Development of a programme for Ghost Gear in relation to the Commonwealth Litter Programme, in the Pacific region

Final Report

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Executive Summary

The negative impacts of lost fishing gear are a growing concern globally. Each year an estimated 640,000 tons of fishing gear is lost or abandoned in oceans, estuaries, and bays. Whether intentionally discarded or accidentally lost, this 'ghost gear' is one of the deadliest forms of marine litter. It catches and wastes target and non-target marine species, damages marine and nearshore habitats, poses navigation risks, and is expensive and hazardous for fishermen and marine communities to deal with (Macfadyen et al., 2009).

In the Western Central Pacific Region, as in many parts of the world, little is known about the extent, causes, and impacts of abandoned, lost or otherwise discarded fishing gear (ALDFG). And little is being done to solve the problems associated with ALDFG. In November 2018, World Animal Protection (WAP) was awarded a grant from the Centre of Environment, Fisheries and Aquaculture Science (Cefas) as part of the Commonwealth Litter Programme (CLIP) to a) identify actions to be taken by fisheries management agencies to better manage ALDFG; b) identify causes of gear loss in the area and provide recommendations to reduce gear loss; and c) provide a baseline of understanding of the extent and locations of ALDFG in the region.

The methods of our project titled ***Development of a programme for Ghost Gear in relation to the Commonwealth Litter Programme*** included:

- Assessing the fisheries management policies and procedures of Vanuatu and Solomon Islands against the Best Practice Framework (BPF) for the Management of Fishing Gear developed by the GGGI (Huntington, 2017) to provide the Vanuatu Fisheries Department and Solomon Islands Ministry of Fisheries and Marine Resources with actionable recommendations that can be incorporated into their operations to reduce harmful impacts caused by ALDFG;
- Using spatial analysis (ESRI ArcGIS 10.5 with Spatial Analyst Tools extension) to design a linear additive model to predict varying levels of likelihood of derelict fishing gear occurrence in Vanuatu and Solomon Islands;
- Conducting interviews with fishers, fisheries managers from Vanuatu and Solomon Islands and participants in the Workshop on Best Practices for the Management of Lost Fishing Gear (Vanuatu, February 2019) to identify areas where gear is known to be lost, why gear is lost and to elicit locally-appropriate suggestions for solving the problems associated with lost fishing gear; and
- Demonstrating the removal of ghost gear and building capacity for future removal of ghost gear by conducting a ghost net removal workshop with local stakeholders in Vanuatu.

The project has resulted in a probability model that predicts where derelict fishing gear will likely occur in Vanuatu and Solomon Islands. In Vanuatu, high probability areas cover relatively large areas around nearly every island, with the largest continuous areas around Malekula, southern Espiritu Santo and Efate. High probability areas in Solomon Islands occur around Choiseul, New Georgia and Santa Isabel islands. Given the significant differences in areas of high, moderate and low probability areas between Vanuatu and Solomon Islands suggests there would be value in further refining the model to be country-specific.

Based on the evidence gathered during several project activities, involving more than one hundred interviews with fishers and other stakeholders, we also have developed a set of recommendations on how ghost gear can be prevented and mitigated by coastal and artisanal fisheries and the fishing industry based on localising global best practice measures detailed in the GGGI BPF (Huntington,

2017). Twenty-four separate actions were identified to address ALDFG in Vanuatu and Solomon Islands, including ensuring end-of-life gear is disposed of properly and stowing gear correctly off of beaches to avoid the gear being washed out to sea, encouraging fishers to practice good fishing practices, such as taking responsibility for their own gear and avoiding reefs to prevent gear loss, and more.

On the curative side of managing ghost gear, the project saw the removal of discarded fishing gear at Blacksands Cave in Port Vila, Vanuatu, which should ensure that the coral on which the nets had grown will be able to recover. Most importantly, the demonstration of the removal also built capacity and provided a training opportunity for ghost gear recovery efforts in the future through a net recovery workshop with local stakeholders in Vanuatu.

As a last component of the project, the participants in the Workshop on Best Practices for the Management of Lost Fishing Gear demonstrated the appetite in the region for developing and implementing locally-specific and culturally-appropriate solutions to addressing ALDFG in Vanuatu and Solomon Islands, which could be leveraged with further support. We will build on the recommendations that came out of this workshop with a more in-depth workshop together with the United Nations Food and Agriculture Organisation (UN FAO) and the GGGI in May 2018, which will result in the development of a locally-relevant ALDFG umbrella programme.

Table of Contents

Figures

Tables

1. Introduction

The negative impacts of lost fishing gear are a growing concern globally. Each year, an estimated 640,000 tonnes of fishing gear is lost or abandoned in oceans, estuaries, and bays. Whether intentionally discarded or accidentally lost, this 'ghost gear' is one of the deadliest forms of marine litter. It catches and wastes target and non-target marine species, damages marine and nearshore habitats, poses navigation risks, and is expensive and hazardous for fishermen and marine communities to deal with (Macfadyen et al., 2009).

Launched by World Animal Protection in 2015, the Global Ghost Gear Initiative (GGGI) is committed to driving solutions to the problem of abandoned, lost or otherwise discarded fishing gear (ALDFG or ghost gear) worldwide. The Global Ghost Gear Initiative is a global multi-stakeholder alliance of close to 100 organisations, business and governments that drives holistic solutions to ghost gear, develops and promotes best practice to inform policy, and collects evidence. The GGGI aims to improve the health of marine ecosystems, protect marine animals and safeguard human health and livelihoods. With more than 96 partnering organisations, including the Pacific countries of Samoa, Tuvalu, Vanuatu, and Palau; and Pacific-based organisations such as the Secretariat of the Regional Environment Programme (SPREP) and the Pacific Island development Forum (PIDF), we bring together the collective knowledge of world experts in fisheries, seafood supply, and lost fishing gear solutions.

In the Western Central Pacific Region, as in many parts of the world, little is known about the extent, causes, and impacts of ALDFG. And little is being done to solve the problems associated with ALDFG.

Defra has provided funding to the Commonwealth Marine Litter Programme (CLIP), which is led by the UK through the Centre for Environment Fisheries and Aquaculture Science (Cefas), to support up to six developing countries across the Commonwealth to develop national litter action plans focusing on plastics entering the oceans. Cefas is working with partners across the Commonwealth to share expertise and find solutions to the environmental and socio-economic problems caused by litter in the marine environment.

This project contributes to several of the objectives of CLiP, including providing baseline information and a way forward to begin addressing harmful impacts of ALDFG specifically in Vanuatu and Solomon Islands.

The objectives of this project were to:

- Identify actions to be taken by fisheries management agencies to better manage ALDFG;
- Identify causes of gear loss in the area and provide recommendations to reduce gear loss;
- Provide a baseline of understanding of the extent and locations of ALDFG in the project area.

To assist in achieving these objectives, World Animal Protection worked with Natural Resources Consultants (NRC), TierraMar, and their on-ground partners World Wildlife Fund (WWF) Solomon Islands and Vanuatu Environmental Science Society (VESS) to:

- Characterise the existing fisheries management structure and authorities, providing an assessment of fisheries management strategies that relate to lost fishing gear.
- Develop derelict fishing gear probability areas to identify potential areas of gear loss and historical accumulations in Vanuatu and Solomon Islands.
- Identify the extent and underlying causes of gear loss in fisheries in the project area and develop recommendations to prevent loss of fishing gear in the project area.
- Facilitate a regional workshop on best practices for the management of fishing gear.
- Undertook a targeted removal of lost/discarded fishing gear in the Pacific region through the execution of a ghost gear removal demonstration project and train local divers on ALDFG removal and decision-making.

1.1 Fisheries in Vanuatu and Solomon Islands

The Republic of Vanuatu and Solomon Islands, as with many Pacific island nations, both manage offshore industrial fisheries and inshore artisanal fisheries. Vanuatu and Solomon Islands are seeking to increase their artisanal fishers' access to high protein pelagic fish, in some cases using anchored fish aggregation devices (aFADs). Bell et al., (2015) summarises the importance of coastal fish production for food security in PICTs, including Vanuatu and Solomon Islands.

1.1.1 Vanuatu

In Vanuatu, fisheries management is the responsibility of the Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB). Within that ministry, the Vanuatu Fisheries Department (VFD) is composed of six divisions: Administration, Management & Policies, Development & Capture, Research & Aquaculture, Seafood verification and Licencing & Compliance.

Related to coastal commercial and inshore artisanal fisheries, Vanuatu's constitution recognises the traditional land tenure based on custom with land further defined in the Land Reform Act to include land under water out to any offshore reef (Republic of Vanuatu, 1988; Hickey, 2007). As such, the Vanuatu Fisheries Department (VFD) acknowledges and supports the traditional community role in fisheries management for inshore fisheries. Resource management in traditional custom villages is often viewed as an 'alternative' to Western fishery management models, many of the traditional resource management practices have parallels with Western models of fisheries management, including spatio-temporal limits to fishing areas, restrictions on harvesting certain species, and size restrictions (Hickey, 2006; Ruddle and Hickey, 2008). While respecting traditional management, some restrictions have been set by VFD on invertebrate harvesting and VFD has recently piloted licensing small fishing vessels (L. Joy, pers com 21 January 2019).

Bell et al., (2015) report that although Vanuatu's need for fish as food by the year 2020 is almost equal to that of Kiribati (10,800t compared to 10,900t), its current coastal fish production is significantly lower than that of Kiribati, with Vanuatu producing only 3,730 t/yr and Kiribati producing 12,960 t/yr. The projected estimated deficit of fish for food in Vanuatu by the year 2035 is second only to Papua New Guinea (-10,400t for Vanuatu compared to -30,090 for Papua New Guinea).

Offshore fisheries management includes licensing both domestic and foreign-flagged vessels. In 2017, Vanuatu flagged vessels included three (3) purse seine vessels, 49 longliners, and no pole and line vessels. In 2017, Solomon Islands flagged vessels operating in the WCPO included ten (10) purse seine vessels, no longliners, and two (2) pole and line vessels (WCPFC, 2018).

1.1.2 Solomon Islands

In Solomon Islands, fisheries management falls under the Ministry of Fisheries and Marine Resources. The ministry is divided into five sections: Offshore Fisheries; Inshore Fisheries; Provincial Fisheries; Policy, Planning and Project Management Unit; and Corporate Services. Coastal commercial and inshore artisanal fisheries are traditionally managed at the community level.

Solomon Islands is also facing a food deficit (Bell et al., 2015). Therefore, reducing the amount of fish wasted in lost fishing gear could be an important piece of the national strategy to maximise food for its communities (FAO, 2017).

Solomon Islands flagged vessels generally operate domestically or in waters of the Parties to the Nauru Agreement. More numerous in Solomon Islands are foreign flagged vessels fishing for tuna and other pelagic species within the EEZ. In 2016, approximately 170 purse seiners and 100 longliners were licensed to fish in Solomon Islands EEZ (Ganapathiraju, 2017). In 2015, 49 foreign flagged vessels (48 Chinese and 1 Fijian) were licensed to operate in the Vanuatu EEZ (Vanuatu Fisheries Dept., 2016).

Recent developments with the National Fisheries Developments, Ltd. (NFD), a subsidiary of TriMarine Group, has added five pole and line vessels and seven purse seine vessels to the Solomon Islands domestic fleet. The NFD operates exclusively in Solomon Islands and supplies the Soltuna processing plant located in Solomon Islands (TriMarine Group, n.d.).

The commercial/industrial fisheries in the project area are predominantly tuna fisheries, with other pelagic species targeted less often. The tuna fishing industry in the Western and Central Pacific Ocean (WCPO) utilises drifting fish aggregating devices (dFADs) to a large degree. Fish naturally aggregate around floating objects and fishers have capitalised on this behaviour, concentrating fishing effort around floating objects and intentionally deploying floating objects to attract fish. In the late 20th century, the use of man-made floating FADs, both anchored and drifting, became commonplace in tuna fishing in the WCPO. Fishing on floating objects increases the success of individual sets and reduces costs for fuel needed to search for free swimming schools of fish (Hall, 1998; Chapman, 2000; Dagorn et al., 2013). Since that time, the use of FADs in tuna fisheries around the world has steadily increased. Estimates of annual global deployments

of FADs range from 45,000 to over 100,000 (Baske et al., 2012). A recent report on marking and monitoring FADs in the WCPO used an estimate of 50,000 FADs deployed annually (MRAG Asia Pacific, 2016). Today, around 50% of the global purse seine tropical tuna catches are made on FADs. Catches in the Western Pacific Ocean account for 25% of the global FAD catches (Western and Central Pacific Fisheries Commission, 2018).

It is common practice for fishers and fishing companies to cease tracking drifting FADs, rather than recovering them, when they drift out of fishing areas (Gilman et al., 2018). Anchored FADs deployed for offshore fishing are also commonly lost through vandalism and other unknown reasons (Macfadyen et al., 2009). Therefore, these lost and untracked FADs become part of the worldwide ALDFG problem. Harmful impacts after the FADs are no longer being tracked or fished by fishing companies include: continued entanglement of vulnerable species in FAD netting and rafts; and harmful impacts to marine and nearshore habitats of 'beached' FADs (Chanrachkij and Loog-on, 2003; Chiappone et al., 2005; Franco et. al., 2009; Blasi et al., 2016; Restrepo et al., 2017). The Seychelles Island Conservation Society, a non-governmental organization that has conservation centres on five islands in the Seychelles, found 96 FADs beached in nearshore areas during dedicated surveys in 2015. They documented 39% of these beached FADs entangled and caught in coral (Balderson and Martin, 2015).

FADs are commonly constructed using netting from old purse seines or other sources. Netting is often wrapped around rafts and used as subsurface appendages, stretching to depths of 70m or more in some cases. Purse seine netting mesh varies from 200mm to 90mm (Franco et al., 2009). This netting can entangle fish and other animals that aggregate around the FAD as well as predators that are attracted to the aggregations of prey species.

While there has been no physical habitat damage documented by drifting FADs in the open ocean, habitat damage occurs when FADs drift into and 'beach' in nearshore habitats, such as coral reefs. The rafts and subsurface appendages can tangle in vegetation and coral, damaging and smothering habitat. There is limited information about the fate and disposition of the tens of thousands of FADs deployed annually in the world's oceans and their impacts on nearshore habitats.

1.1.3 GGGI Best Practice Framework for the Management of Fishing Gear

In the design of this project, we envisioned the GGGI Best Practice Framework (BPF) of Fishing Gear would help in developing best practices for the reduction of ALDFG in Vanuatu and Solomon Islands. The BPF is a comprehensive guidance document detailing best practices for stakeholder throughout the seafood supply chain (from fishers to seafood companies and fisheries managers) to reduce the amount of ghost gear entering our oceans (Huntington, 2016, 2017). It aligns closely with best practice recommendations included in other literature and key international instruments issued by the Food and Agricultural Organisation of the United Nations (e.g. Guidelines for the Marking of Fishing Gear) IMO (e.g. MARPOL Annex V), OSPAR (e.g. Regional Action Plan for the Management and Prevention of Marine Litter) and Regional Fisheries Management Organisations (RFMOs), and provides a reference point for interventions

throughout the supply chain specifically on the issue of ghost gear (Macfadyen et al., 2009; OSPAR Commission, 2014; Gilman, 2015; FAO, 2018).

The BPF provides an overview of the global use of fishing gear and adverse impacts associated with the loss of various fishing gears. Fishing gears covered in the BPF are gillnets, bottom trawls, mid-water trawls, traps and pots, seine nets, FADs, and hooks and lines. Except for trawls, all of these fishing gears are of interest in Vanuatu and Solomon Islands.

The BPF assigns a risk score to each fishing gear. Fishing gear is scored based on its risk of loss and on the likelihood of harmful impacts of lost gear. The BPF scored gillnets, pots and traps, and FADs as the most harmful fishing gear in relation to ALDFG (Table 1).

Table 1. Relative risk of fishing gear to be lost and cause harm

Gear Type	Risk of Loss (1-5)	Negative impact after loss (1-5)	Risk ranking
Gillnets	5	5	1st
Traps and pots	4	4	2nd
Fish Aggregating Devices	4	3	3rd
Hooks and lines	3	3	4th
Bottom trawls	2	3	5th
Mid-water trawls	1	2	6th
Seine nets	1	2	6th

The BPF summarises practices that can be adopted by ten stakeholder groups to minimise and eliminate adverse impacts from lost and abandoned fishing gear. The ten stakeholder groups addressed in the BPF are fishing gear designers, manufacturers, and retailers, fishers, fisheries organisations, port operators, fisheries managers and regulators, fisheries control agencies, fisheries and marine environmental researchers, seafood ecolabel standard and certification programs, seafood businesses, and non-governmental organisations. Each of these stakeholder groups are active to some extent in the seafood supply chain in Vanuatu and Solomon Islands. Particular attention will be paid to the role of fisheries managers and fisheries control officers in the CLiP.

The BPF include categories of management options specific to each stakeholder. Management actions can be adopted and implemented by stakeholders through voluntary measures, within third-party certification schemes, through regulatory measures, and by building awareness. The following is an introduction to the BFP's fishing gear management practices that can prevent and reduce harm caused by ghost gear:

- **Spatial/temporal separation of fishing types** - Separating fishing fleets avoids gear conflicts and can protect sensitive habitats.
- **Innovative gear design to reduce gear loss** - New technological advances, such as smart buoys for shellfish traps, can help fishermen avoid gear loss.

- **Vessel design to prevent gear loss** - Ensuring vessel storage space for damaged gear can prevent loss and abandonment.
- **Fishing gear marking and identification** - Marking gear helps avoid gear conflicts, helps locate lost gear, and identifies legal fishing gear from illegal gear.
- **Improved disposal facilities for end-of-life gear** - Having efficient and reasonably priced disposal options helps prevent dumping gear at sea.
- **Education and awareness** - The harm caused by lost fishing gear is not widely known amongst the seafood sector. Improving this understanding may motivate more careful fishing gear management.
- **Best fishing practices** - Common best fisheries management strategies, including registration, seasonal restrictions, and gear marking help prevent and mitigate gear loss.
- **Innovative gear design to minimise ghost** fishing - Methods to limit ghost fishing, such as requiring biodegradable cord on shellfish pots' escape hatches, are necessary to mitigate the impacts of inevitable loss of gear.
- **Lost fishing gear reporting and retrieval** - Having equipment on board to retrieve lost gear immediately is the best way to avoid harm from lost gear. After-the-fact retrieval programs can also be effective.

The BPF include categories of management options specific to each stakeholder. Management actions can be adopted and implemented by stakeholders through voluntary measures, within third-party certification schemes, through regulatory measures, and by building awareness.

1.1.4 Roles of Fisheries Managers in Reducing Harm from Lost Fishing Gear

There are many reasons why fishing gear is lost. Some common reasons for loss in the Pacific region include snagging of nets, bad weather, strong currents, gear conflicts with other fisheries, vessel conflicts, dumping, and mechanical failure. However, many of these reasons for loss are symptoms of poor fisheries management, which can cause increased pressure on fishers to engage in risky behaviour (Richardson et al., 2018). Recognizing the importance of fisheries management in preventing harm from lost fishing gear, this project focuses much of its work on assessing the fisheries management regime in Vanuatu and Solomon Islands.

The GGGI BPF recognises that fisheries managers and regulators play a unique and critical, frontline role in preventing lost fishing gear by developing and enforcing appropriate fisheries management regulations. Strategies for effective fisheries management outlined in the BPF include:

- Mandating temporal and spatial separation of fishing gear to avoid conflicts;
- Restricting use of some fishing gears in areas with a high risk of loss due to local conditions;
- Requiring adequate marking of fishing gear as detailed in the FAO guidelines;
- Ensuring adequate capacity and training for effective marking of fishing gear;

- Mandating retrieval of lost fishing gear, including FADs, where safe and practical;
- Mandating use of biodegradable materials in certain gears to eliminate ghost fishing;
- Requiring reporting of lost fishing gear; and
- Collaborating on and supporting the retrieval of accumulated lost fishing gear when immediate retrieval is impractical.

Because the abandonment and loss of fishing gear is often associated with Illegal, Unreported, and Unregulated (IUU) fishing, fisheries control agencies play a unique and critical, frontline role in preventing lost fishing gear by enforcing appropriate fisheries management regulations, such as through:

- Gear marking as a condition to holding a license to fish;
- Ensuring gear marking and other requirements relevant to preventing fishing gear loss in Monitoring, Control, and Surveillance activities are followed;
- Conducting at sea and port inspections in accordance with Annex B, paragraph e) of the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing; and
- Establishing appropriate penalties or sanctions for non-compliance with gear marking and other requirements relevant to preventing fishing gear loss.

2. Methodology

2.1 Fisheries Management Characterization

The fisheries management policies and procedures of Vanuatu and Solomon Islands were assessed against the BPF developed by the GGGI (Huntington, 2017) which incorporates key components of the Voluntary Guidelines on the Marking of Fishing Gear recently approved by Fish and Agriculture Organization of the United Nations (FAO) Committee on Fisheries (COFI) (FAO, 2018). This assessment was designed to provide the Vanuatu Fisheries Department and Solomon Islands Ministry of Fisheries and Marine Resources with actionable recommendations that can be incorporated into their operations to reduce harmful impacts caused by lost or abandoned fishing gear. This assessment does not address any issues or give any recommendations related to the effects of fisheries policies on fish stocks or populations.

The BPF identifies key management strategies, such as spatiotemporal restrictions in high-risk fishing areas and gear marking techniques that can prevent and reduce harm from lost fishing gear. The BPF incorporates key actions recommended in the FAO Voluntary Guidelines for the Marking of Fishing Gear (see Table 2, which presents the management practices that were assessed through a review of the national fisheries management policies, plans and regulations. Information about traditional community fisheries management was incorporated into the assessment as much as possible).

The following fisheries management policies and regulations were reviewed during the assessment:

- National Parliament of Solomon Islands. 2015. Fisheries Management Act of 2015; No. 2 of 2015. 23 April 2015.
- Maneniaru, Hon. J. 2017. Fisheries Management Regulations 2017. Supplement to the Solomon Islands Gazette. 11 January 2017. Legal Notice No. 2.
- Ministry of Fisheries and Marine Resources. 2008. Solomon Islands National Fish Aggregation Device (FAD) Management Plan. Honiara.
- Republic of Vanuatu. 2014. Fisheries Act No. 10 of 2014.
- Republic of Vanuatu. n.d. Vanuatu Management Plan for the Regulation of Fish Aggregating Devices.

Corroborating information was gained through interviews with the following fisheries personnel:

- Christopher Arthur, Policy Director, Vanuatu Fisheries Department, interviewed February 22, 2019.
- Ronnelle Panda, Deputy Director of Policy, Solomon Islands Ministry of Fisheries and Marine Resources, interviewed February 21, 2019.

Interviews were structured as checklists and covered all best practices from Table 2. Interviewees were briefed on the content of each best practice outline in Table 2 and were asked if their respective fisheries practices were consistent with this practice. Responses were either yes or no and elaborated on if needed. The outcomes can be found below in Table 4.

The practices of the Vanuatu and Solomon Islands fisheries management authorities were assessed by NRC personnel familiar with fisheries management and with the BPF. Practices identified through review of management policies and practices and through interviews with fisheries managers were rated as low, medium, or high based on how consistent they are with practices in the referenced BPF (Huntington, 2017). Ratings were assigned qualitatively according to the following categories:

Low – no or very little consistency with references

Medium – some consistency with references

High – complete or very close to complete consistency with references

Table 2. Best Practices for fisheries managers, regulators, and control officers

BPF recommended practice
Preventing harm from ghost gear
Restrict use of some fishing gears in areas with a high risk of loss due to local conditions
Mandate temporal and/or spatial separation of fishing gear necessary to avoid loss of fishing gear caused by conflicts

BPF recommended practice
Require the use of biodegradable materials on certain fishing gears and escape panels for pots and traps to minimise ghost fishing if the gear is lost
Provide education to build awareness of the harm caused by lost fishing gear and the practices available to avoid losing fishing gear
Collaborate on and support the retrieval of lost fishing gear
Inform owners of lost gear retrieved, if possible, for re-use and proper disposal
Marking fishing gear
Complete risk assessment process to identify the scope/priorities for fishing gear marking system
Implement and coordinate a fishing gear marking system consistent with the FAO Voluntary Guidelines for the Marking of Fishing Gear
Identify fishing gear marking systems to be used and identify to which fisheries, gears, vessels and areas the systems apply
Collaborate with appropriate partners to provide education to ensure fishers have the capacity and training to follow gear marking guidelines
Reporting lost fishing gear
Ensure there is an effective system in place to report lost or abandoned fishing gear
Develop lost gear reporting protocols cooperatively with gear manufacturers, vessel operators, fishing companies, fishing organisations, and other fisheries administrations
Maintain a lost fishing gear register including the following: type of gear lost, identifying marks, date/time/position of loss/retrieval, reason for loss, weather conditions, other relevant information
Coordinate, communicate, and share information about lost fishing gear with other entities such as RFMOs, and regional and State fisheries managers
Facilitate the reporting of lost fishing gear by small-scale, artisanal and recreational fisheries to appropriate authorities
Fisheries regulation and enforcement
Fishing licensing processes should explicitly include requirement to mark and identify fishing gear as a condition to fish
Required fishing gear marking and spatial of temporal fishing separation should be included in Monitoring, Control, and Surveillance activities
Port State inspection of fishing gear should be conducted in accordance with theprocedures set out in Annex B, paragraph e) of the FAO Agreement on Port State Measures to Prevent,Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO, 2016)

BPF recommended practice
Inspections should be conducted at sea and at port to ensure that gear marking and other requirements relevant to preventing gear loss are adhered to
Deployed gear found without required marking should be reported to the relevant authority
Appropriate penalties or other sanctions should be established to prevent and deter non-compliance with gear marking and other regulations relevant to preventing gear loss
Penalties or sanctions should be proportionate to the non-compliance, clearly communicated to the fishing industry, and should include appropriate consultation and appeal processes

2.2 Development of Derelict Fishing Gear Probability Areas

To ascertain the varying levels of likelihood of derelict fishing gear occurrence in Vanuatu and Solomon Islands, spatial analysis using ESRI ArcGIS 10.5 with the Spatial Analyst Tools extension was conducted to design a linear additive model. The results from this analysis were intended to predict areas where derelict fishing gear will likely occur based on the characteristics of the fishing grounds at known/reported derelict fishing gear locations. This model does not, however, attempt to predict how many gear items or which gear types may occur; nor does it distinguish between the source fisheries from which the derelict gear may have come (small-scale, local or large-scale industrial fisheries). Some data provided the opportunity to investigate and compare these variables, however not to the extent that distinguishing their differences within the probability analysis was justified. The probability model presented here predicts areas where derelict fishing gear of any kind is most likely to occur.

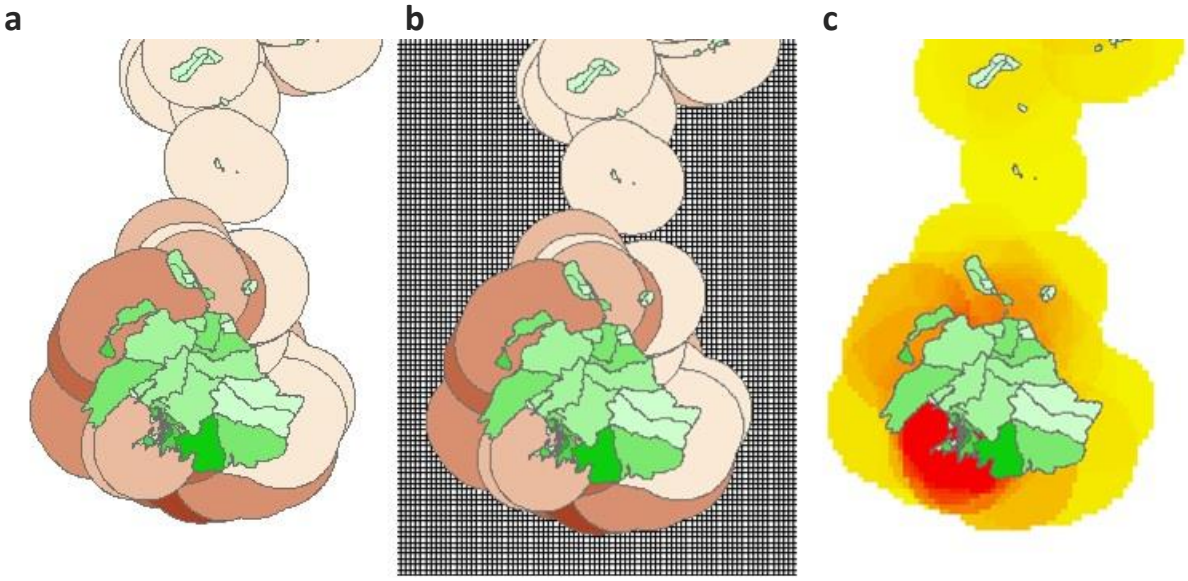
Input included the physical structures of the fishing grounds, oceanic characteristics of the region, biological behaviour of the target species, and human behaviour within the fisheries. To accomplish this, we explored multiple data sets to represent these characteristics of the fisheries. Those included:

- Bathymetry – depth of water; 30 arc seconds resolution (GEBCO 2014; Weatherall et al., 2015))
- Bathymetric Variance – difference in water depth at point relative to surrounding water depths (modification of GEBCO 2014)
- Bathymetric Slope (slope)– derived from GEBCO 2014
- Standard Deviation of Slope (stdev-slope) – localised variance of slope; used to measure the relative roughness or rugosity of a location
- Vector Ruggedness Measure (VRM) – variation in three-dimensional orientation of grid cells within a neighbourhood. ArcGIS Benthic Terrain Modeler extension.
- Reef structures – presence and classification of reef types (Andréfouët et al., 2005)
- Ocean current velocity – velocity (m/s) and direction of ocean currents (CMEMS, 2018)
    - uo: monthly mean of eastward velocity (m/s)
    - vo: monthly mean of northward velocity (m/s)

- Catch and Effort Data
    - Global Landings Data V1.0 – combined 2010-2014 landings (tonnes/km^2) per 30-minute cells by gear type (Watson, 2016)
    - Country Population Statistics (Solomon Islands and Vanuatu) – Number of households with boats, canoes, and people participating in fisheries per Enumeration Area (SPC PopGIS 2018)

Fishing effort data by region from Vanuatu and Solomon Island fisheries management agencies was not attainable during the project period, therefore we utilised two alternative sources of information to depict relative fishing effort from regional fisheries. Specific to the local fisheries, population statistics data describing the number of boats and canoes within each enumeration areas were extrapolated out to 6 nautical miles, based on regulations protecting local fisheries, to depict local nearshore fishing ranges of canoes, small non-powered boats, boats with small outboard engines, and small-powered vessels (Amos 2007; Maneniaru, 2017). All enumeration areas were buffered by 6 nautical miles, with attributes intact. A 0.01 x 0.01-degree fishnet grid covering the study area was created, and the total amount of boats and canoes overlapping each grid were summed. This produced a heat map, generally estimating the maximum number of vessels within range, and potentially fishing, in any given area within 6 nautical miles from shore (Figure 1). Vector data were converted to raster format and values for number of vessels were converted to percent-of-total for analysis purposes.

Figure 1. Example of three step process of extrapolating population statistics data as fishing effort intensity quantified by number of boats and canoes at Efate Island, Vanuatu: (a) layers buffered by potential distance from shore of fishing activity, (b) grids overlain; and (c) number of vessels summed by grid.



Spatial distribution of industrial fishing effort near Vanuatu and Solomon Islands were represented in the Global Landings Data V1.0 dataset (Watson 2016). Unique effort values, represented by tonnes landed per km^2 from 2010 through 2014, were spatially joined with corresponding 0.5" x 0.5" cells in an ArcGIS vector shapefile.

Spatially defined (point data) locations in the study area where derelict fishing gear is known to exist (or previously existed) is an essential component to the probability analysis of where derelict gear may occur. These data were collected by project partners TierraMar, VESS, and WWF in consultations with fisheries managers and fishing communities throughout Solomon Islands and Vanuatu (see method and results below in section 2.3 and 3.3 respectively). Interviews with fishermen in Solomon Islands produced 22 reported known locations of derelict fishing gear items. In Vanuatu, interviewees identified 117 derelict fishing gear locations (Figure 2a). Three locations in Vanuatu were said to have two derelict gear items present (foreign and local), and therefore duplicate points were used to represent each gear item present. In total, 120 derelict gear items in Vanuatu and 22 in Solomon Islands were used for initial spatial analysis. Gear items were primarily nets or net type materials, and in most cases were identified as either *foreign* or *local*, whereas in Solomon Islands the source fisheries of the derelict gear were not reported. Gear described as *local* were assumed to be gillnets, or hook-and-lines based on predominant gear types identified in interview data collected in this study and others (Shaw, 2017; VESS, 2018); while the *foreign* gear were assumed to be FAD materials, purse seine, or longline gear, based on primary gears used by industrial fleet in the region (Richardson et al., 2017). Data were converted from .kmz files to shapefiles for analysis in ArcGIS (Figure 2a).

A total of 142 derelict fishing gear locations were reviewed with the regional characteristics of the fishing grounds; bathymetry, slope, stdev-slope, VRM, number of vessels within 6 nm, fisheries landings, reef features, and ocean current velocity. Using the *Extract Multi Values to Points* tool in the ArcGIS Spatial Analyst toolset, the values from each raster dataset at each derelict gear point location were extracted into a new attribute field. Frequency distribution of values per variable were analysed to identify which of the variables would be suitable as an indicator for derelict fishing gear locations, and then investigated further. During this phase, the primary goal was to identify frequency distributions that appear to have a bell-shaped (normal) curve, or steeply sloped curves. We looked for data that resembles association with the derelict gear locations, and therefore predictability for other similar locations. Random and uniform frequency distributions provide little to no information to assist in identifying values that contribute to derelict fishing gear loss, deposition, or accumulation. As part of the initial analysis process outliers were identified and eliminated from the analysis.

Derelict gear locations that appeared on land, with bathymetric values > 0 m were presumed to be there due to either (a) being deposited on the beach, (b) inaccurate reported point location coordinates, and/or (c) the coarse resolution and associated inaccuracies of the bathymetry dataset used for analysis. In some instances, bathymetry readings were up to +20 m at locations that appeared on the beach or within 100 m of the shoreline in either direction; in such cases the derelict gear location remained in the analysis. In cases where the reported derelict gear location appeared well inland, beyond +20 m, at or near the centre of an island, those points were not used in the analysis. All derelict gear locations in water deeper than 100 m were eliminated from

the initial analysis; the primary purpose for this was to eliminate extraneous analysis of regions beyond depths feasible to conduct derelict fishing gear survey and removal operations. Of the final 142 derelict fishing gear locations reported, 47 targets beyond 100 m water depth, and 10 targets above +20 m altitude (on land) were eliminated from the analysis (Figure 2b).

A total of 85 reported derelict fishing gear locations were used in the probability analysis (Figure 2c).

Figure 2a. Map showing all 139 reported derelict fishing gear locations reported representing 142 derelict fishing gear items.

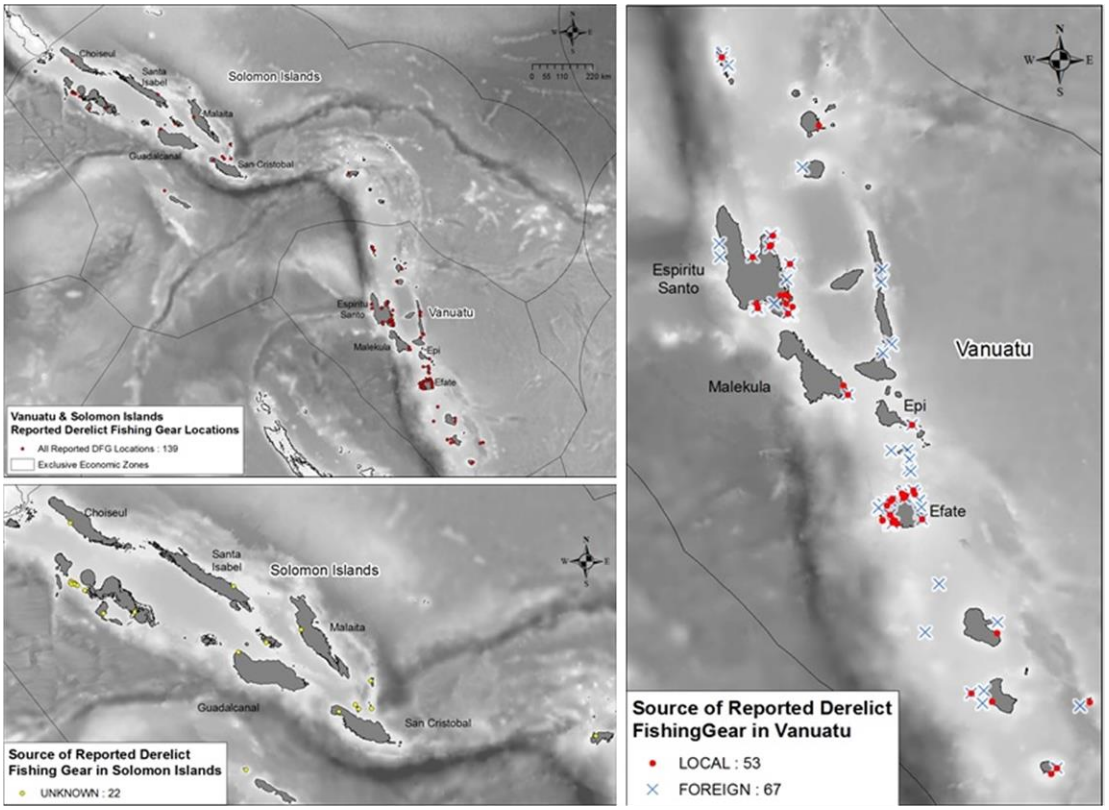


Figure 2b. Map showing 57 reported derelict fishing gear items excluded from probability analysis.

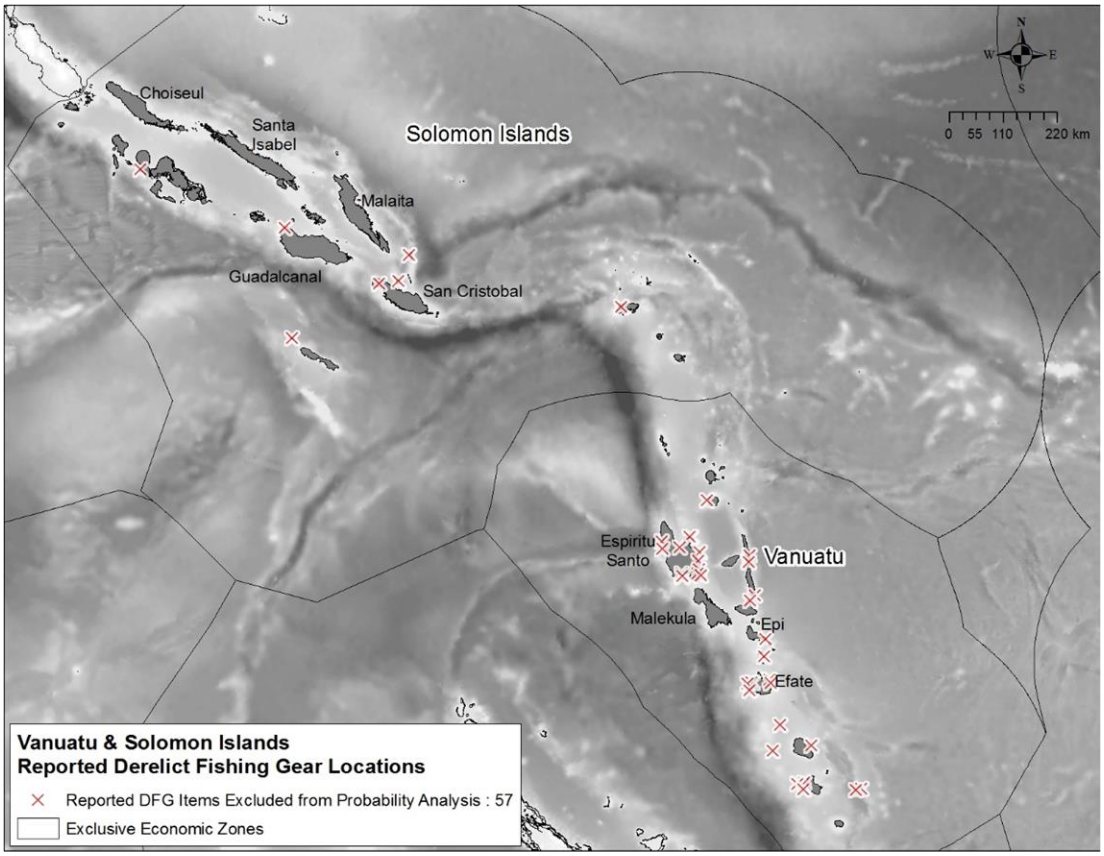


Figure 2c. Map showing 85 reported derelict fishing gear items included in probability analysis.

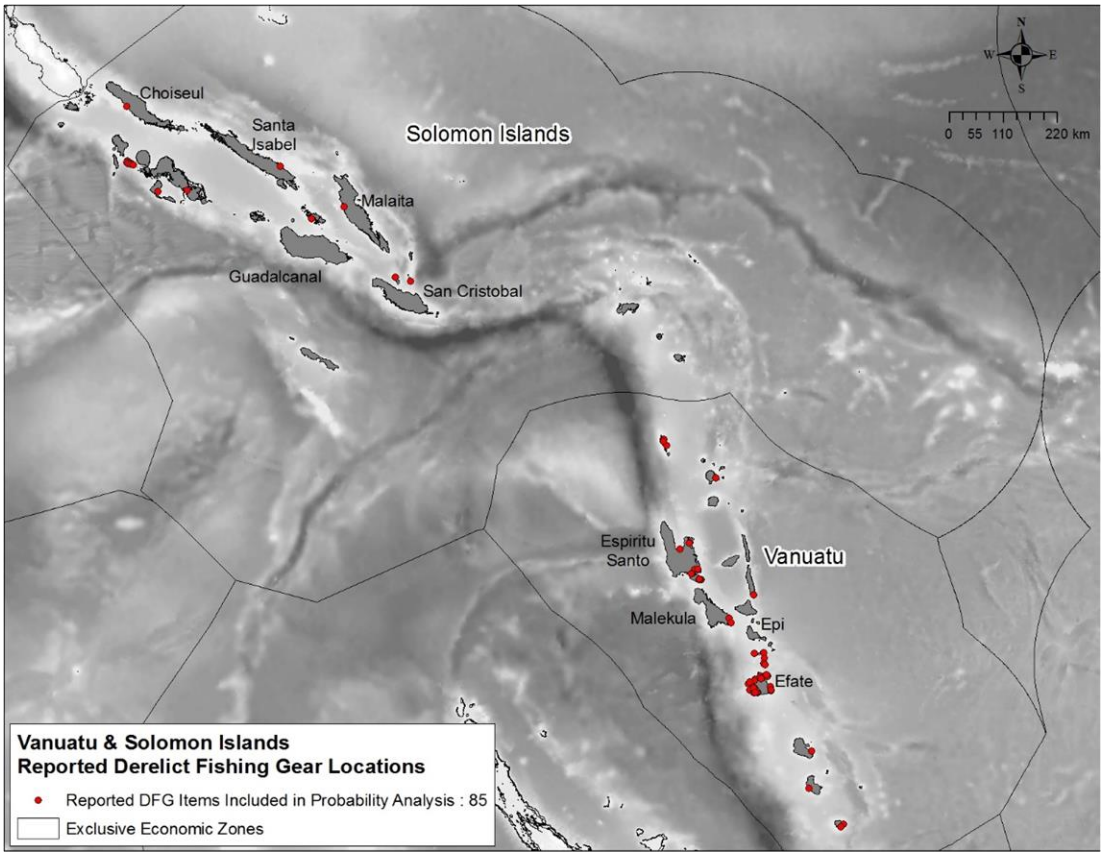
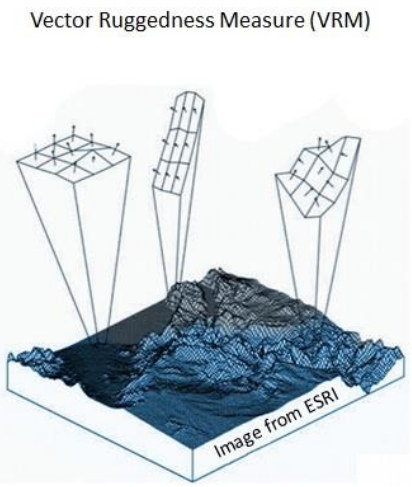


Figure 3. Descriptive statistics of VRM values at reported derelict gear locations in Vanuatu and Solomon Islands and image describing the slope and aspect relationship VRM reports.

VRM_10	
Mean	0.468935013
Standard Error	0.023975788
Median	0.455774
Mode	0.455774
Standard Deviation	0.221045847
Sample Variance	0.048861267
Kurtosis	-0.477794757
Skewness	0.129524599
Range	0.859347
Minimum	0.05914
Maximum	0.918487
Sum	39.8594761
Count	85
Confidence Level(95.0%)	0.047678485



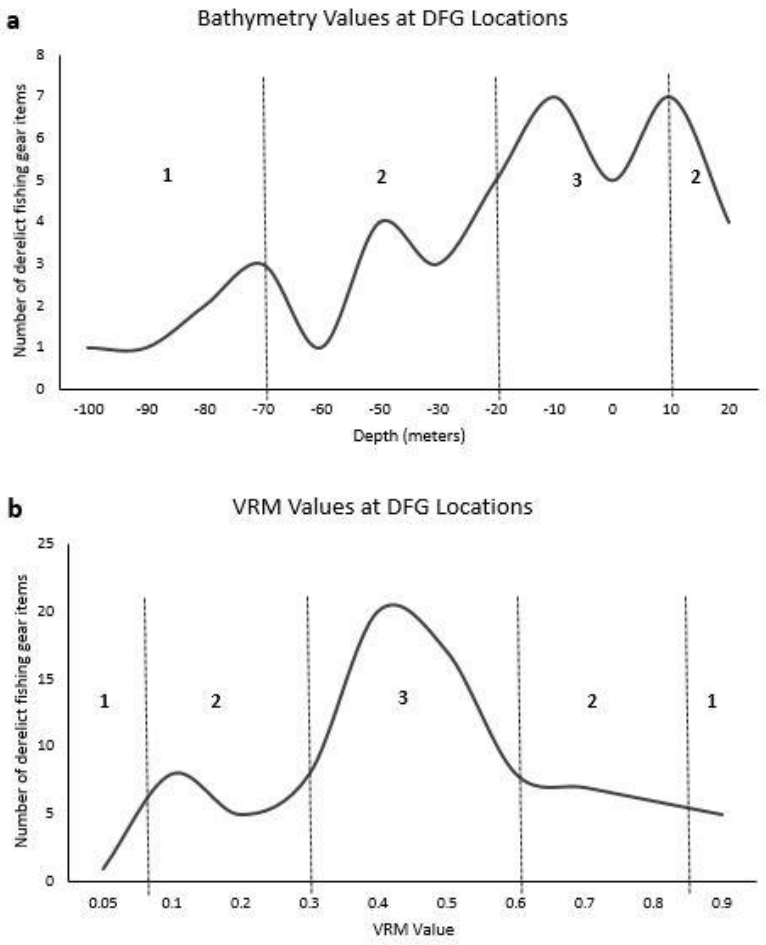
The initial data exploration phase helped determine which of the variables show patterns of association with derelict fishing gear occurrence in the region. Bathymetry was confirmed to be a simple, yet valuable predictor for observed derelict fishing gear locations, and while several iterations of slope and standard deviation of slope were reviewed, none proved to be useful for characterizing the reported derelict fishing gear locations (r = 0.663). That said, the VRM effectively captures variability in slope and aspect of terrain in a single measure (Figure 3) (Sappington et al. 2007); for this study 10 grid cells were used to define the neighbourhood for each value.

The VRM raster developed with the Benthic Terrain Modeler extension showed signs of association with the reported derelict fishing gear locations and was chosen with bathymetry to form the base data to be used for the linear additive model. Figures 4a-b depict the frequency of occurrence of derelict fishing gear by bathymetry and VRM with the classification scheme used for probability rankings.

Data from interviews with local fishermen conducted during this and other projects suggests that fishing occurs year-round in the Solomon Islands, and particularly in Vanuatu, as fishers rarely take any months off (VESS, 2018). For this reason, our review of the ocean currents data included each month of the year for both 2015 and 2016, as analysis of each months' data is necessary to fully capture the variability of ocean currents on the fishing grounds, and their relationship to the reported derelict fishing gear locations. Time constraints did not allow for analysis of ocean current data previous to 2015. To this point only a preliminary analysis of ocean currents values at derelict fishing gear locations have been conducted due to the timing of receiving data to be analysed, and in that analysis no clear association between ocean current data and derelict fishing gear locations were identified. Perhaps in a future iteration of this model ocean currents will be investigated further. The Global Landings V1.0 was used to capture fishing effort combined from both local and industrial fisheries in the study area. Total landings expressed in metric tonnes/km^2 per 0.5° x 0.5° cell for the years 2010 through 2014 were used to represent relative fishing effort throughout the study area.

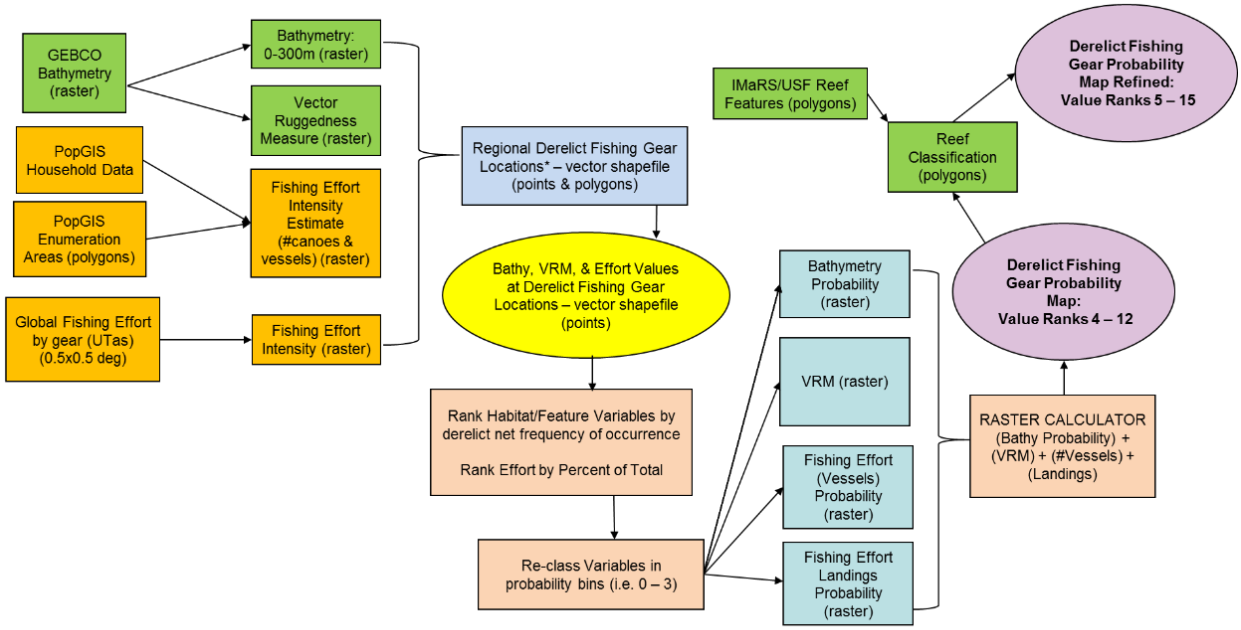
Data proved to follow the general assumption that derelict fishing gear occurrences increase with higher concentrations of fishing effort, and therefore landings data was ranked as such with greater probability rankings where landings values were highest. In following this concept, the estimated fishing effort based on number of canoes and boats per enumeration area was ranked by the percent of total, as ranking values were highest where the highest concentration of canoes and boats occurred.

Figure 4a-b. Frequency of occurrence of reported derelict fishing gear locations at values for bathymetry and VRM in Vanuatu and Solomon Islands; (a) shows number of derelict fishing gear locations by bathymetry with class ranks, (b) shows the number of derelict fishing gear locations by VRM with class ranks.



Using the reclassify tool in ArcGIS, the bathymetry, VRM, and fishing effort were re-classed so that each independent value was represented by an integer value (i.e., 1 – 3) with the highest rank equating to the value set with the highest frequency of derelict fishing gear occurrences. Using the Map Algebra Tool in ArcGIS, the bathymetry and VRM datasets with reclassified values (probability bins) were added together, resulting in a single data layer with cell values from 2 to 6. These values represent the base for low (i.e., 2) to high (i.e., 6) probability of derelict fishing gear occurrence. Fisheries catching estimates from global landings dataset (local and foreign), and the number of (local) vessels per enumeration area were overlaid and the values from areas that intersected the ranked bathymetry and VRM areas were added to the ranking scheme. This produced vector shapefiles with polygons ranked from 4 to 12 and limited the predicted hot spot areas to areas within 100 m water depth. Data without probability ranking values were converted to “No Data” and excluded from the probability model. A flow chart showing the major steps involved in the model building is illustrated in Figure 5.

Figure 5. Illustration of inputs and steps of a linear additive analysis built from multiple data sets representing variables associated with fishing gear loss and lost fishing gear deposition.



The results from this analysis are intended to predict areas where derelict fishing gear will likely occur based on characteristics of the fishing grounds at known/reported derelict fishing gear locations. While this is valuable information, addressing derelict fishing gear through survey and removal operations requires funding and resources that is often limited; enhancing the need for refinement of predictive models such as this to focus on targeted locations, and increase success in locating derelict fishing gear for removal. To refine the identified probability areas, we analysed the relationship between reef features and reported derelict fishing gear locations in the study area. A total of 45 (53%) of the 85 analysed derelict gear locations landed on reef features; 31 (69%) of which were on the *ocean exposed fringing* or *intra-seas exposed fringing* categories, while 14 other targets were on five different reef feature categories. Because these reef features are generally close to shore and easily accessed, they were assigned probability rankings and applied to the predictive model for the purpose of guiding derelict fishing gear surveys to nearshore areas where operations are likely more feasible and cost effective than larger areas that extend further offshore (Table 3).

Table 3. Summary of reef descriptions at reported derelict fishing gear locations and assigned probability rankings

Reef Description	Derelict Gear by Source			Grand Total	Ranking
	Foreign	Local	Unknown		
Atoll rim	1			1	1
Fringing of coastal barrier complex	1			1	1
Intra-seas exposed fringing	**2**	**12**	**1**	**15**	**3**
Island lagoon			3	3	1
Ocean exposed fringing	**7**	**9**		**16**	**3**
Shelf patch-reef complex		1		1	1
Shelf slope	6	2		8	2
Grand Total	17	24	4	45	

2.3 Extent of Gear Loss

Interviews were conducted in December and January 2019 by project partners TierraMar, VESS, and WWF. Fishers, fisheries managers, and other stakeholders from Vanuatu and Solomon Islands were interviewed to identify areas where gear is known to be lost, why gear is lost and to elicit locally appropriate suggestions for solving the problems associated with lost fishing gear.

2.3.1 Gear loss in coastal inshore and artisanal fisheries

2.3.1.1 Interviews and questionnaires

Interviews with focal points were conducted in December 2018 and January 2019 by project partners TierraMar, VESS and WWF. Fishers, fisheries managers and other stakeholders from Vanuatu and Solomon Islands were interviewed to identify areas where gear is known to be lost, why gear is lost and to elicit locally-appropriate suggestions for solving problems associated with lost fishing gear. The following set of standard questions were used.

Fishers

1.a. What sort of fishing are you doing?
1.b. Where do you fish?
1.c. What type of gear do you use?
2.a. Over a year, how much gear do you use?
2.b. How often would you have to buy new gear?

2.c. Where do you buy it from?
3. How often do you have to do repairs to your gear?
4.a. What do you do with the old or damaged gear?
4.b. What happens with old or damaged gear in other villages?
5. Have you or anyone you know ever lost gear, perhaps through it getting tangled or damaged? What caused it to get lost?
6. Have you seen any places where there is a lot of gear either tangled up on the bottom or washed up on beaches?
7. What ideas do you have for how to stop gear being lost or entangled on reefs?

Managers

1. What are the main gears used in fisheries in Solomon Islands/Vanuatu? How many fishers are there? How are fisheries managed?
2. Is the gear licenced (i.e. fishers must have a licence to have a net or line or FAD?)
3. What regulations are in place in relation to FAD design and materials?
4. What regulations are in place relating to lost gear?
5. Are there any hotspot areas you are aware of where it is common to see gear washed up on the beach or floating along the coast? What sort of gear is it?
6. How significant a problem do you think ghost gear is in Solomon Islands and Vanuatu?
7. What ideas do you have for how to stop gear being lost or entangled on reefs?

Other stakeholders

1. Are there any hotspot areas you are aware of where it is common to see fishing gear washed up on the beach or floating along the coast?
2. What sort of gear is it?
3. What happens to the lost gear that washes up? Is it collected, used by community, etc.?
4. How significant a problem do you think it is in Solomon Islands and Vanuatu? What about in other places across the Pacific?
5. What ideas do you have for how to stop gear being lost or entangled on reefs?

Additionally, on February 20, 2019, a Workshop on Best Practices for the Management of Lost Fishing Gear was held in Port Vila, Vanuatu. Thirty-one people from eight nations attended the workshop. Participants represented government fisheries and environmental agencies, appointed officials from FAO, local nongovernmental organisations and other relevant stakeholders (see list of participants in Annex A). During the workshop, information about extent, causes, and solutions to ALDFG in the region was elicited (see agenda in Annex A).

2.3.1.2 Extent and rate of gear loss

To estimate the extent of fishing gear loss in coastal and artisanal fisheries, assumptions and extrapolations were required due to limited data availability. First, the number of fishers was estimated based on available census data, which provide information about households engaging in fishing. To estimate the number of active fishers in Solomon Islands, we reviewed the Solomon Islands Census Report on Economic Activity and Labour Force (Solomon Islands National Statistics

Office, 2009) and downloaded the associated data from PopGIS. These sources provided number of households involved in fishing for subsistence and for sale per enumeration area. As this covers both subsistence and sales, it covers the population of fishers involved in both artisanal and larger-scale commercial fisheries. However, the number of Solomon Island foreign flagged industrial vessels is limited. A similar approach was taken to estimate the number of active fishers in Vanuatu. The Vanuatu National Statistics Office completed a 'mini-census' in 2016, which included a summary of the number of households engaged in marine fishing (Vanuatu National Statistics Office [VNSO], 2016).

Using data from TierraMar interviews with 58 fishers, the percentage of fishers using certain gear types was established (see Annex C and D respectively for more details about the interview methodology and participants). The interviews revealed that 76% (44 out of 58) fishers acknowledged losing gear at some time during their fishing career.

The estimated rate of gear loss in the coastal commercial and artisanal fisheries in the project area are based on data from interviews, including coastal and artisanal fishers, industrial fishing representatives and other stakeholders. The percentage of types of gear being lost and the causes for loss was extrapolated again to the total number of fishers in the project area. Because the interviewed fishers did not indicate the number of gear items lost per year, an estimate of yearly loss rate cannot be developed. Only an estimate of total numbers of gear items lost by type was developed.

2.3.2 Gear loss rate in industrial fisheries

To estimate the fishing gear loss rate for industrial fisheries operating in the project area, NRC analysed data on pollution discharges reported by Richardson et al. (2017). Richardson et al. analysed pollution incidents reported by fisheries observer employed by the Secretariat of the Pacific Community/Pacific Islands Forum Fisheries Agency (SPC/FFA) between 2003 and 2015. They identified the numbers of incidents involving discharges of fishing gear and reported this information by fishery (purse seine, longline, pole and line), by flag of vessels and by location of the incidents. (Richardson et al., 2017). The presented data was further analysed to develop annual gear loss estimates for the purse seine and longline fisheries for Vanuatu and Solomon Islands.

2.3.3 Causes of gear loss

Causes of gear loss were identified during TierraMar interviews with Focal Points and during the structured conversations at the Workshop on Best Practices for the Management of Lost Fishing Gear. Cause of gear loss in the industrial fishing sector were extrapolated from Richardson et al. (2017).

2.3.4 Recommendations for prevention and mitigation of lost fishing gear

Recommendations to prevent and mitigate fishing gear loss were developed based on the identified causes of gear loss and identified barriers to preventing gear loss. Recommendations were informed by local ecological knowledge gathered from interviews and a structured

conversation with the 31 participants of the Workshop on Best Practices for the Management of Lost Fishing Gear.

Responses from interviews and structured workshop conversations were collated and organised by fishery, gear type, and stakeholder group to inform the development of recommendations. Recommendations include applicable best practices identified in the GGGI BPF (Huntington, 2017), as well as specific fisheries management and outreach activities appropriate to the unique fisheries management regime in Vanuatu and Solomon Islands. NRC identified key stakeholders in the Pacific region seafood supply chain that can act to prevent gear loss and minimise harm from lost gear. Recommendations are organised by fishery and gear type and by stakeholder group.

2.4 Supporting Tracking of aFADs

World Animal Protection and NRC recently completed a two-year AFAD Tracking Project with VFD to trial low-cost position tracking devices on aFADs in Vanuatu (Drinkman, 2018) with the following objectives:

- Identify and trial position tracking and marking technologies in aFADs in an artisanal fishery;
- Trial low-cost methods for marking and tracking artisanal aFADS and enhance technical understanding in an artisanal fishery for how fishing gears can be marked and/or tracked; and
- Provide a practical case study on aFAD management from an artisanal fishery to contribute to the FAO Technical Consultation on the Marking of Fishing Gears held in February 2017.

Two recommendations from the AFAD Tracking Project are being undertaken in this arm of CliP:

- Support the continued trialling of existing and newly-designed tracking devices to determine their effectiveness in different locations; and
- Investigate and document areas of accumulation of lost anchored and drifting FADs.

Continued support for the tracking of aFADs is described in this section. The investigation and documentation of areas of accumulation of lost FADs is incorporated into activities described in Sections 2.3 and 3.3 as FADs were considered during analysis of fishing gear loss.

The project included providing to VFD two kinds of tracking devices: Pelagic Data Systems VTS units and SatLink satellite buoys with echosounders. The PDS unit is designed to be attached to a pole and buoy used as an end buoy in the Vatuika AFAD design (Figure 6). The PDS unit is solar powered and relays its position via the cellular network every 1-6 hours depending on the level of solar charging available at the deployment position. The SatLink buoy with echosounder is attached with a rope to the end buoy of the Vatuika AFAD. It is solar-powered and transmits position data hourly over the satellite network. Both devices have a user-protected desk-top interface. Both NRC and VFD personnel have unique user identifications and passwords for these interfaces.

PDS units and SatLink devices were deployed at five AFAD locations and monitored. Results included greater understanding of the benefits and challenges of tracking the positions of AFADs in the challenging marine environment around Vanuatu. In particular, the project found that neither tracking device can withstand being submerged for lengthy periods of time and that cellular and internet service infrastructure is unreliable.

VFD currently owns three Pelagic Data Systems VTS units and one SatLink buoy with echosounder. NRC supported the tracking of AFADs in Vanuatu through continued technical assistance to the VFD related to these units.

Figure 6. PDS unit and SatLink buoy attached to Vatuika AFAD.

2.5 Facilitating a Workshop on Best Practices for the Management of Lost Fishing Gear

We developed the workshop agenda and consulted with VFD leaders to determine the best date for the workshop. Director Kalo Pakoa requested that the workshop be held on 20 February 2019 to allow for maximum participation from those attending the CLiP conference in Port Vila 18-19 February. Subsequently, everyone attending the CLiP conference was invited to the February 20 workshop, as well as all participants in the previous policy workshops held in Vanuatu and Solomon Islands, and other stakeholders.

The workshop objectives were:

1. Connect and build relationships with others working on/interested in lost fishing gear in the Pacific region.
2. Gain a baseline understanding of:
    - the scope and scale of the lost fishing gear problem both *globally, regionally* and *locally*
    - the types of solutions being used to address lost fishing gear
    - regional fisheries management strategies as they pertain to lost fishing gear.
3. Share perspectives and insights about challenges and solutions to preventing negative impacts from lost fishing gear.
4. Identify the key challenges, solutions, and next steps

The workshop was organised as a series of small-group conversations separated by presentations from local fisheries authorities.

3. Results

3.1 Fisheries Management Assessment

Neither Solomon Islands nor Vanuatu fisheries management policies and practices include any measures specifically designed to prevent, mitigate, or eliminate harm from ALDFG (Republic of Vanuatu, n.d.; Ministry of Fisheries and Marine Resources, 2008; Republic of Vanuatu, 2014; National Parliament of Solomon Islands, 2015; Maneniaru, Hon. J., 2017). However, several common fisheries management practices are consistent with the GGGI BPF (Huntington, 2017).

Solomon Islands requires marking of the aFADs it deploys to ensure they are identified as property of the Ministry. And as a member of the Parties to the Nauru Agreement (PNA), all dFADs in Solomon Islands EEZ are required to be tracked via satellite buoy. Fishing companies are required to provide the dFAD positions to the PNA. However, there is no requirement to continue tracking them after they are not being fished. There is also no requirement to retrieve dFADs after they are no longer being fished or tracked.

Vanuatu has made some progress on marking and tracking its aFADs through the project with World Animal Protection (Drinkwin, 2018). The Vatuika FAD design now commonly used in Vanuatu includes a flag on its end buoy to increase visibility of the aFAD (Amos et al., 2014). See Figure 7.

In both countries, industrial vessels are required to be marked with a unique vessel identification, but there are no requirements to mark fishing gear. See Table 4 for a full assessment of management practices against the GGGI BPF (Huntington, 2017).

Figure 7. Vatuika aFAD deployed.

Photo provided by Vanuatu Fisheries Department

Table 4. Consistency of Vanuatu and Solomon Island Fisheries Management, Regulations, and Enforcement with the GGGI BPF and the FAO voluntary Guidelines for the Marking of Fishing Gear

BPF recommended practice	Vanuatu Fisheries Department Practices	Consistency score (High, Medium, Low)	Solomon Islands Ministry of Fisheries and Marine Resources Practices	Consistency score (High, Medium, Low)
Preventing harm from ghost gear				
Restrict use of some fishing gears in areas with a high risk of loss due to local conditions	No fishing area restrictions relate to risk of losing gear. Mandates observation of FAD closure consistent with that mandated in the PNA. This restriction is not related to preventing loss of FADs, but it serves to decrease FAD deployment, thus reducing gear loss.	Low	As a member of the Parties to the Nauru Agreement, Solomon Islands restricts the setting on FADs during a four-month closure period June-September. This restriction is not related to preventing loss of FADs, but it serves to decrease FAD deployment, thus reducing gear loss.	Medium
Mandate temporal and/or spatial separation of fishing gear necessary to avoid loss of fishing gear caused by conflicts	There are bans in some local areas for a certain amount of time based on Custom management practices at the community level. However, no record of any bans implemented related to preventing lost fishing gear.	Low	aFADs deployment is prohibited in navigation shipping lanes. There are bans in some local areas for a certain amount of time based on Custom management practices at the community level. However, no record of any bans implemented related to preventing lost fishing gear.	Low
Require the use of biodegradable materials on certain fishing gears and escape panels for pots and traps to minimise ghost fishing if the gear is lost	None	Low	FAD designs made with biodegradable materials 'preferable' FAD designs should 'minimise entrapment of marine animals'	Low
Provide education to build awareness of the harm caused by lost fishing gear and the practices available to avoid losing fishing gear	None	Low	None	Low
Collaborate on and support the retrieval of lost fishing gear	VFD has collaborated with NRC to retrieve lost AFADs.	Medium	None	Low

BPF recommended practice	Vanuatu Fisheries Department Practices	Consistency score (High, Medium, Low)	Solomon Islands Ministry of Fisheries and Marine Resources Practices	Consistency score (High, Medium, Low)
Inform owners of lost gear retrieved, if possible, for re-use and proper disposal	VFD reused AFAD material retrieved during fall, 2018. When lost gear is found on local beaches, it is common practice for local community members to repurpose the materials.	Medium	None When lost gear is found on local beaches, it is common practice for local community members to repurpose the materials.	Low
Marking fishing gear				
Complete a risk assessment process to identify the scope and priorities for a fishing gear marking system	None	Low	None	Low
Implement and coordinate a fishing gear marking system consistent with the FAO Voluntary Guidelines for the Marking of Fishing Gear	The common Vatuika AFAD design includes marking end buoy with a flag for visibility (Figure 7). Drifting FADs are required to be marked with vessel number.	Medium	All AFADs are marked with stickers denoted that they are property of the Ministry of Fisheries.	Medium
Identify fishing gear marking systems to be used and identify to which fisheries, gears, vessels and areas the systems apply	Industrial fishing vessels operating in the Vanuatu EEZ are required to be marked with a unique vessel number. Drifting FADs are required to be marked with vessel number and a radar reflector to increase visibility.	Low	Industrial fishing vessels operating in the Solomon Islands EEZ are required to be marked with a unique vessel number. All FADs are required to be marked with owner's identification, radar reflector. dFADs are required to be marked with radio beacons.	Low
Collaborate with appropriate partners to provide education to ensure fishers have the capacity and training to follow gear marking guidelines	None	Low	None	Low

Reporting lost fishing gear				
Ensure there is an effective system in place to report lost or abandoned fishing gear	Fishers notify the VFD when AFADs have gone missing. Offshore vessels are required to report loss of FADs to the Department.	Medium	Fishers who have lost gear may notify the Ministry. Offshore fishing vessels are required to notify the MFMR an Marine Division if an aFAD is lost.	Medium
Develop lost gear reporting protocols cooperatively with gear manufacturers, vessel operators, fishing companies, fishing organisations, and other fisheries administrations	In a recent project, VFD developed a lost AFAD communication system with NRC and a local charter fishing company to ensure AFAD positions were monitored and AFADs were retrieved if lost.	Medium	None	Low
Maintain a lost fishing gear register that includes the following: type of gear lost, identifying marks, date/time/position of loss or retrieval, reason for loss, weather conditions, other relevant information	None	Low	As a member of the Parties to the Nauru Agreement, industrial fishing FADs deployed in Solomon Islands EEZ are tracked using satellite buoys and their position is provided to the PNA.	Medium
Coordinate, communicate, and share information about lost fishing gear with other entities such as RFMOs, and regional and State fisheries managers	None	Low	None	Low
Facilitate the reporting of lost fishing gear by small-scale, artisanal and recreational fisheries to appropriate authorities	Reporting of lost AFADs is included in artisanal fishing catch recording.	Medium	None	Low
Fisheries regulation and enforcement				
Fishing licensing processes should explicitly include requirement to mark and identify fishing gear as a condition to fish	As a condition to fish, industrial fishing vessels operating in the Vanuatu EEZ are required to be marked with a unique vessel number.	Medium	As a condition to fish, industrial fishing vessels operating in the Solomon Islands EEZ are required to be marked with a unique vessel number.	Medium

	VFD has started a licensing programme for inshore fisheries. It is in its pilot stage.			
Required fishing gear marking and spatial of temporal fishing separation should be included in Monitoring, Control, and Surveillance activities	Monitoring and surveillance include 100% observer coverage on purse seine vessels operating in the Vanuatu EEZ and 5% observer coverage on longline vessels. Vessels are tracked using the Vessel Monitoring System (VMS) as well as recent aerial monitoring funded by Australis.	Medium	Monitoring and surveillance include 100% observer coverage on purse seine vessels operating in the Vanuatu EEZ and 5% observer coverage on longline vessels. Electronic monitoring of longline vessels has been installed on approximately ten vessels as a pilot program. Vessels are tracked using the Vessel Monitoring System (VMS) as well as recent aerial monitoring funded by Australis.	Medium
Port State inspection of fishing gear should be conducted in accordance with the procedures set out in Annex B, paragraph e) of the FAO Agreement on Port State Measures to Prevent,Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO, 2016)	Port inspections are conducted as funding allows but are not related to gear marking or preventing gear loss.	Medium	Port inspections are conducted as funding allows but are not related to gear marking or preventing gear loss.	Medium
Inspections should be conducted at sea and at port to ensure that gear marking and other requirements relevant to preventing gear loss are adhered to	None. Inspections are conducted but are not related to gear marking or preventing gear loss.	Low	None. Inspections are conducted but are not related to gear marking or preventing gear loss.	Low
Deployed gear found without required marking should be reported to the relevant authority	None	Low	None	Low

Appropriate penalties or other sanctions should be established to prevent and deter non-compliance with gear marking and other regulations relevant to preventing gear loss	None. Any penalties are not related to gear marking of preventing gear loss.	Low	None. Any penalties are not related to gear marking of preventing gear loss.	Low
Penalties or sanctions should be proportionate to the non-compliance, clearly communicated to the fishing industry, and should include appropriate consultation and appeal processes	Regulations include an appeal process.	High	Regulations include an appeal process.	High

3.2 Probability Mapping Analysis

Using values derived from bathymetry, VRM, and estimated fishing effort at 85 reported derelict fishing gear locations in Vanuatu and Solomon Islands, the probability model provides integer values from 4 to 12 (Vanuatu) and 4 to 11 (Solomon Islands) binned in three categories representing low to high probability of derelict fishing gear occurrence within 100 m water depth from the respective shorelines. Additionally, the model was refined to identify probability that occur on nearshore reef features, with integer values from 5 to 15, and 5 to 14 respectively. The differences in the range of integer values between Vanuatu and Solomon Islands exist due to a greater number of landings data reported in Vanuatu waters than in Solomon Island waters in the global fishing dataset. In these iterations of predicting derelict fishing gear probability areas the linear additive model assumes equal weighting of all variables in the equation. Once the probability value is calculated there is no way to distinguish the combination of variables at a given location, and therefore locations with the same probability value may exhibit different characteristics. That said, in order to keep the potential hot spot areas within feasible working depths, fishing effort values were only incorporated into the model where they intersected the ranked bathymetry and VRM areas.

In total the predictive model covers 26,958 km^2 of fishing grounds around Solomon Islands (21,147 km^2) and Vanuatu (5,810 km^2). Table 5 shows the total amount of area of high, moderate and low probability rankings in the study area in Vanuatu and Solomon Islands. Areas of high probability (value: 10 – 12) account for 13% (3,699 km^2) of the study area and contain 62% (n = 53) of the analysed derelict fishing gear locations. Areas of moderate probability (value: 8 – 9) comprise 47% (12,702 km^2) of the study area and contain 32% (n = 27) of the derelict fishing gear locations. Areas of low probability (values: 4 – 7) totalled 39% (10,556 km^2) of the study area and contain 6% (n = 5) of the derelict fishing gear locations analysed. The refined version, including only hot spot areas that land on specific reef features is 3,508 km^2, with the high probability areas (value: 13 – 15) covering 13% (460 km^2), moderate probability areas covering 63% (2,223 km^2), and low probability areas covering 24% (826 km^2). Thirty-one (31) of the derelict fishing gear

locations are inside the high probability reef areas, and 13 are in the moderate probability reef areas (Figures 8-11).

Table 5. Amount of area (km^2) within study area by country identified in high, moderate, and low probability areas for derelict fishing gear occurrence identified in probability analysis.

	Probability Rank	Area (km^2)		Total Area (km^2)
		VANUATU	SOLOMON ISLANDS	
Model	High	2,721	978	3,699
	Moderate	2,446	10,256	12,702
	Low	644	9,913	10,557
Model w/ reef features	High	430	30	460
	Moderate	415	1,808	2,223
	Low	5	821	826

Areas of high probability for derelict gear occurrence in the Solomon Islands are much smaller than those in Vanuatu. In Solomon Islands high probability areas occur around Choiseul, New Georgia, and Santa Isabel Islands, with the largest continuous areas off of southern and north-western Choiseul (Figure 8). Refining the model with the reef features heavily reduces the amount of high probability areas in Solomon Island; however they still occur in many of the same locations on a smaller scale (Figure 9). High probability areas in Vanuatu cover relatively large areas around nearly every island, with the largest continuous areas around Malekula, southern Espiritu Santo, and Efate (Figure 10). Several of these locations also appear as high probability areas in the refined reef-only version of the model, but to a much lesser extent (Figure 11). The large differences in areas of high, moderate, and low probability areas between Solomon Islands and Vanuatu suggests there would be value, particularly to the Solomon Islands, to further refine the model to be more country-specific.

Vanuatu and Solomon Islands are below- and above-sea features caused by accreted terrains, and the subduction of the Indo-Australian Plate below the Pacific Plate (Petterson et al., 1999) (IRIS, 2019). Tectonic processes, including volcanoes and earthquakes have formed these unique islands and quite notably the dynamic seafloor bathymetry surrounding them.

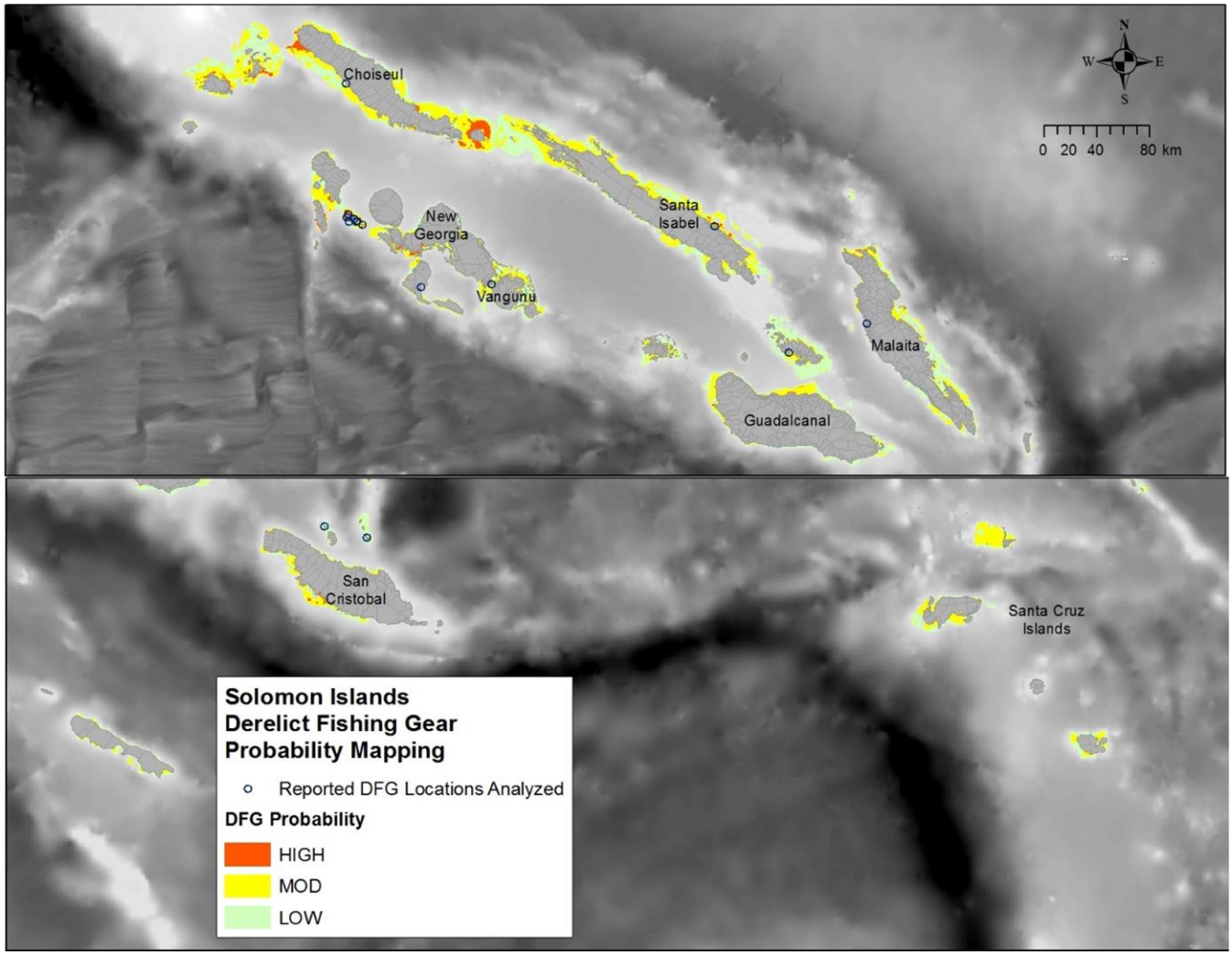


Figure 8. Map showing areas of low, moderate, and high derelict fishing gear probability areas in Solomon Islands based on reported derelict fishing gear locations.

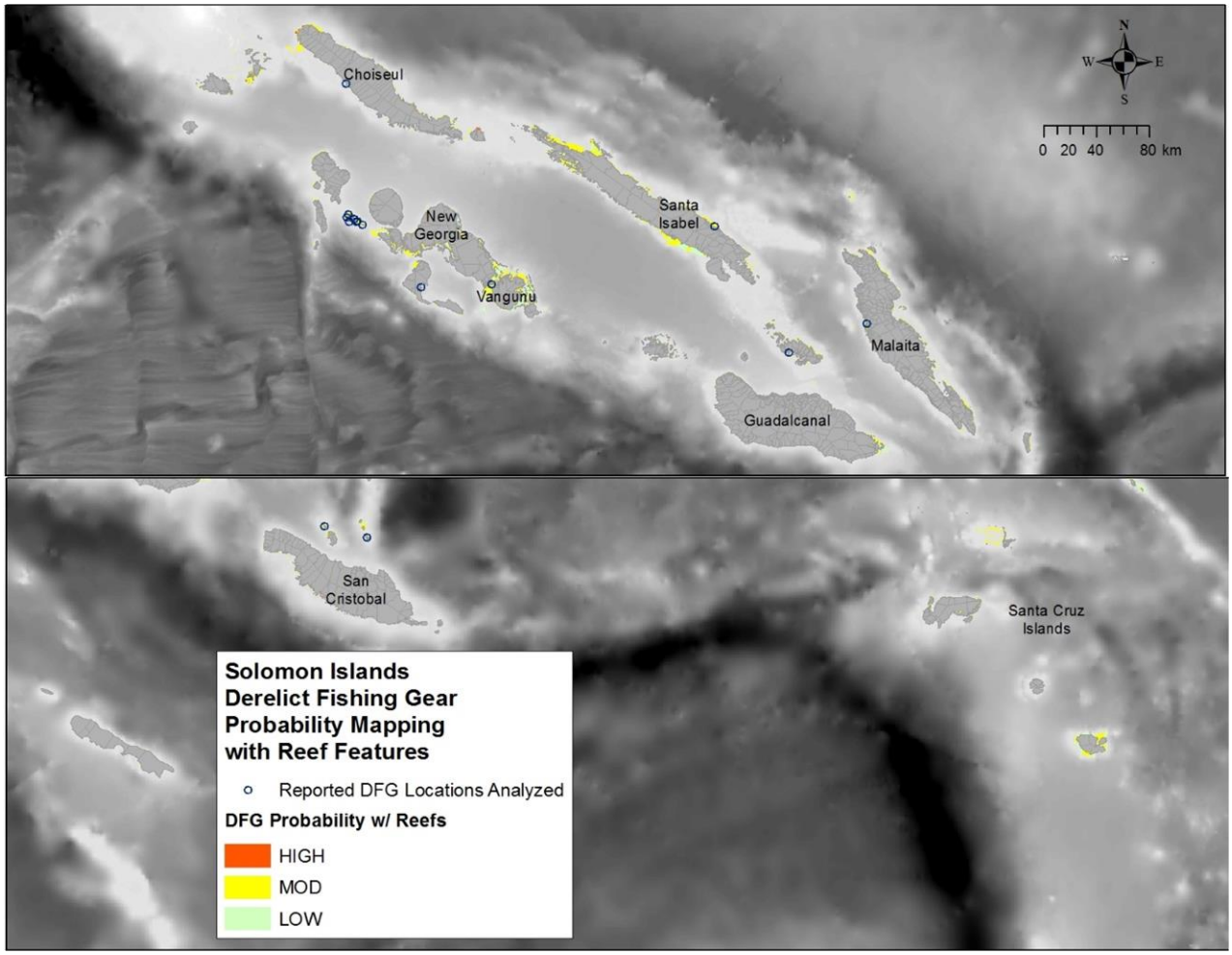


Figure 9. Map showing areas of low, moderate, and high derelict fishing gear probability areas at reef features in Solomon Islands based on reported derelict fishing gear locations.

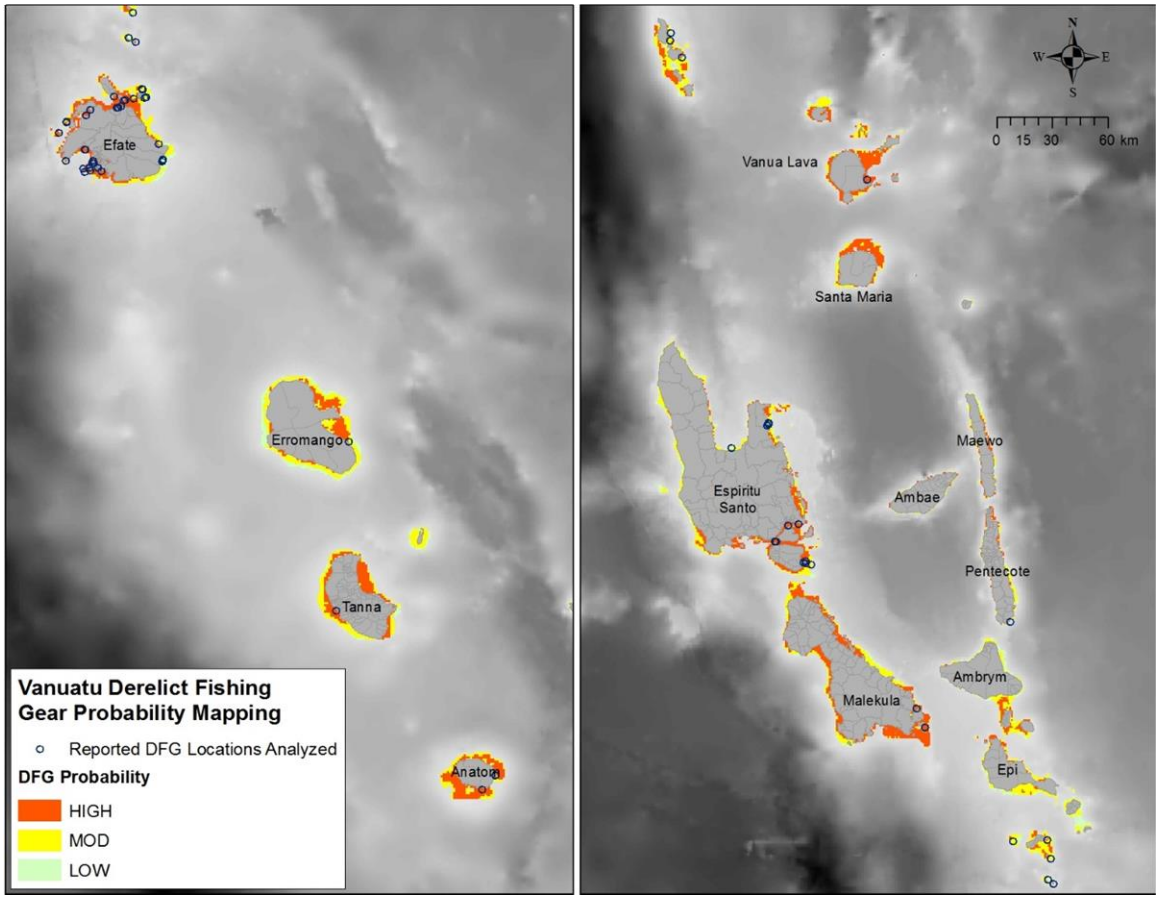


Figure 10. Map showing areas of low, moderate, and high derelict fishing gear probability areas in Vanuatu based on reported derelict fishing gear locations.

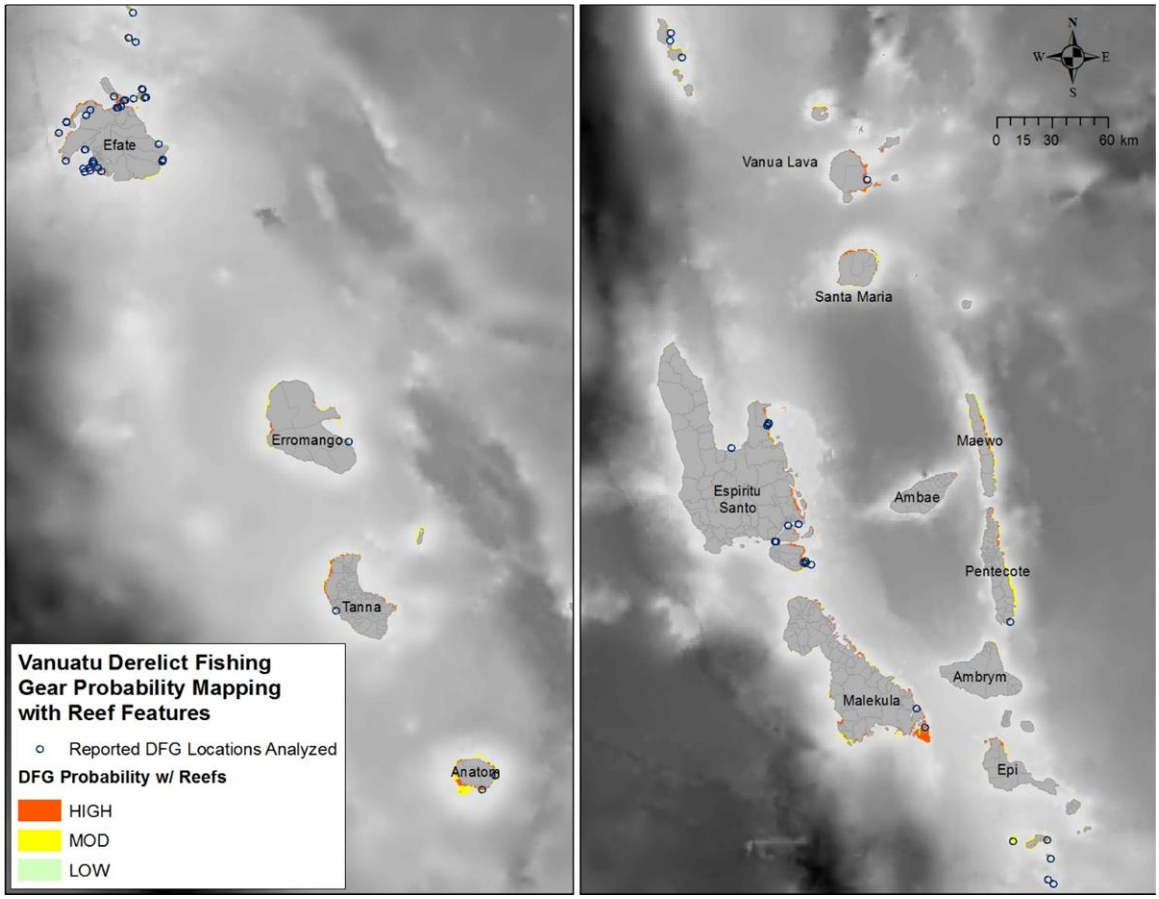
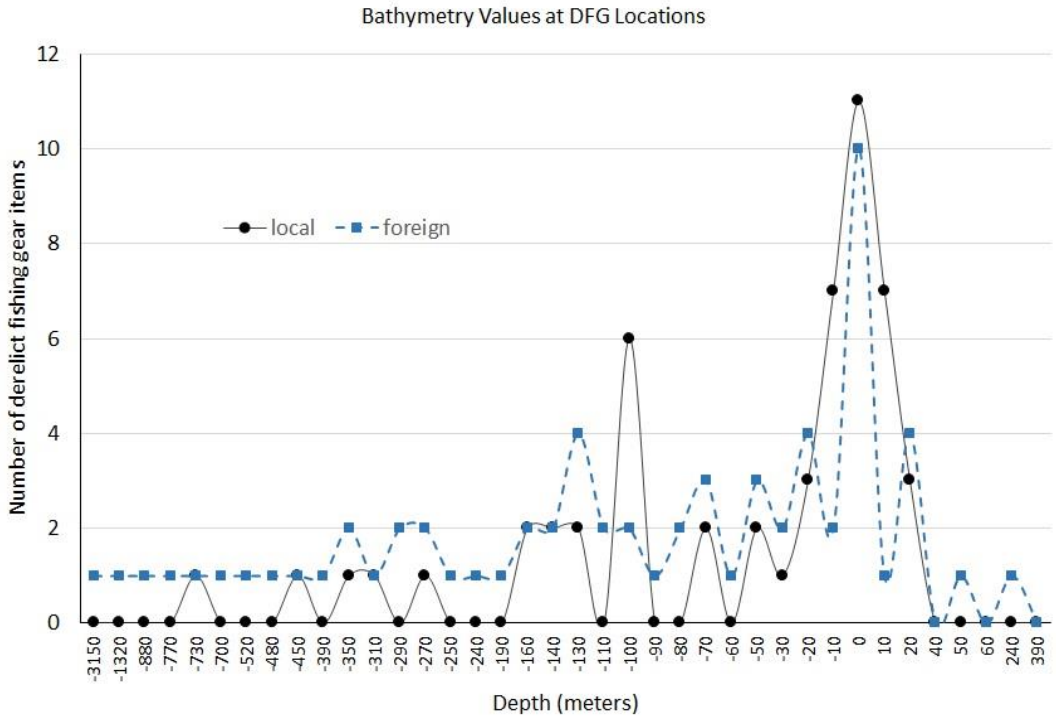


Figure 11. Map showing areas of low, moderate, and high derelict fishing gear probability areas at reef features in Vanuatu based on reported derelict fishing gear locations.

Bathymetry remains as an important component of this research, and the analysed data shows that most of the derelict fishing gear reported in the study area were in water depths of -20m or shallower (Figures 4a and 12). Previous research has identified water depth as a reason for gear loss, as an unexpected shift in water depth can cause gear to become ensnared on the seafloor (Antonelis, 2013; Richardson et al., 2018) Water depth can also be associated as a reason for lost gear deposition and accumulation, as floating lost gear will often eventually drift into a shallow area where it will snag on the seafloor (or beach) and remain. For the purpose of identifying and predicting where derelict fishing gear may be found; whether it is the cause of the gear loss or the reason for the gear to be deposited in any given location, water depth (bathymetry) is a key component and as such remained a foundational component to this analysis.

Figure 12. Frequency distribution of water depth at reported derelict fishing gear locations. Summarised by reported source fishery.



Where human error and bias becomes an issue is if most derelict gear sightings and reports are in shallow water. Since that is where people are more likely to be, the will likely see derelict fishing gear there if it is present on a higher frequency than they would see it in deeper water. One interesting finding from the bathymetric data at reported derelict gear locations is that the gear identified as foreign was seen more frequently in deeper water than the gear identified as local (Figure 12). Thirty (30) of the 67 (45%) derelict gear items identified as foreign were in water deeper than 100m, whereas 11 of the 53 (21%) of the local gear items were in water beyond

100m. This is likely the result of local fisheries primarily occurring in the nearshore, shallow waters whereas the presence of the foreign fleets is predominantly offshore. Beyond distinguishing between foreign and local, very little data regarding gear type were associated with the reports, and therefore the probability areas reported here are not specific to any gear type or source, rather they depict where derelict fishing gear, in general, will likely occur.

Empirical data related to fishing effort by gear type by area remains the primary gap in data to this point. While information from interview respondents is extremely helpful to identify fishing areas (Shaw, 2017; VESS, 2018), the entire range of the study area was not covered. Estimated fishing grounds by distance from shore based on number of boats and canoes in each enumeration area were useful, and they generally correspond with data available in global landings datasets, however refinement and validation of such estimates would be helpful. The coarse nature of the available data used for this analysis leads to relatively coarse results, therefore further refinement where possible is important in fine-tuning the predictive analysis and in-turn the success of derelict fishing gear investigations into the areas identified to have a high likelihood of derelict gear occurrence. With time and additional data such as from fishing effort metrics from management agencies and detailed descriptions of each reported gear item, further iterations of this probability analysis could include analysis by gear type and other variables, such as ocean currents and wind speeds. Nevertheless, the probability rankings derived from this research will be useful in guiding future derelict fishing gear surveys and removal operations.

3.3 Extent of Gear Loss

3.3.1 Coastal inshore and artisanal fisheries

In 2009, the total number of households involved in fishing in all Solomon Island was 28,238. This number was used as a proxy for numbers of fishers in artisanal and coastal fisheries based on the limited number of Solomon Islands-flagged industrial fishing vessels.

According to the Vanuatu 2016 census, 49% of the households surveyed participate in fishing; the total number of households participating in marine fisheries for the country of Vanuatu was 27,068 (VNSO 2016). This number was used as a proxy for numbers of fishers in artisanal and coastal fisheries based on the limited number of Vanuatu-flagged industrial fishing vessels.

Combining these numbers yields an estimated 55,306 local fishers active in Vanuatu and Solomon Islands.

Taking into account that the questionnaires revealed 44 out of 58 fishers acknowledged losing fishing gear[1], this results in an estimated 42,032 fishers in Vanuatu and Solomon Islands lose fishing gear at some time in their fishing career.

[1] The sample size in Solomon Islands was too small to analyse. Thus, we used the data to extrapolate to both countries.

To estimate the number of fishing gear items lost by gear type, we established the per cent of gear types being used by the fishers interviewed. The types and per centages of gear types being used included gillnets or demersal nets (53%), lines or poles with line (71%), spear guns or hand spears (41%), longlines (5%) and fish traps (3%). Most fishers interviewed used multiple types of fishing gear (Table 5).

Applying these established per centages to the estimated total number of fishers in the project area yielded estimates of numbers of gear types being used (Table 6).

Table 6. Fishing gear used by type by coastal and artisanal fishers

Fishing gear used by coastal and artisanal fishers (N=58)				
gillnet or demersal net	line or pole and line	spear guns or hand spear	longline	fish trap
31	41	24	3	2
53%	71%	41%	5%	3%

The 58 fishers interviewed reported the types of fishing gear they had lost over the course of their career. Forty-four (76%) said they had lost gear and some reported losing multiple types of gear. These numbers of reported incidents of gear loss by gear type are reported in Table 7. Twenty-one fishers, or 43%, reported losing gillnets or demersal nets. Seventeen fishers, or 35%, reported losing lines of poles and line. Six fishers, or 12%, reported losing spear guns or spears. Three fishers, or 6%, reported losing longlines. Two fishers, or 4%, reported losing fish traps.

Rather, only estimated whole numbers of gear items lost can be estimated. We established the number of reported incidents of gear loss by gear type (Table 7).

Table 7. Extrapolated numbers of fishing gear used by type by coastal and artisanal fishers

Fishing gear used by coastal and artisanal fishers extrapolated from census data (N=55,306)				
gillnet or demersal net	line or pole and line	spear guns or hand spear	longline	fish trap
29,560	39,096	22,885	2,861	1,907
53%	71%	41%	5%	3%

To estimate the number of fishers losing gear items by type throughout Vanuatu and Solomon Islands, we extrapolated the percentages of fishers losing specific types of gear to the estimated total number of fishers losing gear (43,032). See Table 8.

Table 8. Number of coastal and artisanal fishers reported lost fishing gear by type

gillnet or demersal net	line or pole and line	spear gun or hand spear	longline	fish trap
21	17	6	3	3
43%	35%	12%	6%	4%

This yielded an estimated 20,025 fishers losing gillnets or demersal nets; 16,210 fishers losing lines of poles and lines; 5,721 losing spear guns or spears; 2,861 fishers losing longlines; and 1,907 fishers losing fish traps (Table 9).

Table 9. Extrapolated number of coastal and artisanal fishers losing fishing gear by type (N=43,032)

gillnet or demersal net	line or pole and line	spear gun or hand spear	longline	fish trap
20,025	16,210	5,721	2,861	1,907
43%	35%	12%	6%	4%

These estimates are not inconsistent with estimates of gear loss in other similar fisheries. In the Puget Sound (USA) salmon gillnet fishery, nets are handled by similar sized boats with 1- or 2-person crews. Antonelis (2012) estimated a 3%-5% loss rate for this fleet in 2012 This equates to an overall estimate of 18 to 42 portions of gillnets lost annually. Over the course of a long-term salmon gillnet fishery in Puget Sound, which is an area considerably smaller than the project area, an estimated 6,000 nets were lost (NWSF, 2007). In Indonesia in the inshore gillnet Tegal fishery in the Central Java Province, fishers working gillnets from small boats <5 GT with 2-3 person crews lose gear infrequently, with one 50m panel lost/year in the 20 boat fishery (FAO, 2017)[2]. In the Algarve fishing fleet in Southern Portugal, local fishermen using gillnets and trammel nets from vessels < 9m and operating in shallow waters within 3nm from shore lose about 3.2 50m panels/boat/year. With 429 local fishing boats operating (in 2003), this equates to 68.64km of net lost per year (Santos et al., 2003)[3].

Lines and pole and line account for 71% of the gear used and 35% of the gear lost in Vanuatu and Solomon Islands. While the BPF ranks hook and line fishing gear fourth in terms of its risk of impacts and loss, behind gillnets, traps and pots, and FADs, in this project area 41% of hooks and line get lost and account for a significant part of the ALDFG. And while harmful impacts from

[2] The loss rate is not available.
[3] It is unknown how many km of nets are lost in Vanuatu and Solomon Islands as there is no data on gear area or length.

gillnets are well documented, harmful impacts from fishing line have been documented particularly in coral reef ecosystems (Chiappone et al., 2005).

In addition, the aFADs deployed by the VFD are lost regularly. Most are expected to remain in place only six months. While aFADs are designed to remain in place with anchors, it is not uncommon for them to break free of their anchors and drift, with the potential to cause similar negative impacts as dFADs if they drift into sensitive nearshore habitats or if they are constructed using entangling netting on surface or subsurface components. An initial programme in Vanuatu in the 1980s deployed 131 aFADs offshore of eight islands. Theses aFADs survived only five months on average and 24% were lost during deployment (Amos et al., 2014).

3.3.2 Offshore commercial and industrial fisheries

Of the 10,613 pollution incidents reported in Richardson et al. (2017) from purse seine vessels, 706 (7%) occurred in Solomon Islands and 56 (1%) occurred in Vanuatu. This is consistent with relative fishing pressure in these countries. Forty-four per cent occurred in Papua New Guinea (PNG). Thirteen per cent (13%) of pollution incidents recorded from purse seine vessels consisted of abandoned, lost, or discarded fishing gear. Many of these were FADs or components of FADs[4].

To determine the annual rate of fishing gear discharge for purse seine vessels in Vanuatu and Solomon Islands, the number of incidents documented during 100% observer operations was multiplied by percentage of incidents that were fishing gear and divided by the number of years of data. Thus, in Solomon Islands, 13%, or 92, of the 706 incidents recorded were fishing gear over twelve years, yielding a rate of 7.6 fishing gear discharges/year. For Vanuatu, using the same approach, a rate of 0.61 discharges/year was calculated

(# incidents recorded * % fishing gear discharge incidents) / 12 yrs = fishing gear discharges/year

Vanuatu purse seine discharges of fishing gear

(56 X .13)/12 = ***0.61 purse seine discharges of fishing gear/year***

Solomon Islands purse seine discharges of fishing gear

(706 X .13)/12 = ***7.6 purse seine discharges of fishing gear/year***

Seventy per cent (70%) of the pollution incidents came from purse seine fishing vessels. Except for PNG-flagged vessels, which accounted for 18% of recorded pollution incidents, most of the pollution incidents were from foreign vessels flagged to Taiwan (16%), USA (15%), Korea (12%0, Philippines (10%), Japan (10%), and China (8%).

Two hundred fourteen (214) pollution incidents were reported from longline vessels. Of these incidents, 27 (13%) occurred within Vanuatu EEZ and 13 (6%) occurred within Solomon Islands EEZ. Vanuatu-flagged vessels accounted for 13% of the pollution incidents recorded for longline

[4] No further specifications were provided.

vessels. Seventeen per cent (17%) of pollution incidents recorded from longline vessels consisted of abandoned, lost, or discarded fishing gear.

In Vanuatu EEZ, thirty-six pollution incidents of abandoned, lost, and discarded fishing gear were recorded. Assuming equal distribution of these occurrences, we can estimate that 4.59 incidents occurred in Vanuatu from 2003 – 2015, or 0.38/year. Longline fishery requires only 5% observer status, whereas 100% observer coverage is required for purse seine vessels. If vessels without observers engage in discharges of fishing gear at the same rate as those with observers, we can estimate that for 100% of longline vessels the rate of discharge of fishing gear is 7.6 incidents/year in Vanuatu. In Solomon Islands, we can estimate that for 100% of longline vessels the rate of discharge of fishing gear is 3.68 incidents/year.

(# incidents recorded * % fishing gear discharge incidents) / 12 yrs * 20 = fishing gear discharges/year

Vanuatu longline fishing gear discharges/year

(27 X .17)/12 X 20 = ***7.6 longline fishing gear discharges/year***

Solomon Islands longline fishing discharges/year

(13 X .17)/12 X 20 = ***3.68 longline fishing gear discharges/year***

3.3.3 FAD loss

Reported pollution incidents documented by Richardson et al. (2017) do not include a systematic accounting of types of fishing gear discharged during the incidents. Rather, the type of gear or other observations are included in an 'other' category. Thus, rigorous analysis of how many FADs or FAD components are included in the 762 pollution incidents reported from purse seine vessels in the project area was not completed. However, anecdotal comments by Richardson et al. (2017) are telling. In a presentation of the report's findings, Richardson provided the following written comments from observers' reports:

> "FAD was retrieved and half of the suspended netting - cut and dumped overboard – along with normal FAD…"
>
> "Netting hanging underneath FAD, 210 fathoms of net"
>
> "Dumping of suspended FAD material without the main floating device."

These are telling examples of the practice of abandoning FADs and FAD components in the sea after they are no longer useful to the fisher. In fact, no tuna fishing company on record in the WCPO has a FAD retrieval program. So, it can be assumed that 100% of FADs deployed eventually sink or beach.

It is not possible to estimate how many of these FADs will end up in Vanuatu or Solomon Islands. However, the Parties to the Nauru Agreement require that all FADs are tracked with satellite buoys and their positions are provided to PNA. Using this data the Secretariat of the Pacific

Community (SPC) documented that 3.7% (641 of 18,648) of FADs tracked by the PNA from January 2016 through May 2017 beached in nearshore areas with some areas of high occurrence in Kiribati, Tuvalu, and Papua New Guinea (Escalle, Lauriane; Brouwer, Stephen; Phillips, Joe Scutt; Pilling, 2017).

3.4 Causes of Gear Loss

The causes of gear loss for artisanal gillnet fisheries commonly include poor weather, gear conflicts, mechanical failure, and fishing in suboptimal conditions. In the Caribbean, poor weather was blamed from most static gear loss (Matthews and Glazer, 2010). This finding is consistent across many fisheries (Gibson, 2013; Huntington, 2016; Richardson et al., 2017, 2018). However, Richardson et al (2018) found that the originating drivers for most gear loss is fisheries management, which can motivate risk-taking by fishers, including fishing in poor weather and fishing too close to reefs. Inadequate fisheries enforcement can cause pressure from illegal, unreported and unregulated (IUU) fishing.

Interviews with local sources in Vanuatu and Solomon Island yielded information about cause of local gear loss in the coastal and artisanal fishing sector. Fishers interviewed identified 72 incidents of fishing gear loss and eleven (11) distinct causes of gear loss: cyclones, weather and waves, tides and currents, snagging on reefs and logs, animal interactions, washed into sea, dumped, abandoned, gear left untended, stolen, and damaged gear. Generally snagging is an issue with gillnets, demersal nets, longlines and lines. All other causes are relevant to all gear types (Table 10).

Table 10. Identified causes of fishing gear loss in coastal and artisanal fisheries

Reason for reported fishing gear loss (N=72 identified incidents)										
Cyclone	Weather and waves	Tides and currents	Snagged on reef or logs	Animal interaction	Washed into sea	Dumped	Abandoned	Gear left unattended	Stolen	Damaged gear
5	11	6	10	17	3	8	1	2	8	1
7%	15%	8%	14%	24%	4%	11%	1%	3%	11%	1%

Causes of gear loss in the industrial fishing sector include the wilful discharges, dumping and abandonment of fishing gear reported by observers and documented in Richardson et al. (2017). The original drivers influencing these actions may include lack of adequate port reception facilities for end-of-life fishing gear, including FADs, lack of storage onboard fishing vessels for end-of-life fishing gear, including FADs, and a lack of awareness of the harmful impacts of ALDFG. Other common causes of fishing gear loss in these types of fisheries include mechanical failure. For

example, in pelagic longline fisheries the spools can get tangled as the line is being pulled off the drum, resulted in portions of the line being cut and discarded overboard. Severe weather and cyclones in the WCPO also contribute to loss of fishing gear. And loss/discard of fishing gear from IUU vessels is also a source of ALDFG in the project area (Macfadyen et al., 2009).

Participants at the Workshop on Best Practices for the Management of Lost Fishing Gear held in Port Vila on February 20, 2019, also observed additional causes of loss, such as: illegal fishing gear being cut by locals, use of mosquito nets in the rivers, low quality gear, and the provision of nets free in Solomon Islands resulting in irresponsible management.

3.5 Recommended Lost Fishing Gear Prevention Strategies

The following recommendation are based on the causes of gear loss identified by: fishers interviewed, by workshop participants, and through published literature (Santos, 2003; Macfadyen, et al., 2009; Antonelis, 2012, 2013; Gilman, 2015; Huntington, 2016; and Richardson et al., 2018). Recommendations include locally-specific solutions suggested by the interviewees and workshop participants as well as best practices outlined in the GGGI BPF (Huntington, 2017).

Fishers interviewed by TierraMar identified 24 separate actions that could be taken to address ALDFG in the project area (Table 11).

Table 11. Solutions recommended by fishers

	Recommended solutions to ALDFG identified during TierraMar interviews with fishers	#times mentioned	%
1	Encourage removal of found gear at sea and on beach	18	17%
2	Build awareness of harm of ALDFG	15	14%
3	Appropriately dispose of end of life gear	12	11%
4	Properly stow gear away from beach	10	10%
5	Maintain gear	7	7%
6	Improve fishing practices (tend gear, watch for sharks, avoid snagging, stow gear on boat)	7	7%
7	Prohibit dumping (regulatory) at community level	6	6%
8	Improve/ increase fisheries enforcement	5	5%
9	Better fisher training (saftey, gear stowage, etc.)	4	4%
10	Improve fisheries management	3	3%
11	Improve cyclone warning system	2	2%
12	Provide better local disposal options/ port reception facilities	2	2%
13	Encourage less damaging fishing gears (biodegradable, etc.)	2	2%
14	Require removal of gear from the sea (regulatory)	2	2%
15	More regulation of foreign vessels	2	2%
16	Remove gear before cyclones/ bad weather	1	1%
17	Don't fish in bad weateher	1	1%
18	Establish a lost gear reporting and removal system	1	1%
19	Increase tabu areas	1	1%
20	Better manage FAD from foreign vessels	1	1%
21	Conduct net repair training	1	1%
22	Collect banned nets from villages and properly dispose of them	1	1%
23	Repurpose old nets	1	1%

The most mentioned solution was to encourage removal of ALDFG from the water and from beaches. Some suggestions involved executing beach clean-ups at regular intervals. Building awareness about the consequences of and harm caused by ALDFG was the second most mentioned solutions. The third and fourth most mentioned solutions relate to ensuring that end-of-life gear is disposed of properly and that gear is stowed correctly off the beach to avoid being washed out to sea or stolen. Some fishers emphasised the need for fishers to take responsibility for maintaining their own gear and to practice good fishing practices, such as staying with their own gear and avoiding reefs to prevent gear loss. Less popular with fishers were regulatory solutions. Though when they were mentioned, any suggested prohibition should be at the community level with the chiefs. Other recommendations mentioned during interviews with stakeholders emphasised the concern with lost fishing gear from foreign vessels operating in Vanuatu and Solomon Islands waters. This concern is supported by data from Richardson et al. (2017) and by observations of foreign gear accumulating on beaches in the project area.

Prevention actions identified at the Workshop on Best Practices for the Management of Lost Fishing Gear included improving port reception facilities or disposal facilities for fishers, changing fishing methods, gear marking, net repair training, and improving fisher awareness.

These recommendations provide an excellent understanding of the appetite at the local level for best practices to prevent harm from ALDFG. They are consistent with the general recommendations and best practices outlined in the GGGI BPF (Huntington, 2017) and reflect the participants area of influence.

We and the (CLiP) programme's partners support developing locally-driven and culturally-appropriate solutions to problems associated with ALDFG. Considering this, we recommend focusing awareness-building activities on four stakeholder groups: NGOs operating in the area of fisheries and conservation; fisheries managers, regulators and control officers; community leaders (chiefs); community fisheries monitors; and artisanal fishers. Information about ALDFG and the GGGI BPF will be provided at the upcoming FAO Best Fishing Practice Workshop scheduled for May 27-30, 2019 in Vanuatu. This workshop will target fisheries managers, regulators, and control officers and NGOs operating in the area of fisheries. For other target audiences, we recommend that information about ALDFG and methods to prevent its harmful impacts be incorporated into other fisheries management outreach, training, and local collaborative projects undertaken by fisheries management and control agencies and NGOs operating in the project area.

We further recommend solutions to the problems in the industrial fishing sector be addressed by improving regulations and requirements around marking, tracking, and retrieving FADs, building capacity for enforcement of current fisheries laws to combat IUU fishing, and strengthening enforcement of laws prohibiting wilful discharges of fishing gear. To address drivers that may be influencing discharges at sea, we recommend improving port reception facilities to allow for safe, economical and efficient disposal of end-of-life gear. And we recommend strengthening requirements to provide deck space and technical equipment to retrieve and stow FADs and other end-of-life fishing gear for proper disposal. We recommend that these actions be pursued at the WCPFC and within the PNA, SPC/FFA and national ministries.

Recommended actions have been collated into categories of actions in the GGGI BPF. Additionally, Table 12 assigns responsibility of the actions to the various stakeholder groups identified in the BPF.

Table 12. Recommendations to addresses identified causes of gear loss

		Coastal Commercial and Artisanal Sector													Industrial Sector				
Relevance to GGGI BPF	Best practice/ Recommendation	Cyclone	Weather and waves	Tides and currents	Snagged on reef or logs	Animal interaction	Washed into sea	Dumped	Abandoned	Gear left unattended	Stolen	Damaged gear	Low quality/ inappropriate gear	Gear not valued (free gear)	Wilful discharges	Mechanical failure	IUU fishing	Sabotage	Stakeholder group/ Implementor
Best fishing practices	Properly stow gear away from beach	x	x				x				x								F, FO
	Maintain gear											x	x	x		x			F, FO
	Improve fishing practices (tend gear, watch for sharks, avoid snagging, stow gear on boat)			x	x	x	x			x	x							x	F, FO, FM
	Remove gear before cyclones/ bad weather	x	x		x				x										F, FO
	Don't fish in bad weateher	x	x		x				x										F, FO
	Conduct net repair training							x	x			x		x					FO, FM, N, G
	Require vessel space and equipment for retreiveing and stowing end-of-life FADs and other gear														x				FM, FC
Education and awareness	Build awareness of harm of ALDFG						x	x	x						x				FO, FM, FC, R, N
	Better fisher training (saftey, gear stowage, etc.)						x		x	x		x	x						FO, FM, N
	Improve cyclone warning system	x	x																FM, FC
Fishing gear marking and identification	Require marking, tracking ofFADs										x						x	x	FM, FC
Improved disposal facilities for end-of-life gear	Appropriately dispose of end of life gear						x	x	x						x				F, FO
	Prohibit dumping (regulatory) at community level							x											FO, FM
	Provide better local disposal options/ port reception facilities						x	x	x						x				FO, P
	Collect banned nets from villages and properly dispose of them						x	x	x										FM, N
	Repurpose old nets						x	x	x										F, FO, N
	Improve end-of-life gear disposal option at ports							x							x				P
Innovative gear design to minimize ghost fishing	Encourage less damaging fishing gears (biodegradable, etc.)												x						FO, FM, FC, R
Lost fishing gear reporting and retrieval	Encourage removal of found gear at sea and on beach						x												FO, N
	Require removal of gear from the sea (regulatory)						x		x										FM, FC
	Establish a lost gear reporting and removal system	x	x	x	x	x										x			FO, FM, FC, N
	Require retreival of FADs														x				FM, FC
Regulatory measure	Improve/ increase fisheries enforcement														x		x	x	FM, FC
	Improve fisheries management	x	x	x										x			x	x	FO, FM
	More regulation of foreign vessels														x		x	x	FM, FC
	Better manage FAD from foreign vessels														x				FM, FC
Spatial/ temporal separation of fishing types	Increase tabu areas			x	x			x	x	x			x						FO

Stakeholder group: F - Fisher; FO- Fisher Organization (in this case community level authority); FM - Fishery Manager/Regulator; FC - Fishery Control Officer; P - Port Operator; N- Nongovernmental Organization;

3.6 Supporting Tracking of aFADs

NRC personnel provided additional training to VFD personnel through online and in-person assistance. In late 2018, VFD personnel notified NRC that the SatLink online interface was not working properly for them. NRC first instructed VFD personnel to ensure the PDS and SatLink units were all fully charged. VFD personnel complied with this request and NRC verified through its own user interface that all units were charged and transmitting position data. NRC then met with Rocky Kaku, VFD on February 18, 2019 to verify that the PDS interface was working successfully for the VFD and to trouble-shoot the problem with the SatLink interface. After learning the extent of the error message being received by VFD, NRC acted as liaison between VFD personnel and the SatLink technical support department. NRC then ensured that technical support was provided directly to VFD personnel to ensure no lag in communications. SatLink assisted VFD personnel and provided them with an updated username and password. VFD personnel confirmed that its SatLink interface is working correctly and they can access the data from the SatLink buoy and echosounder.

VFD personnel are planning to deploy the PDS devices and the SatLink buoy with echosounder on two AFADs to be deployed off Tanna island in the spring. Exact coordinates of the aFADs are yet to be determined.

Additional provision of tracking devices was not possible under the CLiP project due to the compressed project period[5]. It generally takes several weeks to purchase and ship tracking devices to Vanuatu. Deployment then is dependent on selection or new deployment of aFADs by VFD, often taking several months. Deployment often involves travel to outer islands, which can also take several months of planning to combine trips with other work. Ergo, there was not enough time from early January to February to order, ship, and deploy new devices.

3.7 Facilitating a Workshop on Best Practices for the Management of Lost Fishing Gear

3.7.1 Workshop Objectives and Agenda

The Workshop on Best Practices for the Management of Lost Fishing Gear was held at the Warwick Le Lagon Resort in Port Vila, Vanuatu on February 20, 2019. Thirty-three (33) people attended, representing government fisheries and environmental agencies, appointed officials, FAO, local NGOs and other relevant stakeholders. See the attendance list and an agenda of the workshop in Annex A. The workshop was hosted by VFD and opened with a welcome from the VFD Officer-in-Charge, Mr. Sompert Gereva.

Participants of the Workshop on Best Practices for the Management of Lost Fishing Gear.

[5] No tracking device was purchased as part of this project, as there was not enough time to purchase, ship and deploy it within the project period.

The workshop objectives were:

- Connect and build relationships with others working on/interested in lost fishing gear in the Pacific region.
- Gain a baseline understanding of:
  - the scope and scale of the lost fishing gear problem both *globally, regionally* and *locally*
  - the types of solutions being used to address lost fishing gear
  - regional fisheries management strategies as they pertain to lost fishing gear.
- Share perspectives and insights about challenges and solutions to preventing negative impacts from lost fishing gear.
- Identify the key challenges, solutions, and next steps

The workshop agenda included the following presentations:

- Overview of ALDFG issues, solutions and global Ghost Gear Initiative, Ingrid Giskes, Global Campaign Manager, World Animal Protection
- How ghost gear is being addressed in international frameworks, Jessica Sanders, FAO
- Commonwealth Litter Programme, Fiona Preston-Whyte, Centre for Environment, Fisheries and Aquaculture Science
- Vanuatu Fisheries Department FAD Tracking Project, Rocky Kaku, Vanuatu Fisheries Department
- Overview of Solomon Islands Fisheries Department Program, Ronnelle Panda, Ministries of Fisheries and Marine Resources
- Secretariat of the Pacific Regional Environment Programme (SPREP), Anthony Talouli, Pollution Advisor, SPREP
- National Fisheries Development Operations, William Terry, NFD TriMarine
- What we know about lost fishing gear in the region, Anissa Lawrence, TierraMar
- Net removal in Port Vila Harbour, Christina Shaw, VESS
- GGGI Best Practice Framework for the Management of Fishing Gear (BPF), Joan Drinkwin, Natural Resources Consultants

3.7.2 Workshop Participants' Insights

The workshop featured ample time for small-group discussions. Small groups were formed to address the following questions:

Where do you know fishing gear is being lost of found in the region?
Key areas identified included all windward sides of all islands in Vanuatu and on Tanna, Efate, and Santo. In Solomon Islands northern Torres Island was identified as well as the western side of some islands.

Why is this gear being lost or accumulating in this area?
Many identified causes of loss reinforce what was gathered during interviews by TierraMar. Additional causes of loss identified at the workshop included: lack of disposal facility, illegal fishing gear being cut by locals, use of mosquito nets in the rivers, low quality gear, and the provision of nets free in Solomon Islands causing irresponsible management.

What can be done to prevent gear from being lost of accumulating?
Through this process, further insights were gleaned about where lost fishing gear may be causing negative impacts in the project area and why it is being lost. Local insights as to possible solutions ensure that recommendations for future work in this report are informed by local realities and are culturally appropriate. Key recommendations included improving port reception facilities or disposal facilities for fishers, changing fishing methods, gear marking, net repair training, and improving fisher awareness.

Participants were introduced to the different roles that all stakeholders along the seafood supply chain can play to prevent and reduce harm from lost fishing gear. In small groups, participants were presented with checklists of best practices developed for ten stakeholder groups: fishers, fisher organizations, fisheries managers, fisheries control officers, seafood companies, port operators, gear designers and manufacturers, researchers, NGOs, and ecolabel certification schemes.

At the close of the workshop, more insights were enlisted from the participants to answer the following questions:

What additional information is needed, and how should it be collected, to help inform solutions to the lost fishing gear in the Pacific? Research needs? Data needs?
The participants suggested that what is needed is more removal capacity; better information about gillnet use in the region; greater understanding of the socio-economic impact of ghost gear; and a reporting system.

What are some of the barriers to actions/solutions to addressing the issue of lost fishing gear? Capacity? Regulatory? Funding? Feasibility?

Some of the barriers to solutions identified at the workshop included: infeasibility of removing some gear; community conflicts over fishing; fisheries enforcement capacity and the inability to enforce MARPOL; lack of understanding of the harmful impacts of ALDFG.

What are some of the opportunities for action? Short-term (~1 year)? Medium-term (1-3 years)? Longer-term (more than 3 years)?
Workshop participants saw opportunities to integrate best practices for lost fishing gear management into other fisheries projects and programs. They saw opportunities to strengthen fishing associations. They also saw an opportunity to maximise the current global interest in Sustainable Development Goals to obtain financing for solutions.

Of the opportunities for action identified above which ones do you think are the most urgent and what do you think are easily adopted/implemented - to help address gear loss and/or its impacts?
Workshop participants identified education and awareness at the community level as an appropriate next step. They emphasised the need to create education materials that are very visual. They suggested injecting the ghost gear issue into the global dialogue on ocean plastics. And they suggested using information collected at the community level about illegal vessels to act.

Workshop participants will be provided with all the presentations from the workshop, as well as links to key documents discussed at the workshop, such as the GGGI Best Practice Framework for the Management of Fishing Gear. Materials were provided through an online portal in April 2019.

3.7.3 Workshop Recommendations

The following recommendations for actions in the Pacific Region to continue making progress on reducing harmful impacts of lost fishing gear were informed by participants' insights:

1. Ensure the upcoming Best Fishing Practices Workshop (to be delivered 27-30 May 2019) is developed collaboratively with local partners to ensure maximum relevance and effectiveness.
2. Support the implementation of the FAO Voluntary Guidelines for the Marking of Fishing Gears and the GGGI Best Practice Framework for the Management of Fishing Gear – and the development of a locally-relevant ALDFG umbrella programme.
3. Build upon this project identifying likely areas of high fishing gear loss and accumulations by including more detailed fishing data in the predictive model.
4. Document impacts to nearshore habitats from lost fishing gear:
    a. Support VESS' efforts to scientifically document habitat response to the removal of two derelict nets from Blacksands Cave in Mele Bay; and
    b. Ground truth areas of suspected high accumulation of lost fishing gear that were identified in the predictive model.
5. Support the expansion of the VFD FAD tracking efforts.
6. Integrate education about best practices to prevent and reduce harm from lost fishing gear into regional and local project focuses on fishing communities around fisheries, food security and environmental management.
7. Develop systems for report and retrieving lost fishing gear at appropriate scales.

3.8 Retrieval of Ghost Gear in Vanuatu

3.8.1 Ghost net retrieval workshop

Dr. Christina Shaw from the Vanuatu Environmental Science Society (VESS) in partnership with TierraMar delivered a one-day workshop on ghost net retrieval at Chantilly's on the Bay Hotel in Port Vila, Vanuatu on 5th February 2019. The workshop objectives include:

- Provide in-country stakeholders experience in the decision-making process for removing ghost gear; and
- Provide in-country stakeholders experience in planning removal of ghost gear using potential scenarios, considering safety, data collection and proper disposal of ghost gear.

Sixteen people attended the workshop, including representatives from the Department of Environmental Protection and Conservation and the Vanuatu Fisheries Department, along with divers from two of Port Vila's dive companies, Big Blue and Nautilus (see Annex E for the workshop agenda and Annex F for the participant list).

The group scenario exercises were inspired by or based on ghost gear that has been described in Vanuatu during the consultations of this project. The participants were asked to:

- Identify the likely impacts of the ghost gear, the risk to people and habitat, and the costs of gear removal

- Decide whether the gear described in the scenario should be removed (see decision framework in Annex G)
- Plan the removal of the gear based on the scenario

3.8.2 Ghost net retrieval

A ghost net has been known to exist at Blacksands Caves cost to Port Vila, Vanuatu for approximately 20 years. When the net was first discovered, a proportion of the net was stretched between two coral bommies and posed a significant threat of entanglement and ghost fishing. Divers cut the net away from the top floating line and dropped the net to the seabed, where they covered piles of net with rocks to ameliorate this threat. The net remained there in the same condition over the next two decades. The Commonwealth Litter Programme offered the opportunity to remove this net as a demonstration on the theory, methodology and reporting of ghost gear.

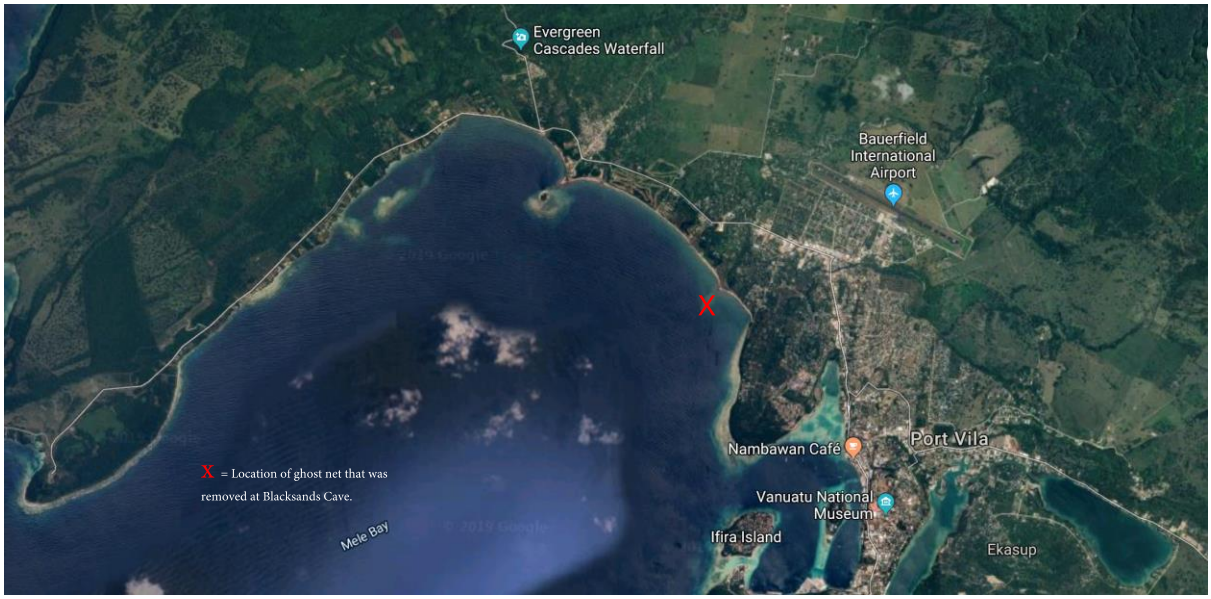


Figure 13. Location of net (marked with a red 'X') at Blacksands Cave, Mele Bay, Vanuatu.

Diving to remove ghost gear carries more risk than recreational diving, which was emphasised during the workshop described above. There is risk of entanglement and increased air consumption when doing work underwater. As the work is often close to the seabed, there is risk of damage to the habitat and silt may become stirred up leading to loss of visibility during the dive. Thus, only experienced divers who have excellent buoyance control should be part of a ghost gear removal team. Divers should ideally have a professional diving qualification and be certified to Rescue Diver at a minimum.

For the removal of the Blacksands Caves net, all members of the diving team were required to attend the workshop outlined in Section 3.8.1, which was held a day before the first removal dive. The first dive was a familiarisation dive with all members of the dive team, including mapping and measuring the net. Silt management was discussed at length given that part of the net was in silt at the deepest part of the dive (approximately 20 metres deep). They agreed on signals of communication with regards to visibility and circumstances requiring abandonment of the dive. For safety reasons, the following rules were put in place and adhered to:

- Team to work in pairs for every dive
- All dives restricted to a maximum of one hour
- Divers required to return to boat with a minimum of 50 bar in their air tank
- Divers required to wear long-sleeved wetsuits to guard against coral abrasions and gloves
- Divers required to carry a dive knife, in addition to their net cutting implement, to use in case of entanglement
- Divers instructed to note any animals entangled by the net

The net retrieval took place February 6-9, 2019. Six divers from Big Blue were chosen to be on the removal team, with a dive team leader who gave the brief before each dive. Five one-hour divers were completed to cut the net away from the coral and remove it from the coral bommies and silt. The entire net was removed except for some small pieces that were embedded in the coral. During the removal it was discovered that there were in fact two nets, the second being a smaller net entangled on the smaller, deeper bommie and adjacent rocks under the larger net. Both nets were gill nets with a floating line at the top and a rope with sinkers at bottom.

Net being cut away from the coral and net pieces collected for proper disposal.

One sea cucumber was trapped in the net being unable to escape but able to feed. It was released alive. One small octopus was found in the net when the net was brought on shore, but it did not appear to have been trapped. There were numerous coral colonies attached to the net, mostly hard acropora corals, and some sponges and bivalves. They were not counted individually as this would have significantly prolonged the diving time and increased the cost and risk of removing the net. Must of the net was encrusted in coral; these corals could not be counted as individual colonies. The details of the net were recorded on Derelict Gear Reporting Forms (Annex I).

The ghost net was successfully and carefully removed to reduce the impact on coral that had grown on the net for two decades. While the net was snagged on the rock, most of it was still mobile in the swell and current and was impacting coral growth and fish density and diversity. With its removal, we expect to see recover of the coral and fish.

The two nets were taken back to shore and examined. Because the net had to be cut up to remove it, it was not possible to measure it. The length of the larger net was measured in the orientation dive and found to be 50

Part of the net that was more tightly snagged on the coral, with coral growing through the net. Divers used scissors to carefully cut around these corals.

metres long and estimated to be 5 metres wide. The smaller net was approximate 20 m long and 5.5 m wide. The knot to knot mesh
size of both the nets was measured at 2.5 cm square and 5 cm stretched.

Pieces of net were measured and weighed to calculate weights for the whole nets including the floating line, floats and sinkers. The larger net had sections, which were buried in the silt and had minimal growth on them. Other sections had significant coral and other marine life growth. Clean and encrusted sections of the net were measured and weighed, and a rough estimate of the amount of coral and sponges attached to the net was made. The smaller net was mostly located in the silt and thus did not have much marine life growing on it.

If the whole net had been clean, it would have weighed 25 kg including ropes, floaters and sinkers. If the whole of the net was as heavily encrusted as the dirty section weighed, it would have weighed 99 kg (25kg of net and 74kg of marine life). The encrusted portion of the net therefore had 1.5 kg marine life embedded or caught in it per metre. It could be assumed that a moderately encrusted net could have 1 kg of marine life in it and a lightly encrusted net 0.5 kg. It was estimated that approximately 25% of the net was relatively clean as it had been buried in silt. Of the remaining 75% of the net, a third was estimated to have been heavily encrusted, similar to the section that was weighed, a third moderately encrusted and a third lightly encrusted. Therefore approximately 38 kg of marine life was attached to the net, although this should be interpreted with caution as many of these calculations have been based on estimates and assumptions.

Coral colonies, bivalves and a sponge removed from the dirty section of net in total weighed 2.5kg which would account for about half the weight of the marine life calculated for this portion of the net. The other half is assumed to be coral, sponges and algae encrusted or attached to the mesh of the net which was too hard to remove and weigh with the resources and time frame available

Recommended next steps:

1. Identify other lost or abandoned fishing gear, assess the feasibility of removal and seek funding to remove it; and
2. Monitor the Blacksands Cave site for the recovery of the coral and fish density and diversity.

4. Compliance Details

None required.

5. Financial Details and Further Needs

See Annex J.

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7. Annexes

Annex A: Best Practices for the Management of Lost Fishing Gear Workshop Agenda and Participant List

Annex B: Workshop Photos

Annex C: Fisher Interview Methodology

Annex D: Stakeholders Interviewed

Annex E: Ghost Net Retrieval Workshop Agenda

Annex F: Ghost Net Retrieval Workshop Participants

Annex G: Decision-making Framework: Circumstances under which ghost gear should be removed

Annex H: Photos of Ghost Fishing Net Retrieved from Blacksands Caves, Vanuatu

Annex I: Derelict Gear Reporting Forms

Annex J: Financial Details and Further Needs

Annex A: Workshop on Best Practices for the Management of Lost Fishing Gear Agenda and Participants

Monday 4th February 2019
Chantilly's Hotel Conference Room
7.30 **am to 4.00 pm**

Agenda

7.30	Registration
7.45	Introduction of people and projects
8.00 – 10.00	What is ghost gear and why does it matter: • An Introduction to abandoned, lost and discarded fishing gear (ALDFG) • Environmental impacts
10.00 – 10.30	Morning Tea
10.30 – 12.00	Ghost Gear removal: • Pros and Cons • Planning • Equipment • Safety considerations • Identification and Reporting
12.00 – 1.00	Lunch
1.00 – 3.00	Planning removal scenarios in groups
3.30 – 4.00	Report back

Participants

Name	Organisation	Country
David Loubser	Secretariat of the Pacific Regional Environment Programme	Vanuatu

Christina Shaw	Vanuatu Environmental Science Society	Vanuatu
Tony Talouli	Secretariat of the Pacific Regional Environment Programme	Samoa
Ella Rizwold	Principle, Health and Environment	Solomon Islands
Donald James Amoralo	Wan Smolbag Theatre	Vanuatu
Serah Ligo	Vanuatu Boy Scouts and Art Guides	Vanuatu
Bobby Patterson	Chief Environmental Health Management Officer	Solomon Islands
William Terry	TriMarine	Solomon Islands
Joan Drinkwin	Natural Resources Consultants	United States
Ingrid Giskes	World Animal Protection	Australia
Anissa Lawrence	TierraMar	Australia
Jessica Sanders	Regional Focal Point, FAO	Samoa
Sompert Gereva	Vanuatu Fisheries Dept.	Vanuatu
Jayven Ham	Vanuatu Fisheries Dept.	Vanuatu
Rocky Kaku	Vanuatu Fisheries Dept.	Vanuatu
Ronnelle Panda	Deputy Director of Policy, Ministry of Fisheries and Marine Resources	Solomon Islands
Karen Raubenheimer	ANCORS	Australia
Willy Missack	Oxfam	Australia
Sally Bailey	TierraMar	Australia
Brian Kumasi	Pacific Islands Forum Fishery Agency	Solomon Islands
Nixson Joseph	Wan Smolbag Theatre	Vanuatu
George Kevan	Oxfam	Australia
Eriko Hibi	FAO	Samoa
Marieke Desender	Cefas	United Kingdom
Sammy James	Seafood Verification Agency	Vanuatu
David Welch	C2O Pacific	Vanuatu
Fiona Presont-Whyte	Cefas	United Kingdom
S. Eti Teumohenga	Office of the Prime Minister, Tonga	Tonga
William Terry	National Fisheries Development, TriMarine	Solomon Islands
Minnie Rafe	TierraMar	Australia
Graham Niwoho	FAO	Samoa
Isso Nihmei	350 Vanuatu	Vanuatu

Annex B: Workshop Photos

Annex C: Fisher Interview Methodology

Project partner TierraMar undertook interviews with 120 fishers, 15 fisheries managers, and 23 other stakeholders (dive shops, sports fishing businesses, tourism operators, government departments (tourism, environment) located across Vanuatu and Solomon Islands between December 2018 and January 2019 (see list of interview participants in Annex D and Table 1 for a breakdown of stakeholders).

Table 1: Number of stakeholders engaged by type

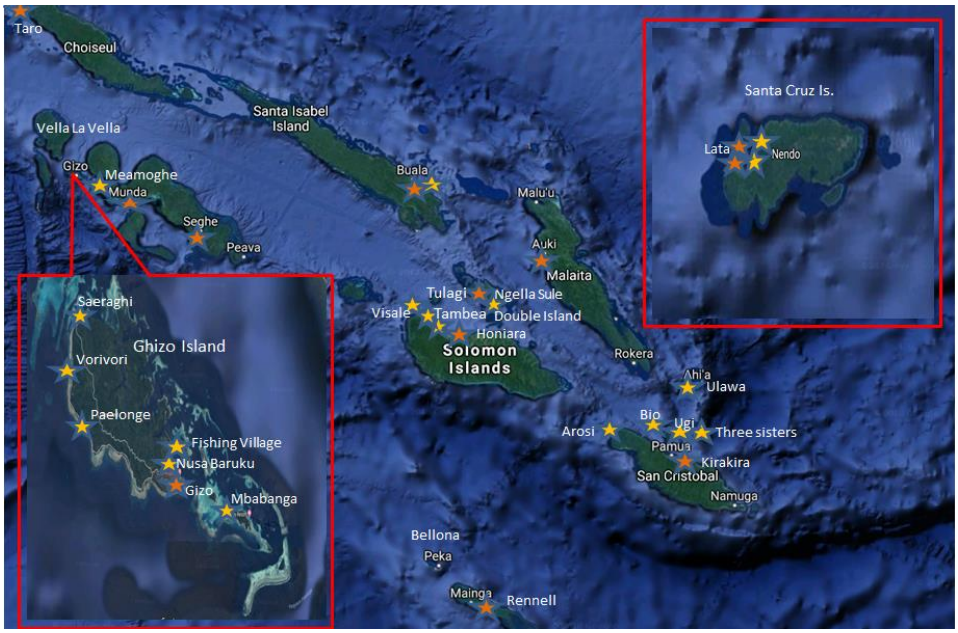
Stakeholder type	Solomon Islands	Vanuatu
Fishers	Temotu– 10 Renbal- 3 Makira – 5 Maliata – 6 Guandalcanal – 9 Central – 8 Western – 11 Choisuel - 8 Isabel – 9 **Total – 69 across all 9 provinces**	Efate – 28 Tafea – 10 Torba – 2 Sanma – 11 **Total 51 across 4 out of 6 provinces**
Fisheries managers/Government departments	11	4
NGOs	2	2
Regional organisations	1	1
Other (dive shops, sports fishing)	9	8
Total stakeholders consulted	**92**	**66**

The aim of the consultation was to identify information useful in understanding whether fishing gear used across each country are high risk gears in terms of potential impacts if they become abandoned, lost or discarded, and collect anecdotal reports of locations of ghost gear entangled on reefs, beaches, shorelines or floating at sea.

The stakeholders consulted were selected because of their considerable knowledge relating to fishing characteristics and effort as well as potential rates and densities for where ghost gear may be located around Vanuatu and Solomon Islands. Interview questions aimed to identify the causes for gear repair/replacement and loss and to identify where ghost gear had been sighted in the two countries.

Standard and tailored questionnaires were developed for stakeholders, grouped into 3 categories: fishers, fishery managers and other stakeholders (as described in Section 2.3.1.1). A sample size of 10 fishers across easily accessible provinces was sought, with no more than 2 fishers per village being interviewed to allow as much spread across coastal regions as possible, given most artisanal fishers will only fish up to several kilometres away from their home. This was then supplemented with fishery managers and other stakeholder interviews. Figure 1 provides the locations where interviews took place in each country. The sample size of 10 fishers is considered an acceptable sample size when compared to comparable projects. For example, in the work that FAO is currently undertaking with the CSIRO on global gear loss estimates to update the 2009 study the sample size is 15 per country per gear type.

Figure 1. Spread of stakeholder consultation showing location in Solomon Islands (red pin depicts fisher consultation and orange pin depicts consultation with other stakeholders).



Consultation was not undertaken face-to-face in more remote provinces such as Renbel in Solomon Islands or for smaller islands in Vanuatu due to time and budget constraints, however where possible phone interviews were conducted. The extended Christmas/Summer holiday period also meant that in some provinces we did not achieve a total of 10 fishers, and that other key people such as fisheries officers and dive shops were not available. The data from all interviews provided a first order level of data that could then be validated through methods described by NRC to provide determine potential hotspot areas (MacMullen et al., 2003; Ayaz et al., 2010, FAO 2016). Following interviews, responses were compiled about gear use, the frequency of gear loss and frequency of gear repair/replacement.

It should be noted that NRC were undertaking their work simultaneously to the on-ground consultation process. Ideally, with a longer timeframe, the on-ground component would have been conducted in two stages – first to interview stakeholders to understand fishing methods and identify potential gear sightings, followed by validation of a sample of those sites (through visual inspection). The second stage, would have involved analysis by NRC, followed by a second level of on-ground

validation (through visual inspection) using hotspots identified. The on-ground consultation process was conducted in partnership with WWF Solomon Islands, Ecological Services Solomon Islands and the Vanuatu Environmental Science Society.

The approach adopted for the ground truthing was based on the complicating factors described above that instilled the need for a pragmatic and rapid assessment approach to obtain first order data:

- Shortened timeframe to deliver the project and delays in being awarded a contract
- Further delays with respect to Christmas and summer holidays which meant many of the key stakeholders were on extended holidays and unavailable for interviews
- Delays to do with bad weather as a result of the cyclone in Solomon Islands that occurred in early January
- Distances and the time it takes to travel around and to provinces in Vanuatu and Solomon Islands, particularly more remote locations
- Consideration of sample sizes from other studies.

Due to limitations with the time available to conduct the project, only one attempt was made to ground truth estimates of reported gear accumulation and habitat impacts in Solomon Islands. An attempt was made to validate potential sightings of gear accumulation areas recorded around Gizo Island in Western Province. Fishers had indicated four locations where ghost gear was entangled on shallow reef systems, namely Paeloge, Vorivori, Saeragi and Fishing villages. These locations are all on the rough side of the island. One day was spent looking for the gear at these locations using surface observation only in a vessel (as gear was reported as being in shallow water and visible from the surface). No evidence of any ghost gear was found.

Validation of probability areas through diving or snorkelling to visually inspect was proposed, depending on easy and safety to access for some key probability areas but with the limited time and delays it was limited to one site per country only. Many probability areas identified are on the side of islands most exposed to rough conditions and very strong currents and not accessible by local dive boats due to safety issues.[6]

[6] No validation has been undertaken for any potential underwater hotspots or fishing gear reported in Vanuatu due to limitations in time and restrictions in vessel capacity.

Annex D: Stakeholders interviewed

Solomon Islands

Name	Gender		Position	Organization / Community	Province
Fisheries managers					
Marsh Maebiru	Male		Senior Compliance Officer	MFMR	Honiara
Brenda Oeta		Female	Offshore team - Compliance Officer	MFMR	Honiara
Duta Kouhiona		Female	CBRM Officer	MFMR	Honiara
Priscilla Pitakaka		Female	CBRM Officer	MFMR	Honiara
David Aram	Male		CBRM Officer	MFMR	Honiara
Asaneth Buarafi		Female	Principle Fisheries Officer	MFMR	Honiara
Andrew Marau	Male		Fisheries Officer	Makira Ulawa Provincial Government	Makira Province
Fraser Kavali	Male		Fisheries Officer	Buala, Isabel	Isabel Province
Peter Bade	Male		Fisheries Officer	MFMR	Star harbour/Makira Ulawa
Other stakeholders					
David Power	Male			FFA	Honiara
Jaimi Aihunu	Male		VMS Officer	FFA	Honiara
Miles	Male		VMS Officer	FFA	Honiara
Phil Lens	Male		VMS Officer	FFA	Honiara
William Terry	Male		NFD Officer	NFD	Noro, Western Province
Alec Hughes	Male		Executive Officer	CM2	Munda, Western Province
Delvene Boso		Female		World Fish	Honiara
Sarah Toni		Female		Isabel Provincial Council of Women	Isabel Province
Stephen Sibiti	Male			World Fish	Western Province
Jully Kalamana		Female	Environment Officer	Provincial Government	Western Province
Merilyn Vana		Female	Environmental Health Officer	Gizo Hospital	Western Province
Danny Kennedy	Male			Dive Gizo	Western Province
Venasio Hou	Male			Ulawa, Malaria Microscopic	Makira Province
David Boseto	Male		CEO	ESSI	Western Province
Fishers					
Samson Gau			Local Fisher	Tuvu Village	Guadalcanal Province
Humphrey Maealea	Male		Local Fisher	Kae Village	Guadalcanal Province
Emily Kwaisulia		Female	Local Fisher	Vatulovo Village	Guadalcanal Province
Nora Tanda		Female	Local Fisher	Vatulovo Village	Guadalcanal Province
Atnas Chilivi	Male		Local Fisher	Tina Village, Visale	Guadalcanal Province
Dion Sio Sara	Male		Local Fisher	Tina Village, Visale	Guadalcanal Province
Dennis Voua	Male		Local Fisher	Tonganote, Kusika	Guadalcanal Province
Francis Sapi	Male		Local Fisher	Tambili, Kusika	Guadalcanal Province
Billy Koke	Male		Local Fisher	Tambea	Guadalcanal Province
Elton Marei	Male		Local Fisher	Karakiha Village	Central Province
Steven Gele	Male		Local Fisher	Hagalu Village	Central Province
Cecil Mangale	Male		Local Fisher	Tulagi Township	Central Province
Vincent Riale	Male		Local Fisher	Tulagi Township	Central Province
Albert Molken	Male		Local Fisher	Haleta Village	Central Province
Gideon Akolo	Male		Local Fisher	Sasape base, Tulagi	Central Province
Augustine Mandela	Male		Local Fisher	Haleta Village	Central Province
John Stewart	Male		Local Fisher	Hagalu Village	Central Province
Ambros Frank	Male		Local Fisher	Luepe Village	Temotu Province
Andrew Yoki	Male		Local Fisher	Mabu Village	Temotu Province
Margreth Inanembwa		Female	Local Fisher	Luova Village	Temotu Province
Obrien Meesa	Male		Local Fisher	Banua Village	Temotu Province
David Deva	Male		Local Fisher	Louva Village	Temotu Province
Richard Bias	Male		Local Fisher	Malo Village	Temotu Province
Steven Sopi	Male		Local Fisher	Neo Village	Temotu Province
Andy Mempua	Male		Local Fisher	Matu Village	Temotu Province
Eli	Male		Local Fisher	Lata	Temotu Province
Ben Nanepla	Male		Local Fisher	Louva Village	Temotu Province
Aima		Female	Local Fisher	Babanga	Western Province
Job Sai	Male		Local Fisher	Paelonge	Western Province
Boni B	Male		Local Fisher	Vori Vori	Western Province
Nei Rimon		Female	Local Fisher	Nusa Baruku	Western Province
Tema Hola		Female	Local Fisher	Saeraghi	Western Province
Tom Pattson	Male		Local Fisher	Fishing Village	Western Province
Rector Nonga	Male		Local Fisher	Rarumana	Western Province
Paitovaki	Male		Local Fisher	Vella la Vella	Western Province
Dickson Rurungu	Male		Local Fisher	Mobil area, Gizo town	Western Province
Peter Mola	Male		Local Fisher	Saeraghi, Ghizo	Western Province
George Peter	Male		Local Fisher	Fishing village, Ghizo	Western Province
Dick Bae	Male		Local Fisher	Fishing village, Ghizo	Western Province
Mary Ngosole		Female	Local Fisher	Supizae Island	Choiseul Province
Cornelius Valaka	Male		Local Fisher	Supizae Island	Choiseul Province
Philip Dakin	Male		Local Fisher	Choiseul Bay	Choiseul Province
Gordon	Male		Local Fisher	Sasamunga	Choiseul Province
Denis	Male		Local Fisher	Sasamunga	Choiseul Province
Solomon	Male		Local Fisher	Sasamunga	Choiseul Province
Misach	Male		Local Fisher	Sasamunga	Choiseul Province
Sandrack	Male		Local Fisher	Sasamunga	Choiseul Province
Anon	Male		Local Fisher	Choiseul Bay	Choiseul Province
Anon	Male		Local Fisher	Choiseul Bay	Choiseul Province
Gifti	Male		Local Fisher	Kilomana, Isabel	Isabel Province
Watisoni	Male		Local Fisher	Buala Village, Isabel	Isabel Province
Jones	Male		Local Fisher	Letasi, Isabel	Isabel Province
Dicky	Male		Local Fisher	Kilomana, Isabel	Isabel Province
Peter	Male		Local Fisher	Jejevo, Isabel	Isabel Province
Robert	Male		Local Fisher	Ngalisagore, Malaita	Malaita Province
Peterson	Male		Local Fisher	Ngalisagore, Malaita	Malaita Province
Harry Jr Walelia	Male		Local Fisher	Langalanga lagoon, Malaita	Malaita Province
Dora		Female	Local Fisher	Uluga, Malaita	Malaita Province
Tome John	Male		Local Fisher	Fishing Village, Honiara	Honiara
Fred	Male		Local Fisher	Fishing Village, Honiara	Honiara
Nelson Mandela	Male		Local Fisher	Makira	Makira

Vanuatu

Name	Position	Organisation	Province/Location	Interview completed
Fisheries Managers				
Lucy Joy	Acting Research Dept	VFD	Shefa	25/01/19
George Amos	FAD program	VFD	Shefa	25/01/19
Clay SARA	FDO-Sanma	VFD	Sanma	1/02/19
Alsen Obed	Northern Fisheries Officer	VFD	Sanma	1/02/19
Jimmy Willie	Torba office Fisheries	VFD	Sanma	1/02/19
Other Stakeholders				
Vatu Molisa	MacBio Country rep	DEPC/IUCN	Shefa	25/01/19
David Loubser	PEBAC Vanuatu country manager	SPREP	Shefa	24/01/19
Mia Rimon	Regional Melanesian director	SPC	Shefa	25/01/19
Krishna Kotra	Coordinator of the science program	USP, Fiji	Shefa	23/01/19
Glarinda Andre	In country director	Live and Learn	Shefa	25/01/19
Emil Samuel	RESCCUE project	Live and Learn	Shefa	25/01/19
Jessica Richardson and Elaine M	Coaches	Vanuatu Rowing Association	Shefa	24/01/19
Mike Crawford (and Andrew Hib	Professional Divers	Big Blue	Shefa	25/01/19
Dave Tony (Phone interview)		Pacific Dive	Sanma	1/02/19
Phill jones		Coral Quays Diving	Sanma	1/02/19
Louis Tiome		Jean lui Restaurant	Sanma	1/02/19
Michlle Temmick	Game fishing business			24/01/23
Wayne	Diving company	Whitegrass	Tanna, Tafea	23/01/23
Fabrice	Fisherman and Tour Guide	Fishing Santo	Sanma	18/01/19
Peter Whitelaw	Diving company	Sailaway	Shefa	24/01/23
Nare Wola	Fishing instructor		Tanna? Whale incident	6/02/19
Alphonse Yemen		Member of Vanuatai Natural Resou	Torba	25/01/19
John Steven		Vanuatu Surfing Association	Shefa	25/01/23
Community				
Mele Community Members	3 local fishermen	Efate Community	Mele, Shefa	8/01/19
Pango Community Members	4 interviews, 3 individual fisherman and one group	Efate Community	Pango, Shefa	9/01/19
Lelepa Landing Community	3 interviews, 2 individual fisherman and one group	Efate Community	Lelepa Landing, Shefa	10/01/19
Emua and Nguna	5 local fishermen	Efate Community	Emua/Nguna, Shefa	10/01/19
Ifira Point	2 local fishermen	Efate Community	Ifira Point, Shefa	11/01/19
Erakor	3 local fishermen + 2 CM	Efate Community	Erakor, Shefa	16/01/19
Lelepa Island	4 local fishermen	Efate Community	Shefa	17/01/19
Ifira Island	3 local fishermen + 2 CM	Efate Community	Shefa	17/01/19
Tanna Communityx6	6xfisherman	Lenekel area	Tanna, Tafea	21/01/19
Erromango Community	1 fisherman		Tafea	21/01/19
Aneityum Community	2 fisherman		Tafea	21/01/19
Toka Iatibu	Area Secretary	Futuna Area Secretary	Futuna, Tafea	21/01/19
Santo Community	9x community fisherman	Luganville	Sanma	1/02/19
Anonymous	Fisherman	Community member Aore	Aore, Sanma	14/01/18

Annex E: Ghost Net Retrieval Workshop Agenda

Tuesday 5th February 2019
Chantilly's Hotel Conference Room

Agenda

8.00	Registration
8.15	Introduction of people and projects
8.30 - 10.00	What is ghost gear and why does it matter? • An introduction to abandoned, lost and discarded fishing gear (ALDFG) • Environmental impacts
10.00 – 10.30	Morning Tea
10.30 – 12.00	Ghost Gear removal: • Pros and cons • Planning • Equipment • Safety considerations • Identification and reporting
12.00 – 1.00	Lunch
1.00 – 3.00	Planning removal scenarios in groups
3.30 – 4.00	Report back

Annex F: Ghost Net Retrieval Workshop Participants

Name	Gender	Organisation	Position
Oliver Mikael	Male	Big Blue	Divemaster
Aaron Taravaki	Male	Big Blue	Divemaster
Nathan Songolapa	Male	Big Blue	Trainee
Fred Pakoa	Male	Big Blue	Divemaster
Jesse Langa	Male	Big Blue	Trainee
Mark Anatu	Male	Big Blue	Divemaster Captain
Vatu Moliosa	Male	Department of Environmental Protection and Conservation / International Union for Conservation of Nature	IUCN Project Liaison Officer
Watdoo Anderson	Female	Nautilus Watersports	Open Water Scuba Instructor
Viki Simon	Female	Nautilus Watersports	Open Water Scuba Instructor
Liz Malham	Female	Nautilus Watersports	Open Water Scuba Instructor
Fran Mesa	Female	Nautilus Watersports	Open Water Scuba Instructor
Pete Philippe	Male	Nautilus Watersports	Owner
Ionie Bolenga	Male	Department of Environmental Protection and Conservation	Waste Management Officer
Andrew Hibgame	Male	Big Blue	Owner, OWSI
Nore Ware	Male	Vanuatu Fisheries Department	Fishing Instructor
Abel Sami	Male	Vanuatu Environmental Science Society	Project Scientist

Annex G: Decision-making Framework – Circumstances under which ghost gear should be removed

Question 1: Is the gear causing harm?

Is the gear causing any of the following:

- Human and vessel safety and navigation hazards
- Harm to protected and/or endangered species
- Harm to fishing (ghostfishing, stock depletion)
- Harm to non-target species
- Harm to sensitive habitats
- Harm to aesthetics

If no, consider if there is a need to remove the gear or not.

If yes to any of the above, move to question 2

Question 2: Is it feasible to remove on scuba?

- Where is the gear? – is it accessible from shore or boat?
- At what depth is it (shallowest and deepest parts) – is it within limits of experience and qualifications of the divers available?
- What sort of gear is it? – How heavy is it? How long is it? Can divers reasonably be expected to handle and remove the gear item.
- Is it entangled or embedded? –Can it be it be removed either in its entirety or in part to mitigate the harm.

If yes to any of the above, go to question 3. If no to any, then this gear cannot be removed on scuba.

Question 3: Will the removal cause harm to the habitat and will it outweigh long-term benefit?

If no, consider whether the gear is better left in situ. If no, continue to Question 4.

Question 4: Is there another method more suitable or more cost effective?

If yes, then explore the other options. If no, continue to Question 5.

Question 5: Are there significant risks associated with removal?

Is there a risk to human safety or vessel safety?

If no, move to question 7. If yes, move to Question 6.

Question 6: Can these risks be mitigated?

Are these risks acceptable in light of the benefit of the gear removal?

If yes, move to question 7. If no, then no attempt should be made to remove the gear.

Question 7: Are there sufficient recourse and capacity to successfully remove the gear?

If a boat is required, is there a suitable boat available?

Are there divers with suitable experience and qualifications available?

Is all the necessary equipment, including any lifting mechanisms required, available?

If no to any of the above, go to question 8. If yes, continue to question 9

Question 8: Can the resources or capacity be brought in?

If yes, continue to question 9. If no, then no attempt should be made to remove the gear.

Question 9: **Can the gear be disposed of in a manner that will prevent it from causing harm in the future?**

If yes, continue to question 10. If no, consider if the gear would be better left in situ.

Question 10: Are the conditions safe for diving?

Is the current too strong to safely remove the net?

Is the water too rough to safely remove the net?

Is the visibility too low to safely remove the net?

If yes, go to question 11. If no, go to question 12

Question 11: Will there be another time when the condition will be safe for diving?

If yes, delay the timing for the removal and go to question 12. If no, then no attempt should be made to remove the gear.

Question 12: Are there any cultural or custom reasons the gear should not be removed?

If yes, go to question 13. If no, go to question 14

Question 13: Can the custom or cultural issue be resolved to allow the net removal to go ahead?

If yes, go to question 14. If no, then no attempt should be made to remove the gear.

Question 14: Have the customary land owners and local community been informed of the plan and have they given their consent to the removal?

If yes, the removal can go ahead. If no, then no attempt should be made to remove the gear.

Annex H: Photos of Ghost Fishing Net Retrieved from Blacksands Caves, Vanuatu

Part of the net that was more tightly snagged on the coral, with coral growing through the net. Divers used scissors to carefully cut around these corals.

Small coral colonies growing on the net

Aaron Taravaki cuts the net away from the coral while Olivier Mikael collects the pieces into a bag

The white scar on this coral was caused by the net rope being wrapped around the rock.

Scaring on coral from the net. The rocks behind this coral colony were bare as the net had been preventing coral growth.

The retrieved net heavily encrusted with coral and other marine life

Sponge and coral growing on the net

Measuring and examining the nets with the help of the CEFAS team

Annex I: Derelict Gear Reporting Forms

Derelict Gear Reporting Form: Gear Data (Net)

Vessel: Godiva Removal Date: 6-9th February 2019 Data Collector: Christine Shaw

	Net 1	Net 2	Net 3	Net 4	Net 5	Net 6
Gear ID	2019B01.	2019B02.				
Lat	17°42'48.03	17°42'48.03				
Long	168° 17'17.68	168° 17'17.68				
Area						
Subarea						
WDFW Area						
Gear Type	Gill net 1 inch	Gill net 1 inch				
Length (m)	50m	~20m				
Width (m)	5m	5m.				
Min Depth	10m	16m.				
Max Depth	19m	22m				
Habitat Type	Coral + Silt	Silt + Coral.				
Habitat Other						
Age	~20yrs old	~20yrs old				
Condition	inactive	inactive.				
Suspension						
Lethal	No	No.				
Survey Date						
Description	Dropped over + between two Coral heads + in Silt					

Derelict Gear Reporting Form: Impact Data

Vessel: Godiva Data Collector: Christine Shaw.

Removal Date: 6-9th February

Gear ID	Gear Type	Species	# Alive	# Dead	Sex	Live Condition	Dead Condition	Description	Specimen ID
2019B01	Gillnet	Sea cucumber	1		?	OK.			
		octopus	1			fine.			

Annex J: Financial Details and Further Needs

	Budget					Actuals
Services Required	**Qty**	**UOM**	**Cost**	**Total Cost**	**VAT**	**Total Cost (£)**
Personnel						
NRC	27	Day	£665.35	£17,964.00		£20,538.00
TierraMar	24	Day	£520.00	£12,480.00		£14,544.00
World Animal Protection Project Lead	16.5	Day	£217.04	£3,581.00		£3,581.00
Christina Shaw, VESS	25	Day	£350.00	£8,750.00		£8,750.00
VESS Staff	20	Day	£35.00	£700.00		£1,765.00
Shannon Seeto, WWF	25	Day	£350.00	£8,750.00		£1,833.91
WWF Staff	20	Day	£35.00	£700.00		£1,479.00
Total Personnel				**£52,926.00**		**£52,490.91**
NRC Travel						
Roundtrip airfare to Pacific	1	Per RT Flight	£1,506.00	£1,506.00		£1,832.00
Transport Bellingham to Seattle	1	Per RT Flight	£64.00	£64.00		-
Local travel	1	Per RT Flight	£167.00	£167.00		-
Lodging	5	Day	£125.00	£625.00		-
Per diem	5	Day	£63.00	£315.00		-
NRC Travel				**£2,677.00**		**£1,832.00**
World Animal Protection Travel						
Travel and accommodation for inception/regional meetings and project visits	1	Total	£1,950.00	£1,950.00		£2,398.31
World Animal Protection Travel				**£1,950.00**		**£2,398.31**
TierraMar Travel						
Rountrip flight to Port Vila	1	Per RT Flight	£500.00	£500.00		-
Lodging	5	Day	£125.00	£625.00		-
Per diem	5	Day	£63.00	£315.00		£2,343.56
TierraMar Travel				**£1,440.00**		**£2,343.56**
Other Travel						
Travel costs of local focal points	1	Lump Sum	£1,521.00	£1,521.00		£2,234.29
Bursary for travel of participants for regional workshop	20	Per participant	£190.00	£3,800.00		£3,479.21
Other Travel				**£5,321.00**		**£5,713.50**
Total Travel				**£11,388.00**		**£12,287.37**
Removal of Ghost Net Workshop (VESS)						
Venue hire catering for theory days	2	Day	£400.00	£800.00		£4,203.64
Printing of materials	1	Lump sum	£200.00	£200.00		£42.00
Boat hire / divers / dive gear	4	Day	£250.00	£1,000.00		£1,054.00

Truck hire for disposal	1	In total	£200.00	£200.00		£133.00
Tipping fees	1	In total	£100.00	£100.00		-
Removal of Ghost Net Workshop Total				**£2,300.00**		**£5,432.64**
Regional Workshop						
Venue hire and catering	1	Lump sum	£8,000.00	£8,000.00		£871.39
Materials	1	Lump sum	£2,000.00	£2,000.00		£68.75
Regional Workshop Total				**£10,000.00**		**£940.14**
Consultation Meetings for Best Practice (VESS)						
Venue hire and catering	20	Per Participant	£80.00	£1,600.00		-
Consultation Meetings for Best Practice (VESS) Total				**£1,600.00**		**-**
Consultation Meetings for Best Practice (WWF)						
Venue hire and catering	20	Per Participant	£80.00	£1,600.00		-
Consultation Meetings for Best Practice (WWF) Total				**£1,600.00**		**-**
Total Meeting and Workshop Costs				**£15,500.00**		**£6,372.78**
Other Project Costs						
Tracking devices	1	In total	£7,604.00	£7,604.00		-
Liftbags and other equipment	1	Lump sum	£3,802.00	£3,802.00		-
Removal expenses local contracts	1	Lump sum	£5,000.00	£5,000.00		-
VESS project administration costs	1	Lump sum	£1,335.00	£1,335.00		£1,052.00
WWF project administration costs	1	Lump sum	£1,335.00	£1,335.00		£628.12
Total Other Project Costs				**£19,076.00**		**£1,680.12**
Total Direct Costs				**£98,890.00**		**£72,831.18**
Indirect Project Costs			15%	£14,834.00		£10,924.68
			Total Cost:	**£113,727.00**		**£83,755.86**

Centre for Environment
Fisheries & Aquaculture
Science

About us

The Centre for Environment, Fisheries and Aquaculture Science is the UK's leading and most diverse centre for applied marine and freshwater science.

We advise UK government and private sector customers on the environmental impact of their policies, programmes and activities through our scientific evidence and impartial expert advice.

Our environmental monitoring and assessment programmes are fundamental to the sustainable development of marine and freshwater industries.

Through the application of our science and technology, we play a major role in growing the marine and freshwater economy, creating jobs, and safeguarding public health and the health of our seas and aquatic resources

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Our customer base and partnerships are broad, spanning Government, public and private sectors, academia, non-governmental organisations (NGOs), at home and internationally.

We work with:

- a wide range of UK Government departments and agencies, including Department for the Environment Food and Rural Affairs (Defra) and Department for Energy and Climate and Change (DECC), Natural Resources Wales, Scotland, Northern Ireland and governments overseas.
- industries across a range of sectors including offshore renewable energy, oil and gas emergency response, marine surveying, fishing and aquaculture.
- other scientists from research councils, universities and EU research programmes.
- NGOs interested in marine and freshwater.
- local communities and voluntary groups, active in protecting the coastal, marine and freshwater environments.

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