

STATE OF ABANDONED, LOST AND DISCARDED FISHING GEAR IN THE CANADIAN MARITIMES (EAST COAST)

By Alexa J. Goodman.
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FISHING GEAR COALITION
OF ATLANTIC CANADA

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EXECUTIVE SUMMARY

State of Abandoned, Lost and Discarded Fishing Gear in the Canadian Maritimes (East Coast) is a comprehensive four-chapter report that details the national and regional efforts around abandoned, lost and discarded fishing gear (ALDFG) – commonly referred to as “ghost gear.” It also presents research on potential solutions to prevent ALDFG and mitigate its effects. This report was prepared by Alexa Goodman on behalf of the Fishing Gear Coalition of Atlantic Canada (FGCAC).

Chapter 1 overviews national and regional measures for managing ALDFG. It includes a summary of the relevant regulations and licence conditions, lost and retrieved gear reporting, and additional management measures such as gear-tagging protocols. Chapter 2 indexes ongoing, completed and planned ALDFG projects in Canada. It captures knowledge and assesses national preventive and mitigative efforts. Chapter 3 reviews the solid waste management of fishing gear in Atlantic Canada. It provides a catalogue of the relevant facilities and manufacturers in each region, and discusses how recycling mechanisms and Extended Producer Responsibility (EPR) could potentially be applied in the future. Chapter 4 provides context for the extent of ALDFG in the Maritimes and Gulf regions, capturing local knowledge in order to centralize information. It compares and contrasts issues, challenges and potential solutions in addressing ALDFG between different regions. Each chapter contains specific thematic recommendations, apart from Chapter 2, for which the recommendations are amalgamated and summarized at the end of the report.

This comprehensive report fulfills the need to centralize baseline information on ALDFG on varying scales. It lays the groundwork for moving forward with preventive and mitigative efforts. The data collected in this report will be used by the FGCAC members in ongoing and planned ALDFG projects, and highlights avenues for future work on behalf of the Coalition.

INTRODUCTION

Marine debris is the most pervasive and ubiquitous pollutant in the [Anthropocene Epoch](#), affecting all marine environments (Rangel-Buitrago et al. 2020; Beaumont et al., 2019; Pierdomenico et al., 2019). Abandoned, lost and discarded fishing gear (ALDFG), commonly referred to as “ghost gear,” makes up a large portion of all marine debris, though gear loss varies by region, fishery and gear type (Richardson et al., 2019a; Goodman et al., 2019). Research has shown that ALDFG has significant negative environmental, economic and social impacts. These include, but are not limited to, habitat degradation, indiscriminate fishing and entanglements, decreased catches, at-sea safety hazards, and vessel damage (National Oceanic and Atmospheric Administration Marine Debris Program, 2015; Gilardi et al., 2010; Macfadyen et al., 2009). However, the extent of the problem is largely unknown as losses are often unrecorded or unobserved, and relevant empirical evidence remains unpublished (Gilman, 2015; Richardson et al., 2019a).

Canada depends on marine ecosystem services and resources to support prominent marine industries such as fishing, shipping and tourism, and to support local livelihoods. Canada’s fisheries (including commercial fish harvesters and crew, aquaculture, and seafood production and packaging) employ around 77,000 individuals. Fisheries are highly valuable to the national economy; in 2017, outputs were valued at over \$10 billion between commercial sea and freshwater fisheries, aquaculture, and seafood preparation and packaging (Fisheries and Oceans Canada [DFO], 2019a). The lobster industry in Atlantic Canada contributes nearly one-third of all Canadian commercial fishery exports by value alone (\$2.2 billion), while fishers nationally depend on healthy stocks to sustain their livelihoods (DFO, 2019a). As the issue of ghost gear has become better understood, and recent entanglement mortality issues with North Atlantic right whales have come to light (Davies and Brilliant, 2019), there has been growing global pressure to address ALDFG. The Canadian government has committed to addressing the issue.

NATIONAL COMMITMENTS

Canada is committed to mitigating reliance on single-use plastics and addressing ALDFG. In 2018, Canada became a signatory country to the [Global Ghost Gear Initiative](#), the leading global alliance for combatting ALDFG. This initiative upholds best management practices and sets international standards. Furthering Canada's commitments to developing strategies to reduce plastic pollution, the federal government released the [Oceans Plastics Charter](#) at the 2018 G7 Summit in Charlevoix, Quebec, and in 2019 announced a plan to ban harmful single-use plastics by 2021 (Government of Canada, 2019). These commitments are reinforced by the Canadian Council of Ministers of the Environment's Canada-wide [Strategy on Zero Plastic Waste](#). In January 2020, the federal government released the [Zero Plastic Waste Initiative](#) to fund projects that reduce plastic waste and pollution in Canada. Fisheries and Oceans Canada (DFO) has made efforts to address the issue of ghost gear. DFO also upholds international commitments made by the United Nations, the International Maritime Organization's (IMO) Marine Environment Protection Committee (MEPC), and others (DFO, 2019b). Beyond DFO's efforts to manage ALDFG, outlined in Chapter 1, there is a growing need to manage and regulate ALDFG at an operational level.

FISHING GEAR COALITION OF ATLANTIC CANADA

The Fishing Gear Coalition of Atlantic Canada (FGCAC) has laid the groundwork to fill the existing operational gap by working alongside government and industry, as well as other stakeholders and rights holders. Since its formation in December 2018, the FGCAC has been working collaboratively on developing sustainable solutions to end-of-life abandoned, lost and discarded fishing and aquaculture gear, and associated materials. The Coalition is composed of over 60 members from various backgrounds, including industry, government, Indigenous communities, academia, non-governmental organizations and the public. Committed to fostering support and collaboration, the Coalition focuses on resource management, retrieval and innovation, and communications and research.

The FGCAC has identified gaps in the knowledge needed to develop and implement solutions to ALDFG in Canada. The current comprehensive report fills those gaps, providing the necessary baseline information. The report focuses on the Maritimes region. Chapter 1 overviews the current ALDFG-management structure nationally. Chapter 2 provides an index of ALDFG projects in Canada. Chapter 3 reviews the solid waste management of fishing gear in Atlantic Canada, and discusses how recycling mechanisms and Extended Producer Responsibility (EPR) could be used. Chapter 4 provides context for the extent of ALDFG in the Maritimes and Gulf regions.



Beach Clean Up at Brooklyn, NS © Marquita Davis

CHAPTER 1 – MANAGING ALDFG: REGULATIONS AND LICENCE CONDITIONS

Chapter 1 outlines national and regional regulatory frameworks for monitoring and managing ALDFG, as mandated by DFO. It reviews relevant regulations and licence conditions. Information was gathered by reviewing available literature and conducting informal interviews with relevant stakeholders, including DFO.

NATIONAL MANAGEMENT

DFO is developing a ghost gear program that includes the new [Sustainable Fisheries Solutions and Retrieval Support Contribution Program](#) (SFSRSCP). This program supports the sustainable management of fisheries by taking concrete actions to prevent ALDFG and to improve retrieval and responsible disposal. The SFSRSCP will fund projects from July 2020 to March 2022. DFO has also established a national ALDFG-management group that has a representative from each DFO region; phone calls every two weeks provide management direction (Kelsey Hayden, pers. comm., Aug. 7, 2019). For more information on DFO's ghost gear program, [email the National Lead](#).

REGULATIONS

There are no regulations that explicitly mention or govern ALDFG across Canada. However, some regulations contain language that supports managing ALDFG and mitigating its effects. The Fisheries Act (1985) outlines measures for the conservation and protection of fish and habitat. Section 35(1) states, "No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational, or Aboriginal fishery, or to fish that support such a fishery." On the subject of removing gear, section 25(2) states, "Subject to the regulations and subsection (3), any person who places or sets any fishing gear or apparatus in any water, along any beach or within any fishery shall remove it when the gear or apparatus is not being tended and prior to the commencement of a close time." Additionally, section 115(2) states, "No person shall leave fishing gear unattended in the water for more than 72 consecutive hours." Gear that remains at sea for more than 72 consecutive hours must be reported.

Under Fishery (General) Regulations, section 27(1) states, "It is prohibited for any person to set, operate or leave unattended in the water any fishing gear other than mobile gear or handlines unless the gear is marked in accordance with subsections (2) to (6) with (a) where a vessel registration number is set out in the licence authorizing the use of that gear, the vessel registration number; or (b) in any other case, the name of the person who owns the gear." Schedule VIII supports section 27(1), stating that leaving fishing gear unattended at sea without proper identification of the owner's name is a proscribed offence punishable by fine.

The Canadian Code of Conduct for Responsible Fishing Operations has guidelines indicating that all lost gear should be reported, and that its removal should be attempted if possible (DFO, 1998). In practice, this may not always happen due to barriers such as lack of enforcement (Goodman et al., 2019). The Code of Conduct prohibits the intentional dumping of fishing gear at sea. This prohibition is reinforced under the Canadian Environmental Protection Act (1999) (Permits for disposal – sections 122 to 136).

NATIONAL TAGGING PROTOCOL

National standards have been established with respect to how gear is tagged, designed and assembled. The protocol includes standards for the numbering system, fishing area identification, locking system and colour coding (Sy Oumar, pers. comm., Feb. 4, 2020). As of 2020, new gear-marking requirements for ropes apply in all DFO Atlantic regions of Eastern Canada. This encompasses the Gulf, Maritimes, Newfoundland and Labrador, and Quebec regions for all non-tended fixed-gear fisheries, as well as crab trap and lobster trap fisheries (Kim Theriault, pers. comm., Feb. 4, 2020; DFO, 2020). The new marking requirements call for interlacing coloured rope to fixed gear based on specific region, target species and fishing area (for lobster and crab trap fisheries only; DFO, 2020). In the event of an entanglement with a marine mammal, the new gear-marking requirements will help determine where the event occurred (country, region and fishery). These requirements will be effective July 1, 2020, for fisheries that open before that date. For those opening later in 2020, the requirements will apply from the beginning of their season (Bernadette Jordan, pers. comm., Feb. 10, 2020; Timothy Hayman, pers. comm., Feb. 5, 2020).

All gear-tag suppliers in Canada are approved by DFO to supply tags in assigned fishing areas that require gear tagging. Tag suppliers could be gear manufacturers or a third party – for example, a fishing industry association or dockside monitoring company (Sy Oumar, pers. comm., Feb. 4, 2020). A national tagging plan has been developed for those interested in becoming tag suppliers; interested parties can propose their tagging plan through DFO's [standardized template](#) (Sy Oumar, pers. comm., Feb. 4, 2020). Tag suppliers act as intermediaries between DFO and fishers, recording lost tags and tag replacements to monitor fishing effort. Only some of this information – such as licence and tag number(s) – gets passed along to DFO through a data entry spreadsheet, and information may vary slightly between regions. This data reporting has excluded any information about gear losses and retrievals, which until recently has been outside the mandate of tag suppliers.

As per the current tagging protocol, tag specifications are consistent for any given fishing area, but may vary slightly by region (Sy Oumar, pers. comm., Feb. 4, 2020). There may be slight differences in how the tags are distributed, depending on the gear-tag plan submitted to DFO. There may also be minor differences between regional tagging plans, depending on whether the area is authorized to use multi-year or single-year tags. This decision is based on consultation between DFO and industry during the fishery advisory meetings (Sy Oumar, pers. comm., Feb. 4, 2020).

LOST AND RETRIEVED GEAR-REPORTING REQUIREMENTS

Since the early 1990s, reporting lost gear has been a licence condition for offshore fisheries. Since 2018, DFO has expanded lost-gear licence conditions to include additional inshore commercial fisheries. These changes started in the Gulf of St. Lawrence in response to the high mortality of North Atlantic right whales in 2017, largely caused by entanglement with fixed gear and vessel strikes (National Oceanic and Atmospheric Administration, 2020; Davies and Brilliant, 2019). In 2019, a new requirement to report any retrieved gear previously reported lost was introduced in commercial fisheries. DFO will continue to expand the lost-gear reporting requirement to additional regions. The intent is to extend reporting requirements to all commercial fisheries – including commercial Aboriginal communal fisheries – that use gear with the potential to become abandoned, lost or discarded. Lost-gear reporting conditions will apply to all regions and fisheries across Canada by 2020, with the exception of fisheries that do not use gear with the potential to become abandoned, lost or discarded, such as dive or digging fisheries (Kelsey Hayden, pers. comm., Aug. 7, 2019). The majority of regional commercial fisheries already have these licence conditions in place. For those fisheries that do not yet have mandatory reporting conditions in place, licence conditions will be implemented in all relevant fisheries by 2020. These changes can be made only between fishing seasons, after DFO has had an opportunity to conduct orderly consultation processes with stakeholders. These vary by fishery and region (Kelsey Hayden, pers. comm., Aug. 7, 2019).

Regulations pertaining to licence conditions are in effect nationwide, though wording varies slightly by region. The following is an excerpt of regulations for the Maritimes region:

THE LICENCE HOLDER/VESSEL OPERATOR MUST REPORT ANY LOST FISHING GEAR TO DFO BY COMPLETING AND SUBMITTING THE LOST FISHING GEAR FORM AVAILABLE ONLINE AT <http://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/index-eng.html> WITHIN 24 HOURS OF DISCOVERING THAT GEAR HAS BEEN LOST, OR WITHIN 24 HOURS OF ARRIVING AT PORT FOR TRIPS LESS THAN 5 DAYS LENGTH.

THE LICENCE HOLDER/VESSEL OPERATOR MUST REPORT THE RETRIEVAL OF ANY OF THEIR OWN PREVIOUSLY REPORTED LOST GEAR TO DFO BY COMPLETING AND SUBMITTING THE RETRIEVAL OF PREVIOUSLY REPORTED FISHING GEAR FORM AVAILABLE ONLINE AT <http://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/index-eng.html> WITHIN 24 HOURS OF RETRIEVING GEAR PREVIOUSLY REPORTED AS LOST, OR WITHIN 24 HOURS OF ARRIVING AT PORT FOR TRIPS LESS THAN 5 DAYS LENGTH. RETRIEVAL CAN ONLY OCCUR UNDER A VALID FISHING LICENCE AND ONLY IN RELATION TO THE SPECIFIC TYPE OF GEAR AUTHORIZED TO BE USED BY THE FISHING LICENCE.

DFO has provided an option for email correspondence to answer any additional questions about ALDFG. However, retrieving ALDFG at sea is currently prohibited under harvester's licence conditions if the gear does not belong to the harvester or is outside of their licensed season. Responsibility for retrieving ALDFG on land remains uncertain as there are jurisdictional issues once the gear is above the high-water line (Jessica Bolle, FGCAC call, August 21, 2019). DFO legislation and regulations apply to fishing activities, so ALDFG above the high-water mark is outside of DFO jurisdiction. Classified as litter, ALDFG on land is considered to be under provincial jurisdiction. If gear washed ashore is still tagged, it should be reported to the local DFO branch (Jessica Bolle, FGCAC call, Aug. 21, 2019). However, the extent to which DFO addresses ALDFG on land still needs to be clearly defined.

CASE STUDY: FUNDY NORTH'S GHOST GEAR RETRIEVAL PERMIT

Fundy North Fishermen's Association (FNFA) in Southwest New Brunswick had an ongoing retrieval licence/permit under Section 52 (scientific research, experimentation, education, aquatic invasive species control, and/or public display) as part of their decadal Ghost Gear Retrieval Project. Over the years they have removed over 1000 lobster traps. Permitting under Section 52 was recently amended to better suit this type of retrieval. Permits are necessary for ALDFG retrieval events. However, the permitting process is being re-evaluated to ease applications. In collaboration with FNFA, the FGCAC is working on improving the permitting process for retrieval events with DFO, which should be ameliorated in 2020.

Note that national reporting requirements currently exclude Indigenous communities with fishing interest (rights holders) for food, social and ceremonial purposes (Kelsey Hayden, Aug. 7, 2019). However, fisheries agreements negotiated under the Aboriginal Fisheries Strategy may contain terms and conditions related to gear. The initial focus of updates to licence condition is on commercial licences, but the intent is to expand to other licence holders as the program evolves (Marina Petrovic, pers. comm., Aug. 27, 2019). Commercial communal licences are needed to report lost gear.

REGIONAL MANAGEMENT

There are six fishing regions across three geographic areas in Canada: Atlantic, Pacific, and Central and Arctic. Individual fishery licence conditions are applied regionally and may include additional measures to indirectly address ALDFG (Marina Petrovic, pers. comm., July 30, 2019). These include specific gear requirements according to the fishery; for example, trap fisheries are required to have escape hatches. As the issue of ALDFG is relatively new, measures will change over time. There is also increasing interest in shifting away from regional approaches to adopt a uniform national approach (Kelsey Hayden, pers. comm., Aug. 7, 2019). Across all regions and fisheries, tagging protocols are currently the primary additional measure used to indirectly manage ALDFG; there may be slight differences between tagging protocols in various regions and fisheries (Sy Oumar, pers. comm., Feb. 4, 2020). The following subsections outline the similarities and differences between additional management measures in Canadian fishing regions.

ATLANTIC REGION

The Atlantic region spans four administrative regions: Maritimes (also known as Scotia Fundy), Gulf, Newfoundland and Labrador, and Quebec. Under Atlantic Fishery Regulations, it is illegal to have gear on board a boat outside of fishing season, or to have gear that is invalidly tagged or belongs to another owner (Minister of Justice, 2018). All commercial fisheries in the Atlantic region have tagging requirements as outlined in the 2018–2020 Protocol for Gear Tagging in Atlantic Commercial Fisheries, enforced under licence conditions (DFO, 2018). The protocol requires commercial fishers to keep a record of their tags, including the individual tag numbers. Within 24 hours of issuing replacement tags, tag suppliers in the Atlantic region must provide the corresponding DFO regional office with updated tagging information (DFO, 2018). As things stand, retrieving ALDFG that is not tagged by the harvester within season or without proper permitting from DFO is illegal according to DFO licence conditions and Atlantic Fishery Regulations (Goodman et al., 2019). However, DFO has begun organizing retrieval days. In July 2019, [Operation Ghost](#) saw the removal of over 100 snow crab pots and over 9 km of rope from the Gulf of St. Lawrence (DFO, 2019b). More retrieval events are expected to take place from 2020 to 2022 through the SFSRSCP.

MARITIMES - SCOTIA-FUNDY

The Maritimes region is the largest and most complex within Atlantic Canada. It has two official measures directed at ALDFG: lost-tag recording and tag replacements (Kelsey Hayden, pers. comm., Aug. 7, 2019). When lobster traps are lost in the Maritimes region, licence conditions require that the lost trap tags be recorded in the “Record of Fishing Gear Tags” form kept on board the vessel. This requirement is specific to the Maritimes region. The information recorded is used to prove which traps are validly tagged if the vessel is boarded by a Conservation and Protection officer. Other information regarding lost gear is expected to be reported to tag suppliers, according to the licence conditions and tag-replacement policies of the relevant tagging plan. These additional direct measures also apply in other Atlantic regions, but specific reporting protocols may vary slightly (Sy Oumar, pers. comm., Feb. 4, 2020).

GULF

Like other Atlantic regions, the Gulf region uses mandatory reporting according to licence conditions and escape mechanisms on trap gear to manage ALDFG. Tagging requirements under the national tagging protocol are also used as indirect measures to manage ALDFG in commercial fisheries and to monitor fishing effort (Josiane Massiera, pers. comm., Sept. 3, 2019).

NEWFOUNDLAND AND LABRADOR

The Newfoundland and Labrador region has similar gear-tagging requirements for their fisheries, including lobster and groundfish fisheries where gillnets are used. Groundfish are highly targeted species in the region, and as of 2019, all groundfish that are targeted using gillnets require net tags. Groundfish General Licence conditions state the following: “You cannot fish with or have onboard the vessel a groundfish gillnet unless a valid tag, issued to you under the authority of the Minister, is securely attached to the head rope of the net in a manner for which the tag was designed.” As in other Atlantic regions, gear tags are provided and managed by a third-party tag supplier (Glen Rowe, pers. comm., Sept. 4, 2019).

QUEBEC

In Quebec, licence conditions outline measures that help manage lost gear: “The licence holder/fishing vessel operator may fish with, have in his possession or have on board the fishing vessel a maximum of (Number – Gear type) during a fishing trip.” There are requirements for fixed gear: “While fishing under these conditions of licence, the licence holder/fishing vessel operator must identify each primary buoy with a sequential number so as to be capable of individually identifying each fishing gear” (Élaine Bouchard, pers. comm., Sept. 26, 2019). These gear-marking measures are similar to those of other Atlantic regions, though wording varies slightly.

PACIFIC REGION

Like the Atlantic, the Pacific region has a range of commercial fisheries and gear types. All fisheries have gear-marking requirements in place, with the exception of diving and hand-picking fisheries; as these do not use harvesting gear, they are not subject to specific reporting requirements for lost or retrieved gear. For Pacific commercial fisheries, mandatory conditions for lost or retrieved fishing gear were implemented in 2019, and will be in place for the entire 2020 fishing season (Greg Savard, pers. comm., Sept. 26, 2019).

Fishing gear that remains attached to the vessel during fishing operations is not typically lost. This is the case for trawling and seine fishing used in salmon and pelagic fisheries (Greg Savard, pers. comm., Sept. 26, 2019). For gillnet fishing in impoundments, nets are not attached to the vessel. This is the case for the roe herring gillnet fishery and kelp fishery. Prone to being lost, such gear must be marked with the fisher's licence number. These gear-marking requirements are similar to those in Atlantic regions. Of the 12 invertebrate fisheries, two (crab and prawn/shrimp by trap) utilize strings of traps to harvest product. Mandatory licence conditions require marking both individual traps and the lines to which the traps are attached. Both of these fisheries experience gear loss, and both have a mandatory requirement in licence conditions to report lost and retrieved gear. When gear is lost, fishers must notify a service provider and must secure new trap tags before new tags can be issued (Greg Savard, pers. comm., Sept. 26, 2019). This requirement is similar to that of the Atlantic Region.

CENTRAL AND ARCTIC REGION

In the Central and Arctic region, gear loss is managed solely through the reporting requirements of licence conditions. There is a tagging program only for nationally managed fisheries (groundfish and offshore shrimp) and a basic version for char fisheries (George Klein, pers. comm., Sept. 3, 2019). Due to the remoteness of Arctic fisheries, implementing complex programs is difficult (George Klein, pers. comm., Sept. 3, 2019). Therefore, the tagging protocol in the Central and Arctic regions differs from that of the Atlantic and Pacific regions, and does not use tags as an additional indirect measure to manage ALDFG.

RECOMMENDATIONS

Based on the current regional management of ALDFG and licence conditions in place or in development, it is recommended that DFO carry out the following measures:

- Continue to implement and expand reporting requirements under the new licence conditions, modifying them over time to suit the specific needs of each fishery in each region. It could be beneficial to implement a retrieval tagging program under Regional Tagging Protocols to monitor and report gear found at sea. This would legitimize the retrieval process and address the limitations of current licence conditions.
- Establish a comprehensive permitting process and notify fishing associations. This would allow industry and organizations to remove ALDFG remaining at sea in a timely and cautious manner.
- Organize retrieval days and/or provide sufficient funding for industry and other interested parties, such as academia and non-governmental organizations, to conduct large-scale gear-retrieval activities, along the lines of Operation Ghost. It could be beneficial to have regularly scheduled time periods after each season to allow for retrievals restricted to permitted areas, to ease targeted monitoring and enforcement.
- Work with the Fishing Gear Coalition of Atlantic Canada and additional stakeholders to develop clear management guidelines for the retrieval and disposal of ALDFG washed ashore above the high-water line.

CHAPTER 2 – STATE OF ALDFG KNOWLEDGE IN CANADA

Chapter 2 captures knowledge from ongoing, completed and future Canadian projects that address ALDFG. This information is essential to understanding what is known about ALDFG in Canada, assessing national efforts, connecting organizations doing similar work and limiting project duplication. An index of international projects – created in partnership with Marina Daoud, an Ecology Action Centre intern – has been included to provide global insight (Appendix A – External).

APPROACH

An online survey was used to assess ongoing, completed and planned projects involving ALDFG. The survey was created in consultation with the FGCAC and delivered using Google Forms (Appendix B). Open from July to October of 2019, the survey was initially circulated within the FGCAC, then circulated among networks to recruit other organizations. The aim was to capture as many ghost gear- and ALDFG-related projects as possible. Additional projects were included in this chapter as the researcher was made aware of them through networking and desktop research. In total, the chapter includes 28 projects. Of these, 21 are ongoing, four are completed and three are in the planning phase (Table 1; Figure 1).

Research was conducted to capture complete information on each project. Each project has been profiled according to information collected through the survey. The profile includes a brief description, specific goals and objectives, major take-aways, successes, lessons learned and notable challenges. Note that some projects are not static in nature and are subject to change over time. While the list provided is as exhaustive as possible, some projects may have been missed during the survey and research.

Table 1. Summary of ALDFG- and ghost gear-related projects captured through the survey, listed by organization. The survey was open from July to October of 2019. Note that contacts are subject to change over time.

ORGANIZATION	CONTACT	LOCATION/SCOPE	PROJECT TITLE
ONGOING			
Ashored Innovations	Aaron Stevenson	Atlantic Canada; Global	Ashored Loss Prevention Strategy
Canadian Whale Institute	N/A	Southern Gulf of St. Lawrence (GSL)	Monitoring and Stewardship Toward New and Effective Risk Mitigation for Right Whales in Atlantic Canada
Canadian Wildlife Federation	Elizabeth Baker	Atlantic Canada	Field testing of ropeless gear to help mitigate entanglement risk to marine mammals

Cape Breton Environmental Association	Dylan Yates	Cape Breton, Nova Scotia	ALDFG Removal
Civic Laboratory for Environmental Action Research (CLEAR)	Max Liboiron	St. John's, Newfoundland	Fragmentation of fishing gear into microplastics
Civic Laboratory for Environmental Action Research (CLEAR)	Max Liboiron	Global; focus on Newfoundland and Labrador	Fish tag circulation project
Canadian Parks and Wilderness Society Newfoundland (CPAWS-NL)	Mary Alliston Butt	Newfoundland and Labrador	Ship-to-Shore NL
Fisheries and Oceans Canada (DFO)	National Manager	Canada; Regional focuses	Ghost Gear Program
EnviroCulture Consulting	Marcus Goodick	Stewiacke, Nova Scotia; Atlantic Canada	Recycling rope, net, and other end-of-life fishing and aquaculture industry plastics into plastic lumber
Fishermen and Scientists Research Society (FSRS)	Shannon Scott Tibbetts	South and Eastern Shore, Nova Scotia	LEK to qualify and map Ghost Gear in NS
Fundy North Fishermen's Association (FNFA)	Darlene Norman-Brown	Bay of Fundy; Gulf Region	Reducing Entanglement Threats Through Ghost Gear Removal: Expanding Lost Fishing Gear Retrieval Projects in the Bay of Fundy and Gulf Regions
Homarus Inc.	Douina Daoud	Southern Gulf of St. Lawrence	To facilitate coexistence between fisheries and species at risk in the southern Gulf of St. Lawrence: Reduction of cordages during fishing, awareness and commitment within the community, ghost-gear retrieval project
Huntsman Marine Science Centre	Jackie Walker	Southwest New Brunswick	Debris Free Fundy
Memorial University	Jessica Melvin	Placentia Bay, Newfoundland	Placentia Bay Ocean Debris Survey (PODS)

Merinov	Jérôme Laurent	Gulf of St. Lawrence	Reduce the threat of ghost fishing to aquatic species at risk in snow crab fishing areas of the Gulf of St. Lawrence by recovering traps abandoned on the seabed
Mingan Island Cetacean Study	Christian Ramp	Gulf of St. Lawrence	Ecology of baleen whales in the Gulf of St. Lawrence
Prince Edward Island Herring Fishermen's Association	Laura Ramsay	Herring Fishing Area 16G, Eastern P.E.I.	16G Gear Retrieval Project
Prince Edward Island Western Gulf Fishermen's Association	Laura Ramsay	Western Gulf, Prince Edward Island	LFA 24 Ghost Gear Clean-up
Steveston Harbour Authority	Glenn Chow	British Columbia	Commercial Fishing Net Recycling
T Buck Suzuki Foundation	Megan Eadie	British Columbia	B.C. Lost Gear Knowledge Gathering
COMPLETED			
Association des crabiers acadiens	Robert Haché	Southern Gulf of St. Lawrence	Lost snow crab fishing gear retrieval by means of grappling high-density fishing locations without sonar identification in the Southern Gulf of St. Lawrence (SGSL)
Association de gestion halieutique autochtone Mi'gmaq et Malécite	Catherine Lambert Koizumi	Bay of Paspébiac (Bay of Chaleurs - Gaspé Peninsula, Quebec)	Cleaning of an aquaculture site in Paspébiac
Clean Foundation	Sonia Smith	Nova Scotia	Ship-to-Shore
Dalhousie University	Alexa Goodman	Bay of Fundy, Nova Scotia and New Brunswick	Ghost Gear and ALDFG research in the Bay of Fundy

PLANNING

Coastal Action	Alexa Goodman	Nova Scotia, South Shore (LFA 33, 34 and 35)	Southwest Nova Scotia Abandoned, Lost and Discarded Fishing Gear (ALDFG) Remediation Project
The Confederacy of Mainland Mi'kmaq	Kate Nelson	Mi'kma'ki Territories	Keskaqowey Apuktuk Memjewey Mi'kma'ki (Ghost Gear in Mi'kma'ki)
World Wildlife Fund Canada	Chelsea Boaler	Gilbert Bay Marine Protected Area, Labrador	Gilbert Bay Marine Protected Area and Ghost Fishing

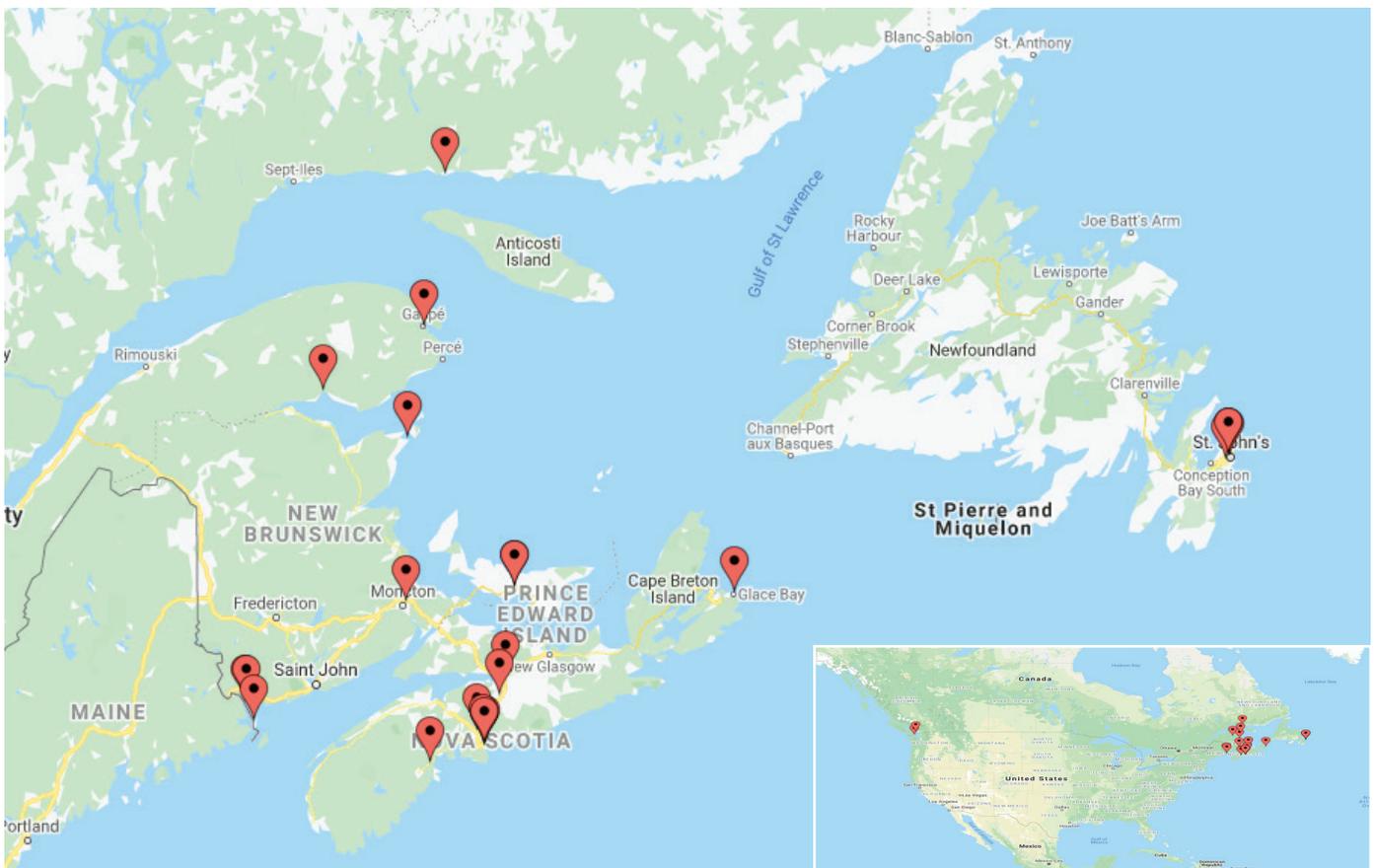


Figure 1. Geographic locations of projects included in Chapter 2, identified by the organization's office. Most projects (26) were in Atlantic Canada. Two were on the West Coast, shown in the smaller map for scale.

ONGOING PROJECTS

Below are profiles of ongoing projects as captured in the online survey. The major take-aways can be seen as valuable contributions to ALDFG knowledge. However, as these ongoing projects are in different phases, some have yet to determine their successes, lessons learned and notable challenges.

ASHORED INNOVATIONS – ASHORED LOSS PREVENTION STRATEGY

Location/Scope: Atlantic Canada and Global

Ashored Inc., an ocean technology company based in Halifax, Nova Scotia, is developing a line of sustainability-enabling technologies. The company focuses on improving the sustainability and efficiency of the commercial marine fishery and minimizing impacts of commercial activities on the oceans. While currently in the research and development phase, the company's signature products are designed to protect endangered marine life, and to capture and display valuable details about the gear and catch with a ropeless fishing system (MOBI) and gear-tracking system (ATLAS).

Goals and Objectives: Develop ropeless fishing and gear-tracking technologies for trap fisheries and expand to include comparable solutions for other fisheries.

Major Take-Aways: Containing ropes on the ocean floor next to the traps, combined with accurate gear tracking, prevents conditions often leading to gear loss and aids in the recovery of gear by marking its last known location.

Successes and Lessons Learned: TBD – Still testing the product.

Notable Challenges: Cost remains a concern to broad adoption.

CANADIAN WHALE INSTITUTE – MONITORING AND STEWARDSHIP TOWARDS NEW AND EFFECTIVE RISK

Mitigation for Right Whales in Atlantic Canada

Location/Scope: Southern Gulf of St. Lawrence (GSL)

This three-year (2019–2022) monitoring, stewardship and outreach project undertakes activities proven to reduce the risk of vessel strikes and fishing-gear entanglements to endangered North Atlantic right whales (NARW). The monitoring program will facilitate stewardship by keeping GSL stakeholders (shipping and fishing industries) apprised of changes in NARW distribution in near real time with data from visual and acoustic surveys. The program will track changes in whale distribution, health, threats and risks in a high-risk foraging habitat – all factors that must be addressed to reduce injury and mortality caused by human activities (shipping and fishing). The work will also document and benefit blue fin whales. The project explicitly addresses national priorities for the Habitat Stewardship Protection/Species at Risk Stream in the following ways:

- It implements priority activities described in right whale and blue whale recovery strategies and action plans.
- It involves collaboration among multiple stakeholders and partners.

Goals and Objectives:

- Collaborate with snow crab fishers to undertake vessel-based monitoring surveys in the Gulf of St. Lawrence for right, fin and blue whales. Fishers (captain and crew) will learn how to identify right whales at sea from their own boats. Through hands-on experience, they will learn about the animals and the risks they face, develop an understanding of whale behaviour, learn to navigate around whales, and become familiar with the research program. All of these factors will increase fishers' capacity and willingness to engage in stewardship.
- Contribute to dynamic management measures and outreach by providing data. Shipping and fishing industries need real-time location information to plan their activities.
- Record fishing gear and vessel activity observed during surveys. The project will employ systematic track line methodology and computerized track and data logging to assess the number, location and individual identification of right and blue whales (i.e., distribution), in selected areas of the Gulf of St. Lawrence.

- Use photos to assess individual health, scarring and entanglements. All whale sightings will be communicated daily to DFO managers, Dalhousie University's Whale Map, Transport Canada's Situational Centre, and the National Marine Fisheries Service Sighting Advisory System. This information will be used for management and advisory purposes, and uploaded to online advisory bulletins.
- With collaborators, conduct real-time acoustic-glider monitoring in the southern GSL during the snow crab fishing period. The gliders have proven to be critical monitoring tools – especially during winter, spring and autumn, when poor sighting conditions significantly reduce aerial and vessel visual surveillance. Visual and acoustic monitoring programs will provide critical data required to manage threats in high-risk areas (i.e., areas of high whale density). CWI is trying to improve the management of at-risk species according to SARA regulations and HSP priorities.
- Encourage participation and collaboration. The project will enable Canadians (fishers as well as national and international vessel owners/operators) to become actively and concretely involved in the stewardship of at-risk whales; this engagement will result in tangible and measurable conservation benefits. For example, fishers will participate in the vessel-based visual monitoring surveys, which will take place onboard their vessel. Monitoring is a critical component of a larger stewardship-and-outreach initiative to reduce risk to whales.

Major Take-Aways: Location of ghost gear and ALDFG recorded by researchers during visual right whale surveys and reported to DFO is used to find and remove ghost gear and ALDFG.

Successes and Lessons Learned: DFO can remove ghost gear and ALDFG reported during surveys from areas where right whales are present. This reduces the risk of entanglement to right whales and other whale species.

Notable Challenges: Surveys are conducted on a snow crab fishing vessel that has capacity to remove ghost gear and ALDFG from water. However, the vessel is not permitted to haul any fishing gear. This delays by days or weeks the removal of gear from areas where right whales are present, increasing the risk of entanglement.

CANADIAN WILDLIFE FEDERATION – FIELD TESTING OF ROPELESS GEAR TO MITIGATE ENTANGLEMENT RISK TO MARINE MAMMALS

Location/Scope: Eastern Canada

Canadian Wildlife Federation is partnering with fish harvesters and fishing organizations to help them lead testing of ropeless fishing gear technologies. CWF is seeking to determine if ropeless gear is feasible for commercial (including communal commercial) fixed-gear fisheries. Ropeless gear may allow harvesters to access fishing areas that have been closed because they pose entanglement risks to marine mammals, such as the critically endangered North Atlantic right whale.

As ropeless gear is still in its infancy, the input of fish harvesters is critical to its further modification and development. CWF has secured funding to purchase different ropeless systems and allow harvesters to test and modify them to determine if they can be made suitable for their local fisheries. CWF has contacted developers of various ropeless systems, all of which use an acoustically triggered release mechanism that allows either a float (buoy) or the gear itself to be brought to the surface for retrieval.

CWF aims to develop a framework to test various ropeless gear systems to determine if they are suitable for a specific commercial fishery. As fish harvesters know best what is required of the gear, CWF wants them to inform this framework and to lead testing on the water. CWF seeks answers to the following questions:

1. Does the gear work?
2. If it doesn't currently work, can modifications be made to make it work?
3. If it doesn't work at all, why is this the case?

This evaluation framework will be developed through consultations with fish harvesters, and adapted throughout field testing of the ropeless gear.

Goals and Objectives:

- To determine whether ropeless fishing gear is a viable option for commercial fisheries in Eastern Canada. Ropeless fishing gear could reduce the risk of entangling marine mammals, including the critically endangered North Atlantic right whale.
- While managing ALDFG is not a specific goal of this project, the use of ropeless fishing gear could ultimately reduce the loss of traditional fishing gear. For example, if there were fewer unattended lines in the water, there would be less chance of vessels cutting off gear. In addition, acoustic location devices on ropeless fishing gear could be used to locate gear that has drifted or been lost.
- CWF's trials will determine failure and success rates of different ropeless systems. As a secondary finding, these trials could contribute information on whether these systems would mitigate ALDFG problems.

Major Take-Aways: Results will determine whether, under certain circumstances, ropeless fishing gear can be used as a viable tool to prevent entanglement of wildlife and subsequent loss of gear. This technology may also spark new ideas for retrieving lost gear – for example, the use of gear-locating technologies or acoustic tagging of gear.

Successes and Lessons Learned: Still in progress.

Notable Challenges:

- The fishing industry has an aversion to ropeless fishing.
- Many ropeless technologies are still in the prototype phase.
- There are general problems with ropeless gear systems.
- Technologies are not suited to some of the harsh conditions in Atlantic Canada.
- There are policy barriers to the use of ropeless gear.
- There are enforcement concerns with the use of ropeless gear.
- It is difficult to find adequate technology to mark and locate ropeless gear.

CAPE BRETON ENVIRONMENTAL ASSOCIATION – ABANDONED, LOST, AND DISCARDED FISHING GEAR (ALDFG) REMOVAL

Location/Scope: Cape Breton, Nova Scotia

Cape Breton Environmental Association (CBEA) has been involved in removing derelict gear from shorelines in Cape Breton for the past year and will continue these efforts. CBEA has also patrolled the coastline for ghost gear in the water and has a few more patrols planned. The goal is to showcase issues associated with ALDFG and collect vital information about the scope of the problem in Cape Breton, both on the shorelines and in the water.

Goals and Objectives: Remove and record ALDFG in Cape Breton.

Major Take-Aways: ALDFG is a major problem and Cape Breton is witnessing its impacts firsthand.

Successes and Lessons Learned: A collaborative approach is the best way to solve the problem of ALDFG.

Notable Challenges: DFO regulations are a barrier for both CBEA and fish harvesters when they try to retrieve ghost gear.

CIVIC LABORATORY FOR ENVIRONMENTAL ACTION RESEARCH (CLEAR) – FRAGMENTATION OF FISHING GEAR INTO MICROPLASTICS

Location/Scope: St. John's, Newfoundland

Master's student Jackie Saturno has created an experimental environment at Memorial University and CLEAR where three different types of common polymer ropes are exposed to simulated environmental conditions. The ropes' respective rates and characteristics of fragmentation into microplastics are recorded.

Goals and Objectives:

- Learn how fishing gear fragments when it is exposed to environmental conditions consistent both with heavy use and loss in the ocean.
- Compare different types of gear for fragmentation characteristics.

Major Take-Aways: This project will determine the ways/rates at which gear becomes a new form of marine pollution via microplastics, including how different polymers contribute in different ways.

Successes and Lessons Learned: TBD

Notable Challenges: TBD

CIVIC LABORATORY FOR ENVIRONMENTAL ACTION RESEARCH (CLEAR) - FISH TAG CIRCULATION PROJECT

Location/Scope: Global, focus on Newfoundland and Labrador

Using fishing tags, this project maps fishing-gear plastics as they circulate away from N.L. and into global waters. It also maps the tags that wash up on some N.L. shores.

Goals and Objectives: Map the circulation of marine plastics using fishing tags (mainly from the lobster fishery).

Major Take-Aways: This project will indicate where N.L. plastics travel to worldwide, as well as where plastic waste that lands in N.L. is coming from.

Successes and Lessons Learned: TBD

Notable Challenges: Patchy data resulting from limited coverage in coastal areas that are easily accessed by beachcombers. Fishing tags are a challenging source of information for spatial and temporal analysis. Since multiple entities have been in charge of manufacturing these tags throughout the years, there is no standardization of the codes used in the tags, resulting in inconsistencies in terms of what information we can extract. For example, only the most recent lobster tags contain information on fishing areas where the tag was deployed and the year of manufacturing. This contrasts with tags pre-2010, which may indicate only that these tags are from Canadian fisheries and provide no temporal information.

CANADIAN PARKS AND WILDERNESS SOCIETY NEWFOUNDLAND (CPAWS-NL) - SHIP-TO-SHORE NL

Location/Scope: Newfoundland and Labrador

Through working with fish harvesters, ocean users and harbour management, this program aims to reduce marine debris and encourage all ocean users to bring all of their waste back to shore and dispose of it properly. CPAWS-NL aims to work with the communities to improve waste disposal and find solutions to make the community a clean space for the people and species that call it home. By identifying barriers that inhibit proper waste disposal, this program will help reduce the amount of waste in our oceans and along Newfoundland and Labrador's diverse coastlines.

Goals and Objectives:

- Reduce marine debris
- Increase education about marine debris
- Find ways to reduce marine debris
- Obtain pledges from N.L. ocean users to bring their garbage back to shore

Major Take-Aways: Now working with FGAC, CPAWS-NL hopes to include more focus on ALDFG in regard to location, quantity and kinds. Currently, the major take-aways are the importance of increasing awareness of marine debris, returning all waste generated at sea to land for proper disposal, and helping harbour authorities find solutions for reducing debris in their own harbours.

Successes and Lessons Learned: S2S NL is relatively new. In early stages, the project installed garbage and recycling bins in Petty Harbour. Due to funding constraints, this aspect of the project was ended after consultation with Clean NS. We now simply provide guidance, education and ideas, and work with the harbours to find and implement solutions. To date, there are 17 Ship-to-Shore Harbours, with more planned in the future. There have also been some great shoreline/harbour clean-ups within some S2S harbours! Learning from other groups like Placentia Bay Ocean Debris Survey (PODS) and CLEAR, CPAWS-NL will be implementing microplastic trawls during harbour visits.

Notable Challenges:

- Financial constraints make it difficult to implement solutions (for example, not having funding to provide waste oil tanks and bins). Land waste management is the biggest challenge, as costs and regulations are not tailored to harbour communities.
- As fishers are busy, it is challenging to get information from them about ghost gear locations. CPAWS-NL is working on getting information regarding wolffish bycatch for a shared project. Though fishers will talk, it is hard to get detailed information (coordinates, exact numbers, etc.).
- Enforcement is a challenge. As an ENGO, CPAWS-NL cannot give harbour authorities the power to enforce regulations against illegal dumping. Granting this authority would be a government decision – a point that we have often brought up. CPAWS-NL can only help the harbour authorities.

FISHERIES AND OCEANS CANADA (DFO) – GHOST GEAR PROGRAM

Location/Scope: Canada, with regional focuses

In development by DFO, this ghost gear program includes the new Sustainable Fisheries Solutions and Retrieval Support Contribution Program. DFO has established a national ALDFG group (Ghost Gear Program), with a representative from each DFO region. Phone calls every two weeks provide direction.

Goals and Objectives: Currently focusing on understanding and decreasing ghost gear remaining at sea, as well as reducing marine plastics and waste.

Major Take-Aways: TBD

Successes and Lessons Learned: TBD

Notable Challenges: TBD

ENVIRO CULTURE CONSULTING – RECYCLING FISHING ROPE AND NET

Location/Scope: Stewiacke, Nova Scotia; and Atlantic Canada

This project challenge is in conjunction with DFO, funded primarily by Goodwood Plastic with grant funding from Innovative Solutions Canada. It aims to determine the viability of using end-of-life net and rope in plastic lumber.

Goals and Objectives: The goal is to blend net and rope into plastic lumber products to determine how this might improve/limit the various products' flexibility. The objective is to manufacture and sell various plastic lumber products that incorporate rope and net.

Major Take-Aways: It is possible to collect and recycle the majority of fishing plastics produced in Atlantic Canada and sell them back as a product.

Successes and Lessons Learned: A bit early too early to disclose results, but it looks promising.

Notable Challenges: Collecting clean supplies of net and rope and grinding the material can be quite challenging.

FISHERMEN AND SCIENTISTS RESEARCH SOCIETY (FSRS) – LOCAL ECOLOGICAL KNOWLEDGE (LEK) TO QUANTIFY AND MAP GHOST GEAR IN NOVA SCOTIA

Location/Scope: South and Eastern Shore, Nova Scotia – 100 km radius from Halifax

Currently, very little is known about the distribution and severity of ghost fishing – ALDFG continuing to catch marine species indiscriminately – in Nova Scotia. Therefore, the effect of ghost gear on Nova Scotia’s commercial and wild stocks, benthic habitats and economy is poorly understood. This pilot project is very important in addressing some of the knowledge gaps surrounding ghost gear quantity and remediation.

Goals and Objectives: This pilot project aims to use local ecological knowledge (LEK) to identify where, what and how much ghost gear is present in Nova Scotia. It will also look at barriers fishers face in recovering and disposing of ghost gear, and offer possible solutions.

Major Take-Aways: TBD

Successes and Lessons Learned: TBD

Notable Challenges: TBD

FUNDY NORTH FISHERMEN’S ASSOCIATION (FNFA) – REDUCING ENTANGLEMENT THREATS THROUGH GHOST GEAR REMOVAL: EXPANDING LOST FISHING GEAR RETRIEVAL PROJECTS IN THE BAY OF FUNDY AND GULF REGIONS

Location/Scope: Bay of Fundy and Gulf Region

This three-year Habitat Stewardship Program (HSP) Species at Risk stream project aims to reduce the threat of whale entanglements with fishing gear in Atlantic Canada through retrieving and preventing ghost gear. The project covers New Brunswick and Quebec, the Bay of Fundy and the Gulf of St. Lawrence. The project addresses the threat of fishing gear interactions to two species that are listed on Canada’s Species at Risk Act – the North Atlantic right whale (Endangered), which is a regional priority species for aquatic projects in the Atlantic; and the Atlantic population of the fin whale (Special Concern).

Project activities include capacity-building activities in the Gulf of St. Lawrence region, such as translating best-practice materials into French and holding educational meetings with Gulf fishers. Other activities include surveying “hotspot” areas of ghost gear in the Southwest New Brunswick waters of the Bay of Fundy; and designing, building and using grapnels to retrieve ghost gear from hotspots. These activities will contribute to recovery strategies for the two targeted at-risk species, by directly removing fishing gear entanglement threats to whales. They will also build capacity in the Gulf region to engage in future projects that aim at managing ghost gear. Project performance will be evaluated with measurable indicators, including the amount of gear retrieved and the longer-term uptake of regional ghost-gear initiatives in the future.

Goals and Objectives: Retrieve ghost gear in designated portions of the Bay of Fundy and collaborate with our counterparts in the Gulf region as they begin their own ghost-gear retrieval projects.

Major Take-Aways:

- With continued efforts, ghost gear can be eliminated or greatly reduced. This lessens the impact on marine life, and reduces the chances of area fishers losing additional gear to entanglement with ghost gear.
- New ghost gear is created when lines are cut and gear is dragged. To prevent this, it’s vitally important to work with other organizations who are on the water. Various parties can agree to put cages on propellers, help each other avoid trap lines, and communicate when vessels have to tow through areas where there could potentially be gear.
- It’s important to create ongoing awareness of the issues of ghost gear, through all forms of social media. People need to be educated about the dangers that entanglements pose to all marine life. They also need to know that deteriorating ghost gear on the ocean floor produces microplastics, which pose a danger to both marine life and humans. In addition, there is also the issue of ghost gear fishing – where lobsters and other crustaceans become trapped and cannot escape. Education on the importance of being good stewards of the oceans is an essential part of eliminating the threat of ghost gear for future generations.

Successes and Lessons Learned: Fundy North has successfully been involved in ghost-gear retrieval since 2008, and won the first ever Gulf of Maine Council on the Marine Environments' Industry Award for this initiative. In 2014, Fundy North was one of the first fishing industry organizations to become a member of the Global Ghost Gear Initiative (GGGI). As the organization was [profiled on the GGGI website](#), a wide range of people learned about the importance of ghost-gear retrieval and Fundy North's work.

Fundy North's fishers designed grapnels for both hard bottom/deeper water and softer bottom/shallower water. These fishers, and the grapnels they designed, were instrumental in clearing two areas of the Bay of Fundy (Saint John Harbour and Head Harbour Passage) of ghost gear. Area fishers immediately noticed the difference as they were no longer losing gear to snarls of ghost gear.

This initial ghost-gear retrieval work spawned an additional Old Gear Retrieval Project, which aimed to create awareness of old gear and prevent the disposal of old gear at sea. This project was highly successful as well: hundreds of fathoms of rope and nets were repurposed, and hundreds of traps were recycled or repurposed. Fundy North created a manual for fishers on ghost-gear retrieval, as well as two videos – one on ghost-gear retrieval, the other on soft bottom grapnel designs and advice on grappling from the fisher who designed the grapnels. These are all available for viewing on the [FNFA website](#); the videos are also available in French and English on the [FNFA YouTube page](#). Throughout the initial project, the fishers learned the best ways to grapple for ghost gear and the best equipment to use to help locate the gear – side-scan sonar. (Interviews with fishers also produce information about new areas of lost gear or snarls.) The need for patience was deemed to be the most important lesson learned when it came to actually grappling for the ghost gear.

Notable Challenges: Some of the most notable challenges involved locating the ghost gear. It required extreme patience to drag back and forth in a grid pattern to try to locate the gear. In some cases, the ghost gear had already been retrieved by other fishers, but not reported as retrieved. Once found, gear was often hard to snag, but the fishers persisted. It was also difficult to find ways to dispose of the old gear retrieved. The gear gathered from our Old Gear project – especially old traps – posed particular challenges. It took a lot of effort and research to find potential solutions to this problem.

HOMARUS INC. - TO FACILITATE COEXISTENCE BETWEEN FISHERIES AND SPECIES AT RISK IN THE SOUTHERN GULF OF ST. LAWRENCE: REDUCTION OF CORDAGES DURING FISHING, AWARENESS AND COMMITMENT WITHIN THE COMMUNITY

Location/Scope: Southern Gulf of St. Lawrence

Homarus Inc. is a non-profit research and development organization created by the Maritime Fishermen's Union (MFU) in 2001. Its mission is to develop tools to ensure the sustainability of the lobster resource and its fishery. With expertise in research and development, and in education and science popularization, combined with a historically close relationship with the fishing industry, Homarus proposed to actively participate in mitigating threats of human-related activities to the fishing industry and to species at risk. To do so, Homarus has started a four-year project whose objectives fall into three main components:

1. Technological innovations in the crab fishery to reduce the risk of entanglements due in part to the amount of rope in the water column during fishing.
2. Training and sensitization of fishers and the general public on the ecology and behaviour of cetaceans and other at-risk species occupying the Gulf of St. Lawrence, responsible fishing, marine pollution, good fishing practices and ocean protection.
3. Implementation of a ghost-gear retrieval project in coastal waters with the lobster fishers.

Specifically, Homarus expects to continue efforts started in 2018 to eliminate vertical ropes from the crab fishery (Component 1). Component 2 is considered essential so that all efforts made by our scientists and participating fishers will be recognized by all fishing fleets. This will garner support for the important task of cleaning up the seafloor on a medium term. The legacy of this ambitious enterprise rests on the education of future generations and emerging fishers.

Goals and Objectives: The activities proposed in this project are consistent with recovery plans for at-risk species identified in the project area (right whale, fin whale, blue whale, great white shark, leatherback turtle). These activities are also intended to counter the threat that at-sea fishing gear – whether active or lost – poses to marine life. Protecting the right whale is a priority issue. Though less well documented, the threat to other at-risk species is equally real.

Major Take-Aways: TBD – The four-year project has just been funded, and the activities have not yet started.

Successes and Lessons Learned: TBD

Notable Challenges:

- Detecting/locating traps in coastal areas
- Involving the community and the fishers in gear-retrieval effort

HUNTSMAN MARINESCIENCE CENTRE – DEBRIS FREE FUNDY

Location/Scope: Southwest New Brunswick

The #DebrisFreeFundy Project is an initiative at the Huntsman Marine Science Centre that aims to keep marine debris out of the Bay of Fundy. This is being accomplished through a rope collection, recycling and repurposing program, eco-friendly business acknowledgement programs, and shoreline clean-ups. Outreach/education initiatives in southwestern New Brunswick communities are informing the public about the importance of a healthy marine ecosystem.

Goals and Objectives: Minimize inputs and remove debris from the Bay of Fundy.

Major Take-Aways: Fishing rope removed from marine environment/Rope collection bins worked/More bins were requested during pilot period and ongoing. 20+ local businesses in the town of St. Andrews participating in the business acknowledgement programs and reducing single-use plastic consumption. 300+ school-aged youth reached through education and outreach initiatives.

Successes and Lessons Learned: 5+ tonnes of rope removed from marine environment and ongoing.

Notable Challenges: Removal and pick-up from bins/Other debris and garbage in bins/End-of-life recycling or extended producer responsibility (EPR) lacking in North America.

MEMORIAL UNIVERSITY – PLACENTIA BAY OCEAN DEBRIS SURVEY (PODS)

Location/Scope: Placentia Bay, Newfoundland

The Placentia Bay Ocean Debris Survey (PODS) is a four-year program for the long-term monitoring of marine plastics in key sites around Placentia Bay, Newfoundland. The survey includes comprehensive repeat surveys of micro- and macroplastics on shorelines, microplastics in surface waters, and macroplastics in benthic environments. This project is jointly funded by DFO and the Ocean Frontier Institute (OFI).

Goals and Objectives: Establish a baseline understanding of marine plastic concentrations on shorelines, in surface waters and on the seafloor at various locations around Placentia Bay. This baseline will include high-resolution information on seasonal changes in marine plastic abundance and distribution.

Major Take-Aways: TBD

Successes and Lessons Learned: Collaborating with local communities to better understand the marine plastic landscape in their region by incorporating local knowledge into the project was a notable success. Providing citizen-science protocols that are accessible and adaptable to local environmental and cultural conditions made collaboration possible.

Notable Challenges: Adapting globally standardized protocols to Newfoundland shorelines that are characterized by coarse sediment and heavy seasonal changes, which fall outside standardized protocols.

MERINOV – REDUCE THE THREAT OF GHOST FISHING TO AQUATIC SPECIES AT RISK IN SNOW CRAB FISHING AREAS OF THE GULF OF ST. LAWRENCE BY RECOVERING TRAPS ABANDONED ON THE SEABED

Location/Scope: Gulf of St. Lawrence

For many at-risk species, entanglements and collisions are major threats. Large animals can become entangled in vertical ropes that remain suspended in the water column. Although entanglement does not necessarily result in the direct death of the animal, it can have long-term negative physiological effects. Threats of entanglement have been clearly identified in the Recovery Plans for Species at Risk and/or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessments.

Snow crab fishers lose traps each year. Since crab fishing has been practised for more than 30 years, it is estimated that several thousand traps rest on the seabed. These traps continue to fish, resulting in ghost fishing. In addition, with their rope remaining in suspension for several years, these traps continue to present a risk of entanglement for the target species.

Lost snow crab traps pose a threat to aquatic species. These traps must be retrieved from the seabed to eliminate this threat. The snow crab fishing areas reach depths of nearly 250 metres and more. Although the fishing grounds are well known in the Gulf of St. Lawrence, the areas to be covered to recover lost traps are considerable. Moreover, it is not possible to proceed blindly by dragging a recovery vehicle. For these reasons, it is crucial to determine the precise location of the traps by means of adapted detection tools, and to recover the traps using gear adapted to the situation.

The project will develop a technology to detect and remove traps lost on the seabed. The objective is to develop an efficient method of gear recovery, transferable to industry and usable on board fishing boats. This gear will reduce the threats of entanglement and bycatch for marine species present, including aquatic species at risk.

Goals and Objectives: The general objective of the project is to carry out a campaign to recover lost traps in the Gulf of St. Lawrence, and to transfer knowledge and technologies to the fishing industry. The project's activities are divided into two parts: Detection and Recovery. The development of protocols for these two components will be carried out simultaneously during the first two years and will be improved in subsequent years, leading to the beginning of the cleaning campaign (years 3 and 4).

Major Take-Aways: TBD – The project has just been funded, and the activities have not yet started.

Successes and Lessons Learned: TBD

Notable Challenges:

- Capacity to detect/locate traps at great depths
- Effectiveness of trap recovery: accuracy, speed, impact on the seabed
- Ability to successfully transfer complex detection technologies to the industry

MINGAN ISLAND CETACEAN STUDY (MICS) – ECOLOGY OF BALEEN WHALES IN THE GULF OF ST. LAWRENCE

Location/Scope: Gulf of St. Lawrence

MICS has been conducting photo identification and biopsy studies on baleen whales in the St. Lawrence since 1979. MICS covers large areas in the GSL and holds the photo-ID catalogues of blue, fin and humpback whales for the region. Due to the large area covered, MICS comes across ghost gear every year in the course of its activities. This gear is reported to DFO, particularly in light of recent NARW activity in the GSL. MICS is also investigating how fishing gear affects the other baleen whale species.

Goals and Objectives: Long-term monitoring of baleen whale population, including interactions with fishing gear.

Major Take-Aways: TBD

Successes and Lessons Learned: TBD

Notable Challenges: Obtaining the funding needed to be present on the water to actually locate the gear.

PRINCE EDWARD ISLAND HERRING FISHERMEN'S ASSOCIATION – 16G GEAR RETRIEVAL PROJECT

Location/Scope: Herring Fishing Area 16G in Eastern P.E.I. - Both North Lake and Fishermen's Bank

This project annually removes gear in the HFA 16G herring fishery each fall. Led by industry in collaboration with local DFO Conservation and Protection, the project is solely funded by the herring fishers in HFA 16G PEI. Local fishers are hired to spend a given number of days searching for gear, and retrieving it if needed. Local fishers pay into a fund that is used to hire local leaders to assist with at-sea work.

Goals and Objectives: Remove lost or abandoned nets – both commercial nets from the fishery and lost bait nets from other fisheries – as well as any other gear that appears lost or discarded. The aim is to remove gear and thus eliminate potential impact on marine species, as well as to maintain safety at sea for all local fishers and stakeholders utilizing this waterway.

Major Take-Aways: This project was initiated by local fishers and funded by fishers as they have seen value in this effort.

Successes and Lessons Learned: Flexibility is important. Rather than focusing on commercial herring only, the project aims to remove anything that appears to be lost/discarded. The program relies on local fishers to report gear they witness on their travels because this encompasses other provinces. So, there is a level of trust with the leaders participating in the project. If gear can be returned to fisher, it is. If parts of the gear can be saved (anchors, rope, etc.) and is in good condition, the fisher hired gets to keep the gear.

Notable Challenges: As the number of fishers in the commercial herring fishery has decreased substantially over the past five years, the number of days needed for any clean-up has decreased, as has the amount of gear used in the area. Gear that cannot be recycled is given to Island Waste Management.

PRINCE EDWARD ISLAND WESTERN GULF FISHERMEN'S ASSOCIATION – LFA 24 GHOST GEAR CLEAN-UP

Location/Scope: Prince County, Prince Edward Island

This project has been going on for well over a decade. It has removed large amounts of ghost gear (mainly lost lobster traps) from the water in the western portion of LFA 24 through the volunteer collaboration with the Western Gulf Fishermen's Association. In the past, occurrence has varied, but the clean-up now occurs annually. Other local fishing associations on P.E.I. have expressed interest in participating in an annual "postseason gear clean-up" through the coordination of the Prince Edward Island Fishermen's Association.

Goals and Objectives: Remove ALDFG from the area.

Major Take-Aways: Great collaboration between industry and DFO Conservation and Protection.

Successes and Lessons Learned: The relationship between DFO enforcement and leadership of the WGFA has been very important; it has allowed the project to come to fruition and continue to work well. The project is volunteer based, with local fishing industry leaders assisting in the search for and retrieval of lost gear. Other provinces have successfully dealt with the logistical challenges of working together effectively.

Notable Challenges: DFO is limited in staffing and resources, yet it is key that they continue participating in this project alongside the associations. It was noted that changing licence requirements and liability coverage were ongoing challenges that should be addressed by the next fishing season. Trap disposal has not been a big issue; most traps are returned to the fisher if they can be identified through tags.

STEVESTON HARBOUR AUTHORITY - COMMERCIAL FISHING NET RECYCLING

Location/Scope: British Columbia

Steveston Harbour Authority has completed a pilot project in which 18 tonnes of old nylon fishing net were collected and shipped to Aquafil to be recycled into ECONYL® nylon yarn. While this has been a great start, the project eventually had to be stopped due to financial challenges. A new sustainable program has been implemented as of January 2019, resulting in over 15 tonnes of nets being sent to a local recycling plant.

Goals and Objectives: Divert nylon fishing nets from landfills by recycling end-of-life commercial fishing nets.

Major Take-Aways: The pilot project provided good insight into the logistical and financial challenges associated with collecting, preparing and shipping nets. Participants learned how to streamline the process to make it efficient and sustainable for everyone.

Successes and Lessons Learned: It is now understood how much material can be recovered from a full seine net, how much labour is required to strip the net from its other parts (cork line, bunt, lead-line), and how to efficiently load a container to maximize the amount of net that can be sent to Aquafil's regeneration plant in Slovenia in a single trip. The pilot project has taught us that shipping nets in containers overseas is not the most efficient or economical way of recycling this material.

Notable Challenges: Getting thousands of kilograms of net from all 454 harbour authorities in British Columbia to us for stripping and recycling.

T BUCK SUZUKI FOUNDATION – B.C. LOST GEAR KNOWLEDGE GATHERING

Location/Scope: British Columbia, Coastal Regions

Though many groups have been working to remove derelict gear from British Columbia's waters, the scope of lost gear in the province is not yet understood. T Buck Suzuki Foundation is working with B.C. commercial fishers to gather local knowledge about what, where, why, and how much fishing gear is lost. Data has been gathered through a series of workshops across the coast and follow-up dialogues with commercial fishers. T Buck Suzuki Foundation is gathering additional information on what fishers are doing, as individuals or associations, to avoid gear loss and prevent ghost fishing.

Goals and Objectives:

- Assess the scope of gear loss in B.C.
- Identify hotspots for lost fishing gear in B.C.
- Understand the challenges unique to each fishery
- Identify fishers interested in future gear-removal projects

Major Take-Aways: TBD

Successes and Lessons Learned: Fishers are open to sharing information and are keen to be involved in efforts to prevent and recover lost gear.

Notable Challenges: Given how large and varied B.C.'s fishing areas are, it has been difficult to make any generalizations about gear loss. Causes of gear loss vary drastically across the province, and include gear conflicts, bottom type, gear specifications, weather and tides. Best practices vary just as much, to the point where a strategy that reduces gear loss in one area could increase it elsewhere.



Stacked lobster traps, Pubnico, June 2018 © Alexa Goodman

COMPLETED PROJECTS

Below are profiles of completed projects as captured in the online survey. The major take-aways can be seen as valuable contributions to ALDFG knowledge.

ASSOCIATION DES CRABIERS ACADIENS – LOST SNOW CRAB FISHING GEAR RETRIEVAL BY MEANS OF GRAPPLING HIGH-DENSITY FISHING LOCATIONS WITHOUT SONAR IDENTIFICATION IN THE SOUTHERN GULF OF ST. LAWRENCE (SGSL)

Location/Scope: Southern Gulf of St. Lawrence (SGSL); Crab Fishing Area 12 (CFA 12)

This project aimed to locate and retrieve lost fishing gear from Crab Fishing Area 12 (CFA 12) in the SGSL to increase knowledge of procedures that can be used to clean the seafloor. The project's activities focused on designing and constructing a ghost-gear retrieval device, choosing areas with a high density of ghost gear, and conducting blind grappling activities at sea. The aim was to produce a list of recommendations on the preferred approach for detecting ghost gear, along with an improved grappling procedure for future efforts.

Goals and Objectives:

The objective of this project was to receive input from stakeholders on methods and challenges encountered in using blind grappling to retrieve ghost gear from the seafloor. Feedback from stakeholders will assist DFO Program Managers in identifying possible future gaps and issues that may need consideration during the delivery of the newly announced Sustainable Fisheries Solutions and Retrieval Support Contribution Program.

Major Take-Aways:

- Ghost Gear Retrieval Device – A custom-designed effective retrieval device:
 - The drag should remain small and light enough for safe handling on a mid-shore crab vessel.
 - The width of the drag should be optimized.
 - The drag should work regardless of which side of it falls on the seabed.
 - The drag should be adapted to secure the ropes and traps hooked on it until hauled to the deck of the vessel.
- Assessment of ghost-gear retrieval area – Due to budget constraints, it was important to choose a high-yield grappling area, demonstrating the project's effectiveness. Choice was based on three (3) major inputs:
 - record of traps reported lost to DFO by fishers during the 2019 fishing season
 - DFO-produced distribution maps of snow crab fishing efforts from 2010 to 2018
 - snow crab fishers' long fishing experience in the Southern Gulf of St. Lawrence
- Blind Retrieval Results – Twenty (20) nautical miles were passed over with a drag of 4.3 m wide. A total of 125 kg of ghost gear was collected, including a snow crab trap and a small gillnet. Lost in 2015, the trap had a semi-floating rope still attached to it with a small secondary buoy. The total weight of all plastics recovered was 45 kg, a figure determined by subtracting the assumed weight of the steel frame (80 kg) from the total weight of all the ghost gear recovered.
- Proposed Retrieval Procedures – Recovering fishing gear from the ocean is a difficult process. Problems fall into two categories: first, finding the ghost gear; and second, retrieving it. For future efforts, it is suggested that side-scan sonars be used to identify lost crab gear. In addition, a machine-learning algorithm could eventually be trained to automatically flag the locations of gear from a side-scan signal. Creating this map would improve the retrieval process, making it possible to completely clear the seafloor. It would also be helpful to have a team dedicated to mapping areas that are considered to have a lot of lost fishing gear. This would help direct the efforts of teams doing the retrieval, and as a whole would render the retrieval efforts much more efficient.

Successes and Lessons Learned:

- Proposed procedure for setting the drag using a pulley and boom:
 - Deploy the safety line buoy and let the rope uncoil as the vessel keeps moving forward.
 - Lift the retrieval device and hold it above the water's surface.
 - Once the safety line is fully uncoiled, the retrieval device can be lowered in the water.
 - When there is enough slack in the retrieval line, the pulley can be moved, and the rope can be attached to the deck at the desired length. A ratio of at least three to one is recommended.
 - Dragging should be done at the boat's slowest speed, around 2 to 3 knots.
- Proposed procedure for hauling:
 - Begin hauling the retriever, using a slower rate of ascent.
 - Watch for signs that indicate the kind of gear being hauled (trap, multiple traps, semi-floating rope, nets, etc.).
 - Secure the drag and gear to the deck before trying to free them. Prepare quick loops and attach points ahead of time.
 - Bring retrieved items on deck one at a time. Cut lines if needed and haul ghost gear slowly, as rope is likely to be weak. Safety should be the first priority. If the situation becomes dangerous, it might be necessary to give up on the recovery.

Notable Challenges: The project confirmed the fishers' assessment of the problem: it is very difficult to grapple without some visualization of ghost-gear locations since the retriever has to pass exactly over the lost gear in order to be able to haul it to the surface. While the experiment allowed the project to develop a much more efficient retrieval device, the next phase is to conduct a broader project that uses side-scan sonar to map the lost gear in Area 12 of the Southern Gulf of St. Lawrence.

ASSOCIATION DE GESTION HALIEUTIQUE AUTOCHTONE MI'GMAQ ET MALÉCITE - CLEANING OF AN AQUACULTURE SITE IN PASPÉBIAC

Location/Scope: Bay of Paspébiac (Bay of Chaleurs – Gaspé Peninsula, Quebec)

Seafloor surveys were conducted using sonar, and underwater structures needing to be removed were identified. A team of divers and a fishing boat proceeded to remove several tons of ghost gear (mostly aquaculture lines and ropes) over 12 days of field work during the summer of 2019.

Goals and Objectives:

- Clean up and reclaim a previously abandoned aquaculture site in the Bay of Paspébiac. This site had been used over the past two decades, leaving lines and other structures on the seafloor. As the hope is to use the site to grow kelp, it needs to be cleaned.
- Remove the underwater structures to reduce risk of entanglement with marine life and reduce safety hazards for boats and other users.

Major Take-Aways: Removing the gear and tangled lines was a long and difficult task. Some marine life (mollusks, kelp) had grown on the ropes, making them heavier and bulkier.

Successes and Lessons Learned: This was a great collaborative project. It was supported by the local fisheries association (Association des pêcheurs professionnels du sud de la Gaspésie) and the provincial and federal governments (MAPAQ and DFO).

Notable Challenges: Most of the site was covered. However, as retrieval took longer than anticipated and the diving team had limited availability, a few ropes were left in the water after the 12-day removal effort. Removing ropes with the fishing boat was not easy, and a few equipment adjustments were needed for proper and safe practices. The removed waste smelled foul. Workers complained of a sickening smell when they worked to fill the same container at the wharf over a few days of summer heat.

CLEAN FOUNDATION - SHIP-TO-SHORE

Location/Scope: Nova Scotia

Clean's Ship-to-Shore program began as a pilot in 2008 with the objective of addressing waste-management practices in Nova Scotia's commercial fishing industry. The program emerged from concerns about waste management, including improper waste-disposal practices by fishers at sea and on land, as well as problematic waste practices at fishing harbours.

Having observed issues with vessel and harbour waste management, concerned stakeholders formed a Marine Waste Management Committee and partnered with Clean to develop and deliver the Ship-to-Shore program in Nova Scotia.

Goals and Objectives: The goal of the program was to create stewardship initiatives to improve waste-management practices in the commercial fishing industry, with the following outcomes:

- Reduce the amount of waste that is disposed of by fishers at sea.
- Divert recyclable and organic harbour authority fishing waste from landfills.
- Improve how waste is managed by harbour authorities in Nova Scotia.

Major Take-Aways:

- Harbour authorities understand the need for improvement.
- Harbour authorities are now knowledgeable about best practices to improve waste management at the harbour.
- Commercial fishers are knowledgeable about the impact of fishing waste items on the marine environment.
- Commercial fishers are aware of the best practices for sorting and storing waste on fishing vessels.
- There is an improved understanding of barriers to/benefits of returning waste to shore and recycling.

Successes and Lessons Learned:

- Engaged over 166 fishing harbours on waste-management issues.
- 94% of participating harbours have adopted at least one requirement of waste management.
- Directly engaged over 4,000 fishers.
- Received more than 600 pledges from fishers to endorse the campaign "Garbage. I Bring It Back."
- Developed the Marine Waste Management Stewardship Toolkit.
- Delivered more than 125 boat bins and vessel-waste assessments.
- Completed more than 150 fisher waste-management surveys.
- Received the 2012 Mobius Awards of Environmental Excellence for Waste Reduction Education Program of the Year.

Notable Challenges: It is hard to meet face to face with all the fishers as they do not all attend meetings or have an interest in education.

DALHOUSIE UNIVERSITY - MANAGING ABANDONED, LOST AND DISCARDED FISHING GEAR IN THE BAY OF FUNDY LOBSTER FISHERY

Location/Scope: Bay of Fundy, Nova Scotia and New Brunswick

ALDFG causes economic losses to fishers and poses safety hazards to marine fauna. Thirty-two lobster fishers and five individuals from fisheries management agencies were interviewed from the Bay of Fundy (BoF) to determine how to mitigate risk to marine fauna from ALDFG. Results show that across four lobster fishing areas within the BoF, fishers regularly lost gear each season, and this gear was often not retrieved. Although fishers informally notified each other of gear losses and sometimes returned retrieved gear to owners, they avoided retrieving old and unidentifiable gear, because possession of this gear is prohibited under their licence conditions. Interviews identified specific reporting, regulatory and community-based solutions to help estimate the extent of ALDFG and manage the problem. To manage ALDFG and mitigate its effects, it is necessary to legalize gear retrievals and establish waste management systems.

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Goals and Objectives: Assess the magnitude of impacts and possible policy solutions.

Major Take-Aways:

- There is no clear estimate of how much gear remains sea.
- There is a need to improve waste management of fishing gear as illegal discarding at sea is still practised.
- Current policies do not allow retrieval of ALDFG.

Successes and Lessons Learned: Policy changes are required to address the issue of ALDFG. It is necessary to legalize gear retrievals and establish waste management systems.

Notable Challenges: Although fishers informally notify each other of gear losses and sometimes return retrieved gear to owners, they avoid retrieving old and unidentifiable gear. Possession of this gear is prohibited under licence conditions, and disposal is challenging.



Ghost net removal at Ministers Island, St. Andrews NB, August 2018 © Alexa Goodman

FUTURE PROJECTS

Below are the profiles of projects being planned as captured in the online survey.

COASTAL ACTION – SOUTHWEST NOVA SCOTIA ABANDONED, LOST AND DISCARDED FISHING GEAR (ALDFG) REMEDIATION PROJECT

Location/Scope: South Shore of Nova Scotia: Lobster Fishing Areas 33, 34 and 35

Abandoned, lost, and discarded fishing gear (ALDFG) in Atlantic Canada contributes heavily to marine debris, threatening the environment, livelihoods, and at-sea safety. The proposed project will prevent, reduce and assess impacts of ALDFG – also known as ghost gear – on the South Shore of Nova Scotia (LFA 33, 34 and 35) from July 2020 to March 2022. This will be accomplished by implementing waste management systems for responsible management of end-of-life gear, retrieving ALDFG from priority areas, conducting an impact assessment of ALDFG from the retrieval, and holding ongoing communication campaigns.

Goals and Objectives:

- Goal 1: Responsible Management
 - Objective: Facilitate effective waste resource management systems for end-of-life fishing gear by placing rope collection bins at select small-craft harbours in LFAs 33-35.
 - Objective: Capture 3–4 tonnes of rope from wharves so that it can be converted into fuel at Sustane Technologies.
- Goal 2: ALDFG Retrieval
 - Objective: Conduct focus groups with fish harvesters to identify “hotspots” for gear loss.
 - Objective: Map hotspots and overlay critical habitat, SARA and COSEWIC species, and areas of fishing significance to identify potential priority areas for retrieval efforts.
 - Objective: Verify and confirm priority areas with fish harvesters with side-scan sonar and develop new grapnels to retrieve the gear, if necessary.
 - Objective: Contract fish harvesters to retrieve ALDFG in priority areas, as permitted by DFO.
- Goal 3: ALDFG Environmental and Economic Impacts
 - Objective: Monitor biofouling and bycatch of ALDFG during retrieval days to assess environmental and economic impacts.
 - Objective: Conduct an impact assessment by analyzing the data collected during monitoring to estimate economic impact from ghost fishing, assess potential threat to commercial lobster stock, and other threats to the environment.
- Goal 4: Project Reporting and Communication
 - Objective: Develop and launch education campaigns targeting fish harvesters and the greater public to order to inform them of the project’s findings and rope collection bins. We hope to stimulate positive media coverage highlighting the industry’s contributions to addressing ALDFG.

THE CONFEDERACY OF MAINLAND MI’KMAQ – KESKAQOWEY APUKTUK MEMJEW EY MI’KMA’KI (GHOST GEAR IN MI’KMA’KI)

Location/Scope: Mi’kma’ki Territories

This project will gather information on ghost gear from Mi’kmaq Communities.

Goals and Objectives: Incorporate local and Mi’kmaq knowledge on the subject and address any specific concerns of the Mi’kmaq. This project will run parallel with the FGAC’s current project.

WORLD WILDLIFE FUND CANADA, GILBERT BAY MARINE PROTECTED AREA AND GHOST FISHING, NEWFOUNDLAND AND LABRADOR

Location/Scope: Gilbert Bay Marine Protected Area, Labrador

This project is a collaboration between World Wildlife Fund Canada (WWF-Canada), NunatuKavut Community Council (NCC) and Memorial University of Newfoundland (MUN). It aims to mitigate the impacts of fishing on Golden cod and other vulnerable species within and adjacent to the Gilbert Bay Marine Protected Area (GB-MPA), established in 2005. Despite MPA protection measures, the Golden cod sub-population is experiencing steep decline. NCC reached out to WWF-Canada with concerns regarding this important species and region. Given the regulatory complexity and industry's reluctance to consider a split or delayed season, partners aim to create an alternative solution to balance economic fishing interests with MPA conservation objectives.

Golden cod are an endemic and isolated resident population that have specifically adapted to the unique conditions of Gilbert Bay. Physical barriers keep this resident population reproductively isolated from other cod populations in the region. They represent significant ecological value as they contribute to intraspecific diversity. Their genetic adaptation offers resilience for the species to changing environmental conditions. Overall, the protection and preservation of these specially adapted components promote the health and recovery of the species.

This project will help WWF-Canada and NCC gather preliminary knowledge about ALDFG in and around the Gilbert Bay MPA. It will highlight areas of concern related to ALDFG within the coastal communities around Gilbert Bay. This information will set the stage for mapping key areas for identifying – and eventually retrieving – ALDFG. By working collaboratively with our partners, this project aims to identify and remove ghost gear to reduce unintended bycatch of vulnerable species adjacent to the Gilbert Bay MPA. The ghost gear component will build on existing WWF-Canada research on the regulatory framework and licence conditions for monitoring and managing ghost gear, both within Canada and globally.

Goals and Objectives: Explore the nature and extent of ghost fishing/bycatch within the 2J stewardship fishery, and investigate the effectiveness of cod pots adjacent to the GB-MPA. The goal of the larger project is to reduce fishing mortality of Golden cod by reducing ghost-gear catch and bycatch within the North Atlantic Fisheries Organization (NAFO) 2J stewardship fishery and measure the effectiveness of shifting fish harvesters from gillnets to cod pots adjacent to the GB-MPA.

The expected outcomes of this project are as follows:

- Increase knowledge about methods for identifying and retrieving ghost gear.
- Learn about the nature and extent of ghost fishing around the GB-MPA.
- Reduce ghost gear in the GB-MPA, both by removing existing ghost gear and by increasing use of more sustainable gear, such as cod pots.
- Support the GB-MPA regulatory conservation objectives, and ultimately, benefit the marine environment and at-risk species by reducing plastic pollution, unsustainable active fishing practices, ghost fishing, and unintended entanglement.

CHAPTER 3 – SOLID WASTE MANAGEMENT OF FISHING GEAR IN THE MARITIMES REGION

Chapter 3 focuses on solid waste management of fishing gear. It explores how we may achieve a circular economy by turning end-of-life waste into a useful resource with economic value, thereby reducing overall environmental impact (Stahel, 2016). This chapter provides management information for fishing-gear waste, including a catalogue of relevant facilities and manufacturers in Atlantic Canada. It discusses how recycling mechanisms and Extended Producer Responsibility (EPR) could potentially be applied in the future. EPR is an approach used to hold producers financially accountable for handling post-consumer goods based on their environmental impact (Shih et al., 2019). Considering that end-of-life fishing gear is problematic and lacks effective management, this research provides useful information in closing the waste cycle.

**“ FISHING GEAR IS AN UNCAPTURED MARKET WITH GREAT POTENTIAL,
IT JUST NEEDS THE RIGHT INGREDIENTS. ”**

Jordan Poste, Terrapure
(pers. comm., Aug. 27, 2019)



Debris Free Fundy Project, Lord's Cove Deer Island Rope Bin, 2018 © Huntsman Marine Science Centre

APPROACH

Preliminary desktop research was conducted in September 2019, in partnership with Marina Daoud during her internship with the Ecology Action Centre. Using geo-coding in ArcGIS Online, researchers identified, catalogued and mapped relevant recycling, disposal and waste-to-energy facilities, as well as gear manufacturers, in Nova Scotia, New Brunswick, Prince Edward Island, Quebec, and Newfoundland and Labrador. Additional desktop research was conducted to determine which facilities and businesses (hereafter referred to as “organizations”) would be suitable for follow-up phone surveys. Organizations were initially emailed to arrange a time for the phone survey and to disclose the nature of the project. Follow-up emails were issued for those who did not respond, in addition to follow-up calls (three maximum). The organizations initially selected also referred additional organizations for participation in the survey. Fifteen surveys were completed, split into two groups: recyclers (8) and manufacturers (7) (Table 2). Questions were specifically tailored to each group (Appendix C).

Table 2. Summary of organizations surveyed for Chapter 2, broken down by recyclers and manufacturers, including the contact name of surveyed individuals and location of participant organizations.

ORGANIZATION NAME	CONTACT NAME	LOCATION
Recyclers		
Terrapure Environmental	Jordan Poste	N.S., Dartmouth
EnviroCulture Consulting	Marcus Goodick	N.S., Port Williams
Goodwood Plastic	Dan Chassie	N.S., Stewiacke
Halifax Construction & Debris Recycling Ltd.	Bev Connell	N.S., Goodwood
Sustane Technologies Inc.	Kevin Cameron	N.S., Chester
Mauser Packaging Solutions	Dave MacDonald	N.S., Springhill
Fundy Region Solid Waste	Brenda Maccallum	N.B., Saint John
Greenisle Environmental Inc.	Wayne Bradley	P.E.I., Charlottetown
MANUFACTURERS		
Lobster Trap Company	Scott Dauphinee	N.S., Yarmouth
Sevaen Gear (formerly Climate Technical Gear)	Clinton Desveaux	N.S., Dartmouth
Vernon d'Eon Lobster Plugs Ltd.	Lloyd d'Eon	N.S. and P.E.I.
Hercules SLR Group - Spartan Marine	Chris Giannou	N.S., Dartmouth
Island Traps	Rob Hurlburt	N.S., Cape Sable Island
Polysteel Atlantic Ltd.	Sean Burke	N.S., Edwardsville
Canada Rope and Twine Ltd.	Matthew Moore	N.S., Bedford

Note: Marcus Goodick and Dan Chassie were surveyed together on the same call, for a total of 14 surveys delivered, split evenly between the two groups.

The following subsections present knowledge gained from the surveys, supported by additional research and relevant literature.

MANAGING FISHING-GEAR WASTE

In the Maritimes region – and in Atlantic Canada more broadly – the fishing industry uses large quantities of gear to support its practices. This gear has a limited lifespan. Gear type varies according to target species, and material components vary with gear type (Table 3). Rope used in the fishing industry can be made of polypropylene, polyethylene, nylon or lead, or may be of the braided variety.

Table 3. Gear type and material used in significant fisheries in Maritime provinces: New Brunswick, Nova Scotia, Prince Edward Island (Adapted from Ackman, 2016).

FISHERY	FISHING GEAR	MATERIAL
Lobster	Wire Frame Traps	Vinyl covered steel; Nylon webbing; Cement; Rubber (sometimes)
	Wooden Frame Traps	Untreated wood; Polyethylene side netting; Cement; Nylon Webbing
	Hybrid Frame Traps	Untreated wood; Vinyl covered steel; Nylon webbing; Cement; Rubber washers and vents
Herring	Purse Seines	Tarred nylon netting; Lead-line; Floats; Steel cable
	Gillnets	Polyethylene monofilament netting; Floats; Weights; Lead-line
Scallops	Offshore Rakes	Steel frame; Steel chain; Netting (unknown material)
	Inshore Rakes	Steel frame; Steel chain
Crab	Conical Crab Traps	Steel frame; Polyethylene netting; Plastic funnel
Haddock	Bottom Trawl Nets	Polyethylene netting; Steel doors; Polypropylene line/steel cable; Weights/weighted rollers; Floats
	Long Line	Polypropylene/monofilament main line; Polypropylene/nylon branch line; Weights; Steel swivels and hooks
Hake	Bottom Trawl Nets	Polyethylene netting; Steel doors; Polypropylene line/steel cable; Weights/weighted rollers; Floats
Redfish	Bottom Trawl Nets	Polyethylene netting; Steel doors; Polypropylene line/steel cable; Weights/weighted rollers; Floats

Note: Gear type and material composition may slightly vary between fishers and regions.

Gear lifespan varies according to a number of factors, including gear type and materials, fishing regions, intensity of use, and ability to be repaired (Ackman, 2016; Goodman et al., 2019). It is roughly estimated that Nova Scotia disposes of between 5,100 and 5,500 tonnes of gear per year – equivalent to the weight of 3,000 cars (Ackman, 2016; Table 4). While this information is specific to Nova Scotia, other Maritime provinces (New Brunswick and Prince Edward Island) have very similar fisheries, and also dispose of gear; however, the quantities will vary. In terms of specific gear types disposed of annually in Nova Scotia, lobster traps (both wire and wood frame) and rope are the most abundant by weight. The same is likely true of New Brunswick and Prince Edward Island, so these items should be the primary focus of waste diversion in the Maritimes region.

Table 4. Estimated gear disposed of annually in Nova Scotia by weight (Ackman, 2016).

GEAR	ESTIMATED ANNUAL DISPOSAL QUANTITY
Wire Frame Traps	980,000 Traps, weighing 3,400,000 kg
Wooden Frame Traps	40,000 Traps, weighing 560,000–920,000 kg
Scallop Rakes	Unknown
Crab Traps Steel Component	3,900 kg
Crab Traps Mesh Component	1,300 kg
Herring Seine Netting	7,500 kg
Herring Gillnet	900 kg
Bottom Trawl Netting	8,900 kg
Rope	1,150,000 kg

The main methods of disposing of gear in Maritime provinces currently include landfilling, burning, reselling, repurposing or illegal discarding at sea (Ackman, 2016; Goodman et al., 2019). Appendix D presents a catalogue and map of existing disposal, recycling and waste-to-energy facilities, as well as gear manufacturers, for Maritime provinces; Appendix E presents the same information for Quebec and Newfoundland. Fishing-gear waste is typically considered as construction and debris (C&D) waste materials and is not generally accepted with residential waste or in residential facilities. Recycling works best with homogenous materials, and C&D waste is often a heterogeneous mix of materials. This poses challenges for recycling fishing gear. Of the seven businesses interviewed in the recycler category, only Halifax C&D deals with C&D waste on a regular basis.

Current disposal methods are considered to have high or moderate environmental impacts. High impacts pose immediate and serious risks to the environment; this is the case for illegal disposal methods such as abandonment at sea and burning. Landfills are considered to have moderate impacts: they contain the material but do not utilize it for anything productive (Ackman, 2016).

Additionally, research has uncovered barriers that limit the effective waste management of fishing gear. Convenience and affordability are important factors for fishers, and must be considered in efforts to encourage effective waste management (Goodman et al., 2019). For fishers, landfilling gear poses barriers such as tipping fee costs (disposal charge), driving distance, labour to dismember gear (non-steel components), and time of year. Some fishers lack environmental understanding regarding the high- and moderate-impact disposal methods, which in turn does not encourage proper waste disposal habits (Ackman, 2016; Goodman, et al., 2019). If these barriers can be addressed, opportunity exists to facilitate proper waste management of fishing gear and establish low-impact disposal methods that create a circular economy.

INSIGHTS FROM RECYCLING ORGANIZATIONS AND FISHING GEAR MANUFACTURERS

Fishing-gear waste is not typically accepted in recycling facilities; only three organizations interviewed in the recycler category indicated that they accept fishing waste. Of the three, Greenisle Environmental Inc. and Mauser Packaging accept only fishing tote bins (hard rigid plastics). Goodwood Plastic accepts most end-of-life fishing and aquaculture plastics, including rope. However, Goodwood Plastic may charge a tipping fee depending on a few factors, such as how easy the rope is to handle. Goodwood Plastic will not accept rope containing lead, which is considered to be a contaminant (Dan Chassie, Goodwood Plastic, pers. comm., Aug. 27, 2019).

When evaluating low-impact waste management systems for fishing gear, one needs to consider how a circular economy can be achieved with recycling. Mauser Packaging Solutions is an example of a closed system that recycles products they make themselves. They create injection and blow moulds of plastics to create navigation buoys and devices for aquaculture. These can be taken back, melted down and extruded into pellets to fill their moulds for new products (Dave MacDonald, Mauser Packaging Solutions, pers. comm., Sept. 4, 2019). In sustaining a circular business model, this company does not accept materials outside of products they produce. While Mauser Packaging Solutions may not be fit for a scalable solution to fishing-gear waste, their circular business model highlights the effectiveness of turning waste back into a resource.

Surveys of businesses in the manufacturer category highlighted the complexity of the fishing-gear supply chain. Only four businesses reported manufacturing products in-house, though they use imported materials: both Polysteel Atlantic and Canada Rope and Twine manufacture rope, while The Lobster Trap Company and Island Traps manufacture traps. Another business (Sevaen Gear) manufactures workwear. Other businesses contacted mainly import finished products for distribution. Talking with these business owners makes it clear that the fishing-gear supply chain is complex: parts and products are imported from a variety of sources, even for those companies that manufacture products in-house. Therefore, the supply chain for each manufacturer and distributor will look different, complicating the applicability of EPR.

TRAP DISPOSAL AND RECYCLING

Traps are challenging to recycle because they are made of mixed materials (i.e., heterogeneous mix). In addition, the polyvinyl chloride (PVC) coating on the wire traps is hard to separate and hinders the recyclability of wire traps (Kevin Cameron, Sustane Technologies, pers. comm., Aug. 27, 2019). Metal gear components are recyclable if they are homogenous (Dan Chassie, Goodwood Plastic, pers. comm., Aug. 27, 2019). Metal recycling could potentially require a tipping fee. Tipping fees are not normally subsidized (Chloe Kennedy, pers. comm., Sept. 30, 2019). Subsidizing tipping fees for one industry over another is unlikely as it sets an expensive precedent for landfill operators and government alike (Kirk Symonds, pers. comm., Sept. 30, 2019). Tipping fees, if any, vary according to the facility and location, as well as other factors such as contamination.

ROPE DISPOSAL AND RECYCLING

While there is potential for scalable rope recycling, recyclers have identified the following barriers: infrastructure, quantity, cost and market demand. Rope is currently not accepted at most C&D disposal and recycling facilities for two main reasons:

1. Rope needs to be in large homogenous quantities to process the material with an end user or market (Bev Connell, Halifax C&D, pers. comm., Aug. 22, 2019). It has been estimated that in Nova Scotia alone, the total quantity of end-of-life rope discarded annually is roughly 1,150,000 kg (Table 4). Therefore, there are large enough quantities of rope in need of diversion; the rope just needs to be isolated and transported to appropriate facilities.
2. Rope and netting can easily get caught, and so can be hazardous to both recycling machinery and employees (Wayne Bradley, Greenisle Environmental Inc., pers. comm., Aug. 23, 2019). Before being processed, rope might require additional treatment. For example, it might need to be cleaned and cut into a usable and non-hazardous size (Kevin Cameron, Sustane Technologies, pers. comm., Aug. 27, 2019).

REUSING AND REPAIRING FISHING GEAR

There is no manufacturing capacity to reuse rope after it has been used in the fishery because it has been weakened. By the end of its life, the rope is worn; reusing it could alter its tensile strength, creating a weakened product (Matthew Moore, Canada Rope and Twine, pers. comm., Sept. 5, 2019; Sean Burke, Polysteel Atlantic, pers. comm., Sept. 3, 2019). Manufacturers are unlikely to repair traps because they expire with use over time. Fishers generally repair what is fixable themselves, or build their own traps (Lloyd d'Eon, Vernon d'Eon Lobster Plugs Ltd., pers. comm., Aug. 27, 2019; Rob Hurlburt, Island Traps, pers. comm., Sept. 13, 2019). To highlight just how much repair work fishers do themselves, Rob from Island Traps on Cape Sable Island reported \$50,000 to \$100,000 in annual sales of repair supplies.

RECYCLING SYSTEM POTENTIAL

Recycling companies such as Sustane Technologies and Goodwood Plastic have found ways to turn fishing waste – namely rope – back into a valued resource. These companies demonstrate that low-impact waste management systems are viable for the fishing industry.

CASE STUDY: FROM WASTE TO ENERGY — SUSTANE TECHNOLOGIES INC.

Sustane Technologies Inc. turns plastic into #2 diesel fuel through a mechanical process of shredding, cooking and separating materials. The company thus turns plastic back into what it was before – fossil fuel. Sustane is working towards a circular economy by sending the fuel back to individuals, companies and communities where the plastic initially came from. A by-product of Sustane's operations, kerosene is used to support internal processes. Sustane also processes paper, cardboard and diapers for clean biomass pellets used in industrial facilities. Through its combined products, the company is able to recycle 90% of materials that would otherwise be landfilled.

CASE STUDY: A RESOURCE TO BUILD — GOODWOOD PLASTIC

Goodwood Plastic is turning waste into lumber, and has had success using fishing rope. After receiving recyclable materials, the company processes them in-house. First glass, metal and aluminum are removed. Then plastics are mechanically broken down through a granulator and shredded to undergo primary extrusion. Heat is used to remove moisture, and materials are combined into a consistent blend of rigid-type plastics. The blend is then rechilled and chipped down for final extrusion into a board form. Goodwood Plastic also makes some plastics into fuel, according to customers' specifications.

CASE STUDY: GREENISLE'S ROLE AS WASTE INTERMEDIARY

In Charlottetown, PEI Energy Systems used to accept fishing waste directly from fishers, but grew frustrated at receiving items not accepted at the facility in their disposal stream. In addition, the netting and rope were becoming hazardous. Recognizing the need for waste disposal at wharves, Greenisle Environmental Inc. took a different approach: it took on the role of liaison between groups to facilitate material transfers and sorting. Greenisle rents renovation and construction dumpsters, places them at wharves on request and empties them in their facility to sort the waste properly. Currently, the majority of fishing-gear waste is landfilled as only the metal is recyclable. With Greenisle's contribution as an intermediary in properly sorting the waste from wharves, if the hazard of rope and netting could be treated, then perhaps PEI Energy Systems would be willing to accept the materials again. This would divert rope and netting from landfill.

The example of P.E.I.'s Greenisle Environmental Inc. suggests that a waste management system with intermediaries linking fishers to recyclers could work to address identified barriers (Fig. 1). A model could be created from Greenisle's methods. Bins could be placed at wharves for fishers to dispose of their old gear. Intermediaries could then transfer waste to sorting stations or facilities, clean the material (if needed), and cut rope to be sent to recycling companies. The specific roles of intermediaries would vary based on the needs of the recycling company and participating community. Different organizations might fill different roles, resulting in multiple intermediaries (Fig. 1). Intermediary collectors and processors would be similar to Greenisle Environmental Inc. Terrapure could play a key role in this model as they are a large organization with capacity for transportation and pre-processing. However, it might be necessary to acquire machinery to pre-process the rope by shredding it into smaller, more manageable pieces. Additionally, C&D collectors (like Halifax C&D) and municipal waste management (like Fundy Region Solid Waste) could feed into the waste management system by facilitating collection, transportation and storage. Businesses like Sustane Technologies and Goodwood Plastic would be the recycler in this model. On the back end of the model, if the end product was plastic lumber, for example, and was not cycled back to fishers, the product could be distributed and sold to customers. An additional intermediary – such as municipal waste management – could collect product at the end of its lifespan or feed new materials into the system.

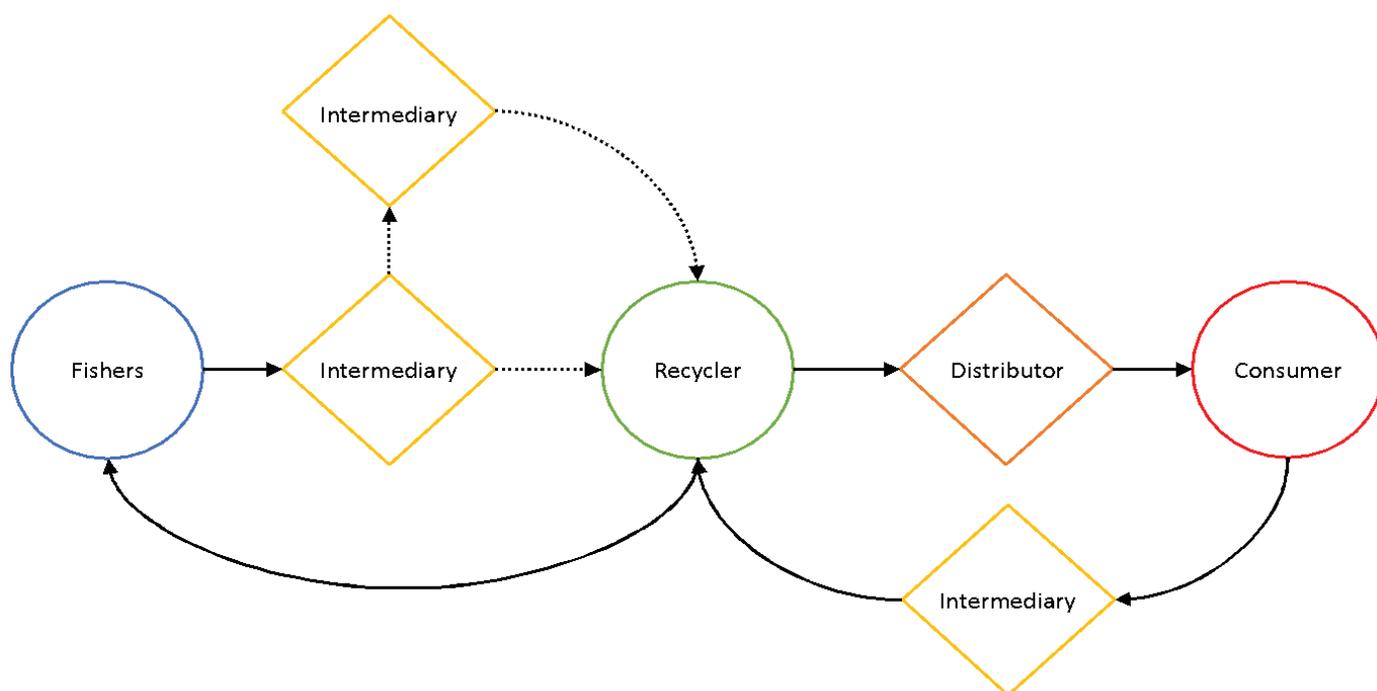


Figure 1. Conceptual circular model for a fishing-gear waste management system specifically tailored to rope. Dashed lines indicate multiple intermediaries to suit the roles needed for the recycler. This model could also be adapted for trap recycling.

As suggested by the work of Ackman (2016), more precise estimates of waste volume are needed to address the capacity of businesses involved in the process. Volume estimates could be by wharf, as is the case for gear being picked up for recycling.

CASE STUDY: DEBRIS FREE FUNDY ROPE BINS — HUNTSMAN MARINE SCIENCE CENTRE

Between March 2018 and September 2019, the Debris Free Fundy project collected over 9,500 pounds of rope from 10 rope bins at seven harbours in Southwest New Brunswick. Some of the rope has been repurposed, after being collected from the rope bins by community members, fishers, etc. However, a lot of the rope from Grand Manan does not end up in the bins, but rather gets taken directly to the transfer station. This initiative is a good example how an intermediary can facilitate the collection process and refine weight estimates of fishing-gear waste, rope in particular.



Debris Free Fundy Project 2019 © Huntsman Marine Science Centre

Waste materials can thus be turned into new products. Government and industry could consider how this capability could be used to work towards a circular economy. For example, plastic lumber sourced from rope at a given wharf could be used to retrofit and update infrastructure at the same wharf, where applicable. This would take a strong commitment from all stakeholders. Another potential circular system would be the waste-to-energy model, where rope disposed of by fishers is transformed into diesel fuel. These are very loose examples of how we may work towards a circular economy; additional research may be needed.

EXTENDED PRODUCER RESPONSIBILITY POTENTIAL

None of the gear manufacturers currently have EPR policies in place. However, that does not mean it is impossible to incorporate EPR or corporate social responsibility (CSR) into existing business models to help achieve a circular economy. Like EPR, CSR is a self-regulating model that helps businesses take accountability for their operations' impacts; CSR benefits both communities and the environment (Hoi et al., 2018). CSR differs from EPR in that it is voluntary and does not require the producer to take financial accountability for handling post-consumer goods with a fee or tax – as is the case with electronics, for example. A local example is the circular business model of the Lobster Trap Company in Yarmouth, Nova Scotia.

CASE STUDY: A CIRCULAR BUSINESS MODEL — THE LOBSTER TRAP COMPANY

Scott Dauphinee, owner of The Lobster Trap Company, calls himself a “lobster-preneur”: his company takes a different approach to manufacturing lobster traps. The company's traps are made with traditional netting inside; the outside is in part made of plastic from recycled material. At the end of the trap's lifespan, the fisher can return it for rebate, and use the money to purchase a new trap. The old trap is disassembled. The plastic is re-flaked and sent back to the manufacturer to be injected into new trap moulds or products. The traps are thus brought full circle.

In the manufacturer category, many business owners reported discussing and considering how to recycle end-of-life gear, and where they might fit into the process. Sean Burke of Polysteel Atlantic thinks that a deposit system might work, but would need a significant amount of thought as the supply chain “gets a little muddy” (pers. comm., Sept. 3, 2019). Chris Giannou of Spartan Marine believes that any type of deposit or rebate system needs to make economic sense and be cost

effective (pers. comm., Sept. 3, 2019). Lloyd d'Eon of Vernon d'Eon Lobster Plugs Ltd. concurs, because “at the end of the day the almighty dollar drives it all” (pers. comm., Aug. 27, 2019). Fixing traps beyond what fishers fix themselves – such as recoating – may cost more than it is worth. Recycling traps may be more feasible. If traps were returned to the supplier or manufacturer, there would need to be an end use or destination for recycling. This would require separating components, perhaps through an intermediary. A model similar to Figure 2 may work for trap recycling.

Consideration was given to a deposit (fee-based EPR) system, similar to the environmental fee on tires. It may be most effective to implement such a system on the distribution end. Some manufacturers feel that the cost should be borne by fishers, as they should bear the responsibility for proper disposal based on the nature of the problem (Sean Burke, Polysteel Atlantic, pers. comm., Sept. 3, 2019). In this scenario, fishers would pay fees to the distributor of traps and/or materials; these fees would allow recyclers to carry out the cycle. However, ideal EPR systems require the producer to take responsibility for the cost of end-of-life management, which may be a challenge to this EPR framework. A fee-based system would need to be federally regulated or incentivized to avoid provincial differences, as legislation plays a key role in addressing this issue (Rob Hurlburt, Island Traps, pers. comm., Sept. 13, 2019). In the European Union, the European Commission determined that implementing an EPR-based system with a deposit scheme would be ideal in addressing ALDFG waste because the total benefits of implementing such a system would be more than the costs (Viool et al., 2018). In the context of Atlantic Canada, further research is needed to determine how the system would work, and which gears it would include. It seems possible that EPR combined with a fee-based system for disposal, particularly for lobster traps, would be a viable management solution.

CONCLUSION AND RECOMMENDATIONS

Opportunities exist to improve solid waste management of fishing gear by establishing a low-impact circular system for end-of-life gear, with potential for EPR to fund such a system. Piloting a project to turn rope back into diesel fuel for fishers could be an effective solution; this model would help close the fishing waste cycle by returning direct benefits to fishers. Pilot projects, with companies like Sustane and Goodwood Plastic, could be explored in different communities, with intermediaries to transfer and pre-process the rope. When it comes to recycling, “there are always challenges with any products coming in,” but intermediaries and innovation can help remove these barriers (Bev Connell, Halifax C&D, pers. comm., Aug. 22, 2019).

The following recommendations are based on the above findings:

- Waste diversion in Maritime provinces should focus on traps (lobster and crab) and rope, based on preliminary disposal quantities.
- Additional waste quantities should be estimated on a finer resolution, based on municipality or waste management region.
- Low-impact waste management systems should be developed to address barriers faced by fishers, such as cost and convenience. These systems should be funded by government(s) and industry.
- Pilot projects should be funded to innovate technology to remove PVC from wire frame traps (lobster and crab) in a cost- and time-effective manner.
- Pilot projects should be funded to innovate technology to process rope and nets for recycling.
- Focus groups should be conducted with businesses and the government to determine how EPR can be applied to fishing gear to fund a circular waste management system.

CHAPTER 4 – QUANTIFYING ABANDONED, LOST AND DISCARDED FISHING GEAR IN THE MARITIMES REGION

Chapter 4 aims to shed light on ALDFG issues by quantifying ALDFG in fixed-gear fisheries across the Maritime provinces – Nova Scotia, New Brunswick and Prince Edward Island. It also quantifies data more precisely on localized scales. Centralizing information makes it possible to develop proposals for [future ghost gear projects](#). Building on past research by Goodman et al. (2019), this chapter provides information on how much, where and why gear is abandoned, lost and discarded; how much gear is replaced annually; and how end-of-life gear is managed. It also provides solutions to problems associated with both retrieval and disposal of ALDFG.

APPROACH

A total of six focus groups in DFO’s Maritimes and Gulf regions (N.S., N.B. and P.E.I.) were conducted over four months of collaboration with other FGAC member organizations, which acted as co-hosts. The focus groups engaged a total of 60 individuals involved in the fishing industry, including fishers (44) and wives (1), fishing association administrators and representatives (10), and NGO representatives (5) (Table 5). The focus groups were conducted using revised methodology from Goodman et al. (2019); the guiding questions can be found in Appendix F. The focus group sessions were, on average, an hour and half long. Logistics, recruitment and materials were coordinated and split between the FGAC and co-hosts.

Table 5. Summary of the focus group dates, locations and co-hosting FGAC member organizations, ordered chronologically.

DATE	LOCATION	CO-HOST(S)
Dec. 15, 2019	Cape Breton, N.S.	Cape Breton Fish Harvesters Association (CBFHA) & Cape Breton Environmental Association (CBEA)
Jan. 9, 2020	Yarmouth, N.S.	Coldwater Lobster Association (CLA)
Jan. 31, 2020	Summerside, P.E.I.	Prince Edward Island Fishermen’s Association (PEIFA) & Prince Edward Island Department of Fisheries and Communities
Feb. 6, 2020	Shediac, N.B.	Homarus Inc. & Maritime Fishermen’s Union (MFU)
Feb. 20, 2020	Tracadie, N.B.	Homarus Inc. & Maritime Fishermen’s Union (MFU)
Mar. 5, 2020	Stellarton, N.S.	Maritime Fishermen’s Union

The sessions were facilitated by Alexa Goodman, the FGAC co-chair, coordinator and researcher. Goodman led the discussion with prompts, and also took notes. The discussion was recorded so that it could be reviewed later; this ensured that all relevant information was captured. Prompts were derived from the predetermined agenda circulated among the co-hosts beforehand (Appendix F). The discussion was facilitated with specific guiding questions; as the group of participants was small, fishers were able to speak up as they wished. The sessions progressed in a relaxed manner. When periods of discussion broke out, the facilitator was able to keep the focus group on track. Before beginning, the facilitator discussed the intent of the workshop, stating whom they work for and their role as a neutral third party trying to facilitate better management of ALDFG. Ground rules were outlined for how the workshop should proceed; these were outlined in the agenda as well. Before the session began, participants were asked if they had any questions or concerns. After a common understanding was reached, the focus group sessions started. Note that names and dates have been removed from quotes included in Chapter 4 to ensure the confidentiality of participants.

SUMMARY OF PARTICIPANTS' FISHERIES AND GEAR TYPES

Fishers who participated in the focus groups primarily target lobster in LFAs 23, 25, 26a, 26b, 27 and 34. This finding complements existing research by Goodman et al. (2019; Fig. 5). Some fishers additionally target crab (snow and rock), as well as scallop, herring, mackerel and halibut. However, as lobster is the dominant fishery, it was the focal point of the focus groups. Fishers mainly use wire traps for lobster and crab, though some use wooden lobster traps. Trap type and configuration vary according to the specific fishing area and the fisher (Table 6). The herring and mackerel fisheries use gillnets or purse seines, and the scallop fishery uses mobile bottom trawls.

Table 6. Summary of the focus group locations, target fisheries and locations, and gear type and configurations, as retained from the focus group sessions.

LOCATION	FISHERIES	LFAS	CFAS	TRAP GEAR AND CONFIGURATIONS
Cape Breton	Lobster, crab, herring, scallop	27	18, 19	Mix of wooden and wire traps, primarily wire, configured in singles or pairs
Yarmouth	Lobster	34	N/A	Wire traps, configured in trawls, single or pairs
Summerside	Lobster, crab, scallop	25	12	Mix of wooden and wire traps
Shediac	Lobster, rock crab, herring, scallop	25	12	Mix of wooden and wire traps, configured in pairs
Tracadie	Lobster, snow crab, rock crab, herring, scallop, mackerel, halibut	23; sub-areas B, C, D	12	Primarily wire traps, configured in trawls; wood traps configured in singles or pairs in area D
Stellarton	Lobster, rock crab, snow crab, herring, scallop	25, 26a, 26b	12, 19	Primarily wire traps, configured in trawls

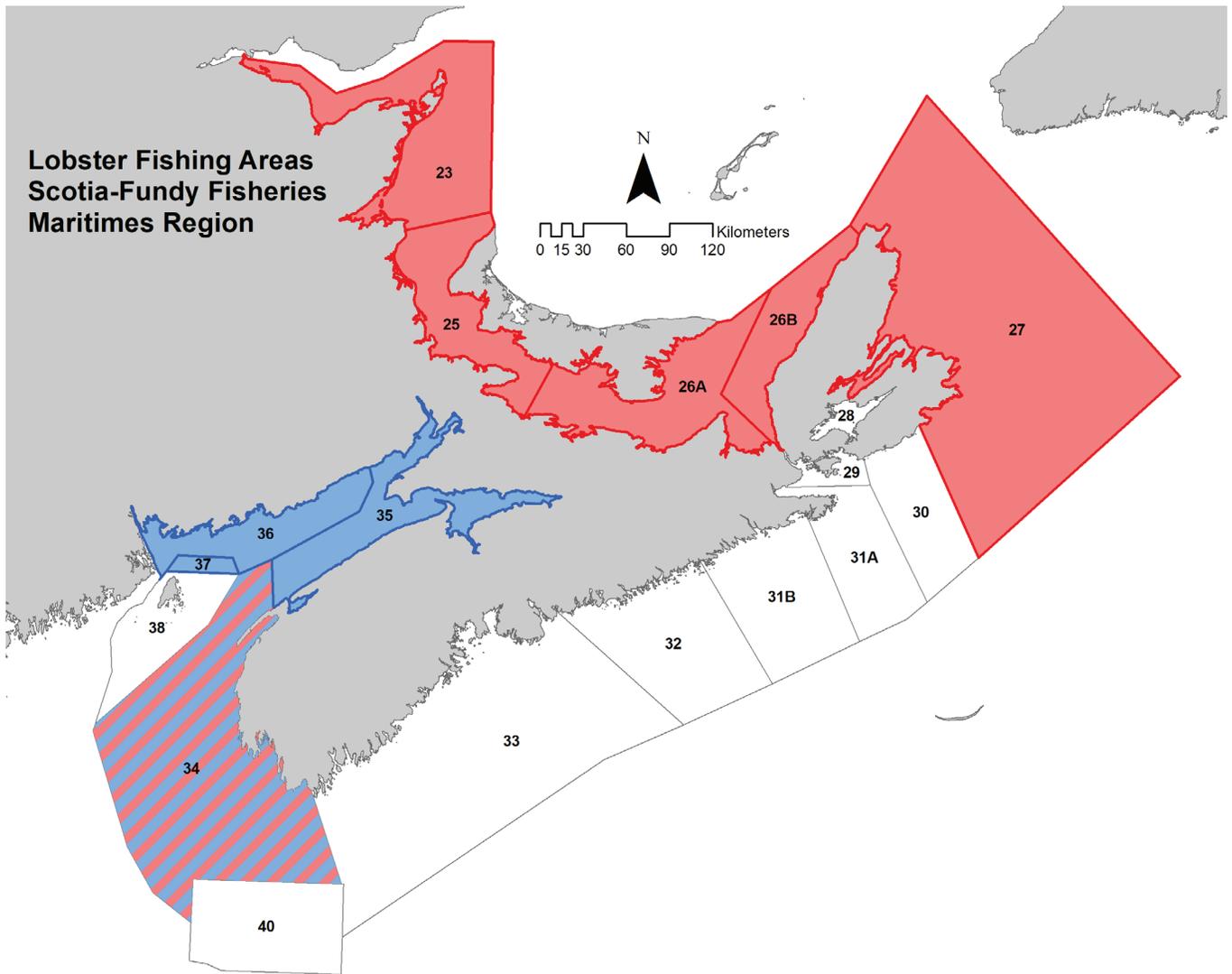


Figure 2. Lobster fishing areas covered in the project's focus groups are shown in red. Those included in the similar study done by Goodman et al. (2019e) are shown in blue. The hashed area denotes overlap between the two projects. Map created by Gary Pardy of Fisheries and Oceans Canada.

GEAR LOSS AND REPLACEMENT

Results in the following section are common to all participants in the focus group unless otherwise noted.

GEAR TYPES LOST

Fishers across all focus groups reported losing lobster traps most commonly, followed by rope; a portion of rope is usually still attached to lost traps. Crab traps may also be lost, but less frequently since there are fewer crab licences than lobster licences. Losses can include the entire trap configuration (trap, rope, buoy and anchor); the amount of rope lost along with traps depends on how the gear was severed. For example, if a buoy was severed from an active trap by another vessel's propeller, a portion of the buoyline would be lost along with the trap, but if a buoyline or groundline was severed close to the trap from chafing on rocky bottom, then minimal rope would be lost with the trap. Sometimes the trap alone is lost, with no rope attached, from chafing on rough bottom or from congestion with other gear; this occurs in LFA 23C and 34, respectively. These findings are consistent with the results of Goodman et al. (2019), who noted that traps are the most commonly lost part, with varying amounts of rope depending on the context of loss.

Some fishers noted that losses have become worse with sinking groundlines (lead-line) associated with North Atlantic Right whale measures outlined in conditions of licence; if a buoy is severed, the rope is not visible and sinks to the seafloor. The conditions of licence state that there must be “no floating rope at the surface of the water between the primary buoy and the trap,” forcing fishers to place sinking rope (lead-line) on the buoyline. Prior to these changes, if a buoy were lost, the rope would still be visible, making retrieval easier. It is more challenging to retrieve single lobster or crab traps than any other trap configuration; with multiple traps, one can attempt retrieval by hooking the groundline between the traps. In the study by Goodman et al. (2019), fishers similarly noted that retrieving single traps was difficult.

Other fixed-gear fisheries may also lose gear. For example, herring gillnets are lost, although infrequently. In these cases, gear-retrieval efforts are easier because herring fisheries are restricted to smaller specific areas than are lobster or crab fisheries. In Stellarton (LFA 26a and 26b), herring fishers recognized that gillnet loss was problematic, and the Herring Federation now hires divers annually to retrieve lost gear during the season. These regular retrieval efforts have proven effective in reducing gear loss; gear losses are now only temporary.

In addition to the harvesting gear, associated fishing materials may also be lost. In certain areas, bait bags are lost to seal predation. Rubber lobster bands are also frequently lost. One fisher classed them as “biodegradable” because they are considered food safe. In reality, these rubber bands can take around 100 years to decompose, depending on environmental conditions (Shah et al., 2013). During the degradation time, rubber bands are an ingestion threat to marine life.

It is important to note that fishers do not want to lose gear. In most cases, fishers make every attempt to locate and retrieve lost gear. One fisher stated that “we do everything to get it back,” especially considering the cost. While some gear is retrieved, some also remains at sea for reasons that vary according to how it was lost.

LOSS VARIABLES

Gear losses were reported to vary according to three main parameters: temporal, spatial and physical. Temporal parameters include the individual year and season, and weather. Spatial parameters include fishing location, and bottom type and depth. Physical parameters include fishing technique and experience, gear modifications and condition, and conflicts. These causes of gear loss are consistent with local causes identified in studies conducted by Goodman et al. (2019) and Fundy North Fishermen’s Association (2016). They are also consistent with global causes identified by the Food and Agriculture Association (Macfadyen et al., 2009) and an ALDFG impact assessment by the European Commission (Viool et al., 2018).

TEMPORAL PARAMETERS

Time-based factors strongly affect gear loss. Losses vary between years, and also between seasons. All focus groups reported that weather events – storms in particular, but also fog – are a significant cause of losses. As fog creates visibility problems, boats may run over active lines, severing gear. In September 2019, Hurricane Dorian caused significant damage in Atlantic Canada (CBC News, 2019; Global News, 2019). Fishers lost a huge amount of gear; it took them weeks or months to locate their gear, when it was possible at all. One fisher reported that some traps were displaced by about 8 nautical miles from their set location. Storms can also compromise gear, leading to abandonment; gear is irretrievable if it becomes buried or “snagged down” on rocks. However, buried gear may be uncovered in time, making retrieval possible. Fishers do not always remove their gear from the water in the event of an oncoming storm because there is uncertainty over the magnitude; removing all gear from the water is laborious and not always justified. Hurricane Dorian was worse than anticipated; storms of such strength have not been common on an annual basis. Studies show that stronger storms and hurricanes are becoming more frequent as the climate continues to change (Holland and Bruyère, 2013). Anomalies like Hurricane Dorian may become more prevalent.

SPATIAL PARAMETERS

Spatial location is a determinant of gear loss. Losses increase with proximity to shore (within 5 to 6 miles of the coastline), because of increased wave action combined with hard or rough bottom types. More loss also takes place in or near traffic lanes. Vessels such as barges, cruise ships and ferries run over active lines, severing buoys from buoylines. Vessel speed plays a role as well – at greater speed, there is less reaction time to avoid running over active gear.

All focus groups identified fishing area and bottom conditions as causes of loss. Fishing on hard or rough bottom, like rocks, increases chafing. This breaks lines, and causes traps to become “snagged down” between rocks. Depth is an important factor in gear retrieval. Shallower waters (less than 30 fathoms or 55 m) make retrieval easier, especially for single traps.

PHYSICAL PARAMETERS

Physical parameters refer to habits, interactions and the gear itself. More experienced fishers tend to lose less gear; they are more practised and have better technique. Some methods for hauling gear lead to less loss than others. Properly maintained gear is less likely to be lost than gear that is faulty or in poor condition; for this reason, fishers tend to replace their gear. Gear modifications and configurations contribute to loss and retrieval rates; these factors affect the ease of retrieval and the size of the target. For example, the introduction of sinking groundline, as required in the conditions of licence, has made retrieval more challenging; in the event that a line is severed, gear is hard to locate without a visual marker.

Conflicts within the same fishery or between fisheries, both intentional and unintentional, have also caused loss. For example, in areas of high fishing activity, traps may accidentally be set on top of one another or too close together, causing snarls or chafing between lines. In these conditions, tension from hauling leads to gear loss. This problem was reported to be prevalent in LFA 34 in areas of high competition, and also on “dumping day” in the spring as gear is set in the dark. In LFAs 23 (sub-area C and D), 26a and 26b, crab vessels with lowered stabilizers run over active lines, severing buoys from buoylines and causing losses. However, the new style of “Beavertail” stabilizers has guards to reduce these types of interactions. Intentional vandalism of gear has been an issue in certain areas in the past, but is becoming less prevalent. Conflict between different sectors has also gone down, resulting in less ALDFG. Understanding these parameters helps us determine why gear is lost and what the retrieval challenges are. This leads to the following question: how much gear remains at sea?

AT-SEA LOSSES

While most fishers try to retrieve lost gear, some gear inevitably remains at sea. The average gear loss across all focus groups varied between 0.5% to 2% of total allowable traps in lobster fisheries. This is less than the global trap loss average of 8.6% annually (Richardson et al., 2019b). Loss values were only provided for the lobster fishery as gear is primarily lost in the lobster fishery based on fishing effort; losses in other fisheries present in the areas covered were noted as negligible in comparison. However, this may not be the case elsewhere in Atlantic Canada. One fisher noted that “only 1 or 2% [of traps] are actually lost” because fishers are mostly able to retrieve lost or parted trawls by grappling. Fishers may also hire divers to retrieve their gear, or set active traps in areas where gear has been lost (noted on GPS systems) to self-snarl the lost gear. As reported in the focus groups, loss rates varied between LFAs (licence numbers provided from DFO Gulf Region and Verna Docherty on March 24, 2020):

- LFA 23, Tracadie: 0.5% (665 licences total; 300 total allowable traps each; roughly 1 to 2 traps per year per licence holder)
- LFA 25, Summerside and Shediac: 2% (712 licences total; 240 total allowable traps each; roughly 5 traps per year per licence holder)
- LFA 26a and 26b, Stellarton: 0.5% (681 licences in LFA26a and 226 in LFA 26b; between 240 and 280 total allowable traps each; roughly 1 to 2 traps per year per licence holder)

- LFA 27, Cape Breton: 1% (516 licences total; 275 total allowable traps each; roughly 3 traps per year per licence holder)
- LFA 34, Yarmouth: 1.5% (978 licences total; 375 total allowable traps each, 400 in the spring; roughly 5 to 6 traps per year per licence holder)

One fisher pointed out that while these trap-loss rates may seem low, “if [traps] are not retrieved, it adds up.” This is especially true if loss rates are multiplied by total licence holders in each LFA. For example, LFA 34 has around 900 licence holders, and fishers estimated that “4,000 to 6,000 [traps] are lost every year.” These are mainly single traps, which are hard to find because they present a smaller target and don’t have much rope for a grapple to attach to. However, as one fisher put it, “If you put in effort, you can catch it.” This sentiment was echoed throughout the focus groups.

Losses were reported to vary greatly from year to year. In the words of one fisher, “In the past five years, I’ve lost two [traps], but it depends. This year I lost none, but last year I lost 10 [traps].” In some areas, fishers stated that they lost between 2 and 10 traps depending on the year. Another reported losing 20 to 25 traps every year, more recently, but indicated that that would be on the higher end of the spectrum. Fishers were hesitant to give a firm number of traps lost due to annual variations.

In P.E.I., one fisher suggested asking tag suppliers for the number of replacement tags as an indicator of how many traps are lost annually. However, a PEIFA representative pointed out that these figures would be misleading as fishers sometimes get new tags without having lost a trap. This point was also made by other fishing associations such as Fundy North, as this mistake has been made in the past. The following example shows the problem with using replacement tags as a loss proxy: in LFA 23, around 5000 replacement tags were issued last year, but only 1000 of those were attributed to loss. The other replacement tags were either used as additional traps or if gear was changed mid-season. The current replacement-tag system is therefore not suitable for estimating gear loss.

Beyond losses, fishers also mentioned that the replacement tags might not be managed effectively, because some claim the tags to use as extra fishable traps, and some do not report losses to use the replacement tags at all in hopes of finding the lost trap. Several fishers also mentioned that at the end of the season, some gear with buoys attached is intentionally left at sea. Sometimes this gear gets brought back to the owner if it is retrieved by DFO; otherwise it remains at sea.



Fin whale surfacing near seabirds, Bay of Fundy, NS, July 2016 © Alexa Goodman

ALDFG HOTSPOTS

During the focus groups, it became evident that gear is lost over a large area – “some here, some there,” as one fisher noted. Fishers do not always know where their gear ends up. This makes it challenging to map ALDFG hotspots, and mapping has been deemed unnecessary in some areas. During the focus groups, fishers verbally identified hotspots as follows.

CAPE BRETON

- North Sydney Harbour, around ferry lines and cruise ships tracks
- Glace Bay

YARMOUTH

- German Bank (most prevalent area identified)
- Lobster Bay
- St. Mary’s Bay
- Trinity Ledge Area
- Cape Island
- Western side of Seal Island
- Bowl to Granite Rock
- Tusket Island
- By shipwrecks more generally

SUMMERSIDE

- West Point to Cape Egmont
- Egmont Bay, inside the contour line
- Higgens wharf
- Boundary line between LFA 25 and 26A
- Summerside Harbour
- By the shipping lane, roughly a mile on each side
- “Moaning” buoy below Confederation Bridge (roughly 4 miles down)

SHEDIAC

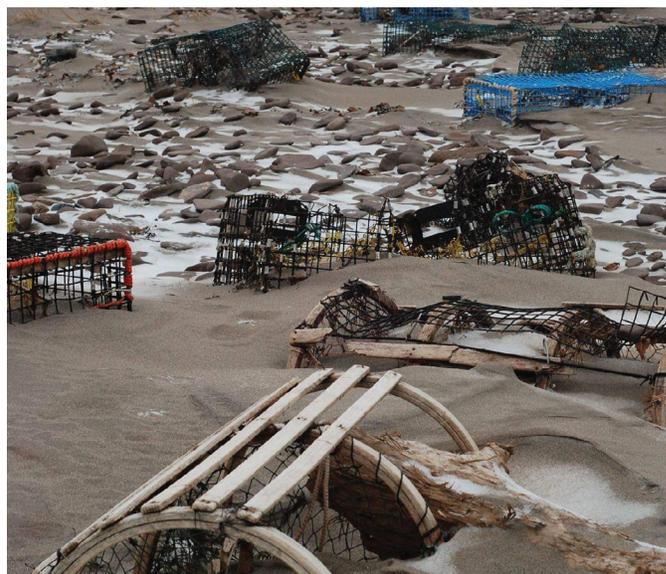
- Egmont
- Richibucto Bay
- Green buoy in Pointe Sapin, 5 miles around
- Fairway buoy in Summerside
- Boundary line between LFA 23 and 25, and 25 and 26a, roughly half a mile on each side
- Around the traffic lane in LFA 25

TRACADIE

- Miscou Island
- Pigeon Hill

STELLARTON

- Traffic lane by ferry terminal in CFA 12
- Shipping lane in crab zone F
- Traffic lane in Northumberland Strait



Miscou Island © Austin Vibert

GEAR REPLACEMENT

Fishers replace portions of their gear annually, keeping their gear in good condition to avoid negligent losses. Across all focus groups, most fishers stated that they replaced around 20% of their gear annually (both traps and rope), with some fishers stating lower averages (10%) and some higher (35 to 40%). Similar to loss rates, replacement rates vary depending on fishers' preference and wear. Wear is normal from operational use; in addition, gear damage tends to be higher with increased storm events, resulting in more gear replacements. Fishers noted that gear in better condition is lost less often; this incentivizes replacing gear regularly and pre-emptively to maintain quality. As one fisher put it, "You don't replace your gear because you lost it, you replace it because it wore out." In general, fishers do not replace gear explicitly because it has been lost or abandoned at sea; this accounts for only 0.5% to 2% of regular gear replacements, equating to around one or two traps per season.

Fishers replace gear components that are worn out or damaged. Wear and damage depend on factors such as fishing location, bottom type, season, and gear configuration and type. Soft bottom, like mud, is less abrasive than rocks, leading to less wear on gear. One fisher noted, "I fish mostly mud and I get a long lifespan out of the rope." Wear also increases with depth: buoylines last longer than groundlines as they are subject to less chafing. Trawl configuration typically lasts longer than singles and pairs as it requires stronger gear with thicker-diameter rope; replacements depend on the number of traps per trawl configuration. Replacements also vary depending on whether the traps were bought new or used, and what the gear type is; wire and wood trap durability varies according to the specific fishing location. During the off season, gear left outside is exposed to the elements; indoor gear storage is preferable as it extends gear life.

In recent years, gear has become more expensive, incentivizing fishers to retrieve lost gear. Gear costs vary based on supplier. A single trap and buoyline configuration can be valued at over \$200; replacing 50 traps could cost around \$7,000. Because of the cost, fishers do not want to lose their gear; most make an effort to locate and retrieve lost gear. However, there are several barriers to retrieval.

RETRIEVAL BARRIERS

While fishers often attempt to retrieve gear when possible, retrieval is hindered by several barriers. These include licence conditions and management relationships, gear configuration and condition, environmental conditions, cost and convenience. These barriers are echoed in the study done by Goodman et al. (2019).

LICENCE CONDITIONS AND MANAGEMENT RELATIONSHIPS

The licence conditions that are currently in place limit gear retrieval. It is prohibited to have someone else's gear in your possession or unmarked gear on board your vessel, or to conduct retrieval outside of season without a permit. As things stand, without a permit, ALDFG cannot be retrieved once the fishing season has ended. This poses a problem because traps are sometimes left at sea, either accidentally or intentionally, and cannot be retrieved unless found during the next season. The permitting process for retrieval events is currently being revised. Fishers are aware of the liability issues if gear is retrieved, and do not want to be caught and reprimanded by Conservation and Protection. However, fishers often take the chance despite retrieval being illegal because they want to do the right thing: "I know it's illegal, but I'll take the chance." Some fishers reset gear found at sea that does not belong to them with alternate buoys. They then report the incident to DFO, which retrieves the gear and brings it to shore. The buoy is returned to the fisher. Fishers may also report ALDFG to local fishing associations.

Scallop fishers frequently find ALDFG, but cannot bring it ashore as this is currently illegal under licence conditions. All focus groups stated that gear retrieval should be allowed, either throughout or at the end of the season. Gear retrieval at season's end may be particularly helpful because fishers may accidentally miss traps when hauling gear in at the end of the season. A specific process is needed to regulate in-season gear retrieval.

Other barriers to retrieval are the permitting and reporting process, and the relationship between fishers and DFO. Fishers noted challenges in contacting DFO for retrieval permission. They report that dealing with DFO is difficult. They expressed irritation at being redirected several times to different departments when they asked questions. Fishers found it frustrating that DFO does not always answer their phones; as a large portion of fishers do not have computers or use email, their capacity to report was limited. They also stated that the process was too time consuming. Some fishers suggested using a DFO text number, as this would be easier than email. Ultimately, fishers would like a simplified reporting mechanism that collects coordinates to ease retrieval efforts. Fishers expressed further frustration at the fact that if ALDFG is found and reported to DFO, they may not retrieve it; they do not want to wait for an officer on board for retrieval. Ultimately, regulations and managerial processes seem to be highly limiting factors in ALDFG retrieval. Existing relations between DFO and fishers pose additional barriers.

GEAR CONFIGURATION AND CONDITION

The gear configuration – specifically the number of traps lost and how they were set (single, double, trawl) – affects retrievability. As previously mentioned, it is hard to grapple for single traps without rope or with sinking lead-line. Fishers noted that searching for single lost traps is like “going blind, one at a time”: “If you happen to hit it, you’re lucky. Go buy a LOTTO 6/49 ticket.” There is little chance of retrieving gear with sinking lines: “Before the sinking rope I could go and get it at slack tide. There was a 75% chance I’d find it. It might take a few weeks to get the tides right, but I’d find it. With the sinking rope, I call PEIFA for a replacement tag because I know I won’t find it.” Some fishers said that they would conduct prolonged searches if they had lost more than four traps. They also indicated that gear is more easily retrieved if it still has a buoy attached.

Over time, ALDFG may form large snarls that become too heavy to retrieve and dispose of. These snarls are common after large storms, which can leave gear be heavily biofouled with natural materials. In such cases, attempting retrieval can be dangerous. Boats may need modifications and extra power to safely retrieve large, heavy snarls. Some fishers suggested using specific gear for such retrievals. They proposed using modified scallop trawls, as does Fundy North Fishermen’s Association (2016).

The condition of gear found at sea is also a retrieval barrier. If the gear found is in poor condition or biofouled, it is left at sea. Fishers bring only fishable gear to shore; they try to return gear to the owner if it is fishable and identifiable. If fishers know who owns the gear, they will reset the gear and call the owner to notify them of the coordinates. It’s an “unwritten rule” that fishers try to return each other’s gear, though they know it is illegal. If the gear is fishable but unidentifiable, fishers will call DFO and notify them of the tag number, as fishers do not want to be reprimanded. These practices have also been recorded in the Bay of Fundy (Goodman et al., 2019), and likely occur throughout Atlantic Canada.

ENVIRONMENTAL CONDITIONS

The physical marine environment – specifically bottom type and conditions, and water movement – creates additional challenges to locating and retrieving gear. For example, deep holes and contours in the seafloor may make grappling difficult, and winter ice will displace gear remaining at sea as it melts. It is also difficult to retrieve gear lost in deep water (over 30 fathoms) or in rough sea state. Locating lost gear can also be a challenge if an active trap line was severed by another vessel, or if storms or tides have displaced the gear.

COST AND CONVENIENCE

It is also important to consider the economic implications of gear retrieval. Fishers noted that fuel cost and the time needed to relocate lost gear are additional limiting factors. Some fishers will not try to retrieve singles because of the perceived cost-benefit: “You won’t burn \$1000 worth of fuel to find a \$100 trap.” Fishers do not want to waste time grappling for gear when chances of retrieval are low: “It’s not even worth trying, ‘cause you won’t find it.” Effort factors in as well: negligence may stop some fishers from looking for their lost gear, and not everyone has a grapple on board their vessel.

OTHER NOTABLE FACTORS

When asked about retrieval barriers, fishers mentioned other notable factors, including onshore ALDFG retrieval and the replacement-tag system. Once gear washes ashore, there is uncertainty about who is responsible for retrieval; in reality, all tagged traps should be reported to DFO for return to the owner. As noted by CBEA, if the gear is on private land, it is the landowner's responsibility. For a shoreline clean-up to take place, permission is needed from the provincial government and the landowner. The process for ALDFG retrieval on land is still fairly unclear and could be made simpler.

Fishers in nearly all focus groups mentioned that getting replacement tags has become too easy, reducing incentive to retrieve gear. It was recommended that there be a more formalized process that differentiates between using replacement tags for actual replacements from loss or for reconfiguration, and for extra traps. It was also suggested that there should be a limit on replacement tags over a certain time period to disincentivize illegal fishing and to encourage fishers to attempt gear retrieval. While several barriers were noted as hindering gear retrieval, the focus groups proposed solutions to address them.

GEAR LOSS AND RETRIEVAL SOLUTIONS

Throughout the focus groups, several solutions were suggested for minimizing gear loss and easing retrieval. Solutions have been grouped by implementation strategy, either through management or industry. Management solutions include improving licence conditions, gear tagging and reporting, and managing and enforcing marine traffic routes. Industry-led solutions include retrieval days, technological advancements, gear innovations and education campaigns.

MANAGEMENT SOLUTIONS

Mitigating gear loss requires changes to how the fishery and marine environment is managed. Solutions – including improvements to licence conditions, gear tagging and reporting, and marine traffic routes – would need to be implemented by federal and regional government bodies.

Licence conditions were identified as among the strongest barriers to gear retrieval. Therefore, DFO should prioritize improving licence conditions to allow for trap retrieval during the season and after it has ended, across all fisheries. The change to licence conditions could be integrated with a retrieval tag system, where retrieved gear is tagged with uniquely numbered “retrieval tags” that are reported to DFO. These tags would not be fishable, but would be intended to legitimize and monitor gear retrieval. They could reduce illegal, unreported and unregulated (IUU) fishing. The system would have to be implemented in consultation with the fishing industry, and be fully fleshed out prior to implementation.

It was suggested that improvements to the existing replacement-tag system would help in monitoring which fishers frequently lose gear. For example, the MFU keeps a record of all fishers who claim replacement tags, and submits daily reports to DFO. In 2020, DFO is expected to increase monitoring. Monitoring the replacement-tag system may help disincentivize illegal fishing by revealing who is using the replacement tags as extra traps and by encouraging fishers to attempt retrieval.

It would also be beneficial to improve the DFO's new system for reporting lost and retrieved gear. More than one method of reporting should be available as emails are not suitable or accessible for many fishers. An automated phone line could be established, allowing fishers to leave an audio message or send a text message. Reporting of ALDFG could also be integrated into the e-log system where applicable. It is important for reporting to be easy and accessible for all demographics of fishers to encourage compliance with the conditions of licence (Goodman et al., 2019).

Improving regulations around traffic and shipping lanes may reduce gear loss. Transport Canada could institute tighter boundary limits around shipping lanes, coupled with an alternate route to better manage vessel traffic in active fishing regions. In the past, education campaigns targeting the shipping and tourism industry have not proven effective in reducing vessel-gear interactions. Tightening traffic routes might reduce these interactions.

INDUSTRY SOLUTIONS

Mitigating gear loss and easing retrieval efforts will require collaborative industry-led solutions, which may include retrieval days, technological advancements, gear innovations and education campaigns. These solutions would need to be implemented by multiple stakeholders: “Everyone needs to work together to move forward.” Stakeholders would include, but not be limited to, fishing associations and their harvesters, other marine industries like aquaculture and transportation, and DFO.

Nearly all focus groups identified retrieval events as the most impactful industry-led solution. Retrieval events could be planned for the first calm day(s) after a fishing season ends, following the example of the [Gulf of Maine Lobster Foundation’s Gear Grab](#) and [Fundy North’s annual retrieval days](#). Retrieval events should be a collaborative effort between industry and the government. They could be regularly scheduled to take place within one or two weeks of the season’s end.

Technology and gear innovations may reduce loss and make it easier to locate and retrieve ALDFG. Examples include gear modifications, new grapnel design and GPS tracking. In terms of gear modifications to ease retrieval of lost traps, one fisher suggested adding cork to the last metre of buoyline; having a portion that floats just above the ground would make retrieval easier. For retrieving single traps, this solution may be more effective than switching to trawls. Fishers have also suggested transitioning away from Styrofoam buoys to hard plastic ones as they are easier to see and do not break down into microplastics as quickly. Propeller guards or “cages” have helped to reduce vessel-gear conflicts in certain areas and could be implemented more broadly; however, design innovations would be necessary to [improve their efficiency](#). Research and development could target improving their design to increase the speed at which they allow vessels to travel. Propeller guards could be used widely across all marine industries to reduce vessel-gear conflicts generating gear loss, but would not necessarily be mandatory. Innovations are also needed to facilitate physically retrieving gear; new grapples could be developed that easily hook gear. This could happen through a collaboration between fishers and engineers, along the lines of the Association des crabiers acadiens project included in Chapter 2.

Monitoring and tracking gear loss would help target retrieval efforts and identify “problem areas.” A pilot project could use GPS receivers (or other technology) to better track lost gear and see where lost traps accumulate. Using a device like [Resqunit](#) might be effective, but the cost needs to be more affordable for fishers if the solution is to be upscaled. A pilot project could be a collaboration between various stakeholders, including fishing associations, academics and business.

Focus groups noted the importance of increasing education by engaging fishers, especially the younger generation, on the topic of ALDFG. More education would stimulate new solutions, encourage retrieval and limit inappropriate disposal. Fishers noted that working towards solutions “could help us with our markets”: they want to show that they are working towards being a “whale-friendly fishery” and are retrieving plastic. Continually engaging fishers on the matter will improve ALDFG management, and should be prioritized.

GEAR DISPOSAL

Gear disposal is an important consideration in managing ALDFG. As a lot of gear is replaced annually, significant quantities are in need of end-of-life management. Responsible management programs promote sustainable end-of-life gear practices by encouraging retrieval and limiting illegal discarding at sea. During the focus groups, fishers indicated how they handle end-of-life gear, mainly old traps and rope.

TRAPS

Fishers dispose of end-of-life traps in several ways, which vary according to area, fisher and trap type. Although some fishers accumulate traps on their property, most try to avoid this by disposing of traps in a timely manner. Wooden traps are often burnt, being used as kindling for fires. Traps are also resold to tourists, mainly from the roadside. Most wire traps are brought to local landfills. Depending on the area, some landfills charge a tipping fee, usually based on weight, and may require the gear to be partly dismantled. Price and requirements vary by landfill. For example, the Yarmouth landfill charges \$10 for

100 traps (10¢ per trap) and Island Waste on P.E.I. charges \$200 for 30 traps (around \$7 per trap). At the St. Louis Wharf in Shediac, fishers use communal funds from the Union's shared crab quota to pay for trap disposal; they allocate \$10,000 to dispose of around 5,000 traps. Another wharf in Stellarton had the harbour authority coordinate a wharf-side dumpster and used a tractor to crush traps for proper disposal; the total annual cost was \$1000. In some areas, traps may be recycled for scrap metal; however, much of it gets sent to a landfill because of the plastic coating on the wire traps. In Stellarton, a fisher noted that he brings around 100 wire traps with the ballast removed to a metal shredder for an \$80 return per load, which covers fuel cost. However, prices vary.

Traps are also resold to other fishers in different areas, either in local Maritime provinces or in Newfoundland and Maine. Some are resold to fishers in areas that fish inshore rocky areas, like LFA 33, because traps inevitably get more worn down in that environment. However, some fishers are hesitant to resell their gear since their old traps may be used as IUU gear, as has happened in the past. Traps are also repurposed for use in the construction of roads and retaining walls.

Disposal options do exist for traps. However, "not all comes back to shore," as some old gear is intentionally discarded at sea. Fishers will remove the netting from the inside of the traps they deem "unfishable," and leave the traps at sea. Some fishers believe that old traps create habitat, since once the netting is removed, lobsters and crabs may move freely without being trapped. This belief was also echoed in the Bay of Fundy (Goodman et al., 2019). However, studies have shown that ALDFG can negatively impact commercial fish stocks through indiscriminate fishing. For example, ALDFG in the Chesapeake Bay blue crab fishery contributed to USD \$300,000 in losses from ghost fishing (Bilkovic et al., 2014). As yet, no study in Atlantic Canada backs up the ALDFG habitat claim, and local fishers expressed skepticism: "I'd rather burn [the traps] than cut them off and leave them on the bottom. Even if you cut the heads, they can still have lobsters that get tangled in the webbing." This is supported by the retrieval efforts of FNFA (2016), which showed that "jumbo" lobsters were trapped in ALDFG traps. Some fishers admit that they used to dispose of gear at sea: "I used to cut it off and leave it out there, but now I take wire [traps] to the landfill." Disposal at sea is likely still practised by fishers in some areas. Some fishers also have "dump spots" out in the woods. However, illegal discarding is less common than in the past, thanks to increased education. In Tracadie, for example, fishers noticed that old traps washing ashore became a problem and started dumping less.

ROPE

Management of end-of-life rope is more streamlined than for traps. Rope can either be disposed of, incinerated, recycled or repurposed. However, some fishers noted that they had stockpiles of old rope on their property. Means of disposal include bringing the rope directly to a landfill or using roadside pick-up, available during spring-cleaning events. In Victoria, P.E.I., the rope is discarded in a waste stream arranged with local businesses. Not all wharves have this type of arrangement, but it can be seen as an exemplary model for rope disposal elsewhere. Some rope is also burnt as it is considered a good fire starter.

Some old rope is recycled into new markets and is repurposed, either given away or sold. For example, rope is sometimes sold to mussel farms, and in Cape Breton rope has been sold to local park management to mark local hiking trails. Rope is given away or exchanged with farmers – specifically blueberry farmers – and hunters. Rope is also given to local mat makers and other artisans. Rope can also be used in various construction projects. Fishers generally know who needs old rope, and community members know who to ask if they need rope; for this reason, it is easier to dispose of rope than traps. Fishers also use old rope to wrap the edges of new traps, reinforcing them to reduce wear from bottom chafing.

DISPOSAL BARRIERS

While participant fishers indicated how they dispose of their end-of-life gear, barriers limiting disposal still exist for end-of-life resource management on large scales. Barriers include cost, convenience and time, and disposal capacity.

Cost is a prominent barrier to proper gear disposal: tipping fees and fuel costs associated with transportation to disposal facilities may disincentivize proper disposal methods. Gear disposal needs to be affordable as fishers will favour free disposal methods. Convenience and time are also important considerations. Dismantling traps for disposal is a laborious job that requires additional time and effort, as does transportation to disposal facilities. Some landfills have specific drop-off times

that don't suit fishers. Ultimately, inconvenience limits proper disposal. As one fisher noted, "For a lot of guys, the laziness of bringing it to the dump is a factor." Fishers are not looking for extra work.

Disposal capacity is another barrier. Fishers would find it helpful to have adequate access to disposal facilities and to know where they can bring old gear. Fishers aren't sure of the best disposal options for each gear component, and don't know whether or not they can dispose of old gear in the household waste stream. Certain landfills may not have the capacity to handle high volumes of end-of-life gear, and may need additional machinery to transport and handle the heavy materials. Fishers noted that to incentivize participation, proper disposal streams need to be convenient and cost effective: "If it's too regulated, people will leave it in the ocean." Fishers suggested solutions to the barriers they identified.

GEAR-DISPOSAL SOLUTIONS

Fishers stated that to manage ALDFG, rope and trap disposal should be prioritized. This would both encourage retrieval and minimize illegal discarding at sea. They proposed large- and small-scale solutions with varying impacts. The gear-disposal solution most often suggested during the focus group was implementing regularly scheduled collection days for end-of-life gear. A truck could collect gear at wharves on specific dates annually, perhaps at the end of the season, with specific pick-up times. This solution would be easier and more convenient than having wharf-side dumpsters, which use up limited space and contaminate other waste streams if left unmonitored. Fishers could pay into a disposal system, along the lines of a recycling fee on tires or electronics; they would pay a set amount, perhaps per trap, to go towards the service. A cost-sharing model between the fishers and the community of interest might be effective for a disposal system. Fishers also need designated disposal and collection spots where they can bring gear directly outside of the collection dates at landfills or transfer stations. Fishers could perhaps work with fishing associations to identify appropriate locations and disposal streams. Locations need to be publicized; fishers want to know where they can bring their old gear. Disposal needs to be affordable, if not free – as one fisher noted, "the cheaper, the better."

Investing in rope recycling is another large-scale solution with high impact. Fishers advocated for rope recycling, noting that "even if we give it away, eventually it ends up in the dump." Currently two facilities in Nova Scotia – Goodwood Plastic and Sustane Technologies Inc. – have the capacity to recycle rope. Facilities need to be scaled up, and fishers need to know where they can bring the rope. Fishers suggested implementing a recycling fee, similar to a bottle deposit or electronic fee. Fishers would pay a fee when purchasing rope, and get this money back when they bring their rope in for recycling. This could be called an "environmental fee" to emphasize the good that fishers are doing. The fee name would need chosen carefully so as not to cause concern with fishers – though as one fisher mentioned, "People will be hesitant no matter what you do." Infrastructure and collection for rope recycling could be established in partnership with the government, rope manufacturers and recyclers.

Small-scale solutions were also discussed during the focus groups. Fishers suggested organizing shoreline clean-ups with the specific intent of retrieving ALDFG washed ashore. They also mentioned crushing traps for road construction and breaking rope down for use in concrete reinforcement. Lastly, fishers noted the need to address lobster bands, which are a source of marine pollution from the industry. They suggested that DFO regulate the kind of bands that buyers supply to fishers.

CONCLUSION AND RECOMMENDATIONS

Discussion with fishers across Maritime provinces and comparison with past regional research have led to several conclusions. Gear loss, primarily lobster traps and rope, ranges between 0.5% and 2% of total allowable traps and varies by temporal, spatial and physical parameters. Hotspots are challenging to identify because losses are widespread. Fishers regularly replace around 20% of their gear to keep it in good condition. Gear retrieval is limited by a number of factors: licence conditions and DFO relations, gear configuration and condition, environmental conditions, cost and convenience. To encourage retrieval and limit illegal discarding at sea, it is important for proper gear disposal to be accessible. Barriers hindering proper disposal include cost, convenience and time, and disposal capacity. Participants proposed a number of ways that management and industry could address barriers to both retrieval and disposal. When determining which solutions to implement, stakeholders should evaluate proposals based on implementation effort and projected outcomes. The following recommendations have been ordered by category based on priority and greatest impact, as discussed in the focus groups:

MANAGEMENT RETRIEVAL SOLUTIONS

- Improve licence conditions to allow for trap retrieval during and after seasons, across all fisheries. This could be integrated with a retrieval-tag system.
- Monitor replacement-tag systems to limit IUU fishing and encourage retrieval.
- Improve the new gear-reporting system by implementing alternative reporting methods that suit all demographics, such as an automated phone line. This change will improve compliance.
- Tighten regulations around vessel traffic and shipping lanes to limit vessel-gear interactions.

INDUSTRY RETRIEVAL SOLUTIONS

- Plan regularly scheduled retrieval events within two weeks of the end of a fishing season, to allow for the retrieval of ALDFG remaining at sea.
- Engage fishers on the topic of ALDFG to find solutions, and to encourage retrieval and proper disposal.
- Improve design efficiency of propeller guards and encourage their use across all marine industries to reduce losses caused by vessel-gear interaction.
- Design new grapples that ease gear retrieval.
- Conduct a pilot project that tracks gear loss with GPS technology.

DISPOSAL SOLUTIONS

- Implement regularly scheduled collection days for end-of-life gear, using a flatbed truck on specific dates annually at the end of the season. This date should correspond to retrieval days to improve effectiveness. The disposal service could be paid for through a cost-sharing model whereby fishers pay a set fee per trap, and the municipality covers the remainder if need be.
- Establish and notify fishers of designated disposal and collection locations where fishers can bring end-of-life gear.
- Implement a rope-recycling system to divert quantities from landfills, perhaps using a recycling fee to cover the cost.

PROJECT RECOMMENDATIONS AND CONCLUSION

This comprehensive report compiles baseline information on ALDFG management for the Maritimes region by bridging knowledge gaps and identifying avenues to address the issue. The report overviews the current ALDFG management structure nationally in Chapter 1, compiles an index of ALDFG projects in Canada in Chapter 2, reviews solid waste management of fishing gear in Atlantic Canada and the applicability of Extended Producer Responsibility in Chapter 3, and examines the extent of ALDFG in the Maritimes and Gulf regions in Chapter 4. From this work, the following recommendations have been synthesized:

- DFO should continue to implement and expand reporting requirements under the new licence conditions, modifying them over time to suit the specific needs of each fishery in each region. It could be beneficial to implement a retrieval tagging program under Regional Tagging Protocols to monitor and report gear found at sea. This measure would legitimize the retrieval process and address the limitations of current licence conditions.
- DFO should establish a comprehensive permitting process and notify fishing associations. This would allow industry and organizations to remove ALDFG remaining at sea in a timely and cautious manner.
- Fishing associations and DFO should monitor replacement-tag systems to limit IUU fishing and encourage retrieval.
- In collaboration with industry, DFO should organize retrieval days and/or provide sufficient funding for industry and other interested parties, such as academia and non-governmental organizations, to conduct large-scale gear-retrieval

activities, along the lines of Operation Ghost. It could be beneficial to have regularly scheduled time periods after each season to allow for retrievals restricted to permitted areas, to ease targeted monitoring and enforcement.

- Transport Canada and DFO should tighten regulations around vessel traffic and shipping lanes to limit vessel-gear interactions.
- DFO should work with the Fishing Gear Coalition of Atlantic Canada to develop clear management guidelines for the retrieval and disposal of ALDFG washed ashore above the high-water line.
- Waste management should focus on diverting traps (lobster and crab) and rope from landfills in Maritime provinces, based on preliminary disposal quantities.
- Industry should implement pilot projects using innovative technology to remove PVC from wire frame traps (lobster and crab), and to process rope and nets for recycling.
- Researchers should conduct focus groups with businesses and government officials to determine how EPR can be applied to fishing gear to fund a circular waste management system.
- Fishers should work with industry experts to design grapples that ease gear retrieval.
- Industry should improve design efficiency of propeller guards. DFO should encourage their use across all marine industries to reduce losses related to vessel-gear interaction.
- Researchers and industry should conduct pilot projects that track gear loss with GPS technology to facilitate finding lost gear.
- Industry should facilitate regularly scheduled collection days for end-of-life gear, using a flatbed truck on specific dates annually at the end of the season. This date should correspond to retrieval days to improve effectiveness. The disposal service could be paid for through a cost-sharing model whereby fishers pay a set fee per trap, and the municipality covers the remainder if need be.
- Municipal and provincial governments and industry should establish and notify fishers of designated disposal and collection locations where fishers can bring end-of-life gear.
- Municipal and provincial governments and industry should implement a rope-recycling system to divert quantities from landfills, perhaps using a recycling fee to cover the cost.
- All relevant stakeholders and rights holders should engage fishers on the topic of ALDFG to find solutions, and to encourage retrieval and proper disposal.

Abandoned, lost and discarded fishing gear is a complex issue that threatens marine life and local livelihoods if unaddressed. While there are many barriers to preventing and mitigating ALDFG, there are also clear avenues forward. As a tangential benefit, addressing ALDFG will reduce IUU fishing. With the Canadian government's commitments and industry willingness to address ALDFG, we can hope to reduce the impacts to our shared marine environment and its resources, provided adequate measures are taken as outlined in this report.

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APPENDICES

APPENDIX A (EXTERNAL) – INTERNATIONAL GHOST GEAR PROJECTS

APPENDIX B – CHAPTER 2 SURVEY QUESTIONS

Section 1: Introduction

Capturing knowledge from ongoing, past and future projects to create a Canadian ghost gear and abandoned, lost and discarded fishing gear project index. This information is essential to assess national efforts, in connecting organizations doing similar work and limiting project duplication.

The survey should take about 10-15 minutes to complete. Your contribution is greatly appreciated and valued.

This survey has been created in partnership with the Fishing Gear Coalition of Atlantic Canada (FGCAC). It will contribute to Chapter 2 of a comprehensive report on abandoned, lost and discarded fishing gear in Canada, with a focus on Atlantic Canada, supported by the World Wildlife Fund Canada. This report will help provide a better understanding of national efforts and avenues for future work moving forward with respect to the issue.

Section 2: Contact Information

Organization Name*

Contact Person Name*

Email*

Phone Number*

[Note: * indicates required field]

Section 3: Project Information

Please fill out the following information so we can capture an understanding of related projects across Canada.

1. Project Title*
2. Project State (Past/ Ongoing/Future - Planning)*
3. Project Location (Scope)*
4. Specific Goals & Objectives (Short & Long Term)*
5. Brief Project Description*
6. Major Take-Aways/Contributions to Ghost Gear and ALDFG Knowledge (Please List)
7. Notable Successes & Lessons Learnt (Please List)
8. Notable Challenges (Please List)
9. Would you like a copy of the final report? (Yes/No)*
10. May we share your contact information with other researchers and organizations involved in similar projects and with the Fishing Gear Coalition of Atlantic Canada? (Yes/No)*
11. Is there anyone else this survey should be circulated with?

APPENDIX C – CHAPTER 3 SURVEY QUESTIONS

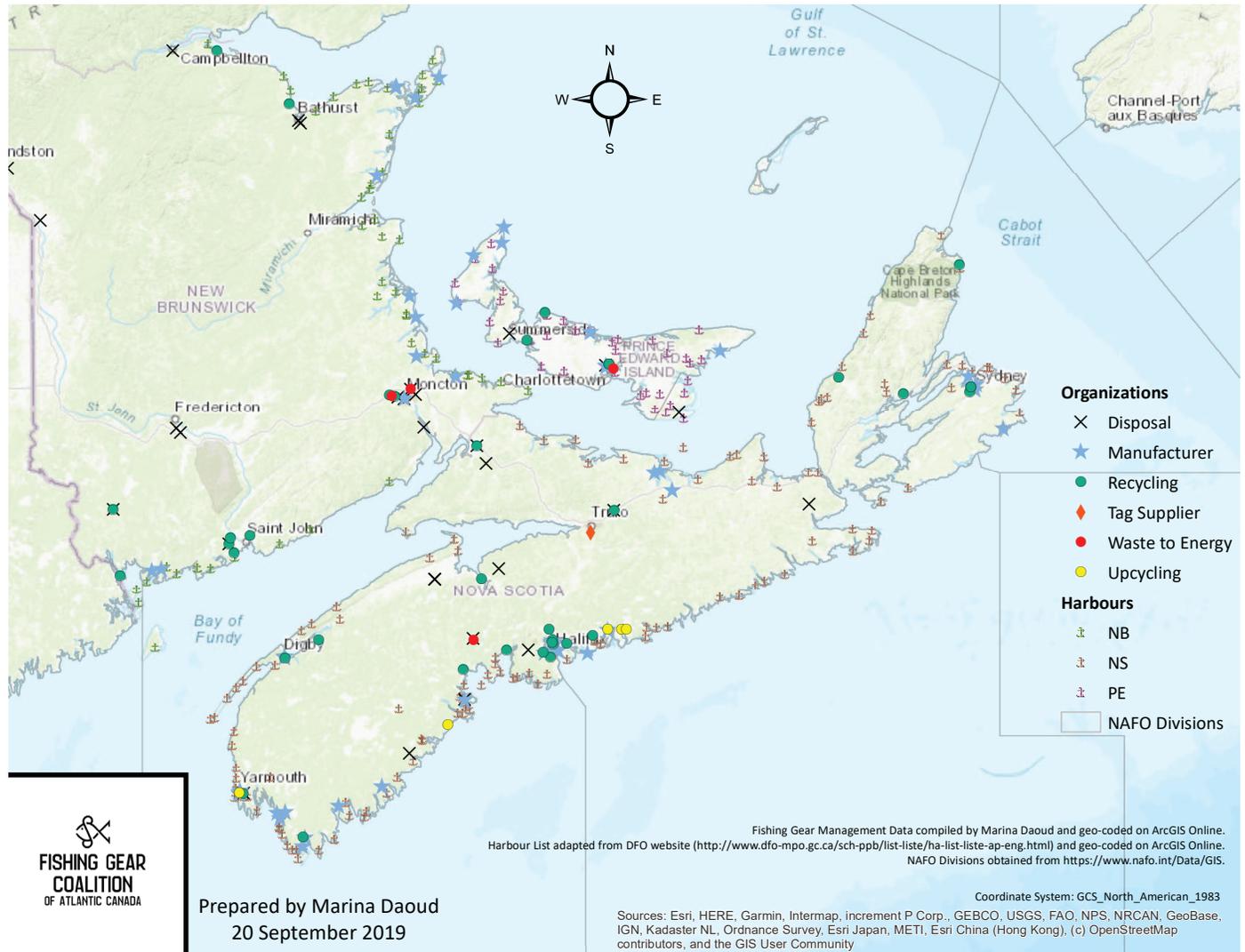
RECYCLING SURVEY QUESTIONS

1. What type of materials do you recycle?
2. Do you accept fishing gear waste (traps, rope, metal, buoys)?
3. What do you do with the materials you collect?
4. How do you recycle collected materials? (Mechanical or Chemical)
5. Do you have the capacity for chemical recycling? (Turning old material into new items by changing the chemical composition)
6. Do you have the capacity to recycle fishing gear?
 - a. Are there any limitations?
7. Other comments

MANUFACTURER SURVEY QUESTIONS

1. Do you manufacture fishing gear or import raw materials?
2. Do you have any existing Extended Producer Responsibility policies? (Definition: a strategy to add all of the environmental costs associated with a product throughout the product life cycle to the market price of that product)
3. Do you have the capacity to repair or reuse old gear?
4. Is a deposit or return system feasible? (similar to a bottle return deposit)
5. Other comments

APPENDIX D - CATALOGUE AND MAP OF RECYCLING, DISPOSAL AND WASTE-TO-ENERGY FACILITIES AND GEAR MANUFACTURERS IN MARITIME PROVINCES: NEW BRUNSWICK (N.B.), NOVA SCOTIA (N.S.) AND PRINCE EDWARD ISLAND (P.E.I.), ORGANIZED BY FACILITY TYPE.



TYPE	PROVINCE	ORGANIZATION NAME	ADDRESS	CITY OR TOWN
Disposal	N.B.	North West Sanitation Services Ltd.	29 Chemin Waddell Loop	Saint André
		CSRNO - COGERNO	248 Chemin Clément Roy	Rivière-Verte
		Restigouche Solid Waste Commission	7 Centennial Dr	Campbellton
		Mr. Trash	325 Munro St	Bathurst
		Fero Waste & Recycling	1035 Riordon Dr	Bathurst

	Fero Waste & Recycling	45 Gillis Rd	Fredericton	
	Southwest New Brunswick Service Commission	5749 Route 3	Lawrence Station	
	Fundy Region Solid Waste	10 Crane Mountain Rd	Saint John	
	GFL Environmental	160 Blizzard St	Fredericton	
	Junk Away	18 MacWilliam Ln	Moncton	
	PBS Waste	45 Checker Dr	Moncton	
	Nelsons Waste Solutions	110 Steeves St	Hillsborough	
	GFL Environmental	1095 Champlain St	Dieppe	
NS	Waste Check	309 Forest St	Yarmouth	
	Region of Queens Waste Management Facility	3750 Nova Scotia Trunk 8	Queens	
	Otter Lake Landfill Facility	600 Otter Lake Dr	Hubley	
	Guysborough Waste Management Facility	151 Waste Management Rd	Guysborough	
	Colchester Balefill Facility	188 Mingo Rd	Kemptown	
	Cumberland Central Landfill	2052 Little Forks Road	Little Forks	
	Eastern Management Centre	100 Donald Hiltz Connector Rd, Kentville	Lawrencetown	
	Western Management Centre	343 Elliott Rd, Lawrencetown	Kentville	
	West Hants Landfill	1569 Walton Woods Rd	Walton	
	Kaizer Meadow Solid Waste Management Facility	450 Kaizer Meadow Rd	Chester	
	Little Forks Municipal Landfill	2063 Little Forks Rd, Nappan	Amherst	
	Halifax Construction & Debris Recycling Ltd.	16 Mills Dr	Goodwood	
P.E.I.	Waste Watch Drop-off Center	378 Cape Bear Rd	Murray River	
	Island Waste Management Corporation	110 Watts Ave	Charlottetown	
	East Prince Waste Management Facility	29786 Western Rd	Miscouche	
Manufacturer	N.B.	Seacoast Fishing Supplies Ltd.	43 Cormier Village Rd	Grand-Barachois
		Sparta Manufacturing	577 Route 535	Notre-Dame
		Entreprises Shippagan	262 Boulevard J. D. Gauthier	Shippagan

	Rainbow Net & Rigging Ltd.	4 Magaguadavic Dr	Saint George
	Richibucto Village Fisherman's	3756 Route 505	Richibucto Village
	SS Fish n Sales inc	4399 Route 11	Tabusintac
	Bouctouche Bay Industries Ltd.	2147 Route 475	Saint-Édouard de Kent
	Sport Monger-Jp Lukeman Sales	121 Cornhill St	Moncton
	Future Nets & Supplies	48 Armstrong Loop Rd	Pennfield
	Spartan Industrial Marine	7721 Rue Saint Paul Hwy 145	Bas Caraquet
	Aqua G Produits Marine Inc.	39 rue Des Pigeons	Pigeon Hill
	Spartan Industry Marine	2252 Rue du Quai	Bas-Caraquet
N.S	Coldwater Lobster Association	368 Main Street Suite 105 Lovitt St	Yarmouth
	Canada Rope and Twine	155 Bluewater Rd	Bedford
	Spartan Industrial Marine	3620 Hwy Barrington	Barrington Passage
	Vernon d'Eon Lobster Plugs Ltd.	6 Barrington Passage	Barrington Passage
	Wade Lobster Traps	3404 Hwy 3	Glenwood
	Rossway Enterprises Ltd. (Lobster Trap Factory)	117 King Street	Digby
	Rossway Enterprises Ltd. (Digby Marine Supply)	8 Prince William Street	Digby
	Crimond Enterprises Limited	133 Ilsley Avenue Umit OO	Dartmouth
	Spartan Industrial Marine	120 Thornhill Dr	Dartmouth
	Wire Rope Industries	84 Thornhill Dr	Dartmouth
	Hampidjan Canada	101 Ilsley Ave	Dartmouth
	Princess Auto	210 Wright Ave	Dartmouth
	Rainbow Net & Rigging Ltd.	109 Simmonds Dr	Dartmouth
	Sevaen Gear (formerly Climate Technical Gear)	100 Wright Ave Unit 22	Dartmouth
	Ocean Gear Inc. (fishing gear)	160 Bluenose Dr	Lunenburg
	Open Seas Instrumentation Inc.	124 W Petpeswick Rd	Musquodoboit Harbour
	Bailey's Plastic Fabrication Ltd. (fisheries)	4731 Highway 207	East Lawrencetown
	Vernon d'Eon Lobster Plugs Ltd.	2419 NS-376	Pictou

Pictou Fishing Supplies	3297 NS-376	Pictou
Stright-MacKay Ltd.	209 Terra Cotta Dr	New Glasgow
Louisbourg Ship Supply & Service Ltd.	7 Commercial St	Louisbourg
Spartan Industrial Marine	1291 Victoria Rd	Sydney
Cape Breton Fish and Marine Supplies	14 Wentworth St	Sydney
Vernon d'Eon Lobster Plugs Ltd.	252 Commercial St	North Sydney
Novatec Braids Ltd.	234 Water St	Yarmouth
Vernon d'Eon Lobster Plugs Ltd.	434 Main St	Yarmouth
Spartan Industrial Marine	44 Hawthorne St	Yarmouth
Fox Hill Marine Wire Ltd.	Great Pubnico Lake Rd	Pubnico
Vernon d'Eon Fishing Supplies Ltd.	373 Hwy 335	West Pubnico
Vernon d'Eon Lobster Plugs Ltd.	129 Water Street	Shelburne
Sable River Fishing Supplies	4 Fishermen's Memorial Hwy	Sable River
Hi-Liner Fishing Gear and Tackle Ltd.	155 Chain Lake Dr	Halifax
The Lobster Trap Company	COVE 27 Parker Street	Dartmouth
Ashored Innovations	COVE 27 Parker Street	Dartmouth
Resquint	COVE 27 Parker Street	Dartmouth
Polysteel Atlantic Ltd.	468 Portsway Avenue	Edwardsville
Island Traps	9 Woodland St	Cape Sable Island

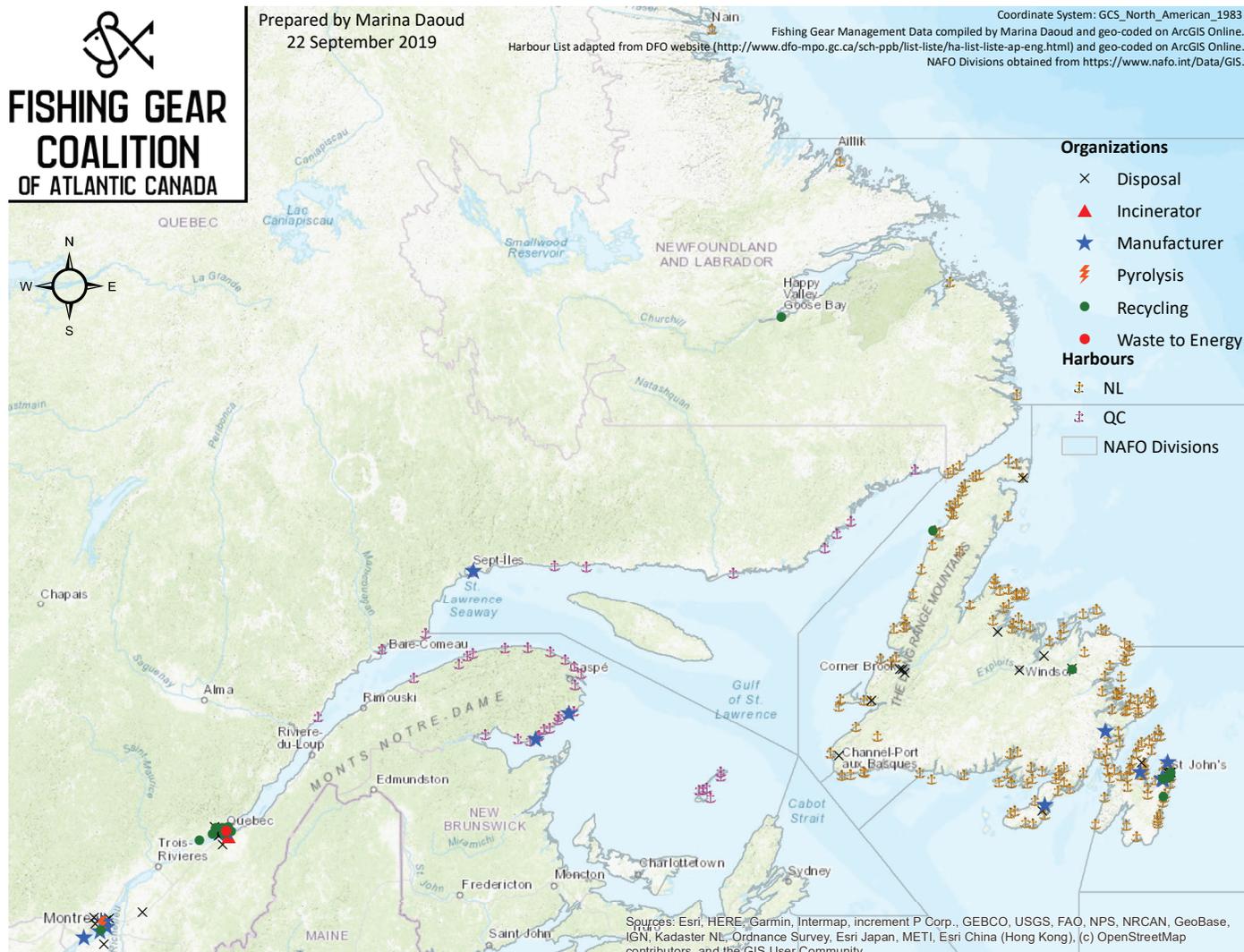
P.E.I.	Vernon d'Eon Lobster Plugs	35 High St	Souris
	Hackett Enterprises Inc.	21383 Route 12	Tignish
	Kildare Bait & Lobster Co Ltd.	169 Harbour Rd	Miminegash
	Kildare Bait & Lobster Co Ltd.	141 Harbour Rd	O'Leary
	PEI Wooden Lobster Buoy	285 Harbourview Dr	North Rustico
	Spartan Industrial Marine	40 Schurman Street	Charlottetown
	Kildare Bait & Lobster Co Ltd.	Judes Point Rd	Tignish
	Mermaid Marine Products	26 Fourth St	Charlottetown

Recycling	N.B	Fero Waste & Recycling	203 Desbrisay Ave	Moncton
		Scotia Recycling Limited	2024 Route 128	Berry Mills
		Huntsman Marine Science Centre Fundy Discovery Aquarium	1 Lower Campus Rd	St. Andrews
		Terrapure Environmental	11 Reid Street	Charlo
		Recyclage Beresford	709 Rue Usine	Beresford
		Fero Waste & Recycling	65 Alloy Dr	Saint John
		Southwest New Brunswick Service Commission	5749 Route 3	Lawrence Station
		Fundy Region Solid Waste	10 Crane Mountain Rd	Saint John
		Grand Bay Redemption Centre	131 River Valley Dr	Grand Bay Westfield
		Saint John Recycling	220 Ashburn Lake Rd	Saint John
	N.S.	Goodwood Plastic Ltd.	84 Simmonds Drive	Dartmouth
		Dartmouth Metals Ltd.	14 Dawn Drive, Dartmouth	Windsor Junction
		Green Tree Recycling Ltd.	44 Greentree Ave	Porters Lake
		Green Tree Recycling Limited	30 Stella Dr	Neils Harbour
		L W Layton Salvage	3239 Highway 358, Canning	
		Halifax Construction & Debris Recycling Ltd.	16 Mills Dr	
		Neil's Harbour New Haven Recycling Depot	690 New Haven Rd	
		Camdon Recycling Limited	345 Gulf Crescent	Edwardsville
		Keltic Recycling Inc.	434 Keltic Dr	Sydney
		Scotia Recycling Ltd.	5 Brown Ave, Dartmouth	Dartmouth
		Scotia Recycling Ltd.	99 Upham Dr, Truro	Hantsport
		Scotia Recycling Ltd.	273 Forest St, Yarmouth	Yarmouth
		Miller Waste Systems	20 Horseshoe Lake Dr	Halifax
		Miller Waste Systems	8 Moore Road	Dartmouth
		Baddeck Transfer Station	445 Old Margaree Road	Baddeck
		Green Island Recycling Ltd.	345 Gulf Crescent Dr	Edwardsville
		Inverness Material Recycling Facility	15109 Highway 19	Strathlorne
Colchester Materials Recovery Facility	Exit 18 Highway 104 185 Mingo Rd	Kemptown		

		Mauser Packaging Solutions	29 Memorial Crescent	Springhill
	P.E.I.	Greenisle Environmental Inc.	15 Superior Crescent	Charlottetown
		Superior Sanitation Services Ltd.	7 Superior Crescent	Charlottetown
		Twin Shores Recycling Center	Gulf Lane	Kensington
		Greenisle Environmental Inc.	175 Industrial Crescent	Summerside
Tag Supplier	N.S.	Mainland Mi'kmaq Development Inc.	57 Martin Crescent, Millbrook Mi'kmaw Community, PO Box 1590	Truro
Upcycling	N.S.	All for Knot Rope Weaving	12628 Highway 2, Lower Onslow	Head of Jeddore
		Captain G's Rope Anchors	636 Myers Point Rd	
		The Crafters Room	47 E Jeddore Rd	Jeddore Oyster Ponds
		Old Anderson House Craft Shop & Gallery	152 W Petpeswick Rd	Musquodoboit Harbour
		Seahags and Scallywags Art Upcycled Treasures Collectibles	87 Water St	Yarmouth
		Mariner Craft	161 Drews Hill Rd Petite Rivière Bridge	Lunenburg
Waste to Energy	N.B.	Stericycle Canada	20 Galloway St	Moncton
		Southeast Eco360 Sud-est	100 Bill Slater Drive	Berry Mills
	N.S.	Lafarge Cement	186 Lower Truro Rd	Chester
		Sustane Technologies Inc.	25 Rainbow Drive	
	P.E.I.	PEI Energy Systems	40 Riverside Dr	Charlottetown

APPENDIX E - CATALOGUE AND MAP OF RECYCLING, DISPOSAL AND WASTE-TO-ENERGY FACILITIES AND GEAR MANUFACTURERS IN QUEBEC (QUE.) AND NEWFOUNDLAND (N.L.), ORGANIZED BY PROVINCE.

Note: This catalogue is as exhaustive as possible – some facilities and businesses may not have appeared in online searches.



PROVINCE	TYPE	ORGANIZATION NAME	ADDRESS	CITY OR TOWN
N.L.	Disposal	Robin Hood Bay Landfill & Recycling	340 E White Hills Rd	St John's
		Around the Bay Disposal Services	NL-70	Carbonear
		Burin Peninsula Waste Management Corporation	98-103 Main Road, Suite 228 Father Berney Memorial Building Salt Pond	Burin
		Containerized Sanitation Ltd.	253 Carolina Ave	Stephenville
		Western Regional Waste Management	14 Main St #203	Corner Brook

	Green Bay Waste Authority	PO Box 116	South Brook
	Northern Peninsula Regional Service Board	173 West St #171	St Anthony
	Central Newfoundland Waste Management	Route 3-1-09	Norris Arm
	Murphy Brothers Ltd.	Watsons Pond Industrial Park	Corner Brook
	Pardy's Waste Management	30 Kyle Av	Mount Pearl
	Eastern Waste Management	255 Major's Path Suite #3	St. John's
	PBO Disposal Gander	26 McCurdy Dr	Gander
	Atlantic Waste Management Ltd.	12 Penway St	Corner Brook
	Codroy Valley Waste Disposal	P.O. Box 105	Doyles
	PBO Industrial Disposal Inc.	12 Duggan St	Grand Falls-Windsor
	Dump Commander, a division of Krown Property Investment Inc.	211 Lemarchant Rd	St. John's
	GFL Environmental	30 Eastland Dr	St. John's
	Bin There Dump That	113 Major's Path	St. John's
Manufacturer	Cape John Industries Ltd.	39 Shoecove Rd Suite 37	La Scie
	Spartan Industrial Marine	203 McGettigan Blvd	Marystown
	ESL Marine Supplies Ltd.	51 Clyde Ave	Mount Pearl
	Spartan Industrial Marine	1140 Topsail Rd	St John's
	North Atlantic Marine Supplies and Services Inc.	1237 Kenmount Rd Unit 2	Paradise
	Hampidjan Canada Ltd.	527 Conception Bay Hwy	Spaniard's Bay
	Mercer's Marine Equipment Ltd.	210 Marine Dr	Clarenville
Recycling	Southern Shore Recycling Depot	297-299 Southern Shore Hwy	Bay Bulls
	Hebert's Recycling Inc.	14 Clyde Av	Mount Pearl
	Ever Green Recycling	Waterford Bridge Rd	St John's
	Ever Green Recycling & Head Office	79 Blackmarsh Rd	St John's
	Maritime Recycling	275 Southside Rd	St John's
	Multi-Materials Stewardship Board	21 Kings Bridge Rd	St John's

		Robin Hood Bay Landfill & Recycling	340 E White Hills Rd	St John's
		MVP Recycling Ltd.	4 Woodland Rd	Port au Choix
		V O N Broadening Horizons Recycling Services	177 Elizabeth Dr	Gander
		Rodger's Group Of Companies	15 Churchill St	Happy Valley-Goose Bay
Que.	Disposal	Recubec Inc.	485 av Marien	Montréal-Est
		Stericycle Inc.	2700 Rue Jean-Pérrin	Quebec City
		Services Matrec Inc.	4365 Boul Saint-Elzéar O	Laval
		Jacques Ronaldo Camionneur Enr	28 Rue Laurentienne	Lévis
		Légaré Transport En Vrac	4004 Rte Jean-Gauvin	Quebec City
		Veolia Services à L'Environnement-Matières Résiduelles	787 boul de la Chaudière	Quebec City
		Stericycle Inc.	81 Rue Roch-Lecuyer	Saint-Remi
		RCI Environnement	9501 boul Ray-Lawson	Anjou
		Norbac Inc.	3 Rue Gaston-Gosselin	Blainville
		SOS Déchets Québec	200 Rue Plante	Saint-Nicolas
		Écocentre Hêtrière	3381 Rue de l'Hêtrière	Quebec City
		Écocentre des Rivières	1700 Rue Provinciale	Quebec City
		SOS Déchets & Conteneurs	4765 1re Ave	Quebec City
		Gestion CBC Inc.	1054 Boulevard Bastien	Quebec City
		Contenants Kelco Inc.	3128 Rue des Verdiers	Quebec City
		Écocentre Val-Bélair	1472 Rue Falardeau	Quebec City
		Écocentre Val-Bélair	1472 Rue Jean Bardot	Quebec City
	Incinerator	L'incinérateur municipal de Lévis	3451 Rue de Vulcain	Lévis
	Manufacturer	Les industries Fipec Inc.	304 Québec 132 Est	Hope Town
		Les industries Fipec Inc.	45 Rue du Parc	Grande-Rivière
		Le Marin Inc.	149 Rue Napoleon	Sept-Iles
		Neptune Marine	105 Rue Abraham Martin #200	Quebec City

	FILMAR Inc.	203-4217 Rue d'Iberville	Montréal
	L'Entrepôt Marine Inc.	379 Boulevard Harwood	Vaudreuil-Dorion
	Barry Cordage Ltd.	6110 boul. des Grandes Prairies	Saint-Léonard
	GROUPE BBH INC	4400 Hickmore	St. Laurent
Pyrolysis	Pyrowave Inc.	601-9500 Rue Meilleur	Montréal
Recycling	Ecocentre Beauportre	425 Boulevard Raymond	Quebec City
	RECYC-QUÉBEC	300 Rue Saint-Paul bureau 411	Quebec City
	La Société VIA	1780 Rue Provinciale	Quebec City
	SRS Environnement Inc.	377 Rue Dupuy	Quebec City
	Plasti-Bac Inc.	1520 Avenue des Affaires	Quebec City
	Écocentre Jean-Talon	1700 Boulevard Jean-Talon O	Quebec City
	Société VIA Inc.	1200 Rue des Riveurs	Lévis
	Service de Récupération Billy Bac	14 Rue des Goélands RR 2	Cap-Santé
	Gaudreau Environnement Inc.	1472 rue Provinciale	Quebec City
	Eco Conseil	256 ch du Domaine	Saint-Augustin-de-Desmaures
	Greenovative Solutions Inc.	8451 ch Dalton	Mont-Royal
Waste to Energy	L'incinérateur de la Ville de Québec	1210 boul Montmorency	Quebec City

APPENDIX F - CHAPTER 4 FOCUS GROUP QUESTIONS

GUIDING QUESTIONS

1. What gear do you lose most?
2. How much gear is abandoned or lost, and why?
3. On average, how much gear is replaced annually?
4. What percentage of gear is replaced from being lost?
5. What is done with old traps? Why? What about rope?
6. Where is gear abandoned, lost or discarded in each region, and why?
7. What prevents retrieving gear?
8. What limits proper disposal?
9. What are possible solutions to fishing gear waste?



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