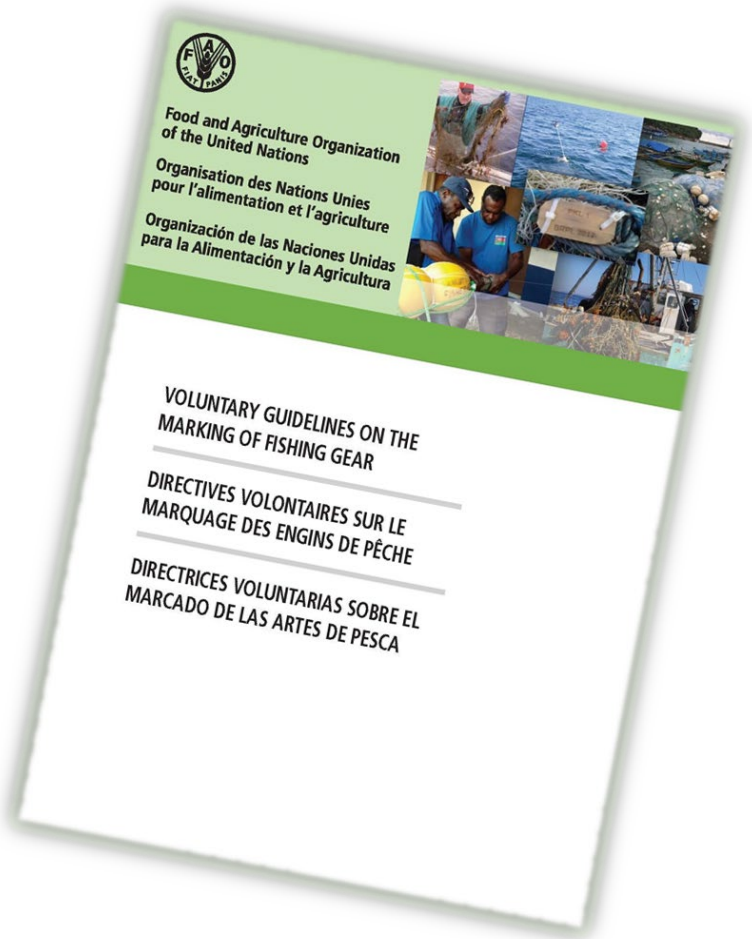
Food and Agriculture Organization of the United Nations

NFIFO/C1261 (En)

FAO Fisheries and Aquaculture Circular

ISSN 2070-6065

OPERATIONALIZATION OF FAO VOLUNTARY GUIDELINES FOR THE MARKING OF FISHING GEAR IN THE INDIAN OCEAN TUNA COMMISSION (IOTC) AREA OF COMPETENCE



Operationalization of FAO Voluntary Guidelines for the Marking of Fishing Gear in the Indian Ocean Tuna Commission (IOTC) area of competence

By

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2022

Required citation:
He, P. & Lansley, J. 2022. *Operationalization of FAO Voluntary Guidelines for the Marking of Fishing Gear in the Indian Ocean Tuna Commission (IOTC) area of competence*. FAO Fisheries and Aquaculture Circular No. 1261. Rome, FAO.
https://doi.org/10.4060/cc2889en

ISBN 978-92-5-137180-0

PREPARATION OF THE DOCUMENT

This document was prepared by the authors for the Indian Ocean Tuna Commission (IOTC) with assistances from the IOTC Secretariat, in particular, Messrs Gerard Domingue and Florian Giroux. The final document was edited by Mr Edward Fortes. We would like to thank Seafish (United Kingdom of Great Britain and Northern Ireland) for generously permitting the use of four fishing gear drawings. Illustrations and tables that have no sources listed were constructed/drawn by the authors.

ABSTRACT

A system for the marking of fishing gear should be an integral part of fisheries management. The marking of fishing gear is an important tool to reduce gear loss and aid recovery, helps in determining ownership, assists in the management and control of fishing effort, facilitates monitoring, control and surveillance, and deters IUU fishing. The marking of fishing gear also contributes to safe navigation.

This document evaluates the major fishing gears that harvest species under the management of the Indian Ocean Tuna Commission (IOTC) through a risk assessment to determine the level of complexity when implementing a system of fishing gear marking. The analysis includes five types of fishing gear, which account for 90 percent of fish landings in the IOTC area of competence, as well as two types of fish aggregating device (FAD). Purse seines, drift gillnets, and drifting FADs are deemed to have "high" or "very high" overall risks, while anchored FADs have "medium" risks, and handline, pole-and-line and trolling lines have "very low" risks.

Based on the evaluation, the document proposed a framework for marking these fishing gears and FADs, based on the principles outlined in the FAO Voluntary Guidelines on the Marking of Fishing Gear. It also provides an indicative economic assessment for implementing a system of fishing gear marking in the IOTC area, based on the responsibilities between the IOTC Secretariat, the Contracting Parties and Cooperating Non-contracting Parties (CPCs), and fishing operators (fishers, fisher organizations and/or corporations).

Implementing a system of fishing gear marking requires extensive effort from the IOTC Secretariat and CPCs in terms of awareness raising and communication. Considering the diversity of CPCs, which are predominately developing states, implementing a system of fishing gear marking in the IOTC area will require careful consideration in terms of capacity-building requirements and financial assistance, especially for the least developed states and Small Island Developing States. As requested by IOTC, a draft resolution for implementing a system of fishing gear marking for the IOTC area of competence has been prepared.

Contents

Preparation of the document iii
Abstract iii
Abbreviations and acronyms x
1. Introduction 1
1.1 Background 1
1.1.1 Voluntary Guidelines on the Marking of Fishing Gear 1
1.1.2 IOTC's work towards the implementation of fishing gear marking 1
1.2 Purpose and scope 1
2. Major fishing gears of interest to IOTC 2
2.1 Purse seines and FADs 3
2.1.1 Purse seines 3
2.1.2 Fish aggregating devices 4
2.2 Drift gillnets 6
2.3 Hook and lines 7
2.3.1 Handlines and pole-and-lines 7
2.3.2 Drift longlines 8
2.3.3 Trolling lines 10
2.3.4 aFADs 10
2.4 Relative importance and plastic materials 11
3. Gear marking technologies and practices 12
3.1 Types of fishing gear marking 12
3.1.1 Physical marking 12
3.1.2 Chemical marking 12
3.1.3 Electronic tags, marks and transmitters 12
3.2 Gear marking for different purposes 13
3.2.1 Gear marking to indicate position and for location tracking and surveillance 13
3.2.2 Gear marking for the identification of origin 14
3.2.3 Gear marking for ownership, capacity management and monitoring 14
3.2.4 Gear marking to aid recovery of lost gear 15
3.3 Examples of gear marking requirements in selected jurisdictions 15
3.3.1 Norway 15
3.3.2 European Union 16
3.3.3 Canada 17
3.3.4 Taiwan Province of China 19
3.3.5 The United States of America 20
3.3.6 The Southern Indian Ocean Fisheries Agreement (SIOFA) 21
4. Current IOTC measures related to gear marking 22
4.1 Current IOTC measures and requirements related to gear marking 22
4.2 Proposals related to gear marking 23
4.3 Examples of marking measures of CPCs 23
5. Risk assessment for the marking of fishing gear 24
5.1 Risk assessment principles 24

5.1.1 General principles ... *24*
5.1.2 Technology readiness ... *25*
5.1.3 Economic considerations ... *26*
5.1.4 Transparency and stakeholder involvement ... *26*
5.2 Fishing gears and risks ... 26
5.2.1 Scoring the likelihood and impact of gears in normal fishing conditions ... *26*
5.2.2 Scoring the impacts or consequences ... *28*
5.2.3 Scoring likelihood and the impact and consequences of ALDFG ... *29*
5.3 Value and importance of reducing or eliminating impacts ... 31
5.4 Categorization of risk ... 32
5.4.1 Fishing gear in normal fishing conditions ... *32*
5.4.2 Abandoned, lost or otherwise discarded fishing gear ... *33*
5.4.3 Overall risk ... *35*
5.5 Prioritization and complexity ... 36
6. A gear marking scheme for the IOTC area of competence ... 36
6.1 General principles ... 36
6.2 A framework for fishing gear marking ... 37
6.3 Areas and fisheries ... 37
6.4 Infrastructure, authorities and stakeholders ... 38
6.4.1 Database ... *38*
6.4.2 Authorities ... *38*
6.4.3 Stakeholders ... *38*
6.5 Recommended marks or marking for IOTC gears ... 38
6.5.1 Recommended information on marks and markings ... *38*
6.5.2 Different types of marks relevant to IOTC gears ... *39*
6.6 Recommended gear marking requirements in the IOTC area of competence ... 40
6.6.1 Purse seines ... *41*
6.6.2 Drift gillnets ... *41*
6.6.3 Drift longlines ... *41*
6.6.4 Handlines and pole-and-lines ... *41*
6.6.5 Trolling lines ... *41*
6.6.6 Anchored FADs ... *42*
6.6.7 Drifting FADs ... *42*
6.6.8 Marking for navigation and safety ... *42*
6.6.9 Summary of the minimum requirements for the marking of fishing gear ... *42*
6.7 Retrieval and reporting of lost, abandoned and recovered gear ... 43
6.7.1 Fishing gear ... *43*
6.7.2 Drifting fish aggregating devices ... *44*
6.8 End-of-life fishing gear ... 45
7. Economic assessment for the implementation of gear marking ... 46
7.1 Costs for fishers ... 46
7.2 Costs for CPCs ... 46

7.3 Costs for the IOTC Secretariat 47
8. Awareness raising and capacity building for the implementation of gear marking 47
8.1 Awareness raising and communication 47
8.1.1 The IOTC Secretariat 47
8.1.2 CPCs 48
8.1.3 International organizations 48
8.1.4 Non-governmental organizations (NGOs) 48
8.2 Capacity-building measures 49
8.2.1 The IOTC Secretariat 49
8.2.2 CPCs 49
8.2.3 International organizations 49
8.2.4 Non-governmental organizations (NGOs) 49
8.3 Special requirements of developing states 50
9. Draft resolution for a system of fishing gear marking in the IOTC area of competence 50
10. Summary 50
References 52
Annex I Draft resolution for a system of fishing gear marking in the IOTC area of competence 55
Appendix I Terms of reference 58
Appendix II International standard statistical classification of fishing gears 60
Appendix III Guidance for the marking of fishing gear to indicate position 62

Figures

Figure 1. The anatomy and components of a purse seine for which the bunt is at the wing..... 3
Figure 2. Modern purse seine encircling a free-swimming fish school 4
Figure 3. A simplified drawing representing a drifting fish aggregating device (dFAD)..... 6
Figure 4. A fleet of drift gillnets near the surface 7
Figure 5. Hand-operated pole-and-lines (LHP 09.1) fishing for skipjack tuna (*Katsuwonus pelamis*) with live bait chum and water jets 8
Figure 6. A fleet of drift longlines (LLD 09.32) set near the surface 9
Figure 7. Basic components and terms used to describe a drift longline (LLD 09.32)..... 9
Figure 8. Trolling lines (LTL 09.5) towed behind a boat using outriggers..... 10
Figure 9. A simplified drawing representing an anchored fish aggregating device (aFAD) 11
Figure 10. Colour combination using two or more different strands of twine interlaced on the same segment to indicate the fishery and region (left), plus tracer with visible inscription identifying country, region, species and fishing area (right) 19
Figure 11. Gillnet marking requirements stipulated by Council of Agriculture (Taiwan Province of China)..... 20
Figure 12. Maldives anchored FAD with marking on its buoy..... 24
Figure 13. Flow chart synthesizing a system of fishing gear marking and its components..... 37
Figure 14. Recommended minimum information on a mark..... 39
Figure 15. Examples of marking for floats and buoys..... 40
Figure 16. Examples of marking for ropes 40
Figure 17. Minimum requirements for the marking of fishing gear 43
Figure 18. Summary of reporting requirements for fishing gears and anchored fish aggregating devices..... 44
Figure 19. Summary of reporting requirements for drifting fish aggregating devices (dFADs) 45
Figure 20. Proposed responsibilities for the implementation of a fishing gear marking scheme in the IOTC area of competence 46

Tables

Table 1. Landings (tonnes) for major gear types of IOTC-managed species in 2019 2
Table 2. IOTC fishing gear and FADs, their relative importance for fish capture in IOTC, and plastic materials 12
Table 3. Likelihood of different risks for fishing gears when they are in normal fishing conditions if they are unmarked or not adequately marked, based on their characteristics of design, fishing mechanism and operation (where 1 is lowest and 5 is highest) 28
Table 4. Impact scores of different risks (where 1 is lowest and 5 is highest), according to their perceived importance by stakeholders, when the gear is in normal fishing conditions 29
Table 5. Scoring the impact of different risk types when a gear is in normal fishing conditions, considering the gear's importance provided in Table 2 29
Table 6. Likelihood scores of ALDFG risks based on gear design characteristics and amount of plastic material (where 1 is lowest and 5 is highest) 31
Table 7. Scores of impacts (or importance) of different ALDFG risks (where 1 is lowest and 5 is highest) 31
Table 8. Impact scores of ALDFG risks for different gear types (where 1 is lowest and 5 is highest) considering scores from Table 7 and the gear's importance scores from Table 2 32
Table 9. Likelihood–impact table for the risk of gear loss when the gear is in normal fishing conditions 32
Table 10. Likelihood–impact table for combined risks when the gear is in normal fishing conditions 33
Table 11. Risk scores for different gear types in normal fishing conditions 33
Table 12. Likelihood–impact table for the risk of plastic pollution once a gear becomes ALDFG 34
Table 13. Likelihood–impact table for combined risks once a gear becomes ALDFG 34
Table 14. Risk scores for different gear types once they become ALDFG 35
Table 15. Overall risks considering both when the gear is in normal fishing conditions (normal) and once it becomes ALDFG 35
Table 16. Likelihood–impact table for combined risks when the gear is in normal fishing conditions and once it becomes ALDFG 36

Abbreviations and acronyms

aFAD..... anchored fish aggregating device
AIS ..... Automatic Identification System
ALDFG ..... abandoned, lost or discarded fishing gear
CCSBT..... Commission for the Conservation of Southern Bluefin Tuna
COLREG ..... Convention on the International Regulations for Preventing Collisions at Sea
COFI ..... Committee on Fisheries (FAO)
CPC..... Cooperating non-contracting parties
CWT..... coded wire tag
dFAD ..... drifting fish aggregating device
DFO ..... Fisheries and Oceans Canada
EEZ..... exclusive economic zone
ETP ..... endangered, threatened, 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
GGGI ..... Global Ghost Gear Initiative
GPS ..... global positioning system
GT ..... gross tonnage
HDPE ..... high-density polyethylene
IMO..... International Maritime Organization
ISSCFG..... International Standard Statistical Classification of Fishing Gear
IOTC ..... Indian Ocean Tuna Commission
IUU fishing ..... 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)
NFC..... near-field communication
PRF ..... port reception facility
RFID ..... radio-frequency identification device
RFMO/A ..... regional fisheries management organization/arrangement
SIOFA ..... Southern Indian Ocean Fisheries Agreement
SWIOFC ..... Southwest 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

1. INTRODUCTION

1.1 Background

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

Fishing gear marking intends to contribute to more sustainable fisheries through prompt reporting and facilitating the retrieval of ALDFG, thereby minimizing the impact on the environment by reducing both marine litter and the ghost fishing caused by ALDFG. Establishing a system of fishing gear marking also provide the means of identifying the ownership and location of fishing gears. It should therefore be considered in the context of broader fisheries management measures which support sustainable fisheries and healthy oceans such as effort control, legality of fishing, and measures against IUU fishing.

1.1.1 Voluntary Guidelines on the Marking of Fishing Gear

The Food and Agriculture Organization of the United Nations (FAO) started to develop guidelines for the marking of fishing gears in the early 1990s. The Voluntary Guidelines on the Marking of Fishing Gear (VGMFG; FAO, 2019a) was endorsed by FAO Members at the Thirty-third Session of the Committee on Fisheries in July 2018.

A guiding principle of VGMFG is that a system of fishing gear marking should be put in place for all gear types unless the relevant authority deems otherwise, whether following a risk assessment or other appropriate means. The VGMFG stresses that a system of fishing gear marking should be considered and implemented in the context of broad fisheries management measures that support sustainable fisheries and healthy oceans including the reduction, minimization and elimination of ALDFG. The VGMFG envisages that marking of fishing gear should be a condition of fishing authorization or license, where appropriate.

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

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

Following the endorsement of the Voluntary Guidelines on the Marking of Fishing Gear by COFI, the European Union, a Member of Indian Ocean Tuna Commission (IOTC), put forward a proposal for a resolution on the marking of fishing gear in 2019, with due consideration of Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL), which prohibits the discharge of all garbage at sea, including from fishing vessels (IOTC, 2019). The proposal called for 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's area of competence are clearly marked. Although the proposal did not receive the required support to pass into a resolution, the Commission tasked the IOTC Secretariat to develop standards for a marking scheme for consideration and adoption by the Commission, taking into account the FAO Voluntary Guidelines on the Marking of Fishing Gear. This report was prepared in response to the Commission's 2019 decision on 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 are applicable to CPCs. The primary focus of gear marking for IOTC is to prevent and reduce the marine pollution caused by ALDFG, though gear marking also has other conservation and management purposes. The report outlines a process and framework for implementing a system of

fishing gear marking, including priority and complexity of gear marking for different gears based on a risk assessment (as recommended by the VGMFG). The report also examines the current relevant conservation measures established by IOTC and how they may be enhanced, while also considering the potential financial implications of implementing a system of fishing gear marking for the IOTC Secretariat and CPCs under different implementation scenarios. Finally, given the CPCs' diverse economic development stages and varying levels of fishery management, the report outlines a number of strategies for raising awareness and capacity building in CPCs, particularly developing states. The Terms of Reference are attached as Appendix I.

2. MAJOR FISHING GEARS OF INTEREST TO IOTC

This chapter provides 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 gear characteristics with regards to gear loss, capacity control and other elated characteristics, including types of plastic materials commonly used in these gears.

This document, adopts the definition of "fishing gear" as provided in Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL):

> 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 sea bed with the intended purpose of capturing or controlling for subsequent capture or harvesting marine or freshwater organisms (IMO, 1978).

Based on the IOTC catch database, the following five gear types are identified as major gears for catching IOTC-managed species in the IOTC's area of competence: purse seines, drift gillnets, handlines and hand-operated pole-and-lines, drift longlines, and trolling lines. The landings for 2019 are provided in Table 1.

Table 1. Landings (tonnes) for major gear types of IOTC-managed species in 2019

Gear	ISSCFG code	Catch (tonnes)	Comments	Relative importance
Purse seine	PS	553 210	Purse seines only	5
Drift gillnet	GND	583 775	All gillnets – majority are presumably 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

Note: For FADs, aFAD and dFAD are not ISSCFG code, but common abbreviations.

The relative importance of aFAD and dFAD is scaled from 1 to 5 and is assigned based on catch related to FADs and number of FADs in use.

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 quantity of FADs employed in the 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, the 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.).

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's area of competence, aFADs are mostly used within THE exclusive economic zones (EEZ) of CPCs and mostly associated with handlines, pole-and-lines, and trolling lines. As in other oceanic tuna fisheries, dFADs are associated with purse seines, mostly on the high seas, but they can drift into the EEZs of CPCs, and in some cases, are grounded in shallow coastal areas.

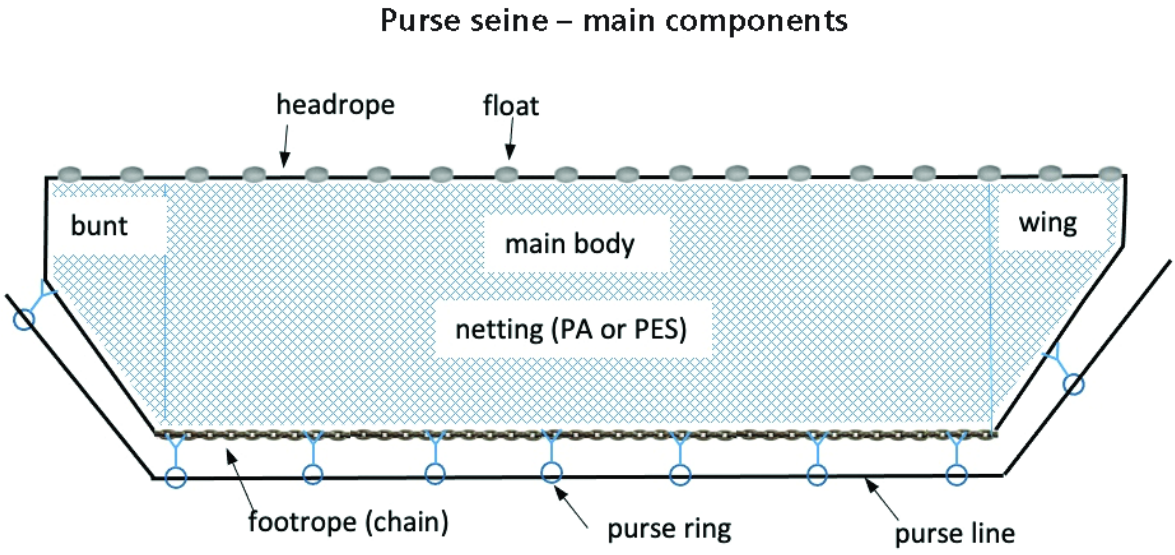
2.1 Purse seines and FADs

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 polyamide nylon (PA) or polyester (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.

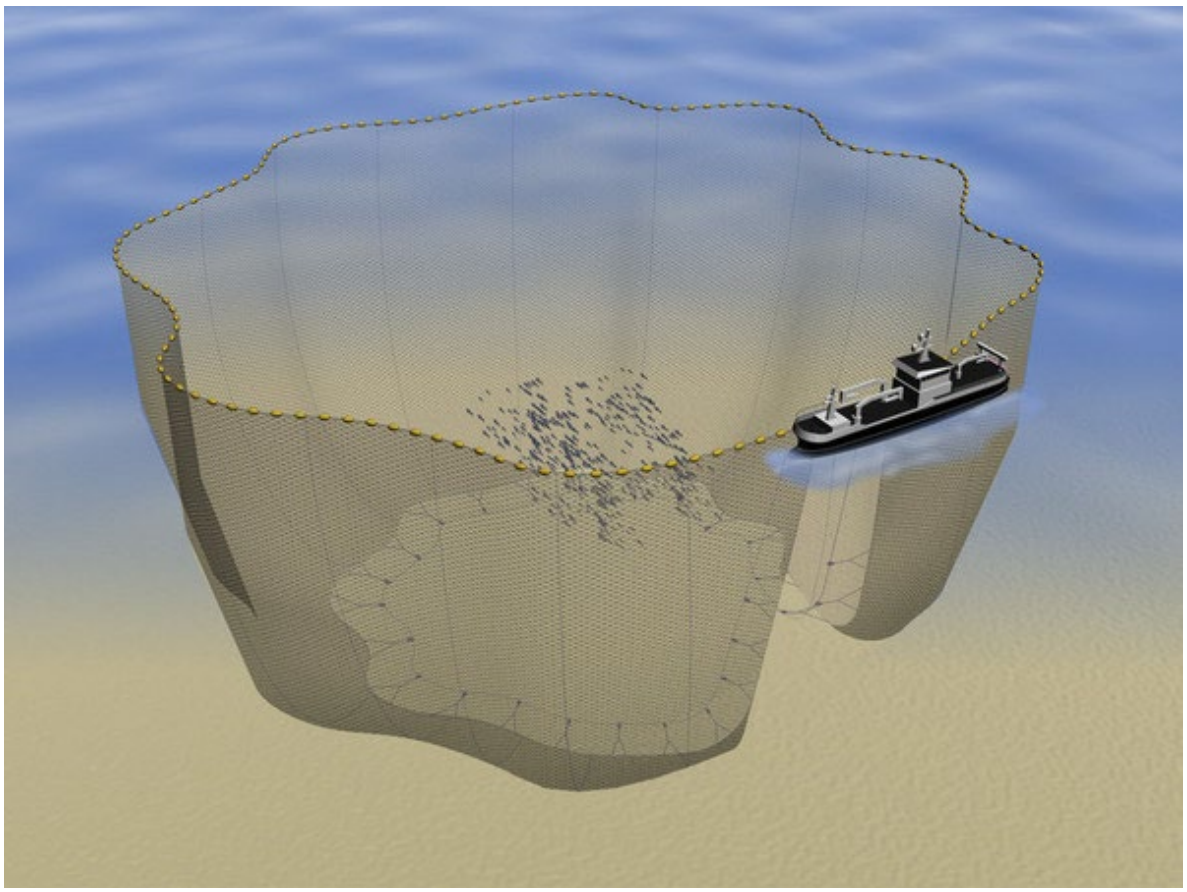


Source: taken from Seafish asset bank, Press Office and Media content, https://www.seafish.org
Note: Drawing not to scale.

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.

As illustrated in Figure 2, a modern tuna purse seine 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. They 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: taken from Seafish asset bank, Press Office and Media content, https://www.seafish.org

2.1.2 Fish aggregating devices

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

These devices can either be anchored (aFAD; also called "moored") and deployed within a nation's EEZ, or drifting (dFAD), often deployed in the high seas. AFADs are mainly used by handline, pole-and-line, trolling line, and vertical line vessels, though sometimes also by purse seine vessels, while 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 of more than 2000 m.

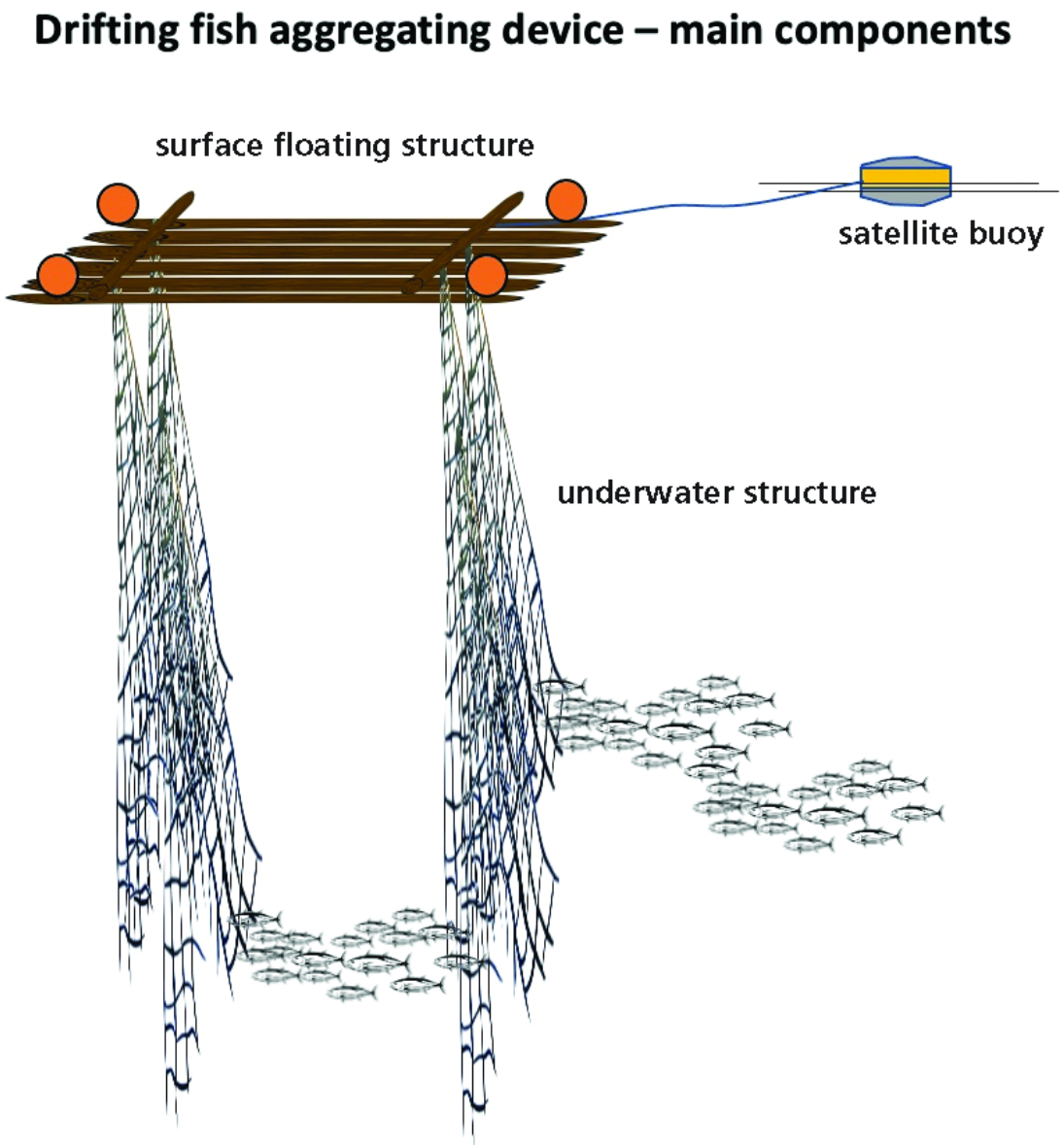
Typically, FADs consist of surface components (rafts), underwater components (appendages) and a marker to indicate or report its position (Figure 3). Drifting FADs often have a marker with an electronic transmitter, sometimes linked to satellite communication. Anchored FADs have a rope leading to an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

While earlier FADs were mostly made from natural, biodegradable materials such as bamboo, wood and tree branches, today most FADs are primarily made of synthetic materials (both surface raft and appendage), with less than 2 percent made entirely 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 other nets, i.e., 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 number of dFADs deployed by industrial purse seine vessels operating within EEZs and on the high seas has led to a significant number of abandoned, lost or otherwise discarded FADs. What is more, without a clear requirement to identify the ownership of dFADs, it is not easy to ascribe the responsibility and/or obligation for their retrieval (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. Some have also expressed concerns 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 has significantly increased the number of FADs a vessel can handle, and speed of detection. While there are no recent reliable assessments, Baske *et al.* (2012) estimated that about 105 000 drifting FADs are in use in 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 purse seine fleets from the European Union (Scott and Lopez, 2014), suggesting that many dFADs are not recovered, but left at sea.

Figure 3. A simplified drawing representing a dFAD



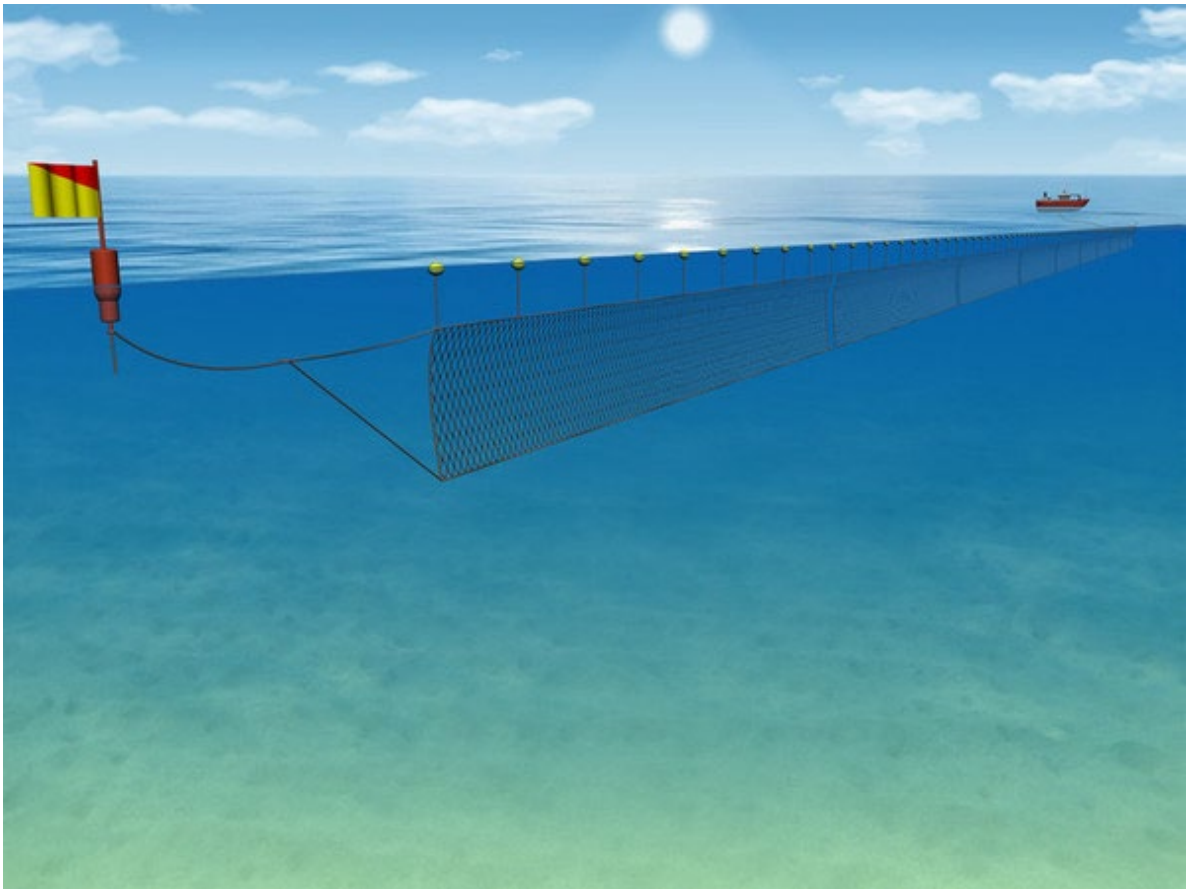
2.2 Drift gillnets

A drift gillnet (or driftnet, Figure 4) is a type of gillnet that is not fixed to the sea bed but allowed to drift with the current. Drift gillnets are usually fished in a fleet that can extend over a great distance in open waters. Drift gillnets typically use PP ropes as their headrope, and PA or lead-sleeved PP rope as their footrope. Netting is typically made of monofilament PA, while the floats used on the headrope are typically made of PVC or EVA. Surface buoys may be made of PVC or PUR. Drift gillnets usually fish on or near the surface but can fish 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, in 1991 the United Nations adopted a resolution banning the use of large-scale driftnets more than 2.5 kilometres long in the high seas (UNGA RES 44/225; UN, 1989). Since then, some regional and national

authorities such as the IOTC, the European Union and other regional fisheries management organizations (RFMOs) have implemented similar bans in their jurisdictions. 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: taken from Seafish asset bank, Press Office and Media content, https://www.seafish.org

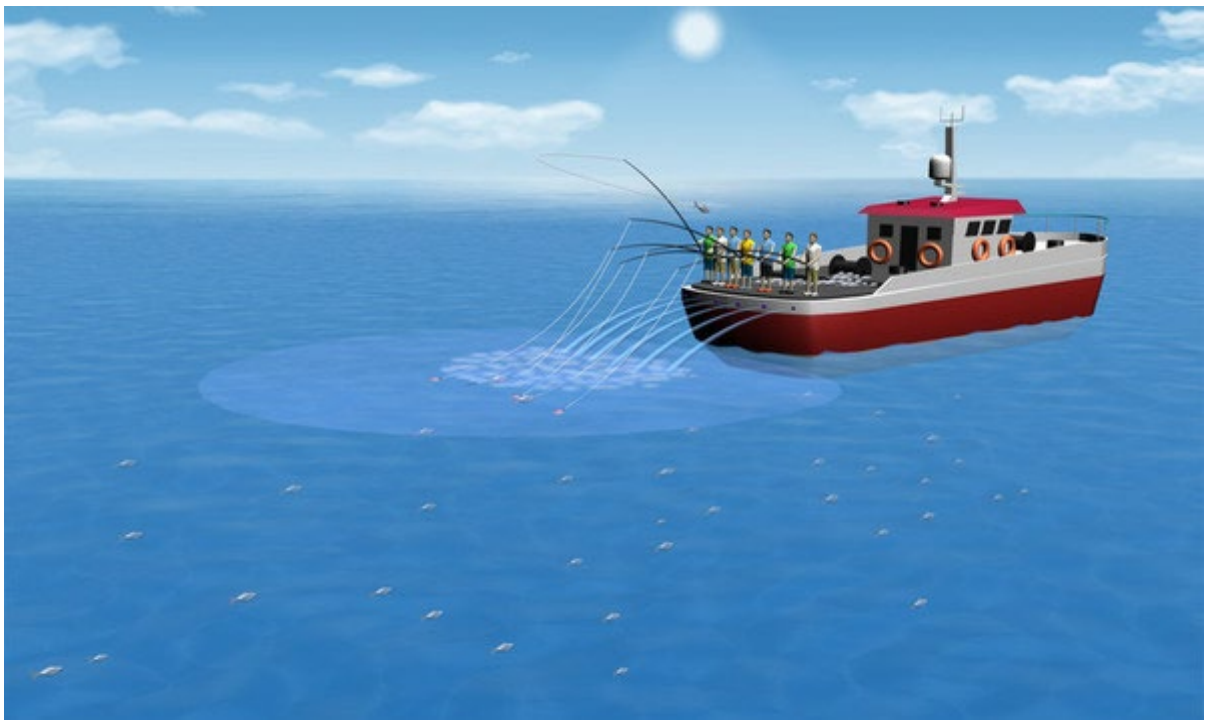
2.3 Hook and lines

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 the IOTC area is pole-and-line fishing for skipjack tuna (*Katsuwonus pelamis*). Skipjack pole-and-line fishing typically uses 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

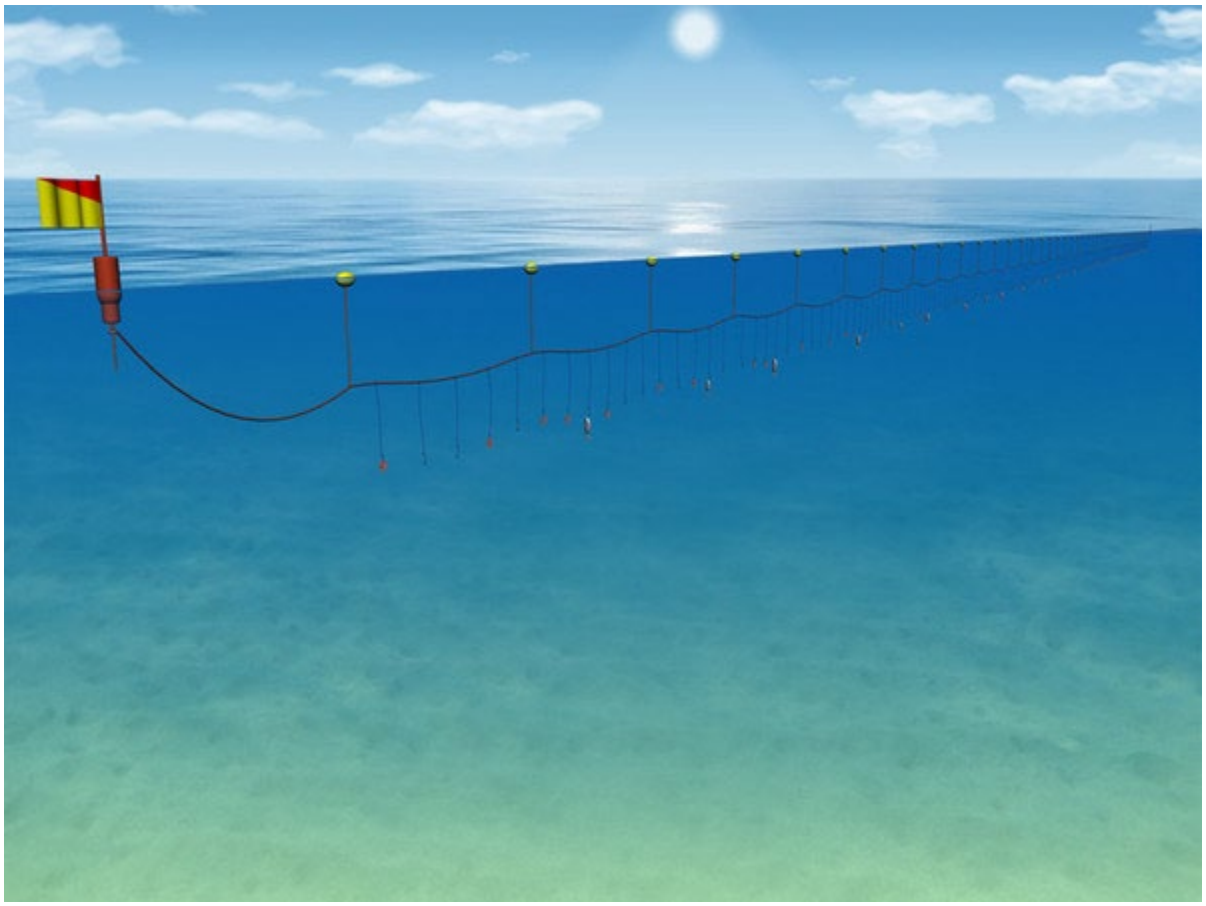


Source: He, P., Chopin, F., Suuronen, P., Ferro, R.S.T and Lansley, J. 2021. *Classification and illustrated definition of fishing gears*. FAO Fisheries and Aquaculture Technical Paper, No. T672. Rome, FAO.
Note: Water jets come from the stern of the boat (underneath the fishers).

2.3.2 Drift longlines

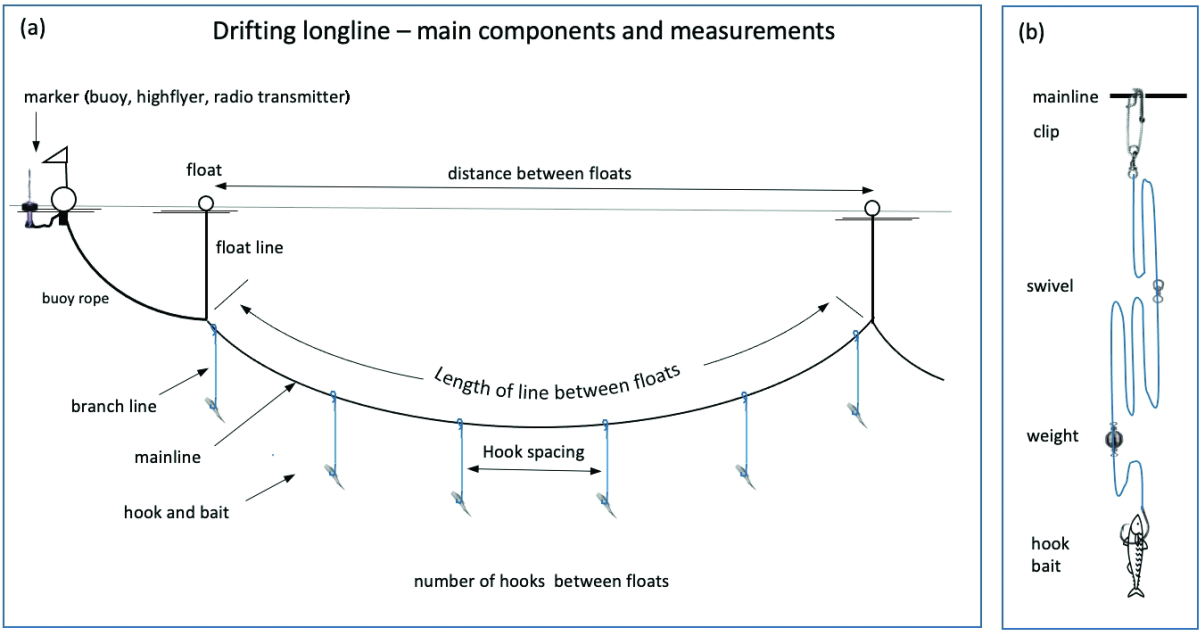
A drift longline is a type of longline that is not fixed to the sea bed and drifts passively with the current, or with the boat (also drifting) attached at one end of the longline (Figure 6). These longlines often fish in open water or high seas targeting tuna or tuna-like species, and are often large 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: taken from Seafish asset bank, Press Office and Media content, https://www.seafish.org

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

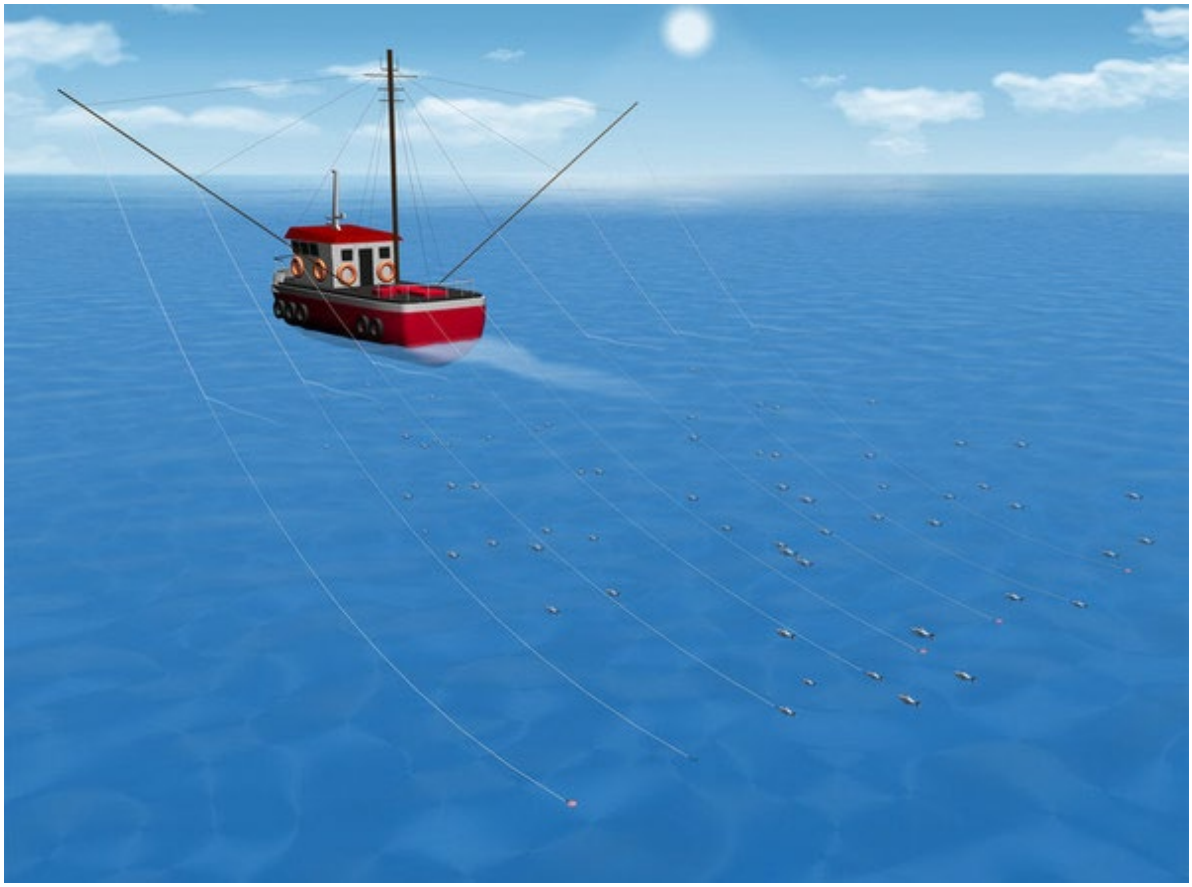


Source: He, P., Chopin, F., Suuronen, P., Ferro, R.S.T and Lansley, J. 2021. *Classification and illustrated definition of fishing gears*. FAO Fisheries and Aquaculture Technical Paper, No. T672. Rome, FAO.

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.



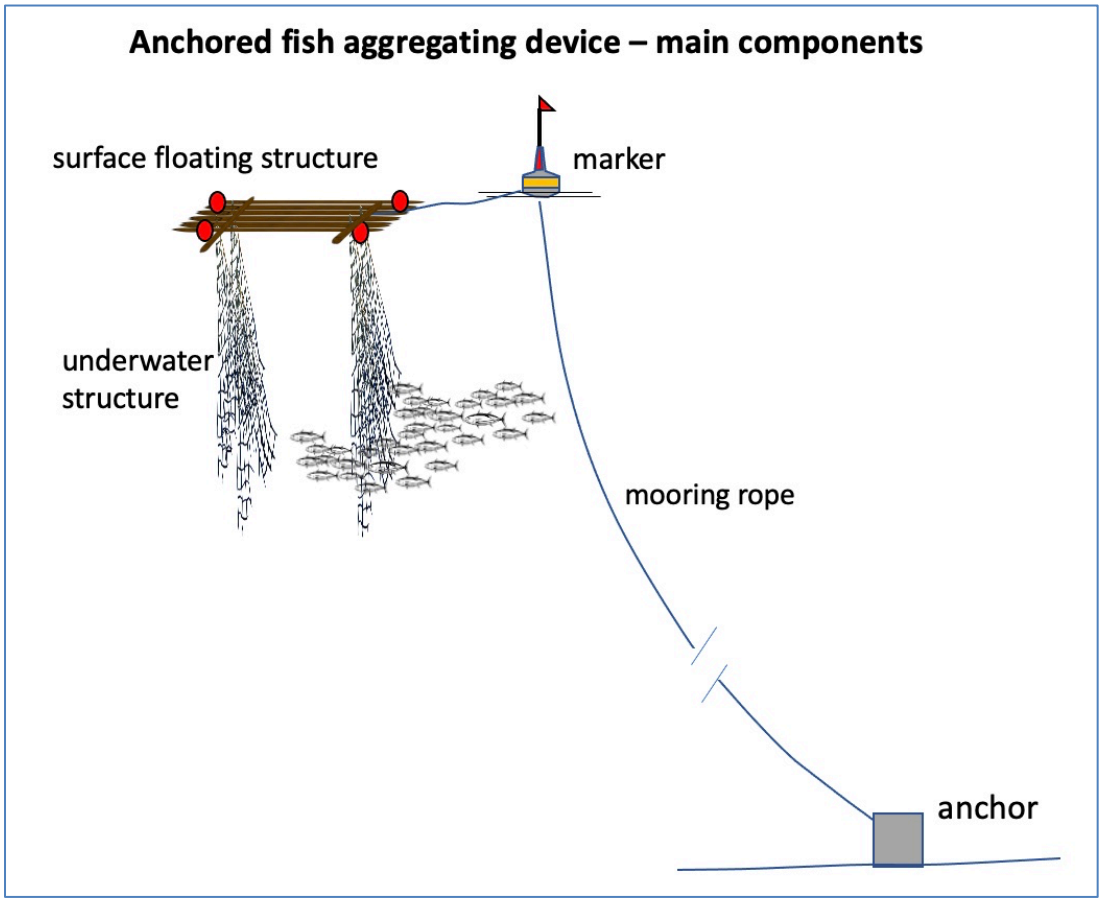
Source: taken from Seafish asset bank, Press Office and Media content, https://www.seafish.org

2.3.4 aFADs

aFADs have a similar surface structure to drifting FADs, except they are anchored or otherwise fixed to the sea bed with a mooring rope, weights or anchors (Figure 9). As their position is fixed, satellite buoys are not used. Big spar buoys, usually equipped with a light, are used to indicate position and aid to navigation.

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

Figure 9. A simplified drawing representing an aFAD



2.4 Relative importance and plastic materials

The relative importance of different gear types for the IOTC area was evaluated by the volume of fish landings in Table 1. The importance of gear was re-scaled to 1 to 5 (where 1 indicates low importance, limited usage and small landings, and 5 indicates high importance and large landing). Scores for the relative importance of gear types are used to estimate the overall plastic content of the gear type (Table 2), as well as the impact of the gear use, which will be discussed in later sections.

Knowledge of the plastic composition of each fishing gear is important. Plastic components of fishing gear do not readily degrade and may remain in the water or on the sea bed for a long period of time as marine debris. Some may also continue to catch fish i.e. ghost fishing. A summary of the relative amount of plastic used – in addition to the types of plastic material in netting, ropes, floatation and surface marking (buoys) for different gear types – is provided in Table 2. The types of materials used in fishing gears provide information on their buoyancy and risk to navigation and/or fouling of sea bed habitats.

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

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

Gear type	Relative importance (1–5)	Plastic materials			Plastic amount (1–5)	Overall plastic amount (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

Notes: See Table 1 for ISSCFG gear code.
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

A variety of fishing gear marking technologies and practices exists: 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 defines 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. (FAO, 2019a)

Types of fishing gear marking may include physical, chemical, electronic and virtual marks. The purposes of marking may include: ownership and legality; capacity control; position to aid navigation; and identifying the origin of ALDFG to track and locate the gear for easy recovery and loss prevention. New technologies for subsea electronic and/or virtual gear will also be examined. Some of information described below is drawn from He and Suuronen (2018).

3.1 Types of fishing gear marking

3.1.1 Physical marking

Physical marking, which can include inscriptions, writing, colours, shapes and tags, has traditionally been used for ownership, legality and capacity control purposes. Buoys, lights, flags and radar reflectors are used to mark position and as an aid to navigation. Physical marking is still the primary means of marking fishing gear today.

3.1.2 Chemical marking

Chemical elements that are embedded during the manufacturing of fishing gear materials may be used to identify the owner of the gear if lost and subsequently recovered, providing there are good records of the sale and resale of gears and materials. Chemical markings cannot be removed easily and provide the material or gear with a permanent "signature", which may be identifiable through the analysis of chemical contents. With sound record-keeping, the owner and manufacturer of the material may be retraced. However, a material's chemical contents cannot be easily identified on site and laboratory analysis is required to obtain the relevant 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 such as radio and satellite transmitters have been used in some fisheries, especially large industrial operations

in offshore areas. These allow the easy location of gear from a distance, or real-time tracking from the vessel and from land. Electronic devices provide much more temporal and spatial information on the gear, as well as biological and environmental information on 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 allows the owner to locate their gear more quickly, while also aiding 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. By facilitating navigation for other ocean users, gear marking for position also improves safety and reduces potential gear damage or loss.

Flags, lights, and radar reflectors

Flags, lights and radar reflectors are the main position markers for coastal fisheries. Gear marking for location enables the quick retrieval of gear, thereby reducing gear loss and conflicts, while also improving safety at sea. Modern electronic devices allow the accurate marking of the set position of stationary gears on an electronic chart, which enables the gear's quick and efficient recovery. Specific requirements for the 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 drone, which greatly increases the area of monitoring and surveillance, thereby providing an enhanced means for enforcement and combating IUU fishing.

The Automatic Identification System

The Automatic Identification System (AIS) is primarily used by shipping vessels, though also increasingly by fishing vessels. While AIS is primarily for safety at sea and port security, AIS can potentially be used as a fishery monitoring system for combating IUU fishing (Robards *et al*., 2016). There is currently no known implementation or formal discussion regarding the use of 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 – no additional onboard equipment would therefore be 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 requires 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 very important for locating "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 to track their position in real time, using satellite buoys. The use of sophisticated markers significantly increases the number of dFADs a vessel can handle, and the speed of detection.

Virtual marking

Given the increasing challenges of megafauna species becoming entangled in the vertical buoy lines of pots and other unattended gears, "rope-less" pot fishing without buoy ropes and surface markers is being developed and tested in several fisheries. Virtual marking technology is being discussed and tested in

order to reduce gear conflict and 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 such as fishery managers and MCS entities. Virtual marks may also be incorporated into electronic navigation charts. The technology is still under development and will require major technological advancement as well as legal and institutional approval (Baumgartner *et al*., 2018).

3.2.2 Gear marking for the identification of origin

The origin of fishing gear and/or its components should ideally be identifiable when they are lost and recovered, and/or entangled with marine animals. Knowing the area, fishery and gear type of the gear components that were originally used provides valuable information for fishing gear modifications to reduce loss and entanglement, as well as for area/season closures and other management measures to reduce entanglement and the potential mortality of vulnerable animals (Wilcox *et al*., 2015).

Colours and tracers

Coloured ropes or tracers are being implemented in the northeastern waters of United States of America (NOAA, 2015) and Eastern Canada (DFO, 2020) to help trace ropes that are entangled in endangered North Atlantic right whales. Only a limited number of colours can easily be distinguished after extensive use at sea. Colours may also fade after prolonged exposure to the sun and sea water. 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 the manufacturer, batch number, and/or material specification can be printed onto the tracer before it is woven into the rope or twine. Fisheries and regions may require specific information to be printed in special orders.

Coded wire tags

Coded wire tags (CWT) have been tested for possible inclusion in fishing ropes for the purposes of providing 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 their readability when ALDFG is recovered. They can potentially provide a large amount of information about the gear and the fishery concerned, as well as potentially the time of last deployment and environmental conditions. Applying RFID tags is less challenging with some types of gear than others. For example, there are still major challenges to incorporating RFID tags into fishing ropes in terms of durability of the tags and the ropes they are woven into 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 pot, gillnet and longline fisheries. Traditionally, various physical tags have been used, usually inscribed with the owner's permit number. In some fisheries, tags are fixed to the gear itself (in the case of gillnets) or attached to its surface markers (in the case of pots), or both. These physical tags can only contain limited information (such as a license number). More advanced tags that contain static information (e.g. license number, owner, vessel) as well as dynamic information (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 also help fishery enforcement combat IUU fishing.

Physical tags

Physical tags are traditionally used for this purpose, usually inscribed with the permit number or owner's name. In some fisheries the tags are fixed to the gear itself, while in others the tags are attached to the surface buoys; in others still, both the underwater and surface components of gear are tagged or marked. Printed tags bearing a bar or QR code can contain more information about the gear.

RFID tags

These 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 enable the speedy relocation and recovery of lost fishing gear will also reduce ALDFG. Gear relocation devices typically use acoustic technology, taking advantage of the superior sound transmission properties of seawater. There are two types of technologies: active pingers and transponders, and passive sonar reflectors. The first is based on detecting specific frequencies of sound from the locator tag using a receiver hydrophone, while the second is based on the 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 on its position.

Transponders

Transponders listen to the acoustic signal from a command unit via a hydrophone. Once it has detected a 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 the acoustic reflectivity of objects underwater so that they can easily be detected by echo sounders or other acoustic equipment. Measures to enhance the 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 their retrieval, establish ownership, and reduce interactions with other vessels for the purposes of safe navigation and to avoid gear conflicts. The need for a uniform marking scheme across management boundaries and in the 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 bases for many fishing gear marking regulations and recommendations for numerous nations and regions. To this end, Annex IV of the *FAO Technical Guidelines for Responsible Fisheries 1. Fishing Operations* (FAO, 1996), "Proposal for the Application of Standard System of Lights and Shapes for the Identification and Location of Fishing Gear", is attached as Appendix 3.

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

3.3.1 Norway

There is a general requirement for fishing gear to be marked in Norwegian 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 the 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 mentioned in i. Pots fished in a fleet of more than one pot must be marked with vessel registration number, and on the float attached to the pot.

(2) Special marking rules outside 4 nautical miles

Gillnets and longlines used in the Norwegian EEZ more than 4 nautical miles from shore baseline must be marked as follows:

i. During the daytime, the fishing gear must have a highflyer with a radar reflector or a flag at both ends. After sunset both ends must have a buoy with a reflector (see section f) and with a light (see section g) so that both end buoys show the location of the fishing gear and its extent.
ii. During the daytime, at the western end (from compass south through west into and with north) the buoy must have two flags, one above the other. The distance between those two flags must be at least 25 cm. The radar reflector can be replaced by the upper flag. After sunset the buoy must have two lights. The distance between the lights must be at least 50 cm.
iii. During the daytime, at the eastern end (from compass north through east to and with south) the buoy must have one flag. A radar reflector can be used instead of the flag. After sunset the buoy must have one light.
iv. The distance between buoys on anchored fishing gear may not exceed 1 nautical mile. If the fishing gear is longer than 1 nautical mile, it must have one or more intermediate buoys between the end buoys. Intermediate buoys shall be marked as described in iii. After sunset middle buoys are not required to have lights, though only if the distance between the light on the fishing gear is no more than 2 nautical miles.
v. The distance between marking buoys on drifting fishing gear may not exceed 2 nautical miles. Fishing gear that is longer than 2 nautical miles must have one or more intermediate buoys between the end buoys. The intermediate buoys must be marked as explained in iii.
vi. Driftnets in a fleet of many connected nets with total length of more than 1 nautical mile must have one or more buoys with light reflectors to assist in visual relocation.
vii. If the topography of the bottom and/or strength of the tide make it impossible to have a buoy on both ends, the length of the fishing gear may not exceed 1 nautical mile.
viii. When one end of the drifting fishing gear is attached to the vessel, marking is not required at that end.
ix. The poles on a highflyer must be at least 2 m above the surface. The marker, whether the pole or the top marker, must have a light reflector that can reflect light in all directions.
x. The light on the highflyer must be yellow and visible from a distance of at least 2 nautical miles, in clear visibility and in darkness. Constant lights, which are on all the time, or flashing lights, may be used. However, both constant and flashing lights on the same marker are not permitted. Flashing lights must flash at a rate of 20–25 flashes 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, which 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 nautical miles 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 irrelevance to IOTC],

(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 the 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 at 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 and Labrador and Quebec regions (DFO, 2020). The new requirements are a part of Canada's efforts to improve tracking of gear when lost, address ghost gear, and further identify management measures to reduce threats to marine mammals, in particular the North Atlantic right whale. The requirements are implemented to trace gear origin, specifically the country, region and target species, as well as lobster and snow crab fishing areas. The gear marking requirements consist of interlacing different strands of coloured twine with 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 the 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).

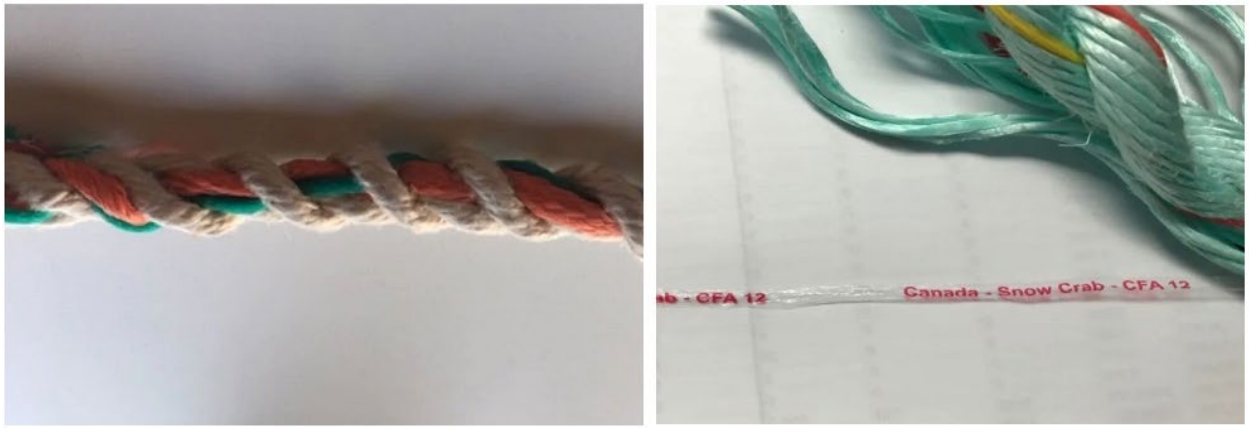
ii. For lobster and snow crab fisheries only, a third colour is used to mark different fishing areas. The third colour is added to a subsequent segment of rope immediately after the segment of rope with the first two colours

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 where applicable, at the discretion of fish harvesters, such as on the rope from the primary buoy to the secondary buoy, and on the groundlines.

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, region(s), 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), plus tracer with visible inscription identifying country, region, species and fishing area (right)



Source: Canada Department of Fisheries and Oceans. 2020. Notices to Fish Harvesters. Gear marking requirements for non-tended fixed gear fisheries in eastern Canada (2019-12-20). https://www.qc.dfo-mpo.gc.ca/en/node/787

3.3.4 Taiwan Province of China

Taiwan Province of China recently implemented marking for gillnets, as published in *Gillnet Net Fisheries* Fishing *Gear Marking Measures*, which came into 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:

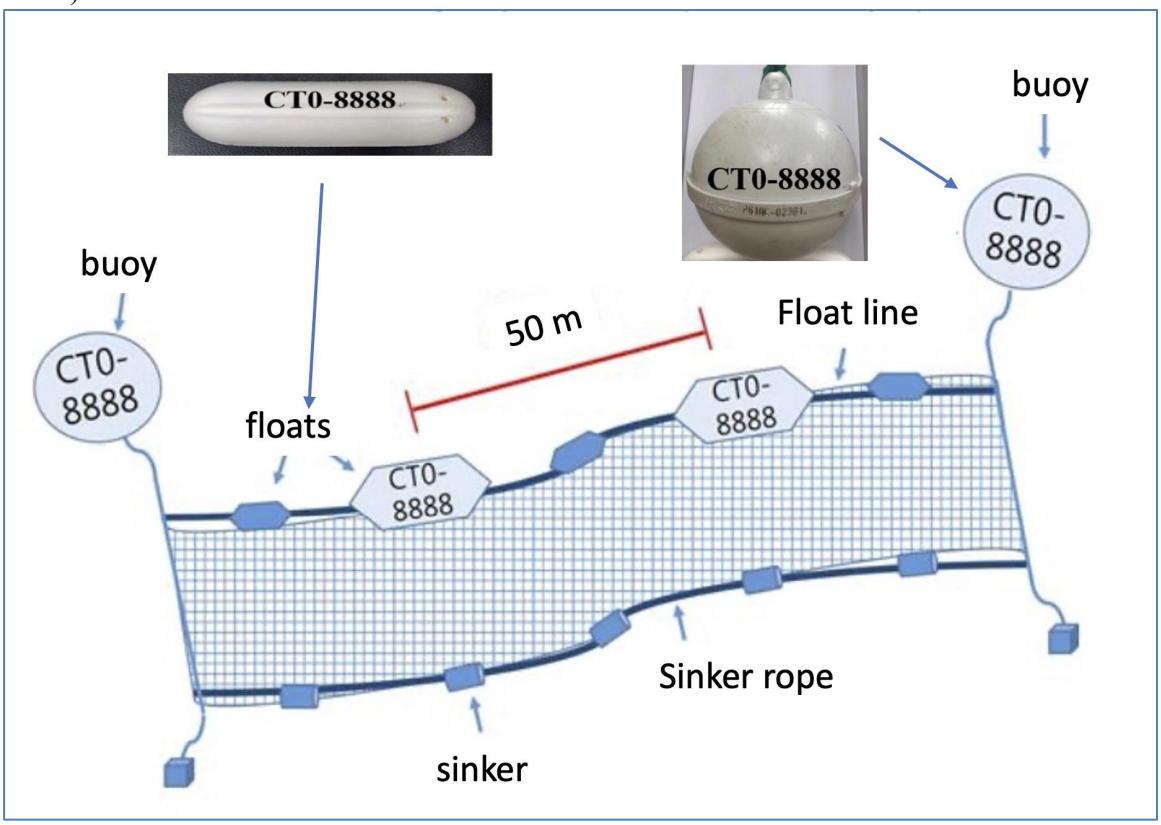
i. Should be written, painted, engraved or tied to the label, or any other means that makes it difficult to remove (or peel off).
ii. Should be marked with the vessel identification number, with legible font sizes.

(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 a float shorter than 8 cm, or where there are no floats on the float line, the marking should be 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, navigational 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 shall in turn record the notification according to the format prescribed by the authority.

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



Source: CoA. 2018. Gear marking measures for gillnet fisheries [刺網漁業漁具標示措施]. Council of Agriculture Notice, Agriculture and Fisheries No. 1091322238A. Taipei, Council of Agriculture. https://www.rootlaw.com.tw/LawArticle.aspx?LawID=A040270061050100-1100114

3.3.5 United States of America

Under the Magnusson-Stevens Fisheries Management and Conservation Act of 1996, and its subsequent renewals, the United States 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 northeast 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 written confirmation issued by the Regional Administrator on board, 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 as lost, missing or destroyed, by letter or fax to the Regional Administrator.

v. Replacement tags. Vessel owners or operators seeking the replacement of lost, destroyed or missing tags must request a 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 reissued.

3.3.6 The Southern Indian Ocean Fisheries Agreement (SIOFA)

The SIOFA's agreement Conservation and Management Measure (CMM) for control of fishing activities in the agreement area (CMM 2018/09) includes provisions for the gear marking, as well as its reporting and retrieval. Below 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 sea bed 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 nautical miles 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. 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 TO 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

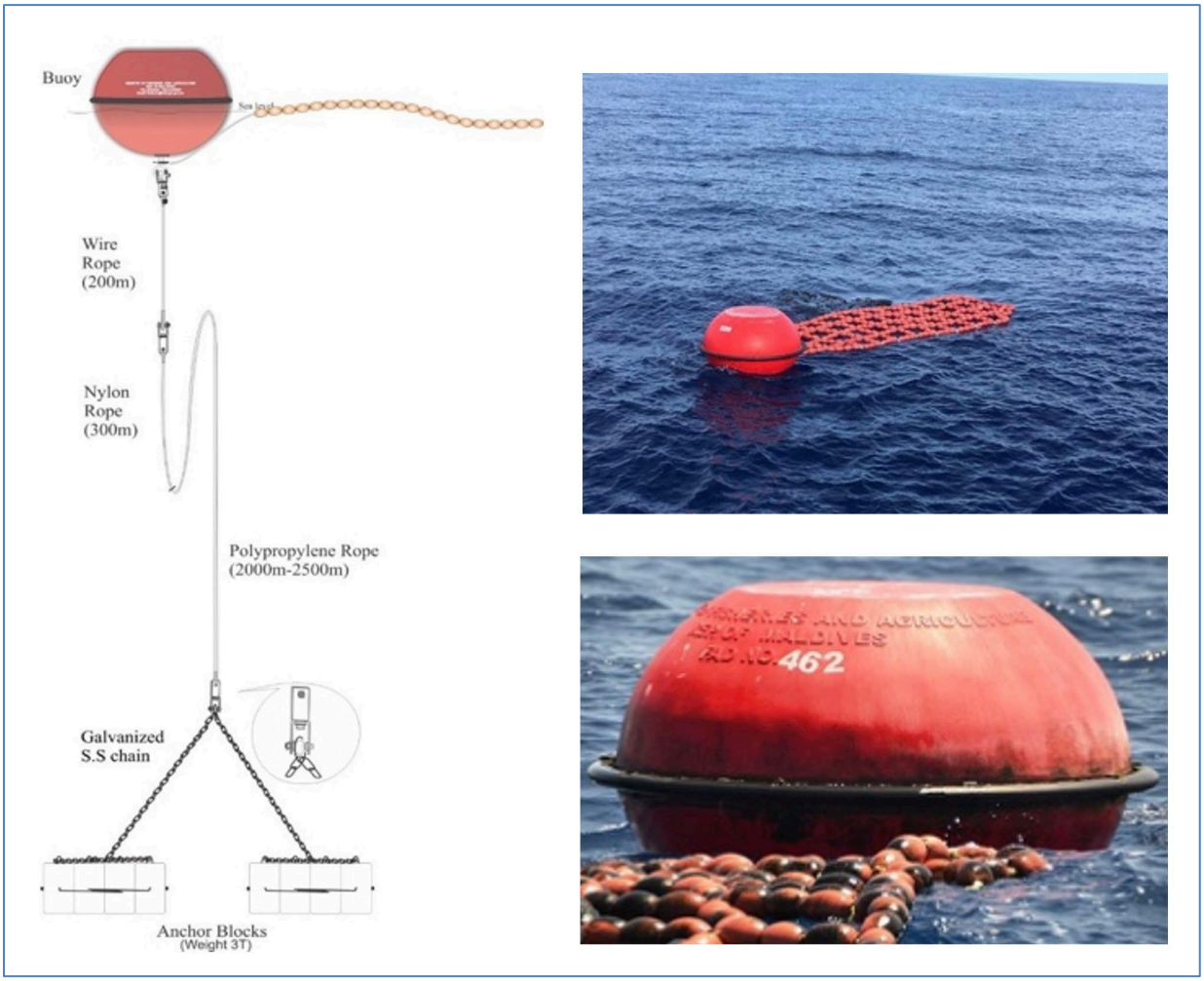
The proposal "On marking of fishing gear and prevention of marine pollution" (IOTC-2019-S23-PropL[E]) was submitted by the European Union in 2019 but was not adopted into a resolution. The proposal set out general principles and detailed measures on the marking, reporting and recovery or retrieval of ALDFG, as well as means for the 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 aimed 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 the government of Maldives. 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 FAD's unique number was printed prior to deployment.

Figure 12. Maldives anchored FAD with marking on its buoy



Source: Adam, M., Jauhary, A., Azheem, M. and Jaufer, A. 2019. Use of Anchored FADs in the Maldives – Notes for a Case Study for Assessing ALDFG. IOTC-2019-WPTT21-58. http://www.iotc.org/sites/default/files/documents/2019/10/IOTC-2019-WPTT21-58.pdf

5. RISK ASSESSMENT FOR THE MARKING OF FISHING GEAR

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

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

5.1 Risk assessment principles

5.1.1 General principles

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

- estimation of the consequence (impact) of the lack of a system of fishing gear marking (or an inadequate marking system) in the fishery under consideration;

- estimation of the probability of the identified risk occurring as a result of the lack of a system of gear marking (or an inadequate marking system) in the fishery under consideration;
- scoring of the impact, which may be determined by the nature and design of the gear, and modified by the perceived importance of the risk by stakeholders; and
- categorization of the risk.

A risk assessment should take into account the risk associated with both actively fished gear and 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, as well as the area of operation (as suggested in the VGMFG). This will allow simple small-scale fishing methods, usually handheld 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 limited to:

- ecological risks (plastic pollution; status of species impacted; ghost fishing; impact on endangered, threatened and protected (ETP) species; vulnerability and fragility of habitats);
- 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; 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); and
- implementation risks (different users; language; level of organization; availability and quality of information; international, regional and local expert support).

Determining a risk level requires estimates of the consequences and likelihood based on the best available science, as well as local ecological knowledge and stakeholder inputs. To be able to defend estimates, a clear rationale should be provided on how estimated levels were calculated, so that the determination can be traced and verified. Regional standardization is desirable, but fishery- or location-specific criteria are possible if justifiable. A clear rationale also provides a basis from which future assessments can be made. The information, data and opinions collected and consolidated through the initial scoping exercise (from both experts and fishers) 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, notably through advances in electronics, communication technologies and infrastructure (He and Suuronen, 2018). However, there are great disparities between regions and nations. A risk assessment should therefore include an assessment of the feasibility of implementing a gear marking system in the fisheries/nations where the system is to be implemented. 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 technology within the system?

5.1.3 Economic considerations

With regard to economic considerations, the following questions may be asked:

- Is the technology (and associated cost) fit for the required purpose?
- Do the countries, regions and/or regional fishery body in question have the administrative capacity and financial resources 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 follow written rules of procedure. Arrangements for conducting risk assessments, and their resulting decisions, should be carried out with a balance of independent technical experts and representatives from those involved in the system development, revision and approval processes. Stakeholders for risk assessment and the development of the gear marking schemes which may result, may include:

- representatives of fishery management and enforcement authorities;
- the fishing industry and fisher organizations;
- the scientific and research community;
- non-governmental organizations;
- fish processors, traders and retailers;
- consumer associations and seafood certification bodies.

5.2 Fishing gears and risks

The process for conducting risk assessments for the marking of fishing gear should start with the identification of scope, area, fishery, and gears to be assessed. In addition, 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) should also be considered (FAO, 2019b). This should be followed by the collection of fishing gear and fishery data and gear loss data, as well as where and when loss has often occurred (hotspot identification). The process should involve diverse stakeholders, often through stakeholder surveys, workshops or other similar mechanisms. 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 evaluate the importance and economic impact of lost gear and ghost fishing (which results from gear loss) differently. A risk assessment for the marking of fishing gear involves the following steps.

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

The 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 conducted in the same area. Scoring the likelihood of risks occurring for different gear types is based 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;
- navigational hazard.

One of the primary purposes of gear marking at the surface is to indicate its position so that it may be subsequently retrieved by its owner, and to indicate to other fishers not to set or tow their gears in the same location. Proper gear marking reduces gear loss as a result of a fisher's inability to find their gear, and damage and entanglement caused by gear conflicts. Good gear marking also helps other fishers and vessels stay away from the gear for safe navigation, especially in areas with heavy vessel traffic.

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:

- size and number of gear units being fished;
- sea and weather conditions;
- area being fished, including water depth, sea bed type and distance from the port;
- catch amount;
- operator skill;
- machinery malfunction; and
- 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 the partial loss of attended gears is also possible, especially in increment weather and sea conditions. Determining the likelihood of occurrence requires both the specialized knowledge of fishing technologists on fishing gear design and operation, and the local knowledge of how the gear is being used by fishers in the area concerned.

Fishing gear loss

Effective surface gear marking facilitates the locating of previously deployed unattended fishing gear, thereby reducing the probability of gear loss. Gear marking for capacity control also limits excessive amounts of gear, which may lead to abandonment in increment 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 a higher risk of being lost if unmarked or not properly marked. This includes a fisher's inability to find previously deployed gear, or as a result of gear conflicts and/or the inability to avoid unmarked or improperly marked gear. However, unattended gears set for a short period with the vessel monitoring nearby would reduce the likelihood of loss.

Ownership dispute

Many unattended gears are marked on the surface and sometimes also on the gear itself. This has long been common practice to ascertain ownership, deter theft, and avoid fishers accidentally retrieving gear that does not belong to them. The surface buoys of pots, gillnets and longlines are often inscribed with names and/or unique numbers. Attended gears and unattended gears with active monitoring have low likelihoods of ownership disputes and theft, while unattended gears set overnight without active monitoring by the owner vessel have higher likelihoods of this risk.

Overcapacity and effort control

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

Illegal fishing

While fishing gear marking cannot stop illegal fishing, a system of fishing gear marking facilitates monitoring, control and surveillance (MCS) authorities to ascertain the legality of fishing operations and the gear's compliance with regulations. Unmarked or insufficiently marked fishing gear that cannot be linked to an owner or authorization to fish in a specific area may indicate IUU fishing operations

(FAO, 2019a). 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, as well as between stationary and mobile gears. Properly marked gear indicates the position, direction and extent of the gear. Attended gear, and unattended gears with active monitoring have lower likelihoods of gear conflicts, while unattended gears without active monitoring by the owner vessel have higher likelihoods of the risk. Fishing around coastal aFADs, for instance, 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 to inform the position of the gear. Good gear marking also helps other fishers and vessels to stay away from the gear for safe navigation, especially in areas with heavy vessel traffic. The hazards that come from not properly marking at the surface therefore depend on location, and sometimes, season.

Table 3. Likelihood of different risks for fishing gears when they are in normal fishing conditions if they are unmarked or not adequately marked, based on their characteristics of design, fishing mechanism and operation (where 1 is lowest and 5 is highest)

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

Notes: See Table 1 for ISSCFG gear code and abbreviations.
Rescaled to 1–5.

5.2.2 Scoring the 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. The characterization or scoring of the 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 characterization 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 the 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 improving navigation safety?

Table 4. Impact scores of different risks (where 1 is lowest and 5 is highest), according to their 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 mathematically weighted by the importance of gear as provided in Table 2, resulting in weighted impact scores shown in Table 5. The mean impact scores have been rescaled to values from 1 (lowest) to 5 (highest).

Table 5. Scoring the impact of different risk types when a gear is in normal fishing conditions, considering the gear's importance provided in Table 2

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

Notes: See Table 1 for ISSCFG gear code and abbreviations.
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 for the environment, ecosystem and other ocean users, in addition to the costs of replacing the gear for fishers. The severity of consequences (level of impact) is partially related to the gear's design, operation and intrinsic nature, as described below, and modified by stakeholders' recognized importance of the risk.

Plastic pollution

One of the most damaging outcomes of gear that is lost, abandoned or discarded is marine plastic pollution. While gear marking does not reduce marine plastic pollution after the gears have become ALDFG, markings do provide information about the fishery and region where ALDFG originates; in doing so it helps prioritize areas and gears that need to implement measures to reduce gear loss and abandonment, and to make effort to prohibit discards.
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.

Ghost fishing

Another negative outcome of ALDFG is ghost fishing. Some gears are more likely than others to ghost fish after becoming ALDFG, negatively impacting the target fishery resource, its dependent species, and ETP species. Gillnets and entangling nets, and pots are of particular concern in this regard.

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 closures, effort control and gear modification; the latter, by contrast, cannot be controlled once they become ALDFG, unless some design features can be incorporated before they become ALDFG (de-hosting technology).

Traceability of ALDFG

The proper and effective marking of fishing gear is essential to tracing a gear's region and fishery of the origin before it becomes ALDFG. The design of fishing gear markings should take into consideration any national or regional ALDFG reporting requirements, whether they are recommended or mandatory. This is especially important for gear that may become entangled on large megafauna species, as identifying its origin can shed light on measures to reduce entanglement and mortality. The traceability of ALDFG also informs measures to reduce loss and abandonment in specific fisheries through the proper management of gear. The traceability score is related to the mobility of ALDFG of specific gear types – floating ALDFG is more likely to be carried to distant locations from where it was originally lost or abandoned.

Fouling the sea bed

Abandoned, lost or otherwise discarded fishing gears can foul the sea bed if they remain on or sink to it. The likelihood of this risk is related to the type of gear and the density of fishing gear materials. Heavier materials such as PA and PES netting and ropes are likely to foul the sea bed, 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 cost 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 such as large-scale fish traps, may mean loss of fishing for the entire season as gear construction and deployment usually take a long time. The seasonal nature of many such traps also make replacement unfeasible. The economic risks may be more significant in small-scale fisheries in developing countries, where the ability to purchase additional gear may be limited.

Navigation hazards

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

Table 6 provides scores of the likelihood of ALDFG risks if gears are unmarked or not properly marked, based on the size of the gear, material, and characteristics of design and operation. The risk scores 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 have been rescaled to values from 1 (lowest) to 5 (highest).

Table 6. Likelihood scores of ALDFG risks based on gear design characteristics and amount of plastic material (where 1 is lowest and 5 is highest)

Gear type (ISSCFG code)	ALDFG – Likelihood score (1–5)						Mean likelihood score
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling sea bed	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

Note: Rescaled to 1–5.

5.3 Value and importance of reducing or eliminating impacts

Similarly, the importance or value of eliminating or reducing each identified risk once the gear became ALDFG was communicated to the IOTC Secretariat and scored were provided (Table 7). The following questions were asked for each identified ALDFG risk:

- Plastic pollution: How important or significant is ALDFG in contributing to marine plastic pollution in your region?
- Ghost fishing: How important or significant is ALDFG in ghost fishing?
- Traceability of ALDFG: How important is gear marking in tracing the source of ALDFG in the sea (where it originated)?
- Navigational hazards: How significantly does ADLFG impact navigation in your area?
- Fouling the sea bed: How significantly is ADLFG fouling the sea bed (e.g. 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 (where 1 is lowest and 5 is highest)

	ALDFG impact score - Perceived importance of stakeholders (1 - 5)					
Risk type	**Plastic pollution**	**Ghost fishing capacity**	**Traceability of ALDFG**	**Navigation hazard**	**Fouling sea bed**	**Economic loss**
Scores	5.0	5.0	5.0	2.0	5.0	5.0

The impact scores in Table 7 were mathematically weighted by the importance of gear as provided in Table 2, resulting in weighted impact scores for the 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 for different gear types (where 1 is lowest and 5 is highest) considering scores from Table 7 and the gear's importance scores from Table 2

Gear type	ALDFG - impact score (1 - 5)						Mean impact score
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling sea bed	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

Notes: See Table 1 for ISSCFG gear code.
Rescaled to 1 – 5.

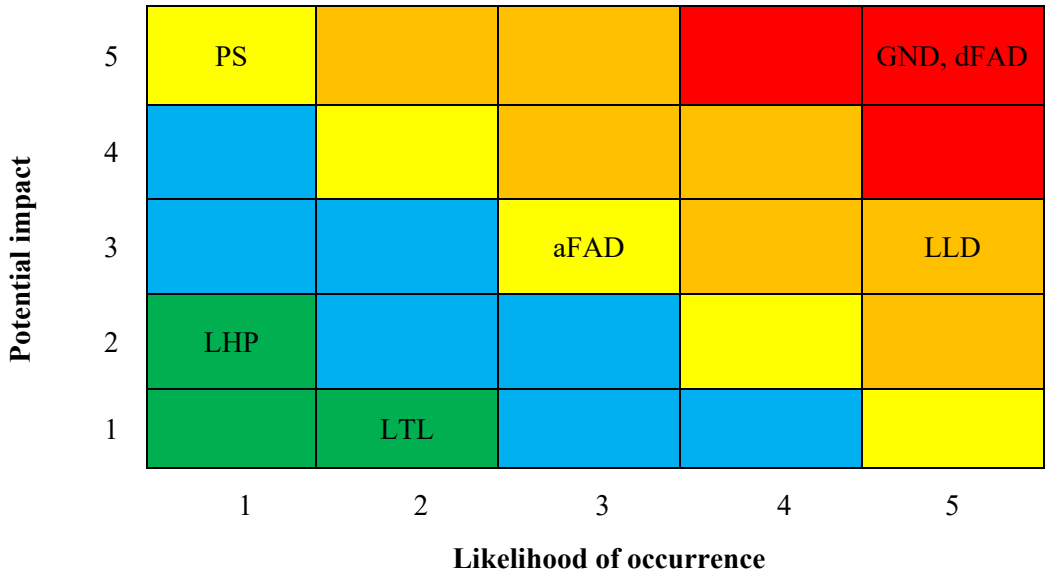
5.4 Categorization of risk

Categorization of risk involves assigning different gears to a specific impact (or consequence), or a combined overall, impact in a likelihood–impact table. It can be done either for fishing gear in normal fishing conditions or once it becomes ALDFG, or for 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), combined with their impact (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).

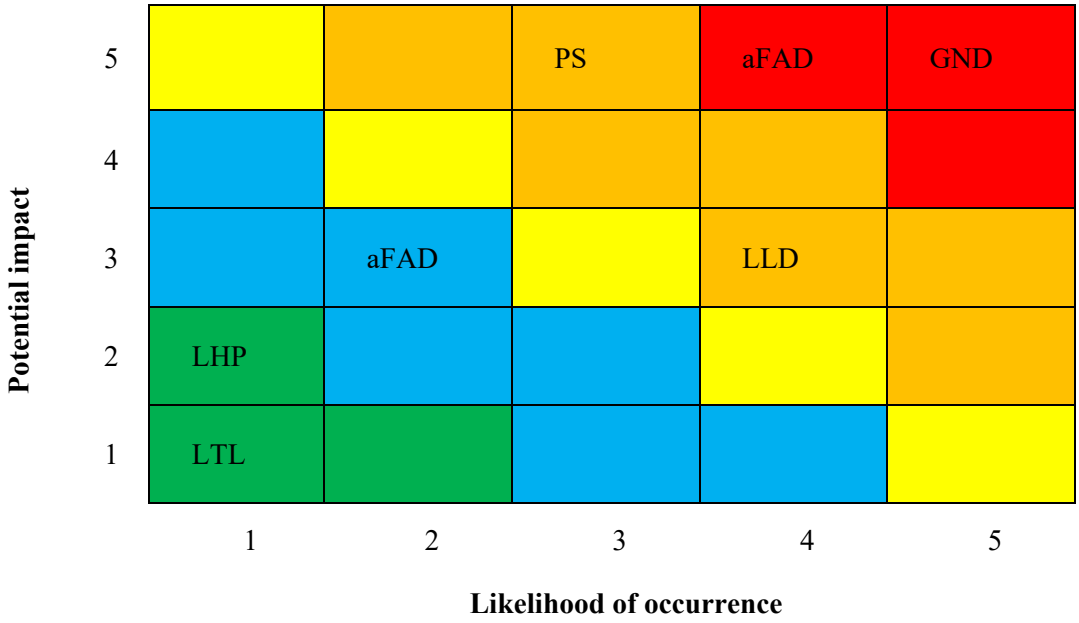
Table 9. Likelihood–impact table for the risk of gear loss when the gear is in normal fishing conditions



Note: See Table 1 for ISSCFG gear code.

Colour key: very low | low | medium | high | very high

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



The specific or combined overall impact risk may also be calculated using the following formula:

Risk = Likelihood of occurrence × Impact

The risk of specific or combined overall impact may be ranked, as shown in Table 11 for combined overall risk. As the table shows, in normal fishing conditions drift gillnet (GND) and drifting FADs (aFAD) have the two highest overall risk scores, while trolling line (LTL) and pole-and-line (LHP) has the two lowest risk scores.

Table 11. Risk scores for different gear types 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 likelihood of certain risks associated with ALDFG (as shown in Table 6), together with their impact (Table 8) can be used to construct likelihood–impact tables for a specific risk (e.g. plastic pollution, Table 12) or combined overall risk (Table 13).

Table 12. Likelihood–impact table for the risk of plastic pollution once a gear becomes ALDFG

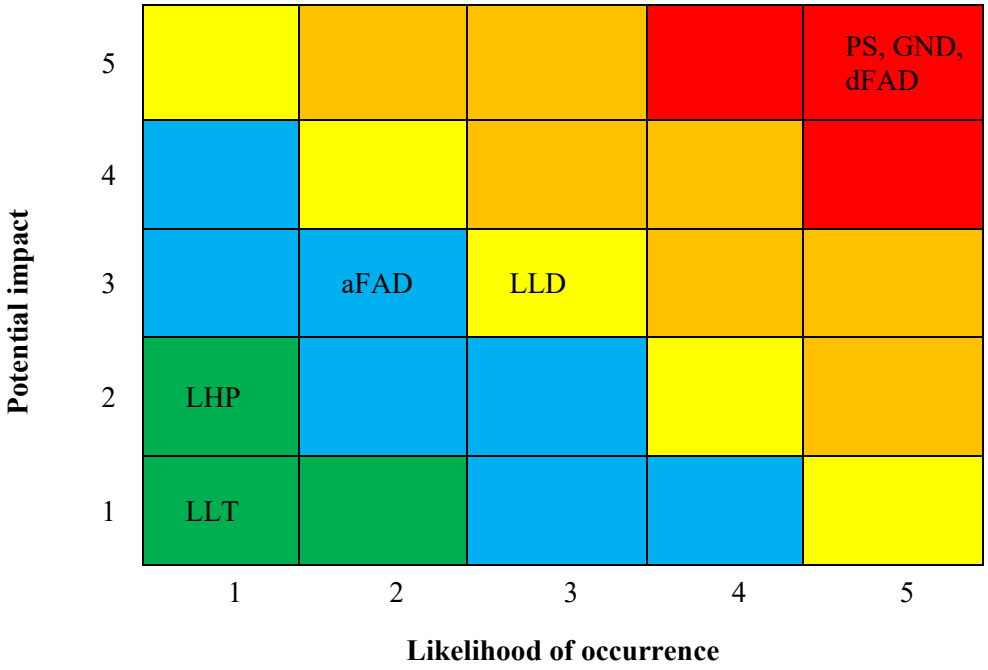
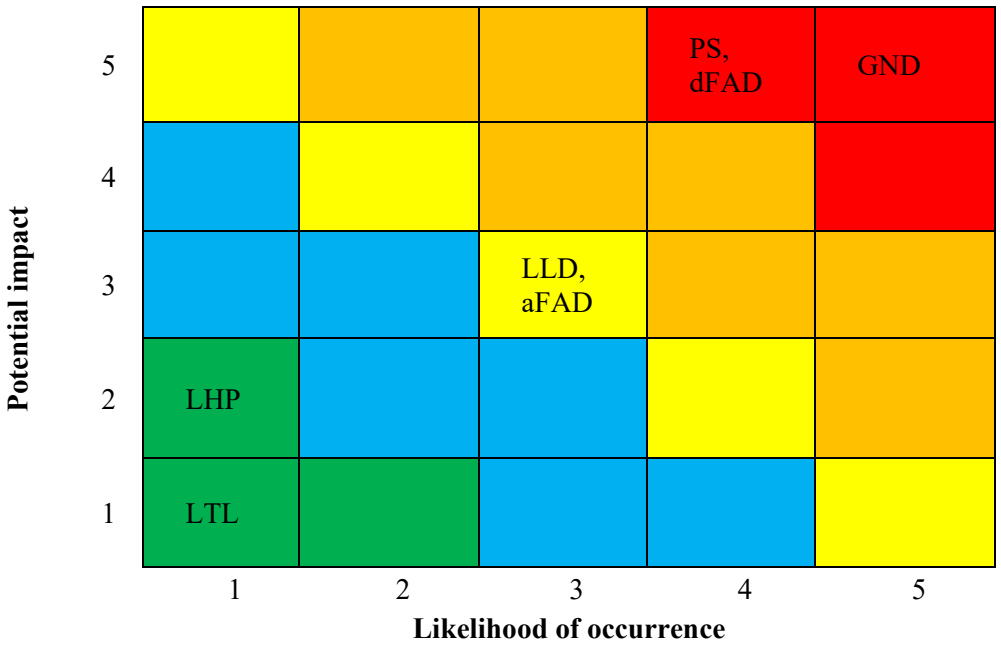


Table 13. Likelihood–impact table for combined risks once a gear becomes ALDFG



The score of a specific risk or combined overall risk may be calculated using the same formula as for gears in normal fishing conditions; so that they can be ranked, as shown in Table 14. As the table shows, purse seines (PS), drift gillnets (GND) and drifting FADs (aFAD) have the three highest overall risk scores when the gear has become ALDFG, while trolling lines (LTL) and handlines/pole-and-lines (LHP) have the two lowest risk scores.

Table 14. Risk scores for different gear types once they become ALDFG

Gear type	ALDFG – risk score						Mean risk score
	Plastic pollution	Ghost fishing	Traceability of ALDFG	Nav. hazard	Fouling sea bed	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

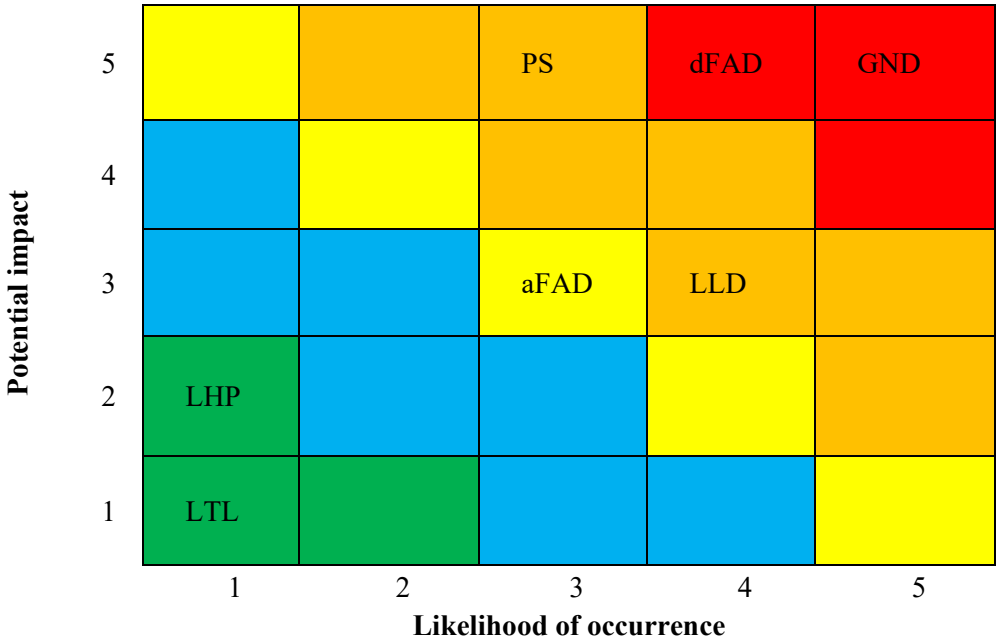
5.4.3 Overall risk

The overall risk of a fishing gear, considering both it is in normal fishing conditions and once it has become 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 gillnets (GND) and aFAD have the highest risk (red, the highest likelihood of occurrence and highest potential impact), while trolling line (LTL) and handlines/pole-and-lines (LHP) have the lowest risk (green) (Table 16).

Table 15. Overall risks considering both when the gear is in normal fishing conditions (normal) and once it becomes 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 once it becomes ALDFG



5.5 Prioritization and complexity

Based on the risk categories and scores for the gears that harvesting IOTC managed species when they are in normal fishing conditions and once 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 therefore be marked with sufficient details to indicate their authorization to fish, ownership, and provide traceability once lost or abandoned. Handlines/pole-and-line and trolling lines are ranked as having "very low" risks overall. Accordingly, the high priority for gear marking should be assigned to drift gillnets, dFAD, purse seines, drift longlines and aFADs. Handlines/'pole-and-line and trolling lines may be marked more simply, for example, with information of ownership and license to fish.

6. A GEAR MARKING SCHEME FOR THE IOTC AREA OF COMPETENCE

6.1 General principles

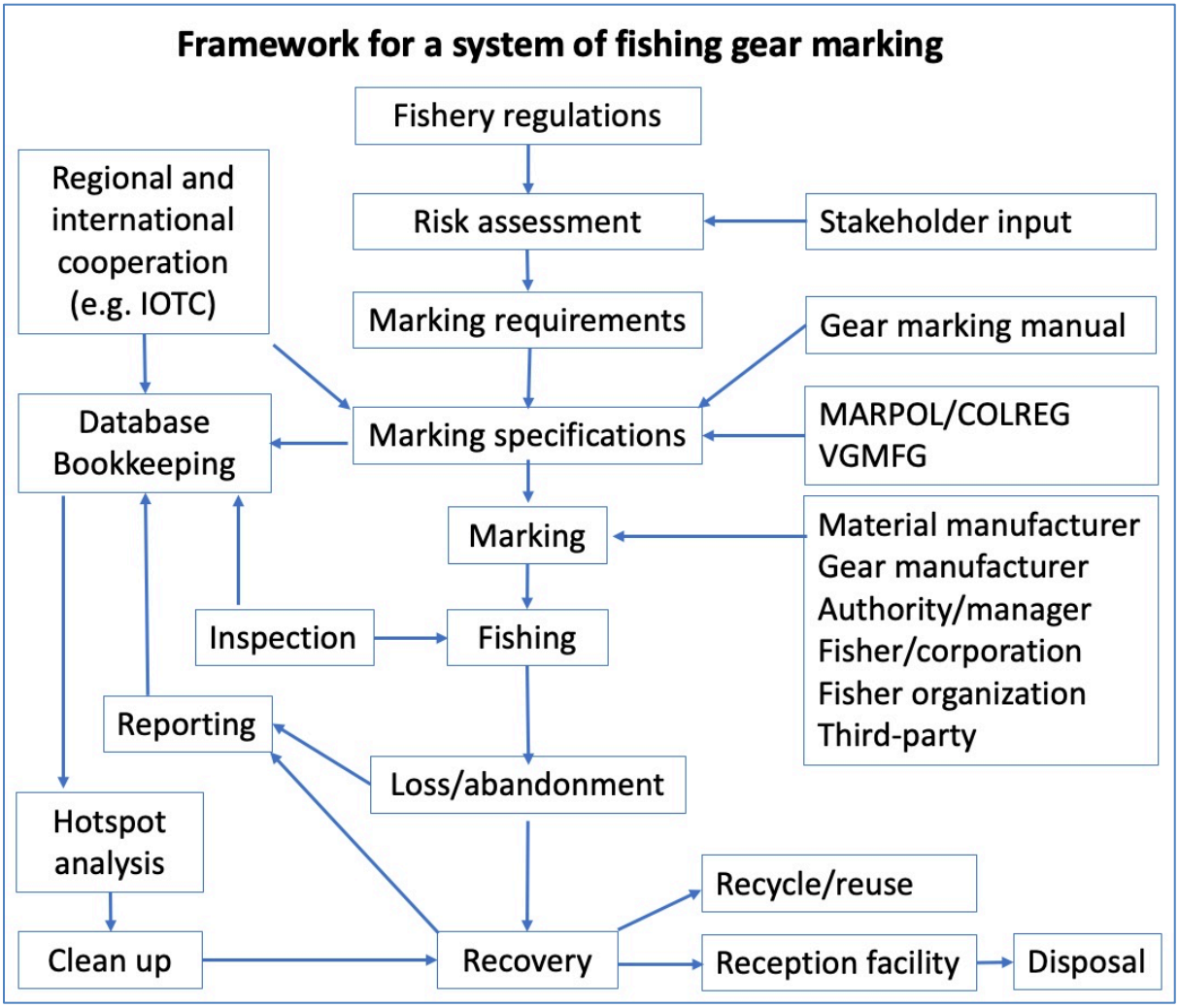
A system of gear marking should be an integral component of and serve as an important tool for fisheries management. It should be compatible with existing international laws and rules, including but not limited to MARPOL Annex V, and COLREG (with particular reference to the marking of fishing gear at 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 the 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

A system of fishing gear marking should include: a risk assessment (as described in Chapter 5); gear-specific marking requirements; a reporting, recording and data management system; mechanisms for the application of data for monitoring control and surveillance, and measures to mitigate the impact of ALDFG, including the retrieval of ALDDFG; and finally the requirement for the 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. Flow chart synthesizing a system of fishing gear marking and its components



6.3 Areas and fisheries

The IOTC area of competence includes the EEZs of CPCs and international waters beyond national jurisdiction across the entire Indian Ocean. The fisheries targeting the species managed by IOTC consist of large-scale industrial operations such as purse seines and drift longlines, as well as small-scale and artisanal fisheries using handline and trolling lines. However, there is currently no agreement of what constitutes artisanal, coastal and semi-industrial fisheries in terms of applying gear marking measures to fishing gears and FADs. What is more, vessels may fish both in national waters and international waters. Therefore, it may not be feasible to separate fisheries and areas when implementing a system of gear marking. However, through a risk assessment, certain gear types that are commonly considered small-scale or artisanal may in fact result in minimal risks 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 record-keeping system on the production, issuance, replacement and termination of marking or markers. Such a system usually involves a database linked to vessel records, fishing licenses and permits, gear regulations, as well as commercial tracing of the manufacture, sale, resale and disposal of fishing gear or its major components. The database may have functionality for user input and query in a controlled manner, with different levels of user access based on authority, relevance and necessity.

6.4.2 Authorities

Fishery management entities should be the principal bodies for designing, establishing, managing and implementing a system of gear marking. For the implementation of gear marking in the IOTC area of competence, the Commission should be the primary body for designing and coordinating the implementation of gear marking, while the 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

The design and implementation of gear marking 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 12 entities that are considered stakeholders. Specifically, for IOTC gear marking implementation, stakeholders may include:

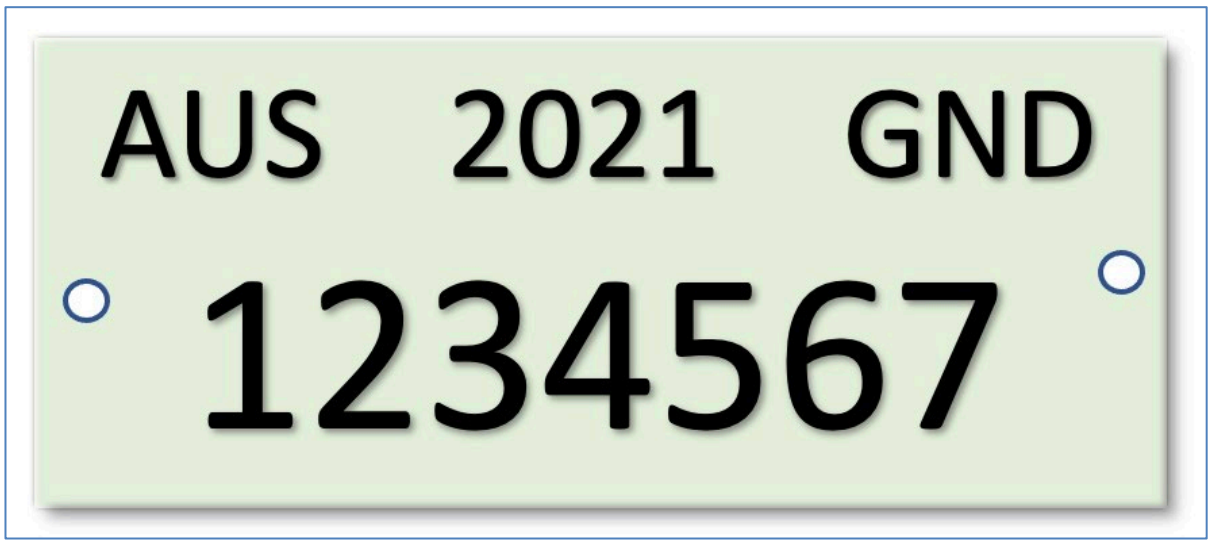
- fishing gear designers and manufacturers
- fishers and fishing company managers and owners
- fisheries organizations
- port operators of CPCs
- fisheries managers and regulators of CPCs
- fisheries control agencies of CPCs
- fisheries and ocean researchers conducting research in the IOTC area
- seafood 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: the country the vessel is flagged to (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 combination), which may be a license/permit number, the vessel's IMO number, or any identifiable number. It may also be useful to include the year 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, though bar codes and QR codes can lose all information if part of the print is damaged or becomes eligible.

Figure 14. Recommended minimum information on a mark



Note: AUS: three-letter ISO country code for Australia; 2021: the year the tag is issued; GND: ISSCFG code for drift gillnet; 1234567: licence number, IMO number, or 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, as shown in Figure 15. Marked floats and buoys can easily be incorporated into gillnets, purse seines, drift longlines and FADs.

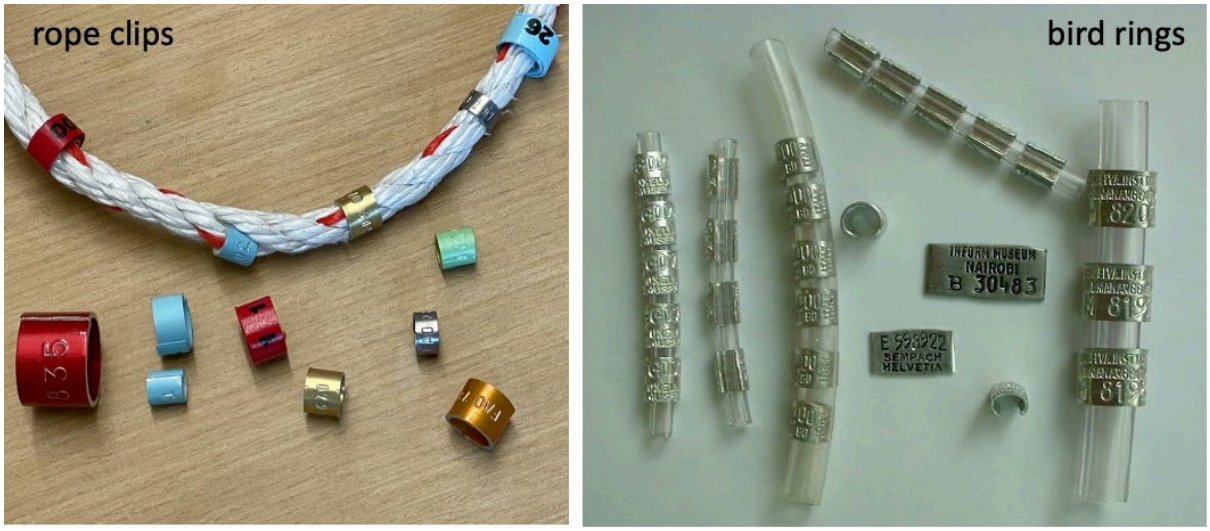
Ropes may be marked with engraved or stamped rope clips or "bird rings", as shown in Figure 16. These rope marks can be used for headropes and footropes of purse seines and gillnets, as well as the mainline of longlines and the buoy ropes of gillnets, longlines and anchored FADs. Additionally, ropes with external, colour-coded tracers or an internal printed tracer may be used to identify a fishery or a region, for example Figure 10.

There is currently no satisfactory means for marking netting in fishing gears. A label made of hard plastic or fabric could 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 the netting itself. The use of plastics as tags and marks should also be restricted, given that these 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, the amount information that can be inscribed on a hook is very limited, and can also be prohibitively expensive. The value of such markings may thus be equally limited.

Figure 15. Examples of marking for floats and buoys

Figure 16. Examples of marking for ropes



Sources: Top left: Authors' own elaboration. Top right: I.O. Mekaniska AB. www.birdring.se/alliten.jpg.

6.6 Recommended gear marking requirements in the IOTC area of competence

Generally speaking, attended gears (purse seines, handlines, pole-and-lines, and trolling lines) are less likely to be lost and present lower risks to safe navigation. The markings on attended gear should focus on:

- the legality of the gear or its components, such as the minimum codend mesh size and an approved bycatch reduction device; and
- capacity control, if multiple gear units are used, or if the size of gear is limited by regulation.

Some large, attended gears that contain a significant amount of plastic components (which have higher risk of plastic pollution when lost) should be marked.

Unattended gears (drift gillnet, drift longlines, aFADs and dFADs) that are left in the sea for a period of time before being hauled and are more likely to be lost. They can also pose risks to navigation if not properly marked. The marking of unattended gears should focus on:

- surface markings to locate the gear or to avoid gear conflicts, and as an aid to navigation, as per the guidelines in Appendix III;
- capacity control, as many of unattended gears contain multiple gear units, which are often subjects to limits;
- ownership and ownership disputes; and
- legality, and illegal fishing.

The ideal (and sometimes imperative) outcome is to ensure that ALDFG can be traced back to its original fishery, location, and sometimes its owner. This helps devise measures to reduce loss in future. In the case of the entanglement of megafauna species in either ALDFG or actively fished gear, tracing the gear type, fishery and location can help devise technical and management measures to reduce such entanglements.

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 whether they comply with management regulations, e.g. minimum mesh size.

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

6.6.2 Drift gillnets

Drift gillnets should be marked with at least one tag or mark for each unit of gillnet – typically 100 m or 50 fathoms (91 m). At least three floats with printed information (as illustrated in Figure 15) should be used on each net: one at 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 the purposes of navigation safety.

6.6.3 Drift longlines

Drift longlines should be marked at regular intervals, such as every 50 m on the mainline, with marks similar to those in Figure 16. Each intermediate float should be marked with the required information shown in Figure 15, which is linked to the owner or license number. Surface markers at each end should bear similar numbers/codes, in addition to surface marker requirements as stipulated for the purposes of 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 the required information on the deck, namely: vessel ID (IMO number), country code and year the mark is issued. Information on the maximum number of lines or poles that are permitted for use on the vessel, if restricted, should also be included on the displayed mark.

6.6.5 Trolling lines

Vessels operating trolling lines should have a similar mark to that outlined for handline and pole-and-line vessels in Section 6.6.4.

6.6.6 Anchored FADs

Anchored FADs should be marked with ownership information, which usually is the government, community or cooperative, as well as the license or permit to deploy the aFAD. 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 with identical information on the buoy. The aFAD should be marked with a surface marker for positioning and to aid 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 FADs should be marked on the structure/raft of the FAD with information about the owner that first deployed the aFAD, the year it was deployed, and license (or IMO) number of the vessel that deployed it. The letters on the marking should be large enough and contrast sufficiently with their background in order to be readable from a vessel at least 50 m away. Reflective material such as that 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 buoy should also be marked with the buoy ID provided by its manufacturer. The mark information on the raft may be different from that in the buoy after the buoy has been switched.

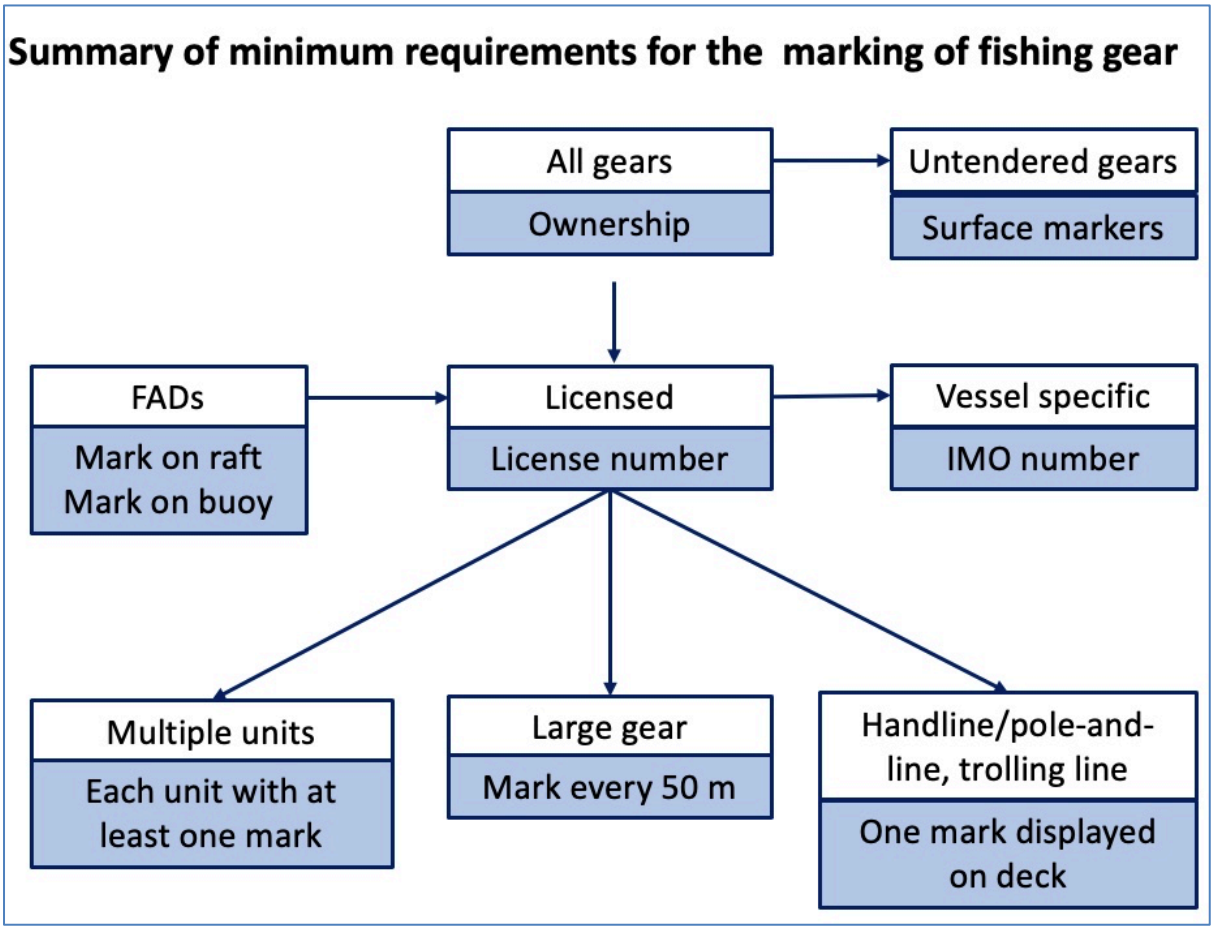
6.6.8 Marking for navigation and safety

The general requirements for the 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 current version of that annex is attached to this report as Appendix III.

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 are provided in Figure 17.

Figure 17. Minimum requirements for the marking of fishing gear



6.7 Retrieval and reporting of lost, abandoned and recovered gear

6.7.1 Fishing gear

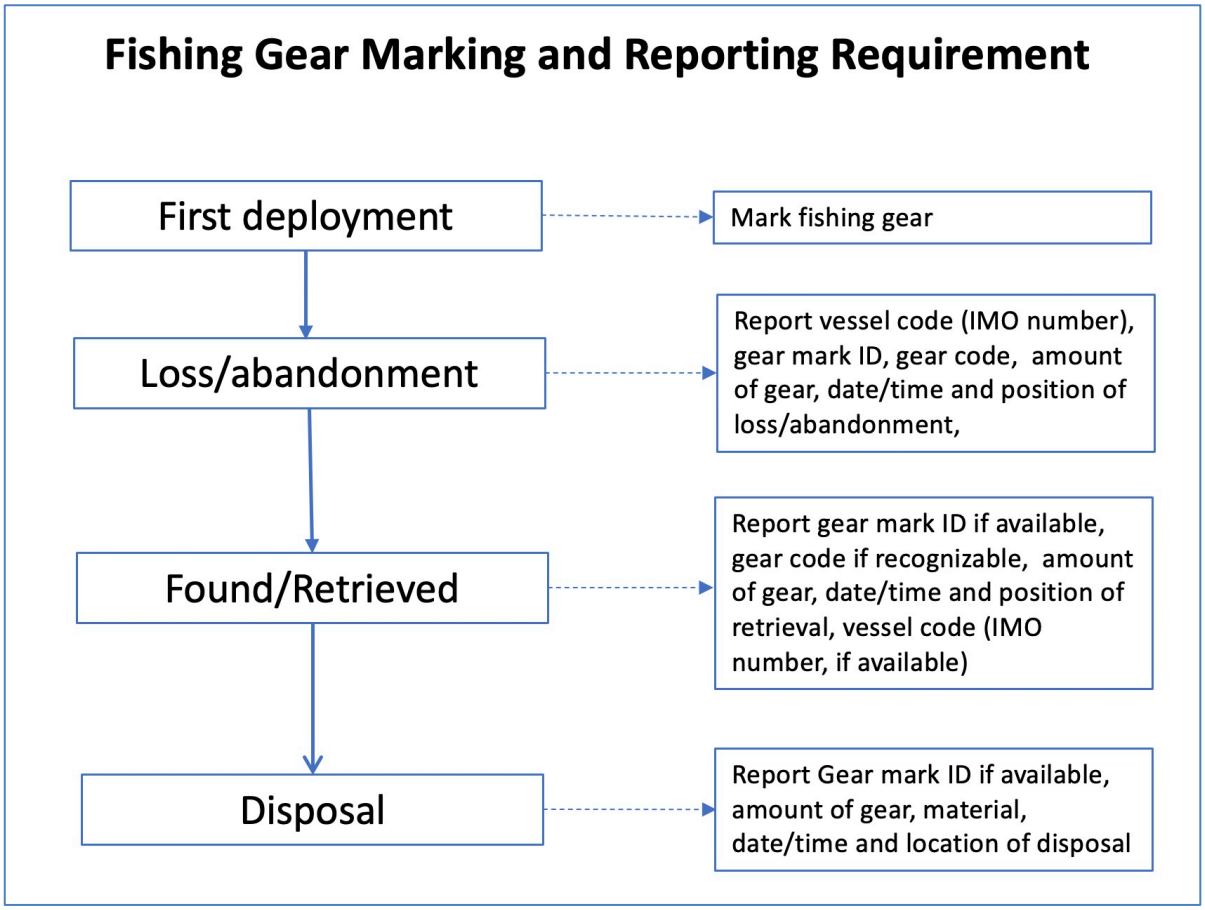
Fishing gear that is lost or abandoned should be recorded and reported to authorities or their designated parties, in order to warn other fishers and enable safe fishing operations, ensure safe navigation for other vessels, and facilitate its future recovery (Figure 18). As a minimum, the following information 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 themselves or by other vessels) should retrieve the derelict gear (if allowed by law) and report it to authorities or their designated parties. As a minimum, the following information should be reported when the gear is retrieved:

- 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 aFAD



When reporting loss and recovery/retrieval, anchored FADs should be treated the same as a fishing gear.

6.7.2 Drifting fish aggregating devices

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

- deploying vessel code (IMO number)
- FAD structure code (mark information on structure)
- instrumented buoy code
- date/time and position of the first deployment
- type of FAD design (regular, non-entangling, biodegradable etc.)
- estimated amount of plastic material.

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

- vessel code (IMO number) that was tracking the FAD
- FAD structure code (mark information on structure)
- manufacturer's code for the deactivated instrumented buoy
- date/time of deactivation
- 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)

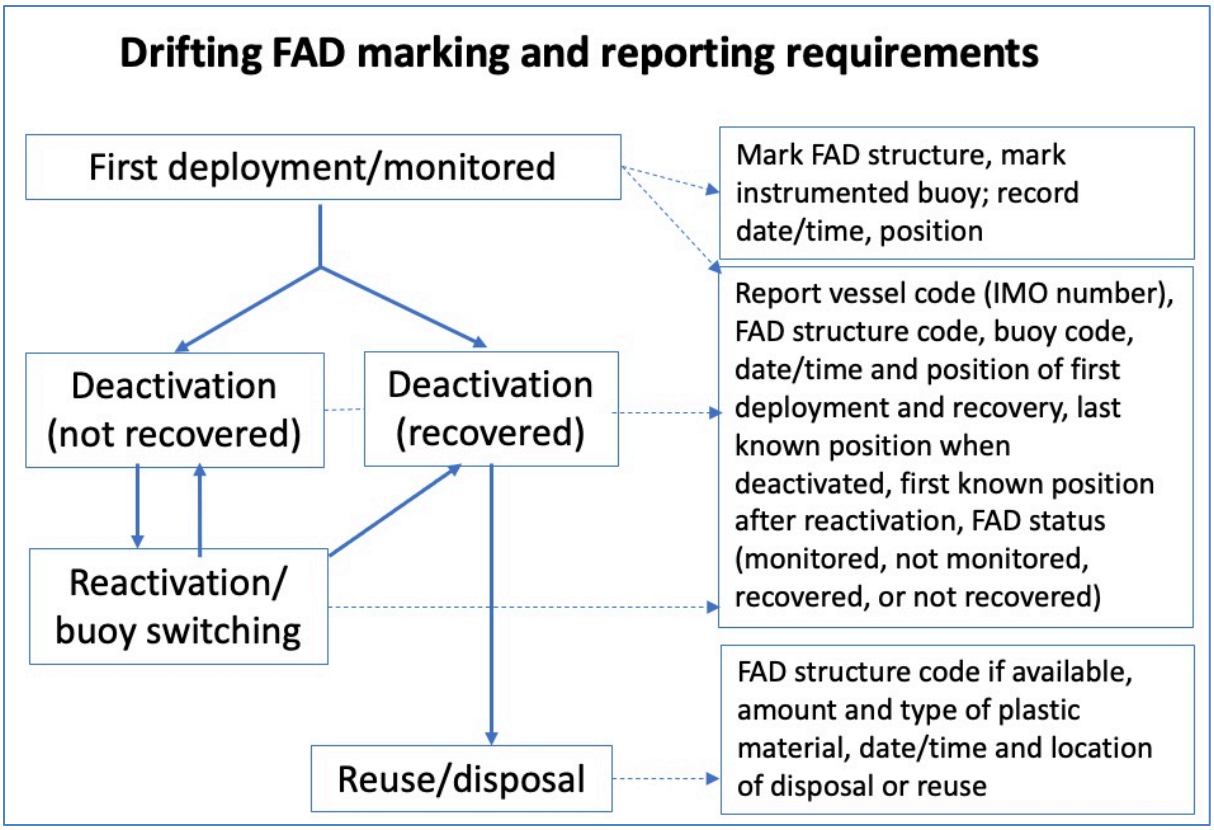
- the code of the instrumented buoy that was attached to the raft (if available)
- the code of the instrumented buoy that is to be attached to the raft
- date/time and position of switching.

Drifting FADs that are recovered and not redeployed should also reported. The following information should be recorded and reported:

- FAD structure code
- instrumented buoy code
- date/time and position of the FAD when it was retrieved
- amount and type of plastic materials retrieved
- vessel ID (IMO code if available) that retrieved the FAD
- final deposition (reused, disposed).

Figure 19 summarizes the reporting requirement for drifting FADs.

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



6.8 End-of-life fishing gear

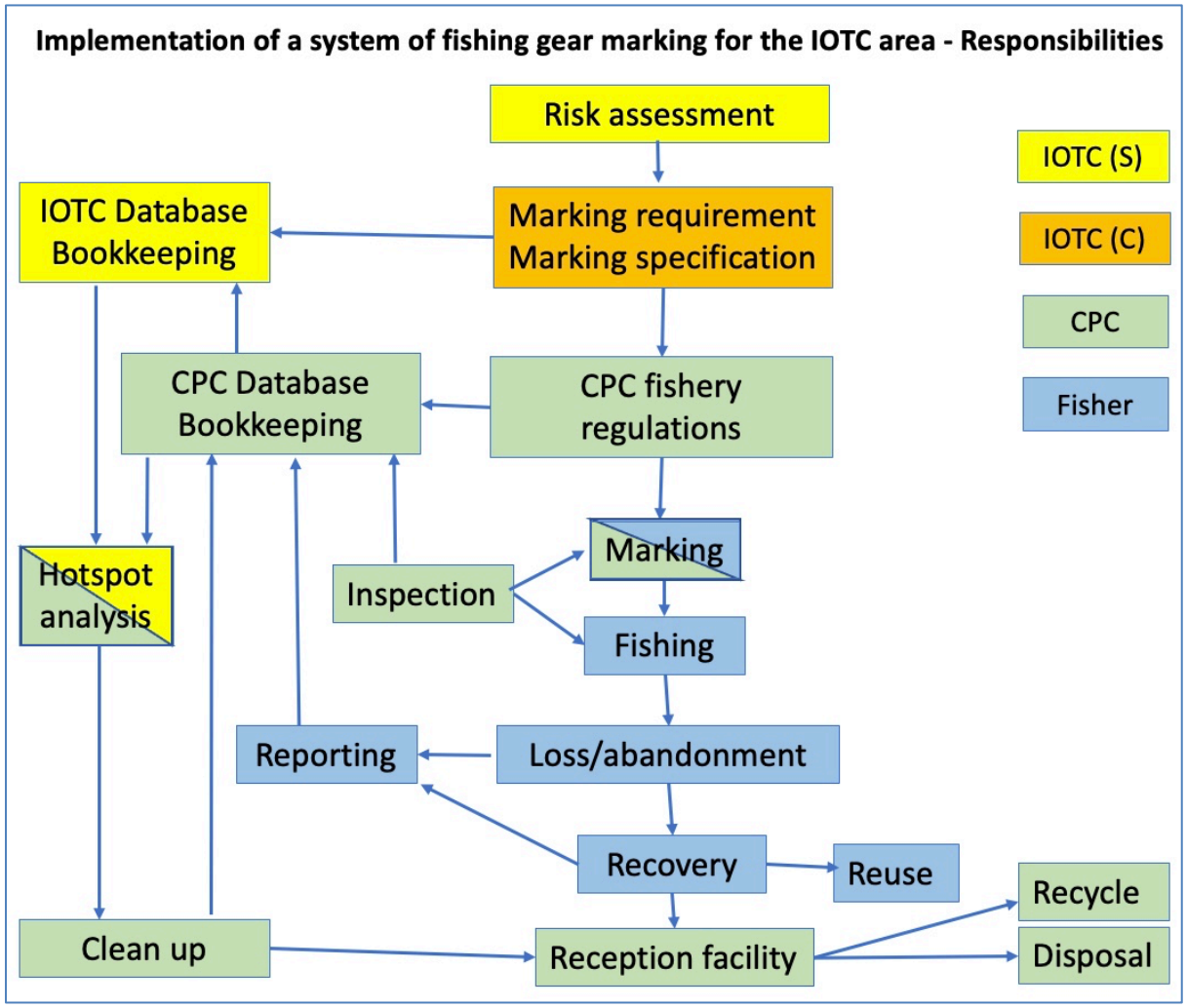
Fishing gears, including FADs, should be reused or disposed of properly when they have fulfilled their intended use or reached the end of their usable life. Fishing ports should provide adequate port reception facilities for the disposal of end-of-life gears and FADs in accordance with MARPOL Annex V.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

- gear mark ID, if available,
- amount and type of plastic materials
- date/time and location of disposal
- vessel code (IMO number) or name of vessel that disposed of the material.

7. ECONOMIC ASSESSMENT FOR THE IMPLEMENTATION OF GEAR MARKING

The costs associated with the implementation of a system of fishing gear marking in the IOTC area of competence may be shared among fishers, CPC authorities and the IOTC Secretariat, as suggested in Figure 20. CPC authorities may include research, management, enforcement, and port authorities, while fishers include individual fishers, cooperatives, and companies/corporations.

Figure 20 Proposed responsibilities for the implementation of a fishing gear marking scheme in the IOTC area of competence



Note: "CPC" refers to CPC research, management, enforcement and port authorities, while "fisher" includes fishers, fishing cooperatives, fishing companies, fisher organizations; "IOTC (S)" refers to the Secretariat; "IOTC (C)" refers to the Commission.

7.1 Costs for fishers

The costs for fishing operators (fishers, vessel owners, fisher organizations or corporations) include purchase and installation (or printing) of marks (or markings) on their fishing gears or their components. Large-scale operations such as purse seines, drift gillnets, and drift longlines, will require more marks or markings, while smaller-scale operations such as handline, pole-and-line and trolling lines require fewer and more simple marks or markings.

7.2 Costs for CPCs

The costs for a CPC can be substantial owing to its responsibilities in making gear marking a requirement in terms of their own fisheries regulations and laws, as well as creating and maintaining gear marking and reporting databases, and enforcing gear marking. The port authorities of CPCs should also establish port reception facilities for accepting end-of-life gears so that they can be either recycled

and/or properly disposed of. It is also recommended that CPC take charge of clean-up operations in their own EEZ following hotspot analysis of ALDFG by the IOTC Secretariat or CPCs.

From a CPC's point of view, the implementation of a system of gear marking may not be limited to gears that target IOTC-managed species; they may include 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 prioritization, complexity and exemptions.

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

7.3 Costs for the IOTC Secretariat

The IOTC Secretariat is responsible for conducting risk assessment for the marking of fishing gear for those gears that catch and land IOTC-managed species. It also defines marking specifications so that they may be incorporated into CPCs' fisheries laws and regulations. The IOTC Secretariat is also responsible for establishing and maintaining a database of gear marking and gear loss/abandonment and retrieval, as reported by CPCs. It should also conduct hotspot analysis of ALDFG, especially for areas beyond national jurisdiction.

As the 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. Furthermore, it may be desirable to include information relating to gear marking in the IOTC Record of Authorized Vessels, in which case a new field may have to be added to this database. Additional costs to the IOTC Secretariat may be minimal, though substantial efforts may be required to encourage and assist CPCs to establish their national systems of recording and reporting, as well as to raise awareness and build capacity.

8. AWARENESS RAISING AND CAPACITY BUILDING FOR THE IMPLEMENTATION OF GEAR MARKING

8.1 Awareness raising and communication

The IOTC Secretariat and CPCs should endeavour to raise awareness (whether jointly or separately) on the detrimental impact of fishing gear that is lost as a result of unmarked or poorly marked fishing gear and FADs, including plastic pollution, ghost fishing, and impacts on protected species. There are many entities that should be engaged in raising awareness and improving communication to implement a system of fishing gear marking. These include: global organizations such as FAO and IMO; regional organizations such as IOTC, CCSBT, SIOFA and SWIOFC; national governments (CPCs), NGOs, and fishers and fisher organizations. For the implementation of fishing gear marking in the IOTC area of competence, the IOTC Secretariat should play a leading role together with CPCs in awareness raising 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, estimated rate of gear loss, and ghost fishing of ALDFG; this will underline the urgent need to implement fishing gear marking and to reduce ALDFG.
- Design outreach materials outlining the benefit of fishing gear marking and make them available to CPCs and other stakeholders.
- Facilitate the development of best-practice approaches to reduce gear loss and plastic pollution.
- Organize 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.

- Develop standards and harmonized measures to reduce gear loss and 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-rising is accurate, up-to-date and appropriate for the target audiences.
- Adapt outreach, education and awareness materials to scenarios that are locally relevant and in appropriate formats, including websites and social media platforms.
- Ensure that outreach materials are translated to local languages where necessary.
- Identify and ensure the appropriate training needs are met for managers, fishing technologists, gear manufacturers and fishers with respect 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 gear loss;
  - employing tools and means for the effective retrieval of lost gear;
  - properly disposing of end-of-life gear; and
  - reusing and repurposing used gear.
- Collaborate with the IOTC Secretariat, other regional bodies and non-governmental organizations (NGOs) on communicating benefits of gear marking, including reducing plastic pollution in the sea.
- Gather fishers' opinions, suggestions and experiences on effective measures to reduce gear loss and recover lost gear, and make them available to fishers in other regions and other countries, where 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 the reduction of marine plastic pollution in high-level meetings such as the UN General Assembly, the FAO Committee on Fisheries (COFI), 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 managing fishing gear in order to reduce 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; and
- identifying opportunities for cooperative planning to harmonize standards and measures and reduce inconsistencies between management frameworks at the global level.

8.1.4 Non-governmental organizations (NGOs)

Both the IOTC Secretariat and CPCs should recognize that NGOs also have an important role in raising awareness and improving communication related to best practices in fishing, and should collaborate with them to reduce gear loss and plastic pollution in capture fisheries. Effective communication and promotion is one of the strengths of NGOs. The Ocean Conservancy's Global Ghost Gear Initiative (GGGI) is one prominent organization in this area, but many others exist. Specific areas in which NGOs could 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; and
- collating and sharing best practice methods for reducing the 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 the 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.
- Organize specialized workshops on setting up recording, reporting and data management framework for CPCs.
- Provide appropriate funding for programmes designed to implement a system of fishing gear marking, especially for developing states, least developed states, and Small Island Developing States.

8.2.2 CPCs

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

- Organize and sponsor capacity-building workshops for managers, enforcement personnel, gear manufacturers and fishers.
- Collaborate with the IOTC Secretariat, and other regional and international organizations to enhance capacity in the implementation and maintenance of a system of fishing gear marking.
- Encourage management and technical staff to participate in training courses offered by the 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 fishing gear marking and the reduction of plastic pollution in fisheries. Specific examples include:

- providing funding and technical assistance to states in the implementation of fishing gear marking and measures to reduce ALDFG;
- sponsoring technical meetings and training workshops for the implementation of gear marking; and
- collating and sharing best-practice methods to estimate gear loss, identify hotspots, report and retrieve lost gear.

8.2.4 Non-governmental organizations (NGOs)

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

- co-sponsoring capacity-building workshops and training sessions for fishery managers of CPCs; and
- supporting, advocating, lobbying 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

The IOTC should fully recognize the special requirements of developing states, notably the least developed states and Small Island Developing States (SIDS). Such requirements should be understood in terms of these states' capacity to implement gear marking measures consistent with an agreed gear marking scheme for the IOTC area, including the assessment of risk and feasibility.
Small-scale and non-industrial fisheries constitute a large proportion 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 marine pollution in fisheries is to be reduced.
States, international and regional organizations, international financial institutions, and other entities should consider offering financial and technical assistance to developing states, especially least developed states and SIDS, to enhance their 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 development of management, legal and regulatory frameworks and infrastructure for the marking of fishing gear;
- development of effective action plans for the reduction of marine plastic pollution, at national and regional scales;
- data collection and assessment of gear loss and hotspots;
- gear loss recording and reporting;
- development and implementation of low-cost, low-tech measures for gear marking that are consistent with the nature of small-scale, artisanal nature of fisheries;
- development of effective monitoring, control and surveillance (MCS);
- carrying out socioeconomic studies on the effects of gear marking and marine plastic reduction measures;
- technology transfer and training;
- enhanced awareness raising, communication and capacity-building measures; and
- 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. The preamble to the draft resolution is omitted. Surface markings for the location of unattended gears and navigation should follow the guidelines proposed in Annex 4 of the *FAO Technical Guidelines for Responsible Fisheries, 1. Fishing Operations* (FAO, 1996), which are attached as Appendix III of this document.

10. SUMMARY

A system of fishing gear marking should be an integral component of, and serve as an important tool for, fisheries management. Gear marking is an important tool to reduce gear loss and aid recovery, determine ownership, assist fishing effort management and control, facilitate monitoring, control and surveillance, and deter IUU fishing. Fishing gear markings are also an important aid to safe navigation. They can be physical, chemical, electronic, and virtual, and can bear various types of information that is linked to the owner, and its license and/or permit to fish.

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

- gear-specific marking requirements;
- a reporting, recording and data management system;
- a mechanism for the application of data for monitoring control and surveillance;

- a mechanism for mitigating the negative impacts of ALDFG (including retrieval of ALDFG);
- provision of adequate port reception facilities for the disposal of ALDFG and end-of-life fishing gear; and
- measures to reuse and recycle the 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 a fishing authorization or license, as well as a vessel, its owner or operator engaged in fishing; and present minimal environmental risks.

This document provides examples of 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. Five fishing gear types were included in the analysis, accounting for 90 percent of landings of managed species in the IOTC area, together with two types of FADs.

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 its ecological and economic characteristics. The determination of risk levels involves the estimation of the consequence (impact) of the lack of a gear marking scheme in the fishery, an estimation of the likelihood of occurrence of the identified risks, scoring of risks, 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; ghost fishing – fishery resource and ETP species); habitat risk; 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 assessment provide basis for determining 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 have medium risks; while handline, pole-and-line and trolling lines have low overall risks.

While anchored FADs can be considered a type of unattended gear, drifting FADs require special consideration with respect to their marking, reporting and recovery. As such, procedures for the marking, reporting and recovery for dFADs are provided for consideration.

Draft texts for a resolution for implementing a system of fishing gear marking for the IOTC area of competence are provided (Annex I). The general requirement for the 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.

References

Adam, M., Jauhary, A., Azheem, M. & Jaufer, A. 2019. *Use of Anchored FADs in the Maldives – Notes for a Case Study for Assessing ALDFG*. IOTC-2019-WPTT21-58. http://www.iotc.org/sites/default/files/documents/2019/10/IOTC-2019-WPTT21-58.pdf

Baske, A., Gibbon, J., Benn, J. & Nickson, A. 2012. *Estimating the use of drifting Fish Aggregation Devices (FADs) around the globe*. PEW Environment Group. pewtrusts.org/~/media/legacy/uploadedfiles/peg/publications/report/FADReport1212pdf.pdf.

Baumgartner, M., Moore, M., Kraus, S., Knowlton, A. & Werner, T. 2018. *Overcoming development, regulatory and funding challenges for ropeless fishing to reduce whale entanglement in the U.S. and Canada*. ropeless.org/wp-content/uploads/sites/112/2018/03/Ropeless_Workshop_Report.pdf

Ben-Yami, M. 1980. *Tuna fishing with pole and line*. Oxford, Fishing News Books.

CoA. 2018. *Gear marking measures for gillnet fisheries* [刺網漁業漁具標示措施]. Council of Agriculture Notice, Agriculture and Fisheries No. 1091322238A. Taipei, Council of Agriculture. https://www.rootlaw.com.tw/LawArticle.aspx?LawID=A040270061050100-1100114

Canada Department of Fisheries and Oceans. 2020. *Notices to Fish Harvesters. Gear marking requirements for non tended fixed gear fisheries in eastern Canada* (2019-12-20). https://www.qc.dfo-mpo.gc.ca/en/node/787.

Escalle, L., Brouwer, S. & Pilling, G. 2018. *Evaluation of dFAD construction materials in the WCPO*. Western and Central Pacific Fisheries Commission, Science Committee. WCPFC-SC14-2018/EB-IP, 1. https://meetings.wcpfc.int/file/6696/download

FAO. 1996. Fishing Operations. *FAO Technical Guidelines for Responsible Fisheries 1.* Rome, FAO.

FAO. 2019a. *Voluntary Guidelines on the Marking of Fishing Gear. Directives volontaires sur le marquage des engins de pêche. Directrices voluntarias sobre el marcado de las artes de pesca.* Rome/Roma. https://www.fao.org/3/ca3546t/ca3546t.pd

FAO. 2019b. Recommendation WECAFC/17/2019/17 "On the marking of fishing gear". In: *FAO Fisheries and Aquaculture Department.* Rome. fao.org/fi/static-media/MeetingDocuments/WECAFC/WECAFC2019/17/RecWECAFCXVII2019_17.pdf

Fisheries and Oceans Canada (DFO). 2020. *Notice to fish harvesters. Update to the conditions of licences related to the mandatory colour scheme for gear marking in eastern Canada.* dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/doc/colour-notice-avis-couleur-eng.pdf

Global Ghost Gear Initiative (GGGI). 2021. *Best Practice Framework for the Management of Fishing Gear: June 2021 Update*. Prepared by Tim Huntington of Poseidon Aquatic Resource Management Ltd for Global Ghost Gear Initiative.ghostgear.org/s/GGGI-Best-Practice-Framework-for-the-Management-of-Fishing-Gear-C-BPF-2021-Update-FINAL.pdf

Gillett, R. 2016. Pole-and-line tuna fishing in the world: Status and trends. *International Pole and Line Foundation report*. Reading, UK, IPNLF. https://ipnlf.org/wp-content/uploads/2021/02/ipnlf-tech-report6status-and-trends-of-pole-and-line-tuna-fishing-1.pdf

Gilman, E., Bigler, B., Muller, B., Moreno, G., Largacha, E.D., Hall, M., Poisson, F., Toole, J., He, P. & Chiang, W-C. 2018. *Stakeholder views on methods to identify ownership and track the position of drifting fish aggregating devices used by tuna purse seine fisheries with reference to FAO's draft guidelines on the marking of fishing gear.* COFI/2018/SBD.17. Rome, FAO. https://www.fao.org/3/BU653en/bu653en.pdf

Hanich, Q., Davis, R., Holmes, G., Amidjogbe, E. R. & Campbell, B. 2019. Drifting fish aggregating *devices* (FADs): deploying, soaking and setting–when is a fad 'fishing'? *The International Journal of Marine and Coastal Law*, 34(4): 731–754.

He, P. & Suuronen, P. 2018. 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. *Marine Pollution Bulletin*, *129*(1): 253–261.

He, P. & Lansley, J. (forthcoming). *A Framework for Conducting a Risk Assessment for a System on the Marking of Fishing Gear*.

He, P., Chopin, F., Surronen, P., Ferro, R.S.T & Lansley, J. 2021. *Classification and illustrated definition of fishing gears*. FAO Fisheries and Aquaculture Technical Paper, No. T672. Rome, FAO. doi.org/10.4060/cb4966en.

IMO. 1978. *International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL). Annex V. Prevention of Pollution by Garbage from Ships*. London, IMO.

IOTC. 2001. *Resolution 01/02. Relating to control of fishing activities*. Indian Ocean Tuna *Commission*. IOTC Conservation and Management Measures. CMM0102. iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_01-02_en.pdf

IOTC. 2017. *Resolution 17/07. On the prohibition to use large-scale driftnets in the IOTC area*. Indian Ocean Tuna Commission. IOTC Conservation and Management Measures. CMM01707. iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_1707_0.pdf

IOTC. 2019. *Resolution 19/02. Procedures on a Fish Aggregating Devices (FADs) Management Plan*. Indian Ocean Tuna Commission. IOTC Conservation and Management Measures. CMM1902. iotc.org/sites/default/files/documents/compliance/cmm/iotc_cmm_1902.pdf

IOTC. 2022. Catch database, *Indian Ocean Tuna Commission***.** https://iotc.org/oqs. Accessed 1 *February* 2022.

Islas-Cital, A., Atkins, P., Gardner, S. & Tiltman, C. 2013. Performance of an enhanced passive sonar *reflector* SonarBell: A practical technology for underwater positioning. *Underwater Technology,* 31(3): 113–122.

Lewis, A.D. 1990. Tropical south Pacific tuna baitfisheries. In: S.J.M. Blaber & J.W. Copland, eds. *Tuna baitfish in the Indo-Pacific Region - Proceedings of a workshop, Honiara, Solomon Islands, 11-13 December 1989.* pp. 10–21. Cited 31 December 2020. ageconsearch.umn.edu/record/134388/files/PR030.pdf.

Lopez, J., Moreno, G., Sancristobal, I. & Murua, J. 2014. Evolution and current state of the *technology* of echo-sounder buoys used by Spanish tropical tuna purse seiners in the Atlantic, Indian and Pacific Oceans. *Fisheries Research, 155*: 127–137.

NOAA Fisheries. 2015. Atlantic Large Whale Take Reduction Plan Gear Marking. In: *NOAA Fisheries*. Silver Spring, MD, USA. Cited 11 July 2022. greateratlantic.fisheries.noaa.gov/protected/whaletrp/docs/

Northwest Indian Fisheries Commission (NWIFC). 2015. Quinault Indian Nation Crab Fleet *Pioneering* Electronic Monitoring for Catch. In: *Northwest Treaty Tribes*. Olympia, WA, USA. Cited 11 July 2022. nwtreatytribes.org/quinault-indian-nation-crab-fleet-pioneering-electronic-monitoring-for-catch.

Preston, G.L., Chapman, L.B., Mead, P.D., Taumaia, P. & Belew, S.E. 1987. *Trolling techniques for the Pacific Islands. A manual for fishermen*. Noumea, New Caledonia, South Pacific Commission. spc.int/DigitalLibrary/Doc/FAME/Manuals/Preston_87_Trolling.pdf.

Robards, M.D., Silber, G. K., Adams, J. D., Arroyo, J., Lorenzini, D., Schwehr, K. & Amos, J. 2016. Conservation science and policy applications of the marine vessel Automatic Identification System (AIS)—a review. *Bulletin of Marine Science*, 92: 75–103.

Scott, G.P. & Lopez, J. 2014. *The use of FADs in tuna fisheries*. Brussels, European Union. www.europarl.europa.eu/cmsdata/60567/att_20140212ATT79234-2304408018198398157.pdf

Toonen, H. M. & Bush, S. R. 2020. The digital frontiers of fisheries governance: Fish attraction *devices*, drones and satellites. *Journal of Environmental Policy & Planning*, *22*: 125–137.

Torres-Irineo, E., Gaertner, D., Chassot, E. & Dreyfus-León, M. 2014. Changes in fishing power and *fishing* strategies driven by new technologies: The case of tropical tuna purse seiners in the eastern Atlantic Ocean. *Fisheries Research*, 155*:* 10–19.

UN. 1989. *Large-scale pelagic driftnet fishing and its impact on the living marine resources of the world's oceans and seas*. United Nations General Assembly. UNGA Res 44/225. https://digitallibrary.un.org/record/82553/files/A_RES_44_225-EN.pdf.

Wilcox, C., Heathcote, G., Goldberg, J., Gunn, R., Peel, D. & Hardesty, B. D. 2015. Understanding the *sources* and effects of abandoned, lost, and discarded fishing gear on marine turtles in northern Australia. *Conservation Biology*, 29: 198–206.

Annex I

DRAFT RESOLUTION FOR A SYSTEM OF FISHING GEAR MARKING IN THE IOTC AREA OF COMPETENCE

Preamble

(Omitted)

Application

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

Database and data management

3. 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.
4. CPCs should report the loss or abandonment of fishing gear to the Secretariat on an annual basis.
5. 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

6. 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.
7. The minimum information on marks should contain information on 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

8. No fishers shall deliberately abandon fishing gear, except for safety reasons.
9. CPCs shall require vessels flying their flags to make all reasonable efforts to reduce, minimize and eliminate abandoned, lost or otherwise discarded fishing gear (ALDFG) while operating in the area of competence.
10. CPCs shall require vessels flying their flag not to discard fishing gear with plastic materials in accordance with MARPOL Annex V.
11. CPCs shall require vessels flying their flag to report gear loss or abandonment within 24 hours to its competent authority, with 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; and
    f. the circumstances that led to the gear being lost or abandoned (e.g. for safety).

Recovery, retrieval and disposal

12. CPCs shall require vessels of their flag fishing with any gear to have appropriate equipment on board to retrieve ALDFG linked to those vessels.
13. CPCs shall require vessels flying their flag to make every reasonable effort to retrieve the gear they lost or abandoned as soon as possible.
14. 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; and
    g. if possible, photographs of the gear retrieved.
15. CPCs should encourage vessels flying their flag to bring back retrieved ALDFG to port for proper disposal.
16. CPCs should make available disposal facilities in major fishing ports of their jurisdiction for proper disposal of end-of-life gear.
17. 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.
18. The Secretariat shall coordinate efforts to retrieve ALDFG in hotspot areas of the high seas in the IOTC area of competence as identified through gear loss data reported by CPCs, fishers or other entities, when deemed feasible and necessary.
19. The Secretariat shall develop a template for reporting the loss and recovery of ALDFG referred to above.

Fish aggregating devices

20. AFAD (aFADs) should be treated the same as fishing gears for marking, reporting, recovery and disposal, as described in 3 to 19.
21. 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 buoy should also be marked with the buoy ID provided by its manufacturer.
22. When a dFAD is first deployed and activated, vessels should report the following information within 24 hours:
    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.); and
    f. estimated amount of plastic material.
23. When a dFAD is deactivated, vessels should report the following information within 24 hours:
    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; and
e. last known position.

24. When an instrumented buoy is activated, vessels should report the following information within 24 hours:

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; and
e. date/time and position of activation.

25. When a drifting FAD is recovered and no longer to be used, vessels should report the following information within 24 hours:

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; and
f. final deposition (reused, disposed), if disposed, location of disposal.

Appendix I

TERMS OF REFERENCE

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

1) Assess the financial costs for operationalising 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 operationalising the VGMFG.
2) Identify, through documented risk assessments, fishing gears and FADs[1], 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.
3) 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.
4) 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.
5) 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.
6) 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).
7) 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.
8) Consider the relationship between marking for licensing/authorisation and marking for visibility, location, options for avoidance for purposes of navigation and identification of ownership.
9) 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-industrial fisheries in terms of applying gear marking measures to fishing gears and FADs.
10) 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.

[1] FADs used for aggregating non-IOTC species shall be exempted.

11) Consider and determine capacity-building requirements of CPCs for the attachment of markers to fishing gears and FADs.

12) 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 standardise any requirements developed.

13) 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

Gear categories (First tier)	Subcategory (Second tier)	Standard abbreviations	ISSCFG code
	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" from *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) 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 night-time 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 night-time 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 night-time,
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.

A system for the marking of fishing gear should be an integral part of fisheries management. The marking of fishing gear is an important tool to reduce gear loss and aid recovery, helps in determining ownership, assists in the management and control of fishing effort, facilitates monitoring, control and surveillance, and deters IUU fishing. The marking of fishing gear also contributes to safe navigation.

This document evaluates the major fishing gears that harvest species under the management of the Indian Ocean Tuna Commission (IOTC) through a risk assessment to determine the level of complexity when implementing a system of fishing gear marking. The analysis includes five types of fishing gear, which account for 90 percent of fish landings in the IOTC area of competence, as well as two types of fish aggregating device (FAD). Purse seines, drift gillnets, and drifting FADs are deemed to have "high" or "very high" overall risks, while anchored FADs have "medium" risks, and handline, pole-and-line and trolling lines have "very low" risks.

Based on the evaluation, the document proposed a framework for marking these fishing gears and FADs, based on the principles outlined in the FAO Voluntary Guidelines on the Marking of Fishing Gear. It also provides an indicative economic assessment for implementing a system of fishing gear marking in the IOTC area. As requested by IOTC, and a draft resolution for implementing a system of fishing gear marking for the IOTC area of competence has been prepared.

Voluntary Guidelines on the Marking of Fishing Gear can be downloaded through the above QR-code

ISBN 978-92-5-137180-0 ISSN 2070-6065

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CC2889EN/1/11.22