5. Review of existing measures to reduce ALDFG

ADDRESSING THE PROBLEM

As earlier chapters of this report illustrate, although the precise magnitude and impacts of ALDFG are yet to be fully quantified and validated, the international community recognizes that the problems ALDFG create are significant enough to warrant action.

Measures implemented to date are often part of activities to address the wider problem of marine litter. A summary of measures being taken under the UNEP Regional Seas Programme on Marine Litter and Abandoned Fishing Gear is presented in the report by the Regional Seas Coordinating Office (UNEP, 2005). The report recognizes that lost and abandoned fishing gear is only one aspect (or component) of the global marine litter problem but it needs to be separately addressed.

Specific measures to address ALDFG are discussed in more detail below. These can be broadly divided between measures that ***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). The examples presented also illustrate that many of these measures can be applied at a variety of levels (internationally, nationally, regionally, locally) and through a variety of mechanisms from legal requirement through to voluntary schemes.

PREVENTATIVE MEASURES

Gear marking

The informal marking of fishing gear is a centuries-old practice to clarify ownership and avoid intra-fishery conflict. The mandatory marking of specific gear to enable identification by competent authorities remains far less widespread.

FAO convened an expert consultation in 1991 through which Guidelines for the Application of a System for the Marking of Fishing Gear were developed. The Guidelines set out the marking system and the responsibilities of owners of gear and fisheries authorities. They also cover the recovery of lost and abandoned gear, salvage and the role of gear manufacturers. In addition liabilities, penalties and control are discussed. (FAO Fisheries Report No. 485, 1991).

Following the expert consultation, FAO produced a set of technical recommendations for the marking of fishing gear (FAO Fisheries Report No. 485 Supplement, 1993) with regard to a standardized system for the type and location of unique identifying marks on tags for each gear type as well as rules to be observed in marking gear so that its presence and extent is obvious to other seafarers.

In 1994, at an expert consultation on the FAO Code of Conduct for Responsible Fisheries in relation to fishing operations, an item on the marking of fishing vessels was included in the debate. The experts offered, *inter alia,* the following solutions:

- reporting of all lost gear in terms of numbers and location to national management entities. Industry and government should consider efforts and means to recover ghost fishing gear; and
- regulatory framework to deal with violators.

They recommended that:

- all fishing gear should be marked, as appropriate, in such a way so as to uniquely identify the ownership of the gear.

Section 8.2.4 of the Code states that "fishing gear should be marked in accordance with national legislation in order that the owner of the gear can be identified. Gear marking requirements should take into account uniform and internationally recognizable gear marking systems" (FAO, 1995). Many FAO Members have gear marking requirements for static gear to support enforcement of licences or for reasons of navigational safety, i.e. marker buoys are labeled rather than the gear itself.

At the RFMO level, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has an active programme to combat marine debris, including debris from fishing activities such as large-scale trawl fisheries for krill and longline fishing for Patagonian toothfish (NRC, 2008). Conservation Measure 10-01 on the Marking of Fishing Gear requires all fishing gear such as pots, marker buoys and floats to be marked with the vessel name, call sign and flag state.

ICCAT does not have measures concerning ALD fishing gear, but Contracting Parties have to ensure that fishing gear is marked in accordance with generally accepted standards. Some nations have, however, already introduced gear marking requirements with explicit recognition of ALDFG issues. Canadian regulations, for example, require static gear to be appropriately marked with operator identifiers: "All types of shrimp traps or ring nets must be marked with the name of the person fishing the gear, i.e. the operator." (DFO, 1993).

The Republic of Korea introduced a gear-marking initiative in 2006 as part of its National Integrated Management Strategy for Marine Litter, which has encouraged fellow member countries of UNEP's Northwest Pacific Area Action Plan (NOWPAP) to adopt similar actions: "Develop and use marked fishing gear to identify its owner or user that will contribute to preventing fisheries-related marine litter being abandoned" (UNEP, 2007).

Generally, the marking of gear remains the choice of individual operators with guidance from authorities focusing on navigational safety rather than ALDFG purposes. For example, in the United Kingdom, advice is provided on the marking of fishing gear by the Maritime and Coastguard Agency (MCA, 2000) and is intended to reduce navigational risk of static gear to vessel operators. See also the FAO technical guidelines on the marking of fishing gear (FAO, 1993).

Even where tagging schemes are introduced, such as in the Australian Northern prawn fleet, tags tend to be attached to headropes and groundropes rather than directly to sections of net or line. This is understandable given the practicalities of implementing such a scheme, but does not assist in the identification of most ALDFG as this is predominantly made up of nets and lines.

Coded wire tags can be implanted into netting and scanned for identifying data when required. Alternatively rogue yarn (a yarn of different twist or color from the rest) can be inserted into multistrand twines. This has been used in Japan to distinguish gear from fishers based in specific management areas.

In 2006, the EC introduced regulations requiring the marking of passive gears (static longlines, gillnets and trammel nets) and beam trawls with the vessels' port licence number as a clear identifier. This applies to all vessels fishing this gear in Community waters outside of member state territorial waters (EC, 2006). To date most Member States have not introduced similar gear identification regulations for vessels fishing within their territorial waters.

Currently there are few examples of national requirements for gear marking intended to address the problem of ALDFG, i.e. marking to prohibit the deliberate abandonment of gear through enabling identification of ownership.

On-board technology to avoid or locate gear

The increasing use of GPS and sea-bed mapping technology by fishing vessels affords benefits in terms of both reducing initial loss and improving the location and subsequent recovery of lost gear. Acoustic instruments that use a combination of two echoes returned from the bottom, offer this possibility. The accuracy of navigation in modern fishing vessels is currently very high when using a GPS system (in the range of ±3 m).

With improvements in sea-bed imaging technology, some mobile gear can be towed close to the sea bed or known obstacles, enabling reduced direct impact/contact with the sea bed or these obstacles, thereby reducing the risk of gear snagging and loss. For static gear, technology can also enable the more accurate setting and subsequent location and retrieval of gear.

The main determinant of successful recovery appears to be the reason for the initial loss of fishing gear; fishers report that where nets are trawled away, it is virtually impossible to recover them at sea (although Danish trawlers catching lost nets are reported to deliver them to the harbour, where they can be identified through tags with vessel number) (Brown *et al.,* 2005).

Transponders are now a common feature in many large-scale fisheries with the satellite tracking of vessels for safety and MCS purposes, and the use of transponders on gear such as marker buoys or floats is becoming more readily available. The fitting of transponders to gear improves the ability to locate gear in the water. This is an added cost to the fisher and is therefore most likely to be used by fishing operations where gear tends to be larger and more expensive than in artisanal fisheries. Large vessels operating mobile gear may already use transponders or sensors attached to the gear to aid net deployment and operation. These large vessels are also more likely to have the capacity to locate and retrieve gear if it is lost.

The use of transponders in coastal fisheries or by small-scale fleets is limited due to cost and technology constraints. For coastal fisheries it is often assumed that the combination of an inshore location where landmarks can be used for bearings and more affordable GPS means that the use of transponders is unnecessary for gear location purposes. But in many fisheries their wider adoption would provide an additional method of location to reduce gear loss through misplacement at minimal additional cost.

Port State measures

Port State measures are seen to be critical in addressing IUU fishing, which is a significant contributor to ALDFG problems as illegal fishers are unlikely to comply with regulation including any measures to reduce ALDFG. Those engaged in IUU fishing are also assumed to be key contributors to abandoned gear prompted by MCS activity.

In 2001, FAO Members, recognizing the threat of IUU fishing, developed within the framework of the 1995 FAO Code of Conduct for Responsible Fisheries, an International Plan of Action (IPOA) to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU). Port state control, or rather the weakness or absence of it, is often quoted as one of the weak links in the chain that facilitates IUU fishing (FAO, 2004). If effective, port State measures can help ensure ALDFG caused by vessels registered under a port state flag or using a state's port facilities is addressed.

A model scheme was devised to address IUU fishing at the port state level. In addition to a reduction in IUU fishing having a positive influence on reducing ALDFG in general, the model scheme proposes port inspections that will enable "examination of any areas of the fishing vessel that is required, including …the nets and any other gear, equipment…to verify compliance with relevant conservation and management measures". Port State measures can therefore contribute to the implementation and enforcement of preventative measures.

FAO is encouraging the strengthening of port State measures in order to combat IUU. In part this is being accomplished through workshops to increase national capacity in inspection and promote regional cooperation. One of the inspection processes being proposed (relating to gear inspection and the marking of gear) is integral to this. Gear inventories for vessels in international waters are also proposed; how a flag state manages its own vessels in its own waters would remain a national issue (J. Fitzpatrick, FAO, personal communication.).

The 27th Session of COFI in 2007 acknowledged the urgent need for a comprehensive suite of port State measures, and strong support was provided for the proposal to develop a new legally binding instrument based on the Model Scheme on Port State Measures to Combat IUU Fishing and the IPOA-IUU.

Onshore collection/reception and/or payment for old/retrieved gear

The provision of appropriate collection facilities is a preventative measure, as it can reduce the likelihood that a fisher will discard unwanted gear at sea. Justification for this provision is provided in the earlier chapter on the causes of ALDFG.

MARPOL Annex V Regulation 7 requires that "the Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them." (IMO, 2006). There has, however, been international recognition that there are scale and capacity issues that have prevented the provision of adequate reception facilities at small ports and harbours, many of which are fishing harbours. For Pacific Island States, a lack of port reception facilities for fishing operations (90 percent of which are foreign) resulted in the South Pacific Regional Environment Programme (SPREP) identifying solid waste management as the number one issue facing Pacific Island States (Kiessling, 2004). While in the United States, the recent NRC report notes that "the United States Coast Guard's (USCG) Certificate of Adequacy (COA) program bases its certification not on whether the ports actually accept shipborne garbage, but on whether they are capable of accepting garbage or can demonstrate that they have service providers on-call who can accept the garbage. While vessel crews docking at these berths well understand that such a service is not usually provided free of charge, vessel crews, ready and willing to pay for disposal services either directly from the facility or via independent entities, are not always able to secure these services, even from those ports with COAs." (NRC, 2008).

The long-term initiative to address the port waste reception problem by FAO and IMO under the BOBP (see heading "International recognition of the ALDFG problem" page 1) initially quantified and categorized the waste problem in fishery harbours in various countries within the Bay of Bengal before developing readily understandable guidelines for the operation of fishery harbours.

The Chennai Declaration was produced from an FAO expert consultation in 1999; it included a number of recommendations to be adopted by national administrations. One recommendation was "the charging of tariffs for services provided by fishery harbors and landing sites and incorporation of effective mechanisms for collection in order to generate revenue, which should be used in the management and maintenance of fishery harbors and landing sites" (FAO, 2000). Although "rational" tariffs are recommended, any additional tariff for reception of waste such as fishing gear may be a disincentive to fishers compared to burning or dumping at no immediate direct cost.

Numerous initiatives have since been developed that provide free waste reception facilities for solid waste such as fishing gear, or these costs are incorporated into general berthing charges or landing fees. In the Baltic gillnet fishery for cod, when nets have reached the end of their useful life, they are generally disposed of in containers in the harbour, with the costs of disposal already contained as part of port fees, so there appears little economic incentive for fishers to deliberately discard nets at sea to avoid onshore costs of doing so. In Greece, net fishers report that they tend to strip the old net off the ropes, and dispose of it in the municipal tip. There is therefore no cost involved and no incentive to discard nets at sea (Brown *et al.*, 2005).

Where recreational fishing is a significant sector, the discarding of monofilament line can be a major contributor to ALDFG. Individually, small amounts tend to be discarded, but the numbers of participants mean that this becomes a significant problem where enforcement of regulations is unlikely to be cost effective and education combined with reception facilities is seen to be a more appropriate route. The safe disposal of monofilament line by United States recreational fishers is encouraged by pier-side reception facilities in several states.

In some circumstances where ALDFG gear is perceived to be a particular problem, authorities have created positive incentives through reward schemes for disposal of old and unwanted gear in appropriate facilities. Box 15 describes a highly targeted project that was in part prompted by the tragic sinking of a passenger ferry after it became entangled in discarded fishing gear. The Korean Government Department, Ministry of Maritime Affairs and Fisheries (MOMAF), purchases waste fishing gear returned to port by fishers; this is reported to be highly effective in terms of recovery and disposal of gear, but there is no evidence that cost–benefit analysis has been undertaken for a scheme that is dependent on significant public funding.

Elsewhere fishing sector schemes target marine litter in general. For example, the Fishing-for-Litter project implemented in the North Sea was originally started by the North Sea Directorate of the Dutch Government in cooperation with the Dutch Fisheries Association in March 2000. The aim of the project was to clear the North Sea from litter by bringing ashore the litter that is trawled up as part of fishing activities and disposing of it on land. The project then rolled out the scheme to other ports around the North Sea. By the end of the three-year project in 2004, 54 boats were involved in four countries, and 450 tonnes of litter had been collected. Without direct

BOX 15

The Korean Waste Fishing Gear Buy-back Project

The Waste Fishing Gear Buy-back project has been implemented successfully in the Republic of Korea since 2003, aiming at collecting fisheries-related marine litter (such as fishing nets, traps, lines, floats) deposited in the sea and on the sea bed. Since fishers used to collect waste fishing gear during fishing operation and throw it back into the sea, the buy-back project is especially designed to encourage fishers to bring ashore the litter collected, as part of fishing activities. This is achieved by providing large, hardwearing bags to the boats so that litter can be easily collected and deposited on the quayside.

An economic incentive is also given to fishers: when they bring back waste fishing gear collected during fishing operation to the designated place, it is purchased at the cost of approximately US$10 per 100 litre bag. The budget for this programme is shared between central and local governments.

Annual amount of litter collected and annual budget or Waste Fishing Gear Buy-back Project

	2003	2004	2005	2006
Litter collected *(tonnes)*	578	2 453	3 076	5 137
Budget (US%)	730 000	2 127 000	2 601 000	3 678 000

Source: Cho in APEC (2004).

financial benefit for fishers involved in the Fishing-for-Litter project, the cooperation of the vessels and their crews is on a voluntary basis, like voluntary participation in beach clean-ups.

Reduced fishing effort

Reducing overall fishing effort (e.g. by limiting fishing time or the amount of gear per vessel) is a fisheries management measure that can also be expected to affect rates of ALDFG. The effect on ALDFG is likely to be a subsidiary impact rather than the primary driver for applying effort reduction measures in a fishery. Effort reduction measures can affect the causes and levels of ALDFG in different ways, depending on the type of input restriction.

For static gear, the amount of gear in the water and the time it is left in the water (soak time), both influence the probability that gear will be lost or discarded, with greater gear use and longer soak times increasing the chances of lost gear.

Many fisheries already limit fishing efforts by monitoring use of pots or number of net hours where soak time is included as a key variable. For example, management of the crab fishery in the CCAMLR region requires an accurate reporting of location data, number of pots set, spacing of pots on the line, number of pots lost, depth, soak time and bait type (CCAMLR, 2006). However, this amounts to soak time's contributing to an overall limit of effort rather than a limit imposed on soak time specifically.

Some fisheries with high catch values and low gear costs create a financial incentive for vessels to fish with large amounts of gear, even if a proportion of that gear is likely to be lost or used only once and then discarded. Vessels may therefore shoot gear, accepting that a proportion will not be recovered. The findings from the DeepNet project illustrate how a lack of regulation may result in a situation where problems of ALDFG arise (Hareide *et al.,* 2005; see Box 16).

A further measure associated with effort limitation is a limit to the soak time for static gear, that is how long it can be left in the water. Leaving gear in the water for longer increases its catch potential, but also increases the likelihood of losing the gear

BOX 16

The DeepNet Project

Since the mid-1990s, a fleet of up to 50 vessels has been conducting a gillnet fishery on the continental slopes to the west of the British Isles, North of Shetland, and at Rockall and the Hatton Bank. Vessels currently participating in the fishery are reported to use up to 250 km of gear, and the nets are left fishing unattended and hauled every three to ten days with trip lengths varying between four and eight weeks. The total amount of nets constantly fishing by the fleet at the same time is conservatively estimated at between 5 800 km and 8 700 km, and the vessels leave their gear fishing while they land their fish.

The vessels are not capable of carrying their nets back to port and only the headline and footropes are brought ashore while the net sheets are discarded; they are either bagged on board, burnt or dumped at sea. These vessels are competing on the same grounds as demersal trawlers and longliners, and this gear conflict is adding to the amount of lost nets. The total amount of loss and discarding of nets is not known, although anecdotal evidence suggests that up to 30 kms of gear are routinely discarded per vessel per trip, which in deepwater locations are known to continue catching for two to three years after loss. The long soak times in this fishery also result in a high proportion of the catch being unfit for human consumption, with on average 65 percent of the monkfish being discarded from nets with four to ten day soak times.

Source: Hareide *et al.* (2005).

as bad weather or other fishers remove the gear. Fishers operating large amounts of gear may also simply forget where some sets of gear are located, which is more likely the longer the gear is left. Such abandonment or discarding of gear is in violation of MARPOL Annex V and as such should be addressed by the flag state of the vessels engaged in the fishery.

The EC banned the use of deep-sea gillnets in some areas in waters deeper than 600 m and only permitted their use at other depths under conditions designed to avoid ghost fishing. The ban (introduced in the TAC and Quota Regulation that was adopted at the Council in December 2005) applies to all nets greater than 200 m, with the exception of the hake and monk fishery, which has additional limits on soak time and maximum length of nets that can be deployed. Norway adopted specific regulations on fishing with gillnets and it raised the issue of ALD fishing gear and marine debris in the North East Atlantic Fisheries Commission (NEAFC), which led to several prohibitions for use of gillnets in deepwater. Vessels in the NEAFC Regulatory Area were prohibited from deploying gillnets, entangling nets or trammel nets in waters deeper than 200 m until regulatory measures were adopted, and all such nets were to be removed by February 2006.

As Box 16 notes, a long soak time will also significantly reduce catch quality. Regulatory measures have therefore been implemented through codes of good practice to improve or assure overall catch quality from a fishery, with the additional benefit that ALDFG may also be reduced. A maximum soak time of 48 hours is already in place in Sweden (Brown *et al.,* 2005).

Output or catch restrictions (e.g. a quota allocated per vessel) can also have positive side effects with respect to ALDFG. The International Pacific Halibut Commission (IPHC) reports that overall gear losses have decreased markedly since the introduction of individual transferable quotas. With the removal of a "race for fish", fishers can better manage their own effort; operating less gear per vessel and having more time for retrieval over a longer operational season (Barlow and Baake, undated). Output restrictions could, however, contribute to ALDFG in some circumstances if, for example, a fisher is deemed to be contravening quota restrictions through recovery of all his gear (and its associated catch).

Spatial management (zoning schemes)

Spatial management can avoid ALDFG by actively segregating marine users or, more commonly, by better ensuring that other marine users are aware of the likely presence of fishing gear in the waters. This reduces the navigational hazard of fishing gear to other marine users and thus reduces the likelihood that gear is damaged or moved.

Spatial management is also applied more specifically to the fisheries sector through the zoning of areas and the establishment of agreements between fishers, which can both serve to reduce ALDFG, often through reduction of gear conflict (a key cause of ALDFG), and can reduce its impact by avoiding fishing activities in sensitive habitats.

There are some successful examples of fishers' agreements between sectors, such as the agreements established between English inshore static gear fishers and French trawlers (Woodhatch and Crean, 1999). Some of these agreements were initially facilitated by the United Kingdom National Federation of Fishermen's Organisations (NFFO), but have remained operational without a need for more formal management measures. In the few instances where there has been a persistent breaking of an agreement, local fisheries management by-laws have been implemented.

Spatial management at a local level may also reduce ALDFG through fostering a stewardship approach to an area. In Malaysia, the establishment of Fishermen Economic Groups (FEG) as co-management mechanisms have given a sense of ownership to fishers, who rightly feel that the FADs and artificial reefs now belong to them and should be properly used, preserved and protected (Nasir, 2002).

MITIGATING (REDUCING IMPACT) MEASURES

Technology can be used to reduce the impacts of ALDFG, particularly through alterations to the gear itself to minimize the potential to ghost fish, but also through ways to better manage gear in the water. These areas are discussed in more detail below.

Reduced ghost catches through the use of biodegradable nets and pots

A number of shellfish fisheries are required to use degradable escape panels in traps. For example, Florida's spiny lobster fishery has had such a requirement since 1982 (Matthews and Donahue, 1996). 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". 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.

In Canada, recreational fishing traps require features "to ensure that if the trap is lost, the section secured by the cord will rot, allowing captive crabs to escape and to prevent the trap from continuing to fish". (DFO, 2007). Also in Canada, the Pacific Region Integrated Fisheries Management Plan for crab by traps, 2008, includes various requirements related to biodegradable escape mechanisms (see www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/plans08/crab08pl.pdf). The use of biodegradable materials is less evident in net fisheries.

There have been some efforts to develop biodegradable and oxy-degradable plastics for use in the fishing industry. For example, the Australian and New Zealand Environment Conservation Council (ANZECC) was instrumental in promoting a national approach towards the use of biodegradable materials in bait bag manufacture (Kiessling, 2003). A biodegradable bait bag has been developed for use by recreational fishers in Queensland and is likely to be introduced to western Australia. Trials have now begun for the development of biodegradable ice bags.

FIGURE 11
Crab trap with rot cord

Source: Fisheries and Oceans, Canada.

BOX 17

Passive pinger wins a prize for the United Kingdom in the WWF Smart Gear Competition

An innovative device which could significantly reduce the number of harbour porpoises and other cetaceans caught in fishing nets has won a prize the for the United Kingdom in the International Smart Gear Competition organized by WWF.

Since the 1990s, acoustic pingers have been effective in reducing cetacean bycatch. However, their relatively high cost has hindered their wider implementation, as have concerns over reliability and whether they cause noise pollution to the animal's environment in the long term. Developed by Aquatec Group Ltd, the Passive Porpoise Deterrent alerts porpoises to the presence of fishing nets using resonant acoustic reflectors that increase the net's "acoustic visibility", and do so in a less complicated way than the currently used pingers. When a porpoise emits a click, the reflectors transmit back a stronger echo, making the reflectors appear to the porpoise to be much larger objects than they are, and thus alerting them to danger.

Source: www.Seafish.org, United Kingdom news release, 15 November 2007.

Reduced ghost catches of incidental catch species

Fishing gears with the potential to capture significant bycatch of non-target species (cetaceans, pinnipeds, turtles, seabirds) when actively fishing, also have the potential to result in non-target species bycatch once gear is abandoned, lost or discarded. Mitigating against such ghost fishing of bycatch can be effected by using the same measures as in active fishery, such as acoustic beacons ("pingers"), reflectors in gillnet and set net fishing gears. But it should be recognized that the effectiveness of such measures can rapidly decrease when gear is no longer actively being fished and the pingers run out of power over time.

Of perhaps greater significance to ALDFG reduction are mitigation measures that are effective even when fishing gear is not being actively fished. Trials are progressing with substances that reflect sound, such as barium sulfate, with such substances being added to nylon net during production. The additive does not affect the performance or the look of the net in any way, but it reflects sound waves in ranges used by echo-locating animals (Schueller, 2001). Other developments supported by WWF's International Smart Gear Competition (www.smartgear.org) have produced weak ropes that are operationally sound, but break with the action of marine mammals, and magnets attached to longlines to repel sharks. Innovative solutions such as the passive pinger (see Box 17) should retain effectiveness even when the gear is lost.

EX-POST CLEAN-UP/CURATIVE MEASURES

Locating lost gear

As discussed under heading "On-board technology to avoid or locate gear" (page 58), generally fishers will make every possible attempt to locate and recover their own gear as it has a significant economic cost in most fisheries, although they will consider the time and fuel costs necessary to do so. This chapter addresses locating lost gear and where a survey may be needed to inform subsequent recovery.

Surveys can range from those with low costs, such as land-based beach surveys involving volunteers, to those at sea with high costs, using side scan sonar operated from sophisticated marine research vessels. The type of survey required and/or possible is dependent upon the type of ALDFG expected to be the key issue in the area and upon the resources available. Land-based surveys are common, and may be the most appropriate form of survey where the key impact is onshore entanglement or littering, such as on turtle nesting beaches. The Ocean Conservancy's Marine Debris monitoring program has a widely adopted annual international coastal clean-up that provides guidelines for beach survey and subsequent clean-up (www.oceanconservancy.org).

Sea-based surveys can be used to locate lost fishing gear that may still be ghost fishing or damaging habitats. Where no accurate information on location of gear is available, the use of modeling techniques, local knowledge and anecdotal information to identify potential hotspots is essential in order to better target a survey intended for gear retrieval. Towed-diver surveys of the northwestern Hawaiian Islands were better targeted with the identification of high entanglement risk zones (HERZ) through recognizing 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) is a sea-bed mapping technology that 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. Figure 12 shows the images from a SSS survey that could enable the accurate location of fishing traps. The sport trap appears as a square shape at the top of the image, and the commercial trap, the circular shape, and the line appear at the bottom of the image.

The NOAA Gulf of Mexico Marine Debris Project has used SSS from survey vessels in its retrieval of large marine debris and is also using an autonomous survey vessel (ASV). The vehicle has a maximum operating depth of 100 m, but it is used primarily for shallow water surveys (depths of less than 50 m). The ASV (Figure 13) is used to detect and map submerged wrecks, rock, and other objects that pose a hazard to navigation for commercial and recreational vessels. Deployment of the ASV must be strictly controlled to ensure it does not itself create a navigational hazard.

In the United States, from 1986 to 2002, the International Coastal Cleanup removed 89 million pounds of debris from more than 130 000 miles of shoreline. Starting in 1995, more than 108 000 divers also collected 2.2 million pounds of trash in over 3 900 miles of underwater habitat (United States Commission on Ocean Policy, 2004).

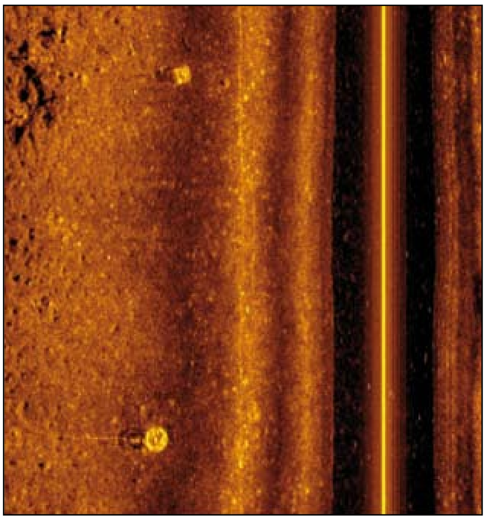
Other possible sources of information might include skipper interviews and the interpretation of VMS plots.

Better reporting of gear loss

Reporting of gear loss may come from the operators of the fishing gear themselves or from other operators that have come across ALDFG. Direct reporting from the operator of the gear should enable more accurate location and identification of the gear, but such reporting is rare.

However, ships (including fishing vessels) over 400 GT and ships certified to carry 15 or more persons, representing a very small fraction of the global fishing fleet, are required under MARPOL to carry a garbage management plan that the crew should follow. Such ships are to be provided with a garbage record book, to include the dumping or loss of fishing gear at sea as well as discharging gear to reception facilities. The garbage record book is subject to inspection by the appropriate administration, usually on an annual basis, but it is also subject to random inspections by the coast guard and fisheries monitoring, control and surveillance officers and port state officers. Therefore, if smaller vessels were to be required by regulations in the shipping or fisheries acts to meet the same conditions that apply to the larger vessels, the record book would be subject to the same inspection procedures. A number of national maritime administrations (such as the Icelandic Maritime Administration) provide guidelines in relation to fishing vessels together with the record book on the reporting

FIGURE 12
Side scan sonar image of ALD traps



Source: Innerspace Exploration Team, United States (from Natural Resources Consultants, Inc., 2007).

FIGURE 13
Autonomous survey vessel used in the Gulf of Mexico

Source: NOAA Marine Debris Program.

of fishing gear lost at sea or incinerated. The form of a garbage record book is given in the Appendix to Annex V of MARPOL.

There are varied approaches and differing national capacities to record and report gear loss. Malaysia established a national inventory of net types and other fishing gear and Latvia obtained data on gear losses and economical casualties to fisheries through a fisheries data collection system and specific questionnaires sent to fishers. Namibia expressed the need for both technical and financial assistance to study and develop a data collection system on gear loss (UNEP, 2005).

In the United States, the California Lost Fishing Gear Recovery Project provides an online reporting form and a free phone number for any marine user to report

FIGURE 14
Creeper gear for recovery of gillnets on board the MFV *India Rose*

Source: Hareide *et al.*, 2005.

the location of ALD gear. The NOAA Fisheries Service has also adopted a set of federal regulations that apply to foreign fishing vessels fishing in the United States Exclusive Economic Zone (EEZ). In addition to requiring foreign vessels to have permits, on-board observers and recordkeeping, and to facilitate enforcement, the regulations contain an express prohibition of the disposal or abandonment of fishing gear, and foreign fishing vessels are also required to report accidental loss or emergency jettisoning of gear to the United States Coast Guard.

The Norwegians have a mandatory reporting procedure that is effective – it is estimated that in excess of 80 percent of losses are reported (Norman Graham, personal communication, 2008). Even though many gear recovery programmes promote a "no blame" approach to lost gear reporting (as advocated by the Northwest Straits Derelict Fishing Gear Removal Project in the northwest of Washington State, United States), there are issues to overcome both in terms of confidentiality relating to precise fishing locations, and of professional pride in admitting gear loss. It is therefore the reporting of ALDFG by other marine users that is most common. In many instances it is recreational users who report lost gear to authorities. Reporting to specific gear programmes by the public has proved to be a useful information source if facilitated (e.g. with online reporting or free phone numbers) and advertised appropriately. This has been significantly assisted by the widespread adoption of GPS technology to enable an accurate logging of location.

Gear recovery programmes

Curative measures often take the form of gear retrieval programmes, which typically entail using a creeper or grapnel (Figure 14) to snag nets. Gear retrieval programmes have been undertaken in net fisheries in Sweden and Poland (Brown and Macfadyen, 2007). Retrieval programmes are also routinely employed by Norway, which led to Norwegian, English and Irish collaborative projects to recover ALDFG from the Northeast deepwater Atlantic gillnet fishery.

The United States has several ongoing gear location and retrieval programmes; many of these are supported by NOAA's Marine Debris Program. For example, the SeaDoc Society at the University of California, Davis Wildlife Health Center, launched the

FIGURE 15
The Gulf States ALD Crab Trap Removal Programme

Source: The Gulf States Marine Fisheries Commission.

California Lost Fishing Gear Recovery Project in July 2005. This project encourages ocean users to report the presence of lost gear, and hires experienced and certified SCUBA divers to remove gear from near-shore waters in a safe and environmentally sensitive manner. Since May 2006, the California Lost Fishing Gear Recovery Project has retrieved nearly 11 tonnes of gear (see www.mehp.vetmed.ucdavis.edu/derelictgear.html).

To better direct gear recovery efforts, some programmes target certain gears such as traps that can be located using remote sensing technology, while others target known hotspots where significant quantities of lost gear may collect or where the habitat is particularly sensitive (as in marine mammal or bird colonies).

The Gulf States Marine Fisheries Commission (GSMFC) produced guidelines for developing ALD trap removal programmes in the Gulf of Mexico. Many elements of the guidelines are transferable to other fisheries and other areas (GSMFC, 2003). Coordinated through GSMFC, a number of states in the United States of America arrange annual voluntary short-term closures and targeted clean-up operations in trap fisheries with assistance from the fishers themselves (see Figure 15). The Louisiana Department of Wildlife and Fisheries reported that "abandoned crab trap closures and clean ups...proved very successful in regards to the total number of retrieved traps, volunteer participation and acceptance by all user groups". Between 2004 and 2007 over 183 boats participated in retrieving nearly 16 000 traps from 1 405 708 acres of coastal waters of the United States (see www.derelictcrabtrap.net/).

The Australian Government has provided AU$2 million (US$1.9 million) in funding to coastal communities in the Gulf of Carpentaria for a project to address ALD fishing nets known as the Carpentaria Ghost Net Programme. Community groups have formed a network to clean up beaches and establish a coordinated information

FIGURE 16
"Ghost net" retrieved by a Scottish trawler in 2004

Source: Directorate of Fisheries, Norway.

recording process to build a picture of the quantities, impacts and likely origins of ghost nets across northern Australian waters.

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

However, gear recovery programmes may face certain legal constraints and challenges. As the recent NRC report noted, "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).

Disposal and recycling

There are numerous examples of the reuse and recycling of ALDFG:

- reuse of nets in fencing for agriculture and aquaculture operations in Taiwan Province of China (APEC, 2004);
- use by rangers in northeast Arnhem Land, Australia, of ALD fishing nets found on the coast to harden coastal tracks for vehicles (Kiessling, 2003);
- recycling of monofilament line from quayside collection boxes (mainly from recreational fishers in the United States) (see www.healthebay.org); and
- reuse of recovered nets in some cases for fishing or recycling of recovered nets into soccer nets.

In other cases recovered gear will need to be disposed of (Washington State Department of Fish and Wildlife ALD fishing gear recovery project).

The Honolulu Derelict Net Recycling Program installed a container for reception of ALD nets and material from various origins recovered by the local longline fleet. In the first year, 11 tonnes of material were recovered and transported to the nearby waste-to-energy incinerator. One tonne of such material produces enough electricity to power a home for five months (Yates, 2007). This programme was operated as a public-private partnership, which reduced cost to the public purse and encouraged greater industry participation.

A similar public-private partnership was established with a recycler in Washington State, United States. The Washington ports, located within an hour or so from the recycler, benefited from providing a service to their fishers and from the free hauling and pickup they received when a recycling container was full (reducing their extremely high waste disposal costs). The Alaska communities, which were 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, which could generate revenue or be used for other commodities (such as baled cardboard or metals), to help defray the costs of transport or had the transport 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 as funds for coordination and promotion of the programme have been reduced (Recht and Hendrickson, 2004).

In isolated areas, burning may appear to be a convenient alternative, but this can create further problems. The burning of debris collected north of the Hawaiian Islands region was found to produce a toxic gaseous by-product (Marine Debris Workshop, Hawaii, 2000).

The Japanese national law categorizes plastic objects such as fishing nets and floats as industrial wastes. Industrial wastes are disposed of only in authorized disposal plants or plants operated by local governments. With respect to recycling technology, efforts have been promoted to develop efficient recovery systems for floating styrofoam materials, mainly coming from aquaculture, which has the problem of involving huge transportation costs because of the low density of the materials (Inoue and Yoshioka, 2004).

AWARENESS RAISING

Raising awareness of the ALDFG problem is a cross-cutting measure that can aid the development and implementation of the measures previously described. It can target fishers themselves, port operators, marine users or the general public through local, national, regional or international campaigns.

Graphic images of entangled marine species are often used to publicize the dangers resulting from ALDFG, but care must be taken that this does not act as a disincentive to fishers to report ALDFG despite the "no blame" approach advocated by various gear recovery programmes.

To raise awareness effectively, the specific problem needs to be understood so that actions can be appropriately targeted. For example, net identification on northern Australia's beaches found that 80 percent of nets originated from outside Australian waters (Kiessling, 2005). As a result of this knowledge, it was understood that engagement at a wider regional level was necessary to tackle the problem.

Increasing the awareness of fishers to issues, including ALDFG, is being addressed at an international level through training materials such as the 2001 version of the joint FAO, ILO and IMO publication *Training and Certification of Fishing Vessel Personnel 2001*. This publication also addresses the FAO Code of Conduct for Responsible Fisheries and deals with lost fishing gear, including discarded fishing gear. However, there remains a need to inform fishers who may not have access to formal training or certification courses for fishing vessel personnel about the ALDFG issue. In such cases, administrations would have to provide additional training to extension services, particularly in relation to the small-scale fisheries sector, in order to reach fishers and fishing communities.

The effective education of stakeholders and facilitation of a change in behaviour can become self-policing and extend beyond those directly targeted to change behaviour in society as a whole. For example, the International Coastal Cleanup (ICC) Program has coordinated volunteer-based marine litter campaigns for several years. The international network has expanded, with several new countries joining the programme in 2006, and many countries had notable increases in participation over 2005, while the training of ICC national coordinators has enabled the establishment of a network of clean-up operations that span the globe (Ocean Conservancy, 2007).

A recent regional workshop in the Caribbean resulted in a decision to undertake a study to describe and quantify the problem of ALD fishing gear in the Wider Caribbean, within the context of fisheries management and the prevention of loss of fishing gear, and to propose solutions to prevent the loss of fishing gear. The study should include solutions for the prevention or reduction of the loss of fishing gear. In particular, it was suggested that the prevention or reduction of loss of fishing gear should be a component of fisheries management plans and that the fisheries administrations in each country should take the lead role in this exercise at the national level. The WECAFC Secretariat and the CRFM will coordinate the study with the assistance of NOAA (Bisessar Chakalall, FAOSLAC, personal communication, 2008).

Raising awareness can also be achieved, and indeed requires, good long-term monitoring programmes to collect data on ALDFG over time, so as to assess trends. Monitoring marine debris and its impacts is a permanent agenda item of CCAMLR and its scientific committee. Members submit yearly surveys of debris on beaches and in seabird colonies, of marine wildlife entanglements, and of hydrocarbon soiling of mammals and seabirds. The secretariat maintains a marine debris database from 12 index sites on the Antarctic Peninsula and on Antarctic and subantarctic islands.

EFFECTIVENESS OF MEASURES

Various measures have emerged to tackle the ALDFG problem as it becomes better understood, including the situations and motivations that result in ALDFG. Some of these measures appear to be possible in theory, but may not be effective in practice. It is therefore important to understand why certain measures are effective in certain situations and why others are not. There have, however, been very few studies to date on the effectiveness of measures. Where parties have attempted to tackle ALDFG, only one or two approaches have been adopted. Comparative analysis is therefore difficult, beyond identifying common features in the situations encountered and the measures adopted.

A measure's "effectiveness" has to date been based on expert judgment, as there are few situations where a baseline is available showing the scale of the problem and enabling targets to be set. For example, results from the DeepNet project led to crude estimates of 1 254 km of gear being lost in the fishery each year (Hareide *et al.*, 2005). A follow-up retrieval programme led by Irish authorities resulted in the recovery of approximately 35 km to 40 km of lost gear, amounting to around 3 percent of estimated annual gear losses. An ALD fishing gear recovery programme carried out in Port Susan, United States, in 2006 identified 403 items from a side scan sonar survey of approximately 95 percent of the known coastal fishing grounds. Seventy-three percent of those items could be investigated by diver and 174 items or 43 percent of the total items identified were removed. These two gear retrieval examples illustrate that levels of effectiveness are likely to differ markedly between measures and between fisheries. It will be possible to determine if these are effective levels of retrieval for the fisheries concerned only through repeated operations. The ability to assess effectiveness of measures should therefore improve as more research is done, as the ALDFG problem becomes better understood and as there are more reports on measures taken to enable comparison.

In the absence of accurate baseline information, determining the effectiveness of a measure is likely to be based on aspects such as acceptability of the measure by stakeholders and associated with this, the measure's enforceability. If fishers feel that a measure is imposing unacceptable restrictions or costs on them, compliance is likely to be low. Low levels of compliance are also likely when a measure is difficult to enforce in practice.

Expert workshops held as part of the EC ghost fishing project (Brown *et al.*, 2005) identified that the perceived effectiveness of proposed measures varied between fisheries, suggesting that a "one size fits all" approach would not work in addressing ALDFG. Table 8 shows the different views of the expert working groups on the effectiveness of measures to tackle ALDFG in the Baltic and the (English) Western Channel. While there was general agreement on which measures are relevant, differences are particularly evident in what the experts believed is acceptable or enforceable in these fisheries. There are, however, areas of commonality. Measures such as acoustic detection systems, biodegradable nets and alternative gears are considered unacceptable by fishers in both fisheries.

As Table 9 shows, many measures are difficult to monitor and enforce without a comprehensive observer programme. Observer programmes can be effective in MCS of offshore fisheries, but are costly to implement and it is a cost often borne by nation

TABLE 8
Assessment of measures to address ALDFG in the Baltic Sea and the English Western Channel
Key: red+ low effectiveness; amber ++ medium effectiveness; green +++ high effectiveness

Management Option	Relevance		Effectiveness		Acceptability		Enforceability	
	Baltic	Channel	Baltic	Channel	Baltic	Channel	Baltic	Channel
Identification marking	+++	+++	+	++	+++	++	+	+++
Reporting losses	+++	+++	++	+++	+++	+++	++	++
Acoustic detection	+++	+	+++	+	+	+	+++	+
Zoning schemes	+++	+++	+++	+++	++	+++	++	+++
Biodegradable nets	++	+	?	++	?	+	?	++
Gear use limits	+++	+++	+++	+++	+++	++	++	++
Soak time limits	+++	+++	+++	+++	+++	++	+++	+
Retrieval programmes	+++	+++	++	+++	+++	+++	++	++
Alternative gears	++	+++	++	+++	+	+	+++	++
Mandatory return of nets	+++		+++		++		+	
Incentive schemes		+++		+++		+++		+++

Source: Poseidon, adapted from expert workshop outputs in Brown *et al.*, 2005.

TABLE 9
Potential management measures proposed by the DeepNet Project

Recommendation	Positives	Negatives
The introduction of restrictions on the length of gear deployed at a given time either by overall length or by fleet of nets. Such restrictions were introduced in NE Altantic driftnet fisheries for albacore tuna.	Reduce fishing effort	Difficult to enforce and to monitor, although VMS does provide a level of control
The certification of fishing gear through labelling	Provide better information on fishing effort	Legal responsibility, problems with damaged or repaired gear, and potentially easy to circumvent
A requirement that vessels cannot leave gear at sea while landing	Reduces discarding through extended soak times	Difficult to enforce and to monitor, although a combination of VMS and adequate marking of gear will provide a level of control
Mesh sizes for fixed gears in region 3 to be harmonized with regions 1 and 2, in particular for hake and monkfish	Stop the use of small mesh sizes in regions 1 and 2	None
A requirement that all gears be marked clearly at either end	Reduce the amount of lost gear and also reduce hazard to other fishing vessels	Difficult to enforce; original EU proposals were too complex to be enforceable
The introduction of measures that stop the stripping of the headline and leadline and dumping of used netting at sea	Reduce the dumping of nets at sea	Difficult to enforce and potentially could have the opposite effect
The spatial management of effort by gear sectors, separating towed and static gears	A proven method of reducing the gear conflict and net loss	Probably difficult to administer and enforce in offshore areas and international waters
Closed areas to protect ecologically sensitive habitats, such as hydrothermal vents, deepwater corals, or other characteristic habitats, such as seamounts	Reduce the amount of lost gear and protect sensitive habitats	Difficult to monitor and enforce if areas are too small, but VMS will allow monitoring of bigger areas. Widespread objection from other sectors of the industry

Source: Hareide *et al.*, 2005.

states rather than by those targeting the fishery. It is also apparent that the suitability of measures varies significantly between fisheries.

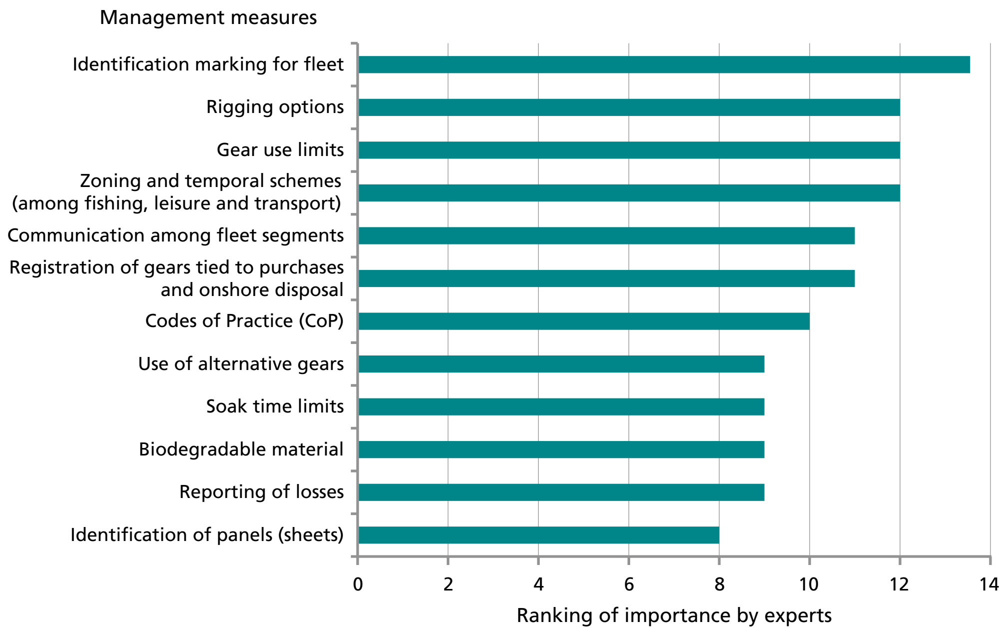
Figure 17 presents potential management measures to reduce gear loss and ghost fishing within the eastern Mediterranean net fisheries, as reported in Brown *et al.*, 2005. Here gear identification was the main priority because of its perceived effectiveness.

COST-EFFECTIVENESS OF MEASURES

The cost-effectiveness of ALDFG measures can be considered by comparing their costs against the (estimated) benefits. The costs associated with ALDFG are discussed under heading "Costs of ALDFG", page 42, but to date few ALDFG programmes have reported the cost-effectiveness of measures, and quantification is often limited to the volume of gear recovered. This is to some extent the result of the difficulty in putting quantifiable estimates on some types of costs. But where cost–benefit analysis has been undertaken, even with the accepted limits to estimations, some have shown a positive cost–benefit ratio. Box 18 shows that recovery programmes can be cost-effective in relation to the direct costs of ALDFG in terms of the value of commercial species lost to ghost fishing. The positive cost–benefit ratio would be far greater with the inclusion of indirect and intangible costs such as human safety and avoidance of the mortality of non-target species, especially if threatened or vulnerable.

However, in certain circumstances a gear recovery programme may not prove to be cost-effective. Brown and Macfadyen (2007) identified that by the time a retrieval

FIGURE 17
Prioritization of management measures for the eastern Mediterranean



Source: Poll output of expert working groups reported in Brown *et al.*, (2005). Bottom axis refers to relative ranking of importance across the expert opinion.

programme is implemented, ghost nets may only be making very small ghost catches due to the rapid decline in catch rates over time. The benefits of preventing this ghost catch may therefore be minimal unless very large quantities of netting are being lost and/or nets are lost in deepwater with little current/tidal activity, thereby reducing the rate of decline in catch rates.

Additionally, the benefits of retrieval programmes may be limited where nets are lost in areas of high trawl activity, because in such cases trawlers can be expected either to pick up or ball up a large proportion of lost nets, resulting in reduced ghost fishing catches in comparison to active catches. Gear retrieval programmes are therefore likely to prove most cost-effective compared to "do nothing", where gear can be located and retrieved quickly (otherwise much of the measurable damage is done), and/or where a significant amount of gear is lost that cannot be recovered by regular fishing activity itself.

A cost–benefit model developed by Brown and Macfadyen (2007) suggests that (a) gear retrieval programmes may only be cost-effective in fisheries where the actual costs of ghost fishing are high; and (b) preventative measures are likely to be preferable to curative ones (see Box 18). Measures that prevent gear loss, can avoid the potentially high costs associated with ghost catches immediately after gear loss, which retrieval programmes are unlikely to be able to do, and they avoid the cost of time spent searching for that gear. However, even in highly regulated fisheries where gear loss is minimized, there may be some need for gear retrieval (Norman Graham, personal communication, 2008).

One of the few attempts to date to compare cost-effectiveness of various gear retrieval methods was by Wiig (2004). Through applying a "hazard hierarchy" in order of killing intensity and cost per tonne removed, he sought the maximum environmental benefit for the minimum cost. He concluded that while certain clean-up programmes (beach clean-ups) are far less expensive than ghost net retrieval at sea – and certain types of debris (crab pots and snagged net) are more hazardous – the ghost net programme

BOX 18
Cost–benefit analysis of ALD fishing gear removal in Puget Sound, United States of America

Information collected over the past four years (from 2004 to 2007) during the Northwest Straits Initiative's ALD fishing gear survey and removal programme in Puget Sound, Washington State, was used to estimate costs and directly measurable benefits of ALD fishing gear removal.

Costs of the ALD net survey and removal totaled US$4 960 per acre of net removed. Costs of survey and removal of ALD pots/traps totaled US$193 per pot/trap. Directly measurable monetized benefits of ALD fishing gear removal were based on the commercial ex-vessel value of species saved from mortality over a one-year period for ALD pots/traps, totaling US$248 per pot/trap and a ten-year period for ALD nets, totaling US$6 285 per net. The cost–benefit ratio was positive and similar for the removal of both gear types, measuring 1:1.28 for pots/traps and 1:1.27 for ALD nets.

Although indirect benefit values of human safety, unimpeded vessel navigation, habitat restoration, reduction in mortality of non-commercial and protected or endangered species and pollution removal were not monetized, ALD fishing gear removal compared favorably in cost-effectiveness with habitat restoration and wildlife rehabilitation projects. Given the expected long-term life span of these mainly synthetic-based ALD gears, negative impacts may continue for many years or decades beyond the ten-year period used in the cost–benefit analysis. The cumulative costs of not removing the ALD gear now will likely be much higher in the future.

Source: Natural Resources Consultants, Inc., 2007.

will be more cost-efficient in reducing marine animal deaths caused by marine debris. This research was, however, hindered by a lack of available data. The results were based on the circumstances found in the specific United States programmes being considered, where the damage caused by ghost nets in situ was deemed to be far greater than the damage caused by gear that washed ashore. In other situations, the opposite may be true, such as in the turtle-nesting beaches of Australia's Northern Territory, where the most damaging impacts identified are caused by entanglement ashore.

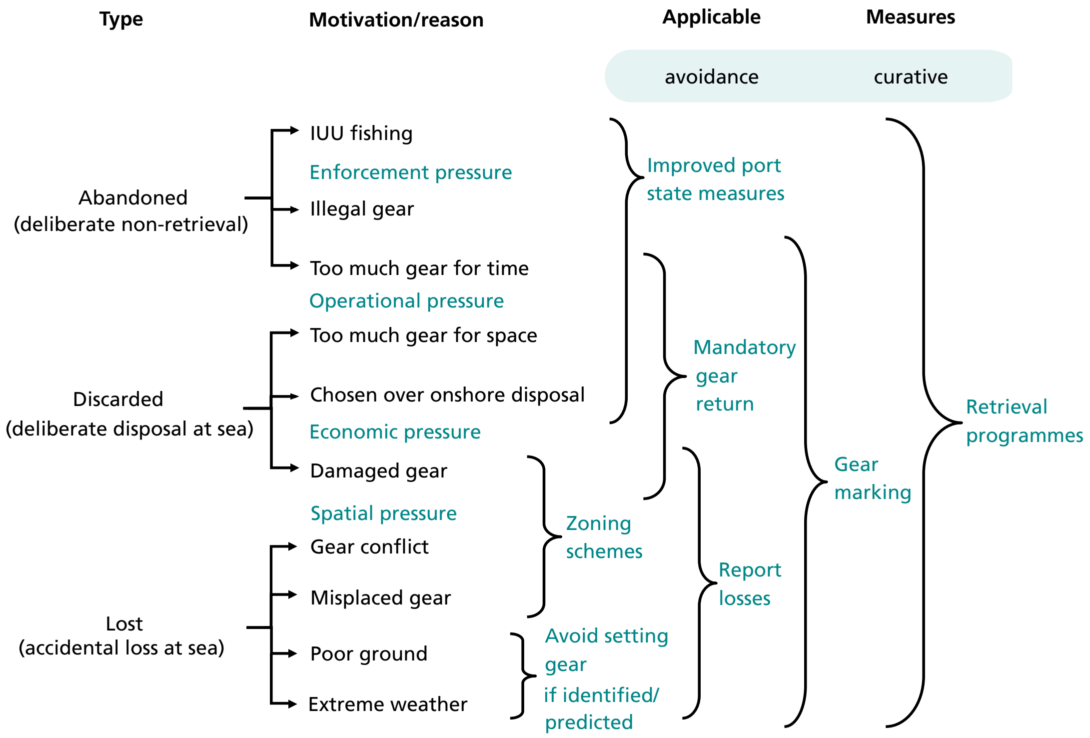
Assessing the effectiveness of curative measures such as gear retrieval is a simpler process than for most preventative measures, where it may be difficult to establish that the retention of fishing gear that would otherwise have been abandoned/lost/discarded, is a result of a particular preventative measure. The impact of preventative measures and awareness-raising initiatives tend to be inferred from surveys of fisher behaviour or opinion.

SUMMARY OF EXISTING MEASURES TO REDUCE ALDFG

A variety of measures aimed at the prevention, mitigation or cure of ALDFG have been identified, with many being implemented across the globe. Some measures, such as gear recovery programmes, are specific measures to tackle ALDFG, while others, such as effort restrictions (pot limits, soak time limits), may be implemented to tackle more general problems of overcapacity, but may have the additional benefit of reducing ALDFG.

The most appropriate measure to tackle ALDFG is more likely to be identified if the type and cause of ALDFG is known for any particular situation. For example, if gear

FIGURE 18
Types of ALDFG, their causes and measures to address



Source: Poseidon, 2008.

conflict is a key cause of lost gear, better spatial management to avoid conflict should reduce the incidence of ALDFG. Where discarding of unwanted or damaged gear at sea is seen to be an issue, a lack of accessible reception facilities may be a key factor and the provision of those facilities should reduce ALDFG.

Figure 18 summarizes the various types of ALDFG and the measures applicable in addressing them. The range of applicable measures move from preventative/avoidance measures (most effective) on the left to curative measures on the right. As the figure indicates, preventative measures are more targeted to specific types of ALDFG, while curative measures can address ALDFG from numerous causes. Fisheries may well experience several types of ALDFG due to a variety of causes.

Many measures are also of limited effectiveness in isolation, and it is therefore suggested that a suite of measures should be implemented. Curative measures could be implemented promptly while preventative measures would be implemented once the causes of ALDFG are known. For example, a comparatively intensive gear retrieval programme may be undertaken initially to remove the immediate problem, but this should be supported by measures to prevent the recurrence of an ALDFG problem in the area, e.g. through awareness-raising, communication between fishers and/or provision of reception facilities.

Measures imposed or taken in isolation may not be effective. For example, gear marking is only likely to make a significant difference if this is supported by an MCS regime that ensures a high level of industry compliance. So too, the provision of waste facilities will only avoid inappropriate disposal if there are incentives (regulatory or economic) applied to encourage their use.

A number of measures to tackle ALDFG remain theoretical rather than applicable in real world situations. Some gear adaptations to reduce or mitigate ALDFG, such as biodegradable nets or lines, are possible, but further testing and cost issues still need to be overcome. Economic incentives are only applied in a small number of cases (such as the payment by Korean authorities to fishers for delivering unwanted or ALD gear). It is difficult to determine the economically optimum level of payment in this instance – particularly because many of the benefits to the marine environment remain difficult to quantify.

A consistent conclusion from a number of recent projects and workshops on ALDFG[19] is that "prevention is better than cure". This is certainly true in environmental terms, but has also been found to hold true in the limited number of cost-effectiveness studies. In general, curative programmes tend to be less effective and more costly than avoidance measures, but they can still be cost-effective when considered against doing nothing. For example, gear retrieval programmes have been shown to be cost-effective when considered against the cost of ghost fishing resulting from leaving ALDFG *in situ*.

[19] See outputs from FANTARED and DeepNet projects and workshop discussions presented in Brown *et al.* (2005).