPCs should encourage vessels flying their flag to bring back retrieved ALDFG to port for proper disposal.
17. CPCs should make available disposal facilities in major fishing ports of their jurisdiction for proper disposal of end-of-life gear.
18. CPCs shall coordinate effort to retrieve ALDFG in hotspot area within their EEZ as identified through data reported by fishers or other entities, when feasible.

19. The Secretariat shall coordinate effort to retrieve ALDFG in hotspot areas in high seas of IOTC area of competence as identified through gear loss data as reported by CPCs, fishers or other entities, when deemed feasible and necessary.
20. The Secretariat shall develop a template for reporting of loss and recovery of ALDFG referred above.

Fish aggregating devices

21. Anchored fish aggregating devices (aFDAs) should be treated the same as fishing gears for marking, reporting, recovery and disposal, as described in 3 to 19.
22. Drifting fish aggregating devices (dFADs) should be marked as follows:
 - a. All dFADs should be attached with an instrumented buoy that can transmit position via a satellite;
 - b. Drifting FADs should be marked on the structure/raft of the dFAD with information about the owner that first deployed the dFAD, year deployed, and license (or IMO) number. The letters on the marking should be large enough and with sufficient contrast to their background so that they are readable from a vessel at least 50 m away;
 - c. The instrumented buoy should also be physically marked with information printed or painted on the outside of the buoy. In addition to the minimum information for other gears, an instrumented buoys should also be marked with the buoy ID provided by its manufacturer.
23. Vessels should report within 24 hours the following information when a dFAD is first deployed and activated:
 - a. Deploying vessel identifier (IMO number or IOTC number);
 - b. FAD structure code (Mark information on structure);
 - c. Instrumented buoy code;
 - d. Date/time and position of first deployment;
 - e. Type of FAD design (regular, non-entangling, biodegradable, etc.);
 - f. Estimated amount of plastic material.
24. Vessels should report within 24 hours the following information when a dFAD is deactivated:

- a. Vessel code (IMO number) tracking the FAD;
 - b. FAD structure code (Mark information on structure);
 - c. Manufacturer's code of the instrumented buoy that is deactivated;
 - d. Date/time of deactivation;
 - e. The last known position.
25. Vessels should report within 24 hours the following information when an instrumented buoy is activated:
 - a. Vessel code (IMO number);
 - b. FAD structure code (mark information on structure);
 - c. Instrumented buoy code that was attached to the raft (if available);
 - d. Instrumented buoy code that is to be attached to the raft;
 - e. Date/time and position of activation.
26. Vessels should report within 24 hours the following information when a drifting FAD is recovered and no longer to be used:
 - a. FAD structure code;
 - b. Instrumented buoy code;
 - c. Date/time and position of the FAD when it is retrieved;
 - d. Amount and type of plastic materials retrieved;
 - e. Vessel ID (IMO code if available) that retrieved the FAD;
 - f. Final deposition (reused, disposed), if disposed, location of disposal.

Appendix I. Terms of References

Develop a scheme for IOTC to operationalize the FAO Voluntary Guidelines on the Marking of Fishing Gear (VGMFG)

- Assess the financial costs for operationalizing the FAO VGMFG in the IOTC Area, bearing in mind that the vast disparity in development status among IOTC CPCs may necessitate a phased approach for operationalizing the VGMFG.
- Identify, through documented risk assessments, fishing gears and FADs² which are widely used in IOTC fisheries that can contribute to marine pollution through abandonment, becoming lost or are otherwise discarded. Such risk assessments methodology to be developed based on the guidelines provided in the Annex of the VGMFG.
- Collate, for comparative purposes, the relevant IOTC regulations or administrative measures and international instruments/guidelines that pertain to the marking of fishing gears and FADs as identified for marking in the risk assessment that can contribute to marine pollution through abandonment, becoming lost or are otherwise discarded.
- Assess existing IOTC measures to allow for the effective implementation, monitoring, control and enforcement of a fishing gears and FADs marking scheme in IOTC fisheries, including the removal and disposal, plus any other enforcement action related to unmarked fishing gears and FADs.
- Consider how measures specified in para 4 may be improved and, where a need is identified, prepare draft proposals which shall be considered by the Commission for adoption in accordance with the mandate of the IOTC Agreement.
- Review the purpose and the design of existing fishing gear markers relevant to IOTC fishing gears and FADs identified for marking, particularly in the light of practicality for placement on fishing gears and FADs, impact on fishing efficiency (catchability), affordability, safety of use, environmental impact, potential contribution to measures against IUU fishing activities and technological developments. In considering the affordability for marking of fishing gears and FADs consideration must be given to possible alternative and less expensive options for Developing Countries and Least Developed Countries (LDCs).
- Consideration given to the design of existing fishing gears and FADs markers and how they may be improved to better meet requirements identified in para 6.
- Consider the relationship between marking for licensing/authorization and marking for visibility, location, options for avoidance for purposes of navigation and identification of ownership.
- Review the practicality of identifying and separating areas and fisheries, bearing in mind the current lack of agreement of what constitutes artisanal, coastal and semi-

² FADs used for aggregating non-IOTC species shall be exempted.

industrial fisheries in terms of applying gear marking measures to fishing gears and FADs.

- Propose means to raise awareness of:
 - a) the detriment to the environment, the safety of navigation, and the risk to life at sea, associated with poorly marked or abandoned fishing gears and FADs.
 - b) the benefits of the marking of fishing gears and FADs.
- Consider and determine capacity-building requirements of CPCs for the attachment of markers to fishing gears and FADs.
- In undertaking the above tasks, due considerations shall be given to initiatives which will be considered by the IMO, and especially in the context of the International Convention for the Prevention of Pollution from Ships (MARPOL), to streamline and standardize any requirements developed.
- Publish a report of its findings and conclusions for consideration by the IOTC Working Party on the Implementation of Conservation and Management Measures, Compliance Committee, Standing Committee on Administration and Finance, and the Commission.

Appendix II. International Standard Statistical Classification of Fishing Gears

International Standard Statistical Classification of Fishing Gears (ISSCFG), Rev.1 (2016)

Gear categories (First tier)	Subcategory (Second tier)	Standard abbreviations	ISSCFG code
SURROUNDING NETS			01
	Purse seines	PS	01.1
	Surrounding nets without purse lines	LA	01.2
	Surrounding nets (nei)	SUX	01.9
SEINE NETS			02
	Beach seines	SB	02.1
	Boat seines	SV	02.2
	Seine nets (nei)	SX	02.9
TRAWLS			03
	Beam trawls	TBB	03.11
	Single boat bottom otter trawls	OTB	03.12
	Twin bottom otter trawls	OTT	03.13
	Multiple bottom otter trawls	OTP	03.14
	Bottom pair trawls	PTB	03.15
	Bottom trawls (nei)	TB	03.19
	Single boat midwater otter trawls	OTM	03.21
	Midwater pair trawls	PTM	03.22
	Midwater trawls (nei)	TM	03.29
	Semipelagic trawls	TSP	03.3
	Trawls (nei)	TX	03.9
DREDGES			04
	Towed dredges	DRB	04.1
	Hand dredges	DRH	04.2
	Mechanized dredges	DRM	04.3
	Dredges (nei)	DRX	04.9
LIFT NETS			05
	Portable lift nets	LNP	05.1
	Boat-operated lift nets	LNB	05.2
	Shore-operated stationary lift nets	LNS	05.3
	Lift nets (nei)	LN	05.9
FALLING GEAR			06
	Cast nets	FCN	06.1
	Cover pots/Lantern nets	FCO	06.2
	Falling gear (nei)	FG	06.9
GILLNETS AND ENTANGLING NETS			07
	Set gillnets (anchored)	GNS	07.1
	Drift gillnets	GND	07.2
	Encircling gillnets	GNC	07.3
	Fixed gillnets (on stakes)	GNF	07.4
	Trammel nets	GTR	07.5

	Combined gillnets-trammel nets	GTN	07.6
	Gillnets and entangling nets (nei)	GEN	07.9
TRAPS			08
	Stationary uncovered pound nets	FPN	08.1
	Pots	FPO	08.2
	Fyke nets	FYK	08.3
	Stow nets	FSN	08.4
	Barriers, fences, weirs, etc.	FWR	08.5
	Aerial traps	FAR	08.6
	Traps (nei)	FIX	08.9
HOOKS AND LINES			09
	Handlines and hand-operated pole-and-lines	LHP	09.1
	Mechanized lines and pole-and-lines	LHM	09.2
	Set longlines	LLS	09.31
	Drift longlines	LLD	09.32
	Longlines (nei)	LL	09.39
	Vertical lines	LVT	09.4
	Trolling lines	LTL	09.5
	Hooks and lines (nei)	LX	09.9
MISCELLANEOUS Gear			10
	Harpoons	HAR	10.1
	Hand implements (Wrenching gear, Clamps, Tongs, Rakes, Spears)	MHI	10.2
	Pumps	MPM	10.3
	Electric fishing	MEL	10.4
	Pushnets	MPN	10.5
	Scoopnets	MSP	10.6
	Drive-in nets	MDR	10.7
	Diving	MDV	10.8
	Gear nei	MIS	10.9
GEAR NOT KNOWN			99
	Gear not known	NK	99.9

Appendix III. Guidance for the Marking of Fishing Gear to Indicate Position

Annex IV “Proposal for the Application of Standard System of Lights and Shapes for the Identification and Location of Fishing Gear” to FAO Technical Guidelines for Responsible Fisheries 1. Fishing Operations (FAO, 1996).

One of the key purposes of gear marking is to allow fishing vessels, control authorities and other maritime users to easily locate and therefore avoid fishing gear that has been deployed, especially where the responsible fishing vessel is absent. The key requirements for the marking of fishing gear are as follows:

- i. Marking equipment (e.g., flags, lights, buoys, etc.) should be in a suitable size so as not to alter the fishing characteristics of the gear and affect handling on deck, with consequence for crew safety and vessel stability.
- ii. Marking equipment should not be difficult and dangerous to deploy and retrieve.
- iii. Radar reflectors should be designed without sharp edges. They should be effective and reliably detectable.
- iv. Lighting should be powerful, robust, energy efficient and compact.
- v. Marking need to be affordable in the context of the fishery involved.

Buoys, fitted with lights, radar reflectors and flags, increase the visibility of the spar buoy on the fishing gear to approaching vessels and assists them to navigate safely around the fishing gear. It also enables the owner to detect the marker at a greater distance. In addition, the cardinal system of shapes and lights would indicate the direction in which the passive gear is lying so that mobile gear vessel can fish in the vicinity without causing gear conflict which often cause loss of gear.

Nets and line that are set less than 2 m from the surface are considered to be a special navigational hazard to passing vessels, therefore they are subject to a more rigorous marking regime. For these fishing gears, spaces (“gates”) should be left in the nets and line so that small vessels can pass safely through them particularly where there is high traffic density. These “gates” could be marked by two extremity markers, if practicable.

Buoys, lights, radar reflectors, flags and radio beacons used for marking fishing gear

Lights come in many shapes and sizes. For energy efficiency, the conventional lights should have a sensor which switches on the light automatically at dusk and then switches off at daylight, for example, using a Passive Infra-Red (PIR) sensor. High power strobe lights are commonly used but they are not readily available in all countries. The lights should be visible at a distance of two nautical miles and should not be confusable with lights specified for those required by vessels under the Collision Regulations or for navigational buoys, beacons or lighthouses.

LED lighting: light emitting diode (LED) lighting has been around for about 30 years, but major advances in brightness, power efficiency and form have been made over the last decade. LED lights are more energy efficient than conventional incandescent lights and very compact, making LEDs an obvious choice for marine lighting. Furthermore, they can be provided in a number of different colours (commonly red, green, white, yellow and blue), can be programmed to standard International Association of Marine Aids and Lighthouse Authorities (IALA) flash characters, as well as customized to new flash patterns. Depending upon their size, they can have a visible range of 1 nautical mile to over 12 nautical miles. They can be

robust (e.g., rated as IP68 in terms of protection against water ingress) and maintenance free with service lives in excess of ten years. Power can be provided by batteries and/or solar power. Battery lives are from 3 - 5 years, so the devices potentially require no maintenance or additional cost during this period, providing major advantages over the alkaline battery powered basic lights.

Radar reflectors can be a good aid to increase the detection range of the spar buoy for vessels fitted with radar. This helps the fishing vessel to locate the gear and the passing vessels to avoid the gear. The radar reflectors should be light in weight so that they can be carried high on the spar. Wire types are recommended over solid types to decrease wind resistance. The radar reflectors may be the traditional octahedral shape or in a round shape.

Flags should be displayed to increase the visibility of the marker, but should be placed in a position that does not interfere with the visibility of the light at night. They should be in suitable size so as not to affect the spar buoys' ability to stand erect in strong winds. Water resistant materials are recommended so that they are light even when wet and would not affect the flag's ability to stand upright. The dimensions of the flag should be at least 25 x 35 cm and the distance between two flags on the spar (if more than one) shall be at least 10 cm. The flag colour should be such as to be visible at considerable distances; fluorescent colours or black are recommended.

Radio beacons are used to mark fishing gear which can be subsequently recovered by using a radio direction finding system. They can emit a coded signal so that in areas of high fishing concentration each buoy is discernible by its owners. Many merchant and navy vessels are now fitted with scanning receivers which can detect the signals transmitted by these beacons, thus alerting these passing vessels to the presence of fishing activity in the area. Such markers are good technical options, though their cost- effectiveness should be considered in each fishery.

Spar buoys shapes are varied and are often constructed with a plastic or aluminium pole. The pole is inserted through the centre hole of an inflatable spar buoy which is inflated and thus holds the pole securely. A weight is fastened on to the base of the pole so that the pole stands upright. The size of the weight is dependent on the wind resistance of the flags and/or the radar reflectors on the other end and on the prevailing weather conditions. This type of spar buoy can be visible for up to three nautical miles to the naked eye and can be detected even further by radar if fitted with a radar reflector. Gear marking details should be marked on the buoy and on the flags, if required, with indelible marking ink for the monitoring and control purposes (see also CIR 404/2011; Article 11). Supplementary buoys are normally used in conjunction with spar buoys as the spar buoy is to act as a marker and not to support the fishing gear, sometimes however in small scale fishing gear used inshore the functions are combined in one buoy.

Satellite beacons, with the use of FADs as a fishing aid, should have both a spar buoy with flag and lights and a radio or satellite beacon attached to the specifications in these guidelines.

APPENDIX MARKING THE POSITION OF A GEAR IN THE WATER COLUMN

The FAO 1996 Proposal for the Application of a Standard System of Lights and Shapes for the Identification and Location of Fishing Gear was prepared on the basis of the Report of the 1991 Expert Consultation for the Marking of Fishing Gear (FAO Fisheries Report No. 485 and its Supplement) and the outcome of discussions at the International Maritime Organization (IMO). The content (without the gear drawings) of this 1996 Annex is the following:

1. General Provisions

- 1.1 In order to protect fishers and their gear and to warn other mariners of the presence of deployed fishing gear, States should make provisions in national legislation for the adoption of a standard system of lights and shapes for the identification of fishing gear and for marking its position in the water.
- 1.2 States should make provisions for the inclusion of the details of the system in training programmes for fishers and mariners.
- 1.3 The need to comply with a system of lights and shapes related to fishing gear, fishing implements and fishing vessels should be in a condition of the authorization to fish.

2. Technical Provisions

- 2.1. The system should take into account:
 - a) the provisions of the International Regulations for the Prevention of Collisions at Sea (COLREGS),
 - b) any local rules, including rules of navigation governing river, lake or coastal fisheries,
 - c) regulations pertaining to offshore structures; and
 - d) systems for the marking of fishing gear for the identification of ownership.
 - 2.2. Where practicable, all position indicators attached to fishing gear should:
 - a) be as conspicuous as possible in a clear daytime atmosphere from a distance of at least 2 nautical miles at sea level,
 - b) carry radar reflectors,
 - c) carry lights with characteristics which do not conflict with those of navigational marks and which would be visible on a clear night at a distance of at least 2 nautical miles; and
 - d) be fitted with a coloured flag or flags of fluorescent material, as an aid to daytime visibility.
 - 2.3. Light and shapes should also indicate the direction and extent of set and drifting gear.
 - 2.4. Electronic devices, such as transponders and radio beacons which automatically and continuously indicate their position by means of signals may be used in addition to the lights and shapes. Such devices, however, must not operate at frequencies that would conflict with other devices used for navigation and search and rescue purpose.
- ## 3. Application of a Standard System
- 3.1. An individual pot, trap, fyke net, stake net and other similar gear, should be marked with a buoy or other device at the surface to indicate its position. Gear set in series, such as a number of pots connected on a line, should be marked at each end with a buoy.

- 3.2. Anchored or drifting fishing gear with the upper continuous edge of the gear at a depth of more than 2 metres below the surface should be marked in the following manner:
- a) fishing gear set below the level of the sea and extending from an anchor or parent vessel, should be marked at both extremities by a spar buoy and at intermediate positions. The distance between the intermediate marks, and between the intermediate marks closest to the extremities and the extremity markers should not exceed one kilometre. In the case of fishing gear attached to a vessel, the extremity of the gear nearest to the vessel need not carry a marker,
 - b) for recognition in daytime, the westernmost end spar buoy of such gear extending horizontally in the sea should be fitted with two flags one above the other or one flag and a radar reflector. The end spar buoy at the most easterly extremity should be fitted with one flag or a radar reflector, and
 - c) for nighttime recognition, the most westerly end spar buoy should have two white lights one above the other, the most easterly end spar buoy to have one white light.
- 3.3. Fishing gear set within the upper two metres of the water column, and therefore a hazard to small transiting vessels, should be marked in the following manner:
- a) for daytime recognition, the extremities of the gear should have spar buoys carrying top marks consisting of two spherical shapes, one above the other at no more than one metre apart; the diameter of the upper of the two spheres to be smaller but no less than one half diameter of the lower one,
 - b) for nighttime recognition, the spar buoys placed at the extremity of the gear should have two yellow lights, one above the other at no less than one metre apart and of different characteristics to lights fitted to intermediate buoys,
 - c) gear extending more than one kilometre should have intermediate buoys placed at distances of not more than one kilometre; intermediate spar buoys should have one spherical shape for daytime recognition and one yellow light for nighttime,
 - d) "gates" should be provided for the free passage of surface vessels. Each side of the gate should be marked by spar buoys; the closest intermediate float should not be more than 10 meters from these spar buoys; and
 - e) attended gear need not be marked at the extremity attached to a fishing vessel.
- 3.4. The dhan-buoy used with active gear, such as anchor seining, fly dragging and purse seining, should comply with the provisions as set out in paragraph 2.2.
- 3.5. Fish aggregating devices (FADs) should be marked in the same way as fishing gear and carry means to identify their position by day and night. As a minimum requirement, they should comply with the provisions set out in paragraph 2.2. The requirements of paragraph 2.4. should apply to the use of electronic devices fitted to FAD's.

4. Technical Specifications

- 4.1. A spar buoy should meet the following requirements:

- a) the pole of a spar buoy extending above the flotation buoy should have a height of at least 2 metres; the height of the spar buoy may be less than 2 metres if an

administration is satisfied that the fishing gear so marked would not be a hazard to navigation,

- b) where radar reflectors are required, they should be fitted at the top of the pole
- c) the size of flags should be less than 25 centimetres in height and 35 centimetres in width; when two flags are required, the distance between them should not be less than 10 centimetres; flags should be made of waterproof material in fluorescent colours,
- d) lights should be attached to the pole in such a way that they will not be obscured by a flag,
- e) for shapes that give the appearance of being spherical when viewed from a distance, provided for in paragraph 3.3 c) above, the lower of the spherical shapes and the shape, if only one is fitted, should have a diameter of not less than 30 centimetres, the upper shape should be smaller in diameter but not less than half that of the lower shape; and when two shapes are required, they should not be less than 10 centimetres apart; and
- f) intermediate floats should have a diameter of not less than 50 centimetres.

4.2. Radar reflectors should be:

- a) as light as possible,
- b) octahedral in shape; and
- c) of metal plate or wire mesh construction.

4.3. Lights should be visible at a distance of at least 2 nautical miles; and preferably of a type that are fitted with sensors that automatically switch the light on at dusk and off at daylight.

4.4. Radio Beacons may be of the type that can be attached to the pole of the spar buoy or FAD, if they are of the free-floating type, they should be linked to the spar buoy.