The problem of abandoned, lost, and otherwise discarded fishing gear in Eastern Caribbean small-scale fisheries: understanding the challenges, defining solutions

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THE PROBLEM OF ABANDONED, LOST AND OTHERWISE DISCARDED FISHING GEAR IN EASTERN CARIBBEAN SMALL-SCALE FISHERIES

Understanding the challenges, defining solutions.
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THE PROBLEM OF ABANDONED, LOST AND OTHERWISE DISCARDED FISHING GEAR IN EASTERN CARIBBEAN, SMALL-SCALE FISHERIES

Understanding the Challenges, Defining Solutions

Tricia A. Lovell
Antigua & Barbuda/Trinidad and Tobago

A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Maritime Affairs

WMU RESEARCH REPORT SERIES
No. 29, August 2023
WMU Publications
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Abstract

Abandoned, lost, and otherwise discarded fishing gear (ALDFG—also termed derelict fishing gear) is a complex and significant global challenge for which strong, robust, and holistic governance is required. ALDFG is considered the most dangerous form of marine debris, as it is designed to capture marine organisms and can do so long after it has become derelict. While there has been an increasing body of work in academic literature on the scale, impact, and management of ALDFG, significant knowledge gaps still exist about how this challenge is affecting the small-scale fisheries of the Eastern Caribbean. This research has been designed to comprehensively review the ALDFG challenge in the Eastern Caribbean. It considers not only issues of scale and impact but also the policy landscape, governance regime, and mechanisms for improved governance.

The study utilised a socio-legal approach to conduct a critical analysis of ALDFG associated with Eastern Caribbean small-scale fisheries. The qualitative methodologies utilised in the assessment were interviews of a range of stakeholders, case studies and legal reviews. The study is underpinned by the environmental governance framework proposed by Bennett and Satterfield, and has adopted a three-step research framework that seeks to: (1) establish baselines and set the context of the research theme; (2) understand the existing governance regime including challenges and barriers; and (3) outline mechanisms for improved governance.

The study focused on the English-speaking members and associate members of the Organisation of Eastern Caribbean States, as well as Barbados. The empirical data obtained through this study have revealed that ALDFG in the Eastern Caribbean is not only a localised challenge but a transboundary threat. Several key informants reported encountering derelict gear that seemingly entered the region from as far away as the Eastern Atlantic Region. Polypropylene nets, ropes, fish aggregating device components, fish crates and octopus traps are among the observed forms of ALDFG that originated outside the study area. Data derived from fisher surveys in Dominica and in Antigua and Barbuda also indicate that, with regard to drivers of loss in local fisheries, environmental drivers are the major contributor, not just in the case of trap fisheries but also for line fisheries.

With regard to the legal and policy landscape for ALDFG in the Eastern Caribbean, it was found that the regulatory regime was fragmented, relatively weak, and largely lacking in ALDFG-focused legislation. While some fisheries management measures have been shown to aid in the mitigation of ALDFG-related threats, these were not legislated for throughout the sub region. Investigations on the implementation of gear marking systems within two jurisdictions highlighted the weaknesses in
compliance, and implementation gaps that exist with regard to ALDFG regulatory provision in the two case study jurisdictions.

Governance of ALDFG in the Eastern Caribbean is challenged by a number of structural, institutional, and procedural barriers, along with cross-cutting barriers that affect not only fisheries but also other sectors that may be involved in the management, compliance, and surveillance of fishing gear, and in the execution of end-of-life strategies. For many of the Eastern Caribbean jurisdictions that were part of this study, the issue of ALDFG was generally not prioritised by national fisheries agencies. This may be linked to limited public awareness of the challenges, since much of the region’s ALDFG remains hidden in the ocean environment, but it may also be linked to the limited capacities that exist within these government agencies. Limitations in the available financial and human resource capacity to effectively manage the issue, challenges in coordination, lack of supporting infrastructure, data and information gaps, and communication gaps are among the main challenges highlighted by policy experts interviewed for this research. Policy incoherence was also a proposed as a major barrier to ALDFG governance, not only nationally but also regionally. In fact, the lack of synergies, coordination and collaboration on matters relating to ALDFG, and broader ocean governance may become further exemplified when moving up the governance scale from national to regional level.

In order to improve governance of ALDFG, a range of recommendations were proposed by key informants participating in this research. Mechanisms to create collaborative arrangements at both the national and regional levels, for instance, can assist in overcoming policy coherence challenges. Training and capacity building as well as awareness activities may provide the requisite knowledge, data, and information that fisheries managers may need to begin prioritising ALDFG within their national fisheries management regimes. The need for establishing open lines of communication with other actors outside the fisheries sector—for instance customs departments and waste management bodies—is also acknowledged, to allow for improvements in the monitoring and surveillance of fishing gear entering the fisheries system, as well as strategies for managing ALDFG waste and end-of-life gear.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALDFG</td>
<td>Abandoned, lost and otherwise discarded fishing gear</td>
</tr>
<tr>
<td>CARICOM</td>
<td>Caribbean Community</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CRFM</td>
<td>Caribbean Regional Fisheries Mechanism</td>
</tr>
<tr>
<td>CTC</td>
<td>Closing the Circle Programme: Marine Debris, Sargassum and Marine Spatial Planning in the Eastern Caribbean.</td>
</tr>
<tr>
<td>FAD</td>
<td>Fish aggregating device</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation (of the United Nations)</td>
</tr>
<tr>
<td>GESAMP</td>
<td>Group of Experts on the Scientific Aspects of Marine Protection</td>
</tr>
<tr>
<td>GCFI</td>
<td>Gulf and Caribbean Fish Institute</td>
</tr>
<tr>
<td>GGGI</td>
<td>Global Ghost Gear Initiative</td>
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<tr>
<td>GPML</td>
<td>Global Partnership on Marine Litter</td>
</tr>
<tr>
<td>GPML-Caribe</td>
<td>GPML-Caribbean</td>
</tr>
<tr>
<td>ICCAT</td>
<td>International Commission for the Conservation of Atlantic Tuna</td>
</tr>
<tr>
<td>ILBI</td>
<td>International legally binding instrument</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
</tr>
<tr>
<td>IUU</td>
<td>Illegal, unreported and unregulated (fishing)</td>
</tr>
<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from Ships</td>
</tr>
<tr>
<td>MEPC</td>
<td>Marine Environment Protection Committee (of the IMO)</td>
</tr>
<tr>
<td>MFAD</td>
<td>Moored fish aggregating device</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
</tr>
<tr>
<td>OECS</td>
<td>Organisation of Eastern Caribbean States</td>
</tr>
<tr>
<td>RAPMaLi</td>
<td>Regional Action Plan on Marine Litter</td>
</tr>
<tr>
<td>SGD</td>
<td>St. Georges Declaration</td>
</tr>
<tr>
<td>SIDS</td>
<td>Small island developing states</td>
</tr>
<tr>
<td>TBTI</td>
<td>Too big to ignore</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<tr>
<td>UNEA</td>
<td>United Nations Environment Assembly</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNEP-CEP</td>
<td>UNEP-Caribbean Environment Programme</td>
</tr>
<tr>
<td>UNEP-CAR/RCU</td>
<td>UNEP-Caribbean/Regional Coordinating Unit</td>
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<tr>
<td>USD</td>
<td>United States dollars</td>
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<tr>
<td>VGMFG</td>
<td>Voluntary Guidelines for the Marking of Fishing Gear</td>
</tr>
<tr>
<td>WECAFC</td>
<td>Western Central Atlantic Fisheries Commission</td>
</tr>
<tr>
<td>WMU</td>
<td>World Maritime University</td>
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<tr>
<td>XCD</td>
<td>East Caribbean dollars</td>
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1 Introduction

Marine litter, also termed marine debris, is ubiquitous in the global ocean, and can be found from the deepest parts of the ocean floor to ocean gyres; in remote regions far from human activity, and on coastal beaches and nearshore ecosystems (Chassignet et al., 2021; Chiba et al., 2018; Galgani et al., 2015; Lebreton et al., 2022; Tekman et al., 2017). Defined as “persistent, manufactured or processed solid material [that is] discarded, disposed of, or abandoned in the marine and coastal environment” (UNEP, 2009, pp. 13), marine debris can lead to considerable environmental harm and result in the deaths of marine and coastal wildlife. Entanglement in marine debris and ingestion of debris fragments have been recorded for a range of species, including marine reptiles, cetaceans, elasmobranchs and bird species (Bond et al., 2013; Duncan et al., 2017; Laist, 1997; Parton et al., 2019; Rodríguez et al., 2022).

Litter can enter the marine environment through multiple pathways: from the air, through rivers and streamways, and by unintentional and intentional discards (Courtene-Jones et al., 2021; Löhr et al., 2017; Rech et al., 2014; UNEP, 2021). Once litter enters the ocean, the distribution and accumulation of floating debris are controlled by currents, as well as physical oceanographic phenomena—including large-scale open ocean processes, internal tides, coastal currents, and vertical transport and mixing—which distribute floating debris particles into these areas (Chassignet et al., 2021; Van Sebille et al., 2020). Thus marine litter also poses a transboundary environmental challenge that requires cross-border collaboration for its governance.

It is widely acknowledged that the vast majority of debris in the ocean originates from land-based sources (Bellou et al., 2021; Galgani et al., 2015; GESAMP, 2021; UNEP, 2021). However, the contribution of sea-based sources of marine litter to the global burden of ocean debris is poorly understood (Folbert et al., 2022; GESAMP, 2021). Sea-based marine litter may be defined as “any form of human-made, synthetic debris deposited directly into seawater from a vessel, facility or activity that is situated in or on, or is taking place entirely on or within, the ocean” (GESAMP, 2021, p. 11). This includes the intertidal and pelagic zones, and encompasses “adjacent seawater bodies [such as] harbours, bays, estuaries, and lagoons” (GESAMP, 2021, p. 11). Thus, sea-based marine litter may originate from shipping activities, recreational boating including the cruise ship industry and
chartered yachts, legal and illegal dumping, mariculture, and fisheries (Carić & Mackelworth, 2014; Chassignet et al., 2021; Folbert et al., 2022; García-Rivera et al., 2017; GESAMP, 2021; Moore, 2014; Saliba et al., 2022). Further, it has been noted that some forms of sea-based marine litter (particularly abandoned, lost and otherwise discarded fishing gear: ALDFG) may have an even greater impact on marine wildlife and habitats than other forms of marine debris, as they are designed to capture, ensnare or entangle marine wildlife (GESAMP, 2021; Nama & Prusty, 2021).

1.1 Fisheries as a source of marine litter

Marine capture fisheries play an important role in global food security and economic development, and provide livelihood and employment to millions around the world. This is true not only for industrial and large-scale commercial fleets, but also for small-scale, artisanal, and subsistence fisheries. In 2020 the world had an estimated 4.1 million fishing vessels, with Asia hosting approximately two-thirds of the global fleet (FAO, 2022). While there was an overall downward trend in the global fleet size between 2015 and 2020, this was accompanied by an increase in motorisation and a shift towards larger more powerful vessels (FAO, 2022). Notwithstanding this, in 2020 an estimated 81 per cent of the global fishing fleet of known length measured less than 12 m. Most of these vessels were located in Asia, followed by Latin America and the Caribbean (FAO, 2022). As a result, a significant portion of marine capture production results from small-scale fishing vessels. In fact, small-scale fisheries contribute an estimated 36.9 million tonnes of seafood to global landings each year, amounting to 40 per cent of annual capture (FAO et al., 2023). It has also been shown that artisanal fishing effort, in all regions but Europe and Oceania, is equal to or larger than that of their industrial fleets (Rousseau et al., 2019). In fact, small-scale fisheries employ more individuals than other marine sectors including industrial fisheries and the oil and gas sector (Smith & Basurto, 2019).

All this fishing effort—while essential to global food security, community development, and economic growth—may have negative effects on marine and coastal ecosystems. One of the most significant of these potential effects is the contribution to the growing global marine debris crisis, particularly through abandoned, lost, and otherwise discarded fishing gear (ALDFG). ALDFG, also termed derelict fishing gear, refers to any device or component of a device used for the capture, control or harvest of marine organisms that has become derelict, and is no longer under the control of the fisher or vessel from which it was deployed (GESAMP, 2021). This includes both active and passive gear types, fish aggregating devices (FADs), and gear components such as floats, buoys and ropes.
FAO (2019, p.6) defines “abandoned”, “lost” and “discarded” fishing gear as follows: abandoned gear refers to “fishing gear over which [an] operator/owner has control and that could be retrieved by the owner/operator, but that is deliberately left at sea due to force majeure or other unforeseen reasons”. Lost fishing gear is “gear over which the owner/operator has accidentally lost control and that cannot be located and/or retrieved by the owner/operator”. Discarded fishing gear refers to “gear that is released at sea without any attempt for further control or recovery by the owner/operator”.

As previously noted, it is widely acknowledged that most of the marine debris found in the global ocean originates from land-based sources. However, one study has shown that ALDFG may make up the majority of floating debris found in offshore areas like the North Pacific Garbage Patch (Lebreton et al., 2022). That assessment found that as much as 75-86 per cent of floating plastic in the area could be considered ALDFG (Lebreton et al., 2022). Another recent study estimated the average annual loss of fishing gear globally to be 1.82 per cent (±0.20%), including 0.81 per cent (±0.19%) of all gill nets, 3.33% (±0.59 per cent) of all longlines and mainlines, and 0.74% (±0.11 per cent) of all traps (Richardson et al., 2022). This equates to 2,962.91 km² of gill nets, 739,582.8 km of longline mainlines, 15,570,273 km of longline branch lines, and 25,382,742 pots and traps each year (Richardson et al., 2022). That study, however, acknowledged that these estimates were largely based on commercial fisheries, and noted the knowledge gap that exists with regard to artisanal and recreational fisheries, as well as illegal, unreported and unregulated (IUU) fishing (Richardson et al., 2022).

There is a need to improve our understanding of the life cycle and end-of-life management of fishing gear, the effectiveness of interventions to avoid, minimise and remEDIATE their production and associated negative impacts, and to fill knowledge gaps on the trends in the amount of ALDFG entering the marine environment (Gilman et al., 2022). Further, there is an identified need to address regional disparities in available data and the knowledge gap that exists with regard to ALDFG originating from artisanal fleets (GESAMP, 2021; Richardson et al., 2022; Richardson, Hardesty, et al., 2021; Richardson, Wilcox, et al., 2021). It has also been observed that studies considering the effectiveness of policy instruments that target actors in marine-based sources of marine litter, including fisheries stakeholders, are largely absent (Alpizar et al., 2020). Thus, there is clearly an identified need for robust, comprehensive, and holistic research that focuses on understanding ALDFG within the context of small-scale fisheries. This is needed not only from the viewpoint of uncovering the scale and impact of the challenge, but also to address the policy landscape, governance environment, and the interactions of various actors.
The drivers of fishing gear loss are many and may include environmental causes, conflicts at sea, management failures or operational errors (GESAMP, 2021; Gilman et al., 2022; Richardson, Hardesty, et al., 2021) (Figure 1). While few studies have considered the interactions or relationships between these various drivers, it can be inferred that they are not mutually exclusive and, in fact, affect and are affected by each other. For example, for fishers who utilise inferior or makeshift materials to mark traps (an operational driver), the likelihood of losses due to other drivers may increase. For example, such traps may be less visible to navigating vessels (classified as a conflict driver) or may be more likely affected by severe weather (an environmental driver). Similarly, weaknesses in compliance regimes or gaps in legislation may influence operational drivers, such as the practice of abandoning or actively discarding fishing gear at sea.

Figure 1: Categories of drivers for fishing gear loss (adapted from GESAMP, 2021)

Once derelict, fishing gear may negatively affect marine and coastal habitats, and associated wildlife. Perhaps the most severe ALDFG impact is the ability for some gear to continue capturing marine organisms (a phenomenon often referred to as “ghost fishing”) or entangling wildlife, including many endangered species, long after they have become derelict. Ghost fishing, of both commercial and non-commercial species, by derelict gear can affect stock sustainability, lead to economic losses, and affect food security and the livelihoods of fishing communities (Do & Armstrong, 2023; Goodman et al., 2021; Macfadyen et al., 2009).

Like other forms of marine litter, ALDFG can disrupt ecological processes, with one study showing that entanglement and catches resulting from them caused the most significant disruptions, especially for hard corals and reef fishes (Carvalho-Souza et al., 2018). Derelict fishing lines can entangle and damage gorgonians and sponges, and have been shown to lead to increased colony mortality when affecting branching corals (Asoh et al., 2004; Beneli et al., 2020; Carvalho-Souza et al.,
Reefs that have become smothered by nets may also experience tissue loss and fragmentation (Valderrama Ballesteros et al., 2018). In addition to negatively impacting wildlife and marine habitats, ALDFG can create navigational hazards, and lead to socio-economic losses to fishers and fishing communities (Goodman et al., 2021; Hong et al., 2017; Jeffrey et al., 2016; Mouat et al., 2010).

Like many other complex environmental challenges, ALDFG associated with Eastern Caribbean small-scale fisheries requires coordinated governance approaches that take into account the inherent complexities associated with ocean governance in this region. By considering the issue through a governance lens, this research seeks to advance the discourse surrounding ALDFG not only to consider issues of scale, impact, and management but also to reflect on the need for creating effective, robust, and responsive governance solutions that take account of these inherent complexities.

1.2 Small-scale fisheries and ALDFG

As noted, there are major knowledge gaps regarding the contribution of small-scale fisheries to the marine debris burden in the global ocean, through ALDFG. This is also true for the Caribbean region, including among the small islands of the Eastern Caribbean. While this work seeks to contribute to filling the research gap in this area, it is important to first examine the complexity and diversity of small-scale fisheries and challenges associated with their governance. Gaining an understanding of the complex nature of small-scale fisheries can help to provide valuable insight into the challenges that may be associated with the governance of ALDFG in the Eastern Caribbean fishing sector.

For many, the term small-scale fisheries may evoke images of small canoes, powered by hand, using low-tech equipment, by fishers living in small rural communities. However, in the global context, small-scale fisheries are much more heterogeneous. Thus, while there is no universal definition for the term “small-scale fisheries”, it can be said that small-scale fisheries are complex, variable, and shaped by local cultures and traditions (de Oliveira Leis et al., 2019). They are also often governed by diverse and complex systems that mirror the complexity and diversity of the fisheries systems themselves (Chuenpagdee & Jentoft, 2015).

Globally and regionally, small-scale fisheries are variable in terms of their operations and technology, which exist along a continuum (FAO et al., 2023). Thus, while there can be no doubt that the fisher in a rural community—utilising a small, open, non-motorised canoe—is considered “small-scale”, in the context of the Caribbean and other regions so too is the sport-fisher with a motorised fibreglass launch fishing with the use of GPS, a fish finder and six reels attached to the vessel.
These observed variabilities in global small-scale fisheries may be due to differences in the economic conditions between developed and developing countries or differences in geography, ecology and market conditions of the species being targeted (FAO et al., 2023). Small-scale fisheries are often difficult to monitor, assess, keep under surveillance, and manage, as fishers often utilise a multiplicity of different gear types to capture a range of species, while moving between landing sites, many of which may be remote (Ourêns et al., 2022).

As in other parts of the world, the small-scale fisheries of Latin America and the Caribbean are highly diverse and complex. Thus, approaches to fisheries management and governance may differ across the region, based on national circumstances (de Oliveira Leis et al., 2019). For the smaller islands of the Eastern Caribbean sub-region, this diversity and complexity is no less significant. The Eastern Caribbean’s fishing sector is multi-gear and multi-species in nature, as fishers use a variety of both passive and active gear to target a diverse array of marine and coastal organisms (CRFM, 2021; de Oliveira Leis et al., 2019). Fish pots (in a range of shapes), handlines and longlines, seine nets and gill nets are among the various gear types used to harvest sedentary, demersal, coastal and large pelagic species. Further, it is not uncommon for single operators to utilise more than one gear type, which may vary throughout the year based on seasonal availability of target species (CRFM, 2021). The fishing fleets in these islands are generally dominated by small coastal vessels (many less than 12 m in length) (CRFM, 2021). However, the sector also plays an important role in national food security and may serve as a safety net industry when there are limitations in other livelihood options (Turner et al., 2019). Further, in small-scale fisheries, unlike large-scale, industrial sectors there is less vertical integration across the value chain, as post-harvest activities are generally people intensive and often involve entire families or communities (Chuenpagdee & Jentoft, 2015).

In 2020, it was estimated that approximately 6000 vessels were operating in the marine capture fisheries of the English-speaking member states of the Organisation of Eastern Caribbean States (OECS) and Barbados, most of which were less than 12 m in length (CRFM, 2021)1. Grenada had the largest fleet, numbering 2,310 vessels, while Montserrat’s fleet of 33 vessels was the smallest. In recent years a number of Eastern Caribbean governments have sought to shift pressure away from nearshore reefs by promoting the use of moored fish aggregating devices (MFADs). In 2020, it was estimated that there were just over 3,500 MFADs deployed across the insular Caribbean region, approximately 110 of which were located in the Eastern Caribbean jurisdictions that form part of this study (Wilson et al., 2020). Approximately 71 per cent of these were privately owned (Wilson et al., 2020). This

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1 The available statistics did not include the British Virgin Islands as they are not members of the CRFM and were therefore excluded from that study.
is concerning as the proliferation of privately owned MFADs can add to the marine debris burden in the sub-region, as these are often cheaply constructed and have a high turnover rate (Wilson et al., 2020). In the Caribbean region, MFADs may be deployed in one of three ways; as a private FAD owned by an individual, as a private collective or as a public FAD, placed by the government (Sadusky et al., 2018).

Throughout the Caribbean region, despite gaps in knowledge and research, there is strong evidence that ALDFG is already of concern to fisheries managers and has been affecting both marine habitats and wildlife. In 2010, a Caribbean-wide assessment of the opinions of ALDFG in the region revealed some concern about the issue of ALDFG among those interviewed, with 65 per cent of interviewees indicating this (Matthews, 2010). In 2019, the Food and Agriculture Organisation (of the United Nations) (FAO) conducted pre-survey questionnaires ahead of a regional workshop for South America and the Caribbean on best practices to prevent ALDFG. Of the individuals polled, approximately 70 per cent considered ALDFG to be of high or major concern (FAO, 2020b). Additionally, fish trap losses associated with severe weather events have been documented in some jurisdictions. In Antigua and Barbuda, for instance, an estimated 12,000 traps were lost following the passage of Hurricane Louis in 1995 (Horsford, 2010). More recently, following the passage of Hurricane Irma in 2017, fishers in that jurisdiction reportedly lost 2,177 fish traps with an estimated replacement cost totalling $387, 240.00 (XCD) ($143, 422.22 USD) (Horsford, 2017). Dominica trap fishers reportedly lost more than a combined 4,500 traps due to 1999s Hurricane Lenny, 2007s Hurricane Dean and 2008s Hurricane Omar (Norris et al., 2011). In 2017, Hurricane Maria devastated several islands across the East and Northern Caribbean, following which fishers in Puerto Rico reported losing approximately 6,700 trap (Agar et al., 2020). It has been observed that lost traps made of wire mesh can continue to ghost fish for more than a year after becoming derelict (Norris et al., 2011).

Set against this context, it must be noted that the diversity, complexity and dynamic nature of small-scale fisheries are not always easily subject to government intervention (Jentoft & Chuenpagdee, 2015). Small-scale fishers are often wary of government interference, and undertake much of their activities and practices independently of the rules and policies set by national governments (Jentoft & Chuenpagdee, 2015). A recent study on fisheries performance relative to governance attributes in small-scale fisheries revealed poor social cohesion and high levels of conflicts across the small-scale fisheries that formed part of the assessment (Ouréns et al., 2022). That study also highlighted that empowering fishing communities by encouraging adaptive and transparent actions could lead to improved performance of small-scale fishing sectors (Ouréns et al., 2022).
1.3 Transboundary nature of ALDFG

Like other environmental challenges in the marine environment, marine litter including ALDFG can be considered a transboundary threat. Transboundary environmental challenges are those that cross national borders, whereby an environmental problem that originates in one country affects one or more cross-border jurisdictions (Lidskog et al., 2011). As has previously been noted, marine litter may be carried on currents to various parts of the ocean environment, from coastal waters to ocean gyres. Thus, the transboundary nature of this environmental challenge also means that the associated impacts may be transboundary as well.

In the Mediterranean region, scientists investigating transboundary marine debris analysed the origins of plastic waste observed in national marine protected areas across several countries (Hatzonikolakis et al., 2022). Through the use of simulation distribution models and cluster analysis they found that macroplastic pollutants travelled longer distances, and thus were more likely to contribute to transboundary pollution than microplastics (Hatzonikolakis et al., 2022). For each of the countries included in the study (excluding Albania and Algeria), it was found that, for at least one of the marine protected areas in their jurisdictions, 55 per cent of macroplastic found, originated outside their borders (Hatzonikolakis et al., 2022).

Derelict fishing nets were found to be a significant transboundary problem in the Arafura and Timor Seas (Butler et al., 2013), where scientists observed high entanglement of marine turtles in areas with a high density of derelict nets and high turtle density (Wilcox et al., 2013). Up to 2010, researchers at the Carpenteria Ghost Nets Programme in the Gulf of Carpenteria recorded ghost nets from at least six different countries (Taiwan, Indonesia, the Republic of Korea, Australia, Thailand and Japan) since they started studying the issue in 2005 (Gunn et al., 2010).

Due to their location relative to sub-tropical gyres and the influence of trade wind belts, many small island developing states (SIDS) are more likely to be affected by influxes of buoyant marine litter (Lachmann et al., 2017). Thus, research has shown that SIDS are more likely to be inundated by long-range transported marine plastic litter than many other coastal areas (Lachmann et al., 2017). In South Eleuthera, in the Bahamas, scientists investigating the spatial trends in debris on shorelines recorded large numbers of octopus traps on Atlantic facing beaches of that island (Ambrose et al., 2019). It was further noted that those traps, which were also recorded on beaches in Bermuda and San Salvador, likely originated off the Atlantic coasts of Morocco and Mauritania, where artisanal fishers utilised them in the harvesting of octopus (Ambrose et al., 2019). Sampling of marine litter debris off the Southern section of Morocco’s Atlantic coast found that those traps constituted 95.44 per cent of sampled plastic waste (Loulad et al., 2016).
Governance of transboundary environmental challenges goes beyond acknowledging the cross-border effects of the threat to recognising that the associated expertise, public and private sector influences, and community effects are also transboundary (Lidskog et al., 2011). In this regard, the transboundary nature of ALDFG requires not only national-level interventions but also regional and international cooperation (Macfadyen et al., 2009). It requires cross-border cooperation—by actors at multiple levels—in the examination of risk, analysis of trends and pathways, and consideration of management interventions.

1.4 From global to local: tackling fisheries-related marine litter

ALDFG is a global challenge that lies at the nexus of fisheries management, maritime transport, environmental governance and solid waste management. Achieving effective governance of this complex challenge, therefore, will require intersectoral coordination and collaboration not only at national level, but also regionally and internationally (Figure 2). ALDFG is first and foremost a fisheries challenge. Fisheries rules are crucial for regulating the usage and technical measures governing various categories of gear, while fisheries compliance systems constitute an important component of the management regime for ALDFG (Gilman et al., 2022; Richardson et al., 2018). ALDFG is also a waste management challenge, as derelict gear that is retrieved from the marine environment or gear that has reached its end-of-life will need to be integrated into the waste management sector. This means there must be facilities for the collection, transfer, safe disposal and/or recycling of gear material (FAO, 2019). Protection of the marine environment from all forms of pollution is critical for the sustainability of SIDS. Thus marine pollution rules may outline measures for prohibiting the disposal of certain categories of waste into the marine environment. Finally, as fishers are operating in a shared marine space, there must be mechanisms in place to ensure that deployed gear does not impede navigation, nor are the activities of other maritime industries impacting their use. The placement MFADs, use of traps and deployment of nets could all impact maritime traffic and navigation. Thus, there is an inherent need to ensure fishers and fisheries authorities are aware of commercial sea lanes, and conversely for marine transport authorities to be made aware of the location of commercial fishing grounds, MFAD deployment areas and other possible fisheries related hazards to navigation. Once this information is shared, these features can be charted and mariners made aware of their location.
Across the globe there is a network of national, regional and international agencies, environmental instruments and intergovernmental bodies with mandates or established rules relevant to ALDFG management (Figure 3). In the Eastern Caribbean, ALDFG stakeholders include both national and regional fisheries management bodies, multilateral environmental treaty bodies, and regional and sub-regional intergovernmental bodies that have established rules of cooperation in both fisheries management and environmental preservation.

Figure 2: The ALDFG governance nexus (conceptual framework by author)
1.4.1 Global

At global level, the United Nations Convention on the Law of the Sea (UNCLOS) is the supreme instrument that sets out a comprehensive legal regime governing the global ocean, its resources and sustainable use (United Nations Convention on the Law of the Sea, 1982). Article 210 of UNCLOS outlines the obligation of states to adopt measures to prevent and control pollution of the marine environment by dumping. Further, Article 211 urges states, through “the competent international organisation” to establish “rules and standards to prevent, reduce and control pollution of the marine environment from vessels”.

While UNCLOS is perhaps the most comprehensive ocean governance treaty, it was not the first global instrument to address the issue of marine pollution and, by extension, the marine debris challenge. In fact, marine litter has been recognised as a global threat since the early 1970s, leading to the formulation of a number of major instruments aimed at preventing litter inputs into the world’s oceans (GESAMP, 2021). The London Convention is one of the earliest global treaties aimed at addressing marine pollution and with an aim to effectively control all “sources of pollution of the marine environment” through dumping (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1977). Annex I of the London Convention outlined categories of waste that were prohibited from dumping, including persistent plastics such as netting and ropes (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter,

Enacted under the International Maritime Organisation (IMO), the International Convention for the Prevention of Pollution from Ships (MARPOL) and its six technical annexes sets out regulatory provisions aimed at preventing and minimising both accidental and operational pollution from ships (International Convention for the Prevention of Pollution from Ships, 1973, Modified by the Protocol of 1978 (MARPOL) (Entered into Force 2 October 1983), 1973). Annex V of the Convention, which entered into force in December 1988, is concerned with preventing waste pollution from ships. Since its entry into force, Annex V of MARPOL has been subject to a number of revisions and the adoption of resolutions and technical guidelines to aid states with its implementation. In 2017, the Marine Environment Protection Committee (MEPC) to the Convention adopted Resolution MEPC.295 (71), which provides guidelines for implementing MARPOL Annex V. Section 2.2 of the Guidelines presents several recommendations relating to the management of fishing gear, including the obligation to report accidental losses or discard of fishing gear in the sea that may pose a threat to the marine environment or impede navigation (IMO, 2017). Annex V also provides for the establishment of “Special Areas”, which are defined as seas, “where for recognized technical reasons in relation to oceanographical and ecological conditions and to the particular character of traffic the adoption of special mandatory methods for the prevention of sea pollution by garbage is required” (IMO, 2001). The disposal of all plastics, including synthetic ropes and synthetic fishing nets, is prohibited both within and outside such special areas (Protocol Relating to the International Convention for the Prevention of Pollution From Ships, 1973 (with Annexes, Final Act and International Convention of 1973). Concluded at London on 17 February 1978, 1978). In 1991 the Caribbean Sea was designated as a special area, and the status entered into force in April 1993 (IMO, 2018). It is notable that the Convention does not apply in the case of fishing nets or material incidental to the repair of such nets that have been accidentally lost, “provided that all reasonable precautions have been taken to prevent such loss” (Protocol Relating to the International Convention for the Prevention of Pollution From Ships, 1973 (with Annexes, Final Act and International Convention of 1973). Concluded at London on 17 February 1978, 1978). At its 78th Session the MEPC agreed to instruct the Pollution Prevention Response Sub-Committee of the IMO to develop a goal-based mandatory requirement for gear marking under MARPOL Annex V (IMO, 2022).

In early 2022, UNEA adopted a resolution to commence negotiation of a new global plastics treaty (UNEA, 2022). Once successfully negotiated and passed, the new
international legally binding instrument (ILBI) will be the most ambitious multilateral instrument aimed at addressing plastic pollution in the global ocean. While the treaty text is still being negotiated it remains unclear to what extent ALDFG will form part of this new instrument. Arguably, the existing international regime for ALDFG falls short of holistically addressing the challenge of ALDFG and many gaps remain, including in relation to small-scale fisheries. Notwithstanding this, it is interesting to note that several countries, in their pre-session submissions ahead of the 2\textsuperscript{nd} session of the International Negotiating Committee, signalled the need for the global instruments to address issues relating to fisheries-derived marine litter (including ALDFG). For instance, the government of Argentina noted that the ILBI should address the problems caused by fishing gear, while the government of the United Kingdom noted that it “should include obligations to address sea-based sources of plastic pollution, such as fishing and aquaculture gear…” (UNEP, 2023). As many as 20 member governments, two regional groupings (the European Union and the Association of African States), and two allied groups (the Alliance of Small Island States and the High Ambition Coalition) included such recommendations within their submissions (UNEP, 2023).

In addition to multi-lateral environmental instruments, there exists in the global architecture for ALDFG governance, voluntary guidelines, policies and framework documents that can aid countries in managing this threat. The FAO Voluntary Guidelines on the Marking of Fishing Gear (VGMFG) have been developed as a global tool to combat, minimise and eliminate ALDFG while “facilitating the identification and recovery of such gear” (FAO, 2019, p. 1). While they are voluntary, the Guidelines provide a mechanism for assisting states to meet relevant international obligations, while reducing the hazards to navigation caused by derelict gear thereby contributing to improved safety at sea (FAO, 2019). According to section 20 of the Guidelines, any system for marking fishing gear should include provisions for:

(i) reporting of derelict gear;
(ii) reporting of fishing gear found;
(iii) recovery of derelict gear; and
(iv) where possible, the safe and environmentally sound disposal of unwanted gear.

In order to ensure the safe disposal of gear, the guidelines advocate for the provision of adequate port reception facilities, as well as infrastructure development to support the recycling of recovered gear. Recognising the special circumstances of developing states and small-scale fisheries, the Guidelines also advocate technical assistance for capacity building through technology transfer and training, as well as financial support to assist such states in developing regulatory frameworks, institutional arrangements and the strengthening of research and development.
During its 15th Conference of Parties in December 2022, the CBD adopted the Kunming-Montreal Global Biodiversity Framework (CBD, 2022). Target 7, one of the 23 global targets for 2030, focuses on reducing “pollution risk and the negative impact of pollution from all sources…to levels that are not harmful to biodiversity and ecosystem functions and services” (CBD, 2022). This includes measures to prevent, reduce, and eliminate plastic pollution.

Finally, the Global Ghost Gear Initiative (GGGI), which is a cross-sectoral alliance of public and private actors, non-governmental organisations (NGO), and academia has developed a best practice, framework document to assist countries in managing the threat of ALDFG (GGGI, 2021). It provides gear specific best practice recommendations for a range of both static and active gear as well as FADs.

1.4.2 Regional

Both at the level of the Wider Caribbean (which includes both insular and continental coastal states and territories throughout the Caribbean Sea, as well as the Gulf of Mexico and adjacent Atlantic waters) and through the sub-regional groupings of the Caribbean Community (CARICOM) and the OECS, Caribbean governments have established and/or are party to a number of fisheries and non-fisheries related instruments that have set out policies, guidelines and measures relevant to ALDFG governance. For the Wider Caribbean, the United Nations Regional Seas Programme is governed by the Cartagena Convention and administered by the United Nations Environment Programme-Caribbean Environment Programme (UNEP-CEP).

Three regional protocols have been developed under the Cartagena Convention. The first of these is the Protocol on Specially Protected Areas and Wildlife (SPAW), which focuses on the management, conservation and sustainable use of marine and coastal biodiversity in the Wider Caribbean. In 2007 the UNEP Caribbean/Regional Coordinating Unit (UNEP-CAR/RCU) developed a Regional Marine Litter Action Plan (the RAPMaLi) which was later updated in 2014. The RAPMaLi (Corbin et al., 2014) identifies gaps and needs for marine litter management in the Wider Caribbean and presents priority actions focusing on five thematic areas:

- legislation, policies and enforcement;
- institutional frameworks and stakeholder involvement;
- monitoring programmes;
- education and outreach; and
- solid waste management strategies.
While much of the RAPMaLi is focused on land-based sources of marine litter, several of the recommended priority actions hold relevance to the management of derelict gear.

Priority actions related to legislation, policies and enforcement within the RAPMaLi include:

- **(Action 1)** evaluation of existing legislation, regulations and enforcement practices;
- **(Action 2)** establishment or enhancement of government sponsored “litter wardens” with special programmes geared at fishers; and
- **(Action 4)** expansion of the ratification of MARPOL Annex V within the region.

Priority actions related to monitoring of marine debris include:

- **(Action 4)**, which advocates for research from fisheries and other resource management agencies on the impacts of marine litter on wildlife; and
- **(Action 5)**, which calls for assessing the economic impacts of marine litter including clean-up effort costs and costs for lost or abandoned gear.

In addition, there is a priority action relating to education and outreach:

- **(Action 1)** calls for the development of specialised education programmes for stakeholders including subsistence and commercial fishers in order to address derelict fishing gear.

Finally, the RAPMaLi advocates for the development of national and regional strategies for tackling marine litter, and urges engagement with all stakeholders including those within the region’s fisheries sectors (Corbin et al., 2014).

The RAPMaLi is supported by a Regional Marine Litter Strategy, which was developed in consultation with government agencies, civil society organisations, the private sector and regional institutions (Ali et al., 2021). The Regional Strategy recognises the increasing significance of ALDFG as a source of marine litter (Ali et al., 2021). The Strategy has not outlined specific recommendations for the management of ALDFG in the Caribbean region. Instead, it presents a number of cross-cutting goals and strategies relevant to management of both land- and sea-based sources of marine litter. This includes the need to create enabling policies that promote reduction in marine litter, private sector engagement, development of effective communication tools and capacity building (Ali et al., 2021).
In addition to regional environmental instruments and policies, several fisheries policies, recommendations and management decisions have been developed—both jointly and individually—by the International Commission for the Conservation of Atlantic Tuna (ICCAT), the Western Central Atlantic Fisheries Commission (WECAFC) and the Caribbean Regional Fisheries Mechanism (CRFM). All three of these entities serve as regional fisheries bodies and/or regional fisheries management organisations with overlapping mandates and jurisdictions. ICCAT’s Convention area is the largest and extends to all waters of the Atlantic including adjacent seas in the Caribbean, North Atlantic and Mediterranean region. WECAFC’s area of competence includes FAO statistical area 31\(^2\) in the Western Atlantic and the northern part of FAO fishing area 41,\(^3\) off North Brazil (van Anrooy, 2016). The CRFM exists as a mechanism under CARICOM, and was inaugurated in 2003.

ICCAT’s management recommendations on ALDFG entered into force in June 2020 and prohibits the abandonment and discard of fishing gear in the Convention area, except for safety reasons (ICCAT, 2019). Further, it requires vessels greater than 12 m to have equipment on board for the retrieval of fishing gear. These measures, however, do not apply to longline gear, which is the main gear employed by the pelagic, artisanal fleets of Barbados and OECS members that are party to the Tuna Convention (Grenada, St. Vincent and the Grenadines, and the United Kingdom (UK) overseas territories through the UK) (ICCAT, 2019).

WECAFC’s recommendation 17/2019/17 calls on members to implement the voluntary guidelines on marking of fishing gear (WECAFC, 2019), a call that is also echoed in the Regional Action Plan to Prevent, Deter and Eliminate, IUU Fishing in WECAFC Member States (FAO, 2020a).

\(^2\) FAO statistical area 31 includes all marine waters of the Western Central Atlantic bounded by a line beginning from a point on the coast of South America at 5°00’N latitude; thence in a northerly direction along this coast past the Atlantic entry to the Panama Canal; thence along the coasts of Central and North America to a point on this coast at 35°00’N latitude; thence due east along this parallel to 42°00’W longitude; thence due north along this meridian to 36°00’N latitude; thence due east along this parallel to 40°00’W longitude; thence due south along this meridian to 5°00’N latitude; thence due west along this parallel to the original point at 5°00’N latitude on the coast of South America.

\(^3\) The Southwest Atlantic statistical area 41 comprises all the marine waters bounded by a line starting from a point on the coast of South America at 5°00’N latitude; thence due east to 30°00’W longitude; thence due south to the Equator; thence due east to 20°00’W longitude; thence due south to 50°00’S latitude, thence due west to 50°00’W longitude; thence due south to 60°00’S latitude; thence due west to 67°16’W longitude; thence due north to the point at 56°22’S latitude - 67°16’W longitude; thence due east along a line at 56°22’S latitude to the point at 65°43’W longitude, thence following a line joining the points at 55°22’S - 65°43’W, 55°11’S - 66°04’W, 55°07’S - 66°25’W; thence in a northerly direction along the coast of South America to the starting point.
Both CARICOM and the OECS were established by treaties that include obligations to cooperate on a range of issues, including protection of the marine environment. Under Article 140 of the Revised Treaty of Chaguaramas, CARICOM members and associate members—which include all states and territories that are part of this research—agree to cooperate in “protecting the environment from the effects of vessel source pollution and combating such effects” (CARICOM, 2001). Under Article 140 (5) states are also urged to implement “relevant international...instruments relating to prevention of pollution from ships (CARICOM, 2001).

The Revised Treaty of Basseterre, which governs the OECS, outlines the purposes and functions of the intergovernmental body, including promotion of cooperation among member states (OECS, 2010). Article 24 of the Revised Treaty urges members to implement the St. George’s Declaration which outlines Principles of Environmental Sustainability (OECS, 2010). The goals outlined in the New St. George’s Declaration (SGD2040) include the need for sustainable management of the marine resources of the Eastern Caribbean as well as the adoption of integrated approaches to waste management through “management practices that reduce waste and pollution in the marine environment” (OECS, 2020a).

In addition to the work of formal regional bodies and instruments, relevant initiatives have also been undertaken by regional and global cross-sectoral networks such as the Gulf and Caribbean Fisheries Institute (GCFI). The Global Ghost Gear Initiative (GGGI) has collaborated with Caribbean governments and the CRFM to develop a regional plan of action to manage ALDFG. While the regional plan has not been formally endorsed by governments, it provides a guiding framework for improved management of this threat. The plan builds on the GGGI’s global best practice framework document and sets out a gear class risk assessment for a variety of gears. It sets out recommendations for preventing, mitigating and remediating various forms of ALDFG, and identifies key actors to implement the proposed actions.

GCFI is a not-for-profit body dedicated to information exchange on the use and management of marine resources in the Gulf and Caribbean region. Together with the Secretariat to the Cartagena Convention, they serve as co-hosts of the Caribbean Node of the GPML (GPML-Caribe, 2023). As part of its work under the GPML-Caribe, the GCFI has undertaken several regional activities to raise awareness about ALDFG as well as to gather valuable baseline data about ALDFG and ALDFG solutions (GCFI, 2020). This work includes hotspot mapping and predictive modelling exercises in Montserrat, as well as peer-to-peer, fisher-led awareness raising activities in St. Vincent & the Grenadines (Antonelis et al., 2022; GCFI, 2020).
1.4.3 National

Management of ALDFG at the national level—as at the regional level—can only be achieved through a multi-sectoral approach and the enactment of rules and policies that can help prevent ALDFG, mitigate its impacts and remediate or remove it, where practicable. The three-pronged approach of prevention, mitigation and remediation of ALDFG has been widely promoted as best practice (GESAMP, 2021; GGGI, 2021; Gilman et al., 2022; Macfadyen et al., 2009). The ALDFG management hierarchy, as it is referred to herein, is reminiscent of and intrinsically linked to the waste hierarchy, which promotes prevention over reuse, recycling, recovery and disposal of waste (Figure 4). Just as with the waste hierarchy, this model orders ALDFG management interventions according to the most-preferable approach. Thus, prevention of ALDFG should be the primary focus of ALDFG management, followed by mitigation and remediation measures. Mitigation of associated impacts requires planning and technological advancements, particularly in gear design, and is therefore placed on the second tier of the ALDFG hierarchy, while remediation should be approached when all other measures fail.

![Figure 2: ALDFG management hierarchy and its relationship to the waste hierarchy](image)

In the context of ALDFG management, prevention refers to activities or measures that may be employed by fishers or relevant management authorities to avoid fishing gear being lost, abandoned or discarded at sea. This may include proper gear management and storage on the part of fishers, the availability of facilities, including end of life facilities, to reduce the likelihood of fishers abandoning gear at sea, the introduction of gear marking schemes and improvements in fisheries management, and compliance regimes (GGGI, 2021). Since it may not always be possible to avoid gear loss or feasible to retrieve derelict fishing gear, mitigation measures may be
employed to reduce the resulting harmful effects (GGGI, 2021; Gilman et al., 2022). In those cases, it may be possible to use technical measures and gear design techniques to reduce the impact of ALDFG. For example, the use of biodegradable panels and inclusion of escape panels in traps help to reduce ghost fishing, while the use of rope-less gear and non-entangling FAD designs may help to reduce incidences of wildlife entanglement (Gilman et al., 2022). Remediation measures are those that can aid in the retrieval of ALDFG. This may include mechanisms for reporting lost gear and the locating and removal of derelict gear from the marine environment. It can be said that the waste hierarchy largely begins where the ALDFG hierarchy ends, as remediated ALDFG or end-of-life gear should be subject to the same waste management practices as other categories of solid waste (that is reuse, recycling, recovery and disposal).

Remediation solutions aimed at removal of ALDFG may be challenging for small island nations like those in the Eastern Caribbean. Much of the ALDFG remains submerged, making retrieval difficult, costly and—at times—infeasible. Additionally, many island governments lack the human, technical and financial resources to dedicate to large-scale efforts to clean up of the ocean floor. Additionally, small islands are often plagued by “underdeveloped or fragile waste management systems” (Singh et al., 2023, p.1). The identified barriers to effective solid waste management in island environments include limited physical space, high operational costs for waste management and lack of capital and financing options (Singh et al., 2023).

1.5 Research questions

Fundamentally, this research is designed to aid in filling knowledge gaps regarding the challenge of ALDFG in Eastern Caribbean small-scale fisheries. Consideration of its scale, internal and external drivers, existing management tools, and the guiding policy and legal regime provide critical baselines for addressing broader issues of governance.

As previously noted, the central aim of this research is “To explore strategies for improved governance of ALDFG in Eastern Caribbean small-scale fisheries”. This is developed through consideration of three supporting objectives and four related research questions. To guide the study, objectives and questions have been designed to (1) set the context and establish baselines regarding ALDFG in the Eastern Caribbean, (2) understand the current governance environment including any existing barriers or gaps, and (3) to propose strategies towards an improved governance regime (Table 1)
Table 1: Research approach, objectives and supporting research questions

<table>
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<tr>
<th>Research approach</th>
<th>Research objectives</th>
<th>Research questions</th>
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<tr>
<td>Context setting: ALDFG in the study area</td>
<td>To understand the drivers, scale and impact of ALDFG in Eastern Caribbean small-scale fisheries</td>
<td>What is the current scale and impact of ALDFG associated with Eastern Caribbean small-scale fisheries? What are the major drivers of ALDFG in the Eastern Caribbean sub-region?</td>
</tr>
<tr>
<td>Understanding the governance environment</td>
<td>To assess the existing governance environment and analyse the barriers to the effective governance of ALDFG in Eastern Caribbean small-scale fisheries</td>
<td>What are the current structural, institutional and procedural barriers that may contribute to ineffective governance of ALDFG in Eastern Caribbean small-scale fisheries?</td>
</tr>
<tr>
<td>Present strategies for improved governance</td>
<td>To outline improved governance approaches that take account of the updated state of knowledge and recognise the interlinkages between national, regional and global processes relating to ALDFG</td>
<td>How can Eastern Caribbean small-island developing states overcome identified barriers and the inherent complexities of small-scale fisheries to achieve improved governance?</td>
</tr>
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</table>

1.6 Study area

This research is focused on the English speaking small-island developing states of the Eastern Caribbean, and includes the members and associate members of the Organisation of Eastern Caribbean States (OECS) (members: Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines; associate members: Anguilla, and the British Virgin Islands) as well as Barbados (Figure 5). The Eastern Caribbean sub-region was selected for this research as it is the target area for the Closing the Circle Programme (CTC), under which this work is being undertaken (WMU, 2023). The OECS is an intergovernmental body dedicated to regional cooperation, harmonisation and joint action in a number of areas, including economic integration, scientific cooperation and matters relating to the sea and its resources (OECS, 2010). To this end, in the early 1980s the islands of the OECS “began to develop harmonised fisheries laws”, which form the basis for the fisheries acts and regulations of most jurisdictions to this day (Haughton, 2003, p. 194). Barbados, while not an OECS member state, later updated its fisheries laws so that they were in alignment with the harmonised legislation of the OECS (Haughton, 2003). The jurisdictions that form part of this analysis, therefore, have been selected based on their similar approaches to fisheries governance and harmonised legislative frameworks. While Martinique and Guadeloupe are currently associate members of the OECS they joined much later...
(in 2015 and 2019 respectively), and thus their legislation is not based on the harmonised fisheries law. Therefore, they have been excluded from this study.

The research has been undertaken using a two-tiered approach. While the overall study focuses on the 10 jurisdictions identified above, two countries have been selected as case studies for more in-depth assessments. They provide empirical baseline data on the drivers, scale and impact of ALDFG in the Eastern Caribbean sub-region. The two countries (Antigua and Barbuda, and Dominica) were selected due to the differences in their fishing sectors and marine biogeography. All 10 jurisdictions have been included in other investigations that form part of the study, including analysing the various policy and legal regimes for ALDFG management.

The islands of the Eastern Caribbean are small, and highly vulnerable to both natural and economic shocks (Alleyne, 2018). Their economies are saddled with high public debt, which largely grew as a result of the severe health and economic fallout of the COVID-19 pandemic (Alleyne et al., 2022). Because of their high external debt, limited availability of development assistance, and volatile foreign investment revenues their ability to support sustainable development activities is severely constrained (UNDP Independent Evaluation Office, 2021). Eastern Caribbean jurisdictions are also highly dependent on tourism (much of which is marine based),
and are among the 21 countries in the world with the highest tourism GDP income (UNDP, 2022; UNDP Independent Evaluation Office, 2021). In recent years they have placed a growing emphasis on the development of the blue economy, recognising that, despite their small land masses, they have large ocean space and the potential for blue growth (OECS, 2020b; UNDP, 2020). In the OECS, the collective ratio of land to marine space is approximately 1:85 (OECS, 2020b), while Barbados’ marine zone is 430 times the size of its land mass (Government of Barbados, 2021).

The two case study jurisdictions (Antigua and Barbuda, and Dominica) are quite different in their geography, climatic conditions and marine environment. Antigua and Barbuda is an archipelagic state with one of the largest continental shelves in the Eastern Caribbean, totalling approximately 3700 km² (Georges et al., 2015). Antigua’s Eastern and Southern shelves are dominated by coral reef systems while its many embayments are colonised by seagrass communities (The Nature Conservancy, 2016). In contrast to Antigua and Barbuda’s wide shelf area, Dominica has a very narrow coastal shelf, and its coral frameworks are not as extensive, with the largest fringing reef system located along its northern region (Steiner & Willette, 2010; The Nature Conservancy, 2016). Coral frameworks refer to the three-dimensional calcified reef structures that provide habitat to marine fish and invertebrate species (McLaughlin et al., 2023). Dominica’s western shelf is dominated by seagrass meadows and holds the expanse of sandy coastal habitats (Steiner & Willette, 2010; The Nature Conservancy, 2016). Relatively meagre assemblages of seagrass communities can also be found in sheltered bays located leeward of headlands (The Nature Conservancy, 2016). The contrasting marine biogeographies of the two countries are reflected in the profiles of their fishing sectors. While both Antigua and Barbuda, and Dominica have multi-species, multi-gear fisheries, the fishing sector in Antigua and Barbuda is mainly based on the harvest of demersal fish and invertebrate species, and benthic organisms, including the queen conch (*Aliger gigas*, previously known as *Strombus gigas* or *Lobatus gigas*). In recent years there has been a move towards the introduction of MFADs and a growing interest in the harvest of large pelagic species; however marine capture production continues to be dominated by demersal and benthic species (CRFM, 2021; Montes et al., 2019). On the other hand, in Dominica large, offshore pelagics make up the majority of recorded landings (CRFM, 2021; Theophille & Hutchinson, 2012). In contrast to Antigua and Barbuda, MFADs have been utilised in Dominica’s fishing sector since 1987, when they were first introduced to increase the yield of large pelagic resources (Ramdeen et al., 2014).
1.7 Structure of the Thesis

This work presents a critical analysis of the threat of ALDFG within the context of Eastern Caribbean small-scale fisheries. The data generated from this study firstly provide a valuable baseline for understanding the local drivers of ALDFG in the sub-region, while giving insight into the scale and impact of the threat. This research, however, is underpinned by consideration of the challenges associated with ALDFG governance in a region that has been described as geopolitically complex (Fanning et al., 2021), and where the ocean governance regime has been characterised by a maze of institutions, intergovernmental bodies and environmental instruments, with overlapping and often competing mandates (Chakalall et al., 2007).

This research forms part of a broader programme within the WMU Sasakawa-Global Ocean Institute, which is focused on Marine Debris, Sargassum and Marine Spatial Planning in the Eastern Caribbean. The CTC was designed with stakeholders in the Eastern Caribbean to address issues that were of high priority for that region. By adopting a co-design approach to its programme development, CTC is well situated to provide meaningful and impactful research to regional governments, with benefits beyond the generation of scientific knowledge. It also helps to avoid the pitfalls associated with parachute science as has seemingly become emblematic of marine litter research in Caribbean SIDS (Stöfen-O’Brien et al., 2022).

This thesis is divided into five chapters. Chapter one (current chapter) provides an overview and background of the core themes of the thesis. This includes the current state of knowledge relating to ALDFG globally, an analysis of the complex nature of small-scale fisheries and the existing multi-level governance framework for ALDFG. It also outlines the aim, objectives, research questions and a description of the study area. Chapter two presents the theoretical underpinnings and conceptual frameworks that have been utilised to help guide the research. Chapter 3 outlines the research approach and the methods used for data gathering. The results are presented in Chapter 4 through a summary analysis of the core publications and how they relate to the research objectives and supporting research questions. Chapter 5 presents a discussion of the results in light of the conceptual framework and theoretical underpinnings that guide this work.

1.8 Research Impact

The traditional view of research impact in academia focused on bibliometric measures, based on citation scores (Dotti & Walczyk, 2022, p. 2). However, increasingly, both policy makers and academics have an expectation that academic
research should contribute to addressing contemporary societal challenges such as climate change, water and energy usage, the United Nations Sustainable Development Goals and the growing marine debris crisis (Bornmann, 2017; Dotti & Walczyk, 2022). Thus, research evaluation has transitioned from focusing purely on bibliometrics to considering their applications, utility and relevance to the broader society (Lauronen, 2020). The concept of societal impact of research was borne out of this growing realisation and the need to build alliances between the research community and broader societal partners to address the growing list of global challenges (Mehta et al., 2020).

Societal impact can be viewed as one component of “societal value”, where value is considered in light of its relevance to society (that is, the research provides use and benefit beyond science) and its impact (that is, the science makes a demonstrable contribution to society) (Lindgreen et al., 2021). It results from the iterative and intricate interactive processes that may exist between the scientific community, governments, private industries and NGOs (Spaapen & van Drooge, 2011). Thus, achieving impact requires not only the efforts of the academic community but also interactions between academia and other stakeholders and collaborators, who may take on board scientific knowledge in the formation of policies and concrete actions for improved governance (Pedersen & Hvidtfeldt, 2023).

Societal impact may be regarded in terms of the concrete or measurable effects it can bring (for example, new medical technology) or in light of broader societal goals and challenges such as improved quality of life (Spaapen & van Drooge, 2011). Pederson and Hvildtfeldt (2023, p. 2) highlight the need to trace “impacts through larger webs of interaction”. Thus, they argue, micro-level impacts and their causal roles form the building blocks of macro-level impacts (Pedersen & Hvidtfeldt, 2023). Building on the work of Muhonen et al. (2020), they propose that research impact assessment should be reoriented to focus on micro-impacts and how they affect society, policy and business (Pedersen & Hvidtfeldt, 2023).

Muhonen et al (2020), through empirical analysis of 60 case studies, characterised different typologies of impact pathways that can lead to different types of knowledge and research orientations as well as different productive interactions and research beneficiaries. Through this work, they were able to visualise the range of mechanisms and conditions by which social science and humanities research encourages societal impact (such as through collaboration, public engagement, and social innovation among others) (Muhonen et al., 2020).

As previously noted, this research forms part of a broader programme, which was designed in collaboration with stakeholders in the Eastern Caribbean. This study is perhaps the first within this region to consider the challenge of ALDFG through the governance lens. Historically, much of the ALDFG research in the Caribbean has
focused on understanding the impacts of derelict traps as well as the use of gear design techniques to reduce the likelihood of ghost fishing (Horsford et al., 2018; Munro et al., 2003; Norris et al., 2011, 2013; Renchen et al., 2012, 2014; Selliah et al., 2001). One recent study utilised predictive modelling techniques for identifying locations of lost gear in Montserrat (Antonelis et al., 2022). The design and approach of this current study, therefore, has been novel for the Eastern Caribbean as it is a first attempt to consider the issue of ALDFG in a holistic manner. The holistic design of this research project helps to provide multi-stakeholder perspectives regarding ALDFG in the Eastern Caribbean, not only from the view point of fishers but also divers, fisheries managers and regional bodies.

Some of the data generated from this study will contribute to the FAO’s global assessment on ALDFG. FAO has designed a global survey to understand the causes and scale of ALDFG, globally. To this end, standardised gear-specific questionnaires have been developed for 10 gear types and a global portal has been designed. FAO provided training on use of global survey instruments and its online portal.

It is acknowledged that impact planning is an iterative process and, further, that impact is continuous. Thus, a project’s impact does not end when the project ends. On the contrary, there continues to be the need and opportunities for refining the research, creating new knowledge and sharing of information with a range of stakeholders, which may extend beyond the life of any research project. To this end an impact plan has been designed for this research project, and is included as Appendix 1 to this thesis.
2 Theoretical foundation and key concepts

The global ocean is threatened by complex, multi-scalar pressures that require collective action (Berkowitz et al., 2020). This is the result not only of anthropogenic activities, but also of failures in governance (Berkowitz et al., 2020). This research presents an analysis of ALDFG and its governance in Eastern Caribbean small-scale fisheries. It seeks to uncover barriers to effective governance with a view to presenting approaches that can help overcome these barriers. As has been highlighted, ALDFG is a complex challenge that requires integrated solutions for its effective governance. In the following sections, the key concepts and theories that underpin this work will be elucidated.

2.1 Understanding governance: theoretical foundations

The fundamentally important role of the ocean in global economic development, livelihood and food security, climate regulation and biodiversity preservation cannot be overstated. However, for SIDS the ocean is vital to their development and resilience. It forms part of their cultural identity while their economies and social well-being are intrinsically linked to its health. Climate vulnerabilities—coupled with unsustainable development and resource use—threaten the resilience and economic development of these small island economies. SIDS are more likely to be affected by the declining health of the ocean than any other country grouping (UNCTAD, 2014). Thus, for SIDS, the need for robust, integrated and effective ocean governance is crucial.

Ocean governance is complex and includes the influences of multiple drivers and varying actors, each of whom may have differing goals, agendas and worldviews (Haas et al., 2022). Its complexity and the quest for achieving sustainability and resilience within the marine sphere, necessitates holistic, ecosystem-based governance approaches that are grounded in the best available science and knowledge (Winther et al., 2020).
The small-scale fisheries of the Caribbean region, including the Eastern Caribbean, face many challenges, owing to the high diversity of their marine ecology and social dynamics of their fisheries systems. Thus, in the same vein as ocean governance, it can also be argued that the diversity and complexity of small-scale fisheries require a transition from management to governance that aligns with local realities (Chuenpagdee & Jentoft, 2015). Small-scale fisheries do not exist in a vacuum but form part of a broader governing system that includes multiple actors, different societal sectors and variabilities in resources (Chuenpagdee & Jentoft, 2015).

ALDFG management is only a component of the fisheries governance regime that is linked in the ocean governance architecture not only nationally but regionally and globally as well. In the context of ALDFG governance, just as with small-scale fisheries, its integration with and relevance to other sectors is self-evident. Therefore, the solutions for it must be holistic, multi-sectored and integrated.

As both small-scale fisheries and ALDFG require comprehensive governance approaches, the elements and characteristics of governance must be examined, as well as how this concept differs from the concept of management. Traditionally governance was the task of governments; so-called top-down or hierarchical governing systems, whereby governments set the rules, policies and standards which were then imposed on other actors (Kooiman & Bavinck, 2005). In early writings about governance, it was not uncommon for the term to be used as a synonym for “government” (Graham et al., 2003). However, as the discourse on governance has advanced, to introduce newer perspectives, the lines between public and private actors have become blurred (Kooiman & Bavinck, 2005). Thus, from this viewpoint, governance goes beyond state level decision-making and associated policies, to include processes that allow for coordination and collaboration with civil society actors (Partelow et al., 2023). It is concerned with how power is exercised by these various sectors and their societal interests (Graham et al., 2003). The sharing of knowledge, communication and negotiation are key elements of modern governance processes that seek to achieve sustainability and environmental justice (Partelow et al., 2023). In short, governance actors are seeking to reconcile their collective interests while the discourse on governance theory provides a means for understanding how the exchange between the state and society can aid in defining and implementing collective goals and objectives (Peters & Pierre, 2008). Thus, citizens and organised stakeholders become increasingly responsible for the production of public governance through the application of various self-regulating techniques (Agger et al., 2008).

To assess the governance environment related to ALDFG in the Eastern Caribbean, a conceptual framework has been adopted that can serve as a lens through which to view the findings of this research. While there is a growing body of work outlining various concepts of governance, this research will be grounded by the practical
framework on environmental governance that was developed by Bennett and Satterfield (2018) (Figure 6). Bennett and Satterfield’s practical framework builds on the work of other governance scholars and presents an overarching set of objectives that are supported by a range of governance attributes (Bennett & Satterfield, 2018). This framework was chosen because it allows for evaluation and analysis of governance performance in diverse contexts and at different scales (Bennett & Satterfield, 2018). While this serves as the basis for the assessment, it will also be viewed in light of other key concepts that have been garnered from the literature as emblematic of the sector and region on which this research is based.

While there is no universal definition for governance, Bennett and Satterfield (2018) have proposed a definition based on the work of Graham et al (2003), under which governance refers to the institutions, structures and processes that “determine how; power is exercised, citizens are given a voice and decisions are made on issues of public concern” (Graham et al., 2003, p. i). Thus, based on this definition, a governance system includes three major elements; institutions, structures and processes. Institutions of governance refer to formal or informal rules “that shape human interactions” and “guide, support, or constrain human or management actions” (Bennett & Satterfield, 2018). They include decision-making procedures including rights and norms, rules, legislation and systems of agreement (Kooiman & Bavinck, 2005). Thus, institutions allow societies to regulate and organise structured and routine interactions (Ostrom, 2005). In the context of this study institutions may include the laws and policies governing ALDFG, fisheries and waste management as well as the practices, norms and informal rules employed by fishers to manage their gear. Structures refer both to formal bodies and organisations and informal stakeholder networks that may be involved in different aspects of governance (Bennett & Satterfield, 2018). At the national level, this includes not only state agencies but also civil society groups, cooperatives and other stakeholder groupings. Regionally, this may also include regional fisheries bodies, intergovernmental committees, regional ministerial fora, and the bodies and organs of regional seas programmes.
Governance processes refer to the means by which governance functions are performed. This includes procedures for outlining institutional mandates, conflict resolution practices, law making and policy formulation, and implementation systems for such rules and policies (Bennett & Satterfield, 2018). Bennett and Satterfield (2018) also suggest that environmental governance has four distinct objectives; namely effectiveness, equity, responsiveness and robustness.
Effective governance is concerned with improving the functioning of environmental systems so that societal needs are met (Bennett & Satterfield, 2018; Jaja, 2014). In corporate governance theory, the need to achieve effectiveness in governance stems from an obligation to fulfil stakeholder needs, as there is a recognition of the need for accountability in undertaking governance actions (Sahay, 2016). Accountability can be defined as “a relationship between an actor and a forum, in which the actor has an obligation to explain and justify his or her conduct [while] the forum [that is, stakeholders] can pose questions and pass judgement” (Bovens, 2007, p. 450). This requires an exchange of views so that stakeholders are adequately informed about governance directives and governance actors understand the views and expectations of the stakeholder groups. Effective governance requires that purposeful governance actions are undertaken in a manner that also coordinates the expectations and actors in the system (Borrás, 2009). Thus coordination is another key aspect of effective governance, whereby the concerns, views and expectations of various actors within the system are aligned and their interactions coherently organised (Borrás, 2009). Achieving effectiveness in governance requires the setting of clear goals and targets, and the provision of strategic direction towards their achievement. Evaluating governance effectiveness has traditionally been viewed from the point of view of goal attainment (Lavenex & Križić, 2022). However, Lavenex and Križić (2022) describe three dimensions of effectiveness, relating to facilitation of policy making, policy implementation or outcome, and policy impact. In policy making, effectiveness can be measured in terms of the depth, reach and coverage of policies, and whether they are successfully being implemented (Lavenex & Križić, 2022). In evaluating policy implementation and outcome, there is a need to understand the extent to which governance policies affect the behaviour of intended stakeholder groups, and whether such groups comply with the policy outputs (Lavenex & Križić, 2022). Finally, in considering policy impact, evaluation of effectiveness refers to whether the objectives and targets that have been set out in policy instruments are successfully being met (Lavenex & Križić, 2022).

Equitable governance works towards participation and inclusiveness to avoid marginalisation and disenfranchisement of stakeholder groups (Bennett & Satterfield, 2018). To understand how governance and equity intersect it is first necessary to examine the concept of equity (or social equity) in greater detail. The concept of social equity is undeniably linked to the sustainable development ideology. The landmark 1987 Brundtland Report on sustainable development promoted a developmental approach that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987). The need for intergenerational equity is one of the main considerations of the report, which also recognises the need for equity within each generation. Equity is also linked to principles of justice, with one scholar suggesting that it refers to the “normative
criteria used to orient the implementation of principle(s)/theory(s) of justice” (Grasso, 2007, p. 225). While traditionally the view of equity has been one-dimensional, there is a growing understanding that equity should be viewed as a multi-dimensional concept relating to processes, the distribution of risk and reward, recognition of diverse value and knowledge systems, and the need to acknowledge and respond to the uneven playing field that may exist for some groups (Friedman et al., 2018; McDermott et al., 2013; Pascual et al., 2014; Ruoso & Plant, 2021; Sarkki et al., 2017). Distributive/distributional equity refers to the need for fair distribution of costs, risks, and benefits (McDermott et al., 2013). Procedural equity is concerned with the need for representation and participation in decision making processes, especially for marginalised groups, and considers themes such as transparency and openness in these processes (McDermott et al., 2013; Sarkki et al., 2017). Contextual equity considers unevenness in the pre-existing social, economic and political conditions across society that may influence the ability of various actors to participate in decision-making processes. (McDermott et al., 2013; Pascual et al., 2014). Finally, recognitional equity recognises the need to respect diverse knowledge systems, values and norms of all categories of stakeholders (Pascual et al., 2014; Ruoso & Plant, 2021). Achieving equity in governance systems requires a clear mandate and intent, as well as supporting structures that can facilitate participation in decision making by all categories of stakeholders.

Responsive governance is adaptable to changing environmental conditions and diverse contexts (Bennett & Satterfield, 2018). It requires sensitivity to the needs of communities and receptiveness to their demands, even as these demands change with evolving social and environmental conditions (Abrha, 2016). Thus, responsiveness may be defined as “the outcome that can be achieved when institutions and institutional relationships are designed in such a way that they are cognizant and respond appropriately to the universally legitimate expectations of individuals” (Popescu, 2014, p. 146). Anticipation, adaptability, flexibility and innovation are all key elements of a responsive governance system (Bennett & Satterfield, 2018). To this end the flexibility to changing social and environmental conditions that is exemplified by adaptive management approaches can aid in facilitating a responsive governance environment (Weeks & Jupiter, 2013). Further, responsiveness in governance can be achieved not only through adoption of adaptive management but also by promoting participatory approaches in policy development and related management systems and processes (Podger et al., 2012).

The concept of robustness emerged from the field of engineering, where it was considered to be one of the internal drivers of complexity (Carlson & Doyle, 2002; DiGiano & Racelis, 2012). In this vein robustness is described as a system’s ability to maintain its characteristics despite fluctuations (Carlson & Doyle, 2002). Robust governance should be able to anticipate adverse events while maintaining well-functioning mechanisms to adapt to changing circumstances (Pot et al., 2023). As
robust governance is concerned with maintaining functioning systems in the face of crises and perturbations, there is a need for institutions and actors to remain structurally connected both horizontally and vertically (Bennett & Satterfield, 2018). Structural connections may be facilitated and enabled by bridging organisations, thus robust governance institutions are often nested and polycentric (Bennett & Satterfield, 2018). In this regard, establishing mechanisms for achieving policy coherence across sectors and through multiple levels of governance may be crucial to achieving robust governance. However, Shawoo et al (2022) caution that policy coherence may be considered “politically contingent”, as actors may seek to advance their interests and ideologies through coherence. Thus, there is a need to acknowledge the role political factors may play in the goals that are set, procedures for prioritisation of such goals and how trade-offs may be managed (Shawoo et al., 2022). Thus, the application of a participative approach to achieving policy coherence can promote “transformative sustainability”, by responding to multiple levels of needs (Koff et al., 2002).

One of the foundational questions of this research is to understand the barriers associated with ALDFG governance in Eastern Caribbean small-scale fisheries, with a view to identifying mechanisms for overcoming them. Governance systems do not exist in a vacuum and may be influenced by external or internal forces that can compromise their ability to effectively outline, implement and assess policies and laws that fulfil governance mandates. Analysing governance barriers presents an opportunity to develop actionable issues and challenges that can be addressed through planning (Lubell et al., 2021). For the purpose of this study, governance barriers in the context of ALDFG governance may be defined as impediments or obstacles that impede or hamper the ability of ALDFG governance actors to effectively develop policies, coordinate actions and implement strategies for management. The exact constitution of governance barriers may depend on the particularities of a region or locality—including their economic, political and environmental history—and may be related to specific focus area, mission or practice (Moser & Ekstrom, 2010; Wälitalo et al., 2023). Thus, empirical data are needed to understand the barriers that may be acting upon a particular system.

### 2.2 Complexity, governance and ALDFG

Both natural and social systems can be viewed as “complex”, while many environmental challenges include the added complexity of the how these two systems interact (Berkes et al., 2003). In fact, it can be said that as contemporary societies increase in complexity there is a need for interconnected governance systems that can meet the growing demand that results (Pierre & Peters, 2005). San Miguel (2023) argues that complexity is about the process by which interactions at
small scales can lead to order at larger scales. Thus, complex systems are often associated with multi-scale challenges, which may comprise many interacting units (San Miguel, 2023). Complex systems are often hierarchical, comprising many subsystems (Berkes et al., 2003). Further, complex resource systems link ecological and social components, which includes institutions, organisations and economic systems (Gunderson, 2003). In decision-making, however, complexity and diversity can result in higher degrees of uncertainty or ambiguity in governance systems (Head & Alford, 2015).

Several aspects of ALDFG governance in Eastern Caribbean small-scale fisheries are complex. First, small-scale fisheries themselves are complex. In the Caribbean region this complexity is borne out in the sector’s heterogeneities, the multiple actors, and the formal and informal networks at various levels. The region’s small-scale fisheries operate in diverse ecosystems and target a variety of species using many different fishing practices (de Oliveira Leis et al., 2019). Second, the Caribbean, as previously observed, has been described as one of the most geopolitically complex regions in the world (Fanning et al., 2021). The ocean governance architecture for the Caribbean region is equally complex. It comprises a network of regional and subregional, intergovernmental and non-governmental arrangements that includes sectoral agencies that hold responsibility for fisheries management, pollution control and biodiversity protection (Mahon & Fanning, 2021). It also includes economic integration bodies, as well as academic institutions and science and technology organisations (Mahon & Fanning, 2021). Third, ALDFG, as a component of the global marine debris crisis, is a complex challenge, requiring the cooperation of a multiplicity of actors not just in the fisheries sector but also in environmental protection, waste management and maritime transport. It is driven by local as well as transboundary forces and, like other forms of marine debris, can be transported on ocean currents.

2.3 Overcoming Complexity: polycentric Governance

Complexity theory suggests that due to the interdependencies between various policy systems activities in one policy sphere may create barriers to environmental policy making in others (Macintosh & Wilkinson, 2016). Thus, with regard to ALDFG governance, failures in solid waste management systems, for example, may create barriers to effective governance of ALDFG by eliminating opportunities for proper management of end-of-life and recovered derelict gear.

Polycentric governance has been proposed as a means for overcoming such complexity. Polycentric governance recognises interdependent systems with multiple centres of decision in which no one agency holds ultimate responsibility
The shared responsibility model in polycentric governance systems, makes it easier for them to adapt to both societal and environmental changes (Carlisle & Gruby, 2019). As observed by Bennett and Satterfield (2018) polycentric/nested governance is key to achieving robust governance.

The term polycentricity was first introduced by Michael Polanyi in 1951, in his published essay “The Logic of Liberty” (Carlisle & Gruby, 2019; Marshall, 2015). A decade later, in 1961, Vincent Ostrom, Tiebout and Robert Warren adopted the term while seeking to understand “whether the activities of a diverse array of public and private agencies engaged in providing and producing…public services in metropolitan areas were chaotic,…or potentially a productive arrangement” (Ostrom, 2010, p. 643). They developed the term “polycentric governance”, while seeking to form a more “nuanced understanding of complex human systems” (Savage & Dang, 2021, p. 630). Polycentric governance moves beyond a dichotomous view of the world to a system with many centres of decision-making (Ostrom, 2010).

Governance arrangements may be regarded as polycentric when the constituent centres of decision-making operate autonomously from each other, whether or not such entities are formally independent of each other (Marshall, 2015). A distinction can be made between polycentric governance arrangements and polycentric governance systems based on whether or not decision-making entities can be judged as coherent, thus coherency in decision-making is a prerequisite for polycentric governance systems (Marshall, 2015).

While studying polycentric governance configurations in the semi-sovereign European Union overseas territories scientists proposed four sub-variables and several supporting indicators that could be analysed in the study of polycentric governance, based on the works of Marshall (2015) (Vaas et al., 2017). These may have relevance in the context of the Eastern Caribbean, where there are strong regional integration arrangements through the OECS as well as CARICOM. Autonomous decision-making centres, coherence in the overarching system of rules, stability and tightness were all proposed as characteristic of such arrangements.

Polycentric arrangements form part of the ocean governance architecture covering a number of areas including fisheries, pollution and biodiversity (Mahon & Fanning, 2019). In the Caribbean, polycentric governance has also been investigated in the context of the sargassum challenge (van der Plank et al., 2022). In the latter case, the authors declared that significant benefits were to be found in polycentric governance of the sargassum influxes despite a lack of coordination linked to a larger political process (van der Plank et al., 2022).
3 Methods

3.1 Research methodologies and strategies

The complex and multi-layered nature of societal relations with the ocean leads to a diversity of community perceptions which are influenced by socio-demography, “dependency and connection” with the marine environment and resources, and access to marine spaces (Fletcher & Potts, 2007; Jefferson et al., 2021; McKinley et al., 2022; McKinley & Fletcher, 2010). Understanding this relationship between socio-anthropological systems and the natural world is critical for designing responsive and robust governance solutions to complex problems. Qualitative methods help researchers to address questions of a “social, economic and policy” nature (Barclay et al., 2017), and are, therefore, well suited to governance enquiries.

Inductive reasoning procedures form a major part of qualitative studies, as researchers seek to derive interpretations and meanings directly from the data (Thorne, 2000). Qualitative studies rely on extensive interaction with the people participating in the study to explore their perspectives and interpret their experiences (Wong, 2008). Further, qualitative studies enable the researcher to explore and understand the meaning ascribed to social or anthropogenic problems by research subjects (Creswell, 2009).

In undertaking qualitative research several strategies of enquiry may be employed, which “provide specific direction for procedures in a research design” (Creswell, 2009, p. 28). Two strategies presented by Creswell (2009) are deemed to be most relevant to this research: case studies, which allow for the exploration of in-depth programmes, events, activities, processes or one or more individual, and phenomenological research strategies, which identify the “essence of human experiences about a phenomenon as described by participants” (Creswell, 2009, p. 30).

As this study is concerned with questions of governance, there is a need not only to examine the views and experiences of stakeholders but also to consider the legal and policy regimes relevant to ALDFG governance and their interface with socio-cultural systems. Policy analysis provides a mechanism for “understanding how and why governments enact policies and their effects” (Browne et al., 2019, p. 1). Browne et al. (20019) describe three major approaches to policy analysis:
traditional, mainstream and interpretive. Traditional approaches seek to understand how policy challenges can be solved, mainstream approaches include “studies of agenda-setting, policy processes and networks, and, finally, interpretive analysis is focused on problem representation and understanding how the policy problem is defined” (Browne et al., 2019, p. 4). While traditional policy approaches are focused on facts, mainstream analysis focuses on values, actors and political rationality, and interpretive analysis considers meanings (Browne et al., 2019).

In addition to understanding the policy environment, this research also seeks to analyse the legal landscape and legislative gaps, and how they relate to other aspects of the governance environment. The interplay between law and society has been observed for centuries, as law responds to the needs and desires of the broader society (Bhadra Chaudhuri, 2015). Socio-legal research can help to locate “legal practices within the context of other social practices which constitute their immediate environment” (Bhadra Chaudhuri, 2015, p. 146). By subjecting legal practices to empirical enquiry researchers are able to go beyond the articulation of rules and processes to consider their meaning and effect as interpreted, enforced and experienced by society (Bhadra Chaudhuri, 2015, 147). Socio-legal research broadens legal discourse in terms of its theoretical and conceptual framework, and can help generate empirical evidence to related research questions (McConville & Chui, 2017).

3.1.1 Methodology, strategies and sampling techniques

Data gathering for this research adopted a socio-legal approach with data source triangulation of multiple categories of stakeholders. Data source triangulation is achieved when a study employs various data sources, that may include data of differing temporal and spatial dimensions (UNAIDS, 2010). This allows for findings to be corroborated, and for weaker data sets to be compensated by stronger data units, resulting in increased validity of the results (UNAIDS, 2010).

Data triangulation was used in this research to gain a broad range of perspectives on the major research aims. As noted previously, the research framework has been designed based on the three-pronged approach: (1) context setting and establishing baselines; (2) understanding the governance environment, including the policy and legal regime, as well as barriers and opportunities to improved governance; and finally (3) through application of a theoretical lens, assimilating the findings and presenting conclusions and recommendations (Figure 7). Document analysis, policy and legislative reviews, and semi-structured and open-ended interviews of a range of stakeholders, both nationally and regionally, enabled comprehensive assessment based on this research framework.
Both convenience (opportunistic) and purposive sampling techniques were employed in this study (Andrade, 2021; Palinkas et al., 2015). Fishers and divers from the two case study jurisdictions were targeted through convenience sampling by visiting landing sites and dive shops, and speaking to individuals who were willing to be interviewed. This sampling technique was primarily used in research undertaken for Paper 1 and some components of Paper 3.

Other key informants who formed part of the study were selected through purposive sampling combined with a snowballing technique (Naderifar et al., 2017), in order to gain the insights of a broad cross section of stakeholders at various levels. Purposive sampling (also referred to as purposeful sampling) allows the researcher to select interview subjects with a desired knowledge base, expertise or characteristics (Andrade, 2021; Palinkas et al., 2015). For this research, interview participants with expertise in fisheries management, ocean governance, or who were involved in environmental conservation work were the primary target. Both national-level and regional-level expertise was targeted. Snowball sampling relies on interview subjects to assist in the recruitment of other interviewees through their networks (Naderifar et al., 2017). Purposive sampling techniques were employed in Papers 3 and 4.
3.1.2 Literature review

In order to gain a broad base of knowledge on the subject matter and to evaluate key gaps in the research a narrative literature review was undertaken (Ferrari, 2015; Green et al., 2001). Key search terms were entered into Google Scholar, Scopus and ScienceDirect based on the broad themes of ALDFG, derelict fishing gear, small-scale fisheries and governance. Snowballing techniques were also applied to access academic articles, reports and other forms of grey literature that were cited in some of the articles.

In addition to search engines the works of fisheries management bodies, ALDFG “competent bodies”, and regional organisations were consulted through their websites. These agencies and organisations have produced guidance documents, regional strategies, and synthesis documents on ALDFG or other forms of marine debris. The organisations whose works were consulted included the Cartagena Convention, the CRFM, WECAFC, ICCAT, the Group of Experts on the Scientific Aspects of Marine Protection (GESAMP), FAO, GCFI and the GGGI.

3.1.3 In-depth legal and policy review

An in-depth legal and policy review was undertaken in order to assess the institutional frameworks, national legislative landscape and regional policy framework relevant to governance of ALDFG in the Eastern Caribbean region. This was the methodological approach utilised for Paper 2 and some aspects of Paper 3. To assess the legislative and policy environment for Paper 2, a range of legal and policy instruments were assessed against an established baseline of best practice with a view to analysing existing gaps. The best practice baseline was based on a review of the literature and the guidance documents developed by the GGGI. In order to analyse existing gaps a matrix assessment was used in the review of existing legislation, to determine the degree to which there was alignment with best practices (Table 2).
<table>
<thead>
<tr>
<th>Measure</th>
<th>Explanatory notes as outlined in literature</th>
<th>Assessment question for this study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>National fisheries laws</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisheries act in place</td>
<td>Acts of parliament may serve as a critical “basis for authorizing regulatory actions to prevent and mitigate ALDFG issues” (GGGI, 2020).</td>
<td>Does the state/territory have legislation in place governing management of the fisheries sector?</td>
</tr>
<tr>
<td>Fisheries regulations in place</td>
<td>Fisheries Acts authorise the formation of command-and-control fisheries management measures contained in Regulations, which may aid in managing the threat of ALDFG (Gilman, 2015; GGGI 2021).</td>
<td>Does fisheries legislation include specific regulatory provisions governing the use, management and/or discarding of fishing gear?</td>
</tr>
<tr>
<td><strong>Preventive measures in fisheries laws</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gear marking</td>
<td>Marking of fishing gear includes position markers (such as surface markers) and identifiers that allow for identification of the responsible vessel/individual. It may assist in reducing IUU and dangers to navigation, and can deter abandonment or discard of gear (GGGI, 2021).</td>
<td>Is there legislation that requires that fishing gear be marked?</td>
</tr>
<tr>
<td>Traceability</td>
<td>Traceability measures may include the attachment of radar reflectors and radio buoys to allow for tracking of gear and reducing risk of loss (Gilman, 2015)</td>
<td>Is there legislation governing traceability of fishing gear?</td>
</tr>
<tr>
<td>Spatial management</td>
<td>Separating gear through spatial management systems can reduce the likelihood of gear conflict between static and active gear (GGGI 2021).</td>
<td>Does the state/territory have legislation in place setting spatial restrictions on fishing activity?</td>
</tr>
<tr>
<td>Temporal management</td>
<td>Separating gear temporally can also serve to reduce the likelihood of gear conflict (Gilman, 2015).</td>
<td>Does the state/territory have legislation in place setting temporal restrictions on fishing activity?</td>
</tr>
<tr>
<td>Time restriction for gear deployment</td>
<td>Input controls that limit the amount of time gear is left in the water can reduce the likelihood of gear loss (Gilman, 2015)</td>
<td>Does fisheries legislation include input control measures, such as soak time for specific gear?</td>
</tr>
<tr>
<td>Gear bans</td>
<td>Bans on the use of certain gear known to be of high risk to ghost fishing or entanglement of wildlife has been beneficial in some areas (Gilman, 2015), such as bans on gillnets or trammel nets.</td>
<td>Does legislation include measures that prohibit or restrict the use of certain types of gear that may have deleterious effects if they become derelict?</td>
</tr>
<tr>
<td><strong>Mitigation measures in fisheries laws</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical measures for traps</td>
<td>Some modifications in trap design established to reduce by-catch (such as mesh size restrictions or escape panels) can help to reduce ghost fishing rates if left derelict. (Gilman, 2015)</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in traps?</td>
</tr>
<tr>
<td>Technical measures for nets</td>
<td>Modifications in net design aimed at reducing by-catch (such as, mesh size or length restrictions) can also aid in reducing ghost fishing rates if the nets are left derelict (Gilman, 2015)</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in nets?</td>
</tr>
<tr>
<td>Technical measures for lines</td>
<td>There has been little work to mitigate the impact of derelict lines. However for longline gear “methods such as setting lines at night versus daytime and using deterrents such as streamers during line setting have been suggested” (NOAA Marine Debris Program, 2015).</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in lines (hand lines or longlines)?</td>
</tr>
<tr>
<td>Technical measures for FADs</td>
<td>Technical measures for FADs may provide opportunities to improve the longevity of FADs and minimise the risk of entanglement (Adam et al., 2019; Beverly et al., 2012)</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in FADs?</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Provisions on durability of gear</td>
<td>Using less durable gear/reducing the breaking strength of gear may aid larger animals to break free from derelict gear (Gilman, 2015)</td>
<td>Does legislation include technical measures regarding the durability of gear in order to reduce the duration of ghost fishing or use of biodegradable material?</td>
</tr>
<tr>
<td>Biodegradable material in gear / biodegradable gear</td>
<td>Using biodegradable material in certain gear can assist in reducing ghost fishing if they become derelict (for example biodegradable panels in traps) (Gilman, 2015) or biodegradable materials in FADs (GGGI, 2021).</td>
<td>Does legislation include technical measures requiring the use of biodegradable material in certain gear?</td>
</tr>
<tr>
<td>Marine pollution or other relevant laws</td>
<td>ALDFG is not only a fisheries management problem but also a vessel source pollution problem (Hodgson, 2022). Therefore, marine pollution laws may contain relevant command and control provisions for the management of ALDFG.</td>
<td>Does the state/territory have legislation in place that includes provisions relevant to the management and prevention of marine pollution?</td>
</tr>
<tr>
<td>Ban on intentional discard of fishing gear</td>
<td>Fisheries laws generally did not include provisions prohibiting the intentional discard of fishing gear at sea. “Measures banning intentional discarding and abandonment of fishing gear…can be effective if surveillance and enforcement systems elicit strong compliance” (Gilman, 2015).</td>
<td>Does marine pollution or other relevant legislation include provisions governing derelict fishing gear or other forms of marine debris, including a ban on the intentional discard of fishing gear at sea?</td>
</tr>
<tr>
<td>Remediation of ALDFG: Provisions in marine pollution or other relevant laws</td>
<td>“[T]he effectiveness of gear marking systems would be significantly enhanced when incentives exist to…encourage the reporting of lost or abandoned fishing gears…” (FAO, 2016). This would assist in the provision of data to understand the scale of the problem and help support recovery (Hodgson, 2022).</td>
<td>Is there an obligation for fishers or vessels to report derelict fishing gear?</td>
</tr>
<tr>
<td>Obligation to report</td>
<td>FAO (2019) advises that owners and operators should be encouraged to “make every reasonable effort” to retrieve ALDFG having due regard for human safety and damage that may result from retrieval efforts.</td>
<td>Is there an obligation for fishers or vessels to find and retrieve derelict fishing gear?</td>
</tr>
</tbody>
</table>

The legislation and policy documents that were reviewed in the assessment of the legal and policy regime included fisheries management legislation, environment protection laws, waste management legislation and relevant policies for each of the 10 states and territories that were part of this research (Table 3).
Table 3: Legislation and policy documents reviewed during legal and policy gap analysis

<table>
<thead>
<tr>
<th>State/territory</th>
<th>Legislation</th>
<th>Policy documents</th>
</tr>
</thead>
</table>
| Anguilla                 | Fisheries Protection Act 2000  
Fisheries Protection Regulations  
| Antigua and Barbuda      | Fisheries Act 2006  
Fisheries Regulations 2013  
Environmental Protection and Management Act 2019 | Maritime Economy Plan – Antigua and Barbuda (CMEP, 2021)  
Antigua and Barbuda’s Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (Fisheries Division, 2010) |
| Barbados                 | Fisheries Act 1995  
Fisheries (Management) Regulations 1998  
Fisheries Regulations 2003  
Merchant Shipping (Prevention of Pollution by Garbage from Ships) Regulations 2020 | Virgin Islands Strategic Blue Economy Road Map (Government of the Virgin Islands & UNDP, 2020) |
| Dominica                 | Fisheries Act 1987  
| Grenada                  | Fisheries Act 1986  
Fisheries Regulations 1987  
| Montserrat               | Fisheries Act 2000  
Merchant Shipping (Prevention of Pollution by Garbage from Ships) Regulations 2020 | Draft National Ocean Policy for St. Kitts and Nevis (Howell Marine Consulting and Sustainable Seas Ltd., 2019c)  
National maritime policy and action plan (Department of Maritime Affairs, 2015)  
St. Kitts and Nevis National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (Department of Marine Resources, 2015) |
| St. Kitts and Nevis      | Fisheries Act 2016  
Fisheries Regulations 1995  
Marine Pollution Management Act 2002 | Draft National Ocean Policy for St. Kitts and Nevis (Howell Marine Consulting and Sustainable Seas Ltd., 2019c)  
National maritime policy and action plan (Department of Maritime Affairs, 2015)  
St. Kitts and Nevis National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (Department of Marine Resources, 2015) |
| St. Lucia                | Fisheries Act 1984  
Fisheries Regulations 1994 | Draft National Ocean Policy for St. Lucia (Howell Marine Consulting and Sustainable Seas Ltd., 2019d) |
Fisheries Regulations 1987  
A similar approach was utilised for Paper 3; however only specific legislative provisions and policies that were relevant to implementation of VGMFG were considered. Thus, legal instruments were reviewed with a view to determining whether:

- They included gear marking provisions
- Such provisions included a requirement for traceability
- Technical specifications were outlined in legislation
- They included an obligation to report.

To complete the legal analysis for Paper 3, an approach adapted from Wilson et al. (2022) was employed. This allowed for scoring of the regulatory strength in support of implementation of the VGMFG. In this approach the assessed legislation was scored either a zero or one based on the status of its regulatory provisions relating to: (a) the obligation to report ALDFG, and (b) the inclusion of technical specifications for applying gear marking provisions in legislation. For those two parameters, if there were no regulations a score of 0 was assigned, while a score of 1 was assigned if regulations existed. The score assignments for the metrics relating to gear marking laws and on traceability were adjusted to take into account the number of gears any such requirements applied to. Countries that required gear markings and traceability measures to be applied to all categories of gear utilised in the fisheries were assigned a score of 1. Countries that required gear markings or outlined traceability requirements for one or more, but not all, gear types were given a score of 0.5. Countries with no gear marking or traceability requirements in legislation were given a score of 0. Scores were then averaged.

3.1.4 Key informant interviews

Interviews were necessary to establishing baselines regarding the nature and scale of the challenge within the study area, as well as to gain insight on the governance environment and barriers to effective governance and to inform key recommendations. This method was primarily utilised in the development of Papers 1, 3 and 4.

Fishers from Antigua, Barbuda and Dominica were interviewed over a period of two months in summer 2022. The survey instruments utilised in this research were derived from the FAO Global Assessment of abandoned lost and discarded fishing gear and used with their permission (Appendix 2). Based on the global assessment requirements, a different survey instrument was delivered for each gear type.

A total of 56 fishers were interviewed across the three islands. This included 28 line fishers, 36 trap fishers and 14 net fishers (due to the multi-gear nature of the fisheries sectors in both jurisdictions some fishers agreed to respond to more than one survey instrument). In addition to fisher interviews, divers were also opportunistically
targeted at landing sites or dive shops. Only the data derived from 49 fishers—as well as the interview data for all divers—were utilised in the generation of Paper 1, as that paper did not focus on the net fisheries in either jurisdiction. This decision was taken to eliminate the net fisheries from this analysis, as the sample size in at least one jurisdiction was quite small. Data from all 56 fishers were utilised in completing Paper 3 as a means of evaluating compliance with and implementation of gear marking schemes in the two case-study countries.

Interviews with fishers and divers, as primary stakeholders, were necessary for context setting and establishing baselines. Key aspects of context setting included gaining insight into the drivers of gear loss, quantities of gear being lost and the observed effects. Diver interviews provided insight on the scale of the challenge, as divers were asked to indicate the most frequently observed forms of ALDFG. Those interviews also provided important clues to the transboundary nature of the challenge as divers were able to report on derelict gear that did not originate in the local fisheries. The FAO Global Assessment survey instruments were primarily made up of structured and semi-structured interview questions. Semi-structured interview questions were also used during interviews with divers (Appendix 3). In both instances the results of the interviews were uploaded into Excel spreadsheets for analysis.

To assist with the assessment for Paper 4, a total of 17 key informant interviews were also conducted with a range of national and regional experts representing fisheries management agencies, marine conservation bodies, and regional organisations (these have been labelled “governance stakeholders”). Two of these key informants were also divers and responded to questions that were developed for the diver interviews. All the key informant interviews were conducted via Zoom. Semi-structured and open-ended interview questions were addressed to national and regional policy makers, marine conservation experts and fisheries managers who provided key insights into the governance environment and experienced governance challenges (Appendix 4). It also allowed experts to offer their perspectives on mechanisms for improved governance. All interviews with these “governance stakeholders”, both national and regional, were first transcribed utilising Otter AI software before being uploaded to NVIVO for analysis.

A purposive sampling strategy combined with snowballing was utilised in selecting key informants who could contribute to Paper 4. The sampling strategy targeted not only fisheries management experts but also marine park authorities, non-governmental bodies involved in marine conservation work, fisheries stakeholder groups and regional experts (Table 4).
Table 4: Sample size of experts interviewed for Paper 4

<table>
<thead>
<tr>
<th>Category of expert</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisheries experts</td>
<td>5</td>
</tr>
<tr>
<td>Marine park authorities</td>
<td>4</td>
</tr>
<tr>
<td>National NGOs and stakeholder bodies</td>
<td>4</td>
</tr>
<tr>
<td>Regional intergovernmental representatives</td>
<td>1</td>
</tr>
<tr>
<td>Regional fisheries management representatives</td>
<td>1</td>
</tr>
<tr>
<td>Regional marine conservation/fisheries NGOs</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Sample Size</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

3.1.5 Case study

Case studies were one of the first methodological approaches to be used in qualitative studies (Starman, 2013). Thus, they have been used extensively in a range of disciplines, but particularly in the social sciences (Crowe et al., 2011). As a research approach, the use of case studies is “particularly [pertinent]…when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context” (Crowe et al., 2011, p. 1). Using case studies allows the researcher to gather information on explanatory questions such as how and why an intervention is being implemented, or to understand gaps in implementation (Crowe et al., 2011).

In case study research, the data that is gathered should be detailed and cover various aspects of the case. Thus, it is useful to utilise multiple methods of data gathering, including semi- and unstructured interviews and document analysis (Ylikoski & Zahle, 2019). Data triangulation, which involves the collection of empirical evidence from multiple sources, helps to add depth, rigour, complexity and breadth to investigative research (Rashid et al., 2019). The goal of a case study is to provide in-depth, holistic and intensive analysis and description of the case being evaluated (Ylikoski & Zahle, 2019). Case studies may be standalone or they can be used to support other kinds of studies (Ylikoski & Zahle, 2019).

In order to gather empirical, baseline data on the incidence, drivers and impacts of ALDFG in the context of Eastern Caribbean small-scale fisheries, a case-study methodology was also employed for this research. The case study method was used in the development of Paper 1 on Understanding the drivers, scale and impact of ALDFG in the Eastern Caribbean, and some aspects of Paper 3 on implementation of the VGMFG. With regard to Paper 3, a case study analysis of implementation of
the VGMFG provided insight into compliance and implementation gaps associated with the governance of ALDFG in Eastern Caribbean small-scale fisheries.

### 3.1.6 Data analysis

As has been noted, this is a qualitative study that has adopted a socio-legal approach. It utilised a variety of qualitative methodologies, including legal and policy analysis. As a result, a range of analytical tools and methods were applied to the data. Data derived for Paper 1 were analysed to generate descriptive statistics on the drivers, scale and impact of ALDFG in the Eastern Caribbean. Some elements of Paper 3 were also analysed in this manner, namely the fisher interview questions seeking to understand whether fishers marked their gear and the manner in which their gears were marked. In both cases, fisher interview data was uploaded to an Excel spreadsheet for analysis. Paper 2 and some elements of Paper 3 (dealing with legislative support for gear marking), were analysed using the methodology outlined in Section 3.1.3 (that is, the in-depth legal review).

Some data generated for Paper 3, along with the data for Paper 4, were recorded in interview transcripts. All transcripts were generated with the assistance of Otter AI, a real time transcription software, which can automatically capture, transcribe and summarise online meeting conversations. Otter AI was allowed to join the online interviews through the Zoom Platform, and automatically capture the audio for transcription. On a few rare occasions, audio files were uploaded after the meetings, to be transcribed. Once the meeting audio was transcribed, a process of review, and correction was carried out. The corrected transcription text was then uploaded to NVIVO for analysis. NVIVO is a qualitative analysis software that enables the organisation, coding and analysis of qualitative data sets. All the data were coded manually in NVIVO using a mixed strategy (deductive and inductive coding). Through deductive coding, a basic list of code categories was first developed to organise the data into broad themes (Table 5). Deductive coding assigns a pre-determined list of codes to the data, thereby allowing for maintenance of focus on key areas of importance to the research design (Linneberg & Korsgaard, 2019). This was followed by an inductive coding strategy whereby all other codes were revealed from analysis of the transcription text. In inductive coding, the codes are developed by utilising codes or phrases from the interview participants themselves and, thus, are loyal to the data (Linneberg & Korsgaard, 2019). Deductive codes determined for this research were based on the three-pronged approach as well as elements of the conceptual framework. To set the context, some data was coded perception. This included key informant views on whether ALDFG was of concern in the region, their broad perspectives on the most concerning gear types, and drivers of gear loss. Regarding the governance environment and the barriers to governance, deductive codes were aligned to the elements of governance included in the conceptual
framework (that is institutional barriers, structural barriers and procedural barriers). Additionally, a fourth category of cross-cutting barriers was also identified. Associated inductive codes are borne out in the results based on key informant interview data. The final deductive code was concerned with the need to articulate mechanisms for improved governance (that is facilitators).

Table 5: Deductive codes utilised in NVIVO for Paper 4

<table>
<thead>
<tr>
<th>Deductive Data codes</th>
<th>Inductive Data Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptions</td>
<td>No associated inductive codes</td>
</tr>
<tr>
<td>Institutional barriers</td>
<td></td>
</tr>
<tr>
<td>Structural barriers</td>
<td>Articulated in Table 11. Identified barriers were inductively coded.</td>
</tr>
<tr>
<td>Procedural barriers</td>
<td></td>
</tr>
<tr>
<td>Cross-cutting barriers</td>
<td></td>
</tr>
<tr>
<td>Facilitators of improved governance</td>
<td>Articulated in Table 12 and Figure 15.</td>
</tr>
</tbody>
</table>
4 Results

The core objective and research questions that underpin this thesis have been addressed in four academic publications (Figure 8). Three of these have been published, while the fourth is in the final stages of review for publication (Appendix 5).

Collectively, the data, insights and perspectives that have been gained from the four publications present an analysis of the issue of ALDFG in Eastern Caribbean small-scale fisheries, the challenges and barriers associated with its governance, and opportunities for these to be overcome with a view to achieving improved governance. The following is a summary of the four papers, including their aims, methodologies, data employed, and key results (Table 6). The results will be further elaborated on in the following sections, including how they have contributed to responding to the four research questions that guide this dissertation.
Table 6: Summary of the research aims, data and methodology, and key findings of the four thesis publications

<table>
<thead>
<tr>
<th>Aims of the research paper</th>
<th>Paper I: Drivers, scale and impact of ALDFG</th>
<th>Paper 2: Legal and policy gaps in ALDFG governance</th>
<th>Implementation of VGMFG: Case study analysis of implementation and compliance gaps</th>
<th>Governance of ALDFG: Barriers and opportunities for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>To understand what the drivers of ALDFG and fishing gear loss in the Eastern Caribbean are</td>
<td>To outline the existing legal and policy landscape associated with the governance of ALDFG in the Eastern Caribbean</td>
<td>To analyse the compliance and implementation gaps associated with ALDFG governance in the Eastern Caribbean., through case study approach</td>
<td>To assess the major barriers associated with ALDFG governance in the Eastern Caribbean.</td>
<td>To outline how Eastern Caribbean small island states can overcome major barriers with a view to improving the governance of ALDFG in the Eastern Caribbean.</td>
</tr>
<tr>
<td>To gain insight into the scale of ALDFG in Eastern Caribbean small-scale fisheries</td>
<td>To determine the legislative and policy gaps associated with ALDFG governance in the sub-region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To outline the impacts associated with ALDFG in the Eastern Caribbean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methodologies employed</td>
<td>Case Study</td>
<td>Legal review</td>
<td>Case Study</td>
<td>Key informant interviews: Open ended and semi-structured</td>
</tr>
<tr>
<td></td>
<td>Semi-structured interviews</td>
<td>Policy analysis</td>
<td>Legal review</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Content analysis</td>
<td>Key informant interviews: Semi-structured and open ended</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>Semi-structured interview responses</td>
<td>Legislation</td>
<td>Legislation</td>
<td>Interview transcripts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy documents</td>
<td>Semi-structured interviews</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Interview transcripts</td>
<td></td>
</tr>
<tr>
<td>Key results</td>
<td>Improved understanding of the drivers of fishing gear loss in Eastern Caribbean small-scale fisheries</td>
<td>Improved understanding of major institutional barrier to ALDFG governance in the Eastern Caribbean – weaknesses in the legal and policy regimes</td>
<td>Compliance and implementation gaps associated with the ALDFG in the Eastern Caribbean – case study results on implementation of the voluntary guidelines on marking of fishing gear</td>
<td>Structural, institutional, procedural and cross-cutting barriers associated with ALDFG governance in the Eastern Caribbean.</td>
</tr>
<tr>
<td></td>
<td>Insights into the scale and transboundary nature of ALDFG in the Eastern Caribbean</td>
<td>Gaps in legal and policy landscape for ALDFG governance in the Eastern Caribbean</td>
<td></td>
<td>Outlined opportunities and recommendations for improved governance.</td>
</tr>
<tr>
<td></td>
<td>Understanding of direct environmental impact and estimates of economic impact associated with ALDFG in the Eastern Caribbean</td>
<td>Legal and policy barriers to ALDFG governance in the Eastern Caribbean</td>
<td></td>
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</tbody>
</table>
4.1 Research Question 1

Research Question 1: What is the current scale and impact of ALDFG associated with Eastern Caribbean small-scale fisheries?

Designing effective governance solutions requires an understanding of the nature of the challenge for which these solutions are being sought. This includes gaining insight into its scale and impact. In considering ALDFG within the small-scale fisheries of the Eastern Caribbean, key questions in this regard may include: What types of gear are being lost and in what quantities? Are fishers losing whole gear components or parts? What forms of ALDFG are found within the area of study and with what frequency? Which factors are contributing to the loss of fishing gear? How are derelict gear affecting marine habitats and wildlife in the Eastern Caribbean? Paper one of this research examined these key questions through analysis of semi-structured interviews with fishers and divers in two Eastern Caribbean states (Antigua and Barbuda, and Dominica). The two case study countries represent what could be described as opposing ends of the diverse spectrum of fisheries systems that exist within the Eastern Caribbean.

Examination of scale of the threat considered three main themes that were addressed in the paper: The amount of gear fishers reported losing (in the case of trap fishers), the components of traps and lines that were lost by fishers and the frequency with which divers encountered various forms of derelict gear. Fishers in Antigua and Barbuda reported losing an average of 19.6 traps per year, which when extrapolated against the most recent estimate of active vessels in the fishery amounted to 2,273 traps per year (Figure 10). Similarly, Dominican fishers reported losing an average of 17 traps per fisher per year, or an estimated average annual total of 2,567 traps for the fishery (Figure 11).

In both countries, fishers reported rarely losing an entire set of traps but more than 80 per cent of Antiguan fishers and over 70 per cent of fishers in Dominica reported having lost a single unit of traps either always or sometimes. For line fishers, plastic lures were the most frequently cited component that fishers reported losing, while almost 90 per cent of line fisher respondents in Dominica reported losing a single unit of line with attached floats and buoys either very frequently or sometimes.

Based on diver observations, fish traps were among the most frequently observed forms of derelict gear in both Dominica and in Antigua and Barbuda. Other forms included monofilament fishing line fragments, polypropylene nets, ropes, and FAD components (Figure 9). In the absence of photographic evidence of submerged derelict gear, the figure below presents an illustration of the types of gear divers reported seeing. Many of the FAD components observed both in Antigua and Barbuda and in Dominica either originated in neighbouring French islands or were illegally set by French fishers in the countries’ exclusive economic zones. This was
determined based on the observed markings of derelict FADs, which were often in French. Divers also reported seeing buoys, spearfishing equipment, crab traps, fish crates and octopus traps. The octopus traps reported by one diver in Antigua and Barbuda are the same as those reportedly found on beaches in the Bahamas, and are thought to have originated in the Eastern Atlantic.

Paper 4 was primarily dedicated to outlining barriers to the governance of ALDFG and to solicit expert’s views on mechanisms for overcoming these to achieve improved governance. However, interviewees were also asked to comment on their perceptions of ALDFG as a regional challenge. With only one exception, all indicated that ALDFG was of concern, with responses ranging from minor to major concern. Fish traps were identified as a major concern by all key informants with one participant commenting that this was a growing concern as fishers have shifted from using biodegradable materials to construct traps (bamboo and cane) to “wire mesh, which takes longer to degrade, [thus] traps stay in the ecosystem for a longer period”. Monofilament fishing lines were reportedly of particular concern in nearshore areas, and were often thought to be associated with shore-based fisheries, while experts from Antigua and Barbuda, St. Kitts and Nevis, Grenada, St. Vincent and the Grenadines, along with regional experts confirmed that MFADs were also contributing to ALDFG in the area.

Figure 9: Examples of gear components that have been identified among derelict fishing gear by divers in the Eastern Caribbean (Clockwise): (A) gillnet, (B) wire mesh fish traps, (C) tangled rope, and (D) recovered FAD components
Estimates of trap loss in Antigua and Barbuda, and Dominica provided an opportunity to also estimate the direct effects on wildlife of derelict traps and the potential economic impact associated with their loss for both jurisdictions (Figures 10 and 11). Do and Armstrong (2023) estimated the average annual catch rate for ghost traps to be 2.77 organisms per trap. While this number seems relatively low it is consistent with a number of other studies, which also observed relatively low mortalities associated with derelict traps and decreasing efficiency as traps degrade (Goodman et al., 2021; Renchen et al., 2014). Norris et al. (2011) estimated a total of four fish would equate to a pound, which is the unit used for fish sales in both countries. Based on the estimated capture potential of ghost traps as proposed by Do and Armstrong (2023) and the conversion recommended by Norris et al (2011) it is estimated that derelict traps in Antigua and Barbuda could result in the capture of an estimated 6,296 individual marine organisms equating to 1,574 lbs (713.95 kg) a year. In Dominica, based on the rate of trap loss, derelict traps are estimated to capture 7,110 marine organisms or 1777.6 lbs (806.3 kg) annually. These figures represent a potential annual loss in revenue for Antigua and Barbuda of East Caribbean $15,740 or US$5,829.63 for the trap fishery (Figure 11). In Dominica these losses are estimated at EC$14,220 or US$5,266.67 USD (Figure 12) each year. These figures may appear relatively small, but do not include the replacement cost for lost traps.

**Figure 10:** Estimated trap loss, ghost fishing potential and associated economic loss for trap fishers in Antigua and Barbuda ($1 USD = $2.70 XCD)
Divers both in Antigua and in Barbuda and Dominica observed impacts to wildlife and benthic ecosystems associated with traps as well as other forms of derelict fishing gear. Monofilament fishing lines—which were frequently encountered in shallow, nearshore areas—were often observed snagged on reefs and, in a few rare instances, entangled around marine fauna. Derelict gillnets were observed ghost fishing in both jurisdictions and entangled around reefs, which could result in damage to coral colonies. Polypropylene nets were rarely observed entangled around marine wildlife but were seen smothering large sections of reef in one encounter. Observed effects associated with derelict traps included scarring of the marine benthos and ghost fishing.

4.2 Research Question 2

Research Question 2: What are the major drivers of ALDFG in Eastern Caribbean small-scale fisheries?

Paper 1 considered issues relating to environmental, conflict, and operational drivers of loss as experienced by fishers in Antigua and Barbuda, and Dominica. Papers 2 and 3, on the other hand, provide insight regarding management related drivers, in addition to addressing barriers to effective governance as outlined in research question 3.
Paper 1 illustrated that, as in other regions, the drivers of gear loss in the two case study islands are varied and often dependent on local conditions, including the biogeography of the marine environment and local practices. Categorising the major drivers into three main groupings (environmental, conflict and operational) it was shown that for both trap and line fishers across the two countries, environmental drivers were the most frequently cited causes of gear loss. Thus, ranking drivers based on the frequency with which fishers identified them as a cause of trap loss, environmental drivers were the most frequent, followed by conflict drivers and operational drivers (Figures 12 and 13). Poor weather was found to be a major environmental driver of trap loss, a result which is consistent with the findings in other Caribbean jurisdictions (Antonelis et al., 2021, 2022; Antonelis & Drinkwin, 2021; Gallagher et al., 2023; Richardson, Hardesty, et al., 2021) (Table 7)

![Diagram of Drivers of Fish Trap Loss](image)

**Figure 12**: Drivers of fish trap loss in Antigua and Barbuda, and Dominica and frequency with which fishers identified them in interview.
Table 7: Ranking of the most significant drivers of fish trap loss across four Caribbean states. (Rankings have been based on the frequency with which fishers cited the specific driver as leading to gear loss)

<table>
<thead>
<tr>
<th>Ranking of the most significant drivers of trap loss in four Caribbean states</th>
<th>Antigua and Barbuda (Current Study)</th>
<th>Dominica (Current Study)</th>
<th>Montserrat Derived from (Antonelis et al., 2022)</th>
<th>Belize Derived from (Antonelis &amp; Drinkwin, 2021)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Poor weather</td>
<td>Poor weather</td>
<td>High vessel traffic</td>
<td>Poor weather</td>
</tr>
<tr>
<td>2</td>
<td>Vandalism</td>
<td>Drifting out of range and snagging</td>
<td>Poor weather</td>
<td>Strong currents and drifting out of range</td>
</tr>
<tr>
<td>3</td>
<td>Snagging, strong currents and operator error</td>
<td>Vessel traffic</td>
<td>Strong current and vandalism</td>
<td>Vandalism</td>
</tr>
<tr>
<td>4</td>
<td>Conflict with other gear and vessel traffic</td>
<td>Strong currents</td>
<td>Lost surface markers</td>
<td></td>
</tr>
</tbody>
</table>

As with trap fishers, environmental drivers were among the most frequently cited causes of line loss in both Antigua and Barbuda, and Dominica with towing by large animals and snagging on benthic obstructions being the most frequently cited (Figure 13). Operational drivers were not as critical for line fishers as for trap fishers but in both instances, they were among the least cited by the interviewed fishers as a cause of gear loss.

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**Figure 13:** Drivers of line loss in Antigua and Barbuda and Dominica, and frequency with which fishers identified them

While paper 1 did not directly address possible management drivers of fishing gear loss, Papers 2 and 3 considered, among other issues, fisheries management failings that could affect ALDFG within the Eastern Caribbean. Paper 2 focused on a review of the policy and legislative landscape for ALDFG governance in the OECS and Barbados, while Paper 3 zeroed in on marking of fishing gear and the implementation of the VGMFG. Both of these analyses were conducted for the full study area (English speaking OECS members and associate members and Barbados), while Paper 3 also utilised the case study methodology to analyse gaps in compliance.

Management failings, regulatory gaps, and weaknesses in compliance regimes may all increase the likelihood of fishers mismanaging or abandoning gear, or dis incentivise fishers from implementing ALDFG mitigation measures such as mesh size restrictions for traps and nets (Gilman et al., 2022). Paper 2 revealed significant weaknesses in the regulatory landscape for ALDFG in the Eastern Caribbean, including outdated or missing legislation and ineffective marine pollution instruments that largely ignored matters relating to sea-based sources of marine litter. Fisheries enforcement is also a major challenge for many of the islands, as they often lack the technical and financial capacity to fully police their exclusive economic zones (TBTI, 2018).

Marking of fishing gear and the voluntary guidelines for its implementation are seen as critical elements of ALDFG governance, as inclusion of such provisions in legislation may serve to dissuade fishers from abandoning gear at sea, and may also increase the visibility of static gear for navigating vessels. Examination of the legislation throughout the study area, however, revealed significant variability in legislative support for marking of gear, and a number of gaps in national laws. Applying an approach developed by Wilson et al (2022), Paper 3 analysed the legislative strengths of the various gear marking laws across the Eastern Caribbean. While 70 per cent of the jurisdictions had provisions requiring the marking of at least one gear type, only Antigua and Barbuda, outlined technical specifications for how such markings should be applied to active gear. That jurisdiction, however, did not mandate reporting of ALDFG. The British overseas territories were the only territories that included a legal provision for reporting of derelict gear. However, this was not through local legislation but based on United Kingdom laws. Of the seven countries that included legislative support for the marking of fishing gear in local fisheries laws, only four included a requirement for traceability. Overall, Antigua and Barbuda’s national fisheries laws provided the strongest legal support for implementation of the voluntary guidelines, while Dominica and Grenada had no legal support (Figure 14 and Table 8).
**Figure 14:** Map illustrating the legislative strength of gear marking rules across the assessed jurisdictions (created in Excel)

**Table 8: Legislative strength scores for assessed jurisdictions**

<table>
<thead>
<tr>
<th></th>
<th>Legislative support</th>
<th>Technical specifications</th>
<th>Traceability</th>
<th>Reporting of lost gear</th>
<th>Regulatory strength average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antigua and Barbuda</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0.75</td>
</tr>
<tr>
<td>Anguilla</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>British Virgin Islands</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.38</td>
</tr>
<tr>
<td>Montserrat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>St. Kitts and Nevis</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>St. Vincent and the Grenadines</td>
<td>0.5</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>Barbados</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.13</td>
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<tr>
<td>Dominica</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Grenada</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>
Both the decision to utilise gear markings or not, as well as the materials used to mark fishing gear could affect losses. This was illustrated by key informants when questioned about the practice of gear marking within their local fisheries. Thus, in addition to passing vessels and losses resulting from severe weather, deployment strategies practised by trap fishers were concerning to experts in Antigua and Barbuda, Grenada, and St. Kitts and Nevis, who indicated they were likely leading to losses. First, the practice of utilising plastic bottles to mark the location of fish traps, which;

“as they continuously get exposed to the [sun] they break down with UV exposure. So [with] continuous use and they end up failing, [and] breaking off”.

For fishers who set traps without surface markers, one expert observed;

“[T]hey stand a higher chance of losing them, because sometimes the traps end up in deeper waters”.

Blind traps, set or abandoned in vulnerable habitats were observed causing damage to corals, as noted by one conservation expert;

“So, a lot of times when I'm diving, what I see is a lot of people set their fish pots blind, and sometimes you can tell when they're turned over, or they're on top of a coral head, or they're obviously breaking apart, so they've been abandoned…[and] you can see it… just…rubbing against the reef in a not a good way”.

4.3 Research Question 3

Research Question 3: What are the current structural, institutional and procedural barriers that may contribute to ineffective governance of ALDFG in Eastern Caribbean Small-Scale Fisheries

Papers 2, 3 and 4 provided key findings regarding the structural, institutional and procedural barriers relating to ALDFG. One of the most important barriers relates to the policy, legislative and compliance regimes, which were assessed in Papers 2 and 3. As noted above, Paper 2 revealed significant gaps and weaknesses in the regulatory regime for the management of ALDFG. This could help to drive ALDFG and could also be considered a major institutional barrier. That study also highlighted that significant fragmentation exists in the legal and policy regime, with relevant laws being split between fisheries and waste management legislation, marine pollution laws (where those existed) and/or environmental protection laws, while many countries lacked many best-practice provisions within their legislation (Table 9). The need for strong intersectoral collaboration and cooperation is evident,
and policy coherence is also necessary across these sectors in order to avoid internal conflicts between these various agencies.

Table 9: Overview of legislative measures and existing gaps in the management of ALDFG in the OECS and Barbados.

(Symbol Key: ☑ = yes/present, ☐ = No/Absent, ⚫ = all gear, ☐ = FADs only, 🔒 = traps only; ⋁ = gillnets, ⌂ = Trawl nets, ⚔ = trammel or entangling nets, ⚋ = Environmental Protection Act, ☠ = Solid Waste Management Act; State/Territory Abbreviations: AN = Anguilla, AB = Antigua & Barbuda, BA = Barbados, BI = the British Virgin Islands, DO = Dominica, GE = Grenada, MO = Montserrat, SK = St. Kitts & Nevis, SL = St. Lucia, SV = St. Vincent & the Grenadines)

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>AN</th>
<th>AB</th>
<th>BA</th>
<th>BI</th>
<th>DO</th>
<th>GR</th>
<th>MO</th>
<th>SK</th>
<th>SL</th>
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<tbody>
<tr>
<td>National fisheries laws</td>
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<td>Fisheries act in place</td>
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<td>Fisheries regulations in place</td>
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<td>Preventative measures in fisheries laws</td>
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<tr>
<td>Gear marking</td>
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<td>Traceability</td>
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<td>Spatial management</td>
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<td>Temporal management</td>
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<td>Input controls (time limiting gear deployment)</td>
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<td>Gear bans (on certain nets)</td>
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<td>Mitigation measures in fisheries laws</td>
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<td>Technical measures for traps: mesh size</td>
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<td>Technical measures for nets: mesh size⁴</td>
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<td>Technical measures for nets: length</td>
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<td>Technical measures for lines</td>
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<td>Technical measures for anchored FADs</td>
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<tr>
<td>Ban use of corrosion resistant material on traps</td>
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<td>Biodegradable gear (components): traps</td>
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<td>National marine pollution measures</td>
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<td>Marine pollution or other relevant laws</td>
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</table>

⁴ In the case of Anguilla, the regulations allow for mesh size restrictions on nets but none have been stipulated.
Paper 3 highlighted weaknesses in the compliance regime related to the marking of fishing gear. In Antigua and Barbuda—which was shown to have probably the strongest legislative system to support the implementation of the VGMFG—this did not necessarily translate into strong compliance among the fishers who were interviewed. In fact, the majority of the fishers (more than 85 per cent) were not even aware of the legislation requiring marking of fishing gear. Thus, while many fishers admitted to marking their gear this was rarely done in compliance with the technical specifications outlined in the fisheries regulations. Two-thirds of those interviewed in Antigua and Barbuda did not mark their gear in a traceable manner, despite this being a requirement under the fisheries legislation.

In Dominica, while there was no legal requirement for the marking of fishing gear, the results were quite similar. That is, most fishers who were interviewed (90 per cent) indicated that they marked their fishing gear (either always or sometimes). However, only 18.5 per cent of those who indicated that they marked their gear, did so in a manner that was traceable.

The compliance gaps that were highlighted by fishers in the two case study jurisdictions were also corroborated by fisheries managers in Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines (Table 10). Fisheries managers reported on a reluctance among fishers to mark their fishing gears leading to a high degree of compliance, even in cases where legislation mandated that gears be marked. As observed in the two case study countries, fishers often utilised non-traceable unique identifiers, particularly for the marking of fish traps.

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5 In one of the multi-island jurisdictions two representatives were interviewed from each of the main islands.
### Table 10: Statements of interviewed fisheries managers on gear marking compliance

<table>
<thead>
<tr>
<th>Legal requirement</th>
<th>Gear Marking Compliance (statement of Fisheries Managers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>“some, not all, do mark the pots”</td>
</tr>
<tr>
<td></td>
<td>“It is their personal markings you know, yeah. It's their personal markings they would put on it, you know”.</td>
</tr>
<tr>
<td>Marking of FADs and traps</td>
<td>“They're supposed to mark [traps] with their vessel number…but they don’t”.</td>
</tr>
<tr>
<td></td>
<td>“The level of non-compliance is high”.</td>
</tr>
<tr>
<td>Marking of FADs and traps</td>
<td>“Most of [the markings] are basically on the buoys not the trap itself. But some people design their traps differently in a sense. They have a certain way that they will set their traps…”</td>
</tr>
<tr>
<td></td>
<td>“Compliance is always a problem”</td>
</tr>
<tr>
<td>Marking of traps</td>
<td>“The initiative [for marking of gear]was proposed a long time ago and it has never gained…traction”.</td>
</tr>
<tr>
<td></td>
<td>“fishers don't like to be tracked, and they just look at it as another medium for tracking their activities.”</td>
</tr>
<tr>
<td>Marking of FADs.</td>
<td>“The fishers do have their own sort of unique identifiers for their pots”.</td>
</tr>
<tr>
<td></td>
<td>“We do have markings on the FAD. It's mandated by legislation”</td>
</tr>
</tbody>
</table>

Key informants also outlined a number of challenges relating to instituting national gear marking schemes, including mechanisms for reporting lost gear within their relevant jurisdictions. These included:

- Lack of data and information on the amount of gear deployed within national fisheries sectors,
- Limitations in capacity to collect gear marking and other gear-related data,
- Lack of formal systems and supporting infrastructure for gear loss reporting,
- Lack of political will to implement compliance mechanisms, and
- Reluctance on the part of fishers to report gear losses

In Paper 4, governance actors from across the study area were interviewed and asked to comment on the nature of the ALDFG challenge within their relevant jurisdictions, as well as the current governance approaches. The results are summarised in Table 11. The barriers that were identified through interviews have been categorised according to the key components of governance proposed by Bennett and Satterfield (2018). Thus, institutional barriers related to gaps and failings in the legislative or policy environment; structural barriers may relate to weaknesses and challenges experienced by key agencies; and procedural barriers relate to procedures and functions for undertaking governance. Procedural barriers may include procedures for policy formulation, cross-sectoral coordination and communication. In addition to these thematic barriers, cross-cutting barriers that
may affect multiple components of governance were also identified. While the barriers have been presented as distinct, it is important to note that there may be linkages between them. For instance, structural barriers may exaggerate or contribute to institutional or procedural barriers as well.

Table 11: Identified barriers by key informants

<table>
<thead>
<tr>
<th>Data codes</th>
<th>Institutional barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lack of clear policy directives on ALDFG</td>
</tr>
<tr>
<td></td>
<td>Policy incoherence across sectors</td>
</tr>
<tr>
<td></td>
<td>Lack of ALDFG-focused legislation</td>
</tr>
<tr>
<td></td>
<td>Fragmentation of laws</td>
</tr>
<tr>
<td>Structural barriers</td>
<td>Limited financial resources</td>
</tr>
<tr>
<td></td>
<td>Limited or lack of human resources</td>
</tr>
<tr>
<td></td>
<td>Limitations in the technical capacity of agencies</td>
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<td>Weaknesses in waste management sector</td>
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<td>High cost of recycling for end-of-life or retrieved derelict gear</td>
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<td>Procedural barriers</td>
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<td>Lack of understanding of effects of ALDFG</td>
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Policy incoherence was a major institutional barrier identified by several key informants, from both national agencies and regional bodies. One highlighted the tensions that sometimes existed between fisheries managers and agencies involved in environmental management, noting that “we are trying to work together across the sectors [but] it is still very challenging, because we have had differences in the way we deal with some issues. And, you know, it has been difficult to bridge the gap sometimes”. Policy coherence is a concern not only for national governments but also for regional coordination efforts, where the “lack of synergies and sometimes coordination and collaboration and coherence, really just gets further exemplified when you go up to the regional level”.

As observed in Table 11 above, other institutional barriers included fragmented or missing legislation and a lack of clear policy direction. As was highlighted earlier, the weaknesses in the legislative landscape that were identified by a number of key informants were corroborated by the gap analysis completed in Paper 2.
The jurisdictions that form part of this study have small, fragile economies, many of which are plagued by high external debt; hence it is not surprising that capacity limitations were identified by several key informants as major barriers to effective governance of ALDFG. Lack of or limited human and financial resources not only hinder the ability of sectoral agencies to address ALDFG, but also can contribute to or affect other barriers as well. Financial limitations likely contribute to the gaps and weaknesses in supporting infrastructure and mechanisms for ALDFG governance. Lack of mechanisms for reporting, limitations to collecting data and information on ALDFG, lack of supporting infrastructure to allow for compilation, analysis, storage and dissemination of not only ALDFG data but other environmental data were among the issues raised by experts, and which may be linked to the limitations in capacity that exist within sectoral agencies.

The limitations in both human, financial and technical capacity of management agencies extend beyond the fisheries sector to other relevant sectors (e.g. the waste management sector). Limitations in the waste sector may compromise the ability of national governments to create effective waste management strategies for retrieved ALDFG or end-of-life gear. While recycling of fishing gear (especially plastic gear) has been promoted, this may not be a viable for the small islands of the Eastern Caribbean. One of the experts working on end-of-life strategies for fishing gear in the Caribbean region noted that;

A lot of the work that has been done so far within the Caribbean, has found that the feasibility of recycling isn't looking so great, just because of the…high expenses of transport inter-island, as well as just the…full costs of having to ship outside and the amount of gear that would have to be collected for this to be cost effective. [Additionally] high start-up costs to develop an in-Caribbean recycling effort would be…very unfeasible”.

As a result, governments may have to employ other strategies for the management of retrieved derelict gear or gear that has reached its end of life.

If agencies are not aware of their mandates as relates to the governance of ALDFG this creates a procedural barrier that may lead to gaps in the governance system. One key informant observed the following when discussing national coordination efforts for ocean governance:

“I don't think… the requisite framework is there to say who's responsible for what…[so] I think that there needs to be a framing policy that clearly dictates who is responsible for what, because people tend to shirk responsibility”.

Further, if clear mandates are not defined, and there is a lack of clarity on the burden of responsibility by the various agencies, it may lead to gaps in the governance system. For instance, Customs authorities play an essential role in the surveillance,
monitoring, and compliance of fishing gear entering the market through ports of entry. However, the governance system may be compromised if there are gaps in communication or a lack of understanding of their role and mandates related to gear management. As observed by one key informant;

“…we…passed legislation changing…the minimum mesh size for nets for example. And although we had increased the size of the mesh size, the people were still able to import what would be considered then illegal nets…. Although we had communicated with customs that we had a gear

Mesh size is one of several mitigation strategies for minimising the impacts of derelict gear to habitats and wildlife.

In addition to structural, institutional and procedural governance barriers, experts also identified a number of factors that could be considered cross-cutting barriers. This relates to those conditions that may affect more than one aspect of governance. Perhaps one of the most critical of these, as identified by key informants, was the lack of prioritisation to the challenge of ALDFG by regulatory agencies, including fisheries management bodies, within various jurisdictions. This may be due to a general lack of knowledge and information on the issue, as there was also thought to be a lack of available data. Surprisingly, several of those interviewed indicated that they were not familiar with the term “abandoned lost or otherwise discarded fishing gear” or “derelict fishing gear” with one participant observing that it was the first time hearing the term in a “contextualised manner”. The lack of prioritisation of the issue may also be due to the lack of visibility of derelict gear, much of which remains submerged. On the other hand, as observed by one key informant, much of the debris that has been observed in coastal areas is land-based or has been “viewed by local authorities as external to local fishing, subsistence fishing, small-scale fishers, etc”. Several key informants commented that limitations in the human and financial capacity of fishery management agencies were also likely contributing to Divisions not prioritising ALDFG within their core mandates, particularly as they seek to balance conservation objectives with the need for economic development of fisheries. One key informant observed: “I think the balance between conservation and commercial fishing [has] to happen but I think that the Fisheries Division [has] become more now as a business They don’t have the balance of conservation, so the conservation side of it is left behind”.
4.4 Research Question 4

Research Question 4: How can Eastern Caribbean Small Island Developing States (SIDS) overcome the identified barriers and inherent complexities of small-scale fisheries to achieve improved governance

As has been noted the main aim of this research is to explore strategies for improved governance of ALDFG in Eastern Caribbean small-scale fisheries. Therefore, while some elements of management may be discussed, these will mainly be analysed from the perspective of their intersection with broader governance issues. Considerable work has been undertaken by various international bodies and global stakeholder partnerships (FAO and the GGGI) to outline practices for managing derelict gear based on the ALDFG management hierarchy of prevention, mitigation and remediation (Figure 4 above). In fact, these best practices were the central element for assessing the legal and policy gaps for ALDFG management in Papers 2 and 3.

As can be inferred from the applied conceptual framework, overcoming governance barriers to ALDFG associated with Eastern Caribbean small-scale fisheries requires robust, effective, responsive and equitable action. It also requires both horizontal and vertical integration strategies in the development of policies, alignment of regulatory systems and addressing research needs. These strategies should aid to overcome the complexities associated with the multi-level, intersectoral challenge posed by ALDFG governance. Paper 4 synthesised the main research output concerned with capturing the perspectives of governance actors on the major barriers to governance within the sub-region, including analysis of how such barriers could be overcome for improved governance. However, there are several important findings relating to barriers and facilitators of improved governance that have also been revealed in both Paper 2 and Paper 3.

As outlined in Paper 2, due to legislative fragmentation there is a strong need to establish effective cross-sectoral collaboration nationally, sub-regionally and throughout the Caribbean. That paper also concluded that there is a strong need for legislative reform and strengthening of the legislation (both for the fisheries sector and the waste/marine pollution sectors) as many of the legislative provisions that currently exist were not developed with the issue of ALDFG in mind. The need to share information with fishers as well as gather valuable data and insight from them was also highlighted. Paper 3 revealed the compliance gaps that exist regarding the implementation of gear marking schemes in the Eastern Caribbean, and which are likely to extend to other aspects of ALDFG governance. The need for awareness-raising programmes to inform fishers and fisheries groups was then highlighted. This research has also demonstrated the role non-fisheries actors may play in addressing the challenge of ALDFG. Recreational and commercial divers, marine
conservation agencies and marine park management bodies could play valuable roles in identifying and reporting the location of submerged derelict fishing gear. As demonstrated in Paper 3, reporting of ALDFG was a challenge in many jurisdictions, which lacked the basic infrastructure and mechanisms to allow for this. While in many jurisdictions there is no legal imperative to report derelict gear, there is value in instituting no-fault reporting schemes for derelict gear, in which divers and other users of the marine environment may participate. A similar scheme was instituted during the earliest days of the lionfish invasion of the Eastern Caribbean. As highlighted by one of the key informants:

“The mechanism that was...kind of developed and... it's still being utilised to a lesser extent, with regard to reporting the sightings of lionfish where... people would mark it, send a GPS coordinates. That, mechanism... was working fairly well, where people wherever you come across, maybe a big cluster of it you would report it to, there used to be [an] online portal where you would report the GPS coordinates...”

Based on the perspectives of key informants who were consulted for Paper 4, and the findings of legal reviews and assessments, additional recommendations on how to improve the governance regime are presented (Table 12). One key informant detailed the ongoing work of their organisation in using fisher-led, peer-to-peer outreach and education activities as a means of raising awareness. Awareness raising was seen as an important component for overcoming both structural and cross-cutting barriers. Fishers who are engaged and educated are more likely to practise sustainable gear management strategies. As noted by many interviewees, fishers do not wish to lose their gear, as this represents a loss of revenue and time if they are forced to construct new gear. However, understanding the ramifications of ALDFG, including the socioeconomic effects on the fishing sector, may lead fishers to improve their gear management practices to avoid losses during deployment and retrieval.

The strong need for policy coherence, not just at national level but also sub-regionally and regionally, while taking account of global strategies, was identified as a priority. There is an overarching need to move away from siloed approaches and to set common targets and goals to address this complex challenge. Establishment or strengthening of existing mechanisms for intersectoral collaboration at the national and regional levels creates opportunities for improving policy coherence both vertically and horizontally. In this regard, regional and national intersectoral bodies such as ocean governance committees and regional mechanisms such as regional ministerial committees, the regional ocean governance team and committees and conferences of the Cartagena Convention and SPAW Protocol may help create the synergies and cooperation required to achieve policy coherence. As one expert noted:
“At the regional level, we have a number of partnerships that are sealed through formal Memoranda of Agreement, memoranda of understanding. So, for example, we have agreement with the Caribbean Regional Fisheries Mechanism and UN Environment so that we can address issues of common concerns.”

The need for collaborative arrangements is clear and the mechanisms to allow for this may exist; However there may be challenges in executing such arrangements effectively. As noted by one key informant, “while we have this arrangement for cooperation, it is not always easy to achieve the compromises that will then comfort both sides”.

**Table 12: Mechanisms and actions for achieving improved governance identified by study**

<table>
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<tr>
<th>Elements of governance</th>
<th>National</th>
<th>Regional</th>
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<tr>
<td><strong>Institutions</strong></td>
<td>Review and reform legislation</td>
<td>Provide technical advice and assist countries in legal and policy assessments (e.g. through the promotion of model legislation)</td>
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<td></td>
<td>Create national ALDFG action plans based on best practice outlined in the regional plan.</td>
<td>Assist countries to undertake national ALDFG reviews</td>
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<td>Collaborate with waste management authorities to integrate end-of-life gear management strategies into national waste management policies and plans</td>
<td>Disseminate the Regional ALDFG Action Plan through technical fora and meetings and conferences of various organs and bodies of the regional institutions.</td>
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<td><strong>Structures</strong></td>
<td>Solicit support from donors and other partners</td>
<td>Support national ALDFG training initiatives</td>
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<td>Train and build capacity of fisheries personnel</td>
<td>Convene regional training and capacity building initiatives to increase regional awareness of ALDFG</td>
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<td></td>
<td>Institute no-fault reporting scheme for fishers, divers and other stakeholders</td>
<td>Support national governments to establish reporting mechanisms</td>
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<td><strong>Procedures</strong></td>
<td>Build trust</td>
<td>Promote the regional actional plan for ALDFG management</td>
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<td>Undertake national review of ALDFG governance regimes, to clearly identify roles and mandates (Framing Policy)</td>
<td>Undertake intra-regional assessments of ALDFG centred policies and mandates by regional bodies.</td>
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<td>Engage intersectoral committees to promote integrated planning</td>
<td>Utilise or leverage existing networks and regional processes (e.g. CRFM, the OECS Council of Ministers on Environmental Sustainability, and the Regional Ocean Governance Team)</td>
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<td>Develop ALDFG policy collaboratively and implement through consultation (e.g. Fisheries Advisory Committees)</td>
<td>Include ALDFG-centred themes in regional technical meetings and Conferences of the Parties for the Cartagena Convention and relevant Protocols</td>
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<tr>
<td><strong>Cross-cutting</strong></td>
<td>Build awareness for both fishers and governance actors</td>
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The GGGI, in consultation with CRFM, has developed a Regional Action Plan for ALDFG. The plan is designed to be modular, presenting best practice approaches for managing the broad categories of gear utilised in the Caribbean region. There is a need to disseminate the plan to national governments, as several of the national key informants were not aware of its existence. However, beyond that, national
governments should consider adapting the action plan to create national and local plans that take account of the local circumstances, the particularities of the fisheries sectors, and local understandings of the drivers of ALDFG. National ALDFG plans should also consider strategies for managing end-of-life gear and/or derelict gear that may be retrieved from the marine environment. Thus, it would be necessary to engage solid waste management bodies to allow for the integration of ALDFG-centred strategies into national waste management plans and policies.

4.5 Limitations of the study and future research

As with all qualitative research that is reliant on interviews, data quality may be influenced by several factors, including the interpretations and comprehension skills of the interview subjects. Fisher and diver interviews were typically conducted in the field while they were often engaged in other tasks at the landing site including gear repairs and scaling of fish. Thus, it is possible that fishers may not have been completely engaged during the interviews, resulting in inaccuracies in the data collected. Limitations in the sample size for some components of the research (for example diver interviews) is acknowledged; however through data triangulation and the interviews with multiple sources it is hoped that this limitation has been overcome.

Interviews with other key informants were conducted via Zoom and in a very few instances technical difficulties were encountered relating to internet connection. Additionally, several interviews were interrupted. It is acknowledged that this could have broken the momentum. Further, while the original interview plan sought to connect with key informants for every island that formed part of the study, some difficulties were encountered with reaching this target.

The research not only presented a baseline regarding ALDFG in the context of Eastern Caribbean small-scale fisheries. It has also highlighted some key gaps and opportunities for future research. Based on the preliminary findings of the analysis, further research is needed to investigate the contributions of recreational fishing and MFADs to the ALDFG burden in the Eastern Caribbean. Additionally, there is a need to understand the transboundary versus localised nature of ALDFG as well as the interaction between ALDFG and sargassum influxes into the Caribbean region.
5 Discussion and conclusion

This research has presented an analysis of ALDFG associated with Eastern Caribbean small-scale fisheries by viewing the issue through a governance lens. By moving beyond matters relating to the scale and impact of the challenge it has provided an assessment of the policy and legislative landscape and governance environment, while considering mechanisms for improved governance in the sub-region. Because the fisheries being examined are small-scale in nature, it is further acknowledged that any intervention for improved governance of ALDFG must be practical, cost effective and appropriate to the local contexts.

As has been demonstrated, small-scale fisheries in the Eastern Caribbean—as well as the issue of ALDFG—are complex, characterised by their multi-scalar and intersectoral nature. This research has reaffirmed that ALDFG is a challenge in the Eastern Caribbean context, and there is a need for improved governance of this threat. It has, however, also demonstrated that cultural differences and local customs, as well as the biogeography of the coastal environment, may play major roles in shaping the fisheries as well as affecting when and how fishing gear becomes derelict.

Paper 1 revealed that environmental drivers were among the major causes of both line and fish trap losses in the case study countries, while fish trap loss is a major cause for concern in both jurisdictions. These results are, in fact, consistent with the findings in other regions of the world. Severe weather, for instance, was found to be the most significant driver of fishing gear loss in Sri Lanka (Gallagher et al., 2023) and the second most cited cause of trap loss, globally (Richardson, Hardesty, et al., 2021; Richardson, Wilcox, et al., 2021). Richardson, Hardesty et al. (2021) also noted that snagging on benthic obstructions was a major driver of loss for gear that came in contact with the seafloor. Regarding fish trap losses, operational drivers surrounding the use of marker buoys have been highlighted. Both the decision to set traps underwater without visible marker buoys and the use of fabricated markers made from plastic bottles appear to contribute to fishing gear loss. In Antigua and Barbuda, fishers who set traps underwater raised concerns of gear conflicts on overcrowded fishing grounds. The reluctance of fishers to utilise marker buoys has also been shown to lead to fish trap loss in other countries (for example in Oman and Kuwait) (Vadziutsina & Riera, 2020). Similarly, the use of fabricated markers in Dominica is concerning, particularly as concerns about the use and poor visibility
of “homemade” marker buoys for fish traps have also been raised in the neighbouring island of Montserrat, where they have become a navigational hazard to commercial vessels traversing shipping grounds (Dosell et al., 2021). This practice was also concerning to interviewed experts in St. Kitts and Nevis and Grenada. In both cases the marine experts expressed concern about the practice of fishers utilising plastic Clorox or water bottles to mark traps.

Fisheries interventions may aid in curbing ALDFG resulting from local conflict, operational and/or management drivers of gear loss. However, external drivers such as weather, sargassum and the transboundary movement of derelict gear may be harder to manage. For instance, incidences of MFAD components drifting into these islands from neighbouring French territories cannot be addressed without the cooperation of fisheries and other authorities in those islands. Similarly, to curb the losses of locally deployed MFADs a combination of fisheries and non-fisheries control measures may be required. For instance, area-based management may help to reduce losses resulting from vessel traffic, by ensuring MFADs are deployed away from shipping lanes and other navigation zones. This would require the cooperation and collaboration of fisheries and port management authorities, while hydrographic agencies and/or charting authorities should be engaged to ensure their locations are precisely charted and communicated to mariners. Ensuring MFADs are compliant with gear marking regimes and adequately fitted with lights and radar reflectors is also critical to reduce losses. Frequent inspection of MFAD mooring lines and the use of durable materials for surface and subsurface components (anchors, lines and surface buoys) could also aid in this regard (Gilman et al., 2022).

In recent years the use of submerged/subsurface MFADs has been promoted, as they have been shown to reduce vandalism, may be used in high-traffic areas, and can reduce wear on FAD lines associated with waves and storms (Taquet, 2013). In some jurisdictions (e.g. Antigua and Barbuda, and Dominica) the promotion of collaborative or fisher-led FAD management programmes has achieved some success and has led to the development of FAD management guidelines as well as the institution of limited entry regimes (Sadusky et al., 2018). Sadusky et al. (2018) promoted a limited entry/licensing regime for FAD fisheries in the region, noting that unrestricted access to FADs can lead to conflict and place significant pressures on fish stocks.

Both Paper 2 and Paper 3 highlighted the need for legislative and policy review and reform, if Eastern Caribbean governments wish to address the challenge of ALDFG in their jurisdictions. Fragmentation of legislation and policy, as well as a general lack of ALDFG-focused regulations, was apparent across the entire study area. Those two studies also highlighted that effective and efficient management of derelict fishing gear in Eastern Caribbean fisheries would require not only government intervention but also stakeholder cooperation, buy-in and support. The breadth of knowledge possessed by fishers about the management of gear, the
drivers of loss, and operating in the marine environment can provide insight into how governance of ALDFG can be improved in the sub-region. Further, the fragmented nature of the regulatory and policy regime for managing derelict fishing gear highlights the need to establish effective mechanisms for cross-sectoral cooperation and collaboration, which may not currently exist within these jurisdictions.

In addition to considering legislative weaknesses for gear marking systems, Paper 3 illustrated the compliance gap and enforcement failings that may exist across the sub-region by examining the case of gear marking implementation in the study area. As was observed, despite a legislative requirement in Antigua and Barbuda for fishers to mark their traps in a manner that allows for traceability, many fishers were not aware of this provision and were generally non-compliant. There is a clear need for fisheries managers to raise awareness about the need for, and benefits of, ensuring gear is marked and how this can help to reduce ALDFG. Researchers in the Gulf of Thailand found that that a general willingness to adopt gear marking practices emerged among both small-scale and industrial gillnet fishers of that region, as their awareness of the issue grew during the interview process for their study (Chumchuen & Krueajun, 2021). This may also be true for other aspects of ALDFG management. For instance, increasing fisher awareness of the economic losses that can result from gear loss and derelict gear, may influence them to adopt mitigative strategies such as the inclusion of biodegradable panels in some gear.

It is acknowledged that marking of fishing gear is only one of the many practical tools to addressing various drivers of fishing gear loss. While it may not reduce or eliminate all drivers of gear loss, gear markings can help reduce some conflict and operational drivers. This research revealed that environmental drivers were among the leading causes of gear losses in the Eastern Caribbean, but also showed that vandalism, vessel traffic and intentional discards were reported by at least 25 per cent of fishers in the case of trap fisheries in the two case study jurisdictions. In fact, more than two-thirds of respondents reported losses due to vessel traffic and vandalism in the case of traps, with just under one-third of line fishers doing the same. As noted, gear marking refers not only to the identifying marks for an individual or entity deploying a particular gear unit, but also methods employed to signal the presence of gear in the water (FAO, 2019), such as surface buoys, lights and reflectors. Thus, markings that increase the visibility of gear in the water may reduce the risk of vessel strikes, while markings that signify gear ownership may reduce the likelihood of fishers abandoning gear at sea or help reduce incidence of vandalism and theft (FAO, 2019; Gilman et al., 2022).

It also noted that the compliance and implementation gaps that have been highlighted through research in Paper 3 are not unique to the challenge of ALDFG and gear marking. In fact, they may be emblematic of the overall governance
challenge associated with small-scale fisheries. In the Caribbean region, weaknesses in the governance structures, limited capacity for surveillance and monitoring, and poor public participation create significant challenges for governance of the region’s small-scale fisheries (de Oliveira Leis et al., 2019). These capacity challenges also extend to other sectors with a role to play in the management of ALDFG, including the waste sector.

Paper 4 considered issues of governance, including barriers and opportunities for improvement. The environmental governance framework proposed by Bennett and Satterfield (2018) present foundational principles on how governance can be improved through the creation of a robust, effective, equitable and responsive governance environment. Interviews with key informants provided key insights and recommendations into how this could be achieved, not just at national level but also regionally and sub-regionally.

Identification of the governance barriers is a first step towards creating an improved governance environment for ALDFG in the Eastern Caribbean. Thus the insights gained from Paper 4 form, perhaps, the most important element of this research. The findings from this analysis have underscored that not only is the governance of ALDFG intersectoral, the associated challenges and barriers are intersectoral as well. For instance the capacity challenges experienced by fisheries management bodies may also be shared by other agencies involved in surveillance and compliance of ALDFG, as well as with the waste management sector. If governments are to pursue remediation measures, including the removal of derelict gear from the marine environment and/or establishment of end-of-life gear management facilities, the waste management sector will be crucial. Schneider et al (2018) advised that for the management of marine litter a systems perspective is required. Thus, elements relating to supply chains, transportation and port reception facilities must be considered. Further, the completion of quantitative environmental assessment for the system would be required (Schneider et al., 2018). It should be re-emphasized that large-scale clean-up efforts of the ocean floor would be challenging and impractical for many Eastern Caribbean islands with limited capacity, no mechanisms for reporting, and a lack of data and information on the amount of gear being deployed within their sectors. Additionally, as was previously noted, the solid waste management sector for many of these jurisdictions is underdeveloped and fragile, while being plagued by many of the same capacity issues as other sectors of the economy, including small-scale fisheries. As a result, many of the islands may lack the facilities to adequately treat derelict gear that may have been removed from the ocean environment. Debris that is removed from the marine environment would be subject to the same waste management strategies as land-based litter (that is, reuse, recycle, recovery and disposal) (Schneider et al., 2018). For instance, the promotion of circularity in fishing gear management, through recycling, has been promoted by a number of governments (Charter, 2023;
European Commission, 2020; Juan et al., 2021). However, as was observed by one expert, in the Eastern Caribbean, this may be difficult and too costly to implement. Thus, as illustrated through the ALDFG management hierarchy, emphasis must be placed on mechanisms for preventing gear losses. These measures should be linked to identified drivers. As has been previously highlighted, the GGGI along with academic researchers have outlined a number of best practice approaches and guidelines to assist countries in overcoming these local drivers (GGGI, 2021; Gilman et al., 2022; Richardson et al., 2018).

In addition to identifying key barriers, Paper 4 presented a number of mechanisms/actions for achieving improved governance. The need for awareness building, not only on the part of fishers but also from policy makers and resource managers was seen as an important prerequisite for achieving improved governance of ALDFG. Awareness building can be viewed as a central first step to aid in overcoming a number of cross cutting barriers, including the lack of prioritisation of ALDFG management by fisheries departments. Ideally, fishers who are more informed about the potential socioeconomic and environmental impacts of ALDFG would be more inclined to seek to reduce gear loss.

Strengthening of legislation is another key step, in particular the establishment of ALDFG-focused legislation. However, it is acknowledged that legislative reform could be a lengthy and complicated process and may be viewed as a long-term strategy. Further, legislative improvement needs to be complemented by mechanisms to allow for cooperation in policy development and ALDFG strategy planning, not only at the national level but also throughout the Eastern Caribbean. Issues of policy incoherence were identified by several national key informants as well as those operating at the CARICOM and Wider Caribbean region. Policy coherence is fundamental to strengthening the interconnectedness between different sectors and environmental policy areas relevant to the governance of ALDFG (Nilsson et al., 2012). It can be defined as a mechanism that “systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives” (Nilsson et al., 2012, p. 396). Utilising existing networks of cooperation and regional processes such as ocean governance teams and conferences of the parties for regional ocean governance instruments can aid in achieving multi-level policy coherence. However, this must be complemented by national level initiatives that engage not only public sector actors but fishers and non-governmental organisations.

The need to build trust among the various agencies not only nationally but also regionally can prove crucial to establishing a coherent policy environment. Trust can be seen as an essential element for ensuring the desired interactions and outcomes are achieved within governance systems (Klijn et al., 2010), and is critical to achieving legitimacy in governance (Proszowska et al., 2022). Trust among
various governance actors stimulates information exchange and facilitates learning (Klijn et al., 2010). When there is mutual trust among various actors, concerns about opportunism decline so that parties can operate, even in changing environments, without the worry of opportunistic attempts (Puranam & Vanneste, 2009). Thus in systems where there is mutual trust, adaptive capacity is enhanced. (Puranam & Vanneste, 2009). Trust can be achieved through transparency in policy development and implementation, including collaborative arrangements.

As was demonstrated in Chapter 2, this research can be viewed through the lens of a conceptual framework adapted from Bennett and Satterfield’s Environmental Governance framework. Thus an attempt has been made to summarise the key findings within the concept of this framework (Figure15). By introducing elements of intra-regional and national level coordination there, is once again, a recognition of the need for both vertical and horizontal integration of ALDFG governance. A polycentric systems approach to governance could help to achieve the required level of coordination; however, the associated challenges are also acknowledged (Fanning et al., 2021; Mahon & Fanning, 2019; van der Plank et al., 2022). Van der Plank et al. (2022) highlighted the need to explicitly address the structure and function of polycentric systems in relation to regional governance of the Sargassum challenge. The same could be said for the challenge of ALDFG governance. Thus as noted by key informants, it is necessary to clearly articulate the roles and mandates of various governance actors as it relates to ALDFG management in the region. This should be undertaken not just nationally but at the regional level as well.

Moving forward, Eastern Caribbean governments need to also consider how national and regional actions align with and relate to the global ALDFG governance architecture; particularly as the international community continues to negotiate the new plastics treaty. Given the inherent vulnerabilities of SIDS including those in the Eastern Caribbean—relating to ALDFG governance, weaknesses in their waste management sectors, their exposure to transboundary marine debris, and the severe human, financial and technical constraints experienced by regional governments—it is critical that they remain engaged and play an active role in shaping this new treaty, including how it addresses the challenge of ALDFG and aligns with existing instruments.
Figure 15: Understanding the intersection between governance barriers and proposed mechanisms for improved governance through the conceptual framework
While the limitations of this research noted, it has provided a baseline for considering ALDFG governance in the context of the Eastern Caribbean region. Elements of the approach may be adapted for future work, or to support analysis of other categories of gear that were not analysed in depth for this research (for example FADs and net fisheries).
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https://doi.org/10.1016/j.shpsa.2019.10.003
# Appendix 1: Research impact plan

<table>
<thead>
<tr>
<th>What goal do you aim to achieve with your research?</th>
<th>Who are the central stakeholders who can help you realise the goal?</th>
<th>What are the entry points for reaching stakeholders?</th>
<th>What are central conditions that need to be in place to achieve your goal?</th>
<th>What are the indicators of success of your research?</th>
<th>What is the long term impact (legacy) of your project and the conditions needed to support it?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title</strong></td>
<td><strong>Subtitle</strong></td>
<td><strong>Fishers in two islands have been reached through data collection interviews. Other entry points for reaching stakeholders include regional fisheries conferences, such as the annual Gulf and Caribbean Fisheries Institute Conference (GCFI) Information sharing with the regional fisheries body (Caribbean Regional Fisheries Mechanism) and the Regional Conferences of the Cartagena Convention the CTC programme also continues to share with OECS leaders.</strong></td>
<td><strong>Fishers and other key informants are willing to engage and to share their knowledge on key aspects of this challenge. Access to relevant policy documents and or national legislation relevant to management of ALDFG in the Eastern Caribbean</strong></td>
<td><strong>Improved state of knowledge State agencies and regional bodies willing to continue engaging on this issue. Information disseminated through regional conferences and technical briefs (as required).</strong></td>
<td><strong>The project should be able to improve the state of knowledge as it relates to ALDFG in the Eastern Caribbean region. It can also provide tools to national fisheries management agencies to undertake policy and legal framework assessments.</strong></td>
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<tr>
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<td><strong>Fishers</strong></td>
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<tr>
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<td><strong>National fisheries management authorities</strong></td>
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<td><strong>Stakeholders are generally located within the Eastern Caribbean sub-region</strong></td>
<td><strong>Research is accepted for presentation and regional fisheries research conferences Regional bodies and initiatives will provide a forum for sharing of results.</strong></td>
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</tr>
</tbody>
</table>

**Key Assumptions**

- The data will be available, and stakeholders will be willing to share information and collaborate on this project.
- Stakeholders are generally located within the Eastern Caribbean sub-region.
- Research is accepted for presentation and regional fisheries research conferences.
- Regional bodies and initiatives will provide a forum for sharing of results.
- The issue of ALDFG will be prioritised by relevant bodies for the institution of improved management arrangements.
7 Appendix 2: Semi-structured interview questions for fishers

_Fisher Interview Parameters Analysed in Paper 1 – Traps_

5.1 When/If you lose a trap/pot or parts of it, which one of the following elements are lost? Please refer to manual for the description (drawings 2 to 6) of each element.

<table>
<thead>
<tr>
<th>Traps and pots elements</th>
<th>Very frequently</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>One entire set (with all elements)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One unit (one trap)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buoys</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net cut-off</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

5.2 Over a typical year estimate how many individual traps could be lost or approximate weight of fragments (in kg)?

5.9 When vessel loses traps, what are the main causes of the gear loss? Answer each line by selecting one the four possible responses provided.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Always</th>
<th>Some times</th>
<th>Never</th>
<th>Don’t Know/Not Relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net snagged on an obstruction, such as reef, rocky area or shipwreck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor weather conditions</td>
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<td></td>
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</tr>
<tr>
<td>Damage or towed away by large animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drifted out of area and cannot be accessed by the vessel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faulty, old or damaged gear</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator error</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong currents</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Deep water (e.g. line to buoy too short)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gear not properly stored on board</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict with other gear, e.g. trawls towing away nets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vandalism (stolen or destroyed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The surface marking is lost, sunk or malfunctioned</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gear intentionally discarded overboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment failure (i.e hauler or location equipment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High traffic of other vessels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of communications between fishing vessels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
**Fisher Interview Parameters Analysed in Paper 1 – Lines**

5.1 When/If you lose fishing gear with hooks or longlines or parts of it, which one of the following elements are lost?

<table>
<thead>
<tr>
<th>Hook and Line elements</th>
<th>Very frequently</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>One entire set (with all elements)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>One unit (one trap)</td>
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<tr>
<td>Buoys</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Lures</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

5.9 When vessel loses hooks or lines, what are the main causes of the gear loss?

<table>
<thead>
<tr>
<th>Causes</th>
<th>Always</th>
<th>Sometimes</th>
<th>Never</th>
<th>Don’t Know/Not Relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net snagged on an obstruction, such as reef, rocky area or shipwreck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor weather conditions</td>
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<td>Damage or towed away by large animals</td>
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<td>Drifted out of area and cannot be accessed by the vessel</td>
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<tr>
<td>Faulty, old or damaged gear</td>
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<tr>
<td>Operator error</td>
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<td>Strong currents</td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gear intentionally discarded overboard</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment failure (i.e. hauler or location equipment)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High traffic of other vessels</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lack of communications between fishing vessels</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fisher Interview Parameters Analysed For Paper 3**

5.6 Are lost traps reported?

Select one. Always Sometimes Never

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.7 If informed or reported, identify the person or agency to whom the loss is reported (Select all relevant):

<table>
<thead>
<tr>
<th>Options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Nearby vessels</td>
<td></td>
</tr>
<tr>
<td>Owner of the vessel</td>
<td></td>
</tr>
<tr>
<td>National or local fisheries administration</td>
<td></td>
</tr>
<tr>
<td>Coastguard/ navy</td>
<td></td>
</tr>
<tr>
<td>Fishermen’s association/representative</td>
<td></td>
</tr>
<tr>
<td>Reported in logbook or trip report</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

7.1 Are you aware of any laws or regulations for marking fishing gear in the fisheries where you operate? Select from the following.

<table>
<thead>
<tr>
<th>Options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
</tr>
</tbody>
</table>

7.2 Is the fishing gear in use marked in any way? Select from the following

<table>
<thead>
<tr>
<th>Options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
</tr>
</tbody>
</table>

7.2.1 If yes, are the marks with name or number traceable to owner or vessel? Select from the following

<table>
<thead>
<tr>
<th>Options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Don’t know</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3: Semi-structured interview questions for divers

Diver Interview Questions

- How old are you?

- How many years have you been a diver?

- What is your primary purpose for diving? Recreation  Fishing  Conservation/Management

- Have you ever heard of the terms abandoned, lost or otherwise discarded fishing gear or derelict fishing gear?
  Yes  No

- If Yes, please explain what you understand by these terms.

- Based on this definition (either provided by interviewee or myself) have you ever encountered what appears to be abandoned, lost or otherwise discarded fishing gear while diving?
  Yes  No

- If yes, please indicate what types of gear you have encountered:
  Fish traps  Monofilament nets  Multifilament/polypropylene nets  Fishing line  FAD components  Other

- For each type of derelict gear encountered, please indicate the frequency with which you have encountered it. Always  Frequently  Sometimes  Rarely  Never
● When you have encountered derelict gear have you noticed it affecting habitats (snagged) or wildlife (have you seen fish or other marine life entrapped or entangled in derelict gear?)?

● Over the past 10 years has the problem of ALDFG been getting better or worse, or is it the same?

● In the next 5 years do you think the problem will get better or worse, or will it remain the same?

● Do you have any thoughts on how the management of ALDFG can be improved in your country?
Appendix 4: Semi-structured interview questions for policy makers and governance actors

Interview Questions Pertaining to Gear Marking for Paper 3
- Do fishers mark their gear?
- Do they do so in a manner that is traceable/How is gear marked?
- Is there a requirement for fishers to report lost gear?
- If not, what are the main barriers preventing reporting mechanisms?

Interview Questions Analysed for Paper 4
- Please indicate which organisation you work with and your role in the organisation.
- Are you familiar with the term abandoned lost and discarded fishing gear or derelict fishing gear?
- In your opinion, do you consider ALDFG to be an area of concern in your island or the region?
- If yes, how severe a problem do you consider it to be, and what gears are the most significant?
- What are some of the major information gaps regarding ALDFG in your country or region?
- Do you currently conduct any research or collect data on ALDFG in your country or region?
- Do you think as an agency, country or region we are sufficiently equipped to manage the challenge of ALDFG?
- In your opinion what are some of the major barriers/constraints to effective management of ALDFG in your country or region?
• What is your perspective on how the governance of ALDFG can be improved in the country or region.
• Over the past 10 years, has the problem of ALDFG been getting better or worse or is it the same?
• In the next 5 years do you think the problem will get better or worse or will it remain the same?
10 Appendix 5: Papers included in this dissertation

Abandoned, lost and otherwise discarded fishing gear (ALDFG) presents a significant and complex challenge which can result in severe deleterious impacts to habitats, marine wildlife, and fishing and coastal communities the world over. Small island states like the countries of the Eastern Caribbean are highly vulnerable to a range of external stressors, therefore it is essential to gain an understanding of the threat posed by all forms of marine debris including ALDFG to the sub-region. To gain an understanding of the drivers, scale and impact of the threat associated with small-scale fisheries of the Eastern Caribbean, interviews with 49 fish trap and line fishers as well as 14 divers in Antigua and Barbuda, and Dominica were conducted. Interviews were completed over the course of two months (July – August 2022) at landing sites around all three islands. Fish traps continue to be a major contributor to ALDFG in the study area, with an estimated 2,273 traps and 2,567 being lost on Antigua and Barbuda, and Dominica respectively, based on the most recent estimates of the fishing fleet. Severe weather and snagging of benthic obstructions have emerged as the most significant contributors to fish trap loss in both countries while towing of fishing lines was the most frequently identified cause in the countries’ line fisheries. Observed variabilities in drivers of loss between both countries may be attributed to a number of factors including diversities in the fishing sectors, differences in local practices and heterogeneity in the biogeography of the marine environment. Further, evidence shows that the challenge of ALDFG within the Eastern Caribbean context, goes beyond local drivers of loss and may be influenced by transboundary inputs from both within and outside the region. Divers reported encountering not only ALDFG originating from within the two countries but some forms of ALDFG that may have drifted into the area from neighbouring islands (MFAD components) or further afield (polypropylene netting). Managing this challenge effectively will require not only fisheries specific interventions but the cooperation and collaboration of pool of stakeholders both nationally and beyond.

**KEYWORDS**

Eastern Caribbean small-scale fisheries, ALDFG, fishing gear loss, ALDFG drivers, ALDFG scale, ALDFG impact
1 Introduction

Abandoned, lost and otherwise discarded fishing gear (ALDFG), also referred to as derelict fishing gear, is a complex global problem for which there remain large knowledge gaps and regional disparities in our understanding of its scope and scale (Richardson et al., 2019; GESAMP, 2021; Richardson et al., 2021b; Do and Armstrong, 2023). Despite these knowledge gaps, it has been well established that ALDFG is of growing concern to the sustainability of global fisheries (Richardson et al., 2019) and is a major component of floating plastic debris found in some regions (Lebreton et al., 2022). It is also widely considered to be perhaps the most dangerous form of marine debris since it is designed to entrap, ensnare or capture marine organisms and can do so long after it becomes derelict (Norris et al., 2011; NOAA Marine Debris Program, 2015; Wilcox et al., 2015; Nama and Prusty, 2021). ALDFG threatens wildlife and benthic habitats, can result in navigational hazards, and may lead to negative socioeconomic impacts to fishers (Laist, 1997; Asoh et al., 2004; Hong et al., 2013; NOAA Marine Debris Program, 2015; Stelfox et al., 2016; Hong et al., 2017). Derelict traps on the ocean floor may shift leading to scouring of the substrate and damage to marine organisms including stony corals, sponges and gorgonians (Stevens, 2021). Other impacts associated with ALDFG may include the transfer and distribution of microplastics into the food web, distribution of harmful algal blooms and the transfer of invasive alien species (Gilman et al., 2022).

The islands of the Eastern Caribbean are highly dependent on tourism, which is among the highest income earners in countries like Antigua and Barbuda, and St. Kitts and Nevis (UNDP, 2022). Much of this tourism is nature based and marine oriented, thus there is a strong economic imperative to address those issues that negatively impact the marine environment including all forms of marine pollution. With their dependence on tourism, high product importations and poor waste management systems, Caribbean islands generate more waste per capita than the global average (Clayton et al., 2021). Further, while it is widely acknowledged that land-based sources constitute the major contributor of marine litter globally, including in the Caribbean (UNEP-CEP, 2014; Diez et al., 2019), the sources of marine debris in the region can be attributed not only to poor waste management practices and land-based activities such as coastal tourism but also to nearshore maritime activities including fishing (Kanhai et al., 2022). The issue of marine debris in the Caribbean has also been shown to be a transboundary challenge, with evidence suggesting that plastic waste originating from both within and outside the region is transported and distributed through sea surface currents (Kanhai et al., 2022). In a recent study it was found that micro-plastic waste found in the coastal waters of Antigua were likely transported to the area from the North Atlantic Ocean (Courteme-Jones et al., 2021). That study also found that, of the countries assessed, Antigua was the only one where plastic rope featured among the most significant sources of marine litter material (Courteme-Jones et al., 2021).

The drivers of fishing gear loss are varied and dependent on a number of local and global factors, including “operational and environmental variables, and gear characteristics” (Richardson et al., 2022). A recent study has suggested that on average 0.81% of gillnets, 3.33% of longline mainlines and 0.74% of all traps or pots are lost, globally each year (Richardson et al., 2022). However, that study also noted that major knowledge gaps remain on the losses experienced by artisanal and recreational fisheries (Richardson et al., 2022). In a previous global assessment of ALDFG drivers it was further found that weather was one of the most commonly identified causes of fishing gear loss among seven countries across all regions of the globe (Richardson et al., 2021a). This was followed by wildlife interactions and snagging of benthic obstructions by gear that interacts with the seafloor (Richardson et al., 2021a). Understanding fisheries specific drivers as well as their relative importance and magnitude is critical to identifying priorities for intervention (Gilman et al., 2022).

In the small islands of the Eastern Caribbean few academic articles have focused on understanding the scale and impact of ALDFG or identifying drivers of loss. A review of the grey literature, however, provides evidence that ALDFG is of growing concern to regional fisheries authorities and is occurring within small-scale fisheries in the Caribbean region. Further, one assessment on the opinions of ALDFG in the Caribbean found that marine debris and ALDFG were regarded as areas of concern among the majority of persons interviewed (85% and 65% of respondents respectively) (Matthews, 2010). Fish traps were considered to be most common form of ALDFG followed by a range of different nets, and various forms of hook and line gear (Matthews, 2010). Interviews participants also reported that as much as 60.1% of ALDFG was located underwater with the remaining components likely to be found floating or deposited on shorelines (Matthews, 2010). Interviews of fisheries officials in the Wider Caribbean ahead of FAO’s 2019 regional workshop on best practices to reduce and prevent ALDFG also revealed that more than half of the respondents viewed ALDFG as high or major concern for the Caribbean region (FAO, 2020). Among the challenges identified by interviewees for its management were the lack of reporting, lack of awareness among fishers and the inability to retrieve lost gear (FAO, 2020).

Post-cyclone damage assessments and other research conducted by some Eastern Caribbean countries and territories provide strong evidence that severe weather (both storms and hurricanes) potentially serve as a major contributory factor of fishing gear loss in the region, particularly within fish trap fisheries. Damage assessments conducted in Antigua and Barbuda, and Dominica in the wake of tropical cyclones that affected the Eastern Caribbean from the late 1990s to as recently as 2017 resulted in an estimated loss of 19,781 traps across the two small island developing states that form part of this review (Horsford, 2010; Norris, 2011; Horsford, 2017). Each of these traps could continue to capture marine organisms (ghost fish) for up to a year (Norris et al., 2011), and perhaps longer in the case of traps braced with steel instead of wood.
The fisheries of the Eastern Caribbean small-island states can largely be categorized as small-scale or artisanal in nature. They are generally multi-gear, multi-species fisheries and utilize a variety of gear (i.e., hand line, long line, beach or boat seines, gillnets and traps) for the harvesting of a range of different pelagic, demersal and benthic/sedentary resources (CREFM, 2021). Fish traps used in East Caribbean fisheries and which, according to previous reports, are among the most concerning forms of ALDFG (Matthews, 2010), are mainly constructed from either welded steel or wooden frames, which are covered by a wire mesh. Traps may be constructed in a variety of shapes (rectangular, Z/S shaped or a chevron/arrow-head pattern) with one or more funnels through which fish and other marine organisms enter and may also include an escape hatch/door.

In addition to these main gear types, a number of Eastern Caribbean states have in recent years been steadily introducing moored fish aggregating devices (MFADs) into their national fisheries. A recent study of the region’s MFAD fishing sector estimated that there was a total of 110 MFADs deployed in the Eastern Caribbean states of Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, and The British Virgin Islands (Wilson et al., 2020). In many states, the vast majority of these were privately owned either by an individual or a small group of fishers (Wilson et al., 2020). MFADs can provide important social and ecological benefits to small-scale fisheries in the Eastern Caribbean (Wilson et al., 2020); however, if poorly managed, they also have the potential to contribute to marine pollution since MFADs will eventually degrade and become lost at sea (Sinopoli et al., 2020). This is even more concerning given the large number of privately owned MFADs in the region as these are quite often cheaply constructed with high turnover rates (Wilson et al., 2020). A recent evaluation of the regulatory strength of MFAD management within the Caribbean found that only Antigua and Barbuda, and St. Vincent and the Grenadines had relatively high regulatory strengths when assessing their management regimes against a three-component governance framework (regulation of MFAD deployment, regulation of access to MFADs, and regulation of fishing practices on MFADs) (Wilson et al., 2022). The regulatory strength scores were based on a range of 0 to 1, with both countries achieving the maximum score of 1 (Wilson et al., 2022). By contrast, all other Eastern Caribbean states scored less than 0.5 (Wilson et al., 2022).

The following study sought to understand the drivers, scale and impact of ALDFG within the context of Eastern Caribbean small-scale fisheries. To do so fishers in two Eastern Caribbean Island states Antigua and Barbuda, and Dominica were interviewed. The archipelagic state of Antigua and Barbuda has an estimated shelf area of 3 886 square km (Pauly et al., 2020). This includes the Antigua and Barbuda shelf, South Bank, a section of the Anguilla shelf, Redonda shelf, Havers Shoal and a section of the St. Kitts and Nevis Shelf (Singh-Renton and McIvor, 2015). By contrast, Dominica’s shelf is significantly smaller, measuring just 356 square km (Pauly et al., 2020). These differences in their bathymetry have likely impacted the characteristics of the countries’ fisheries sectors. For instance, Antigua’s benthic habitat is dominated by coral frameworks on the Eastern and Southern shelves and coastal embayments around the island “are heavily colonized by seagrasses” (The Nature Conservancy, 2016). The Antigua and Barbuda shelf from which the main islands emerge is one of the largest in the Eastern Caribbean and supports a substantial demersal fishery (Singh-Renton and McIvor, 2015). On the other hand, Dominica’s narrow coastal shelf has a “paucity of coral frameworks” (The Nature Conservancy, 2016) while pelagic species make up the majority of the country’s landings (FAO, 2022). These two countries were chosen since the author considers that they offer contrasting representations of the Eastern Caribbean’s diverse artisanal fleet (one sector being largely dominated by a demersal fleet, with the other dominated by a pelagic fleet).

2 Methodology

2.1 Gear loss questionnaires

To complete this research, gear loss questionnaires from the FAO Global Assessment of ALDFG were administered to line and trap fishers on the islands of Antigua, Barbuda, and Dominica. Face-to-face interviews were conducted over the course of two months (July to August 2022) at various landing sites. Because interviewees were randomly and opportunistically targeted only primary landing sites were visited over the data collection period. Due to the multi-gear nature of the fisheries, fishers who engaged in more than one type of fishing activity were asked to respond to more than one gear questionnaire.

A total of 49 gear fishers were interviewed across both countries (23 in Antigua and Barbuda and 26 in Dominica). Of these 36 were trap fishers and 28 were line fishers, with several participants operating more than one gear type. Participants ranged in age from 28 years to more than 70 years old. Many indicated that they had been fishing since childhood, while more than 75% had over 20 fishing experience. Only one fisher indicated he had been fishing for one year, while all others had been fishing for at least five years or more. While a complete set of interview questions was asked of each participant only those questions that would provide insight into drivers, of gear loss as well as scale and impact of ALDFG have been analysed for this research. Responses to the examined questions were loaded unto an Excel spread sheet and analysed. The parameters analysed throughisher interviews were: (1) Main causes of fishing gear loss for both line and trap fishers, (2) Frequency of loss for component gear parts for both line and trap fishers, and (3) Rates of Trap Loss (Supplementary Data sheet 1).

2.2 Diver interviews

To gain a clearer understanding of the scale of the ALDFG challenge within the two countries being assessed and to augment the gear specific data derived from the FAO Global Assessment questionnaires, diver interviews provided an opportunity to assess the underwater environment and ALDFG encounter rates. For these diver interviews, semi-structure interview questions were used in order to assess to what extent divers encountered ALDFG.
during diving operations, the frequency of such encounters and the most abundant forms of derelict gear frequently encountered (Supplementary Data Sheet 2). Divers were also asked to comment on some of the observed impacts associated with the derelict fishing gear. To gain a variety of diver perspectives the researcher targeted not only commercial SCUBA diving spear fishers and/or conch divers but also recreational divers and divers who engage in conservation work. A total of 14 divers were interviewed across the two countries (9 were spear fishers/conch divers, 2 were recreational divers and 3 were conservation workers).

2.3 Data limitations

The quality of the data collected through interviews may be influenced by a number of factors including the ability of fishers to comprehend the questions being posed and the avoidance of bias by the interviewer while posing questions. Because questionnaires were administered in the field, often while fishers were working (e.g., repairing gear), the possibility exists that inaccuracies may have been introduced as a result of fishers not being completely engaged. The results from these interviews may be extrapolated across the study area, however, it must be acknowledged that this is limited by the availability of current data on the population size of the fisheries being studied.

The inclusion of diver interviews provided an opportunity to gain an understanding regarding submerged forms of ALDFG that exist within the study area. It is acknowledged that the sample size for divers interviewed is relatively small, particularly in the case of Dominica, but the information that they have provided remains valuable. It is also acknowledged that ALDFG encounter rates by divers may be influenced by a number of external factors including the depths they dive and proximity to fishing grounds. The inclusion of spare fishers as well as recreational divers could help compensate for these influences, but ultimately the results could have been improved with a larger sample size.

3 Results

3.1 Understanding the drivers of ALFDG and drivers of gear loss in the Eastern Caribbean

A number of similarities were observed with regard to the identified drivers of trap and line loss in both Antigua and Barbuda, and Dominica. In both Antigua and Barbuda, and Dominica severe weather and snagging on benthic obstructions were among the most frequently cited causes of fish trap loss (Supplementary Figure 1). Drifting out of range appeared to be a greater concern in Dominica while vandalism, and conflict with other gear were more often cited in Antigua and Barbuda. Towing of line gear by large animals (mainly pelagic fish) was the most significant cause of line loss in both jurisdictions (Supplementary Figure 2). A detailed analysis of these results is presented in the following sections.

3.1.1 Antigua and Barbuda

Among the trap fishers who were interviewed in Antigua and Barbuda, the most frequently identified causes of gear loss were severe weather (92.9% of respondents), vandalism (85.7% of respondents), and snagging on reefs, rocks or other obstructions (78.6% of respondents) (Figure 1). Strong currents and operator error were also found to be major causes of fish trap loss in Antigua and Barbuda, as indicated by 78.6% of respondents. Few individuals (~ 30%) identified the loss or malfunctioning of surface markers as a major cause of trap loss with most fishers indicating that this was not relevant to their operation. Contrastingly, conflict with other gears was reported by more than 50% of interviewees. Neither of these results are surprising since trap fishers in Antigua and Barbuda typically set their traps “blind” in an effort to avoid theft. In blind setting, two traps are tied together without a surface marker attached and their location marked with a GPS. In order to haul the traps, fishers use a grapnel (“creeper”) to catch and retrieve the
connecting rope. Approximately 38% of trap fishers indicated that they intentionally discarded traps at sea once they reached their end of life. However, this practice was primarily indicated by those fishers who used wood to brace/form the frame of their traps. In those instances, the fishers indicated that they removed the rope and any other plastic component from the traps, crushed the funnel to prevent fish from entering, and discarded the wire at sea. The ropes and buoys/other plastic components were returned to land and reused or discarded onshore. Fishers who used steel-frame traps generally brought them back to shore once the wire mesh had reached its end of life. The corroded wire mesh was then removed from the steel frame which was repaired/rewelded and used to reconstruct the traps with a new mesh, while the old mesh was discarded in the garbage. Fishers generally have dedicated containers on board for the storage of lines on the way to the fishing ground. Deepwater was also not a major driver of loss for line fishers.

With over half of respondents attributing the loss of traps and line to faulty or damaged gear, it raises concerns about the gear management routine across both fisheries. Trap ropes that are not maintained may snap during deployment or retrieval. Similarly, fishing lines may be weakened as a result of rodents or other vermin chewing on lines that have not been properly cleaned or stored following a fishing trip.

3.1.2 Dominica

In Dominica, the major causes of trap loss reported by interviewees presented some similarities with the Antigua and Barbuda results (Figure 3). For instance, severe weather emerged as the most commonly cited cause of fish trap loss in Dominica as well as in Antigua and Barbuda. In the case of Dominica, just over 90% of respondents indicated that this occurred either always or sometimes. Further, while, encounters with vessel traffic was sometimes revealed to be a major cause of trap loss in both countries by more than half of the interviewees, it is interesting to note that in Dominica just under 24% of respondents indicated this always occurred. This is perhaps not surprising given that while many fishers in Antigua and Barbuda set traps underwater the vast majority of Dominican fishers who were interviewed indicated that traps were set with surface markings. Further in many instances these fishers admitted to using plastic water or Clorox bottles instead of buoys to mark the location of their traps. Markers made from plastic bottles may be more difficult to see by oncoming vessels, are more likely to sink if they become filled with water or may be more easily cut away because they are not as durable as purpose-built marker buoys. Other major causes of trap loss in Dominica, as reported by more than half of the respondents, were traps drifting out of range, strong currents, and deep water.

Equipment failure was not a major identified cause of trap loss, although all but one fisher indicated that they deployed and hauled traps by hand and generally used land marks to locate traps. While the intentional discard of fish traps by fishers was largely not reported, approximately 32% of respondents admitted to discarding the metal fish traps at sea once they are no longer usable (Figure 3). Almost all of the fishers interviewed indicated that their traps were built from wire mesh and braced with wood. One fisher indicated that he uses bamboo traps while another indicated he constructs his traps with a steel frame.

FIGURE 2
Summary of interview results from Antigua and Barbuda to the question: “When a vessel loses hooks or lines, what are the main causes of the gear loss and corresponding frequency of occurrence?” (n = 9).
Both snagging and towing by large animals have emerged as a major contributing factor to the loss of fishing lines in Dominica (Figure 4), with approximately 74% and 84% of respondents respectively indicating that these sometimes led to line loss. Given that many of the interviewed fishers were targeting large pelagics such as tuna and marlin it is unsurprising that towing by large animals has been identified as a major cause of line loss. Fishers noted that large tunas often broke the lines or in some instances towed the “line traps” that fishers carry to the MFAD. These line traps are constructed of 2 or 3 small buoys attached to the vertical line and hook. Weather was not a major identified cause of line loss, with only approximately 74% of respondents indicating this never occurred.

Faulty gear was identified as a contributor of both trap and line loss by 47.6% and 66.17% of trap and line fishers respectively.

3.2 Understanding the Scale of ALDFG in the Eastern Caribbean

In order to gain insight on the scale of the ALDFG challenge in Antigua and Barbuda, and Dominica, fishers were asked to comment on the frequency with which they lost various components of both trap and line gears. This data was supplemented by information provided by divers who were asked to comment on their encounters with derelict fishing gear while diving. Combined results of diver interviews indicate that fish traps, line fragments, polypropylene netting and ropes are the most frequently encountered forms of submerged ALDFG (Supplementary Figure 3), with more than 80% of divers indicating they observe traps either always, frequently or sometimes (Supplementary Figure 4), more than 90% of divers

FIGURE 3
Summary of survey results from Dominica to the question: “When a vessel loses traps, what are the main causes of the gear loss and their corresponding frequency of occurrence?” (n = 21).

FIGURE 4
Summary of interview results from Dominica to the question: “When a vessel loses hooks or lines, what are the main causes of the gear loss and corresponding frequency of occurrence?” (n = 18).
observing polypropylene netting either frequently or sometimes (Supplementary Figure 5), more than 80% of divers encountering line fragments either always, frequently or sometimes (Supplementary Figure 6) and 70% of divers encountering ropes either frequently or sometimes (Supplementary Figure 7).

3.2.1 Antigua and Barbuda

Fishers were asked to indicate how often they lost either an entire set (all traps that were set), one unit (a single trap or traps that may be linked to form a single unit), or the surface buoys used in marking of traps. Of the fishers interviewed more than 50% indicated that they rarely or never lost an entire set of traps at once (Figure 5). Those who reported on the loss of an entire set, largely attributed such losses to severe weather, mainly hurricanes and storms. Because many of the fishers set traps underwater, without surface markers, many indicated that the loss of marker buoys was not applicable to their operations. All fishers who were interviewed indicated they had at least lost a single trap or a single unit of traps, with 30% indicating this occurred frequently, 53% indicating it occurred sometimes and 15% noting this rarely occurred.

In addition to commenting on the gear components that were lost and the frequency with which they were lost, trap fishers were also asked to estimate the number of traps lost in a typical year. Responses ranged from 2 to 60 traps at an average rate of 19.6 traps per vessel, extrapolated against the total of 116 vessels it is estimated that fishers lose an average of 2,273 traps per year, or about 34% of the estimated total of traps actively fishing. Undeniably the rate of fishing gear loss is likely to be affected by a number of external factors including the size of the fishing operation, fishing depths, the presence or absence of surface markers, and overcrowding on fishing grounds. Some fishers indicated that traps set in shallower waters were more likely to be affected by rolling currents. Further, as previously noted fishers who set their traps underwater in overcrowded fishing grounds were often impacted by gear conflicts as traps may become entangled if they are set on or near other traps.

Line fishers were asked to indicate how often they lost an entire set of lines (all lines actively fishing), a single unit of line, attached buoys only, attached floats only or plastic lures (artificial bait). Very few fishers indicated that they frequently or sometimes lost an entire set of lines, with more than 70% of those interviewed indicating that this either never occurred, was a rare occurrence or was not applicable to their operation (Figure 6). The one individual who explained that this was not applicable to their operation noted that he only fished a single hand line at a time. More than half of the fishers indicated that they had never lost a single unit of line, while that same ratio noted that they had lost buoys either sometimes or rarely. Almost 80% of the fishers interviewed indicated that they lost plastic lures either very frequently or sometimes.

Encounter rates of derelict gear by divers is likely to vary depending on depth, proximity to fishing grounds and the time of year; However, they can provide valuable insight into the scale of the challenge. The results of these diver interviews have highlighted that ALDFG is not only a localised issue for Antigua and Barbuda but is also a transboundary challenge. This is underscored by the observations of divers who reported encountering ALDFG associated with Sargassum influxes as well as the observation of gear not typically utilised in the country’s fishing sector. Among the reported forms of ALDFG observed by divers were FAD components, rope, and polypropylene netting (Figure 7).

Traps were among the most frequently observed forms of derelict gear by divers along with monofilament fishing lines and

![Figure 5](https://example.com/fig5.png)

**Figure 5**

Summary of interview results from Antigua and Barbuda to the question: “When or if fish traps or parts of traps are lost which of the following elements are lost and in what frequency?” (n = 14).
ropes (Figure 8). Interestingly, multifilament/polypropylene net fragments were also identified as a major form of encountered ALDFG as noted by 89% of the divers interviewed. These nets are not typically utilised by small-scale fishers in Antigua and Barbuda and have likely drifted into coastal areas from outside the country’s EEZ or may be cut away from MFADs. Additionally, 56% of divers reported encountering FAD components (mainly buoys, ropes or FAD heads). These, often, had markings in French, indicating that they either drifted from neighbouring French territories or were illegally set in Antigua and Barbuda’s EEZ by French fishers. Other components of gear identified by divers included octopus traps and fish crates that may have drifted across the Atlantic (based on the markings observed), crab traps and spearfishing equipment.

For the two most frequently reported ALDFG gear types (traps and polypropylene/multi-filament net fragments) the frequency with which such gear was encountered was also assessed (Figure 9). More than half of the respondents (62%) reported encountering traps frequently, while 25% noted that they observed traps only sometimes. In contrast only about one third (1/3) of the respondents reported encountering the polypropylene nets frequently, and 45% observed them sometimes (Figure 8). Divers who encountered these large nets reported that they generally returned them to shore and utilised them to construct conch baskets and fencing among other uses. Many of the divers who were interviewed noted that monofilament fishing lines were mainly found in shallow areas, snagged on reefs and rocks. One
interviewee reported on having removed 15 lbs of monofilament line from a shallow reef system located within the National Park during a coastal clean-up. Based on the location and the manner in which the lines were found, the diver, who is also an expert marine ecologist, surmised that the lines were likely due to shore-based, recreational fishers and not commercial fishers. Shore-based fisheries are not regulated in Antigua and Barbuda.

3.2.2 Dominica
As in Antigua and Barbuda, the scale of fishing gear loss in Dominica may be influenced by a number of factors. In contrast to Antigua and Barbuda, more than 60% of those interviewed indicated that they sometimes experienced the loss of marker buoys (Figure 10). This result is not surprising given that fishers in Antigua and Barbuda typically set traps underwater without buoys, while Dominica fishers continue to mark traps with surface markers many of which are fabricated from plastic bottles. More than half of fishers indicated that they experienced the loss of a single unit of traps either frequently or sometimes while this number was much lower when fishers were asked if they experienced the loss of an entire set of traps (>70% as compared just under 30%).

The rate of loss for fish traps was highly variable among interview participants ranging from 1 to 50 traps lost per year, at an average loss rate of 17 traps per fisher, per year in Dominica. While this number seems quite similar to the average experienced in Antigua and Barbuda, it should be noted that trap fishers in Dominica reported fishing between 3 and 60 traps per trip at an average rate of 16 traps per fisher per trip. Based on the most recently available census data for the Dominican fishing fleet, there were 151 trap fishers in 2011. Thus, based on the reported averages, it can be estimated that fishers lose approximately 2,567 traps per
year on that island. This is rate of loss is concerning, especially when compared to the estimated 2,416 traps deployed across the fishing fleet during regular operations.

Few line fishers (21% of respondents) indicated that they experienced the loss of a complete set of lines either frequently or sometimes, while almost all interview participants (~89% of respondents) admitted to having lost at least a single line unit (Figure 11). As in the case of Antigua and Barbuda more than half (~84%) of those interviewed in Dominica admitted to having lost artificial lures either frequently or sometimes. The loss of buoys alone was rarely experienced as most fishers indicated that once the buoys were lost it was likely that the entire unit of line would also be lost.

Unfortunately, only five divers could be interviewed in Dominica. Of the various forms of derelict gear encountered by divers, fish traps followed by monofilament lines were the most frequently observed by interviewees (Figure 12). Although much of Dominica’s line fishery targets large pelagics in the deep ocean, interviewees reported observing monofilament lines in relatively shallow areas. One interviewee suggested that this was the result of nearshore/shore-based fishing. Three divers reported occasionally seeing the large polypropylene nets. When encountered, these nets were either left at sea, as they are known to attract fish when floating or returned to shore to make hammocks and other upcycled products.

When considering the frequency with which the most commonly observed gears were encountered, 80% of interviewed
divers indicated that they saw derelict traps either rarely or sometimes, although one person indicated that they saw derelict traps all the time (Figure 13). Contrastingly, all interviewees indicated that they encountered derelict monofilament line fragments either, always, frequently or rarely (Figure 13). This result is perhaps not surprising given that Dominica’s fishing sector is largely based on the harvest of pelagic resources, despite many of the fishers who participated in this research utilising multiple gear including traps for the harvest of demersal species.

3.3 Understanding the impacts of ALDFG in the Eastern Caribbean

The academic literature is rife with numerous articles that have presented significant information on the range of socioeconomic, ecological, and other impacts associated with ALDFG. The purpose of this section is not to restate what has already been presented by numerous academics but to consider the examples and cases highlighted by divers and fishers who formed part of this research, as well as to present preliminary estimates of the ghost fishing potential of lost traps and associated socioeconomic impacts.

In addition to indicating the frequency of encounters with various forms of ALDFG, divers were asked to comment on whether the gear was impacting any marine life or habitat. Derelict traps in both Antigua and Barbuda were often found with fish and/or crustaceans entrapped in them. Several divers, however, indicated that older traps lost their catching function as they became degraded over time or were damaged by either sharks or eels trying to prey on entrapped marine life. One diver shared his observation that traps that broke down resulted in a scarring of the benthic environment.
Ghost fishing associated with derelict traps have been documented in a number of fisheries both within (Renchen et al., 2008; Norris et al., 2011; Renchen et al., 2014) and outside the Caribbean region (Erzini et al., 2008). Do and Armstrong (2023) estimated the average annual catch rate for ghost traps to be 2.77 organisms per trap. While this number seems relatively low it is consistent with a number of other studies which also observed relatively low mortalities associated with derelict traps and decreasing efficiency as traps degrade (Renchen et al., 2014; Goodman et al., 2021). This estimate, however should be considered in the context of fish stock health as well as the total amount of derelict traps within the fishery. For instance, given estimates of annual trap losses in Antigua and Barbuda, and Dominica, the study by Do and Armstrong (2023) suggests that ghost traps may be responsible for the capture of approximately 6, 296 and 7, 110 marine organisms each year, respectively. Norris et al. (2011) estimated a total of four fish would equate to a pound, which is the unit used for fish sales in both countries. By this metric, derelict traps in Antigua and Barbuda may be responsible for the capture of an estimated 1,574 pounds of fish annually, while in Dominica this would equate to an estimated 1,777.5 pounds. This is valued at $15, 740 East Caribbean dollars in the case of Antigua and Barbuda and $14, 220.00 East Caribbean dollars in the case of Dominica, based on the market price of $10/pound and $8/pound respectively, as reported by fishers. This assumes that all fish captured within the traps are of commercial value but does not take account for lobsters which capture a higher price on the market.

As reported by the divers, both gillnets and large polypropylene nets were observed to have marine life entangled in them; however, divers who encountered the polypropylene nets indicated that entanglement of marine organisms was relatively rare. More eels, turtles and lobsters were among the marine life observed entangled in derelict nets. Derelict gill nets were also observed entangling coral reefs while one diver indicated they had observed a reef being smothered by a large section of the polypropylene net. Fishers in both Antigua and Barbuda, and Dominica noted that, when found floating, polypropylene nets often acted as drifting FADs so that fishers often target these areas for the capture of pelagic resources. In Antigua, one diver reported that a large gill net had created a navigational hazard as the net, which had likely been abandoned by the fisher, had become entangled in rocks and stretched over 400 metres. The diver reported taking several days to remove the net, sections at a time.

Fishing line was most often encountered snagged around reefs; However, one conch diver reported seeing a nylon fishing line wrapped around the horns of a queen conch. Divers who reported encountering ropes mainly observed these encrusted on reefs. However, one individual reported seeing a turtle entangled by a large mass of rope mixed with net. Because the FAD parts that were encountered were usually just the buoys none of the divers reported seeing them impacting wildlife. However, the possibility remains that large masses of buoys may become navigational hazards.

4 Discussion

Fish trap losses in both Antigua and Barbuda, and Dominica appear to be a major challenge and contributor to ALDFG. In both cases severe weather has emerged as the leading driver of trap loss, as reported by more than 90% of respondents. These results are consistent with the findings of other similar studies where severe weather was found to be the most significant driver of fishing gear loss in Sri Lanka (Gallagher et al., 2023) and the second most cited cause of trap loss, globally (Richardson et al., 2021a). Richardson et al. (2021a) also noted that snagging on benthic obstructions was a major driver of loss for gear that came in contact with the seafloor.

While that assessment did not include snagging among the list of drivers for the trap assessment, 70% of those interviewed cited avoidance of snagging areas as a major preventative action (Richardson et al., 2021a). In both Antigua and Barbuda, and Dominica snagging of benthic obstructions was cited by more than 70% of respondents as a cause of trap loss.

This study has revealed that critical differences in how trap fishers operate across the study area, have likely led to differences in some of the other major associated drivers. For instance, many trap fishers in Antigua and Barbuda have switched to setting traps underwater in order to avoid theft. However, this appears to have led to increasing gear conflicts on overcrowded fishing grounds as traps become entangled with each other. The reluctance of fishers to utilise marker buoys has been shown to lead fish trap loss in other regions (Vadziutsina and Riera, 2020). Fishers in Dominica, on the other hand, continue to set traps on buoys. Unfortunately, in many instances, fishers do not utilise proper buoys, opting instead to use Clorox or water bottles to mark the location of their traps. This has created a twofold problem for fishers in Dominica. The first is the high incidences of traps being cut by vessel traffic, while the second is the increased likelihood that buoys may become submerged if the bottles take on water. Concerns about the use and poor visibility of “homemade” marker buoys for fish traps have also been raised in the neighbouring island of Montserrat where they have become a navigational hazard to commercial vessels traversing shipping grounds (Dosell et al., 2021).

More than 80% of fishers in Dominica cited drifting of gear out of range as a frequent cause of trap loss, often leading to such gear going “over the edge” into deeper waters. The use of area-based management measures to separate fishing operations from areas of high vessel traffic as well as the use of purpose-fit buoys with higher visibility as advised in Gilman et al. (2022) could help to curb trap losses in Dominica’s trap fishery. In Antigua and Barbuda, on the other hand there is a strong need for improved fisher communication in order to reduce gear conflict. Additionally, to mitigate the impacts of lost traps promoting the use of biodegradable panels in both cases should be prioritized.

Comparing the results from the current assessment with recent predictive modelling assessments of ALDFG in Montserrat and Belize (Antonelis and Drinkwin, 2021; Antonelis et al., 2022) reveals a number of similarities. Severe weather has been revealed to be
TABLE 1 Ranking of the most significant drivers of fish trap loss across four Caribbean states.

<table>
<thead>
<tr>
<th>Ranking of the Most Significant Drivers of Trap Loss in four Caribbean states</th>
<th>Antigua and Barbuda</th>
<th>Dominica</th>
<th>Montserrat</th>
<th>Belize</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Poor weather</td>
<td>Poor weather</td>
<td>High vessel traffic</td>
<td>Poor weather</td>
</tr>
<tr>
<td>2</td>
<td>Vandalism</td>
<td>Drifting out of range and Snagging</td>
<td>Poor weather</td>
<td>Strong currents and drifting out of range</td>
</tr>
<tr>
<td>3</td>
<td>Snagging, Strong current and operator error</td>
<td>Vessel traffic</td>
<td>Strong current and vandalism</td>
<td>Vandalism</td>
</tr>
<tr>
<td>4</td>
<td>Conflict with other gear and vessel traffic</td>
<td>Strong currents</td>
<td>Lost surface markers</td>
<td></td>
</tr>
</tbody>
</table>

(Rankings have been based on the frequency with which fishers cited the specific driver as leading to gear loss).

among the top two major causes of trap loss in all four states, while strong currents is also among the top four drivers (Table 1). As the Caribbean region continues to experience more frequent and severe storms it will be critical for fisheries managers and fishers to enact strategies to reduce the number of traps lost due to severe weather.

The snagging of shallow reefs by fishing line in Antigua and Barbuda is another area of concern, particularly since this appears to be due to the recreational, shore-based fishery which is not regulated. An area-based management approach could help to mitigate this issue (Gilman et al., 2022). For example, fisheries authorities could move to prevent shore-based fishing in areas with a high probability of snagging or areas with sensitive habitats. However, because recreational fishers do not require a permit to fish from shore, this would need to be accompanied by a very strong public outreach programme to increase the likelihood of compliance.

The relatively high number of fishers who attributed both line and trap loss to faulty gear is concerning. Richardson et al. (2021a) observed that gear maintenance was an important factor not only with regard to the lifetime of the gear but also impacted loss. Thus, to reduce losses resulting from faulty gear it is recommended that fishers undertake routine examination and maintenance of gear before any fishing trip.

While fisheries interventions may aid in curbing ALDFG resulting from local drivers, external drivers such as weather, sargassum and the transboundary movement of derelict gear may be harder to manage. For instance, the incidences of MFAF components drifting into these islands from neighbouring French territories cannot be addressed without the cooperation of fisheries and other authorities in those islands.

The loss of locally deployed MFADs may be reduced through a combination of fisheries and non-fisheries control measures. For instance, area-based management may aid in the reduction of losses resulting for vessel traffic, by ensuring MFADs are deployed away from shipping lanes and other navigation zones. This would require the cooperation and collaboration of fisheries and port management authorities, while hydrographic agencies and/or charting authorities should be engaged to ensure their locations are precisely charted and communicated to mariners. Ensuring MFADs are compliant with gear marking regimes and adequately fitted with lights and radar reflectors is also critical to reducing losses. Frequent inspection of MFAF mooring lines and the use of durable materials for surface and subsurface components (anchors, lines and surface buoys) could also aid in this regard (Gilman et al., 2022). In recent years the use of submerged/subsurface MFADs has been promoted, as they have been shown to reduce vandalism, may be used in high traffic areas and can reduce wear on FAD lines associated with waves and storms (Taquet, 2013).

This study has demonstrated that the dive community has played and can continue to play a crucial role in managing ALDFG in these small islands, particularly for derelict gear that may be submerged and transboundary. As was shown through this research, divers routinely encounter various forms of ALDFG while diving and several have indicated that they actively seek to remove small ALDFG fragments such as lines or nets from reef areas. However, with no incentive or mechanisms to report these encounters a major opportunity is lost to elicit their support in managing this threat. Fisheries officials could consider instituting a no-fault online reporting system to encourage recreational divers to report encounters with ALDFG.

As has been previously highlighted the small-scale fisheries of the Eastern Caribbean are diverse and complex. This diversity is borne out not only by the multi-gear, multi-species nature of the fisheries but also by environmental heterogeneity and variabilities in the local drivers of loss. Mitigating the impacts of ALDFG requires that management approaches match local circumstances (Gilman et al., 2022). Therefore, it is important to continue uncovering the diversity of issues and challenges relevant to the management of this threat within the context of Eastern Caribbean small-scale fisheries.

5 Conclusion

The loss of fishing gear, particularly for small-scale fisheries in a region prone to tropical cyclones and seasonal swells, is difficult to curb completely. This notwithstanding, the results of these fisher surveys have provided valuable insight into those drivers that could
be managed with the right fisheries interventions. This study is seen as only a first step in understanding the drivers, scale and impact of ALDFG the Eastern Caribbean sub-region. While inferences can be made based on the results of this study, it is important to acknowledge the variabilities that may exist across the sub-region and which are inherent to small-scale fisheries, globally. As has been shown by this study, cultural differences and local customs as well as the biogeography of the coastal environment may play critical roles in shaping the fisheries as well as impacting when and how fishing gear become derelict. The current study, despite its limitations, does provide a critical baseline for the two islands that formed part of the assessment. They also present an opportunity for comparisons with similar studies both inside and outside the Eastern Caribbean sub-region. It is hoped that this assessment will meaningfully contribute to the growing body of literature on ALDFG, while helping to fill knowledge gaps as they relate to ALDFG associated with small-scale fisheries. ALDFG in Eastern Caribbean small-scale fisheries is a real threat that is already resulting in impacts to fishers, marine organisms and marine benthic communities. Therefore, it is critical that work continues in seeking to elucidate on the overall scale of the problem for the sub-region.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by World Maritime University Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study or recorded their verbal consent at the start of the interview.

Author contributions

Conceptualisation of this research, methodology, data collection, data analysis and interpretation, all assessments, writing and editing of the manuscript was completed by the sole author of this research. The work was supervised by Dr. Aspasia Pastra, Dr. Ronan Long and Dr. Meinhard Doelle before his passing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2023.1139259/full#supplementary-material
References


Managing abandoned, lost and otherwise discarded fishing gear (Derelict Gear) in Eastern Caribbean small-scale fisheries: An assessment of legislative, regulatory and policy gaps

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ABSTRACT

The issue of abandoned, lost and otherwise discarded fishing gear (ALDFG) is a complex global challenge that affects not only industrial fleets but small-scale fisheries as well. Having been described as perhaps the most dangerous form of marine litter, it is important to not only understand the scale and nature of the problem globally but whether existing management regimes can respond to this complex issue.

For the islands of the Eastern Caribbean, as in several other regions of the world, research has shown that there are significant knowledge gaps in our understanding of ALDFG and its management. This research has focused on discerning the legislative, regulatory and policy gaps associated with the management of ALDFG in small-scale fisheries of several Eastern Caribbean States (Antigua and Barbuda, Barbados, The British Virgin Islands, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines). Through an examination of national fisheries, pollution, solid waste and environmental protection laws as well as policies related to marine litter and/or fisheries a number of weaknesses have been identified in the legal, regulatory and policy landscape for these islands as it relates to the management of ALDFG. These weaknesses have been borne out in outdated and missing fisheries laws, ineffective marine pollution instruments that lack provisions focused on marine-sources of waste, as well as the complexities related to the multi-gear nature of the sub-region’s fisheries. Improvements to the legal, regulatory and policy framework for the management of ALDFG in the Eastern Caribbean will aid in curbing the proliferation and adverse impacts of ALDFG in the region. However this must be accompanied by targeted research to understand not only the scale of the challenge but the drivers of loss. This will assist in the defining of purpose-fit solutions to a complex challenge.

1. Introduction

Working group 43 on Ocean Based sources of marine debris of the Joint Group of Experts on Scientific Aspects of Marine Protection (GESAMP), describes sea-based litter as “synthetic…debris deposited directly into seawater from a vessel, facility or activity that is situated in or on, or is taking place entirely on or within, the ocean…” [24]. This includes abandoned, lost and otherwise discarded gear (ALDFG), further defined as “any physical device or part thereof or combination of items that may be placed on or in the water or on the seabed with the intended purpose of capturing or controlling (for subsequent capture) or harvesting, marine organisms” [24]. ALDFG is a global challenge associated with large-scale industrial fishing and small-scale/artisanal fleets alike. It has been shown to have significant deleterious impacts to marine habitats and wildlife (including many threatened species). Recorded entanglements of seabirds, marine turtles and marine mammals has largely been attributed to fishing gear (especially ALDFG) over any other form of marine plastic [22,41,68]. Fishing lines entangling branching colonies have been shown to result in increased colony mortality [2,4] while corals covered by other forms of ALDFG, including nets, may experience damage including tissue loss and fragmentation [74]. Investigations of marine debris in benthic communities of the Central Mediterranean Sea found that ALDFG constituted the main component of litter on the seafloor, prompting the authors to conclude that “seafloor marine debris represents an insidious deleterious pressure on the deep marine ecosystem” [8]. Derelict gear can also create navigational hazards as observed in United Kingdom Harbours where the most frequently reported cause of failed propellers was identified as ALDFG [51] and result in socio-economic losses [40,47]. Socio-economic losses associated with
ALDFG may stem from the need to replace lost fishing gear, lost fishing time and stock declines caused by ghost fishing [40,51]. In a 2021 assessment of ALDFG impacts in SW Nova Scotia it was estimated that ghost fishing of target species by derelict gear resulted in annual commercial losses ranging from $82,000 - $176,000 CAD for lobster fishers [30]. In the context of Canadian fishers this figure may be relatively small compared to the value of the fishery, however for small-scale fisheries, such impacts may be more acutely felt by fishers already grappling with declining fish stocks in the face of a changing global climate. Consequently, ALDFG is a challenge that needs to be managed, even in the face of data scarcity.

Despite work being undertaken to understand the causes and impacts of fishing gear loss, abandonment or discard, both internationally and in the Wider Caribbean [26,41,46,47,62,63] significant knowledge gaps exist in relation to the “amounts and rates of ALDFG” as well as the “type, quantity and impact of sea-based sources of marine litter for most regions” [12,24,59,64]. These knowledge gaps notwithstanding, there is little doubt that derelict fishing gear poses a grave threat to ocean health [58,59].

In the Wider Caribbean there is generally felt to be a dearth of knowledge regarding the challenge of derelict fishing gear; however, this appears to be particularly acute among the small island states of the Eastern Caribbean. In a meta-analysis of published literature related to derelict fishing gear globally, it was observed that there were very few studies focusing on derelict gear associated with the small-scale fisheries of the Eastern Caribbean [62]. Of the sixty publications containing quantitative data analysed in that review, only two focused on Eastern Caribbean fisheries outside of the United States territories. Of these, one was a 1983 report on the trap fisheries of Barbados while the second was a 2010 report to the Gulf and Caribbean Fisheries Institute (GCFI) titled “Assessing Opinions on Abandoned, Lost, or Discarded Fishing gear in the Caribbean”. According to the latter report, net-based fisheries in the region may experience up to 79.2% of gear loss, abandonment or discard, while 56.8% of traps were estimated to become derelict [46]. A 2008 assessment of Saba Bank fishers estimated that traps were being lost at a rate of 5–20% of all traps, equating to between 260–988 traps being lost annually in that fishery [71]. Fishers in Grenada have reported high losses of anchored fish aggregating devices (aFADs) on the Western side of island, likely as a result of merchant shipping traffic [15]. Thus, despite the regional disparity in data availability for the Eastern Caribbean there are clear signals that ALDFG is occurring in the sub-region’s fisheries.

The causes of gear loss are many, yet this can be exacerbated by strong tides, currents or winds as may be associated with tropical cyclones, thus resulting in significant losses of passive gear such as traps [47,56,59]. In such instances gear, which have been carried away from their location become more difficult, costly and/or dangerous to retrieve [59]. For instance, after Hurricane Earl in 2010, fishers in Antigua and Barbuda reportedly lost 1,104 traps, approximately 14.8% of the 7,483 traps said to be in, operation prior to the passage of the storm [20]. Similarly, after the passage of hurricane Irma in 2017 preliminary assessments indicated that as many as 2,177 traps were reportedly lost [21]. These numbers, however, pale in comparison to the over 12,000 traps estimated to have been lost in Antigua and Barbuda as a result of Hurricane Luis in 1995 [20]. In Dominica, a combined estimate of 4,500 traps were lost in 1999’s Hurricane Lenny, 2007’s Hurricane Dean and 2008’s Hurricane Omar [57]. Given what is known about the ghost fishing potential of lost traps [56,57,60,61,69] this a major concern in a region prone to hurricanes and severe storms. In fact, Norris et al. [57] estimated that traps constructed of wire mesh and a wooden frame could continue to capture fish more than a year after being left derelict, potentially impacting fish populations as well as the sustainability of small-scale fisheries. Thus, there is an urgent need for research and development which can aid in improving the management of passive gear as well as management systems that can contribute to increased rates of retrieval.

Surveys conducted by the FAO ahead of a 2019 regional workshop on derelict gear in Latin America and the Caribbean revealed that more than half of the respondents considered the issue of derelict gear to be of high or major concern in the area [17]. However, survey respondents also noted that a lack of reporting mechanisms, absence of regulations, inability to retrieve gear and lack of awareness by fishers were among the most significant challenges to effectively managing the threat of derelict gear in the region [17].

Like much of the Wider Caribbean region, Eastern Caribbean small-scale fisheries are characterised as multi-species, multi-gear fisheries, which contribute significantly to the region’s food security, and the livelihoods of vulnerable communities [9,70]. The multi-gear character of the fisheries sectors in these islands brings a level of complexity to the effective management of the challenge of derelict gear since measures must be able to respond to the multi-faceted nature of the industry at an appropriate scale taking into account the socio-economic realities of these small islands.

With the exception of St. Kitts and Nevis, and St. Vincent and the Grenadines, whose open ship registries register or have registered large offshore pelagic vessels operating on the high seas, the fishing fleets of the Eastern Caribbean islands are dominated by small coastal vessels that harvest multiple species utilising a range of mostly passive gear. In 2020, the sub-region’s artisanal fleet was estimated at approximately six thousand vessels, landing close to 19,000 tonnes of fish and other products [9,18]. Gears typically utilised in the sub-region’s small-scale fisheries are traps of various designs, cast nets, Gill nets, beach seines, hand lines, trolling lines and long lines [9]. Anchored Fish Aggregating devices are utilised by many of the pelagic fisheries in the region as well as SCUBA and freediving gear for harvesting of queen conch and other benthic or sedentary species. Species harvested range from small coastal and large offshore pelagics, to demersal, deep-slope and sedentary species and marine mammals as in the case of St. Vincent and the Grenadines and St. Lucia.

Managing derelict fishing gear should form a central part of any fisheries management regime. This means not only seeking to prevent or reduce the likelihood of gear becoming lost, abandoned or discarded but also the establishment of measures aimed at reducing impacts to wildlife and ecosystems in the event gear do become derelict. Broader fisheries management controls generally established for the conservation of stocks may assist in managing the threat of abandoned, lost or discarded gear [25,28]. This notwithstanding, Hodgson [32] describes ALDFG as simultaneously a fisheries challenge as well as a maritime transport and environmental problem. Thus, the legal regime for its management at all levels may go beyond such fisheries management rules. Further, while regulatory control measures as contained in fisheries laws are a critical component of ALDFG governance, they form only a part of a suite of management measures that also include mechanisms for implementation of such rules and the enactment of monitoring control and surveillance systems to aid in compliance. Weaknesses in either the regulatory regime or other components of the fisheries management system are likely to result in ineffective governance of this threat.

This outlook notwithstanding, legislation serves as an “important basis for authorising regulatory action to prevent and mitigate ALDFG” [27]. Such laws may specify prohibited activities, or stipulate where and how certain activities may occur [32]. Command and control provisions as contained in national laws should also seek to foster non-compliance through a system of appropriate sanctions [32]. In a global review of ALDFG laws, the Global Ghost Gear Initiative [27] suggested that there is a “paucity of “legislation, legislative elements and rules” specifically targeting ALDFG. Coupled with this, insufficient enabling conditions and implementation support has resulted in ineffective laws [27] at all levels of governance. At the international level Gold et al. [29] described inadequacies in the current regime for the management of marine litter and suggested that new international mechanisms should work in tandem with regional, national and sub-national programmes to achieve reductions in all sources. In the case of marine debris originating from
small-scale fisheries the role of national instruments may be ever more critical as existing international instruments are generally ineffective in managing debris from smaller fishing vessels [32].

Where command and control provisions are absent, policies may aid in establishing priorities and direction towards the achievement of conservation and management goals. They can also offer opportunities to engage with and reflect the views of stakeholders. While the international community works towards the creation of a new global plastics treaty, it is critical to note that as early as the 1970s the recognition of marine debris as a global threat prompted the formulation of several international instruments aimed at preventing inputs of marine debris through dumping (The London Convention and Protocol) and from ships (MARPOL Annex V) [24]. At the regional level, both fisheries and non-fisheries instruments, bodies and programmes have also worked to design and implement policies for the management of marine debris from multiple sources. The Caribbean regional seas programme, through the Cartagena Convention and its protocols has developed a Regional Action Plan for the Management of Marine Litter (RAPMaLi) while the smaller Eastern Caribbean islands of the Organisation of Eastern Caribbean States (OECS) have developed harmonised policy approaches aimed at responding to priority environmental problems and creating opportunities for nature-based solutions in the Eastern Caribbean (OECS 2020). The OECS is a Caribbean sub-regional intergovernmental body that promotes cooperation and economic integration of member states through policy harmonisation and a common economic market. For the OECS sub-region, the St. George’s Declaration (SGD) is the key policy instrument that focuses on sustainability principles in environmental governance. With its recent review, the SGD 2040, while not entirely focused on fisheries governance or its environmental impacts, includes a targeted goal and objectives relating to pollution management.

While many islands of the Wider Caribbean have increased efforts to manage land-based sources of marine debris, through bans on single use plastic bags and Styrofoam containers [6] there is a need to understand to what extent the existing legal and policy landscape within the small-island states of the Eastern Caribbean can respond to the challenge of marine-based sources of marine litter like ALDFG. This review analysed whether the current regime is sufficiently robust to effectively manage the challenge of ALDFG in Member and the English-speaking Associate Member States of the OECS and Barbados (Fig. 1). The review identified gaps in the regulatory regime, considered cross-sectoral challenges and presented preliminary conclusions on how to achieve improved management.

2. Methodology: Benchmarking for analysis

A gap analysis provides an opportunity to take stock of the current legal and policy landscape that exists in the management of derelict fishing gear within the countries being reviewed. By benchmarking existing national legal and policy frameworks against proposed best practice guidelines and recommendations that have been developed by competent international organizations and initiatives or have been presented in academic writing, it offers an opportunity for priority setting.

The assessment approach is based on Gilman [25], while the established benchmarks were set against best practice guidance developed and presented in Global Ghost Gear Initiative [28], Gilman [25] and McFayden et al. [47]. In each case, a three-pronged approach has been proposed with a view to preventing, mitigating/remediating derelict fishing gear. The measures examined relate to gear design and deployment, legislative prohibitions on the discard of fishing gear and mechanisms for the reporting and retrieval of derelict gear.

The legislation that formed part of this review were the Fisheries Acts and Regulations of each country/territory, Marine Pollution laws (where they existed), solid waste management legislation and Environmental Protection Acts. Using a matrix assessment, the text of each of the legislations were reviewed to assess their alignment with best practices approaches, i.e., whether they contained:

1. Preventative provisions requiring:
    a. Marking of fishing gear
    b. Traceability measures,
    c. Gear design to reduce loss (e.g., through entanglement)
    d. Spatial/temporal restrictions on gear deployment
    e. On-shore collection facilities; and
    f. Reduction in fishing effort through limitations on the usage of gear (e.g., time limits)

Fig. 1. States and Territories Considered in This Review.
(2) Mediating measures/measures to mitigate the impacts of derelict gear based on solutions gear design aimed at reducing impacts of lost, abandoned or discarded gear such as:
- the use of biodegradable materials in gear
- the inclusion of escape hatches in passive gear to reduce incidences of ghost fishing.

(3) Remediation/curative measures relating to the
- a. reporting,
- b. locating,
- c. recovery,
- d. or recycle of derelict gear

Table 1 presents a description of each of the measures that were considered, the explanatory notes as outlined in the literature and the question used in assessing the measure.

The gap assessment also considered gaps in national marine pollution, fisheries, and environmental policies relevant to the management of ALDFG in the target countries.

3. Results

Table 2 summarises how well states and territories have aligned with the assessed regulatory benchmarks. It highlights a number of weaknesses in the national legal landscape governing ALDFG for many of the states and territories that were part of this review. It also reveals significant gaps in the command-and-control provisions for its management. While this review has focused on the smaller islands of the Eastern Caribbean it should be noted that the challenges outlined herein are not unique to the OECS and Barbados. Trinidad and Tobago’s Fisheries Act dates back to 1916 with the most recent amendments having been completed in 1975. Further, while the Fisheries Regulations have out set technical restrictions on net length and mesh size for a variety of nets there are no clear provisions aimed at managing ALDFG.

3.1. Fragmentation of national laws

Overall, very few of the legislation examined were designed to take into account the management of derelict fishing gear. Further, the policy and legislative regime relevant to the management of derelict fishing gear in the OECS and Barbados was found to be fragmented with relevant provisions being split between fisheries laws, marine pollution or merchant shipping laws, waste management laws and environmental protection legislation. In the case of the British Overseas Territories of Anguilla, British Virgin Islands and Montserrat, legislative provisions governing derelict gear management may be located in local laws of the territory or within wider United Kingdom legislation. This, therefore, means that in almost all cases the management regime for derelict gear is a cross-sectoral issue with various agencies having mandated responsibility. Measures relating to the prohibition of the purposeful discard of fishing gear or plastics which may include fishing lines or ropes were generally located within Marine Pollution legislation, Environmental Protection Legislation (in the case of Antigua and Barbuda) and Waste Management Legislation (in the case of Grenada and Dominica). Similarly, obligations for reporting of such plastic waste including fishing gear being discarded in the marine environment were provided for within these laws. Provisions relating to mitigating the impacts of derelict gear and/or reducing gear loss, abandonment or discard (e.g., gear marking), were primarily found within national fisheries laws, although in some cases these were entirely absent.

This fragmentation of national legislation in almost every country or territory reviewed means that responsibility for managing derelict gear should be shared between national fisheries, environmental or solid waste management agencies as well as marine service departments which administer the MARPOL Conventions within the various states.

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<tbody>
<tr>
<td>Description of Regulatory Measures Considered in the Gap Assessment</td>
<td>Acts of parliament may serve as critical “basis for authorizing regulatory actions to prevent and mitigate ALDFG issues” [27].</td>
<td>Fisheries Acts authorise the formation of command-and-control fisheries management measures contained in Regulations, which may aid in managing the threat of ALDFG [25,28].</td>
<td>Marking of fishing gear includes position markers (e.g., surface markers) and identifiers that allow for identification of responsible vessel/individual. It may assist in reducing IUU, dangers to navigation, and can deter abandonment or discard of gear [28].</td>
<td>Separating gear through spatial management systems can reduce the likelihood of gear conflict between static and active gear [28].</td>
<td>Separating gear temporarily can also serve to reduce the likelihood of gear conflict [25].</td>
<td>Input controls that limit the amount of time gear is left in the water can reduce the likelihood of gear loss [25].</td>
<td>Bans on the use of certain gear known to be of high risk to ghost fishing or entanglement of wildlife has been beneficial in some areas [25]: e.g., bans on gillnets or trawl nets.</td>
<td>Does fisheries legislation include measures aimed at preventing or restricting the use certain types of gear that may result in deleterious impacts if they become derelict?</td>
<td>Some modifications in trap design established to reduce by-catch (e.g., mesh size restrictions or escape panels) can aid in reducing ghost fishing rates if left derelict. [25]</td>
<td>Modifications in net design aimed at reducing by-catch (e.g., mesh size or length restrictions) can also aid in reducing ghost fishing rates if left derelict. [25]</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in traps?</td>
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Table 1

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<tr>
<th>Measure</th>
<th>Explanatory Notes as outlined in Literature</th>
<th>Assessment Question for this Study</th>
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<tbody>
<tr>
<td>National Fisheries Laws</td>
<td>Acts of parliament may serve as critical “basis for authorizing regulatory actions to prevent and mitigate ALDFG issues” [27].</td>
<td>Does the state/territory have in place legislation governing the management of the fisheries sector?</td>
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<tr>
<td>Fisheries Act in Place</td>
<td>Fisheries Acts authorise the formation of command-and-control fisheries management measures contained in Regulations, which may aid in managing the threat of ALDFG [25,28].</td>
<td>Does fisheries legislation include specific regulatory provisions governing the use, management and/or discard of fishing gear?</td>
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<tr>
<td>Fisheries Regulations in Place</td>
<td>Marking of fishing gear includes position markers (e.g., surface markers) and identifiers that allow for identification of responsible vessel/individual. It may assist in reducing IUU, dangers to navigation, and can deter abandonment or discard of gear [28].</td>
<td>Is there legislation that requires that fishing gear be marked?</td>
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<tr>
<td>Preventive Measures in Fisheries Laws</td>
<td>Separating gear through spatial management systems can reduce the likelihood of gear conflict between static and active gear [28].</td>
<td>Does the state/territory have in place legislation setting spatial restrictions on fishing activity?</td>
</tr>
<tr>
<td>Spatial Management</td>
<td>Separating gear temporarily can also serve to reduce the likelihood of gear conflict [25].</td>
<td>Does the state/territory have in place legislation setting temporal restrictions on fishing activity?</td>
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<tr>
<td>Temporal Management</td>
<td>Input controls that limit the amount of time gear is left in the water can reduce the likelihood of gear loss [25].</td>
<td>Does fisheries legislation include input control measures such as soak time for specific gear?</td>
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<td>Time Restriction for Gear Deployment</td>
<td>Bans on the use of certain gear known to be of high risk to ghost fishing or entanglement of wildlife has been beneficial in some areas [25]: e.g., bans on gillnets or trawl nets.</td>
<td>Does legislation include measures that prohibit or restrict the use certain types of gear that may result in deleterious impacts if they become derelict?</td>
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<tr>
<td>Gear Bans</td>
<td>Does the state/territory have in place legislation governing traceability of fishing gear?</td>
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<tr>
<td>Mitigation Measures in Fisheries Laws</td>
<td>Does the state/territory have in place legislation governing traceability of fishing gear?</td>
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<tr>
<td>Technical Measures for Traps</td>
<td>Some modifications in trap design established to reduce by-catch (e.g., mesh size restrictions or escape panels) can aid in reducing ghost fishing rates if left derelict. [25]</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in traps?</td>
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<tr>
<td>Technical Measures for Nets</td>
<td>Modifications in net design aimed at reducing by-catch (e.g., mesh size or length restrictions) can also aid in reducing ghost fishing rates if left derelict. [25]</td>
<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in Nets?</td>
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<th>Measure</th>
<th>Explanatory Notes as outlined in Literature</th>
<th>Assessment Question for this Study</th>
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<tr>
<td>Technical Measures</td>
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<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in Lines (hand line or longline)?</td>
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<td>Lines</td>
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<td>Is there legislation that sets out technical measures aimed at by-catch mitigation in FADs?</td>
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<td>Technical Measures</td>
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<td>Does legislation include technical measures regarding the durability of gear in order to reduce the duration of ghost fishing or use of biodegradable material?</td>
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<td>FADs</td>
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<td>Does legislation include technical measures requiring the use of biodegradable material in certain gear?</td>
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<td>Provisions on Durability of Gear</td>
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<td>Does the state/territory have in place legislation that includes provisions relevant to the management and prevention of marine pollution?</td>
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<td>Biodegradable Material</td>
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<td>Does such Marine Pollution or other relevant legislation include provisions governing derelict fishing gear or other forms of marine debris including a ban on the intentional discard of fishing gear at sea?</td>
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<td>in Gear</td>
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<td>Is there an obligation for fisheries or vessels to report derelict fishing gear?</td>
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<tr>
<td>Biodegradable Gear</td>
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<td>Is there an obligation for fisheries or vessels to find and retrieve derelict fishing gear?</td>
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<td>Marine Pollution or Other</td>
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<td>Relevant Laws</td>
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<td>Ban on intentional discard of</td>
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<td>ALDFG Provisions in Marine</td>
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<td>Obligation to Report</td>
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<td>according to FAO [16], “the effectiveness of gear marking systems would be significantly enhanced when incentives exist to encourage the reporting of lost or abandoned fishing gears...” thereby assisting in the provision of data to understand the scope and scale of the problem and help support recovery [32].</td>
<td>Is there an obligation for fisheries or vessels to report derelict fishing gear?</td>
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<tr>
<td>Obligation to Find and Retrieve</td>
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<td>FAO [16] advises that owners and operators should be encouraged to “make every reasonable effort” to retrieve ALDFG</td>
<td>Is there an obligation for fisheries or vessels to find and retrieve derelict fishing gear?</td>
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3.2. Gaps in national fisheries laws

With few exceptions, most of the regulatory provisions in the OECS sub-region and Barbados have remained unchanged since the mid-80s to early 90s. Antigua and Barbuda reviewed and updated its Fisheries Act in 2006 while its Fisheries Regulations were enacted in 2013. St. Kitts and Nevis updated its Fisheries Act to a Fisheries, Aquaculture and Marine Resources Act in 2017 but has yet to enact implementing regulations. Until this is completed, the 1995 regulations remain in effect. As a result of the outdated nature of much of the fisheries legislation that form part of this assessment, significant gaps were identified in the fisheries regime for the effective management, prevention or mitigation of the impacts of derelict fishing gear in small-scale fisheries of OECS member states and Barbados. Despite having Fisheries Acts, neither Dominica nor Montserrat had enabling Fisheries Regulations while Grenada’s Fisheries Regulations lack specific provisions governing the management and use of fishing gear. To a large extent the reviewed provisions while they hold relevance to the management of derelict fishing gear were primarily designed as fisheries control measures for stock conservation.

Among the measures that could aid in preventing fishing gear loss, one of the most consistently stipulated provisions was gear marking, however only Antigua and Barbuda’s Fisheries Regulations included the requirement as well as technical specifications for the marking of all gear (traps, lines, nets and anchored FADs). With the exception of Grenada, Montserrat and Dominica, all other states required traps and/or anchored FADs to be marked (Fig. 2).

According to the FAO [16], which presents Voluntary Guidelines on Gear Marking, such schemes should also include provisions for the (i) reporting of derelict gear, (ii) reporting of fishing gear found; (iii) recovery of derelict gear, and (iv) where possible, the safe and environmentally sound disposal of unwanted gear. None of the reviewed fisheries laws stipulated that derelict gear should be reported to a regulatory body.

Traceability provisions in national legislation were generally quite weak as there were no stipulated requirements for the use of GPS technology in gear deployment. However, in some instances fishers have been known to utilise GPS in the setting of traps. Most FADs utilised in Eastern Caribbean small-scale fisheries are moored rather than drifting [65] and several states require that a permit be sought for the placement of anchored FADS within their waters (Anguilla, Antigua and Barbuda, St. Kitts and Nevis and St. Vincent and the Grenadines). In those states and territories where anchored FADs are routinely deployed, legislation requires that they be fitted with radar reflectors to avoid collision by navigating vessels (Fig. 3). Applicants are also required to provide information on the location of deployed FADS to the national authority in each case, a practice that can also aid in ensuring the traceability of deployed FADs.

The reviewed laws were found to have generally weak/no provisions that outlined technical gear design measures aimed at reducing fishing gear loss. However, in a practice referred to as “setting blind”; trap fishers in Antigua and Barbuda are known to set traps underwater, without surface ropes and with the aid of GPS in an effort to reduce trap theft [33]. The use of “roveless gear” has been promoted as a means of reducing gear loss caused by wildlife entanglement [28]. In fact, in an effort to reduce entanglements of the critically endangered North Atlantic Right whales the National Marine Fisheries Service of the
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United States has, for several years, been researching the use of ropeless technology for trap fisheries [3,49,53,71]. Explored ropeless technological replacements include GPS and acoustic marking systems as well as bottom stowed retrieval designs each of which has been shown to provide strong options for eliminating right whale entanglements [53]. However, if not carefully managed, the deployment of ropeless traps may result in trap “layover” of different sets, especially in crowded fishing grounds, thus requiring the use of “robust virtual trap markers” to reduce this risk [49]. The use of acoustic markers may not be feasible for small-scale fisheries in the developing world; however, Moore [49] suggests that bottom access zoning may help to alleviate the risk of gear conflicts arising from ropeless trap deployment.

None of the national fisheries laws that formed part of this assessment included spatial measures relevant to the management of derelict fishing gear or established temporal separation of gear. However, two States (Antigua and Barbuda, St. Lucia) and the British Virgin Islands set restrictions on the soak time for deployed nets which ranged from 4–8 hours. While such an input control measure has been established for the conservation of fish stocks, it could assist in reducing the loss of deployed nets.

Almost all of the fisheries regulations reviewed included fishing effort control measures through technical gear restrictions. Such

Table 2
Overview of Legislative Measures and Existing Gaps in the Management of ALDFG in the OECS and Barbados (Symbol Key: □ = yes/present, □ = No/Absent, ● = all gear, ◊ = FADs only, ▼ = traps only, ◆ = gillnets, ○ = Trawl nets, ◇ = trammel or entangling nets, □ = Environmental Protection Act, ▣ = Solid Waste Management Act; State/Territory Abbreviations: ANG = Anguilla, AB = Antigua and Barbuda, BAR = Barbados, BVI = the British Virgin Islands, DOM = Dominica, GRE = Grenada, MON = Montserrat, SKN = St. Kitts and Nevis, SLU = St. Lucia, SVG = St. Vincent and the Grenadines).

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<td>Preventative Measures in Fisheries Laws</td>
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<td>Gear Bait (on certain nets)</td>
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<td>Ban use of corrosion resistant material on traps</td>
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<td>Prohibits discard of garbage or pollutants</td>
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T.A. Lovell
restrictions can aid in remediating the impacts of derelict gear by reducing ghost fishing. Several States have established mesh size restrictions for various gear including traps, gill nets and seines. Some laws included provisions on the maximum length of nets and/or the prohibition on the use of certain types of nets (Fig. 4). Antigua and Barbuda and the British Virgin Islands are the only state and territory that require fish traps be fitted with biodegradable panels, while only Antigua and Barbuda and Barbados have provisions for the inclusion of escape hatches within traps (Fig. 5). Notwithstanding this, a number of countries in the sub-region have undertaken research in the use of biodegradable panels and/or escape gaps in Eastern Caribbean small-scale fisheries [34,52,58,66].

None of the fisheries laws reviewed contained clear provisions preventing the disposal of gear at sea, or mandating that derelict gear be reported and removed. Such provisions were generally found within other legislation such as marine pollution laws. It should be noted, however, that some states routinely undertake post hurricane/storm damage assessments through which fishers are able to report the loss of gear due to storm events.
3.3. Gaps in marine pollution and/or other relevant legislation

Outside of the regulatory stipulations related to fisheries, some countries of the OECS and Barbados have legislation focused on the management of marine pollution, environmental protection or solid waste management, which may include provisions for derelict fishing gear. However, in almost every case these provisions were relatively weak, and often did not specifically stipulate their application to fishing gear. Fig. 6 presents a summary of the kinds of provisions enshrined in national or local laws governing discard of waste (including derelict gear) into the marine environment.

St. Kitts and Nevis is one of the few countries in the sub-region that has enacted marine pollution legislation. Part III of the [44] (St. Kitts and Nevis) concerns the control of Marine Pollution from Vessels, while Sections 8 (2) and (3) outline the following:

“(2) No person shall dump or discharge a prohibited substance from any vessel, platform, structure or apparatus into the territorial waters of Saint Christopher and Nevis.

(3) No person shall dump or discharge a prohibited substance from a Saint Christopher and Nevis ship into any part of the sea outside St. Christopher and Nevis waters.”

In the context of this section of the Act “Prohibited Substance” includes “any plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags”.

The [43] (Barbados) prohibits the release of any pollutant into the environment which violate applicable standards, conditions or requirements specified under the Act. The Act mandates the Director of the Environmental Engineering Division to maintain a register of pollutants along with prohibited levels. While the MPCA “establishes rules and regulations for the prevention, reduction and control of pollution of the marine environment and puts enforcement measures in place” [50] its application to the management of derelict fishing gear is not clearly outlined.

In 2019, St. Vincent and the Grenadines enacted its marine pollution legislation which includes provisions concerned with compliance to MARPOL. Section 22 of the [45] (St. Vincent and the Grenadines), prohibits dumping of waste at sea except for “waste listed in Annex I of the London Convention…subject to the [issuance] of a permit”. Under Part V, Section 33 (1) of the Act MARPOL provisions apply to all St. Vincent and the Grenadines ships as well as ships operating within the waters of St. Vincent and the Grenadines. According to Part V, Section 34 of the Act a duty to comply with the provisions of MARPOL together with any code adopted by the IMO is conveyed upon the owner and master of a ship, any person responsible for the operation of a ship and any other person who has an obligation conferred on them by MARPOL.

In the case of the [75] (Grenada), there are no specific provisions governing derelict gear, however, under Section 33 it is prohibited to deposit litter or other waste in or on the territorial waters and marine waters of Grenada among other areas. Under that Act the definition of waste includes any material discarded from ships/aircrafts/vehicles. While ship-generated waste is defined as any waste generated on a ship or other sea-going craft. Similarly, Section 19(1) of the [67] (the Commonwealth of Dominica) prohibits the deposit of solid waste “in or on any…beach, foreshore [or] marine waters without a license” but does not specify fishing gear.
Schedule II Part A of the [13] (Antigua and Barbuda) outlines prohibited pollutants. Included in this are “Persistent plastics and other persistent synthetic material, including netting and ropes, which may remain in suspension in the sea in such a manner as to:

(a) interfere materially with fishing, navigation and other legitimate uses of the sea; or
(b) present a risk to the health or safety of any living marine resource;”

In the case of the British Overseas Territories, the [48] (United Kingdom) applies. Section 3 (c) of the regulations defines “United Kingdom ship[s]” meaning ships:

(i) registered in the United Kingdom; or
(ii) not registered under the law of any country but is wholly owned by persons each of whom is—

(aa) a British Citizen, a British Overseas Territories citizen or a British overseas citizen; or,

(bb) a body corporate which is established under the law of any part of the United Kingdom and has its principal place of business in the United Kingdom.

Under these regulations it is prohibited to discharge garbage into the sea. However, under Section 8 (1) c and d exemptions exist for fishing gear accidentally lost “provided that all reasonable precautions” were taken to avoid loss and for gear discarded so as to protect the marine environment or safety of the crew. Fishing gear accidentally lost or discharged and posing a significant threat to the marine environment or navigation must be reported.

In the Caribbean, sound waste management is one of the main sustainability challenges with many countries, including those in the Eastern Caribbean, being plagued by uncontrolled final disposal, and inappropriate waste collection strategies [73]. Further, while circular designs for fishing gear management have been promoted in the European Union and elsewhere, in the Caribbean there is a “need to adapt legal rules” to allow for circular economy approaches to waste management, including changes to the definition of “end-of-waste” [73].

3.4. Gaps in supporting policy

In the absence of national laws, policy instruments (either regionally or nationally developed) may provide voluntary guidance and recommendations that can aid in the management of abandoned, lost and discarded fishing gear. At the regional level, the Global Ghost Gear Initiative has collaborated with fisheries leaders from the Caribbean in order to develop a Regional Action Plan to Prevent ALDFG. The plan provides a systematic approach for the prevention, mitigation and remediation of ALDFG from the main gear types utilised in Caribbean fisheries. By presenting a gear centred approach the Regional Action Plan offers an opportunity for countries to adapt the plan based on their national circumstances and according to their fisheries. The ALDFG Regional Action Plan is a relatively new policy instrument, therefore it is difficult to measure its implementation at the national level. However, the proposed actions included within the regime are aligned to the best practice approaches that formed part of this analysis.

In addition to considering national adaptation of the Regional ALDFG Action Plan, “effective deterrents of illegal, unregulated and unreported fishing” as may be outlined in National Plans of Action may serve to reduce the “incentives for abandoning fishing gear” at sea [25]. Best Practice manuals, Fisheries Manual Plans and broader conservation actions may also provide policy guidance on sustainability in fisheries including the responsible disposal of waste associated with the sector. Of the 10 states and territories that formed part of this review, only two countries, St. Kitts and Nevis, and Antigua and Barbuda had completed National Plans of Action to Prevent, Deter, and Eliminate IUU Fishing. While neither of the plans included specific measures relating to the management of derelict fishing gear a number of the proposed measures could help to support such efforts. For instance, Antigua and Barbuda’s NPOA, though outdated, includes the recommendation for mandatory training of fishermen on a number of issues including basic seamanship and navigation, safety at sea, and fisheries regulations [19]. This offers the opportunity to integrate into such training programmes, awareness building regimes focused on the challenge of derelict fishing gear, associated threats and technical solutions. Relevant policy approaches outlined in the NPOA of St. Kitts and Nevis including improved monitoring, control and surveillance measures such as the institution of
“at-sea inspection” schemes, port state control measures to deter IUU fishing [10] may also support a management regime for derelict fishing gear.

For countries with active FAD fisheries, the Caribbean Regional Fisheries Mechanism (CRFM), in consultation with the Western Central Atlantic Fisheries Commission (WCAFC) and the Japanese International Cooperation Agency (JICA), has developed a Best Practice Manual for Moored FADs. The Manual which provides practical guidance on the design construction and deployment of moored FADs which may aid in reducing the likelihood of FADs being lost. Among the key aspects considered were appropriate anchoring systems, suitable buoyancy and effective maintenance of FADs [23].

Very few of the states or territories had in place fisheries management plans. However, the issue of marine pollution was broadly addressed in a variety of policies, strategies and action programmes, governing a range of sectors. Anguilla’s Marine Park’s Plan was one of the few instruments that included explicit policy directives relevant to ALDFG, urging for the marking of traps and that they be fitted with biodegradable panels [77]. The BVI’s Blue Economy Road Map included a call to ensure activities being undertaken in the marine environment do not lead to environmental damage and urged for action to address the “issue of ghost pots” [31]. Many of the other policies including the draft ocean policies of Dominica, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines incorporated general language recognising the need to control pollution from land and sea-based sources while promoting compliance with MARPOL. In addition to its draft Ocean Policy St. Kitts and Nevis also has in place a Maritime Action Plan which urges for preservation of the marine environment through the elimination of pollution from various sources, including garbage, in compliance with MARPOL. Table 3 summarises the relevant policies for each of the states and territories.

3.5. Weaknesses in compliance regimes

Legislative and regulatory provisions can only be effective if accompanied by a strong compliance regime that includes both punitive measures, and monitoring, control and surveillance systems. In general, for those countries that had fisheries management regulations in place, they included provisions relating to offenses and penalties that allowed for the application of fines to persons contravening any of the regulatory provisions. Antigua and Barbuda was the only country to detail compulsory offences fees based on a three-strikes rule.

Enforcement of fisheries rules, however, remains a significant challenge for these small islands, which often lack the financial and technical capacity to adequately police their large ocean zones [70]. For instance, the maritime space of the OECS islands is approximately eighty-one (81) times larger than their collective land area [42]. These limitations to effective compliance systems can lead to issues relating to illegal, unreported and unregulated fishing [70] and may hinder enforcement of regulatory provisions relating to gear management.

4. Conclusions

The issue of derelict fishing gear has received relatively little attention in the small-scale fisheries of the OECS and Barbados. While some countries have undertaken research in seeking to understand and manage this threat, outdated and missing fisheries laws, ineffective marine pollution instruments that lack provisions focused on marine-sources of waste, and complexities related to the multi-gear nature of the fisheries have resulted in a policy and regulatory landscape that falls short of effectively addressing the threat of derelict gear at the national level.

For the small island developing states of the Organisation of the Eastern Caribbean States and Barbados, legislative review and reform is urgently needed if they are to effectively manage the challenge of abandoned, lost and discarded fishing gear within their small-scale

<table>
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<tr>
<th>Table 3</th>
<th>Summary of Policies Relevant to the Management of Abandoned Lost and Otherwise Discarded Fishing Gear in Various Countries and Territories.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Policy Instrument</td>
</tr>
<tr>
<td>Anguilla</td>
<td>Wynne [77]: Adaptive Management Plan for</td>
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<td></td>
<td>Anguilla’s Marine Park System and Associated</td>
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<td>Shallow Water Habitats and Fisheries</td>
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<tr>
<td>British Virgin Islands</td>
<td>Government of the Virgin Islands and UNDP [31]: Virgin Islands Strategic Blue Economy Road Map.</td>
</tr>
<tr>
<td>St. Kitts and Nevis</td>
<td>Department of Maritime Affairs [11]: National maritime policy and action plan</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Draft National Ocean Policies for each state.</td>
</tr>
</tbody>
</table>
ghost fishing. This research could assist policy makers in designing possession critical knowledge on how various gears are deployed, managed, tion but also stakeholder cooperation, buy-in and support. Fishers Eastern Caribbean fisheries will require not only government interven post Storm Damage Assessment procedures in some states provide an opportunity for fishers to report the loss of fishing gear caused by natural hazards, a procedure that could be extended to allow for routine reporting on other forms of gear loss, including information on quantity, location and type of gear.

The effective and efficient management of derelict fishing gear in Eastern Caribbean fisheries will require not only government interven tion but also stakeholder cooperation, buy-in and support. Fishers possess critical knowledge on how various gears are deployed, managed, retrieved as well as the factors that may contribute to such gear becoming lost, abandoned or discarded. It is, therefore, critical, that they be consulted and informed about this significant threat so that they are able to assist in guiding efforts that may be undertaken to improve or reform the regulatory landscape for managing derelict gear.

The fragmented nature of the regulatory and policy regime for managing derelict fishing gear, highlights the need for the establishment of effective mechanisms for cross-sectoral cooperation and collaboration which may not currently exist within these states and territories. The establishment of Fisheries Advisory Committees, as allowed under some of the existing fishing laws could help in fulfilling this role with the inclusion of, not only fisheries stakeholders but environmental or waste management agencies.

Improvements to the legal, regulatory and policy framework for the management of ALDFG in the Eastern Caribbean will aid in curbing the proliferation and adverse impacts of ALDFG in the region. However this must be accompanied by targeted research to understand not only the scale of the challenge but the drivers of loss. This will assist in the defining of purpose-fit solutions to a complex challenge. While this policy analysis focused on understanding the current regulatory and policy landscape relevant to the management of ALDFG in Eastern Caribbean small-scale fisheries it is only a first step towards identifying the full spectrum of governance challenges that may exist in these islands. Future research will focus on understanding how existing pol icies and laws are being implemented and enforced in these countries as well as seek to uncover whether there are gaps or challenges to their implementation.

CRediT authorship contribution statement

Conceptualisation, methodology, assessment, writing and editing of the manuscript was completed by the sole author of this research. While the author conceptualised the maps that were used in the manuscript they were created by Sarah Mahadeo, Research Associate at the WMU-Sasakiwa Global Ocean Institute. The work was supervised by Dr. Aspasia Pastra, Dr. Ronan Long and Dr. Meinhard Doelle before his passing.

Data availability

Data will be made available on request.

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References

Paper III
Implementing the voluntary guidelines for the marking of fishing gear in eastern Caribbean small-scale fisheries: An assessment of gear marking provisions

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ARTICLE INFO

ABSTRACT

Managing abandoned, lost and otherwise discarded fishing gear (ALDFG) is a critical challenge that can be aided by the establishment of strong provisions for the marking of gear. This study presents an analysis of implementation of the VGMFG in Eastern Caribbean states. It provides a socio-legal review of this issue and an analysis of compliance and implementation gaps. Empirical data was gathered through interviews with 56 fishers in 2 jurisdictions as well as 6 national and regional fisheries management experts.

Antigua and Barbuda’s Fisheries Regulations provided the strongest support to implementation of the VGMFG, while neither Dominica nor Grenada had weak regulatory support for gear marking. Both fishers and fisheries managers in the region confirmed compliance and implementation gaps in the establishment of gear marking schemes, while regional fisheries experts highlighted the limited human, financial and infrastructural capacity of departments to effectively implement such schemes along with other ALDFG management measures.

1. Introduction

Abandoned, lost and otherwise discarded fishing gear (ALDFG) form a significant and particularly deadly component of marine litter, globally. The threats to wildlife, benthic habitats, navigation and human wellbeing posed by ALDFG have been well documented in academic literature (Duncan et al., 2017; GESAMP, 2021; Gilman et al., 2021; Hong et al., 2017; Macfadyen et al., 2009) and their adverse impacts have become increasingly “problematic over recent decades” (Gilman et al., 2022). ALDFG may originate from both passive and active gear types and also includes components of gear and materials that may be used in the deployment or marking of such gear, for instance ropes, buoys, floats and lures (GESAMP, 2021). Fish aggregating devices (FADs), both anchored and drifting also contribute to ALDFG (Churchill, 2004; Sinopoli et al., 2020) and, in the Mediterranean region, were found to cause severe damage to benthic habitats due to the ropes damaging corals (Consoli et al., 2020). Monofilament fishing lines have been known to cause death and damage to coral colonies (Asoh et al., 2004). Ghost fishing associated with derelict traps have been well studied and documented in the Caribbean and other regions (Norris et al., 2011; Rencen et al., 2014; Uhrin, 2016). Derelict fishing nets are known to cause damage to both benthic habitats such as coral reefs and can lead to mortality of a range of both vertebrate and invertebrate marine organisms, including many threatened species (Good et al., 2010; Valderrama Ballesteros et al., 2018; Wilcox et al., 2013).

While there remains an urgent need to understand the drivers, scale and impacts of this global challenge, including in the Caribbean region, much work has already been undertaken to examine strong, integrated approaches for its management. The marking of fishing gear, “when combined with a robust fisheries management framework” can help to reduce ALDFG” (Gilman et al., 2022). Further, the enactment of strong provisions for the marking of fishing gear can aid in establishing ownership, thereby serving as a disincentive for intentional discard (He and Suuronen, 2018). It can also help to achieve supply chain traceability and facilitate “extended producer responsibility schemes” for fishing gear (Gilman et al., 2022). Gear marking is particularly important in the management of passive gear fisheries such as trap-based and gillnet fisheries. Stakeholders including fishers and fisheries managers in Taiwan’s gillnet fishery ranked gear marking as the most critical preventative measure for ALDFG, based on an analytical hierarchy procedure (Yang, 2023). In some instances, however, the use of gear marking schemes to increase visibility of passive gear may conflict with
approaches aimed at reducing theft or vandalism (e.g., setting traps without surface markings). In those cases, fishery specific drivers and predicted mitigative efficacy could help guide the selection between conflicting approaches (Gilman et al., 2022).

To assist countries in establishing gear marking schemes the FAO has developed Voluntary Guidelines on the Marking of Fishing Gear Marking (VGMFG). The guidelines can be viewed as a critical tool to aid in “combating, minimising and preventing” ALDFG (FAO, 2019). Though they are a voluntary tool and global in scope, the VGMFG provide a framework to assist states in implementing robust gear-marking schemes while taking account of national circumstances. Thus, the guidelines can be applied not only to large-scale industrial and commercial fleets but also to small-scale fisheries in developing states. Further, they hold relevance to gear used for the capture of marine products as well as both drifting and anchored FADs.

According to the VGMFG a system of gear marking should apply to all fishing gear, based on risk assessment findings, while “taking account of the practical requirements” of the target fishery (FAO, 2019). Under the voluntary guidelines a gear mark is defined as; both an identifier of the individual or entity “responsible for use of the fishing gear”, as well as means of “signifying the presence, scale and nature of gear in the water” (FAO, 2019). Among the key components outlined in the Voluntary Guidelines, it is noted that gear marking schemes should be set out in, or supported by national and sub-national legislation, be complemented by reporting and monitoring schemes, and allow for gear traceability (FAO, 2019). The gear marking system should also provide for the “requirements and specifications” that allow for: (a) reporting of ALDFG, (b) reporting of gear found, (c) recovery of ALDFG; and (d) the sound disposal of ALDFG (FAO, 2019). Including gear marking in legislation can assist in clarifying the rules of fishing operations (Yang, 2023). To aid countries in implementing the VGMFG, FAO has developed supplementary manuals to the guidelines outlining a four-step risk assessment procedure (He and Lansley, 2023) and technical guidance on how to mark the most commonly used gear types including FADs (Einarsson et al., 2023). The technical guidance document recommends the following types of information be included in gear marking systems: country code, unique ownership identifiers such as vessel registration numbers, the date, gear code and contact details.

At its 78th session, the Marine Environmental Protection Committee (MEPC) of the International Maritime Organisation (IMO) considered the issue of gear marking and urged Member States to draft amendments to Marpol Annex V, making it mandatory for vessels covered by the convention to mark their fishing gear (International Maritime Organisation, 2022). The MEPC also invited the Sub-Committee to develop a circular, promoting the VGMFG, which is significant given that, with the exception of Grenada, Barbados along with all members of the Organisation of Eastern Caribbean States (OECS) are party to Marpol Annex V.

Having due regard for these developments at the IMO and the critical role gear marking can play in preventing and managing ALDFG, following is an in-depth assessment of readiness of small island developing states of the Eastern Caribbean to implement the voluntary guidelines. The states that formed part of this assessment are the independent member states and territories of the OECS (Antigua and Barbuda, the British Virgin Islands, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines) as well as Barbados (Fig. 1). As members and participating states of the Caribbean Regional Fisheries Mechanism (CRFM) and Western Central Atlantic Fisheries Commission (WECAFC), these states have adopted recommendation 17/2019/17, which urges all members to adopt the Voluntary Guidelines on the Marking of Fishing Gear. This recommendation

![Map of the islands that were included in this review (Source: Lovell, 2023).](image-url)
was also echoed in the Regional Action Plan to Prevent, Deter and Eliminate, Illegal, Unreported and Unregulated Fishing in WECARF Member States, which was developed in collaboration with the CRFM and OSPESCA.

This review examined the national fisheries laws and the provisions relating to the marking of fishing gear. It also assessed to what extent states have in place supporting fisheries management measures including reporting mechanisms, as well as monitoring control and surveillance regimes. The assessment considered not only gear used for the capture of fish and marine products but also gear used in the ag-gregation of fish (i.e., moored Fish Aggregating Devices – MFADs), which have grown in popularity across the Caribbean in recent years. The growing number of MFADs in the region has the potential to contribute to ALDFG, especially considering the number of privately owned MFADs being deployed. Privately deployed MFADs may be “cheaply constructed and have high rates of turnover” (Wilson et al., 2022).

In addition to considering the current regulatory landscape and alignment with the Voluntary Guidelines, this assessment also examined implementation and compliance gaps with regard to gear marking in the sub-region. To do so two categories of stakeholders were interviewed. Firstly, fishers in two Eastern Caribbean states (Antigua and Barbuda, and Dominica) were interviewed to provide empirical evidence on a) fisher’s awareness of gear marking laws (where these existed), b) the implementation of gear marking by fishers, and c) whether the implemented gear marking provisions aligned with the voluntary guidelines (i.e., taking into account traceability). Secondly, fisheries managers from both national and regional fisheries management organisations were asked to comment on gear marking practices within various jurisdictions, as well as barriers to compliance. In both instances, the interviews were conducted as part of a broader assessment on ALDFG governance in the Eastern Caribbean. As a result, questions relating to gear marking were only a component of the interviews (Supplementary Data Sheet). In the case of the fishers, the interview instruments that were utilised are part of the ongoing global assessment of ALDFG being undertaken by the FAO. In the case of fisheries manager interviews, those questions were developed by the developer and approved through the ethics procedures of the World Maritime University.

2. Methodology and data analysis

This study presents a socio-legal analysis of gear marking systems in the Eastern Caribbean (Bhadra Chaudhuri, 2015). It adopted a qualitative approach and utilised both an opportunistic and a purposive sampling design for interviews of various stakeholders (Andrade, 2021; Palinkas et al., 2015). Firstly, an assessment of the legislative support for implementation of the VGMFG was completed through a legal review and analysis of the regulatory strengths of supporting laws. Secondly, an Assessment of implementation and compliance gaps with regard to gear marking legislation was undertaken through interviews of various stakeholders.

2.1. Methodology and data analysis: Regulatory review

The national fisheries laws of the target countries were examined in order to assess whether they could support implementation of the Voluntary Guidelines. The approach is adapted from (Lovell, 2023) and (Wilson et al., 2022) in order to first understand the existing regulatory provisions across the sub-region, and secondly assess the regulatory strengths of these provisions. Assessment of the relevant gear market regulations across the various jurisdictions were guided by the matrix assessment tool adapted from Lovell (2023) (Table 1).

Consideration of the regulatory strength of those provisions adapted the methodology of Wilson et al. (2022) who evaluated the regulatory strength of MFAD governance in the Caribbean region. Assessment of the regulatory strength utilised the following metrics. Countries were scored either a zero or one based on the status of their regulatory provisions relating to; (a) the obligation to report ALDFG, and (b) the inclusion of technical specifications for applying gear marking provisions in legislation. For those two parameters, if there were no regulations a score of 0 was assigned, while a score of 1 was assigned if regulations existed. The score assignments for the metrics relating to gear marking laws and on traceability were adjusted to take into account the number of gears any such requirements applied to. For countries that required gear markings and traceability measures be applied to all categories of gear utilised in the fisheries, they were assigned a score of 1. For those countries that required gear markings or outlined traceability requirements for only one or more but not all gear types, they were given a score of 0.5. If a country had no gear marking or traceability requirements in legislation, they were given a score of 0. Scores were then averaged.

2.2. Methodology and data analysis: Gaps in implementation

2.2.1. Fisher interviews

To gather empirical data that allowed for assessment of compliance and implementation gaps in gear marking schemes fisher interviews were first conducted in two of the Eastern Caribbean jurisdictions. These were done utilising the FAO Global Assessment survey instruments, which also include questions on gear marking. Interviews were conducted over two months in the summer of 2022, targeting fishers at major landing sites across Antigua, Barbuda and Dominica. Fishers were targeted randomly and opportunistically at major landing sites that included both urban and rural communities. The landing sites were geographically distributed across the three islands to include both windward and leeward coastlines. Three sets of parameters were assessed through these interviews: (a) gear marking and traceability of MFADs (b) gear marking and traceability of other categories of gear (fish

<table>
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<tr>
<th>Measure</th>
<th>Explanatory notes as outlined in literature</th>
<th>Assessment question for this study</th>
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<tbody>
<tr>
<td>Gear marking legislation</td>
<td>Marking of fishing gear includes position markers (e.g., surface markers) and identifiers that allow for identification of responsible vessel/individual. It may assist in reducing IUU, dangers to navigation, and can deter abandonment or discard of gear (Global Ghost Gear Initiative, 2021)</td>
<td>Is there legislation that requires that fishing gear be marked?</td>
</tr>
<tr>
<td>Traceability</td>
<td>Traceability measures may include the attachment of radar reflectors and radio buoys to allow for tracking of gear and reducing risk of loss (Gilman, 2015)</td>
<td>Is there legislation governing traceability of fishing gear?</td>
</tr>
<tr>
<td>Technical specifications</td>
<td>Gear marking should be fitted according to technical specifications (FAO, 2019)</td>
<td>Does the legislation include technical specifications on how to apply gear markings?</td>
</tr>
<tr>
<td>Obligation to report</td>
<td>Gear marking systems would be significantly enhanced when incentives exist to encourage the reporting of lost or abandoned fishing gears...” (FAO, 2016), thereby assisting in the provision of data to understand the scope and scale of the problem and help support recovery (Hedison, 2022).</td>
<td>Is there an obligation for fishers or vessels to report delict fishing gear?</td>
</tr>
</tbody>
</table>

Table 1 Matrix assessment for considering legislative provisions relevant to gear marking.
traps, lines and nets), and (c) gear loss reporting.

Over the course of two months 26 fishers were interviewed in Antigua and Barbuda and 30 fishers were interviewed in Dominica. This included a combined total of 28 line fishers, 36 trap fishers and 14 net fishers. Because the fisheries of the Eastern Caribbean are multi-gear in nature, many fishers reported utilising more than one type of gear in their regular operations. As a result, some fishers were asked to respond to more than one gear questionnaire. The data from fisher interviews were uploaded to Excel spreadsheets to allow for analysis and the presentation of descriptive statistics of the results.

2.2.2. Fisheries managers interviews

To allow for data source triangulation, fisheries managers from several other jurisdictions as well as a regional fisheries management body were also interviewed. This was done through purposive sampling of key informants, with all interviews conducted via Zoom. While there was an attempt to interview fisheries managers from all jurisdictions, several countries did not respond to the invitation to be part of this assessment. As a result, only key informants from Barbados and Dominica were interviewed. This was done through purposive sampling from national or sub-national fisheries management agencies along with the representative from the regional body. Fisheries manager interviews were transcribed using Otter AI, a transcription software that automatically transcribes recorded interviews. After correction of interview transcripts, they were uploaded to NVIVO for analysis of the results.

3. Results

3.1. Legislative support

The legal landscape for fisheries management across OECS member states and Barbados is relatively outdated and, in most instances, falls short of effectively addressing the threat of ALDFG (Lovell, 2023). As can be observed in Table 2, there is variability across the assessed states and territories in their legislative support for implementation of the voluntary guidelines. Antigua and Barbuda's Fisheries Act and Regulations provide the most comprehensive set of rules regarding gear marking. This includes legislative provisions that outline both traceability measures and technical specifications for the marking of all gear types (Table 2). Antigua and Barbuda's laws do not, however, include provisions outlining an obligation to report. In most other states/territories, gear marking measures only apply to traps and/or moored Fish Aggregating Devices (MFADs), while neither Dominica nor Grenada have enshrined in legislative, provisions relating to either the marking of fishing gear or the reporting of ALDFG (Tables 2). Anguilla and the British Virgin Islands both have relatively robust legislative strengths that include not only a legal obligation to mark MFADs and fish traps in a manner that allows for traceability in Anguilla but also sets out reporting provisions through UK laws. As colonies of the United Kingdom, these islands, along with Montserrat, are governed not only by their local laws but also by legislation set out by the crown. United Kingdom marine pollution rules require that ALDFG be reported if it poses a risk to the environment or navigation (Merchant Shipping (Prevention of Pollution by Garbage from Ships) Regulations, 2020). As noted previously, with the exception of Antigua and Barbuda, none of other states or territories set out provisions establishing technical specifications on the marking of fishing gear. However, several countries/territories (Barbados, St. Lucia, the British Virgin Islands) have established provisions that require the marking of fishing gear in a manner to be determined by the Chief Fisheries Officer (Table 2).

Based on this assessment, analysis of the regulatory strength of the various fisheries laws and their application to implementation of the VGMFG highlighted that Antigua and Barbuda's fisheries legislation was the strongest among the countries that were part of this analysis, with a score of 0.75 while neither Grenada nor Dominica had supporting regulations that would allow for implementation of the VGMFG (Fig. 2). Anguilla's regulatory strength for gear marking provisions was found to be median, with a score of 0.5, while the British Virgin Islands had a score of 0.38 (Table 3). Montserrat, St. Lucia and St. Kitts and Nevis, and St. Vincent and the Grenadines had relatively weak regulatory support for gear marking along with Barbados (Table 3). Schedule XI of (Fisheries Regulations (Antigua and Barbuda), 2013) summarises the technical specifications that should be applied for the marking of various categories of fishing gear (Table 4). In all instances, the regulations stipulated that markings on the gear should bear the fisher's registration number. Additionally, static gear operating at night (e.g., gillnets and surface longlines) should be equipped with lights to avoid becoming hazards to navigation.

3.2. Implementation gaps

Even the most robust regulatory measures can only be effective if there is strong compliance, or monitoring for compliance. The results of fisher interviews in Antigua and Barbuda, and the Commonwealth of Dominica signal significant challenges in the implementation of gear marking provisions, even when these are stipulated in legislation.

3.2.1. Fishers perspectives - Antigua and Barbuda

Fishers were asked whether they were aware of the national legislation requiring that fishing gear be marked. The majority of those interviewed (just over 80%) were unaware that this provision was enshrined in legislation (Fig. 3). Further, while many indicated that they marked their fishing gear, they were generally found to be non-compliant with the technical specifications set out in the Fisheries Regulations. Both trap and line fishers largely indicated they marked their gear through patterns, gear design or colour coding of surface buoys, when used, none of which provide for traceability. Trap fishers in

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<tbody>
<tr>
<td>Summary of key provisions relating to gear marking as enshrined in legislation of the OECS and Barbados.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Gear marking regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anguilla</td>
<td>• Any fish aggregating device placed in the fishery limits shall be at all times clearly marked with the name of the vessel from which it was placed; • Any person who uses pots or traps for the purpose of taking marine products shall identify his pots or traps and any buoy or marker used in connection therewith by marking them conspicuously with the number of the Foreign Fisherman's Licence or the Commercial Fisherman's Licence which he holds.</td>
</tr>
<tr>
<td>Antigua and Barbuda</td>
<td>• Any fish aggregating device placed in the fishery waters shall bear a radar reflector or such other equipment and markings as the Chief Fisheries Officer may from time to time require. • All fishing gear that is set in the sea and not attached to a fishing vessel shall be clearly marked in accordance with the requirements set out in Schedule XI.</td>
</tr>
<tr>
<td>Barbados</td>
<td>Every fish trap shall be marked for identification in a manner approved by the Chief Fisheries Officer.</td>
</tr>
<tr>
<td>The British Virgin Islands</td>
<td>No person shall set or place any fish pot or trap without an identifying mark issued or approved by the Chief Conservation and Fisheries Officer;</td>
</tr>
<tr>
<td>St. Kitts and Nevis</td>
<td>• Any fish aggregating device placed in the Fishery waters of St. Kitts and Nevis shall: (i) be clearly marked with the name of the owner and of the vessel from which the device was placed;</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>• No person shall set or place any fish pot or trap without an identifying mark issued or approved by the Chief Fisheries Officer.</td>
</tr>
<tr>
<td>St. Vincent and the Grenadines</td>
<td>Any fish aggregating device placed in the fishery waters shall: (a) be clearly marked with the name of the owner and of the vessel from which the device was placed;</td>
</tr>
</tbody>
</table>

Marine Pollution Bulletin 194 (2023) 115292
Antigua and Barbuda do not generally set traps with surface markers but do so underwater by connecting two traps with a floating rope. The traps are retrieved by “creeping” a grapnel across the fishing ground to recover the rope and haul the traps. The location of blind set traps is marked with a GPS. None of these measures provide for traceability to the vessel or the fisher.

MFAD fishers in Antigua and Barbuda were asked to comment on a) whether the MFADs they utilised were marked and b) the manner in which they were marked (Fig. 4). All the fishers who were interviewed indicated that the MFADs had writing on the surface components. None of these measures provide for traceability to the vessel or the fisher.

About 60 % of those interviewed indicated that MFADs were fitted with lights either always or sometimes, while only 40 % reported having radar reflectors.

Almost all of the interviewed fishers (about 77 %) indicated that they did not report lost gear, with several commenting that it did not make sense or there was no one to report losses to. On the rare occasions fishers did report losses, this was mainly done following major storm events or in the case of suspected theft. Antigua and Barbuda’s Fisheries Division routinely undertakes damage assessment reports following tropical cyclones or other major weather events.

3.2.2. Fisher perspectives - Dominica

As shown in Section 2.1, Dominica does not have gear marking provisions enshrined in legislation. Nevertheless, as in the case of Antigua and Barbuda, fishers were interviewed to determine whether or not they employed gear marking measures within their operations. Fishers were asked whether or not they marked various categories of gear (traps, lines and nets) and to describe the type of markings they utilised, in the event they responded in the affirmative. Ninety percent (90 %) of those interviewed indicated that they marked their fishing gear either always or sometimes. However, less than twenty 20 % of those who did mark their gear did so in a manner that allowed for traceability (Fig. 5). The gear markings utilised by fishers included colour coded buoys and patterns in gear design (Fig. 6). Employed patterns ranged from placing a mark on the door to the addition of plastic bottles within the frame of the traps in a specific pattern. Those who used traceable markings did so by writing either their initials, vessel name or number on surface markers, which usually comprised of reused water or bleach bottles.

While the government of Dominica has deployed government owned mega-FADs for use by fishers, a number of individuals indicated that they had deployed privately owned MFADs as well. In Dominica just
under 50% of those interviewed indicated that MFADs used in their operations had writings on the surface components or radar reflectors (Fig. 7). In contrast, the vast majority of interviewees (just under 77%) noted that MFADs did not have lights attached. A number of fishers noted that while MFADs used to be fitted with lights this practice had been discontinued as these components were often stolen and were costly to maintain.

Fifty percent (50%) of respondent fishers in Dominica indicated they never reported lost gear while 40% noted that they did so sometimes. Fishers who indicated reporting lost gear did so primarily if they suspected their gear was stolen or to seek compensation from losses caused by severe weather events.

### 3.2.3. Fisheries managers’ perspectives

Fisheries managers in Grenada, St. Kitts and Nevis, St. Vincent and the Grenadines, and St. Lucia were asked to comment on whether fishers marked their fishing gear and the manner in which such gear were marked. They were also asked to comment on ALDFG reporting within their national fisheries as well as to shed light on major governance barriers relating to ALDFG, including gear marking.

In regards to gear marking practices in the various jurisdictions the results of these interviews were consistent with the results obtained from fisher interviews in Dominica and Antigua and Barbuda. In all cases, the interviews revealed major compliance gaps with regard to gear marking for traps and/or FADs (Table 5). This included not only the absence of gear markings among fishers but non-compliance with technical specifications for traceability.

With regard to reporting of ALDFG or gear loss within the various jurisdictions, these were also consistent with the results of fisher interviews in Antigua and Barbuda, and Dominica. The issues identified by interviewees included:

- The lack of data and information on the amount of gear that is deployed within the various fisheries. Representative of the regional fisheries body observed: “Unless you have good information on the number of gears, the type of gears, where they are deployed and so on, it’s also very difficult...Our basic data and information on the specific gears that are being used by fishers may not be very accurate”.

- Limitations in the Capacity to collect gear marking and other gear related data. As observed by a representative of the regional fisheries management organisation: “We...have limitations...in terms of methodologies for collecting the information [and] human resources...to conduct the interviews and so on or even to physically do the surveys at sea,...to verify the information and the extent of the problem”.

### Table 4

Technical specifications for the marking of various categories of gear in Antigua and Barbuda.

<table>
<thead>
<tr>
<th>Gear type</th>
<th>Technical specifications for marking</th>
</tr>
</thead>
</table>
| Fish traps/pots               | 1) All surface markers or floats shall be permanently marked with the fisher’s registration number  
2) All fish traps/pots shall carry the fisher’s registration number that shall be permanently attached to the frame of the trap. |
| Gillnets                      | 1) All bottom set gillnet shall have surface markers at both ends of the gear which shall be permanently marked with the fisher’s registration number.  
2) All bottom set gillnet operating between 6:00 pm and 6:00 am shall be equipped with net lights at both ends of the gear. The visibility range of the said lights shall be greater than one kilometre (0.54 nautical miles) |
| Flying fish gillnets          | 1) At least one end of every flying fish gillnet shall be equipped with a marker or float which shall be permanently marked with the fisher’s registration number  
2) All droplines shall be equipped with a marker or float which shall be permanently marked with the fisher’s registration number |
| Vertical longlines and drop-lines | 1) All vertical longlines shall be equipped with a marker or float which shall be permanently marked with the fisher’s registration number  
2) All droplines shall be equipped with a marker or float which shall be permanently marked with the fisher’s registration number  
3) All vertical longlines operating between 6:00 pm and 6:00 am shall be equipped with net lights at both ends of the gear. The visibility range of the said lights shall be greater than one kilometre (0.54 nautical miles) |
| Surface longlines             | 1) All surface longlines shall have surface markers at both ends of the gear which shall be permanently marked with the fisher’s registration number.  
2) All surface longlines operating between 6:00 pm and 6:00 am shall be equipped with net lights at both ends of the gear. The visibility range of the said lights shall be greater than one kilometre (0.54 nautical miles) |

Fig. 3. Percentage of interviewed fishers in Antigua and Barbuda who are aware of fishing laws or mark their gear in a manner that is traceable (n = 26).
• The lack of formal reporting systems for gear loss and supporting infrastructure. As observed by one interviewee: “We encourage them but I must say that...there is no formal system in place in terms of reporting but you know, we encourage them.”

• The lack of political will to implement compliance mechanisms: “We live in an environment where sometimes it becomes politically influenced. And when we try to enforce or speak out for certain things, you know, we are faced by certain feedback.”

• The reluctance on the part of fishers to report: “We do have a mechanism where they could report to the extension officer that they lost their gear and the estimated coordinates the gear was last set at. But like I said, again to the secretive nature of the fishing sector, the fishermen”

As was observed in Antigua and Barbuda, and Dominica, interviewees indicated that reporting of gear loss was generally only done in cases where fishers were seeking assistance or compensation for the
replacement of lost gear as a result of severe weather.

4. Discussion and conclusion

The marking of fishing gear is viewed as an important tool in the prevention and management of ALDFG. It has been promoted by the IMO and has prompted the development of voluntary guidelines by the FAO. Gear marking serves a critical tool in the prevention of ALDFG by disincentivising the deliberate abandonment and discard of fishing gear, incentivising the retrieval of lost gear, and creating an incentive to report when gear is lost or abandoned (Gilman et al., 2022). It may also serve as a deterrent for theft and vandalism of gear, which may contribute to ALDFG (Gilman et al., 2022). Further, the use of surface markers, radar reflectors and other means of improving the visibility of passive gear and MFADs, may help to reduce conflicts with navigating vessels (FAO, 2019; Gilman et al., 2022). Implementation of the voluntary guidelines can be aided by the enactment, implementation and enforcement of national legislation that provides not only for the marking of fishing gear but also includes measures for traceability, establishes technical specifications and allows for reporting.

Clear compliance and implementation gaps with regard to the establishment of gear marking schemes exist within the Eastern Caribbean region. This was revealed not only through fisher interviews in two of the study jurisdictions but was also corroborated by interviews with fisheries experts from other countries in the study area. This study also revealed that disparities in legislative strengths generally appeared to have no bearing on compliance gaps across the various jurisdictions. Thus, gaps in implementation of gear marking systems were observed both in countries with relatively strong legislative provisions as well as those with weak or absent legislation. For instance, just over 30% of respondents in Antigua and Barbuda indicated that they marked gear in a traceable manner, while in Dominica that percentage was just under 20%. This was the case not only for gear utilised in the capture of marine organisms but also for gear utilised in the aggregation of fish (MFADs).

The compliance and implementation gaps that have been highlighted through this research are not unique to the challenge of ALDFG and gear marking. In fact, they may be emblematic of the overall governance challenge associated with small-scale fisheries. Small-scale fisheries “do not always lend themselves easily to government intervention” as fishers...
Table 5

<table>
<thead>
<tr>
<th>Legal requirement</th>
<th>Gear marking compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>“some, not all, do mark the pots”</td>
</tr>
<tr>
<td>Marking of FADs and traps</td>
<td>“It is their personal markings you know, yeah. It’s their personal markings they would put on it, you know”</td>
</tr>
<tr>
<td>Marking of FADs and traps</td>
<td>“They’re supposed to mark [traps] with their vessel number… but they don’t”</td>
</tr>
<tr>
<td>Marking of traps</td>
<td>“The level of non-compliance is high”</td>
</tr>
<tr>
<td>Marking of FADs</td>
<td>“Most of [the markings] are basically on the buoys not the trap itself. The same people design their traps differently in a sense. They have a certain way that they will set their traps…”</td>
</tr>
<tr>
<td>Marking of traps</td>
<td>“Compliance is always a problem”</td>
</tr>
<tr>
<td>Marking of FADs</td>
<td>“The initiative [for marking of gear] was proposed a long time ago and it has never gained traction”</td>
</tr>
<tr>
<td>Marking of FADs</td>
<td>“fishers don’t like to be tracked, and they just look at it as another medium for tracking their activities”</td>
</tr>
<tr>
<td>Marking of FADs</td>
<td>“The fishers do have their own set of unique identifiers for their pots”</td>
</tr>
<tr>
<td>Marking of FADs</td>
<td>“We do have markings on the FAD. It’s mandated by legislation”</td>
</tr>
</tbody>
</table>

“value their freedoms and are often suspicious of ambitions articulated on their behalf” (Jentoft and Chuenpagdee, 2015, p. 18). In the Caribbean region, weaknesses in the governance structures, the limited capacity for surveillance and monitoring, and poor public participation create significant challenges to the governance of the region’s small-scale fisheries (de Oliveira Leis et al., 2019).

The results of both the fisher interviews and interviews of fisheries officials signal that there are clear opportunities for implementing the VGMFG including reporting schemes, even in cases where there is no legal imperative to do so. The fact that the majority of fishers in both Antigua and Barbuda, and Dominica employed non-traceable means of marking their gear, bodes well for the implementation of a more robust scheme which includes traceability measures. It was also revealed in interviews with fisheries personnel that this was a practice shared by fishers in other jurisdictions of the Eastern Caribbean. Notwithstanding this practice, it is also clear that there is a strong need for the fisheries authorities in the Eastern Caribbean to undertake comprehensive stakeholder engagement to improve compliance with existing legislation and/or to promote voluntary adoption of traceable gear marking systems. Researchers studying this issue in gillnet fisheries of the Gulf of Thailand, found that a general willingness to adopt gear marking practices emerged among both small-scale and industrial fishers of that region as their awareness of the issue grew during the interview process (Chumchuen and Krueajun, 2021). This sentiment was shared by one of the interviewed senior fisheries technicians, who noted; “It would have to be an education process with the fishers. Showing them the harm that this type of gear can cause to the fishery, and show them how we intend to work together with them to minimise the impact of that type of gear in the marine environment. And I think things like that will assist in reporting”.

There is a clear need to build the awareness of fishers with regard to the issue, including the sensitisation of existing laws and policies relating to gear marking. As observed during the fisher interviews, even in jurisdictions with relatively strong legislative systems, fishers were generally not aware of the legal imperative to mark their gear. Many of the jurisdictions have existing data collection systems in place for the collection of catch-and-effort and biological data, however gear marking and lost gear reporting are generally excluded from such systems. This may be due to the limited human capacity of the various departments to effectively carry out such efforts or the lack of clear guidelines on how to gather such data. The implementation of the FAO’s risk assessment protocol in Eastern Caribbean jurisdictions could aid in building the awareness of fishers to this issue, due to the consultative nature of the process. It could also provide guidance on priority fisheries for full implementation of gear marking systems and inform data gathering protocols for data that would support such systems. In this regard, regional fisheries organisations, such as the Caribbean Regional Fisheries Mechanism (CRFM), along with key partners including the Gulf and Caribbean Fisheries Institute (GCFI) and the Global Ghost Gear Initiative (GGGI) can assist countries in developing such systems.

Declaration of competing interest

Tricia Lovell reports financial support was provided by Nippon Foundation.

Data availability

Data will be made available on request.

Acknowledgements

The author would like to acknowledge the generous funding of the World Maritime University (WMU)-Sasakawa Global Ocean Institute by the Nippon Foundation, as well as for The Nippon Foundation & WMU-Sasakawa Global Ocean Institute’s ‘Closing the Circle Programme: Marine Debris, Sargassum and Marine Spatial Planning in the Eastern Caribbean’. The author is grateful for the major support and guidance provided by Dr. Ronan Long, Dr. Aspasia Pastra and the late Dr. Meinhard Doelle, who serve has PhD supervisors and have therefore provided important review and feedback to this ongoing research. Special thanks to Ms. Sarah Mahadeo, a research fellow under the programme, who produced the illustrative map of the study area. Appreciation also to the entire Closing the Circle team; Dr. Aleke St. John, Dr. Kristin Ambrose, Kristie Alleyene and Roxanne Graham, the GOI support team; Eliza Barjandi, Flavia Lim, Flavia Destro and Mercedes Troisi-Allende and other research colleagues at the Global Ocean Institute.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.11016/j.marpolbul.2023.115292.

References


Paper IV
ABANDONED, LOST AND OTHERWISE DISCARDED FISHING GEAR IN EASTERN CARIBBEAN SMALL-SCALE FISHERIES: BARRIERS, CHALLENGES, AND OPPORTUNITIES FOR IMPROVED GOVERNANCE.

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2Fisheries Division, Ministry of Agriculture, Fisheries and Barbuda Affairs, St. John, Antigua and Barbuda

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ABSTRACT

In recent years there has been a growing focus on filling critical knowledge gaps on the challenge of abandoned, lost and discarded fishing gear (ALDFG) in the global ocean. While not the biggest contributor to the world’s marine debris problem, ALDFG has been shown to be a particularly deadly form of marine litter due to its ability to entangle, entrap, ensnare marine wildlife, damage coastal habitats and result in negative economic impacts to the fishing sector.

In the Eastern Caribbean region, fisheries play a crucial role in ensuring livelihood and food security for vulnerable coastal communities. Therefore effective management interventions that are geared towards eliminating anthropogenic threats to the marine environment, including ALDFG are considered of paramount importance.

This study aims to gain insight into challenges associated with the governance of ALDFG within the small-scale fisheries of the Eastern Caribbean with a view to outlining opportunities
for improvement. A qualitative approach was utilised and interviews were conducted with fisheries and conservation experts from both national and regional level institutions.

The participants revealed that ALDFG was of significant concern for their country or the region and each advocated for the establishment of improved management infrastructure. Identified barriers that could impede this critical goal include; limited human and financial capacity, lack of knowledge and understanding of ALDFG generally, lack of trust, and policy incoherence across sectors and between regional and national agencies. To overcome barriers a multifaceted approach is required including regulatory and institutional improvements.

**INTRODUCTION**

In recent years, there has been a growing focus on filling critical knowledge gaps on the challenge of abandoned, lost, and discarded fishing gear (ALDFG) in the global ocean. As the name suggests ALDFG, also termed derelict fishing gear, results when fishing gear is no longer under the control of the fisher or vessel\(^1\). It refers not only to complete gear units but also the components of gear—including ropes, lines and buoys—that may be used in setting up gear units or constructing fish aggregating devices (FADs)\(^2\). While not the biggest contributor to the world’s marine debris problem, ALDFG has been shown to be a particularly deadly form of marine litter due to its ability to entangle, entrap, and ensnare marine wildlife, damage coastal


\(^2\)Id.
habitats, and result in negative socio-economic impacts to the fishing sector. ALDFG may also create hazards for navigating vessels.

Many known drivers of fishing gear loss include environmental causes, conflicts at sea, management failings, and operational errors (Figure 1). Environmental drivers result when fishing gear is impacted by, or interacts with atmospheric and environmental conditions, leading to losses. Conflict drivers result from fishing gear coming in conflict with other static or active gear or navigating vessels, and also includes gear that is misplaced or lost due to vandalism or theft. Operational drivers may be caused by inexperienced fishers, poor gear maintenance, and operator error during gear deployment, retrieval, or transfer. Management drivers result from failings or inadequacies in fisheries management systems. These may include issues such as a lack of enforcement, inadequate monitoring, and surveillance, or illegal, unregulated, and unreported fishing. While categorised as discrete, ALDFG drivers may affect or be affected by each other. For instance, management failings such as weak compliance systems may influence fishers to discard gear at sea intentionally. Similarly, some operational practices (e.g., inappropriate or no markers) may increase the likelihood of losses due to environmental drivers such as severe weather and strong currents.

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5 GESAMP n. 1 above; Gilman, E., Humberstone, J., Wilson, J. R., Chassot, E., Jackson, A., & Suuronen, P., 2022, Matching fishery specific drivers of abandoned, lost and discarded fishing gear to relevant interventions, Marine Policy, 141.

6 GESAMP Id.

7 GESAMP, id.; Richardson et al. id.

8 GESAMP, id.; Richardson et al. id.

9 GESAMP, id.; Gilman et al., n. 6 above; Richardson et al., id.

10 GESAMP, id.; Gilman et al., id; Richardson et al., id
The grave nature of the threat posed by ALDFG necessitates the establishment of governance arrangements that allow for holistic, robust, and effective management. Such arrangements should be appropriate to local fisheries and marine management systems. This research paper focuses on the challenges associated with the governance of ALDFG within the small-scale fisheries of the Eastern Caribbean with a view to outlining opportunities and approaches for improvement. Ten (10) states and territories form part of this evaluation including the English-speaking Members and Associate Members of the Organisation of Eastern Caribbean States (OECS) (i.e., Antigua and Barbuda, Anguilla, Barbados, the British Virgin Islands, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines) and Barbados.

For the islands of the Eastern Caribbean, maintaining a healthy marine environment is vital for the health and well-being of the communities that live there. Much of the sub-region’s economic development is based on marine industries including marine and coastal tourism and fisheries. While the fishing sector comprises a relatively small fraction of GDP, for many Eastern Caribbean islands its importance to livelihood, food security and community resilience...
cannot be understated. Small-scale fisheries for many of these islands serve as a safety net industry, whereby individuals move into and out of fishing depending on the availability of other livelihood options.\textsuperscript{11}

\textbf{ALDFG Governance in Small-Scale Fisheries: A Complex, Multi-Sected, Multi-Scalar Challenge}

Fisheries in the Caribbean region are increasingly being challenged by local and global external drivers that are either anthropogenic or linked to climate risks.\textsuperscript{12} Competing uses of ocean and coastal spaces, ecosystem degradation, and overfishing are among the challenges faced by the region’s fisheries sector.\textsuperscript{13} Caribbean small-island developing states (SIDS) are especially vulnerable to these external shocks due to their small size, limited marine resources, fragile ecosystems, and high dependence on external trade.\textsuperscript{14} Globally, small-scale fisheries have been described as complex and heterogeneous, making their assessment and management difficult to achieve.\textsuperscript{15} In the Caribbean region, this complexity and heterogeneity are evident when considering the variabilities of their marine biogeography and the multi-species, multi-gear nature of their fisheries.\textsuperscript{16} Many fishers utilise several different types of gear for the harvest and capture of a variety of demersal fish and invertebrate species, large and coastal pelagics,

\begin{itemize}
\item \textsuperscript{11} Turner, R. A., Gill, A., Fitzsimmons, C., Forster J., Mahon, R., Peterson, A., & Stead, S., 2019, Supporting the enhancement of stewardship in small-scale fisheries: Perceptions of governance among Caribbean coral reef fishers, In S. Salas, M. J. Barragán-Paladines, & R. Chuenpagdee (eds.), \textit{Viability and sustainability of small-scale fisheries in Latin America and the Caribbean} (pp. 473-494), Mare Publication Series, Springer
\item \textsuperscript{13} Id.
\item \textsuperscript{15} Guitierrez, N. L., Hilborn, R., Pita, C., & Defeo, O., 2022, Linking small-scale fisheries performance to governance attributes: A quantitative assessment from stakeholders’ perceptions in the Americas and Europe, \textit{Marine Policy}, 136
\end{itemize}
and sedentary organisms like the queen conch (*Aliger gigas*, also known as *Strombus gigas* or *Lobatus gigas*) (CRFM, 2021). Increasingly, some of these islands have also begun to introduce moored Fish Aggregating Devices (MFADs) into their fisheries to boost economic gains and/or reduce fishing pressure on nearshore habitats

The Caribbean’s demersal trap fishery has been described as the most diverse, globally, targeting species from 14 families. Marketing of catches is generally not centralised as many fishers ply their trade at landing sites in the coastal communities where they reside. The most recent estimate (2020) of the Eastern Caribbean’s fishing fleet numbered just under 6,000 vessels, most measuring less than 12 metres in length. Additionally, in 2020, it was estimated that just over 3,500 MFADs were deployed across the insular Caribbean region, approximately 110 of which were located in the Eastern Caribbean jurisdictions that form part of this study.

While the governance of small-scale fisheries may be complex it is only a component of the system that applies to the overall governance of ALDFG. ALDFG, as a governance challenge, resides at the nexus of marine transport, environmental preservation, fisheries governance and solid waste management (Figure 1). Thus, it requires coordination and collaboration of various actors, agencies, sectors and institutions, beyond the fisheries sector.

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17 Vallès, H., 2023, Moored fish aggregating device (MFAD) fisheries in the Caribbean: Regional challenges from the practitioner’s perspective, *Current Opinion in Environmental Sustainability*, 61.
19 This estimate does not include the British Virgin Islands, which was not available. BVI is not a member of the CRFM and therefore was not included as part of that study.
22 Hodgson, S., 2022, *Legal aspects of abandoned, lost and discarded fishing gear*, FAO.
ALDFG is first and foremost a fisheries sector challenge. Fisheries rules are crucial for regulating the usage and technical measures governing the various categories of fishing gear while fisheries compliance systems constitute a critical component of the management regime\textsuperscript{23}. However, derelict gear retrieved from the marine environment or gear that has reached its end of life must be integrated into the waste management sector. This means there must be facilities for the collection, transport, safe disposal and/or recycling of gear material, if available\textsuperscript{24}. Protection of the marine environment from all forms of pollution is critical for the sustainability of SIDs. Marine pollution rules, for instance, may outline measures prohibiting the disposal of certain categories of waste into the marine environment. Finally, as fishers are operating in a shared marine space, there must be mechanisms in place to ensure that the gear that is being deployed does not impede navigation, nor are the activities of other

\textsuperscript{23} Gilman, n. 9 above; Richardson, K., Gunn, R., Wilcox, C., & Hardesty, B.D., 2018, Understanding causes of gear loss provides a sound basis for fisheries management, Marine Policy, 96, 278-284.

maritime industries impacting their use. The placement of MFADs, the use of traps, and the
deployment of nets could all impact transport and navigation in maritime areas. Thus, there is
an inherent need to ensure fishers and fisheries authorities are aware of commercial sea lanes,
and, conversely, for marine transport authorities to be made aware of the location of
commercial fishing grounds, MFAD deployment areas and other possible, fisheries-related,
hazards to navigation. Once this information is shared, these features can be charted and
mariners made aware of their locations.

Local and national coordination is crucial for ALDFG governance; however, they must be
integrated into regional and global processes. Under the United Nations Convention on the
Law of the Sea, state parties have a general obligation to “protect and preserve the Marine
Environment” and should take “all measures...that are necessary to prevent, reduce and
control pollution of the marine environment from any source...and...to harmonise their
policies in this connection”. Prior to UNCLOS, the London Convention and later the London
Protocol considered mechanisms for the “effective control of all sources of pollution of the marine
environment” through dumping. Subsequent to the London Convention and Protocol, the
International Convention for the Prevention of Pollution from Ships (MARPOL), set out
provisions to minimise operational and accidental pollution from ships. Under Annex V of
MARPOL, measures governing the prevention of ship-based garbage pollution into the marine
environment have been established, including a prohibition on discarding plastics into the
marine environment such as synthetic ropes and fishing nets.

26 Id. Art. 194.
Vol 1046, 1046-6749.
(MARPOL) (entered into force 2 October 1983).
29 MARPOL Annex V: Regulations for the prevention of garbage from ships, 1978 (entered into force 31
December 1988)
Regionally, both at the level of the Wider Caribbean and sub-regionally within the Caribbean Community (CARICOM) and the Organisation of Eastern Caribbean States (OECS), countries have committed to collaborate on a number of issues of mutual interest and for the conservation and preservation of the Caribbean marine environment and sustainable use of its resources. One of the most critical instruments in this regard is the Cartagena Convention and its enabling protocols, in particular the Protocol on Special Protected Areas and Wildlife (SPAW). Under the Cartagena Convention, there has been the formulation of a Regional Action Plan on Marine Litter (RAPMaLi) and a supporting Regional Strategy. While they strongly focus on land-based sources of marine litter, both the Strategy and the Action Plan have recognised the dangers posed by ALDFG and have proposed various strategies and actions including cross-cutting ones that can aid in ALDFG management. In the case of the RAPMaLi, this includes the call for the evaluation of existing policies, regulations and enforcement approaches and the enhancement of litter warden programmes, with a special programme focusing on
fishers\textsuperscript{30}. The strategy and Action Plan also recognise the need to create enabling policies that promote the reduction of marine litter and the development of effective communication tools\textsuperscript{31}.

\section*{METHODOLOGY}

This research considers aspects related to the governance of ALDFG in Eastern Caribbean small-scale fisheries. To assist in this evaluation a conceptual framework adopted from Bennett and Satterfield (2018) has been utilised (Figure 2). For the purpose of this study, governance refers to the institutions, structures and processes\textsuperscript{32} that “determine how power is exercised, citizens are given a voice and decisions are made on issues of public concern”\textsuperscript{33}. Within Bennett and Satterfield’s conceptual framework, governance seeks to achieve four distinct objectives: effectiveness, equity, responsiveness, and robustness. For the purpose of evaluation, the model has been extended to recognise that governance systems do not exist in a vacuum and may be influenced by external and internal barriers that compromise the system’s ability to achieve these objectives in seeking to outline, implement and assess policies and laws for fulfilling governance mandates.

\textsuperscript{30} Corbin, C., Wedemier, S., & Franc, E., 2014, CEPT Technical Report 72:: Regional action plan on marine litter management (RAPMaLi) for the Wider Caribbean Region, UNEP-CEP.
\textsuperscript{32} Bennett, N., & Satterfield, T., 2018, Environmental governance: A practical framework to guide design, evaluation and analysis, Conservation Letters, 11(16);
The primary data collection strategy employed was semi-structured interviews with key experts across the region, who represent a range of stakeholders including marine conservation experts, fisheries managers, fishing cooperatives, and regional and sub-regional bodies. A purposive sampling technique combined with snowballing was employed in order to ensure experts possessed the required expertise and knowledge needed to inform the research objectives. Purposive sampling allows researchers to select interview subjects with the desired knowledge base, expertise, or characteristics. A total of seventeen key informants were interviewed over a

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period of seven months, from November 2022 to May 2023 (Table 1). This research is only a component of a larger body of work that included interviews with fishers and divers from two case study countries as well as policy and legal review.

Table 1: Sample Size for Qualitative Interviews

<table>
<thead>
<tr>
<th>Category of Expert</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisheries Expert</td>
<td>5</td>
</tr>
<tr>
<td>Marine Parks Authorities</td>
<td>4</td>
</tr>
<tr>
<td>National NGOs and Stakeholder Bodies</td>
<td>4</td>
</tr>
<tr>
<td>Regional Intergovernmental Rep.</td>
<td>1</td>
</tr>
<tr>
<td>Regional Fisheries Management Rep.</td>
<td>1</td>
</tr>
<tr>
<td>Regional Marine Conservation/Fisheries NGO</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

The semi-structured interview strategy allowed participants to share their perspectives through open dialogue. Thus, participants were first asked their views about the nature of the challenge of ALDFG before commenting on existing barriers to governance and providing insight into the proposed mechanisms for improvement (Supplementary Data Sheet 1).

Analysis of Data

Interview data were coded using both a deductive and inductive coding approach whereby an initial set of codes were set, followed by additional codes that were revealed during the data analysis. Deductive coding assigns a pre-determined list of codes to the data, thereby maintaining focus on key areas of importance to the research design. Thus, through deductive

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coding, a list of code categories was developed to organise the data into themes (Table 2). This was followed by an inductive coding strategy whereby all other codes were revealed from analysis of the transcription text. In inductive coding, the codes are developed by utilising codes or phrases from the interview participants themselves and, thus, are loyal to the data. Inductive codes are mainly presented in the results section of this research paper.

<table>
<thead>
<tr>
<th>Deductive Data codes</th>
<th>Inductive Data Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptions</td>
<td>No associated inductive codes</td>
</tr>
<tr>
<td>Institutional barriers</td>
<td></td>
</tr>
<tr>
<td>Structural barriers</td>
<td>Outlined in Table 3</td>
</tr>
<tr>
<td>Procedural barriers</td>
<td></td>
</tr>
<tr>
<td>Cross-cutting barriers</td>
<td></td>
</tr>
<tr>
<td>Facilitators of improved governance</td>
<td>Results</td>
</tr>
</tbody>
</table>

RESULTS

Stakeholders’ Perception of ALDFG

Interviewees were asked to comment on whether they considered ALDFG a concern within their territories and the region. With only one exception, all indicated that ALDFG was of concern, with responses ranging from minor to major concern. To illustrate their views, stakeholders raised several examples and incidences based on their observations of ALDFG. Fish traps were identified as a major contributor to ALDFG with the highest degree of concern regarding its related impacts (i.e., ghost fishing). As observed by one interviewee;
“because of the shifts from degradable materials, such as bamboo and cane, to the mesh, the wire mesh, which takes longer to degrade, you have that...those traps [staying] in the ecosystem for a longer period.”

In addition to passing vessels and losses resulting from severe weather, deployment strategies practised by trap fishers were concerning to experts in St. Kitts and Nevis, Antigua and Barbuda, and Grenada, who indicated these practices were likely leading to losses. First, the practice of utilising plastic bottles to mark the location of fish traps, which;

“as they continuously get exposed to the [sun] they break down with UV exposure so...they end up failing, [and] breaking off.”

Under a previous study, interviewed fishers in Dominica confirmed that they also utilised plastic bottles in the deployment of traps37.

On the other hand, in Antigua and Barbuda, and St. Kitts and Nevis, key informants confirmed that fishers set traps without surface markers with one expert noting that;

“Those who [don’t] have on the buoys, they stand a higher chance of losing them, because sometimes the traps end up in deeper waters.”

Blind traps, set or abandoned in vulnerable habitats were observed causing damage to corals, as noted by one conservation expert;

“So, a lot of times when I'm diving, what I see is a lot of people set their fish pots blind, and sometimes you can tell when they're turned over, or they're on top of a coral head, or they're obviously breaking apart, so they've been abandoned...[and] you can see it... just...rubbing against the reef....”

Monofilament fishing lines were reportedly of particular concern in nearshore areas and were often thought to be associated with shore-based fisheries.

Despite the policy of utilising moored FADs interviewees confirmed that they were also contributing to the ALDFG burden in the Eastern Caribbean. As observed by one fisheries sector representative;

“FADs are being lost [and] the issue with FADs would be that the line just gets damaged over time... [as] fishers [are] always mooring themselves on the FADs.”

Another interviewee observed:

“From time to time. They would lose FADs, for various reasons, maybe a boat pass and cut it.... especially on the West Coast” (of Grenada).

Interviewees also confirmed the presence of ALDFG that likely originated outside of the jurisdictions. Polypropylene netting, Styrofoam buoys/floats, components of FADs, GPS tracking devices from FADs, and octopus traps were among the identified forms of transboundary ALDFG that were observed in Antigua and Barbuda, St. Kitts and Nevis and Grenada. One interviewee indicated that they observed fish crates that appeared to have originated in Portugal or Morocco and, thus were carried by currents to coastal areas on the Windward coast of Antigua. The octopus traps that were described appear to be the same as those that were observed in the Bahamas, where, one study described discovering “copious amounts of those traps” on Atlantic-facing beaches and also noted that they had also been observed in Bermuda and San Salvador (Ambrose et al 2019). These traps are thought to originate from artisanal fleets in Morocco. In Grenada, one interviewee indicated that the most frequently observed forms of ALDFG found during coastal clean-up activities were
Styrofoam buoys with attached polypropylene nets that likely originated from South American vessels.

**Barriers to Effective Governance**

The barriers identified through interviews have been categorised according to the key components of governance proposed by Bennett and Satterfield\(^{38}\). Thus, institutional barriers relate to gaps and failings in the legislative or policy environment, structural barriers may relate to weaknesses and challenges experienced by key agencies, and procedural barriers relate to procedures and functions of undertaking governance. This may include procedures for policy formulation, cross-sectoral coordination and communication. In addition to these thematic barriers, cross-cutting barriers that may impact multiple governance components have also been identified. Among the identified barriers to effective governance were a lack of human, financial and technical capacity to effectively address the challenge of ALDFG, Lack of policy directives and clear mandates, and the failure of management agencies to prioritise the issue (Table 3).

**Table 3: Identified Barriers by Key Informants**

<table>
<thead>
<tr>
<th>Data codes</th>
<th>Institutional barriers</th>
<th>Structural barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lack of clear policy directives on ALDFG</td>
<td>Limited financial resources</td>
</tr>
<tr>
<td></td>
<td>Policy incoherence across sectors</td>
<td>Limited or lack of human resources</td>
</tr>
<tr>
<td></td>
<td>Lack of ALDFG-focused legislation</td>
<td>Limitations in the technical capacity of agencies</td>
</tr>
<tr>
<td></td>
<td>Fragmentation of laws</td>
<td>Lack of supporting infrastructure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weaknesses in waste management sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High cost of recycling end-of-life or retrieved derelict gear</td>
</tr>
<tr>
<td></td>
<td><strong>Procedural barriers</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of clear mandates</td>
<td></td>
</tr>
</tbody>
</table>

\(^{38}\) Bennett, n. 52 above.
| Lack of clarity on burden of responsibility |
| Lack of/limited enforcement |
| Poor intersectoral coordination |
| **Cross-cutting barriers** |
| ALDFG not prioritized |
| Lack of data and information |
| Lack of awareness by fishers |
| Lack of awareness by resource managers |
| Lack of understanding of effects of ALDFG |

In the following sections, some of the most crucial of these barriers will be explored in further detail.

**Institutional Barriers: Lack of Clear Policy Directives.**

Effective governance requires purposeful governance actions that coordinate the expectations of various actors in the system\(^{39}\). If agencies are not provided with clear policy directives to deal with governance challenges, they may fail to act. This was the view shared by two regional experts, the first of whom noted that:

> “Within the regulatory frameworks both from the fisheries side as well as from the environment side or even waste management side, I’m not so sure that again there was a lot of focus on...ADLFG in terms of what should be appropriate policies and regulations concerning its management, its return, and even how do you deal with it as part of the overall solid waste management response?”

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What we...need [in the region] is a good policy framework, good action plan, setting out our objectives, setting out in clear terms, the problem and setting out in clear terms, some of the things that we...need to do.

Institutional Barriers: Policy Incoherence

Policy incoherence was a major barrier identified by several interviewees representing both national governments, non-governmental organisations and regional bodies. With many fisheries agencies seemingly prioritising production and economic growth over other conservation objectives, there is the potential for conflict. One interviewee highlighted the tensions that sometimes existed between fisheries managers and agencies involved in environmental management, noting that;

“we are trying to work together across the sectors [but] it is still very challenging because we have had differences in the way we deal with some issues. And, you know, it has been difficult to bridge the gap sometimes.”

Another conservation expert commented

“I think the balance between conservation and commercial fishing [has] to happen but I think that the Fisheries Division [has] become more now as a business They don’t have the balance of conservation, so that the conservation side of it is left behind.”

Considering that ALDFG governance requires lateral coordination of policies and actors, and vertical integration at various levels of governance, the issue of policy coherence can be viewed as both a national and a regional challenge. In commenting on the barriers to effective governance, one regional expert noted that in many islands the;
“lack of...coordination...lack of coherence and consistency across the different pieces of policy and legislation” creates a challenge for governance.

They further noted;

“that level of/lack of synergies and sometimes coordination and collaboration and coherence, really just gets further exemplified when you go up to the regional level.”

Policy incoherence is not only a challenge for government sector agencies and regional bodies but also for non-governmental actors and their collaboration with governmental partners. One NGO represented noted that “sometimes government and NGOs don't see eye to eye”.

**Institutional Barriers: Weak and Fragmented Legislation**

Weaknesses in the regulatory regime and fragmentation in the legal landscape for ALDFG management in Eastern Caribbean fisheries were highlighted in an earlier paper that forms part of this overall research project\(^40\). The empirical data collected in this study has corroborated this finding through experts' views.

The lack of ALDFG-focused legislation was raised by a number of experts, with one interviewee commenting that ALDFG has been seen as an “afterthought within overall fisheries, legislation or policy”. Another expert noted that there is a need to;

“strengthen [fisheries laws to] be more specific regarding the issue of abandoned, lost and discarded fishing gear and have specific measures...so that it doesn't slip by.”

The issue of fragmentation was also raised, and as observed by one interviewee:

“This is one of those issues that [is] somewhat fragmented in terms of who should respond to it. Is this a fisheries challenge/problem...Is this more of a maritime issue...is it is it an environmental challenge in terms of environmental regulations, [or] is it a waste management issue?”

The fragmented nature of this issue and the associated legal regime can lead to other associated barriers as will be outlined in the next section.

Structural Barriers: Limited Human and Financial Resources

The jurisdictions that form part of this study have small, fragile economies, many of which are plagued by high external debt; hence it is not surprising that capacity limitations were identified by several key informants as major barriers to effective governance of ALDFG. Lack of or limited human and financial resources not only hinder the ability of sectoral agencies to address ALDFG but also can contribute to or affect other barriers as well. Financial limitations likely contribute to the gaps and weaknesses in supporting infrastructure and mechanisms for ALDFG governance. One fisheries expert observed that in terms of the financial capacity of their department to respond to the threat,

“There's only so much that you...could do without adequate funding. I mean, be it you know, to get a vessel at fisheries....So I mean, water, water-based stuff of that nature, we are going to have to...you know, liaise with somebody a fisher or some something to get out there and conduct any sort of work of that nature”

Human resource challenges relate not only to staff availability but the technical capacity of individual staff members. One fisheries expert noted:
“[P]art of it also is the resources. The data collectors may not be at a given landing site or a lot of the persons we have right now, they're not really divers…to do proper research”…A lot of the persons who are employed now they…don't come with the marine background but sometimes they don't want to apply themselves to learn the industry.”

**Structural Barriers: Lack of Supporting Infrastructure**

Beyond the inadequacies in the policy and legislative regime, as well as limitations in financial and human capacity, the issue of supporting infrastructure to allow agencies to effectively address this issue within their core mandates was raised as by several experts. Lack of mechanisms for reporting, limitations for collecting data and information on ALDFG, lack of supporting infrastructure to allow for compilation, analysis, storage and dissemination of not only ALDFG data but other environmental data were among the issues highlighted by experts. These issues transcend the challenge of ALDFG, and may be emblematic of the challenges faced by fisheries managers, generally. One expert noted:

“In some cases, it relates to the even when the data is collected, how is it compiled, analysed, stored and disseminated. So the lack of appropriate systems at a country level”…I think I think how that data is collected, the capacity to collect the data, the capacity to use the data to inform policy responses, I think has been lacking”

Experts also recognised the added complexity of dealing with submerged derelict gear. With one national expert noting that:

“[T]here are so many there's so many gear that is put into the sea….but then, in terms of what happens after that, how do how do we retrieve it?
"How can we safely remove it from the environment, especially when, you know, they might be 100 and something feet underwater?"

Structural Barriers: Weaknesses in Waste Management and High Cost of Recycling

The limitations in both human, financial and technical capacity of management agencies extend beyond the fisheries sector to other relevant sectors (e.g. the waste management sector). Limitations in the waste sector may compromise the ability of national governments to create effective waste management strategies for retrieved ALDFG or end-of-life gear. While recycling of fishing gear (especially plastic gear) has been promoted, this may not be a viable for the small islands of the Eastern Caribbean. One of the experts working on end-of-life strategies for fishing gear in the Caribbean region noted that:

"A lot of the work that has been done so far within the Caribbean, has found that the feasibility of recycling isn't looking so great, just because of the...high expenses of transport inter-island, as well as just the...full costs of having to ship outside and the amount of gear that would have to be collected for this to be cost effective. [Additionally] high start-up costs to develop an in-Caribbean recycling effort would be...very unfeasible."

As a result, governments may have to employ other strategies for the management of retrieved derelict gear or gear that has reached its end of life.

Procedural Barriers: Lack of clear mandates understanding burden of responsibility

As has been noted previously, ALDFG is an intersectoral governance challenge. Thus, coordination and collaboration of multiple sectors is needed in order to achieve effective and
improved governance. However, unless all sectors are aware of their roles within the governance system, there is unlikely to be true cooperation. One national expert observed the following about national coordination for ocean governance matters;

“I don’t think again, the requisite framework is there to say, who’s responsible for what...[so] I think that there needs to be a framing policy that clearly dictates who is responsible for what, because people tend to shirk responsibility.

Further, if clear mandates are not defined, and there is a lack of clarity on the burden of responsibility by the various agencies, it may lead to gaps in the governance system. For instance, Customs authorities play an essential role in the surveillance, monitoring, and compliance of fishing gear entering the market through ports of entry. However, the governance system may be compromised if there are gaps in communication or a lack of understanding of their role and mandates related to gear management. As observed by one key informant;

“...we...passed legislation changing...the minimum mesh size for nets for example. And although we had increased the size of the mesh size, the people were still able to import what would be considered then illegal nets.... Although we had communicated with customs that we had a gear

**Procedural Barriers: Poor Intersectoral Coordination**

The need for strong intersectoral coordination (both nationally and regionally) in the governance of ALDFG is clear. However, like other aspects of environmental governance, many countries lack the enabling mechanism to allow for this in a strategic and comprehensive way. One regional expert observed:

“It is unfortunate that in these modern times, even though we recognise the importance of collaboration, and even though we recognise the importance of
consultation and stakeholder involvement, and you know, we have commitment all
across the board, to recognise these things and to cooperate and collaborate in
putting together the measures that we think appropriate, in reality, these things get
brushed aside.”

The result is that much of the coordination that needs to occur is either not formalised or may
be temporarily established in the execution of projects. The informal relationships that exist
between technicians across agencies were lauded by one expert in Antigua who noted that:

“[N]ormally I find what works...is this informal relationship among the
technicians...The informal relationships are very good. Where I think may need
[attention is] government institutionalised policy.”

In some instances, temporary mechanisms of collaboration are instituted around projects. This
was an issue raised not only by national level experts in St. Vincent and the Grenadines but by
regional experts as well, with one key informant noting:

“I would say that a couple of things that have worked, and I'm speaking now
in the very broadest sense, is that there have been various programs,
projects and activities that we have done jointly. We have collaborated
with...CRFM on issues of common interest like sargassum and ocean
acidification. We've collaborated with the OECS in terms of some of the
more governance issues and so on. So, I think there has been that level of
collaboration. It...has, I think, tended to be more project based.”

In the absence of sustained, strategic and formalised coordinating mechanisms for ALDFG
governance it is unlikely that holistic governance will be achieved.

Cross-Cutting Barriers: ALDFG not prioritised
Many of the interviewees indicated that ALDFG was not seen as a priority by many of the regulatory agencies within the various countries. Perhaps this is related to the fact that ALDFG is, largely, a hidden threat. As observed by several interviewees, much of the ALDFG is located underwater, therefore, “people don't realise that it's [an] issue”. On the other hand, much of what is found in coastal areas and on beaches is either land-based debris or ALDFG that is thought to be extra-regional. In coastal clean-ups for instance;

“what was being found as it related to [ALDFG]...on beaches, particularly on the east coast of some of the islands, was being viewed by local authorities as external to local fishing, subsistence fishing, small scale fishers, etc.”

The decision not to prioritise ALDFG may also be linked to the limited human, financial and institutional capacity that exists within the various agencies, both of which have been identified as major structural barriers by the interviewees. One participant observed:

“We have not really, you know, done it because resources, I mean, you know, capacity to do it. You tend to focus on other things because you have limited capacity....tend to focus on other aspects of fisheries management.”

Two interviewees raised concerns about technicians being “stretched thin” to deliver on their core mandates while being asked to undertake externally funded projects for which they may not have been included in planning. As observed by one marine conservation expert:

“I think a lot of times what happens is agencies are forced into projects that aren't necessarily a priority, but for some reason, the funding or somebody decides this is what they should be doing.”

As a result, there may be;
“a loss of focus on what the role [of the agency] is and due to limited manpower, [as a result, such projects] may prevent you from doing what you’re supposed to do”

Lack of prioritisation may also be linked to a general lack of knowledge and information on the issue, as there was also thought to be a lack of available data. One regional fisheries expert noted:

“I think we are still at the basic phase of trying to understand the scope and extent of the problem. There are many questions that we have that we need to answer for...so, a lot of basic empirical work needs to be done to better understand the nature and the extent of the of the problem going forward.”

Surprisingly several of those interviewed indicated that they were not familiar with the terms “abandoned lost or otherwise discarded fishing gear” or “derelict fishing gear”. One participant observed:

“It's the first time I'm hearing it in an official manner in a contextualised manner. It's a loose term we use; derelict fishing gear, abandoned fishing gear but in terms of it having a connotation that is significant in to the extent that it has to be researched...I've never.”

Stakeholders may not have a clear undersign of how ALDF affects the marine environment and associated wildlife:

“A lot of people haven't understood the impact...it has on the marine biosphere...So they might have a brief gloss over the concept, but unless it's actively affecting their fisheries and they see that...they will not...understand...the extent at which or how detrimental to the environment that is.”
The lack of prioritisation of ALDFG within the governance regime of national governments has led to a situation whereby much of the management remains ad hoc as one key informant observed:

“Yeah, in my opinion, I don't think I don't think we're managing [ALDFG] in any kind of way. It's kind of haphazard; Whatever happens, happens.”

Opportunities for Improved Governance

Overcoming the myriad challenges and barriers associated with the governance of ALDFG in the region will require a multi-faceted approach including regulatory and institutional improvements, awareness building and improvements in the knowledge base as well as mechanisms for improving coordination and collaboration. It also requires both horizontal and vertical integration strategies in the development of policies, aligning regulatory systems and addressing research needs. There exist a number of mechanisms within the Caribbean region that allow for collaboration and cooperation in various aspects of marine governance. These mechanisms exist both at the level of the sub-region (in the OECS), English speaking Caribbean (CARICOM) and Wider Caribbean (UNEP-CEP and Cartagena Convention and Protocols). While the issue of ALDFG has largely not been integrated into these fora, utilising these existing mechanisms may create the opportunities for policy coordination and coherence building that can lead to holistic governance

Looking beyond the question of barriers, interviewees were also asked to share their views on how some of these barriers could be overcome to create opportunities for improved governance. At the most basic level, many experts emphasised the need improve knowledge and understanding of the issue within the Eastern Caribbean. It is difficult to establish governance arrangements for an issue that is not well understood.
The role of external partners and entities such as the Global Ghost Gear Initiative (GGGI) and the Gulf and Caribbean Fishing Institute GCFI were highlighted as playing crucial roles in building the knowledge base and helping to coordinate activities while leveraging funding. As observed by one interviewee;

“through our network fishers as well as our network of academics, governments, NGOS...we have a role [to play] to coordinate and form partnerships.”

Such partners may also have a role to play in capacity building of key agencies. As has been highlighted through this study, the challenge of both limited or absent human and financial resources is a crucial one for this region. Capacity building is, therefore needed for various of ALDFG management. Technicians from one fisheries agency observed that;

“We would need some capacity building for the fisheries itself in in how best it could manage this issue...It's one thing to know that there are so many...gear that is put into the sea.... But then, in terms of what happens after that, how do how do we retrieve it? How, how can we safely remove it from the environment?

Given the multiple levels of governance, the need for setting of common targets was also highlighted by one interviewee;

“I really think the there is value in...having some level of common targets goals, objectives. How can we ensure that that's a little bit more coordinated and strategic rather than rather than the siloed approach”?

Discussion

Within the small-scale fisheries of the Eastern Caribbean ALDFG is a challenge, that while it has been receiving increasing attention by some governments, it has largely not been prioritised by fisheries management bodies. This may be due to a lack of knowledge about the nature, scale and impact of the challenge or could be related to limitations in resource availability or
the adequate procedures for gathering the relevant data and information at the national level.

Some opportunities for improved governance of the challenge currently do exist with growing partnerships between regional authorities and national fisheries bodies with external partners including the GGGI and the GCFI. Formalising some of these arrangements through formal memoranda of understanding, as has been done by the CRFM with some of its partners, could ensure a more coherent and strategic approach is being taken to addressing the challenge.

Policy coherence is fundamental to strengthening the interconnectedness between different sectors and environmental policy areas relevant to the governance of ALDFG. It can be defined as a mechanism that “systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives.” Utilising existing networks of cooperation and regional processes such as ocean governance teams and conferences of the parties for regional ocean governance instruments can aid in achieving multi-level policy coherence. However, this must be complemented by national level initiatives that engage not only public sector actors but fishers and non-governmental organisations.

The need for trust building was also highlighted as a critical element for improving management of this issue. Adopting governance approaches that allow for sharing of information, cooperation and collaboration may prove crucial to achieving this. It may also assist in overcoming the many complexities related to ALDFG governance in the Eastern Caribbean region. Trust can be seen as an essential element for ensuring the desired interactions and outcomes are achieved within governance systems, and is critical to achieving legitimacy.

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42 Id. P. .396.
in governance. Trust among various governance actors stimulates information exchange and facilitates learning. When there is mutual trust among various actors, concerns about opportunism decline so that parties can operate, even in changing environments, without the worry of opportunistic attempts. Thus in systems where there is mutual trust, adaptive capacity is enhanced. Trust can be achieved through transparency in policy development and implementation, including collaborative arrangements.

Recognising that the governance of ALDFG relies not only on national level interventions but should be coordinated with regional and global processes, there must be a means to allow vertical integration of policies so that national level management aligns with regional and global level best practices and policies. As was revealed through interviews, policy incoherence was identified as one of the governance barriers relating to ALDFG. As has also been noted, ALDFG lies at the nexus of waste management, environmental protection, fisheries management and maritime transport. Therefore, there must be mechanisms in place to allow these various sectors and actors to cooperate, collaborate and align the ALDFG relevant policies. Polycentric governance has been said “to enhance other resilience-enhancing principles by: enabling broader participation of stakeholders and decision-makers; improving trust and cooperation among these actors; increasing accountability; maintaining response diversity, redundancy and improving connectivity.”

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45 Klijn, n. 60 above.
47 Id.
48 Gjerde, K., M., & Yadav, S. S., Polycentricity and regional ocean governance: Implications for the emerging UN agreement on marine biodiversity beyond national jurisdiction. Frontiers in Marine Science 8
DEDICATION

Perhaps the most crucial element of a PhD student’s journey is the relationship you form with you supervisor. The person who is supposed to guide you along, cheer you on, critique, encourage and advise you on your work. For me, Meinhard was the perfect supervisor, who always reminded me that this “was my journey”, that I am the expert of my own topic and his role was to create an atmosphere for me to discover that. Losing him half way through this journey has been difficult. However, the lessons and advice he gave are always present in my mind. My only hope is that through this work I am able to reflect the many nuggets of wisdom he shared with me. This is dedicated to you, Meinhard. Thank you for your encouragement and your council.

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