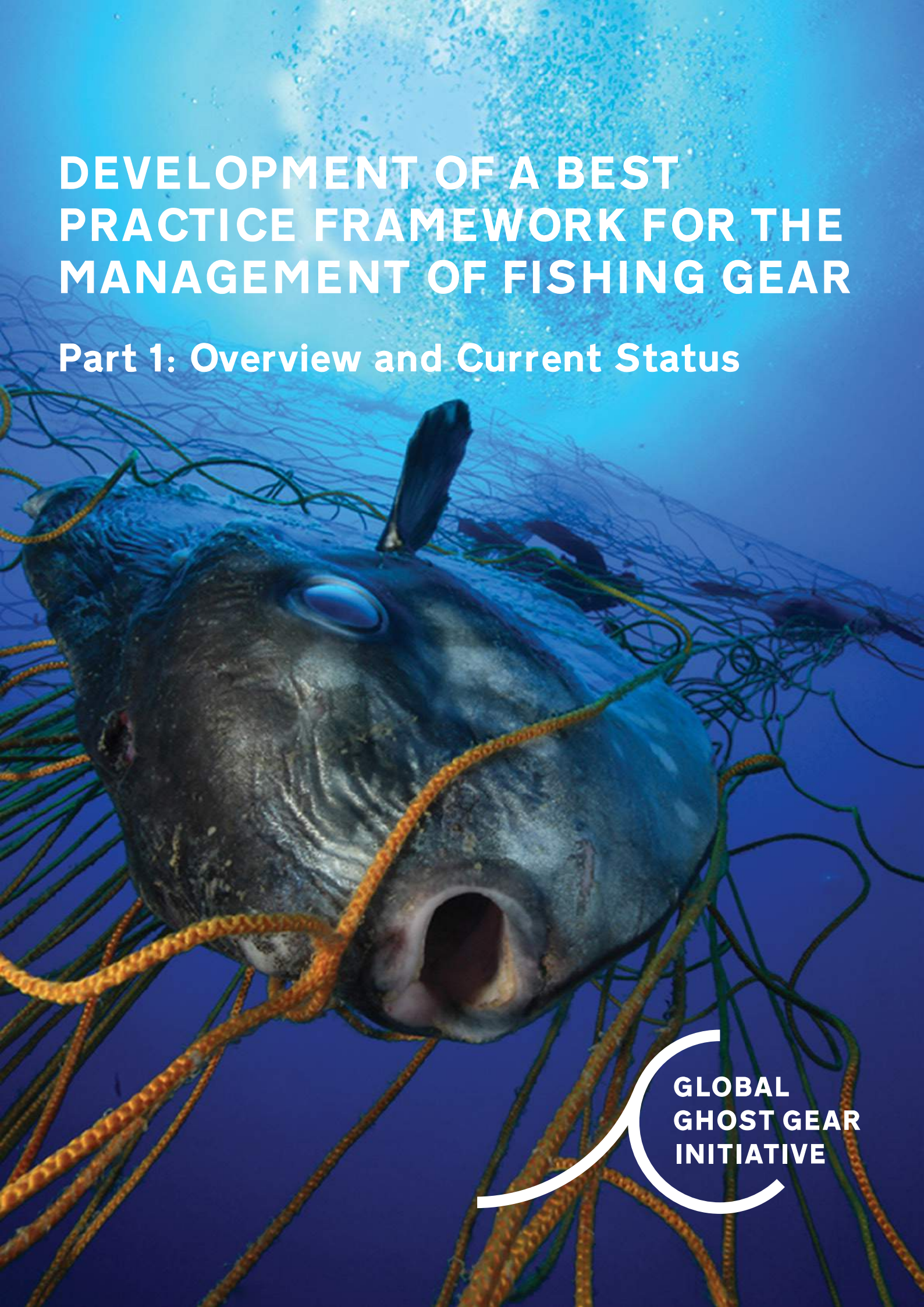
DEVELOPMENT OF A BEST PRACTICE FRAMEWORK FOR THE MANAGEMENT OF FISHING GEAR

Part 1: Overview and Current Status



GLOBAL GHOST GEAR INITIATIVE

Author: Tim Huntington of Poseidon Aquatic Resource Management Ltd

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TABLE OF CONTENTS

TABLES, FIGURES AND BOXES

Figures

Tables

Boxes

ABBREVIATIONS USED

ALDFG	Abandoned, Lost or otherwise Discarded Fishing Gear
BIM	Bord Iascaigh Mhara or BIM (English: Irish Sea Fisheries Board)
EC	European Commission
EU	European Union
FAD	Fish Aggregating Device
FANTARED	Ghost net (in Spanish)
FAO	Food and Agriculture Organization of the United Nations
GGGI	Global Ghost Gear Initiative
GPS	Global Positioning System
GRT	Gross registered tonnage
GT	Gross tonnage
IATTC	Inter-American Tropical Tuna Commission
ISSF	International Seafood Sustainability Foundation
IUU	Illegal, Unreported and Unregulated (fishing)
MSC	Marine Stewardship Council
MSP	Marine Spatial Planning
NOAA	National Oceanic and Atmospheric Administration
PNA	Parties to the Nauru Agreement
RFID	Radio Frequency Identification
ROV	Remote Operated Vehicle
PHA	Polyhydroxyalkanoate
VIMS	Virginia Institute of Marine Science

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Sijmon de Waal / Marine Photobank

1. BACKGROUND AND PURPOSE OF STUDY

1.1 BACKGROUND

The Global Ghost Gear Initiative (GGGI) is a cross-sectoral alliance committed to driving solutions to the problem of lost and abandoned fishing gear (ghost gear) worldwide. The GGGI aims to improve the health of marine ecosystems, protect marine animals, and safeguard human health and livelihoods.

Founded on the best available science and technology, the GGGI is the first initiative dedicated to tackling the problem of ghost fishing gear on a global scale. The GGGI's strength lies in the diversity of its participants that include members of the fishing industry, the private sector, academia, governments, intergovernmental and non-governmental organisations. Every participant has a critical role to play to mitigate ghost gear locally, regionally and globally.

The GGGI was founded by World Animal Protection which will host the Secretariat until 2018. Further information on the GGGI is available at www.ghostgear.org

Three GGGI working groups have been established. This report is under the remit of the 'Define best practices and inform policies working group'. This working group aims to:

- develop a suite of best practices to guide stakeholders in their development of policies and protocols to address ghost gear
- encourage changes in industry practice and influence supply chains and/consumers
- catalyse actions, supported by government policy, to mitigate ghost gear.

Throughout 2016 the 'Define best practices and inform policies working group' focused on developing best practice guidance on managing fishing gear at different stages of its life cycle. The guidance in this document will be used to influence government and industry policy and practice to ensure enhanced mitigation of the ghost gear problem globally.

1.2 OBJECTIVE

The purpose of the study was to develop a framework for best practice in the use of fishing gear. The study is global covering a wide range of fishing gears and users. The framework focuses on the most commonly-used gear types, both in industrial and artisanal fisheries. These types are clearly defined and their global contribution indicated in the study (see below).

The completed framework is expected to be adopted by the 'Define best practices and inform policies working group' and further developed and targeted.

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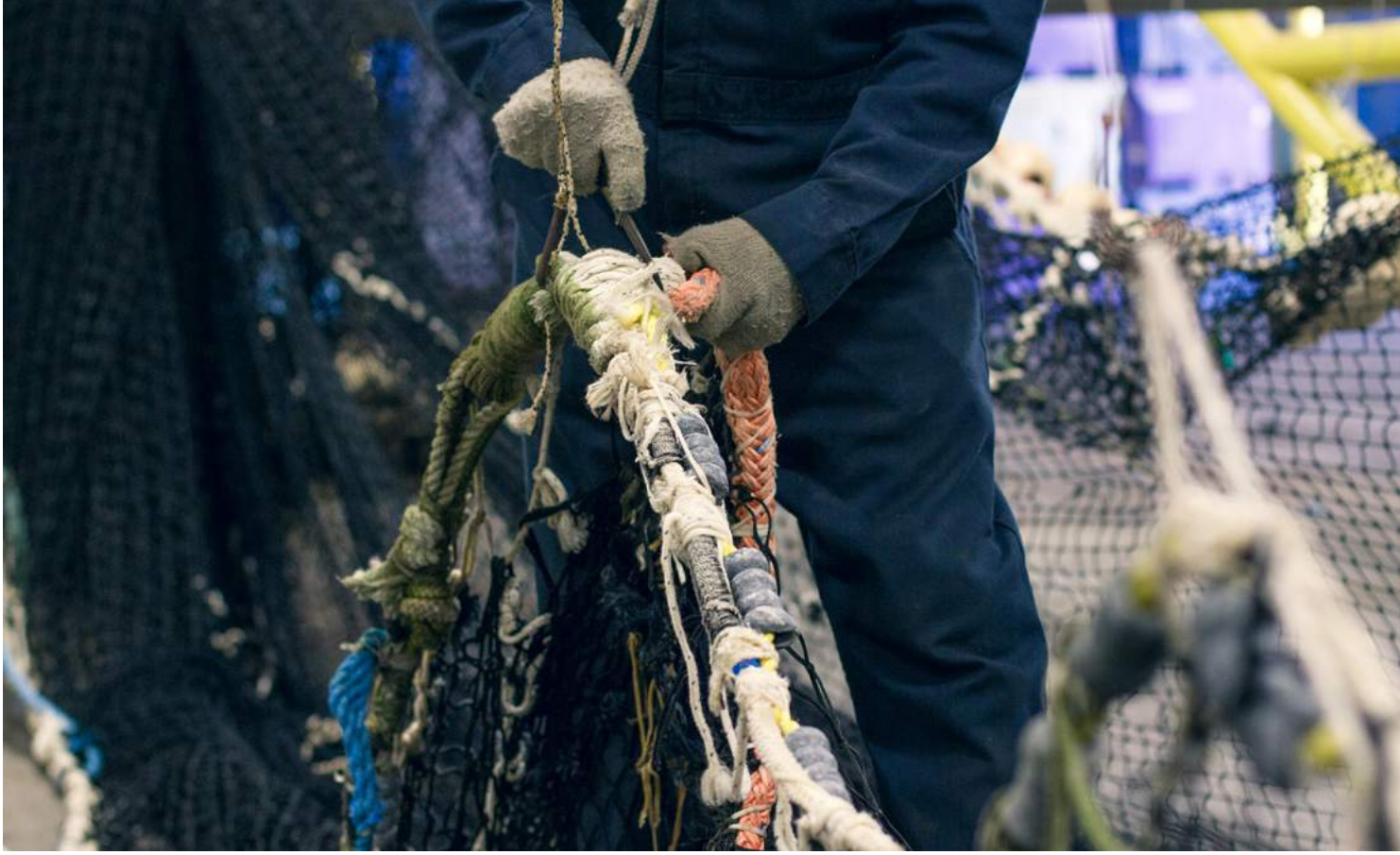


World Animal Protection / Rob Trendiak

1.3 METHODOLOGY

1.3.1 This work was implemented over two phases as outlined below.

1.3.2 Part 1: Overview and current status

Background assessment and scoping

This first activity involved a background assessment of fishing gear's global use to provide:

i. a working quantification of the main fishing gears used (using Bell et al, unpublished; Watson et al, 2004 and other sources)

ii. a brief summary of the main characteristics of these gears in terms of their user type, geographical usage and contribution to Abandoned, Lost and otherwise Discarded Fishing Gear (ALDFG) (from Macfadyen et al, 2009). This first part of the work was submitted to World Animal Protection on 16 May 2016 as a scoping brief for their review and comment

Identifying management options and mechanisms for responsible fishing gear use

This second activity examined two main elements. First, it looked at the current management options for fishing gear. These included: the use of tags and other identification of fishing gear; gear storage to and from fishing grounds, and gear retrieval in case of loss or abandonment.

It then examined how these are implemented – for example through legislation, codes of conduct or inclusion in third-party and other certification schemes. This part of the study was the basis for the framework (see next) and has been issued as this standalone document – 'Part 1: Overview and current status'.

1.3.3 Part 2: Developing a best practice framework for the management of fishing gear

This is the main output of the study. With its scope defined in 'Part 1: Overview and current status', 'Part 2: Best practice framework for the management of fishing gear' is global and covers a wide range of fishing gears and users. It focuses on the most commonly-used gear types, both in industrial and artisanal fisheries, and it targets a broad spectrum of stakeholders. These include gear manufacturers, fishers, port authorities, fisheries management authorities, seafood companies and other interested parties.

This framework will be adopted by the GGGI and further developed and targeted.

Valerie Craig / Marine Photobank

2. DEFINING THE SCOPE OF THE FRAMEWORK

2.1 FISHING GEARS AND THEIR GLOBAL USE

This quantifies fishing gear use around the world to provide a rationale for a proportionate approach over the rest of the study.

2.1.1 Review of fishing gear usage around the world

Introduction

Catching fish and other aquatic organisms from the wild has been practised for millennia. Despite the relatively recent rise of aquaculture it is still an important source of sustenance, income and economic reward for millions of people.

The most recent version of The Food and Agriculture Organization's (FAO) 'World review of fisheries and aquaculture' (FAO, 2014) states the total global capture of 93.7 million tonnes in 2011 was the second-highest ever. This was slightly below the 93.8 million tonnes for 1996.

It also estimates that 39 million people were working in the primary sector of capture fisheries in 2012, of which 37% were working full time. Around 78% of fishers were in Asia. The remainder were in Africa (14%); Latin America and the Caribbean (5%); Europe (1.2%); North America (0.8%) and Oceana (0.3%).

Commercial fishing has risen steeply since the 1970s, though the trend appears to be reaching a plateau. This has occurred due to a considerable reduction in commercial fishing in Europe over the past decade. Recent reductions have also occurred in North America and Africa with a slowdown in other regions too.

The fishing capacity of developed nations had decreased by 37% in 2012 from peak levels in 1991. Conversely, the fishing capacity of developing nations dramatically increased over the last 30 years and drives the global trend (Ye et al, unpublished).

There are good estimates of wild catches by species, geographic areas and fisher type available via FAO's FishStat J online database, OECD, Eurostat, Sea Around Us and others. However, mainly due to a lack of national fisheries data reporting, there is no recurrent quantification of catches by fishing gear. Consequently, there are only a few global estimates of this. These are mainly by Ye at al (unpublished), Watson et al (2004, 2006a and 2006b) and by FAO in their most recent estimation of global discards by fishery (Kelleher, 2004).

With no more recent information than this, we will use these as the basis for our estimates as originally proposed. Although there have been some gear use changes over the last decade, they are not relatively significant for this analysis in providing a proportionate consideration of their use.

Mapping results

Watson et al (2004) attempted to map global fish catches by using the FAO-derived 'Seas around us' catch database and associating seven different gears to assess their relative importance. Their research was based primarily on commercial gear. Artisanal gear types were recorded when the artisanal fishery provided the bulk of the reference information for a species in a given family. The results are shown in Figures 1 and 2 overleaf.

Figure 1 shows the trend in global gear usage in terms of contribution to global catch between 1950 – 2000. This indicates that seine nets (eg purse seines and other forms of ring nets) account for around 35% of global catch in 2000. Mid-water and bottom trawls both account for around 15% each. Gillnets and hook and line both account for about 10% each; with dredges, traps and other unidentified 'other gear' representing the remainder. Trends show that the proportion of catch by each gear has remained surprisingly consistent. The exception is a period over the 1960s when seine net use expanded to nearly 45% (mainly at the expense of mid-water trawls).

In the 1950s, the catches by major countries (See figure 2) were dominated by those taken by gillnet, seine and bottom trawl. By the 1970s, the catch of these major fishing countries by gillnet gear decreased, while their use of mid-water trawl gear increased. This trend, however, was not well reflected in the balance of catch taken by 'other' countries whose relative gear use remained constant.

By the 1990s, the importance of mid-water trawl had decreased for most countries, with the exception of the nations comprising the former Soviet Union. Here the relative catch associated with mid-water trawl actually increased. Seine gear (especially purse seine), continued to be important in the 1990s (see Figure 2).

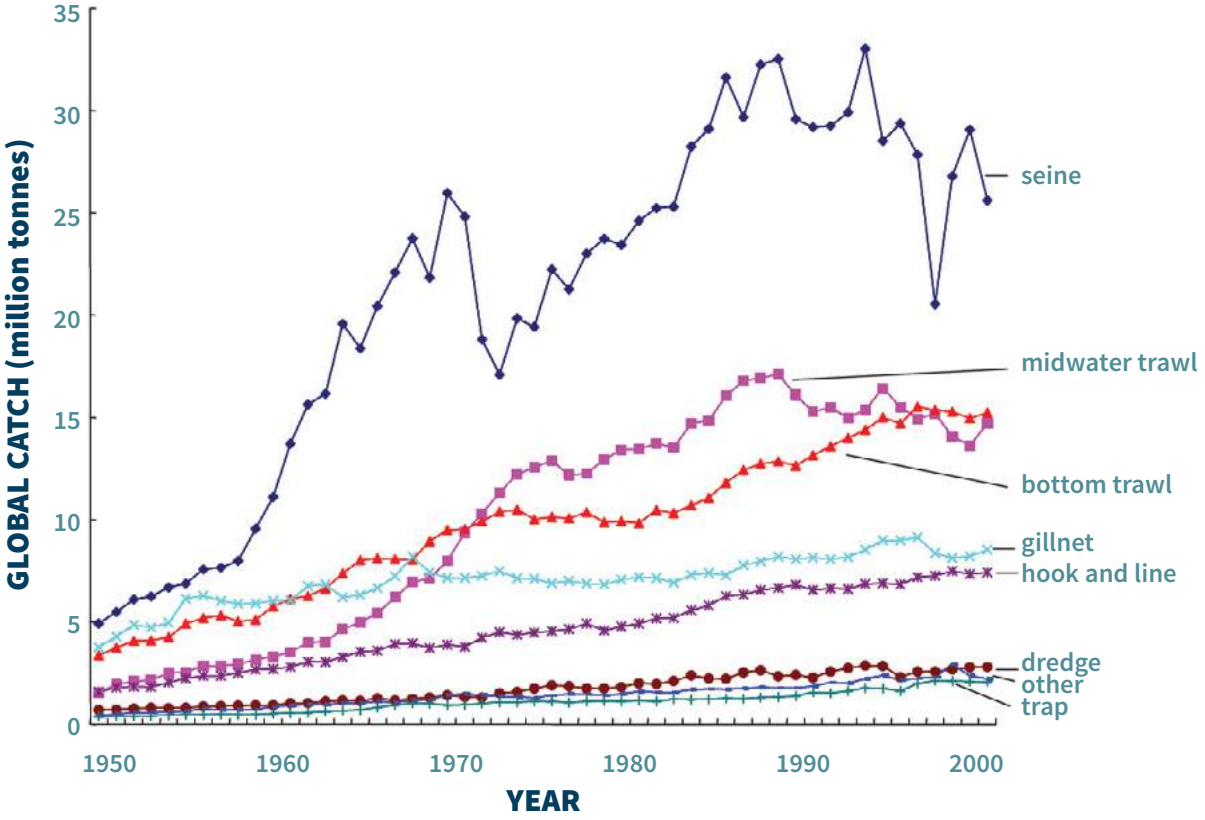


Figure 1: Catch by general fishing gears over the period 1950 – 2000
Source: Watson et al, 2004

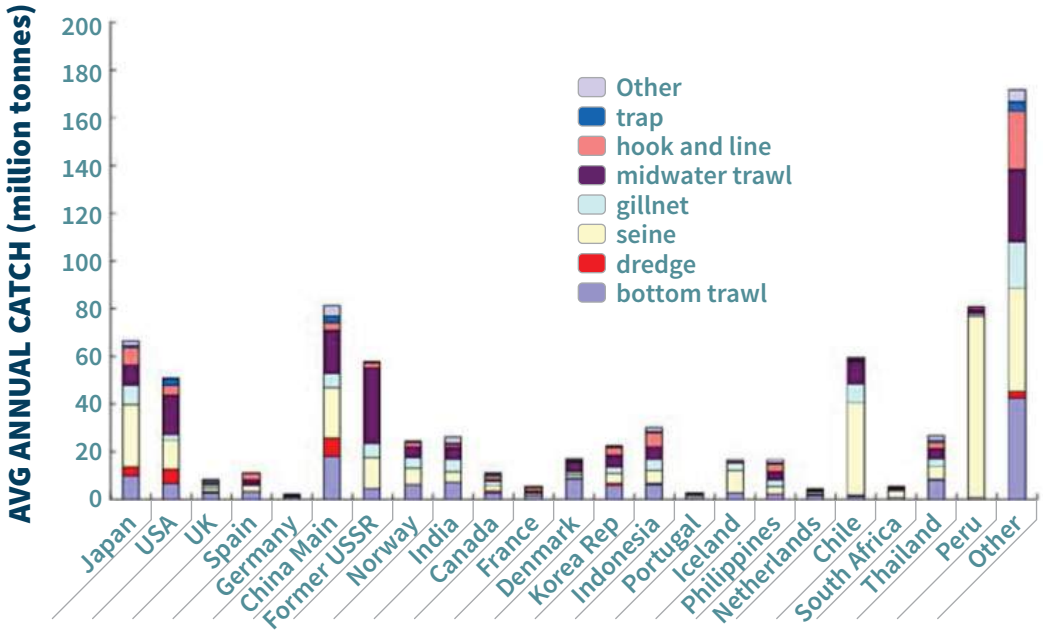


Figure 2: Catch by major fishing countries broken down by general fishing gears for the 1990s
Source: Watson et al, 2004

Ye et al (unpublished), rather than looking at catch volume by fishing gear, instead looked at estimated fishing effort by fishing gear over the period from 1950 to 2012 (see figure below). In contrast to the volume-associated analysis they found that the overwhelming majority of fishing effort is carried out by trawling. Moderate levels of hook and line fishing and only small amounts are reported from other gears.

However, they caveat their results, saying that the data provided to the FAO by many countries included only trawling effort so this result may not be entirely accurate. Furthermore, Ye et al's analysis was based the power characteristics and fishing practices (within each year, length class and fishing gear) of the EU fishing fleet. The assumption was that these were representative of the global fishing fleet.

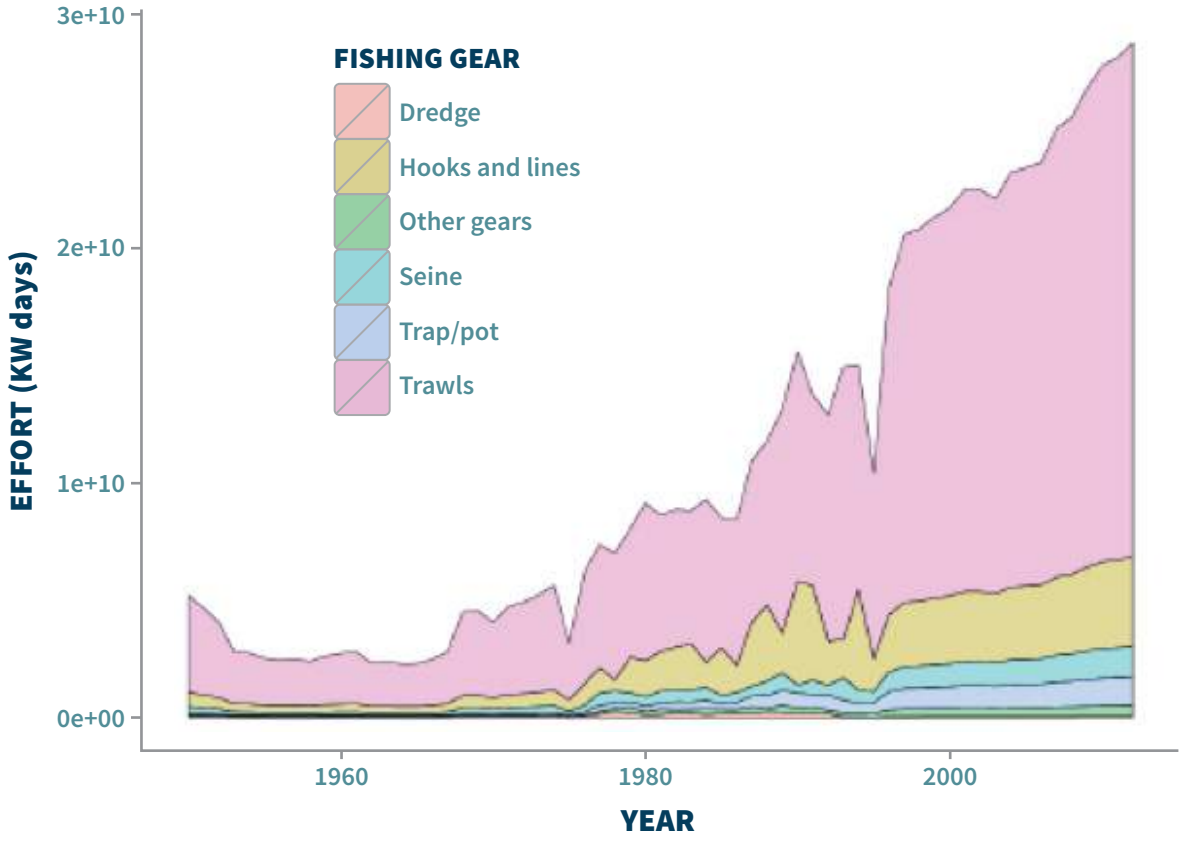


Figure 3: Fishing effort (kW days) broken down by general fishing gears 1950 – 2012
Source: Ye et al, 2012

An analysis of the current EU fleet register confirms that, in terms of power, bottom otter trawls represent the majority of fishing effort at around 27% (see Table 1 overleaf). Other key EU gears are: set gillnets (27% of vessel power); purse seines and pots and traps (10% each); followed by mid-water trawls and set longlines (7% each), and trammel nets (5%). When mapped against the gear categories used by Ye et al (2012), trawls account for 41%; other gears 22%; hooks and lines (including longlines) 12%; seines 10%; pots and traps 10% and dredges 5%.

Given that Ye et al (2012) also used the EU fleet register it is not surprising that the overall figures are similar. Any differences are most likely to be related to the cross-mapping of the detailed gear types to Ye et al's more general gear categories (and their surprising omission of gillnets as a category)

Table 1: Gear type, category and total power of the EU fishing fleet (May 2016)

GEAR	GEAR CATEGORY	GEAR CODE	POWER (kWs)	%
Bottom otter trawl	Trawls	OTB	1,710,930	27%
Set gillnets	Other gears	GNS	985,332	15%
Purse seines	Seine	PS	645,573	10%
Pots and traps	Trap / pot	FPO	609,704	10%
Mid-water otter trawls	Trawls	OTM	451,721	7%
Set longlines	Hooks and lines	LLS	448,672	7%
Trammel nets	Other gears	GTR	334,541	5%
Beam trawls	Trawls	TBB	271,935	4%
Boat dredges	Dredge	DRB	255,259	4%
Drifting longlines	Hooks and lines	LLD	132,878	2%
Hand lines (by hand)	Hooks and lines	LHP	130,634	2%
Mechanised dredges	Dredge	HMD	56,071	1%
Otter twin trawls	Trawls	OTT	52,192	1%
Trolling lines	Hooks and lines	LTL	51,190	1%
Mid-water pair trawls	Trawls	PTM	43,133	1%
Drift nets	Other gears	GND	41,158	1%
Bottom pair trawls	Trawls	PTB	35,383	1%
Beach seines	Other gears	SB	27,771	0%
Gill / trammel nets	Other gears	GTN	21,682	0%
Danish seines	Trawls	SDN	17,074	0%
Scottish seines	Trawls	SSC	15,801	0%
Hand dredges (boat)	Dredge	DRH	8,639	0%
No gear	Other gears	NO	8,187	0%
Hand lines (mechanised)	Hooks and lines	LHM	7,298	0%
Encircling gillnets	Other gears	GNC	5,670	0%
Lampara nets	Seine	LA	4,563	0%
Lift nets (boat)	Other gears	LNB	4,315	0%
Pair seines	Seine	SPR	3,106	0%
Harpoons	Other gears	HAR	1,520	0%
Other	Other gears	Y	10	0%

Source: Extracted from the EU 'Community fishing fleet register' (http://ec.europa.eu/fisheries/fleet/index.cfm) on 18 May 2016

Synthesis

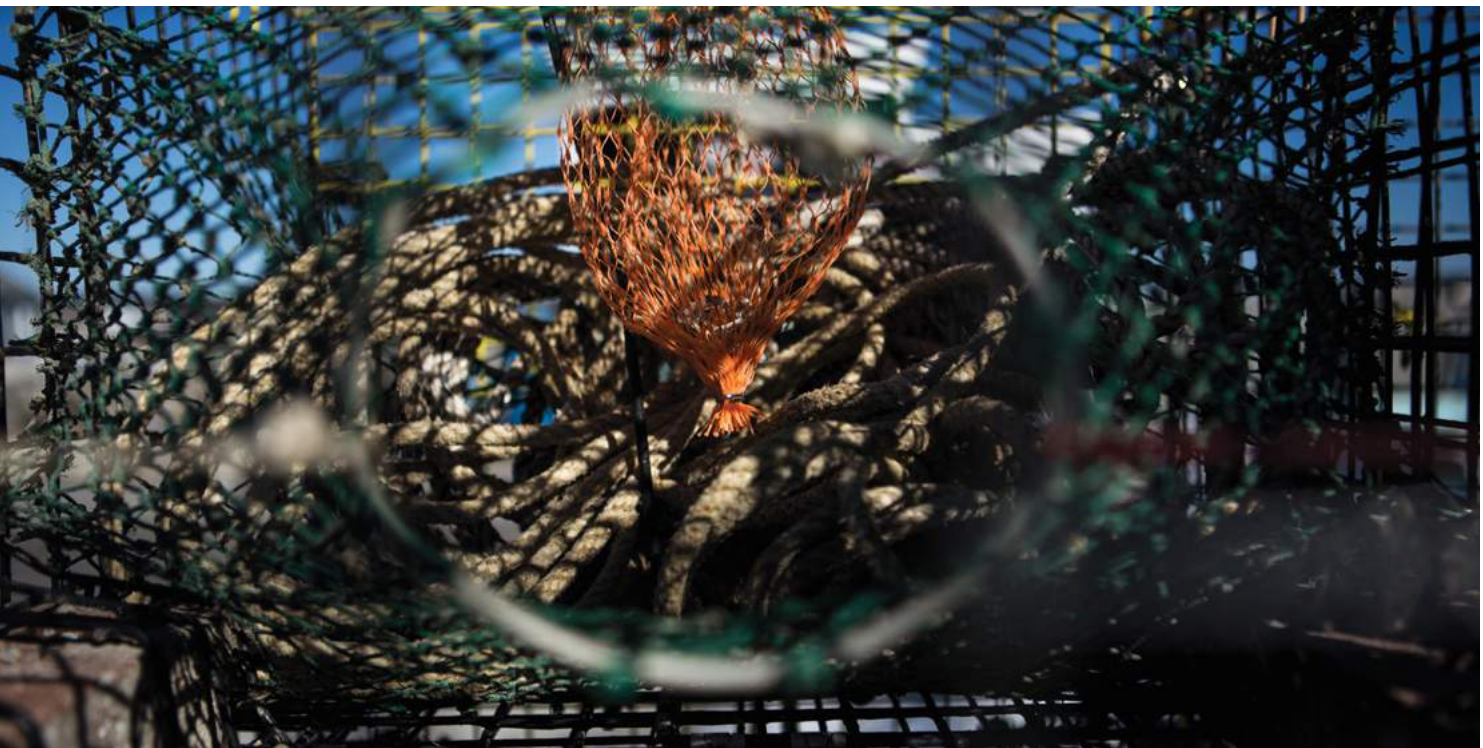
The global volume-associated analysis by Watson et al (2004) and Ye et al's effort-associated analysis mainly differ regarding the relative position of trawl and seine fishing gears. This is understandable; mobile gears such as bottom trawls require considerably more vessel power per tonne of fish caught than essentially passive methods such as purse seines or gillnets.

Considering both sets of analyses the following gear classes are considered for this work.

GEAR CLASS	EXAMPLES OF GEAR TYPES
Bottom trawls	Single, pair, twin and beam trawls for finfish and shrimp. Also include Danish, Scottish and other fly seines.
Mid-water trawls	Single or pair mid-water trawls, mainly targeting small pelagic species.
Seine nets	Includes purse seines, ring nets and beach seines.
Gillnets	Includes fixed, drifting and other tangling nets, including trammel nets.
Hooks and lines	Includes longlines, hand lines, pole and line and jigging, both mechanised and by hand.
Traps and pots	All traps, pots and other static fish traps.
Fish Aggregating Devices (FADs)	Anchored and drifting FADs.

It should be noted that we have also included Fish Aggregating Devices (FADs) in this analysis. FADs are used to aggregate fishes and increase catch per unit effort. They are always used with another gear type (eg seines or hooks and lines) and are often purposely abandoned at sea. Excluded are dredges and other large mechanical devices; these are not easily lost, are readily recovered and not considered to be involved in ghost fishing.

World Animal Protection / Charlie Mahoney



2.1.2 Summary of the main fishing gears and their characteristics

This section will provide a brief description of the main gear types covered in this study. It will also focus on their characteristics and examine their contribution to ALDFG and ghost fishing[1]. On the latter we have described both the susceptibility of the gear to being lost and the impact of it being abandoned, lost and discarded. We have then assigned a subjective risk score on the following two attributes.

1. **Likelihood:** considers the likelihood of gear type being lost, discarded or abandoned in the first place.

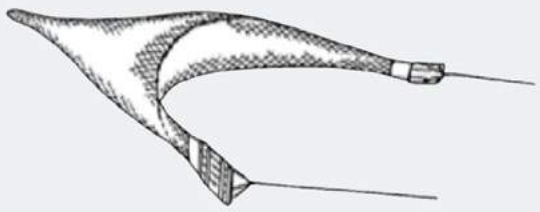
2. **Impact:** considers the impact of abandoned, lost discarded gear on the environment. This includes ghost fishing, the risk of entanglement with marine mammals, reptiles and birds as well as possible habitat damage.

The risk element is scored out of five, and is colour-coded as follows.

Very low | Low | Medium | High | Very high

1. Information sources for this section include FAO (http://www.fao.org/fishery/technology/capture/en) for the illustrations and Macfadyen et al (2009) for the summary text on ALDFG.

BOTTOM TRAWLS



DESCRIPTION

A wide, tapering net ending with a cod end where trapped fish collect. Towed by a powered vessel using trawl warps, they often use doors or a heavy beam to maintain the net opening. Mainly used to capture demersal finfish or shrimp.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Widely used by commercial whitefish, shrimp and nephrops fisheries in temperate waters. More associated with shrimp fisheries in tropical waters. Due to the need for powerful vessels, is generally used by commercial fisheries operating on the continental shelf.

GEOGRAPHIC DISTRIBUTION OF USE

Mainly the eastern seaboard of North America, shallow coastal waters of north-east Europe, the north-east and south-east coasts of South America, West Africa and most coastal waters of South East Asia.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

Apart from the Norwegian, FANTARED and some Irish and United Kingdom surveys, there is little other reference in European literature to the loss levels of trawl nets and other mobile gear. Anecdotal information suggests that considerable effort is put into the immediate recovery of lost gears. This is due to their high value and improvements in navigation and gear marking technologies.

However, it is apparent that some trawl nets are lost, possibly even in considerable volume –three-quarters of fishing debris in Cape Arnhem in Australia consists of trawl nets. It is also likely that trawl warps are sometimes discarded at sea.

Impact of ALDFG

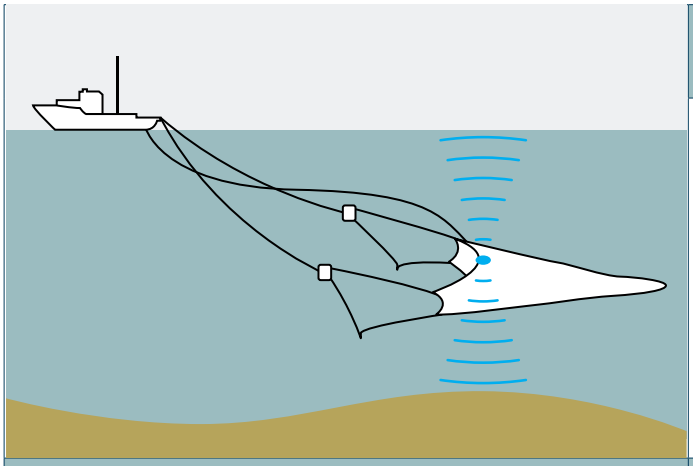
The larger diameter synthetic multifilament twine common to trawl nets is the key factor that reduces ghost fishing mortality in lost trawl gear. It tends to weigh the net down, speeding the substrate aggregation process. However, this can increase the likelihood of entanglement with marine mammals, reptiles or birds.

In dynamic areas, such as tidal streams or even oceanic current gyres, ALD trawl nets may not accrete to the sea bed and may cause more damage as they move around. In this case they may represent a potential navigation hazard or cause physical abrasion to the benthic substrate.

LIKELIHOOD (OF 5):	2

IMPACT (OF 5):	3

MID-WATER TRAWLS



DESCRIPTION

A wide, tapering net ending with a cod end where trapped fish collect. Towed by a powered vessel using trawl warps, they often use doors or a heavy beam to maintain the net opening. Mainly used to capture demersal finfish or shrimp.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Mid-water trawls are usually used to target large schools of small pelagic species such as anchovy, herring, mackerel and capelin. Like bottom trawls they usually require powerful vessels and their large-catch volumes require considerable on-board handling and storage space. As such they are mainly restricted to larger commercial operations.

GEOGRAPHIC DISTRIBUTION OF USE

Mainly used in north-east European waters to capture herring, mackerel and capelin. Used less frequently in tropical waters, although used to target Indian mackerel in the Bay of Bengal.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

As they are fished mid-water they seldom have contact with the bottom and so gear loss is relatively infrequent. Because they are usually large and expensive sets of equipment, attempts will be made to recover this gear. The size of the gear, and the sophistication of the vessels involved, means recovery is usually successful.

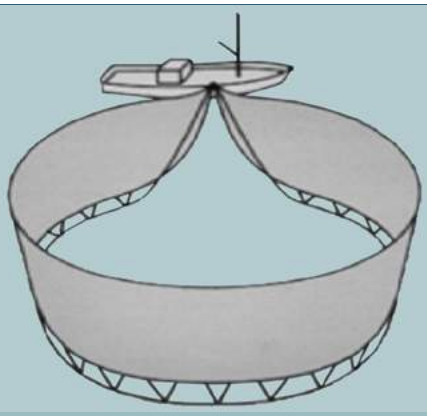
Impact of ALDFG

With a smaller mesh size than bottom trawls, these small pelagic fish targeting nets may capture fish. However, because they are large and heavy they are more likely to quickly accrete to the seabed. Their small mesh means they are less likely to entangle marine animals, but other elements of the gear such as the warps and head / foot ropes may be problematic. They may cause damage to sensitive habitats if moved by currents, but tend to be lost in deeper, possibly less biodiverse seabed areas.

LIKELIHOOD (OF 5): 1

IMPACT (OF 5): 2

SEINE NETS



DESCRIPTION

A purse seine (pictured) is large, surface-set net used to surround a shoal of pelagic fish. The bottom is then drawn together to enclose them.
A ring net works in a similar manner. It is used to surround a shoal of pelagic fish with a wall of netting and is often operated by two boats.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Purse seines and ring nets are used to capture both large and small pelagic fish. They are an important gear for fishing tuna – around 67% of tuna is caught this way – especially in association with FADs.
Purse seines and ring nets are also used for capturing small pelagic species such as anchovy and chub mackerel.

GEOGRAPHIC DISTRIBUTION OF USE

Purse seines are commonly used for tuna fisheries in the Atlantic, Indian and Pacific Ocean waters. They are also an important gear for large small pelagic fisheries in the south- east Pacific Ocean.
Ring nets are commonly used in coastal and archipelagic tropical waters, especially for neritic tunas and small pelagic species.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

Because they are fished on the surface, purse seines and ring nets seldom have impact with the bottom and so complete gear loss is highly unusual. And as they are usually large and expensive sets of equipment, attempts will be made to recover them if lost. Given the size of the gear, the fact that it is floating, and the sophistication of the vessels involved, this is usually successful. There is potential for the loss of floats from purse seines, but these are normally retrieved or washed up and don't threaten marine life. For FADs, see **Section** 0.

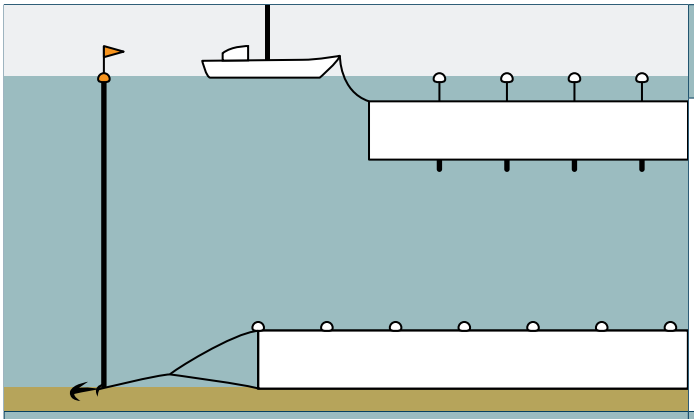
Impact of ALDFG

With a smaller mesh size than bottom trawls, those purses seines targeting small pelagic fish may capture fish. However, because they are large and heavy they are more likely to quickly accrete to the seabed. With a small mesh they are less likely to entangle marine animals. They may cause damage to sensitive habitats if moved by currents, although they will tend to be lost in deeper, possibly less biodiverse seabed areas. However, as mentioned above, ALD purse seines are very rare.

LIKELIHOOD (OF 5):	1

IMPACT (OF 5):	2

GILLNETS



DESCRIPTION

Gillnets are a single wall of netting which can either be fixed or allowed to drift (pictured). They catch fish by enmeshing or entangling them usually around their gill covers.
Trammel nets are a variant of gillnets consisting of three parallel panels of nets with different mesh sizes. They can be used to catch a much wider variety of species.
Entangling nets are usually set on the seabed. They have large meshes to capture shellfish and large whitefish such as monk, ray and turbot. They are also known as ray nets.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Gillnets are widely used in both artisanal and small-scale commercial fisheries worldwide. They are an effective fishing method, suited to a wide range of waters, cheap and easy to buy and repair. Gillnets mainly target demersal and epipelagic finfish, but are also used for small pelagic species and tuna. They can be set on the surface, mid-water or on the bottom.

GEOGRAPHIC DISTRIBUTION OF USE

Gillnets are widely used in both temperate and tropical waters. They are particularly popular in north-east European waters, much of Africa and the Middle East, and South East Asia. They are also a common gear for use in estuarine, river or lake fisheries worldwide.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

Gillnets can have high rates of loss, especially in mixed fisheries areas where gear conflicts (especially with mobile gear) are more likely. Many gillnets are set in areas with strong tidal or other currents, and are susceptible to accidental loss.
As gillnet panels are relatively cheap, there is less incentive to recover lost or abandoned gear. Consequently, their deliberate discarding at sea – either due to lack of storage space or heavy damage – is common.

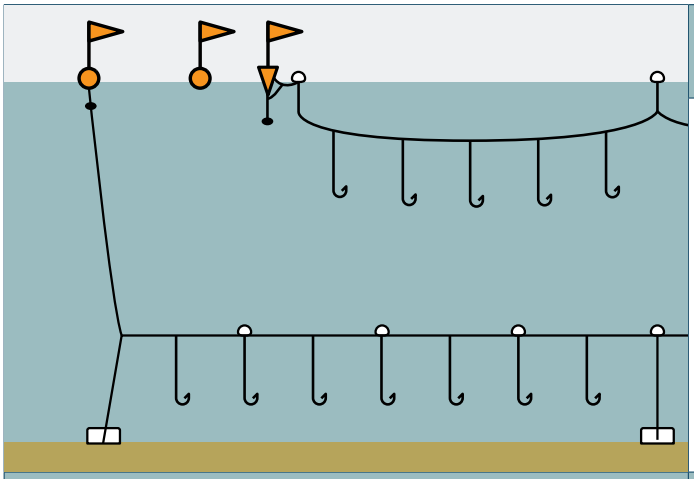
Impact of ALDFG

ALD gillnets can continue to fish before the net breaks down and buoyancy is lost. As they are often made of light material eg monofilament netting they are not easily seen by fish and other marine animals. They will often re-suspend in different current conditions. With a wide range of mesh sizes and structures, the risk of entanglement with marine animals and seabirds is high.
Gillnets will eventually accrete to the substrate. While this shift in disposition may reduce entanglement and subsequent mortality of marine organisms, it does not eliminate species impacts. Nets on the seafloor can continue to ghost fish for the life of the material's structural viability. However the species that are caught may be different than those that were caught when the net was buoyant and suspended in the water column (ie a shift from salmon impacts to crab impacts).

LIKELIHOOD (OF 5): 5

IMPACT (OF 5): 5

HOOKS AND LINES



DESCRIPTION

Longlines (pictured) can be anchored or drifting, both on the surface or on the bottom. They comprise of backing lines of variable lengths, to which are attached a series of baited hooks on snoods.
Hand lines are used for fishing with a single fishing line by hand or can be mechanised.
Jigging is fishing with a rod or machine and is a type of fishing lure. A sinker with hooks on a single or multiple lines is jerked to attract many species of fish in both fresh and saltwater. Trolling is a method of towing artificial lures to attract fish.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Longlines are used extensively, both on the surface (usually targeting large pelagic species such as tunas and billfish) and on the bottom, targeting high value demersal species.
Hand lines are also used to catch tuna and demersal species; they are a common recreational fishing gear.
Jigging is used to catch both finish and cephalopods, often in combination with lights.

GEOGRAPHIC DISTRIBUTION OF USE

Longlines are used in a wide variety of locations. Their use in temperate waters tends to focus on demersal fish such as cod, but can also be used in the water column for species such as halibut. In tropical waters hand lines and longlines are commonly used to catch tuna, and bottom species like snappers and groupers.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

The extensive use of longlines, their often extremely long-set configuration and relatively low cost means that the overall quantity lost is likely to be high. But figures to substantiate this are few and far between. There is also likely to be some deliberate gear discarding when tangled or damaged.

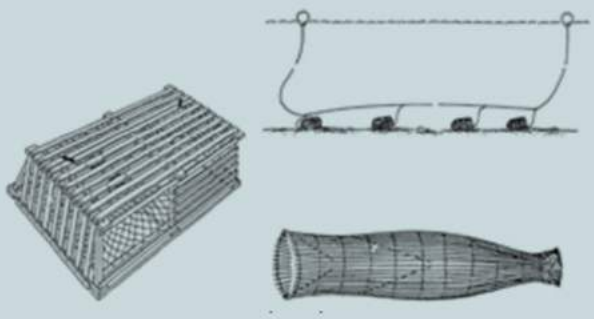
Impact of ALDFG

The mortality rate from lost demersal longlines is usually low. But if it is constructed of monofilament it can persist in the environment.
Ghost mortality is a function of the gear type, the operation and the location regarding active ocean features and elements. Lost longline gear may continue to catch fish as long as bait exists on the hooks. Fish caught on the hooks may themselves become a form of bait for subsequent fish, both target and non-target. Longlines will not stop fishing until all of the hooks are bare. Baited hooks may also pose an ingestment risk to marine mammals, birds, turtles and other animals while the lines themselves pose an entanglement risk.

LIKELIHOOD (OF 5):	3

IMPACT (OF 5):	3

TRAPS AND POTS



DESCRIPTION

Traps and pots[2] are a collective term for structures into which fish or shellfish are guided or enticed through funnels that encourage entry but limit escape. These include pots, creels, cuttle pots, fish traps etc.
For this report they also include fixed gears such as fyke and stake nets. Pots can be made of natural materials like bamboo, as well as plastic and metal.
Traps are normally laid in strings connected by ropes and marked with buoys at each end of the string.

TYPICAL FISHERIES IN WHICH GEAR IS USED

Traps and pots are used in a wide variety of crustacean and finfish fisheries. For crustacean fisheries, traps or parlour type pots are particularly popular to catch lobster, crab and nephrops. Traps can also be used to catch finfish eg the Seychelles cordonnier (rabbitfish) fishery. Most pots are baited.

GEOGRAPHIC DISTRIBUTION OF USE

Traps and pots are usually used in shallow coastal waters, and in the margins of rivers and lakes. The use of pots in temperate waters is mainly targeted at crustacean fisheries, while warmer waters tend to have a more mixed crustacean (eg spiny lobster / swimming crab) / finfish use.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

Like gillnets, the loss of traps and pots is often linked to conflict with towed gears, with other inshore water vessels and even large marine mammals. They are also particularly susceptible to theft and accidental loss through storms and other events. The increased use of GPS and other navigational devices, even by smaller vessels, has reduced the incidence of accidental trap loss. Longer pot strings may be easier to recover, but individual pots may be less so.

Impact of ALDFG

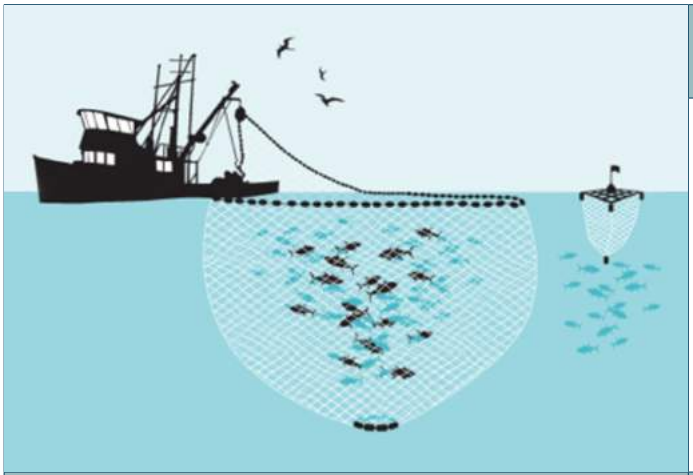
Pots and traps also tend to pass through a progressive process of ghost fishing. The traps are usually baited when they are set; if the pot is lost, over time the bait or lost catch attracts scavengers. These scavengers may then become entrapped and subsequently die, forming new bait for other scavengers. Entrapped animals may escape over time. Animals captured in ALD traps die from starvation, cannibalism, infection, disease, or prolonged exposure to poor water quality (ie low dissolved oxygen). A key point is that catching efficiency is dependent upon gear design, species behaviour and seasonality. A second key risk of this gear is entanglement of large marine mammals with connecting ropes and lines. This can occur when the gear is under control or is abandoned, lost or discarded.

LIKELIHOOD (OF 5):	4

IMPACT (OF 5):	4

2. There does not seem to be any definitive difference between ‘pots’ and ‘traps’ and the two terms are used interchangeably in most literature.

FISH AGGREGATING DEVICES (FADs)



DESCRIPTION

An FAD is a man-made object used to attract fish. The fish are then caught using purse seines or, in coastal waters, hand lines. The purse seines or hand lines are either anchored to a fixed location or left to drift and are tracked by locator beacons. FADs use a combination of natural – eg palm fronds – and artificial – eg netting – materials to extend their presence.

TYPICAL FISHERIES IN WHICH GEAR IS USED

The main users of FADs are tropical tuna fisheries that use a combination of drifting and fixed FADs. Coastal FADs are often used to encourage smaller-scale fishers to move outside the reefs, and will mostly target neritic tunas, jacks and mahi mahi.

GEOGRAPHIC DISTRIBUTION OF USE

Drifting FADs are used extensively in the Atlantic, Indian and Pacific Ocean pelagic tuna fisheries.
Coastal FADs are used particularly by many small island and archipelagic states. They are also used in other tropical coastal waters, usually at depths between 50 –200m – sometimes deeper.

CONTRIBUTION TO ALDFG AND GHOST FISHING

Susceptibility to loss

FAD loss is an increasingly important issue. While drifting FADs represent a considerable investment their accidental loss does occur. This can be, for example, through locator beacon failure or deliberate abandonment (when damaged or superseded). Anchored FADs are possibly more prone to loss, mainly due to mooring failure, and are less easy to recover, as they are not equipped with location equipment.

Impact of ALDFG

The main impact for ALD FADs (and indeed some FADs still under the control of fishers) is from entanglement with FAD netting. Marine turtles and sharks are particularly vulnerable. ALD FADs also come ashore and can damage vulnerable tropical coral reef areas as they beach.

LIKELIHOOD (OF 5):	4

IMPACT (OF 5):	3

SYNOPSIS

GEAR CLASS	LIKELIHOOD	IMPACT	TOTAL RISK
Gillnets	5	5	25
Traps and pots	4	4	16
Fish Aggregating Devices	4	3	12
Hooks and lines	3	3	9
Bottom trawls	2	3	6
Mid-water trawls	1	2	2
Seine nets	1	2	2

Frank Baensch / Marine Photobank

2.2 PROPOSED SCOPE FOR THE REMAINDER OF THE STUDY

The analysis of fishing gear usage has examined two key elements: first the extent of their global use and second the overall risk posed regarding ghost fishing and other ALDFG impacts.

The review of global fishing gear use indicates that seine nets, mid-water and bottom trawls account for most fish catches by volume. When calculated by effort, the results are similar. Trawls (both bottom and mid-water) are ranked highest, but hook and line (including longlines) and gillnets also feature highly. Traps and pots are used less frequently, but still globally significant. When considering the risk of ghost fishing, gillnets pose the most risk, with traps and pots second and FADs third.

The conclusion of this combined analysis is that it is worth considering all these gear types in the best practice framework. Although seine nets and trawls have the lower risk of ghost fishing, the fact that they account for the highest volume of global catches means they need to be considered.

This is especially as losses can be concentrated in relatively small areas. Conversely, while traps and pots and FADs account for lower volumes of fish capture, they have a relatively higher risk of ghost fishing, and so must also be considered.

The above analysis also shows that ghost fishing is a global phenomenon, and this must be reflected in the framework. Both gillnets and traps and pots – the two main fishing gears with a high risk of ghost fishing – are used both in temperate and tropical waters. There will, however, be an emphasis on shallower coastal waters where they are mainly deployed. Mid-water trawls and purse / ring seines are more often deployed in deeper pelagic waters, mainly by larger-scale fisheries, and this again needs consideration.

World Animal Protection / Kristian Whipple

3 IDENTIFYING MANAGEMENT OPTIONS AND MECHANISMS FOR RESPONSIBLE FISHING GEAR USE

This second activity examined the following main elements.

First, it identifies why we need to manage fishing gear. Then, through a brief analysis of the main impacts and drivers, it identifies the main types of management interventions available to the sector.

Second, it looks at the current management options for fishing gear. This includes the use of tags and other identification of fishing gear, gear marking, gear storage to and from fishing grounds and gear retrieval in case it is lost or temporarily abandoned as identified in the first step.

It also looks at the mechanisms as to how these are implemented. This may be, for example, through legislation, codes of conduct or inclusion in third-party and other certification schemes.

This part of the study will be a typology to set the scene for the framework development.

3.1 OUTLINING WHY WE NEED TO MANAGE FISHING GEAR

The capture of wild fish has sustained humankind for millennia[3], and dates back at least 40,000 years to the Upper Palaeolithic period. This likely started with simple traps, moving to 'gorges' (simple hooks) and then expanding to ever more complex and largely static techniques, including simple gillnets and set nets.

Bottom trawling started to develop as early as the 17th century. It was revolutionised with the advent of steam and then diesel engines that have extended both the power and range of fishing activities substantially. The last major revolution was during the 1960s, with the introduction of synthetic fibres and materials that changed the nature and durability of fishing gear.

Over the last couple of decades, gear design has resulted in improvements in gear selectivity. These include bycatch reduction devices for both unwanted and less valuable fish, and for vulnerable marine animals such as sea turtles.

As the sophistication and complexity of fishing gears and their use has developed, so has the need for their responsible use and management. Fishing gears can have a variety of impacts resulting from a combination of gear type and design; rigging; spatial and temporal patterns of use, and intentional and unintentional malpractice. It is the latter that must be managed through a mixture of better gear design, education and awareness and, where these fail, regulation.

To place the current management options (see next section) in context, we have summarised the main impacts, drivers and non-regulatory intervention points in the table overleaf.

This table shows there are a number of common approaches to address the different impacts listed below (in no particular order) and explored in more detail in the next section. As proposed by Macfadyen et al (2009), interventions can be broadly divided into three measures. These are prevent (avoiding the occurrence of ALDFG in the environment); mitigate (reducing the impact of ALDFG in the environment) and cure (removing ALDFG from the environment).

1.	Spatial and / or temporal measures	**PREVENTION**
2.	Gear design to reduce whole or partial loss of the fishing gear	
3.	Vessel design to reduce gear and other marine litter discarding	
4.	Better marking and identification of fishing gear	
5.	Improved redundant fishing gear disposal facilities	
6.	Education and awareness	
7.	Improved fisheries management regime	
8.	Good practice for avoidance, mitigation and response	
9.	Gear design to reduce the incidence and duration of ghost fishing	**MITIGATION**
10.	Lost gear reporting, location and recovery initiatives	**CURE**

All of the above are applicable to ghost fishing, but as the next table shows, can also affect other gear-related impacts including reducing bycatch and habitat damage from fishing activities.

3. See http://news.bbc.co.uk/1/hi/sci/tech/5398850.stm

Table 2: Impacts, drivers and possible non-regulatory intervention points of fishing gear

IMPACT	DRIVER	POTENTIAL NON-REGULATORY INTERVENTION POINTS
Mortality from ghost fishing Contribution to marine litter (including micro-plastics) Lost gear as a navigation hazard	• Accidental gear loss resulting from gear conflicts, storms, misplaced gear, poor ground • Abandoned and discarded fishing gear due to enforcement pressure, inadequate storage space and inconvenience	• Improved marking of fishing gear to show the location, scale and nature of fishing gear in the water • Better identification of fishing gear ownership • Improved redundant fishing gear disposal facilities • Spatial management • Awareness raising • Gear design to reduce (i) gear loss and (ii) ghost catches • Lost gear reporting, location and recovery initiatives • Check in / check out of gear carried
Mortality of unwanted or low-value bycatch	• Unintended consequences of mixed fishery management • Market demand for low value or illegal bycatch	• Improved fisheries management regime • Gear modification or use of more selective gears • Market interventions • Education and awareness
Mortality of vulnerable marine animals and birds	• Fishing in high-risk areas (bird rafting and foraging, marine mammal and reptile migration routes, etc)	• Spatio-temporal measures • Good practice for avoidance, mitigation and response • Education and awareness
Habitat and benthic community damage	• Fishing in high risk areas eg vulnerable marine habits and communities • Inappropriate use of heavy, poorly design or rigged ground gear • Abandoned, lost and discarded fishing gear (ALDFG)	• Spatio-temporal measures • Good practice for avoidance, mitigation and response • Education and awareness • Improved gear design • Measures to reduced ALDFG (see below)

3.2 CURRENT MANAGEMENT OPTIONS FOR FISHING GEAR

3.2.1 Preventative measures

Preventative measures are the default, preferred approach because they prevent ALDFG from getting into the marine environment in the first place.

Spatial and / or temporal measures

The use of spatial and or temporal restrictions on fishing have considerable potential to reduce gear conflicts. They can also help to ensure that fishers reduce the risk of their gear interacting with vulnerable marine habitats or species. With the widespread use of GPS mapping, this is a practical and targeted approach.

However, like most forms of management, the involvement of fishing practitioners and other stakeholders is critical in designating areas and identifying gear time restrictions. This will ensure that stakeholders' professional and expert knowledge is included, that the resulting measures are acceptable and that implementation is possible.

Marine spatial management is not a new concept but is gathering increasing acceptance worldwide. Marine Spatial Planning (MSP) is an important component of the revised EU Common Fisheries Policy (CFP). It enables a strategic approach to fisheries management, providing opportunities to manage fishing effort and increase capture efficiency and the eventual value of seafood products. Spatial management provides the following benefits related to the use of fishing gear.

- Reduces the potential for gear conflict, especially between mobile and static fishing gear, and so maximises the economic potential of individual fisheries.
- Can provide protection of vulnerable marine habitats, where appropriate with the designation of core and buffer areas.
- With a temporal element, can protect vulnerable seabirds and marine animals at periods when the potential for interaction is particularly high. For example, parent seabirds foraging during the nesting season, spawning aggregations, juvenile fish nursing periods.
- Provides opportunities for, and reduces the potential for conflict with, other sea uses, including recreational fishing, sailing and other marine-related activities.

As discussed above, local MSP is a necessary a participatory process to improve both effectiveness and compliance levels. While such approaches are generally part of a wider fisheries management regime, voluntary designations of spatial-temporal zoning measures are not uncommon.

For example, the Scottish Fishermen's Federation, the Scottish Creel Fishermen's Federation, and the Western Isles Fishermen's Association, with Marine Scotland, implemented voluntary measures for three newly designated marine protected areas. These voluntary measures will be replaced by statutory provisions as part of the management implementation programme.

Gear design to reduce whole or partial loss of the fishing gear and its components

Some degree of gear loss is inevitable given the hostile conditions of the marine environment. Fishers understand this and use their knowledge and experience to maintain control over fishing gear; losing gear has inevitable cost and time implications. There is also some scope to reduce further the risk of gear loss through better design.

First, it is important to understand that the loss of a whole gear assembly is unusual. Generally segments of the gear may be lost – for example a net panel or cod end lost through contact with the bottom, or a number of pots lost from a string. Gear loss can also be considered at an even smaller level, with ropes shedding fibres as they abrade under normal wear and tear.

Stephen McGowan / Marine Photobank

Vessel design and other approaches to reduce discarding of gear and other marine litter

While the focus is usually on gear design and materials, there are also other practical approaches to reducing gear loss and marine littering. One particular issue is on-board storage facilities.

Most fishing vessels maximise catch storage and working space, often at the expense of storage areas. For example, a deep-water gillnet fishery involving 50 vessels off the UK continental shelf over the 1990s discarded all their net panels.

They brought back only headline and foot ropes. Up to 30km of gear are routinely discarded per vessel per trip; in deep-water locations this type of gear is known to continue catching for two to three years after loss (Hareide, 2005).

Consequently, improved gear retrieval, packing and storage solutions need to be considered when designing fishing vessels for single or multiple fisheries. One particular issue is the storage of bait box packaging and waste. This is often difficult to control on windy days when crew are in a hurry to get traps baited and into the water.

One initiative addressing this issue is the 'Ship-to-Shore programme'[4] in the province of Nova Scotia, Canada. This has inspired a number of fishers to champion waste management by installing recycling / garbage bins aboard their vessels.

Better marking and identification of fishing gear

As recognised by the recent FAO 'Expert consultation on fishing gear marking' (FAO, 2016), "adequately and systematically marked fishing gears can facilitate reducing:

i. the abandonment and discarding of fishing gears in the aquatic environment

ii. the unintended catch of endangered, threatened and protected species of fish and other animals

iii. the level of Illegal, Unreported and Unregulated (IUU) fishing

iv. dangers to navigation and accidents at sea associated with unattended fishing gear, as well as Abandoned, Lost or otherwise Discarded Fishing Gears (ALDFG);

v. the accumulation of ALDFG in the aquatic environment;

vi. damage to vulnerable and sensitive aquatic habitats; and

vii. economic losses to fishermen resulting from ghost fishing and degradation of fishing grounds."

The marking of fishing gear encompasses two main aspects:

i. surface markers or other devices that indicate the position, nature and extent of the fishing gear

ii. identifiers that allow the relevant authority to identify the party ultimately responsible for the deployment of the fishing gear.

These are briefly examined below.

Marking the position, nature and extent of fishing gear

The Convention on Conduct of Fishing Operations in the North Atlantic (the Atlantic Convention) was adopted in June 1967. Its adoption followed a conference involving the major fishing nations in Europe and North America (UK government, 1967).

The requirements covered signals for different fishing activities (eg lighting combinations for use when trawling). It also covered the marking of the ends of nets, lines and other gear with flags, buoys and radar reflectors. This has been updated by a number of other initiatives; these include FAO 1993 and FAO 2016.

Bord Iascaigh Mhara (BIM) in Ireland conducted a useful review of gear marking standards and the identification of issues that may cause difficulties in their implementation (Robson et al, 2006 and BIM, 2009). Recent developments and technical innovations have seen an adoption of low cost, low power demand marine lighting systems and power provision at sea.

These include solar photo-voltaic power and more efficient battery systems. Other developments include the fitting of radio / satellite buoys for pelagic loglines and FADs.

Identifiers that allow the relevant authority to identify the party ultimately responsible for the deployment of the fishing gear

The loss of all or part of fishing gear is both a financial loss for the vessels concerned, and a potential safety and environmental hazard. While most vessels try to retrieve lost gear with variable levels of success (see Macfadyen et al, 2009; and Brown et al, 2005) considerable amounts of ALDFG – both mobile and static – remain in the marine environment.

Although most degrades over time, or is bound up in the substrate, some is brought to the surface by other fishing boats or is washed ashore. In such cases it would be useful to know where the gear was lost and by who. This would help in estimating the scale and nature of

4. See http://clean.ns.ca/programs/waste/ship-to-shore/

gear loss or, in the case of persistent and deliberate gear discarding, assist in providing evidence to control authorities.

The biggest challenge to allowing the identification of ALDFG is that normally only certain parts, usually the marker buoys, are provided with written identification or identification tags. As a result, most of the gear lost is unidentifiable. Various new technologies have addressed this, including radio and other forms of tags as described below.

- **Electronic tagging:** Electronic tagging, such as the use of Radio Frequency Identification (RFID) tags can be produced relatively cheaply and be embedded with considerable amounts of user-definable information. RFID tags are being used in some fisheries, such as in South West England.
  Here, fishermen allocated a potting permit will now be supplied RFID tags secured to each pot. Marine enforcement officers can then scan each pot using a hand-held RFID reader. This will ensure that only those fishermen with permits are operational within their jurisdiction. Any pots without a tag will be removed from the water.
  One limitation is that the reading distance is only about one metre. This means gear will effectively have to be hauled to access RFID data; this is usually avoided by control agencies. The cost and logistical requirements might also be seen to outweigh the benefits. This is especially so, given that potentially non-compliant vessels using illegal gear or fishing in closed areas are unlikely to adopt this technology.

- **Other forms of tags**: Coded wire tags can be implanted into netting and scanned for identifying data when required. Alternatively, rogue yarn (a yarn of different twist or colour from the rest) can be inserted into multi-strand twines. This has been used in Japan to distinguish gear from fishers based in specific management areas (Macfadyen et al, 2009). Hand-held laser read bar coding is also easy and cheap to produce and print onto plastic tags.

Good practice for avoidance, mitigation and response

The most obvious preventative approach is diligence and good practice on the behalf of the fisher, possibly supported by regulation by the management authority. This might include the following.

- Gear use limits eg limited lengths of gillnet fleets, trap strings, etc to increase control of fishing gear and reduce the risk of damage or loss.

- Soak time limits for static gear such as gillnets and traps. Longer soak times increase the risk of gear loss, so fishers will aim at a balance of achieving a catch and retrieving gear quickly.

- Use of alternative gears as dictated by prevailing weather and other conditions.

- Rigging options that minimise gear loss, even if it compromises catch levels.

- Good communication with other fishers, especially with different segments – eg between static and mobile operators in common fishing grounds.

- Use and sharing of seabed and local current mapping data to reduce snagging and subsequent gear loss.

Improved redundant fishing gear disposal facilities

One key driver for the responsible disposal of old or damaged fishing gear is the convenient access to low cost disposal opportunities. MARPOL Annex V (IMO, 2012) requires that:

i. every ship of above 100 grt should follow a written garbage management plan

ii. prohibits the “discharge into the sea of synthetic fishing net and line scraps”, and provides a methodology for determining the nature and adequacy of port reception facilities for garbage that is based on the “number and types of ship that will call at the port”.

This latter requirement suggests that fishing ports should have adequate gear reception facilities that reflect the scale and nature of their fisheries. This is relatively straightforward for larger fishing ports. It can become problematic, however, for small coastal ports, which have limited quayside space or logistical issues to dispose of this waste responsibly.

Within this general area of gear disposal, there are a number of best practices and management options available.

- **Involvement of gear manufacturers:** Because of corporate environmental responsibilities and tools such as life cycle analysis, gear manufacturers have some responsibility in facilitating the responsible use and disposal of their products. This should be through a number of different ways, including: (i) buy-back of old gear for reconditioning or recycling into new fishing gear (possibly allied to deposit schemes for returned gear) (ii) sponsorship and / or implementation of responsible gear disposal schemes.

- **Recycling and reuse of redundant fishing gear:** Ideally some degree of recovery of the costs of responsible disposal could be gained through recycling and reuse of fishing gear and its materials. This might require some level of local pre-processing of fishing gear into its constituent components – rope, net panels, buoys, fastenings for example – to assist and identify prospective buyers.

This approach, when combined with a wider collection system, could also build up sufficient quantities of gear components to make them further attractive to buyers. This could also be allied with some form of certification or labelling scheme to identify products as recycled fishing gear, and thus gain a higher value (see box below).

- **Alternative uses of redundant fishing gear:** In Australia, rangers in northeast Arnhem Land use ALD fishing nets found on the coast to harden coastal tracks for vehicles (Kiessling, 2003). In some countries old nets are recycled by households into chicken and stock fencing, soccer goals, etc.

Box 1: Recycling of fishing gear in the USA and the UK – case studies

USA

A public-private partnership was established with a recycler an hour away from ports in Washington State, United States. The Washington ports, benefited from providing a service to their fishers. They also benefited from the free hauling and pickup they received when a recycling container was full (reducing their extremely high waste disposal costs).
The Alaska communities, dealing with quickly filling landfills, heavy equipment entanglement problems and difficulties in burying nets, benefited from the removal of this bulky, troublesome material.
Some communities sent baled nets or well-cleaned containers of well-compacted loose net. This could generate revenue or be used for other commodities such as baled cardboard or metals.
This helped defray the costs of transport or the transport was donated mainly by freight companies hauling empty barges southward at the end of the fishing season. From an average collection volume of 46 tonnes between 1991 and 1999, collected volumes have been halved. This is because funds for coordination and promotion of the programme have been reduced (Recht and Hendrickson, 2004). From Macfadyen et al, 2009.

UK

UK seafood company MCB Seafoods is working with Danish recycling company, Plastix, to collect and recycle waste netting. Unlike other recycling companies Plastix is willing to take every type of old fishing gear. This means there is very little time spent sorting at the quayside and nothing has to go to landfill.

Key lessons learned to date include:

i. removing financial barriers and making the process as simple and easy as possible are key to getting the ball rolling and the industry on board

ii. communication on the ground is very important in spreading the word and helping to gather support

iii. the facilities available and the layout of every harbour is different so it is important to have flexibility and not expect everything to run with precision straight away. From http://www.ghostgear.org/solutions/mcb-seafoods-plastix-net-recycling-sussex

Education, awareness and information on ghost fishing

Most fishers are aware of their responsibilities towards maintaining the marine environment and the resource base on which they depend for their livelihoods. They are also fully aware of the need to minimise risk to their gear, and to make every effort to recover lost or abandoned gear where possible.

This said, there are always opportunities for further education and awareness building. This can expand fishers' mindfulness of the consequences of ALDFG in general and ghost fishing in particular. They should also provide additional information on best practice, risk-reduction strategies and new approaches to gear recovery. Various options are outlined below.

- **Development of education and awareness-building material:** A number of awareness campaigns – often associated with the wider issue of marine litter – already exist. These include the NOAA / Ocean Conservancy Council 'Keep the coast clear campaign' in the USA, the MCS 'Marine litter action framework', the ghostfishing.org and of course GGGI itself. Most of these current awareness-building initiatives are generally aimed at the public. They develop consumer awareness of the issue, but do not influence the sector directly.
  There are several programmes working directly with fishermen, but many of these are focussed on gear removal. An example of this is the 'Marine debris location and removal program' in Virginia. However, there are relatively few that focus on the priority approach of working with fishermen to prevent fishing gear being lost in the first place.
  Such education material should focus on practical, high-risk areas. They need to be defined through a participatory approach and might include such issues as bait box litter management, avoiding gear conflict, reporting of abandoned gear, etc. There is also a good case to extend education and awareness to include policy makers, port authorities, and fishery managers (NOAA Marine Debris Program, 2015).

- **Information availability:** As also noted by NOAA (NOAA marine debris program, 2015), one major gap in this area is the lack of web-accessible data products regarding ghost fishing information, studies, and projects.
  Although some databases already exist such as StrandNet. This is an Oracle database, which summarises all records of sick, injured, or dead marine wildlife reported to the department of environment and heritage protection in Queensland, Australia (Department of environment and heritage protection, 2014). It is a powerful tool that centralises data from known mortalities as compiled by five different agencies across the country, including those from derelict fishing gear.

Having a centralised location with one or more searchable databases would be a significant advancement for educational and outreach purposes, not just locally but globally. There would be a need to have mechanisms in place to oversee management, verification, and distribution of such data. Suggestions for data to include are:

- spatial zoning of fishing gear regulations searchable by state/region/nation/fishery
- mortality of organisms searchable by species/region found
- location of found ALDFG with data provided by fishermen, scientists, and general public
- list of projects/initiatives from both governmental and non-governmental organisations to promote collaborations and reduction of duplicative research efforts
- published literature, including government reports, conference summaries, and links to peer reviewed literature.

Improved fisheries management regime

Ghost fishing is best prevented through the specific measures discussed above. But the wider fisheries management regime can affect the risk of fishing gear being abandoned, lost or discarded and consequently lead indirectly to ghost fishing.

Some fisheries are managed on a limited effort basis. This could be through restricting the timing and duration of the fishing season, the number of days at sea or the number of licences issued to fish a certain stock. However, these can have unintended consequences, such as encouraging a race to fish. This in turn may lead to spatial conflicts, short cuts in gear rigging and deployment and possibly higher rates of gear abandonment when time pressures are involved.

The use of an alternate output control management system – for example, the allocation of quotas that can be fished at leisure may solve some of these issues, but can also lead to other problems. These can include discarding (especially in mixed fisheries) and high grading (especially in small pelagic fisheries).

In summary, this is probably not going to be a major focus of any better management guidelines. However, fisheries policy, management and regulatory authorities should be encouraged to consider the implications of fisheries management strategies on fishing gear use and loss. This could possibly be through inclusion in any ex-ante evaluation or impact assessment that might be undertaken.

3.2.2 Mitigation

Mitigation measures are those that are in place when fishing gear is presumed irretrievably lost and unrecoverable.

Gear design to reduce the incidence and duration of ghost fishing

For most gear types – eg gillnets – there have been very few approaches to reduce ghost fishing potential once the gear is lost. The two exceptions are traps / pots and FADs, both of which are examined in more detail below.

Gear design has been the focus of a number of initiatives to prevent lost gear from ghost fishing once control is lost. For example, Florida's spiny lobster fishery has had a requirement for escape mechanisms since 1982 (Matthews and Donahue, 1996). And the fisheries management plan for king and tanner crab in the Bering Sea states that "an escape mechanism is required on all pots; this mechanism will terminate a pots catching and holding ability in case the pot is lost".

Biodegradable escape cords ('rot cords') can be effective at disabling derelict traps, although this depends upon the design involved (Natural Resources Consultants, Inc., 2015). Despite these requirements, trap recovery programmes have identified that significant proportions of the traps recovered do not have the requisite rot cord for reducing catching capacity if lost.

Forty percent of commercial traps recovered in Port Susan, Washington State, did not have rot cords (Natural Resources Consultants, Inc., 2007). This highlights the importance of monitoring and enforcement to support any mitigation measures that are implemented.

Bilkovik et al (2012) tested in a blue crab (Callinectes sapidus) trap fishery a fully biodegradable panel with a cull or escape ring designed for placement on the sides of a crab pot. It completely degrades into environmentally neutral constituents after approximately one year. The authors noted that their solution was more effective than the aforementioned 'rot cords', as biodegradable cull panels create entrance-sized holes for escape in the upper chamber.

They found that newer biodegradable polymers (see box on PHA overleaf) are far more effective then biodegradable plastics produced in the past. They also noted that lost pots can become habitats for marine organisms if modified to become ineffective at trapping. The potential for using modern biodegradable materials are not restricted to trap fisheries. They can also be used for mussel socks and the multitude of other plastics used on board boats, such as bait box packaging material.

Box 2: Polyhydroxyalkanoate (PHA) use as a biodegradable plastic in fisheries

Polyhydroxyalkanoates (PHAs) are a family of naturally occurring biopolyesters produced by bacteria and are completely biodegradable by microbes typically found in the marine environment. PHA meets the American Society of Testing and Materials certification and European Standards for biodegradation in the marine environment (Chanprateep, 2010). It has physical characteristics similar to non-degradable plastics and can be formulated for extrusion into moulded forms. The rate of biodegradation can be controlled by adjusting the thickness of the polymer.
Researchers at the Virginia Institute of Marine Science (VIMS) tested PHA as the material of choice for use in developing escape panels for crab, lobster, and fish traps (VIMS, undated). Earlier methods of providing escape vents for animals captured in lost traps were prone to failure either by degrading too quickly or not at all.
Since PHA is consumed by bacteria, panels made from it have a high level of certainty of dissolving and providing an avenue for escape. And because PHA is consumed by bacteria naturally occurring in water, PHA bio panels have an added benefit of lasting longer if regularly fished.
This is because microbes feeding on the PHA have inhibited or delayed growth when exposed to UV light during trap retrieval. This requires constant regrowth of bacteria on bio panels of active traps. Lost traps however, remain on the bottom out of UV light exposure and populations of bacteria can proliferate and more quickly consume the PHA.

FADs are also fishing gear with a high potential for improved design for reducing both the potential for ghost fishing as well as habitat interactions. It is estimated that FADs are now used for more than 40% of world tropical tuna catches. This makes this technique a major phenomenon for high seas fisheries worldwide, and one that has experienced great expansion over the past three decades (Taquet, 2013).

In 2013 Pew estimated that between 47,000 and 105,000 drifting FADs were being deployed each year in 2011 (Baske et al, 2013). This was updated to 81,000 to 121,000 in 2013, a 14% increase (Gershwin et al, 2015).

French and Spanish purse seine fleets are attempting to develop 'ecological FADs,' which are biodegradable and therefore are not conducive to ghost fishing (Dagorn, 2010). The International Seafood Sustainability Foundation (ISSF) published revised guidelines for the construction of non-entangling FADs (ISSF, 2015). Specific, on-the-water designs were left to be carried out by the fishing industry.

The guidelines compared designs that varied from traditional, high entanglement risk designs to low risk non-entangling FAD designs. These low-risk designs incorporated cloth attractors rather than mesh panels and all biodegradable materials. Self-destructing FADs are also being tested in the Eastern Pacific Ocean (IATTC, 2008) but have so far not been implemented in that region or elsewhere.

World Animal Protection / Kristian Whipple

3.2.3 Cure

Curative measures are those taken to report and assist the recovery of ALDFG. It is recognised that gear recovery can often be an expensive exercise, and so is less of a focus than prevention, but may be appropriate in some circumstances.

Lost, abandoned and found fishing gear reporting

One important management tool often suggested, but still rarely enacted, is the reporting of lost or abandoned fishing gear. It is presumed that deliberately discarded fishing gear will not be reported for obvious reasons.

As noted above, the reporting of the loss or discharge of fishing gear is specifically required by MARPOL Annex V. However, this: (i) excludes fishing gear that is released into the water for later retrieval (eg FADs, traps and static gear) and (ii) only vessels >400 gt are required to carry 'garbage management plans', thus excepting most coastal fishing vessels.

The recent FAO Expert Consultation on fishing gear marking (FAO, 2016) noted that "the effectiveness of gear marking systems would be significantly enhanced when incentives exist to:

i. encourage the uptake of gear marking systems

ii. the reporting of lost or abandoned fishing gears

iii. the safe retrieval and responsible disposal of ALDFG"

They urge relevant authorities to:

i. establish appropriate reporting regimes

ii. develop and maintain a record / register of fishing gear reported as being found, lost, abandoned, or otherwise disposed of[5]

iii. make information about ALDFG available to relevant RFMO/As, other relevant organizations and entities, including stakeholders, as appropriate."

A number of national maritime administrations (such as the Icelandic Maritime Administration) provide guidelines relating to fishing vessels with the record book on the reporting of fishing gear lost at sea or incinerated. Malaysia has established a national inventory of net types and other fishing gear, but otherwise there have been very few initiatives making the reporting of lost or discarded fishing gear mandatory.

One of the factors hindering reporting is the lack of standardisation of fishing gear units, reporting methods and data requirements, database / register structures. There is also difficulty in monitoring the actual retrieval rates of fishing gear.

There are other approaches to estimating the volume and nature of ALDFG. These include the monitoring and tracking of gear use and loss via initiatives such as a 'check out-check in' tactic. This is where vessels are routinely required to account for their fishing gear inventory and balance purchases and sales / loss / disposal.

However, this can impose a considerable burden on both regulatory authorities and the fishers themselves. One area where this approach might work is with FADs. In this case regional fisheries management organisations might require vessels to account for all FAD use and disposal, possibly in association with a third- party certification scheme.

FADs can also be managed by a combination of electronic tracking and restrictions on the total number of active FADs followed by any one vessel (as in IOTC waters). They could also be managed by FAD registration and tracking systems; these are being trialled by the Parties to the Nauru Agreement (PNA) in the Western Central Pacific.

ALDFG location and identification

The position and identity of ALDFG may be reported by the owner of the gear, or by another vessel, but the specific location and identification of fishing gear is a considerable challenge. Sea-based surveys can locate lost fishing gear that may still be ghost fishing or damaging habitats.

If accurate information on gear location is unavailable, modelling techniques, local knowledge and anecdotal information to identify potential hotspots are essential to better target a survey intended for gear retrieval (Macfadyen et al, 2009; NOAA, 2010).

Towed-diver surveys of the north-western Hawaiian Islands were better targeted with the identification of high entanglement risk zones. This was through recognising oceanographic conditions leading to likely collation of marine debris combined with high densities of sensitive species – in this instance, monk seal nursery areas (Donohue et al., 2001).

Side Scan Sonar (SSS), a sea-bed mapping technology, has become more accurate and more affordable in recent years. However, SSS is likely to be applicable where relatively large or readily distinguishable items such as pots or traps are to be located. It can, however, also be used for gillnets.

The NOAA Gulf of Mexico Marine Debris Project has used SSS from survey vessels in its retrieval of large marine debris, assisted by an Autonomous Survey Vessel (ASV). Derelict blue crab traps were mapped in the Virginia portion of Chesapeake Bay by VIMS (Havens et al, undated).

5. Includes fishing gear sold or put ashore and destroyed.

However, the experience and success rates with the use of SSS were mixed (Brown et al, 2004) as outlined below.

- SSS could detect gillnets on soft bottoms, whereas on hard bottoms the signals from gillnets were masked by the stronger bottom echoes. However, areas with lost gillnets are normally on very hard bottoms and so the use of SSS proved to be of limited practical use.
- SSS was used to locate wrecks, but only the superstructure of the vessel could be observed. For the localisation of gillnets this was not sufficient.
- Problems occurred while operating the SSS at greater depth due to difficulties maintaining its stability.
- While the SSS detected several targets in the depth of 50-100m, it could not differentiate between lost and commercial nets.
- In general, the SSS gave imprecise detection of lost nets. Especially the detection of nets on wrecks seemed difficult, except when the gillnet fleet was set with some distance apart from the wreck.

The use of Remote Operating Vehicles (ROVs) also received mixed results, but in general, their use was not very successful. The manoeuvrability of ROVs tended to be hampered by currents, although they detected lost gillnets on wrecks in deep calm waters. However, Melli et al (2016) report the successful use of ROV imaging to investigate marine litter abundance in the north-west Adriatic Sea.

ALDFG recovery

Gear recovery normally takes place first through the use of 'creeps', which are grapnels fabricated specifically for retrieving lost fishing gear. They are a useful, effective and low-cost solution for situations when gear is recently lost or abandoned, and the location known.

Grapnels have a number of forms. They can range from single grapnels (suitable for lost trawls or large net sheets) to beams, such as 'Roger's Grapnel' that snags both ropes and traps (see the Fundy North Fisherman's Association 'Ghost gear retrieval manual' (2016) and associated YouTube video[6]).

In addition to post-lost recovery, there have been a number of historical derelict gear clean-up operations.

The Norwegian Directorate of Fisheries has organised retrieval surveys annually since 1980. From 1980 to 2003, it removed 9,689 gillnets of 30m standard length (approximately 290km) from Norwegian fishing grounds at a cost of around NOK 1.5 million (c. USD 181,000).

In shallow coastal waters, it is possible to survey and retrieve ALDFG through the use of SCUBA and surface supplied air diver surveys. This approach is particularly useful on complex 3-D habitats such as coral reefs and wrecks where traditional 'creeping' is impossible.

Such ventures can include local dive clubs, but can also involve entire coastal communities. This is the case with Australia's Carpentaria Ghost Net Programme where community groups have formed a network to clean up beaches. They have also established a coordinated information recording process to build a picture of the quantities, impacts and likely origins of ghost nets across northern Australian waters.

The Gulf of Maine Lobster Foundation 'Gear grab' initiative encourages fishermen to volunteer their time and for vessels to grapple for lost traps. Recovered gear is brought to a central wharf for sorting and processing. Salvageable traps are returned to their owners, unusable traps are disposed of and the steel is recycled. Information about each recovered trap is recorded and given to scientists to assess the impact on marine habitat[7].

In addition to targeted surveys or initiatives, some states operate a continual system gear recovery. In the Sea of Japan, fisheries patrol vessels from the national agency bring any ALDFG identified to shore. Fishing vessels chartered by fisheries organisations and local government and funded by central government subsidy do the same (Inoue and Yoshioka, 2004).

However, gear recovery programmes may face certain legal constraints and challenges. As noted by the NRC: "in the United States, recovery of DFG may be inhibited by prohibitions against tampering with abandoned gear, the application of cabotage laws and burdensome certification requirements for vessels that transport DFG, and fishery regulations that prohibit vessels from carrying gear that is not a gear type permitted under their license endorsement" (NRC, 2008).

6. See https://www.youtube.com/watch?v=0uH5g0UEp0c&feature=em-share_video_user

7. See http://www.geargrab.org/

3.3 IMPLEMENTATION MECHANISMS FOR FISHING GEAR MANAGEMENT

Having looked at the different management approaches and measures for preventing, mitigating and curing ghost fishing, this section examines how these are applied in practice. The purpose is to help identify how best practice might best be applied through: (i) voluntary actions, possibly via a code of conduct, (ii) third-party certification, (iii) mandatory legislation and / or (iv) better awareness and information (see table and further text below).

Table 3: Initial allocation of implementation mechanisms to measures to prevent ghost fishing

APPROACH	MEASURE	IMPLEMENTATION MECHANISMS			
		Voluntary guidance	Third-party certified	Regulatory	Awareness and information
Preventative	Spatial and / or temporal measures	✓		✓	
	Gear design to reduce whole or partial loss of the fishing gear	✓		?	
	Vessel design to reduce gear and other marine litter discarding	✓		?	
	Better marking and identification of fishing gear	✓	?	✓	
	Improved redundant fishing gear disposal facilities	✓	✓	✓	
	Education and awareness				✓
	Improved fisheries management regime			✓	
	Good practice for avoidance, mitigation and response.	✓	✓		
Mitigation	Design to reduce the incidence and duration of ghost fishing	✓	✓	✓	
Curative	Lost gear reporting, location and recovery initiatives	✓	✓	✓	✓

3.3.1 Voluntary actions and guidance

According to the table on the previous page, most measures investigated in Section 3.2 can be implemented through voluntary means. This rather broad category can include the following approaches.

Codes of conduct: Codes of conduct are often used interchangeably with codes of practice. They are a set of rules, usually established by a representative or umbrella body to harmonise and improve the conduct of its members. Codes of conduct are widely used in the fishing industry to develop and formalise a collective best practice approach, sometimes as support to a third-party certification initiative.

Box 3: Code of good practice to minimise gear conflict and gear loss in gillnet fisheries

THE FANTARED[8] 2 project involved the development of a netting code of good practice to minimise gear conflict and gear loss. It also included the agreement of measures to mitigate the impact of lost gear on commercially important stocks. The gillnet fishing fleets of the UK, Spain, Portugal, France, Sweden and Norway agreed to:

- only set the amount of gear that can be handled regularly and efficiently
- mark gear properly, including the identity of the vessel
- pay close attention to weather patterns and not set gear when poor weather is expected
- ensure that gear is set in such a way as to avoid conflict with other users, and take appropriate precautions when fishing in areas of high marine traffic
- always carry net retrieval gear aboard
- always attempt to retrieve lost gear and reporting its loss where possible.

Regional additions include using radar reflectors, using certain surface buoy combinations for strong current conditions, tagging nets and specifying minimum standards for gear construction.
From Brown et al, 2005.

Voluntary agreements

Another voluntary approach is the establishment of agreements between different parties to improve coordination and reduce the potential for misunderstanding and conflict. A typical example might be communication between different fleet segments operating over a joint fishing ground. Here agreements might be reached regarding access, priority, communication, vessel and gear marking and contingency plans for incidents.

One example of such agreement is the Inshore Potting Agreement (IPA) in South West England. This zoned fishery management scheme has operated since 1978 over an area of approximately 500 km^2. It aims to reduce conflict between different sectors of the fishing industry.

The IPA includes areas for the exclusive use of static gear (principally crab pots), and areas for seasonal static gear use. Towed-gear fishing is allowed in seasonal areas during periods when they are free from static gears. This scheme has worked successfully for nearly 40 years, and has proven to have reduced gear conflict risk. It has also shown it is possible to allow some sectors of the fishing industry to retain access to specific fishery resources while protecting marine benthic species and habitats (Blyth et al, 2004).

Good and responsible design

A third approach, and one rather different from those preceding, is encouraging good and responsible design. This covers a number of different areas, including gear, gear constituents (eg ropes and ironmongery) as well as vessel design.

- **Fishing gear design:** As discussed in the previous section, the particular design of a fishing gear assemblage can dictate its vulnerability to both loss and the gear's ability to ghost fish after control is lost.
- **Fishing gear components:** The design of the constituent components of fishing gear is as important as the design of the whole assemblage. For instance, the use of specific materials (eg biodegradable), can all contribute to the overall robustness of fishing gear, and its behaviour when control is lost. These could include: ropes that do not shed fibres; the integration of identification tags; integration of on-board power, lighting and communication equipment, and robust materials that prevent gear failure in the event of storm or other induced stresses.
- **Vessel design and facilities:** A number of issues associated with ghost fishing can be mitigated through better vessel design. For example, preventing the discarding of gear due to insufficient storage space, or insufficient control and stowage of other marine litter (eg bait packaging). Therefore, the development of innovative and convenient forms of gear and waste storage need to be considered in vessel design and manufacturer.

8. Redes Fantasmas ('ghost nets' in Spanish)

3.3.2 Third-party fisheries certification

The last two decades have seen a rise of seafood-related ecolabels. These are mainly 'Type I'[9] voluntary, multiple criteria-based schemes such as the MSC responsible fishing scheme.

Ecolabelling in fisheries emerged in response to a public and industry perception that public – policy and regulation – mechanisms had failed to manage marine resource sustainability. Ecolabelling provides incentives which drive improvements in fisheries management by rewarding best practice.

These rewards include market access, price premiums and consumer satisfaction. As such, ecolabelling is seen as a tool which can place pressure on governments to address shortfalls in fisheries and aquaculture policy, regulation and management (MRAG et al, 2015).

MRAG et al (2015) mapped over 100 seafood ecolabelling schemes – 73 in detail. Of these, only 16 covered capture fisheries and a further 27 coved both capture fisheries and aquaculture. While we have not done a definitive appraisal of all these capture fisheries eco-labelling schemes, measures to prevent ghost fishing are limited or non-existent in assessments.

The original (Version 1.1) of the MSC Fishery Standard (Principles and Criteria for Sustainable Fishing) specifically included scoring criteria on (i) the loss of fishing gear during fishing operations and (ii) information on the extent and significance of ghost fishing.

However, to simplify the standard in 2004, a new fisheries certification methodology was introduced in 2006. This removed the specific references to lost gear and the potential for ghost fishing.

However, it is still implicit in the current standard (FCR v2.0). The MSC Principles and Criteria for Sustainable Fishing include criteria that relate to ghost fishing and gear loss, including that the fishing operation shall (see Box GSA7 in MSC, 2014)

i. make use of fishing gear and practices designed to avoid the capture of non-target species and non-target size, age, and/or sex of the target species); minimise mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive (3.B.12)

ii. implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas (3.B.13)

iii. minimise operational waste such as lost fishing gear, oil spills, on-board spoilage of catch, etc. (3.B.15).

In summary, unobserved fishing mortality on primary and secondary species[10] and Endangered, Threatened and Protected (ETP) species is still included in MSC's Principle 2, but not explicitly so. This said, MSC does seem to be making some difference in driving better practices. For instance the companies involved in longline fishing of Alaska cod requested a federal government grant of US$500,000. This was specifically research on the impacts of lost longline gear, as recommended by the MSC certification process of that fishery (Washington & Abalouch, 2011).

Relatively few certification standards currently focus on marine litter issues (including lost gear and other litter directly attributable to fishing activities). This is illustrated by the 16 sustainability programmes assessed for WWF International in 2009; only three included waste in their standards. These are:

- the UK's 'Responsible fishing scheme' that considers lost fishing gear recovery, vessel discharges and marine litter recovery
- the 'Clean green' of the Southern Rock Lobster Fishery in Australia that supports removing environmentally unfriendly practices. These include the use of plastic bait box straps, and managing responsible disposal and recycling of marine wastes – oil, plastics and cardboard
- French-based Carrefour's 'pêche responsible' that promotes "responsible production methods and reducing waste" (Accenture Development Partners, 2009).

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9. ISO, 2012, Environmental labels and declarations: how ISO standards help. Available at: http://www.iso.org/iso/environmental-labelling.pdf
10. MSC segregates those species not included in the unit of certification as primary (eg managed) and secondary (eg unmanaged) catch elements.

The KRAV capture fisheries standard does not specifically mention ghost fishing or lost gear, but does include the need for "degradable meshes and degradable panels or equivalent equipment in all cages and traps".

An examination of fisheries certification standards by 'Friend of the Sea' and FairTrade USA suggests that the issue of lost fishing gear or ghost fishing is not included in these standards.

While not an ecolabel per se, the Monterey Bay's 'Seafood Watch' programme includes a Standard for Fisheries. It specifically covers fisheries-related mortality associated with ghost fishing. It also addresses whether there is significant likelihood of ghost fishing and if so whether there is a comprehensive strategy to ghost fishing that includes the following:

i. measures to assess, minimize, and mitigate the impacts of derelict gear from the fishery (eg gear modifications, gear-tending procedures, etc) or

ii. a time-sensitive requirement for reporting gear loss and location. Fisheries must also collect data on lost gear or otherwise demonstrate a method to include ghost fishing impacts in the assessment of fishing mortality (Seafood Watch® Standard for Fisheries, 2016).

3.3.3 Mandatory legislation

Beyond the voluntary approaches of self-determination and third-party-certification described above, the third main implementation approach to the management of fishing gear is mandatory legislation. This option is the primary means of managing authorities to influence fisher behaviour, to better manage gear ensuring it remains under control and their response to losing and recovering gear.

The advantage of legislative measures is that they can be required of all fishers and compliance can be reinforced through punitive measures. However, a legal approach is often expensive to implement and control; and poorly-designed legislation can be both difficult to enforce and, in some cases, be counterproductive.

The main area where a legislative approach has been adopted is in gear marking. This has largely stemmed from international fisheries instruments. These include:

- the United Nations Agreement for the Implementation of Certain Provisions of the Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Fish Stocks Agreement)

- the FAO Code of Conduct for Responsible Fisheries (the CCRF)

- the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement).

These have then been translated into both regional management – for example through the RFMOs (FAD limits, ie IOTC's active FAD limits and IATTC's ban of supply vessels) or through regional blocks such as the European Union) and then into national law.

Hodgson has considered a 'regulatory toolbox of possible approaches to ALDFG' (Stephen Hodgson, pers. comm.,) including the following.

1. **Command and control regulation** – Regulation involves the setting of legally binding rules, either directly in legislation, or as conditions in licences. Regulation is the 'command' part. The enforcement of such rules through the use of civil and/or criminal penalties to sanction non-compliance is the 'control part'. A simple ban on a given activity, such as the deliberate disposal of fishing gear at sea, is one kind of command and control rule that can be imposed. There would be little point in legislating against accidental or unintentional loss of gear.
   Command and control legislation can also be used to require certain actions to be taken in specified circumstances. For example, legislation could require anyone losing fishing gear to report this loss to the relevant authorities and make every effort to recover gear where possible.

2. **Liability regimes** – Liability regimes seek to impose civil liability upon those who cause harm to the environment and/or natural resources through, for example, causing pollution. The amount or quantum of financial damages that must be paid is usually calculated by reference to the costs of remedying the environmental harm.
   Specific liability regimes have been developed in several countries in respect of particularly environmentally harmful activities or those using hazardous substances. Regarding the fisheries sector in general, and ALDFG in particular, it is difficult to see how an 'ordinary' liability regime could be particularly relevant. In particular, what is the harm caused by overfishing or the effects of ALDFG that could give rise to a damages claim?
   Nevertheless, the recovery of ALDFG does have an economic cost. What scope could there be for seeking to recover some or part of that cost if certain requirements are not met in terms, for example, of reporting lost gear?

3. **Impact assessment** – Environmental Impact Assessment (EIA) and Strategic Environment Assessment (SEA) are decision-making tools. They seek to ensure that the potential environmental impacts of specific proposed activities are considered as well as the impacts of a fisheries management

policy or plan. The activities could involve the potential environmental impacts of individual authorisations or the introduction of new fishing techniques.

In the context of ALDFG it is hard to see how impact assessment procedures can have much impact – except perhaps in the sense of designing and funding the operation of fishing ports.

4. **Data and information systems** – Data is absolutely essential to fisheries management. Modern fisheries legislation typically provides the basis for a range of legal rules relating to data. This starts from the collection and collation of fisheries catch and effort data, through storage and information management. In appropriate cases it also involves public access to such data taking into account confidentiality issues. So what could be the relevance of data and information systems to ALDFG? Two main issues would seem to be pertinent. First, globally there is a shortage of data about the scope and scale of the problem of ALDFG. The GGGI has established a working group to address this issue.
Second, and more specifically, if ALDFG is ever to be recovered from the sea information about its location will be essential. Rules on the reporting of ALDFG, either by those who actually lose gear or who come across it, may potentially have a role to play.

3.3.4 Improved awareness, information and other initiatives

The final set of implementation approaches mainly involves raising greater stakeholder awareness of the issue and providing information to assess and combat ALDFG and its consequences. Possible manufacturer-related initiatives to limit gear loss and its impacts are important.

Best practice guidelines

Earlier in this section we examined codes of conduct or good practice as agreed and applied by specific stakeholder groups. A similar, but less targeted approach is the development of wider fairly generic best practice guidelines that will address and inform the fishing community as a whole.

One example of this approach is the FAO gear marking guidelines. An FAO expert consultation prepared guidelines for the marking of fishing gear in 1991 (FAO, 1993). Subsequently a proposed system for marking fishing gear was included in the 1996 FAO 'Technical guidelines for fisheries' (FAO, 1996).

Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) also requires the use of fishing gear identification systems which were updated in 2012. Concern was expressed at COFI 31 (July 2014) over ghost fishing by ALDFG. This paved the way for a new expert consultation on gear marking in 2016 and resulted in the publication of new draft guidelines for the marking and identification of fishing gear (FAO, 2016).

Mike Markovina / Marine Photobank

Information provision

The issue of ALDFG and its role in ghost fishing is well known. In particular, it has attracted the attention of a number of large organisations in recent years. This has resulted in a number of regional and global syntheses, such as Brown et al (2005) and Macfadyen et al (2009). However, there have been very few attempts to either formalise data collection on ALDFG or compile such information.

Gilman (2015) looked at ALDFG data collection provisions among the 19 main global and regional fisheries management bodies. The research found that only four organisations were explicitly mandated by their convention or agreement text to monitor and control ALDFG and ghost fishing.

Gilman suggested that modifying mandates of the other organisations might augment members' political will to monitor, prevent and remediate ALDFG and ghost fishing. He also found that 10 organisations collected logbook or observer data on ALDFG and considered that harmonising data collection protocols where they exist, and filling gaps where lacking, would improve regional monitoring of ALDFG.

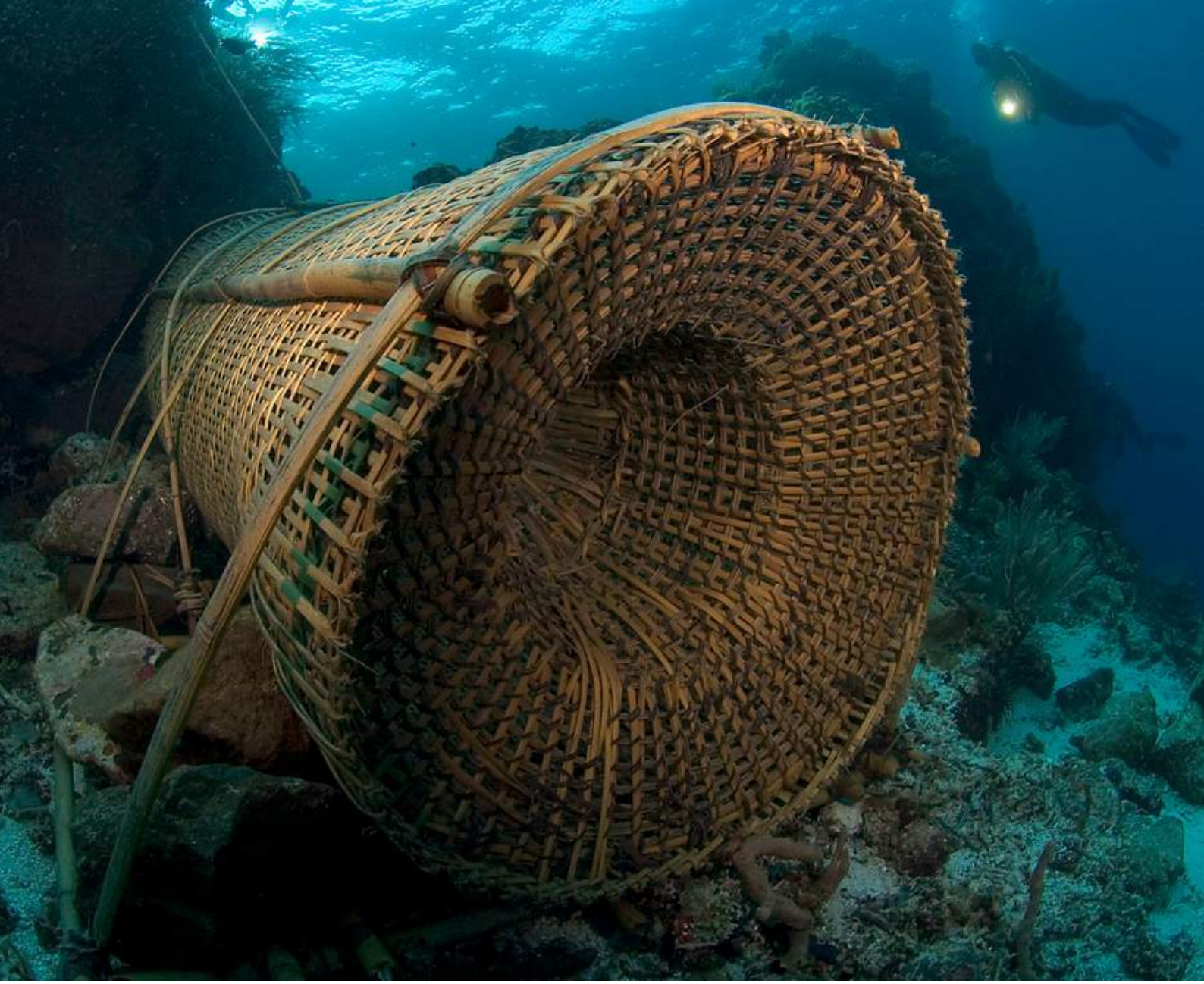
Manufacturer initiatives

Increasing adoption of life cycle analyses by manufacturers, and their incorporation into corporate and social responsibility initiatives, means there is considerable potential for manufacturers to facilitate responsible use of their products. As suggested above, this could include the following initiatives.

- **Gear buy-back schemes / discounted new gear:** One simple approach might be for manufacturers to buy back old gear (for refurbishment or recycling) and discount this value against the purchase of near gear. While apparently simple, there are considerable complications, such as the sorting and collection of old gear and its valuation.

- **Deposit scheme for some gear:** Some discrete gear components, such as plastic pots and buoys could attract an end of life refund when returned to the manufacturer or their agent.

- **Traceability:** Manufacturers should be encouraged to build in traceability to their products marking with manufacturer name, year of manufacture, type of product and production batch.



Sterling Zumbrunn / Marine Photobank

4 RECOMMENDATIONS FOR A BEST PRACTICE FRAMEWORK FOR MANAGING FISHING GEAR

This final task of Phase 1 took stock of the work done so far and proposed a structure for the 'Best practice framework for managing fishing gear' to be produced in the next phase. This section provided some preliminary design proposals which were discussed and agreed with the GGGI 'Define best practices and inform policies working group' over a group call on 25 July 2016.

The purpose of the best practice framework is to "provide clear guidance to a range of relevant stakeholders including seafood businesses, fishing industry, certification bodies and local and national authorities/governments on how to effectively address the issue of ghost gear" (GGGI scope of work to the consultant, April 2016).

4.1 BASIC PRINCIPLES OF THE FRAMEWORK

The following basic principles of the fishing gear best practice framework are proposed.

- As noted by Brown et al (2005), appropriate management responses are likely to be variable for different fisheries, as are the research gaps. However, prevention (ie codes of practices, improved communication between active and passive gear users) and mitigation (eg using biodegradable material to reduce ghost fishing potential) is almost certainly better than cure (retrieval programmes). Consequently, the framework will focus on these two elements in particular.
- Although, as noted above, appropriate management responses will likely be specific to different fisheries, this framework will be generic in approach.
- The framework will be aimed at a wide range of stakeholders, both private and public, non-governmental and governmental.
- The framework will allow the GGGI to involve stakeholders in an informed and structured fashion. This will allow the development of strategies for facilitating change in the use and nature of fishing gear so that ALDFG impact is minimised in the future.

4.2 STRUCTURE OF THE FRAMEWORK

Based on the analysis above, the approach to the framework was to aim it at specific stakeholder groups.

Table 4: Proposed stakeholder-focused best management guidelines for fishing gear

STAKEHOLDER GROUP	BEST PRACTICE AREAS
Gear designers and manufacturers	Embedded traceability; research into, and use of / integration of biodegradable materials; incentives to return redundant / used gear.
Fishers (individuals)	Reduced soak times; gear use limits in high risk areas and during high risk times; marking and identification of fishing gear; responsible storage of gear; reporting of lost gear, guidance on lost / abandoned gear location and retrieval.
Fisheries organisations	Codes of practices specific to fisheries; spatio-temporal agreements with other metiers; monitoring of fishing gear losses; communication protocols.
Port operators	Accessible, low-cost gear and litter disposal facilities; integration into recycling initiatives; better awareness of responsible disposal opportunities; implement 'check out-check in' gear inventories where appropriate.
Fisheries managers and regulators	Designation of spatio-temporal restrictions in high risk areas; development of appropriate gear marking and identification regulations; development of technical regulations to reduced ghost fishing potential in high risk areas; conduct impact assessment to gauge unintended consequences of management actions on gear loss and ghost fishing.
Fisheries control agencies	Establish registry and database of lost / abandoned gear; enforcement of gear marking and identification regulations.
Fisheries and marine environment research	Development of biodegradable materials that are acceptable to fishers, but effective at reducing gear-catching ability after control is lost.
Seafood ecolabel standard and certificate holders	Gear loss and its consequences (eg ghost fishing) needs to be included in all seafood sustainability standards, with supporting guidance provide where necessary.
Seafood companies	Encouraged to ensure that their seafood sourcing avoids high-risk fisheries and that they participate in relevant initiatives eg gear recycling (see Box 1) where possible.
NGOs	Coordination of advocacy, actions and information gathering; contribute to a centralised ALDFG / ghost fishing information hub / forums; organising ALDFG recovery in vulnerable areas.

The final result 'Part 2: Best practice framework for the management of fishing gear', is available as a companion report to this document.

APPENDIX A: REFERENCES

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