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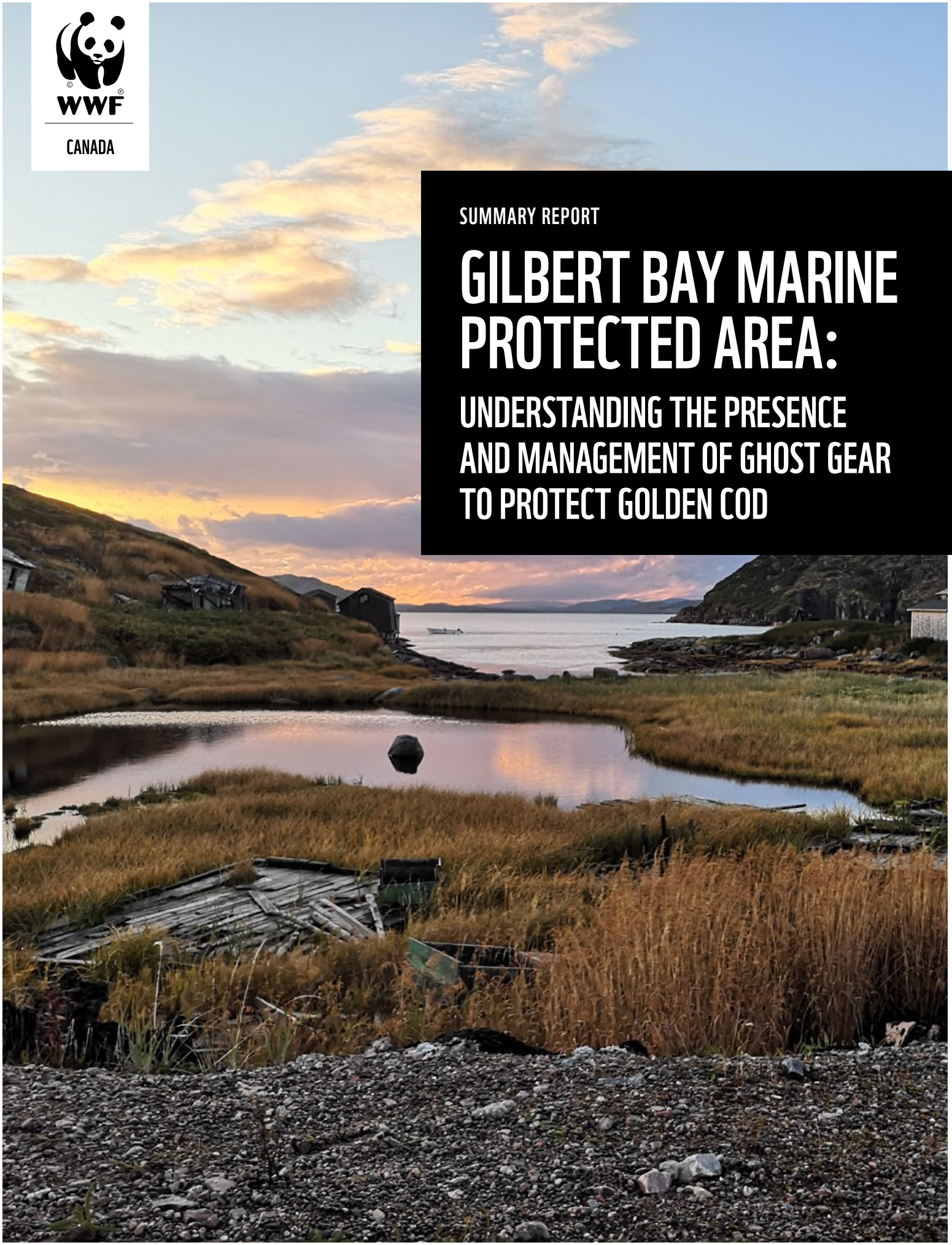

SUMMARY REPORT

GILBERT BAY MARINE PROTECTED AREA:

UNDERSTANDING THE PRESENCE AND MANAGEMENT OF GHOST GEAR TO PROTECT GOLDEN COD

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Article on traditional fisheries by Mallory Harrigan (fish harvester) and Clifford Russel (fish harvester)

Illustrated by Kayla Williams (Big Land Design)

ACKNOWLEDGEMENTS

We would like to acknowledge everyone who has helped the team throughout the course of this project. From conversations with community members to gear collection and sorting with fish harvesters, this work could not have been completed without the support of the people of NunatuKavut. Any contribution, big or small, towards this work has had a monumental impact on the community and marine conservation. We thank you for your service and hope the relationships made will continue to grow and foster a strong connection between fisheries and marine conservation. Nakummek.

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CONTENTS

INTRODUCTION

Oceans are an essential component of the global ecosystem and are a home to a significant amount of biodiversity, carbon-rich ecosystems, food and life.

Humans can create an imbalance in nature and cause harm to the marine environment. Climate change, pollution and habitat degradation are some of the primary threats to ocean life. Increases in plastic, ghost gear, and other marine debris within ocean waters can lead to the decline of important fish and other wildlife species as well as marine habitat generally.

The rich marine environment has provided a means of survival for Labrador communities, which are built around the ocean and have a strong fishing culture. The protection of marine wildlife and habitats is important to all members of the community, including fish harvesters, local residents, environmentalists, government representatives, elders and youth.

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Gilbert Bay
Marine Protected Area
St. Michael's Bay
Pensons Arm
Zone 1A
Zone 2
Gilbert Bay
Rexons Island
Zone 1B
Rexons Cove
Zone 3
Fishing Harbour
Denbigh Island
William's Harbour
Cartwright Island
Alexis Bay
Sandy Hook
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BACKGROUND

GILBERT BAY MARINE PROTECTED AREA

Gilbert Bay is a narrow inlet located on the southeast coast of Labrador (Figure 1), within the traditional territory of NunatuKavut. Gilbert Bay is a culturally significant region to the surrounding communities; members of those communities continue to carry out traditional activities such as hunting, fishing and trapping in and around the Gilbert Bay region. Gilbert Bay was designated as a Marine Protected Area (MPA) under the *Oceans Act* in 2005, after concerns were raised by the local communities of Port Hope Simpson and William's Harbour. They were driven to conserve this unique marine resource and protect a genetically distinct population of cod, known as the "golden cod" (DFO, 2007). The boundaries of the Gilbert Bay MPA are based on information collected on the areal extent of Gilbert Bay cod movement (Morris et al., 2003).

Figure 1. Gilbert Bay Marine Protected Area. Map © NunatuKavut Community Council Inc. Department of Environment and Natural Resources.

Following the resettlement of the community of William's Harbour in 2017, there are no longer any permanent residents living directly adjacent to Gilbert Bay. William's Harbour is still used in the summer by residents of surrounding communities and as a summer fishing station, but it no longer has permanent residents or support services. The closest communities to the MPA are Pinsent's Arm, located 6 kilometres (km) away and the community of Port Hope Simpson, which is located 16 km away.

Since its designation, the Gilbert Bay MPA has transitioned to co-management by NunatuKavut Community Council (NCC) and Fisheries and Oceans Canada (DFO) and has seen the development of two management plans with the third in progress (DFO, 2013). These plans serve as living documents, amended as required to best promote community priorities and ecosystem conservation. Each management plan covers a three-year period and outlines the conservation objectives of the MPA, as well as provides guidance on governance, management and stewardship actions (i.e., monitoring, enforcement, public education and outreach).

Ecological Significance

Gilbert Bay hosts a diversity of resident species. The waters of Gilbert Bay support a wide range of aquatic species, including shellfish; anadromous, pelagic and demersal fish; and several species of marine mammals and waterfowl (Table 1). Culturally important salmonid species (such as salmon, trout and char) can be found in the area and in the surrounding rivers. Major rivers which feed into Gilbert Bay include Shinneys Brook and the Gilbert River, which is met at the inner portion of the bay by a waterfall (Figure 2). Gilbert Bay is unique as it is the only location where a particular subpopulation of Atlantic cod has evolved — the golden cod (*Gadus morhua*). Golden cod have a different appearance to Atlantic cod, and they can survive the colder winters in the frozen inlets of Gilbert Bay. They can be found inside the bay all winter long, as opposed to Atlantic cod who move into deeper waters. The habitat in Gilbert Bay is ideal for golden cod to thrive, and this is where they spawn.

Table 1.
Some of the biodiversity supported by Gilbert Bay.

Species' Common Name	Species' Scientific Name
Arctic char	*Salvelinus alpinus*
Atlantic rock crab	*Cancer irroratus*
Atlantic salmon	*Salmo salar*
Canada geese	*Branta canadensis*
Capelin	*Mallotus villosus*
Cod (Atlantic, northern and golden)	*Gadus morhua*
Common loons	*Gavia immer*
Common mergansers	*Mergus merganser*
Greenland cod	*Gadus ogac*
Grey seals	*Halichoerus grypus*
Harbour porpoises	*Phocoena phocoena*
Harp seals	*Pagophilus groenlandicus*
Herring	*Clupea harengus*
Icelandic scallop	*Chlamys islandica*
Killer whales	*Orcinus orca*
Mackerel	*Scomber scombrus*
Minke whales	*Balaenoptera acutorostrata*
Polar bears	*Ursus maritimus*
Ringed seals	*Pusa hispida*
Rock cod	*Lotella rhacina*
Sculpin	*Myoxocephalus sp.*
Trout (brook and brown)	*Salvelinus fontinalis*
Winter flounder	*Pseudopleuronectes americanus*

Figure 2. Big Falls, also known as Gilbert Falls, is located where the Gilbert River enters the innermost portion of the Gilbert Bay Marine Protected Area (Zone 1).

Gilbert Bay also has a diverse benthic environment filled with urchins, corals, sponges and other benthic species that provide critical habitats and healthy marine ecosystems (Figures 3–5). The importance of conserving and protecting these critical habitats in Gilbert Bay was a major factor in its designation as an MPA. These environments play an important role in the establishment and continued support of the golden cod population (DFO, 2007). Specific areas within Gilbert Bay have been identified as important spawning areas and nursery habitats, such as the Shinneys shown in Figure 2.

Figures 3–5. Image captures from an underwater remotely operated vehicle show the benthic environment within the Gilbert Bay MPA. These images are not representative of the entire region.

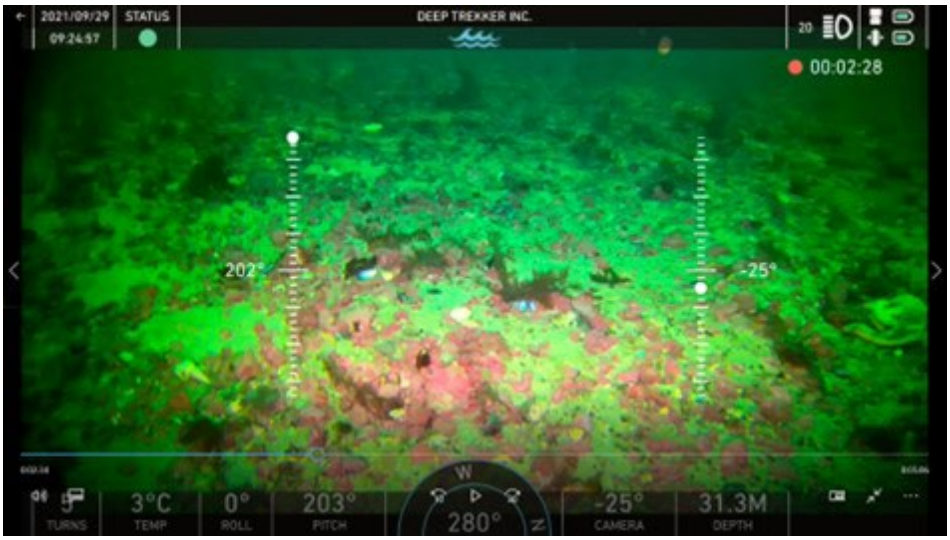

Figure 3

Figure 4

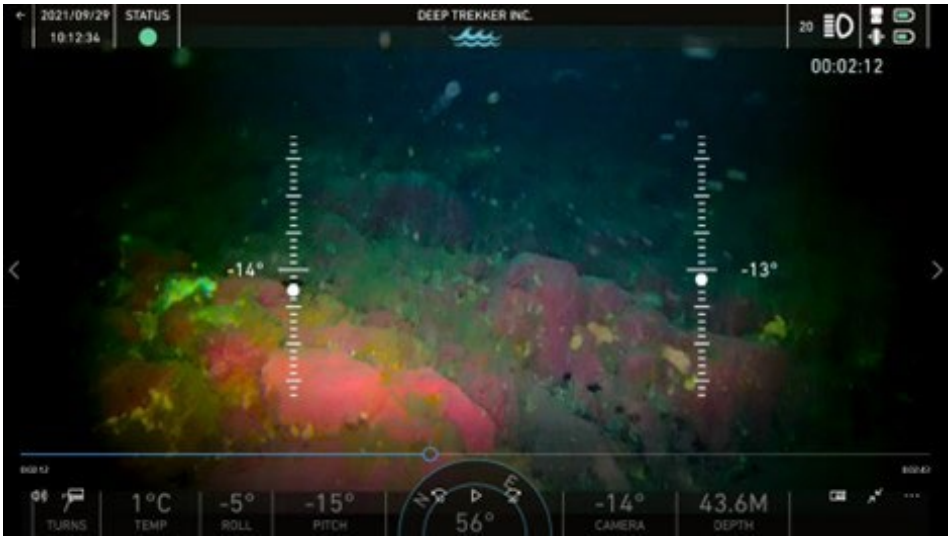

Figure 5

In order to meet the conservation objectives for which the MPA was created, regulatory and non-regulatory measures for conservation have been put in place under the management plan. The management plan focuses on four primary conservation objectives, one regulatory which is overseen by DFO and three non-regulatory which are the responsibilities of NCC.

Gilbert Bay MPA Conservation Objectives

- **Regulatory:** To conserve and protect the Gilbert Bay cod and its habitats.
- **Non-regulatory:** To conserve and protect the Gilbert Bay marine ecosystem.
- **Non-regulatory:** To promote scientific research opportunities that will benefit the marine ecosystem of Gilbert Bay.
- **Non-regulatory:** To promote public awareness and education of the Gilbert Bay MPA.

Figure 6. Ghost gear collected during retrieval efforts (2021–2023).

GOLDEN COD

The waters of Gilbert Bay are the spawning grounds of a genetically distinct population of cod – the Gilbert Bay cod or golden cod (Figure 7). Protection of the Gilbert Bay cod population and its habitats is the primary objective of the Gilbert Bay MPA.

Figure 7. Gilbert Bay cod, known locally as golden cod.

Golden cod are the dominant fish species within Gilbert Bay. Golden cod are locally adapted and can survive in conditions where other Atlantic cod may not. For example, golden cod increased in number during the 1990s while offshore northern cod did not. Protecting this type of biodiversity is important because it helps animals live as their environments change. The Gilbert Bay golden cod population has been studied for over two decades. With the skills and expertise of local people from William's Harbour and Port Hope Simpson, researchers from Memorial University and the DFO have been monitoring the numbers of golden cod, the environment in which they live and the impacts of fishing. Data collected over the last 20 years from golden cod implanted with acoustic tags shows that some of the large golden cod move outside the MPA each year starting in late June and return to the MPA in the fall. This makes them susceptible to removal by fishing activity outside the MPA boundary. The best ways to protect golden cod are those that also strive to protect the livelihoods of local people and fish harvesters.

Measures in place thanks to the MPA designation have aimed to reduce the mortality of golden cod and to give the population a chance to regenerate with regulations and suggestions for adaptations to promote conservation. Examples of such adaptations include increasing the use of live-catch fishing gear adjacent to the MPA and removing end of-life fishing gear (otherwise known as ghost gear) in and near the Gilbert Bay area. Researchers, together with local harvesters and members of the Gilbert Bay Advisory Committee, have been studying these adaptations to see how effective they might be. This includes conducting a study to compare the catch rates of cod pots and gillnets, the survival of cod released from cod pots and possible ways to increase the proper disposal of end-of-life fishing gear, as detailed further in this report.

The best way forward for conservation of golden cod is a solution that considers both the protection of golden cod and the livelihoods of fish harvesters. With increased staff and technical skills, NCC is taking on a greater role in the management of the Gilbert Bay MPA and strives to include input and participation of NunatuKavut Inuit and resource users in all aspects of this management.


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TRADITIONAL FISHERIES IN SOUTHERN LABRADOR

Over the years, fishery practices have changed in Southern Labrador. Monumental changes were made during the cod fishery moratorium. Almost 500 years of fishing activity in Newfoundland and Labrador were ended as the Canadian government imposed a moratorium on the northern cod fishery in 1992, in hopes that it would allow the species to repopulate (Higgins, 2008). Before the moratorium, fish harvesters in the province caught cod in inshore and offshore waters with the use of large gillnets, box-shaped cod traps and longlines (Higgins, 2009).

To better understand the impact fisheries can have on golden cod and the Gilbert Bay MPA habitat, we need to further understand traditional fishery practices. This will enable us to enhance the collaborative process for developing effective solutions to marine conservation issues. Traditional culture is a strong part of Southern Labrador communities and is preserved by community groups, heritage, traditional practices and storytelling.

Clifford Russel, a Northwest Atlantic Fishery Organization (NAFO) harvester, spoke to Mallory Harrigan about a memory from his past when he used to fish with cod traps. Mallory Harrigan wrote the following about his experience and the cod trap fishery practice:

For many fish harvesters, the cod trap fishery is reminiscent of family. Cliff Russell was raised in William's Harbour where his roots in the fishery run deep.

"I'd fish with my cousin and my father, and we teamed up with my uncle for a couple of years."

Traps needed a larger crew to manage, at least two boats, and to be set properly. In the years before the moratorium, small communities were thriving, and families were much larger. Russell had been trap fishing with family members since he was 15, up until the moratorium in 1992.

"We didn't do a very good job," he says with a laugh, as he tells me about fishing with his cousin as young teens. "We used to be really slow haulin', and I think we used to lose a lot of fish over the heads and cut, but we used to do okay."

Russell also fished alongside his father, Howard, who, as cod stocks began to decline, moved on to a job at NL Hydro to support the family while Cliff continued to fish traps.

"Dad used to help me set them, 'cause you needed two boats, but I'd haul them myself once he went on to work."

The fishery was slowing down by the time Russell really got into using traps, but one story in particular stands out to him, from his teenage years when he was eager to have some time off on the weekend.

"I remember one day we had a trap out, and it was on a weekend, which is why I remember it so good. We went over to haul the trap across the bay. When we started haulin' it up, we could feel the fish tuggin' when we first got the cut up. We knew there was a lot of fish then. When we started to haul, we got a bit farther, and the fish started to mesh, trying to swim out through and getting caught, and if that happens you know there's a lot of fish in the trap. So, when we got to the trap, we started dryin' it up. We only got the foot ropes all aboard, and the net was full. We filled up the boat — we were only in a speedboat — but we filled her to the gunnels. There was a couple thousand pounds for sure, and we never even put a dent in how much fish was in it. I was happy we had a good haul, but I was disappointed 'cause I never got to go out that weekend.

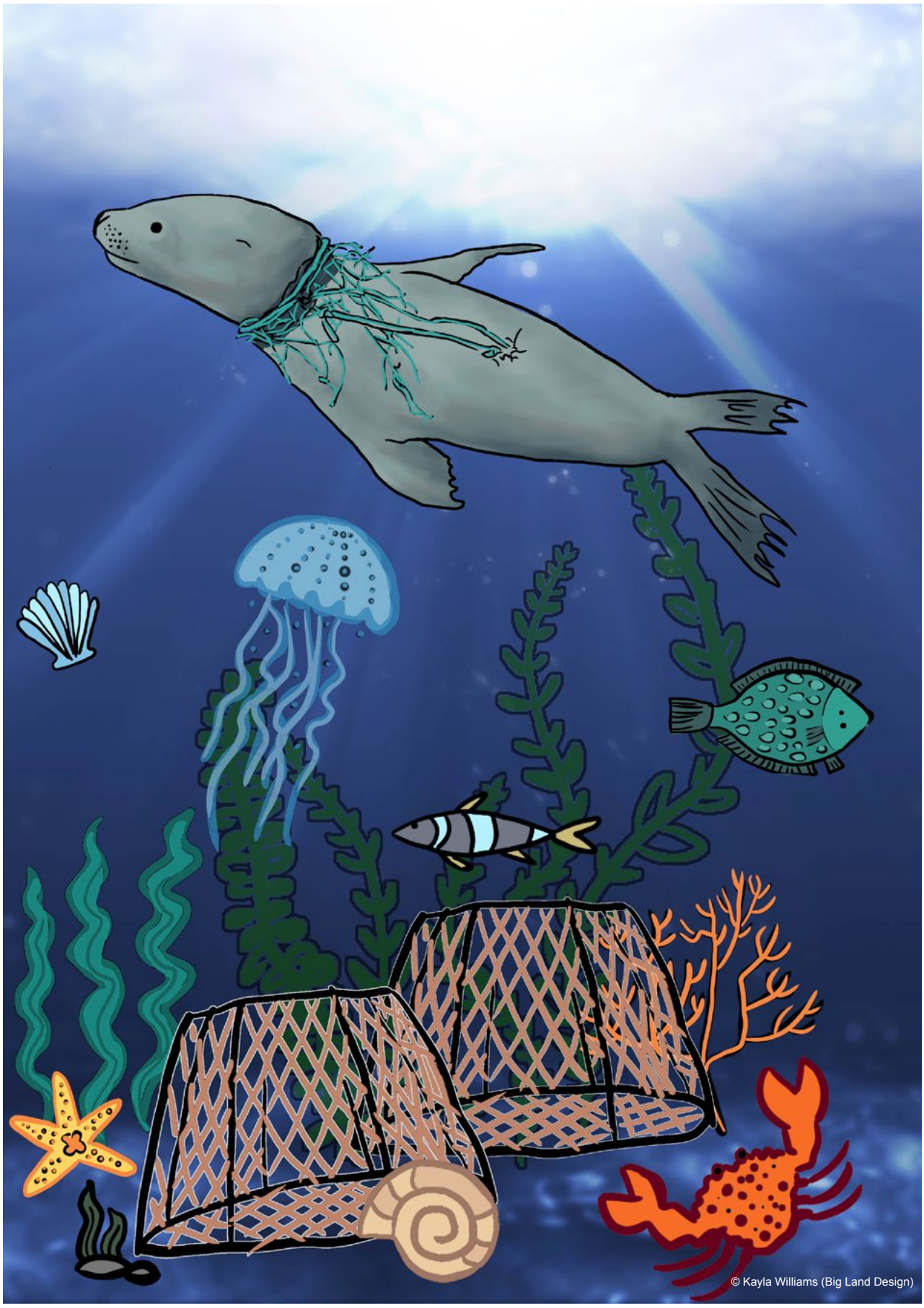
"We just took what we could, started pickin' the big fish out to take in, and I wanted to tie it up and go back the next morning and get it. You could tie the trap off and the fish would stay inside and still be alive. Dad said, 'No, we'll let it go down,' thinking the fish we had would stay, and new fish would bring her full again. Well, when we went back the next morning, she was nearly empty. No new fish, and the ones we got had just about all swam out. It was disappointing, but it was no harm done. It just goes to show how sustainable trap fishing is. If you had your quota almost caught and ended up with too big a haul, you'd just put it back into the water and it'd swim off unharmed. If that was a gillnet, it'd all be dead, so you'd either have to keep it and get in trouble for going over or throw it out and waste all that fish."

Not only is trap fishing more sustainable but the quality of fish is also much better. When fish die in the gillnets before getting hauled up, other species will eat those fish while trapped. Toad crab and sea lice are a menace to net fish in certain areas, causing the price of fish to be cut in half for harvesters. Sometimes they're too far gone and must be discarded.

"There are pros and cons to every method, but it's definitely worth opening up the conversation," Russell says.

Finding a crew for trap fishing can be difficult, especially for harvesters who travel back to resettled areas to fish. Although not as sustainable, gillnets are more affordable and easier to set with a smaller crew. Cod season often stretches into the fall, where fish are in deeper water and traps create a lot more work for a much smaller catch rate.

"Maybe in the future, we can find a way to modify traps so they're easier for smaller crews to set and haul. There was research into it, but when the moratorium happened, it stopped. Hopefully we can open the conversation on it. Giving fish harvesters the option to use traps would be a great opportunity to make the fishery more sustainable."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GHOST GEAR

Abandoned, lost and discarded fishing gear (ALDFG), also known as ghost gear, is fishing gear that is lost or discarded at sea. Some loss of fishing gear from commercial fisheries is inevitable (Drinkwin, 2022). An estimated 600,000 to 800,000 metric tonnes of ghost gear enter the world's oceans each year (Macfadyen, Huntington, & Cappell, 2018). Ghost gear causes environmental and ecological harm by continuing to capture harvestable fish stocks and other marine organisms after it has been lost. Of the species caught by ghost gear, 90% are of commercial value, thereby causing economic losses for the fishing industry, damage to marine ecosystems and entanglement marine mammals (GGGI, 2021; NOAA, 2015). In addition to "ghost fishing," ghost gear can lead to macro and micro plastic pollution in marine environments.

Many harvesters indicated that disposal of fishing gear at sea is uncommon, but it does happen. However, there are cases where gear disposal at sea seems to be prevalent, often due to the perceived minimal or non-existent environmental impacts of doing so, lack of disposal options or a combination of these factors (Dawe et al., 2021).

Some harvesters indicated that they do not want to set or haul their gear in poor weather or ocean conditions, but that it is not always possible due to the fishing season and quotas. For example, fish harvesters may have to start fishing when the season opens and sea ice is still present, or they risk the quota being caught and the fishery closing before the ice disappears. Additionally, harvesters also indicated that technological advances have reduced gear loss over the past 30-plus years. Better quality gear is less likely to wear and break; improved forecasting means that harvesters are better able to protect their gear from loss in harsh conditions; and harvesters mark the location that they set their gear with their personal GPS, so they know where to look if gear is lost.

Gillnets and crab pots are the most common type of gear that continue fishing (ghost fish) when lost or discarded (NOAA, 2015). Gillnets are set vertically in the water column and consist of a monofilament (plastic) net with weights at the bottom and floats at the top. Gillnets are a passive type of fishing gear: they are set and left to fish for a period of time before they are retrieved.

This period of unmonitored fishing makes them more susceptible to becoming lost, where they can do significant harm, as the monofilament nets do not degrade (NOAA, 2015). The level of harm caused by lost gillnets is influenced by currents, tides and water depth as these factors influence the openness of the net as it drifts through the water column. Lost nets in shallow waters with stronger tide and current conditions will ball up more quickly than those in deeper water with less tidal and current influence. A net that remains open is likely to continue fishing (NOAA, 2015). The monofilament used in gillnets is very difficult for marine organisms to see in the water, so it continues to entrap them. Furthermore, nets can continue to fish for the life of the material; those buoyant in the water column impact pelagic species, while nets on the sea floor impact benthic species (GGGI, 2021).

A gillnet lost or discarded in shallow water may only ghost fish for months, while one lost in deeper water can continue to fish for years. The rate of ghost fishing tends to decline over time as marine organisms like algae begin to grow on the nets (biofouling), which increases the visibility and decreases the catching ability of lost nets (NAFO, 2015). Hareide et al. (2005) found that gillnets used in coastal waters of less than 200 metres (m) are not considered to be a significant problem for ghost fishing, while those fishing in water depths of greater than 500 m were much more likely to be lost due to larger net lengths, longer soak times and gear stress.

Crab pots used to fish snow crab consist of a conical steel frame covered with netting. Multiple pots are set on the sea floor connected by groundlines, with lines attached to buoys at the surface that are used for retrieving gear (NOAA, 2015). Smaller conical pots are also used in the toad crab and whelk fisheries, though whelk pots can also be made from plastic. Gear is most often replaced due to wear, rather than loss. Gear loss accounts for only a small portion of replacement, though storm events can lead to significant gear loss.

There is significantly less data on gear loss and fishing mortality for longline, jigging and bottom trawl fisheries (NOAA, 2015). However, it is known that longlines can continue to fish once lost and can cause mortalities by entanglement and hooking. Longlines consist of fishing lines with baited hooks, which can snag on the seabed and break off (Figure 11). The Global Ghost Gear Initiative states that "the extensive use of longlines, their often extremely long-set configuration, and relatively low cost means that the overall quantity of longlines lost is likely to be high" (GGGI, 2021).

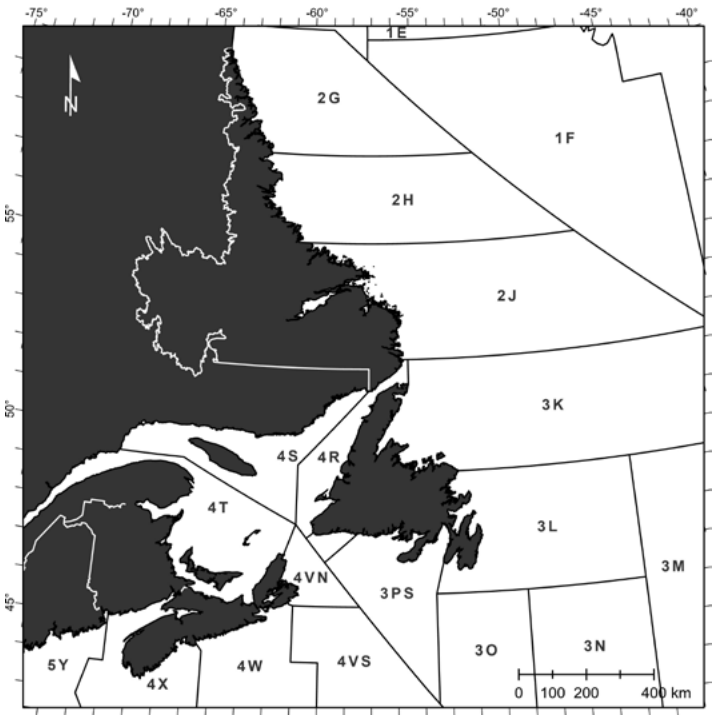

Figure 8. Northwest Atlantic Fishery Organization (NAFO) divisions for Newfoundland and Labrador fisheries. Map © Benjamin Misiuk.

PROJECT GOAL AND OBJECTIVES

This project was a collaboration between WWF-Canada, NunatuKavut Community Council (NCC) and the Fisheries and Marine Institute of Memorial University of Newfoundland (MI) to mitigate the impacts of fishing on golden cod and other vulnerable species within and adjacent to the Gilbert Bay Marine Protected Area (MPA).

Gilbert Bay was designated as an *Oceans Act* MPA in 2005 to protect golden cod. Despite MPA protection measures, the golden cod subpopulation is experiencing steep decline. The MPA monitoring program results show a 95% decline in Gilbert Bay cod biomass since the reopening of the 2J stewardship and recreational cod fisheries in 2006 (Janes et al., 2009). Figure 8, the NAFO fishery map, shows the location of the 2J region (a geographical area where the fishing activity is regulated by NAFO). Given the regulatory complexity of the 2J cod fishery and the Gilbert Bay MPA, the partners aimed to create an alternative solution to balance economic fishing interests with MPA conservation objectives.

The goal of this project was to reduce fishing mortality of golden cod by reducing ghost gear catch and bycatch within the 2J stewardship fishery and to investigate alternative solutions to end-of-life fishing gear and ghost gear management. This project also ultimately benefitted other aquatic species at risk in Gilbert Bay that are incidentally encountered as bycatch in gillnets or entangled in discarded ghost gear including lumpfish, Atlantic sturgeon, white hake, harbour porpoise and killer whale. The project's goal was accomplished through the following project objectives:

- Increase knowledge of methods to identify and retrieve ghost gear;
- Reduce the ghost gear within Gilbert Bay;
- Support the Gilbert Bay MPA regulatory conservation objectives, namely the conservation and protection of the Gilbert Bay cod and its habitats;
- Support the Gilbert Bay MPA non-regulatory conservation objectives, namely the conservation and protection of the Gilbert Bay ecosystem; the promotion of scientific research opportunities on the Gilbert Bay ecosystem; and the promotion of public awareness, education and support of the Gilbert Bay MPA;
- Determine economic benefit of ghost gear management efforts;
- Determine feasibility of various ghost gear adaptive management strategies;
- Enhance public awareness of ghost gear and species at risk issues, while engaging fishers and community members; and
- Benefit the marine environment and species at risk via reduction of plastic pollution, gillnets, ghost fishing and entanglement.

GHOST GEAR INVESTIGATIONS AND RETRIEVALS

Through a collaborative effort, WWF-Canada, NCC and MI coordinated the ghost gear investigation and retrieval efforts. The project aimed to remove ghost gear to reduce unintended bycatch of vulnerable species adjacent to the Gilbert Bay MPA. This was accomplished through the following activities:

- Characterize and assess ghost gear presence and impacts in the study area;
- Collect traditional knowledge of local practices and perceptions concerning ghost gear, target areas, challenges with disposal of end-of-life gear and motivating factors needed to improve current discard practices;
- Develop and share solution-oriented education and outreach tools to build local expertise and capacity;
- Identify, determine feasibility and consult on options for more sustainable gear practices;
- Identify determine feasibility and consult on innovative options and priorities for gear retrieval;
- Retrieve, sort and dispose of end-of-life fishing gear; and
- Investigate options for local recycling mechanisms, gear disposal and storage, and partnerships to create new products from end-of-life and recovered fishing nets.

Figure 9. Crew members analyze live ROV video capture while investigating a potential sea-based ghost gear hot spot.


"Collecting ghost gear is a must in these communities."
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CONSULTATIONS

Methods

Fifteen knowledge holder interviews were completed by the project's MI master's student, Cameron Pye, in order to gather knowledge related to historical ghost gear locations in and around Gilbert Bay MPA (which included a mapping component), as well as other crucial information related to the project. Interview questions were constructed with Alexa Goodman of the Fishing Gear Coalition of Atlantic Canada (FGCAC), while knowledge holders were selected with NCC and contacted by phone and/or email.

Due to COVID-19 protocols, interviews could not be conducted in person; they were conducted and recorded online over Zoom. Interview questions followed a semi-structured format, and qualitative data was analyzed and coded using NVivo qualitative software. The interviews also featured a participatory mapping component using Google Earth where knowledge holders could indicate ALDFG "hot spots." For those without online access, physical charts, which were distributed and collected by NCC personnel, were used to collect data.

Figure 10. Ghost gear collected during retrieval efforts (2021–2023).

Knowledge Holder Interview Analysis (2021)

Interview questions focused on the knowledge holders themselves and their insights and experiences with Gilbert Bay MPA, as well as questions specifically about ghost gear, which included personal encounters and insights with ALDFG and other gear-related matters.

In terms of those interviewed, a mix of commercial fishers and those involved in fisheries management associated with the Gilbert Bay MPA were selected. Species encountered in Gilbert Bay by these knowledge holders included a wide variety of finfish, shellfish, marine mammals, terrestrial mammals, shorebirds, seabirds and other invertebrates.

When asked if ghost gear was believed to be a current issue within Gilbert Bay, no knowledge holders said that it was. Several believed it could be a potential issue, while one knowledge holder believed it had been an issue in the past. Ghost gear wasn't believed to be a problem largely because of the increased activity of commercial scallop draggers post-moratorium. Knowledge holders stated that any fishing gear lost pre-moratorium (e.g., gillnets, traps, etc.) was likely to have been dragged up in areas where scallop draggers were operating. Knowledge holders also cited the limited historical use of fishing gear and overall activity within the Gilbert Bay MPA.

Most knowledge holders reported encountering ghost gear in the past, with fishing nets for finfish and seals being the most frequently mentioned gear. Other gear encountered included crab pots and trawl lines. More than half of those who encountered ghost gear reported bycatch of target or non-target species, which included various species of finfish (such as Gilbert Bay cod), seals and invertebrates. Those who encountered gear reported retrieving it and bringing it ashore, where gear was either burned directly or disposed of in a landfill. Just over half of knowledge holders also reported leaving or releasing gear back into the water due to poor conditions, lack of retrieval equipment and/or inadequate time and storage space. Only a few reported these encounters to third-party groups, such as NCC and DFO, due to the lack of regulatory conditions to report or retrieve gear at the time.

Most knowledge holders reported that they had lost gear in the past, including scallop buckets, gillnets and whelk pots. Reasons for loss depended on gear type. Scallop buckets were typically lost during drags due to rough bottom conditions snagging the buckets. Retrieval attempts included "creeping" for gear: graplins were dragged along the bottom to hook into the lost scallop buckets. Gillnet loss was typically due to ice movement, rough seas and swells that caused the lines to chafe from strain, tangle up and become dislodged. Whelk pots were lost due to deep-water conditions and by scallop draggers unknowingly towing pots away.

To prevent and mitigate gear loss, knowledge holders mentioned several methods, including using sufficient lengths and sizes of ropes and lines, efficient gear marking systems and biodegradable materials to shorten the lifespan of ghost gear. Knowledge holders stated that gear loss is extremely rare in the Gilbert Bay MPA and that fishers do not want to lose gear as gear and retrieval equipment are expensive.

ALDFG retrieval barriers reported by knowledge holders included a mix of physical (rough water, bottom type), economic (funding, cost of retrieval equipment) and political factors (permitting, season timing).

In terms of personal end-of-life gear management, most knowledge holders reported burning or disposing of end-of-life gear in landfills. Burning appeared to be more common in the past, while landfill disposal appears to be the more common choice today. Old and damaged webs are removed from gillnets and destroyed via incineration or landfill disposal. Other gillnet components (headropes, footropes, floats, lines), if in good condition, are reused in combination with new gillnet webs. Metal frames from crab pots and scallop buckets are reused or melted down into iron for other applications.

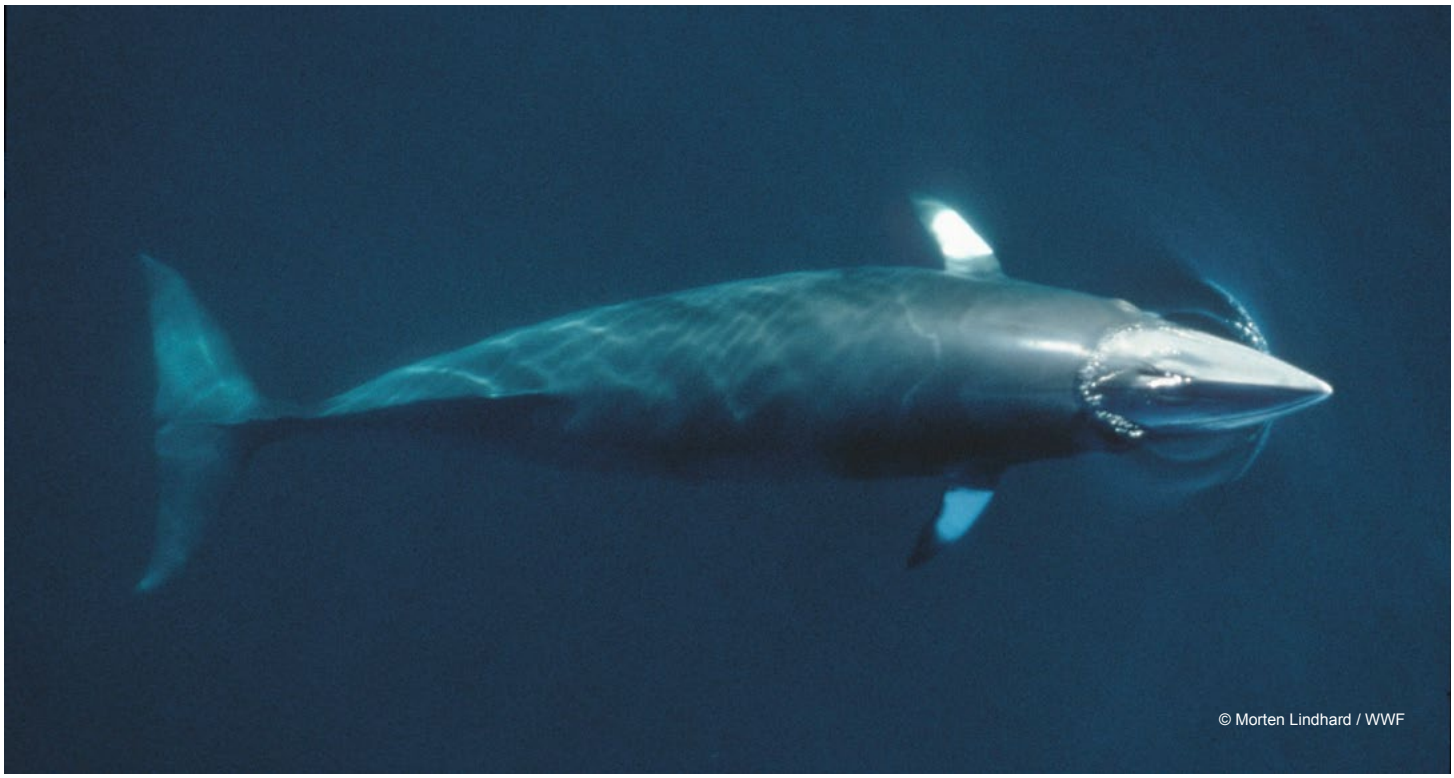
Most knowledge holders did not believe people intentionally discard gear at sea as it could impact marine life and subsequently impact people's livelihoods for those dependent on the fisheries. Only a few had heard talk of people discarding gear at sea in Gilbert Bay, while one had actively seen it in the past.

Knowledge holders were asked for further suggestions on gear retrieval equipment. Suggestions included using graplins to "creep" for gear, gurdies to remove fishing nets from the water, as well as using a combination of longliners and speedboats to tackle different areas. Several knowledge holders did not provide any additional suggestions, stating that the likelihood of encountering ghost gear was low and any additional equipment required for removal was unnecessary.

Economic opportunities for end-of-life gear aligned closely with personal management methods practiced by knowledge holders themselves. These included reusing or selling fishing gear components (e.g., ropes, floats) to other fishers, and using the metal from crab pots as graplins as well as hooks from gaffs and cod jiggers. Other economic opportunities included using twine from cod traps and gillnets as drying flakes and security material, as well as creating and selling arts and crafts items, such as floor mats, doormats, ornaments and bracelets. Plastics as a fuel source and recycling opportunities with fishing rope were also mentioned. Some knowledge holders did not see any potential for end-of-life gear.

Reporting and retrieval incentives for ghost gear included cash rewards for gear collected, as well as raising awareness of the impacts of ghost gear to further encourage people to report it. Interestingly, several knowledge holders stated that they would not personally retrieve gear due to possible legal trouble from DFO. Several knowledge holders stated that if they encountered or captured gear unintentionally, they would place it ashore to remove it from the water. DFO and NCC were mentioned as groups that could aid in the reporting and retrieval of ghost gear.

Other comments regarding the Gilbert Bay MPA and the Gilbert Bay cod included the increasing number of cabins being constructed, as well as concern for land-based gear from collapsing stages in and around the MPA, a notable issue observed and reported in and around the MPA. Additionally, knowledge holders expressed their concern about decreased prey sources for golden cod, primarily capelin, and increased abundance of predators, such as seals. Some stated that historical overfishing of golden cod had decreased the population, while others argued against this sentiment, stating that the numbers have continued to decline despite decreased commercial fishing outside the MPA and restricted commercial fishing inside the MPA post-moratorium.

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GHOST GEAR SURVEYS

Potential ghost gear hot spots within the Gilbert Bay MPA identified through knowledge holder interviews were mapped in Google Earth and used as navigational data for ghost gear investigations (using the Raymarine device). A finalized map of these ghost gear hot spots was created through ArcGIS software (Figure 11).

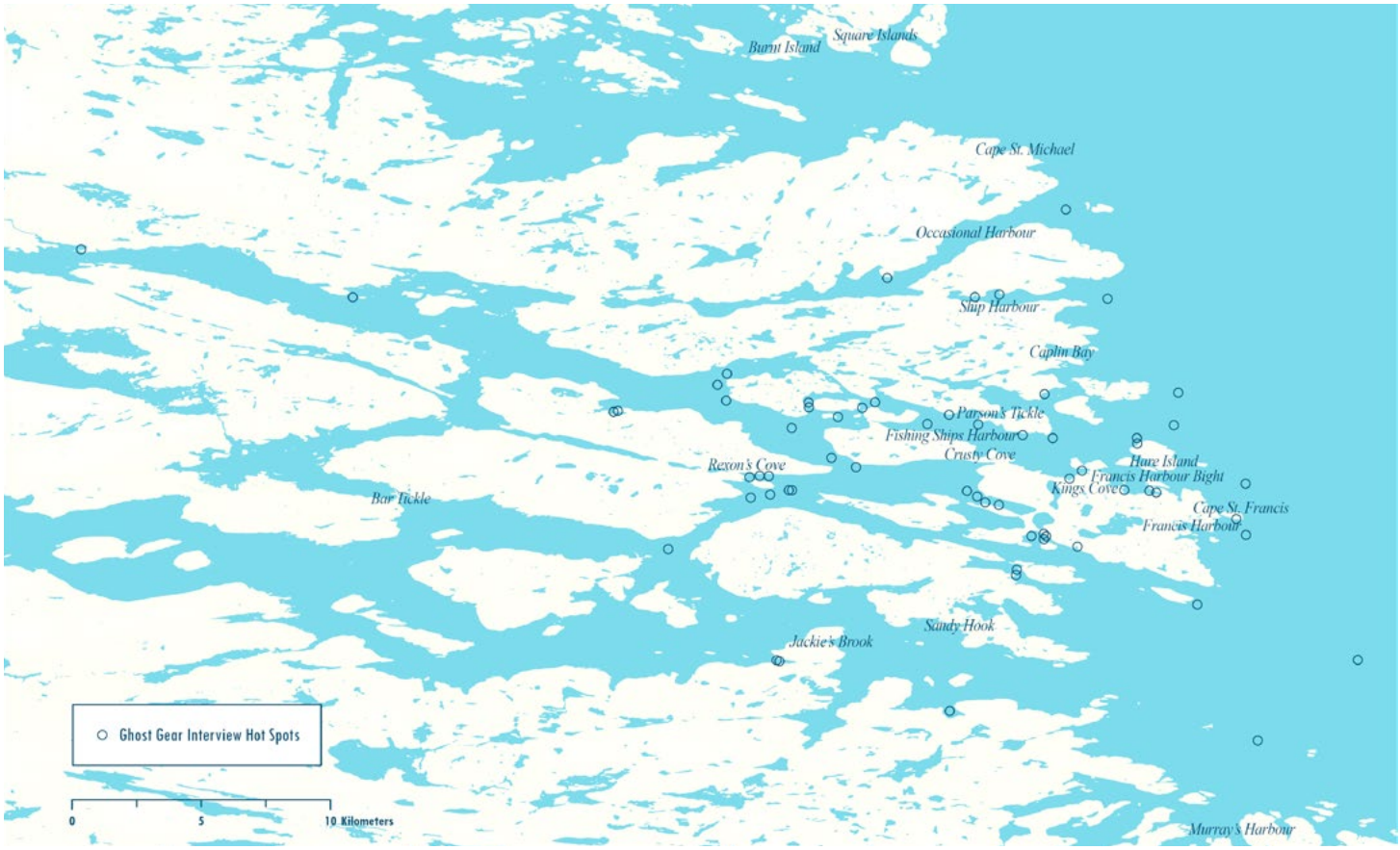

Figure 11. Ghost gear hot spots identified through knowledge holder interviews conducted in 2021. Map © NunatuKavut Community Council Inc. Department of Environment and Natural Resources.

Methods

Sixty-three identified sea-based sites were thoroughly investigated with the use of a side-scan sonar (Raymarine Element 12 HV) with an adjustable mount and a Deep Trekker marine remote-operated vehicle (ROV) camera with a grapple and cutter attachment. The side-scan sonar was running while completing transects over each individual sea-based site. Crew members examined the sonar imagery produced on screen, in real time, for potential ghost gear. The ROV was then deployed at each sea-based site, regardless of the sonar results, to investigate the sea floor thoroughly with the underwater camera. The real-time video capture produced from the ROV was examined to identify aquatic habitat features and any potential ghost gear. Figure 9 shows crew members using ROV technology.

Retrievals were conducted on charter-operated vessels, which included a longliner, a 21-foot speedboat, and a 28-foot Silver Dolphin patrol vessel. The longliner was equipped with a mechanical pot hauler and winch and grapple system.

Ghost gear was retrieved from two of the sea-based sites. Additionally, as the sea-based sites were investigated, the team realized there was a large amount of ghost gear that had been abandoned, discarded or lost on land (along shores, on wharves and within old and collapsing stages). A second visual survey was completed in priority areas, which identified 17 locations where land-based ghost gear was present. These sites were mapped with ArcGIS, as shown in Figure 12. This survey was conducted on vessel and used crew sight and cameras to detect land-based ghost gear. In the final year of the project, new methodology (use of the DJI Mavic 3 aerial drone) was tested to detect other land-based sites.

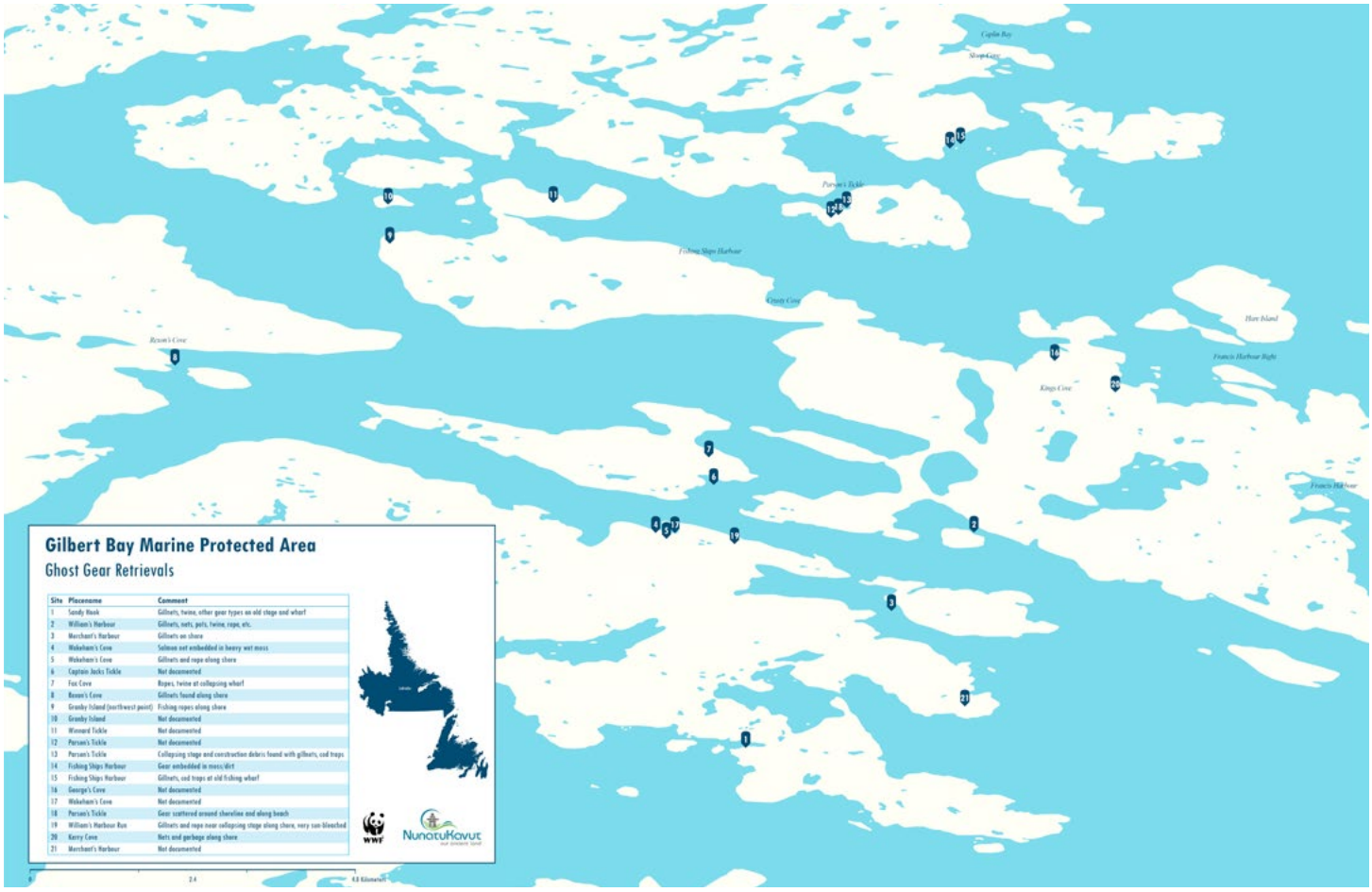

Figure 12. Map of ghost gear retrievals conducted within and around the Gilbert Bay MPA. Map © NunatuKavut Community Council Inc. Department of Environment and Natural Resources.


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GHOST GEAR COLLECTIONS

An approximate total of two tonnes of ghost gear was retrieved from all identified sites throughout the duration of this project. Retrieval sites include two shallow sea-based sites and 19 land-based sites. Table 2 outlines all sites where ghost gear was retrieved and includes site location and general gear types.

The main gear type collected through gear retrievals was gillnet, followed by crab pots. Gillnets were retrieved primarily in an old, destroyed, tangled and/or brittle state. Most crab pots retrieved were in an old and destroyed condition as well. Some retrieved cod traps were found in decent condition. In addition to these gear types, salmon nets, trawl and various pieces of net and/or rope were retrieved. In several instances, gear left on land was sun-bleached and disintegrated upon collection. Figures 6, 10, and 13 illustrate some ghost gear collected. The impact of microplastic pollution on the marine environment became a major concern to crew members and could warrant the study of microplastic pollution in water and marine wildlife within the Gilbert Bay MPA in the future.

Figure 13. Ghost gear collected during retrieval efforts (2021–2023).

Table 2. Ghost gear collected from all retrieval sites throughout the duration of the project.

Site	Latitude	Longitude	Date Identified	Date Retrieved	Location	Gear Type Retrieved
1	52.52799	-55.79616944	01/10/2021	13/08/2022	Sandy Hook	Gillnets, twine, other gear types on old stage and wharf
2	52.5568	-55.76561111	01/10/2021	10/2021	William's Harbour	Gillnets, other nets, pots, twine, rope, etc.
3	52.5463	-55.77665556	01/10/2021	10/2021	Merchant's Harbour	Gillnets on shore
4	52.55573	-55.80617778	01/10/2021	10/2021	Wakeham's Cove	Salmon net embedded in heavy wet moss
5	52.55646	-55.80571667	30/09/2021	10/2021	Wakeham's Cove	Gillnets and rope along shore
6	52.56318	-55.80046389	01/10/2021	10/2021	Captain Jacks Tickle	Not documented
7	52.56688	-55.80111111	30/09/2021	13/08/2022	Fox Cove	Ropes, twine at collapsing wharf
8	52.57916	-55.87261944	01/10/2021	10/2021	Rexon's Cove	Gillnets found along shore
9	52.59548	-55.84384444	30/09/2021	10/2021	Granby Island (northwest point)	Fishing ropes along shore
10	52.60072	-55.844075	30/09/2021	10/2021	Granby Island	Not documented
11	52.60095	-55.82194722	30/09/2021	10/2021	Winter Tickle	Not documented
12	52.59894	-55.78475278	30/09/2021	10/2021	Parson's Tickle	Not documented
13	52.60025	-55.78266667	30/09/2021	10/2021	Parson's Tickle	Collapsing stage and construction debris found with gillnets, cod traps
14	52.60822	-55.76882778	30/09/2021	27/10/2022	Fishing Ships Harbour	Gear embedded in moss/dirt
15	52.60881	-55.76740278	30/09/2021	27/10/2022	Fishing Ships Harbour	Gillnets, cod traps at old fishing wharf
16	52.57979	-55.75479444	30/09/2021	10/2021	George's Cove	Not documented
17	52.55631	-55.806043	11/08/2022	12/08/2022	Wakeham's Cove	Not documented
18	52.5993	-55.783759	11/08/2022	15/08/2022	Parson's Tickle	Gear scattered around shoreline and along beach
19	52.55526	-55.797677	11/08/2022	12/08/2022	William's Harbour Run	Gillnets and rope near collapsing stage along shore, very sun-bleached
20	52.57558	-55.746666	11/08/2022	12/08/2022	Kerry Cove	Nets and garbage along shore
21	52.53355	-55.76682778	11/08/2022	13/08/2022	Merchant's Harbour	Not documented

All gear retrieved throughout the duration of the project was stored in a sea can in Port Hope Simpson (on NCC property). A scale was used to weigh total amounts of collected ghost gear. Some rope, gillnet and cod trap were found in decent condition; this ghost gear was sorted into different bags or containers and used in repurposing practices or recycling initiatives, as noted in the Ghost Gear Management section below. Ghost gear that was found in unusable state for either repurposing or recycling was transported to a waste disposal facility to be landfilled.

GHOST GEAR MANAGEMENT

A primary objective of this project was to investigate innovative and effective solutions for ghost gear management. One portion of tackling the ghost gear issue is investigation and retrieval; however, those efforts act as temporary solutions to the greater picture. Effective strategies to prevent ghost gear from entering marine habitats and to manage end-of-life fishing gear sustainably are areas where more focus is needed.

Two feasibility studies regarding ghost gear management in Newfoundland and Labrador and potential port infrastructure improvements in Southern Labrador were conducted. The report "Abandoned, Lost, and Discarded Fishing Gear Management in Newfoundland and Labrador" expands on and summarizes the existing knowledge on abandoned, lost and discarded fishing gear (ALDFG) and its end-of-life management in Newfoundland and Labrador; this report includes six chapters. "Feasibility Study and Action Plan for Responsible Disposal of Ghost Gear and Improved Port Infrastructure in Newfoundland and Labrador" reviews existing port infrastructure resources, ghost gear management practices and ghost gear disposal and recycling options available to target communities in Southern Labrador. These feasibility studies can be found in Appendices A and B.

All ghost gear collected from retrieval efforts was transported to a holding facility in Port Hope Simpson (Figure 14). It was then sorted and processed for either landfill (disposal), recycling (gillnet recycling pilot program) or repurposing (crafts and artist-led workshop).

Figure 14. Ghost gear sorting and processing in Port Hope Simpson on NCC property.

RECYCLING

WWF-Canada contracted Seaside Apparel and Recycle on the Rock (ROTR) to conduct a gillnet recycling pilot program in 2022. The program is expected to be completed Spring 2023. This program's objective is to determine whether the monofilament plastic from gillnets can be recycled into various products. This pilot program is vital to ghost gear management as there is currently no means to recycle gillnet in Atlantic Canada. Gillnet was the most common gear type retrieved during ghost gear investigations. Gillnets were also identified by fish harvesters as a nuisance and one of the more unsustainable gear types. The outcome from this gillnet recycling pilot program, with its potential means to recycle monofilament plastic webbing, has significant applications for both ghost gear and end-of-life fishing gear, as fish harvesters usually replace the monofilament webbing on their gillnets every few years.

To test the viability of recycling gillnet, ROTR had to accomplish four main tasks: transport the gear from the gear storage point (Port Hope Simpson) to the ROTR recycling workshop in Colliers; wash the gear to remove dirt and marine debris; cut or shred the gear into small manageable pieces; and melt the plastics without excessive burning to use in a sheet press machine in a way that leads to the creation of new products. As this was a small-scale pilot project, each of these steps had to be accomplished with as little capital expenditure as possible.

Washing the ghost gear is one of the most challenging steps of the recycling process. The gear is usually covered in marine debris and bio foul. For the long term, a multi-step cleaning process involving a large industrial shredder will be necessary. For the purposes of the pilot project, the washing was done with two methods: using a pressure washer, stock tank and appropriate cleaning solutions; and leaving the gear outside to be cleaned via natural weathering. ROTR used a large shredder and two new tools (electric pruners and band saw with a knife blade) to cut the nets and rope into small pieces that could be placed directly into the sheet press machine without being shredded.

ROTR attempted to use its current injection machine to create small products from the gillnet. This method was not the primary strategy, but it did provide additional information that may be useful in the future. To recycle larger volumes of plastic as well as more fibrous plastic, ROTR invested in a large sheet press machine capable of producing 4-by-5-foot sheets of plastic. The sheets can be anywhere from 1/8 to 2 inches thick. This machine increased overall production capacity and was able to handle fibrous input material. The resulting sheets are very versatile when it comes to product development. The products produced from this recycling process are dependent on the amount of plastic used. Products can range from small items such as keychains, coasters, jewellery, etc. (Figure 15), to larger items such as trash bins and benches. The economic feasibility of these products is assessed in ROTR's final report.

Figure 15. Products created by Seaside Apparel and Recycle on the Rock through the gillnet recycling pilot program.

The "Gillnet Recycling Pilot Program Report," produced by Seaside Apparel and Recycle on the Rock, can be found in Appendix C.


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REPURPOSING

Repurposing ghost gear into various products is another strategy for ghost gear management. There are several artists across the province who repurpose various types of ghost gear and end-of-life fishing gear into arts and crafts. However, it was not a common practice in Southern Labrador, according to initial conversations and consultations. Several community members did express interest in crafting and reusing materials to create various items (e.g., crafts, home décor, gardening products, etc.).

In partnership with NCC, WWF-Canada hosted an artist-led ghost gear repurposing workshop to educate community members on the importance of reducing and effectively managing ghost gear and on the impacts of ghost gear to species at risk and other wildlife. The workshop also provided a space to gain insight on potential ghost gear repurposing techniques. Prior to the event, held in Port Hope Simpson in November 2022, WWF-Canada engaged community members on potential methods of ghost gear repurposing and identified local artists who could create sustainable products with the retrieved gear. Selected artists then performed demonstrations at the workshop, so participants could learn and practice the techniques (Figures 16–17). Repurposing techniques and crafts included:

- Woven rope coasters,
- Coiled rope coasters,
- Macramé plant holders,
- Twine bracelets (beaded and non-beaded) made from cod trap,
- Line art with gillnet webbing, and
- Material painting with various materials (e.g., rope, net, webbing, beach glass, etc.).

Figures 16–17. Days one and two of the artist-led ghost gear repurposing workshop held in Port Hope Simpson. Participants are holding their finished crafts and art products.

Community members were overall very satisfied with the two-day artist-led workshop; they found it educational and valuable, and it provided an opportunity to connect with community members across generations. Some participants noted their newfound interest in collecting old fishing gear, which would otherwise be discarded in the trash. As one participant said, “I saw some old fishing ropes on my neighbour’s lawn and told him don’t throw it away because I can make something from it.” Several participants thoroughly enjoyed the beading activity with cod trap, and some found the woven rope work to be difficult.

Discussion was held on the economic feasibility for repurposed ghost gear crafts, following the demonstrations and technique practice at the workshop. Participants noted that ghost gear repurposing for crafts could be time-consuming but could work well with further practice. In addition to this, participants noted there are countless opportunities for marketing and selling repurposed ghost gear crafts (e.g., as holiday decorations). In order to build capacity in the community for further repurposed ghost gear crafting ventures, some participants suggested further workshops and groups to connect like-minded crafters with one another and to provide further opportunity to learn new techniques and perspectives.

Minutes from the artist-led ghost gear repurposing craft workshop can be found in Appendix E.

GHOST GEAR WORKING GROUPS

A provincial (Newfoundland and Labrador) Ghost Gear Working Group was first brought together by WWF-Canada in March 2022 and April 2023. Several local, national and international ghost gear and marine conservation experts joined the first meeting to share highlights on their respective projects. Insights from the WWF Global Ghost Gear Group were very valuable as international perspectives on global issues can be very valuable and shine a unique lens on the regional scope. The group discussed key results, challenges, successes and priorities for ghost gear identification, retrieval and management work. The second meeting was held in April 2023 to discuss highlights from respective projects once again, as well as to brainstorm opportunities for collaborative strategies in overlapping regions of work. This ghost gear working group serves many functions regarding ghost gear issues in Atlantic Canada and can be used to develop and manage recommendations for adaptive management.

Moving forward, it would be beneficial to continue with collaborative groups such as the Ghost Gear Working Group and encourage efficient discussion across various groups and stakeholders within the region of this work


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PORT INFRASTRUCTURE

Infrastructure in Southern Labrador for waste management and recycling is not satisfactory. It is no surprise that the infrastructure for collecting ghost gear and end-of-life fishing gear in Southern Labrador is unsatisfactory or non-existent. Figure 18 shows the current waste management facilities, rope repurposers and metal recyclers available in the province (see Appendix A).

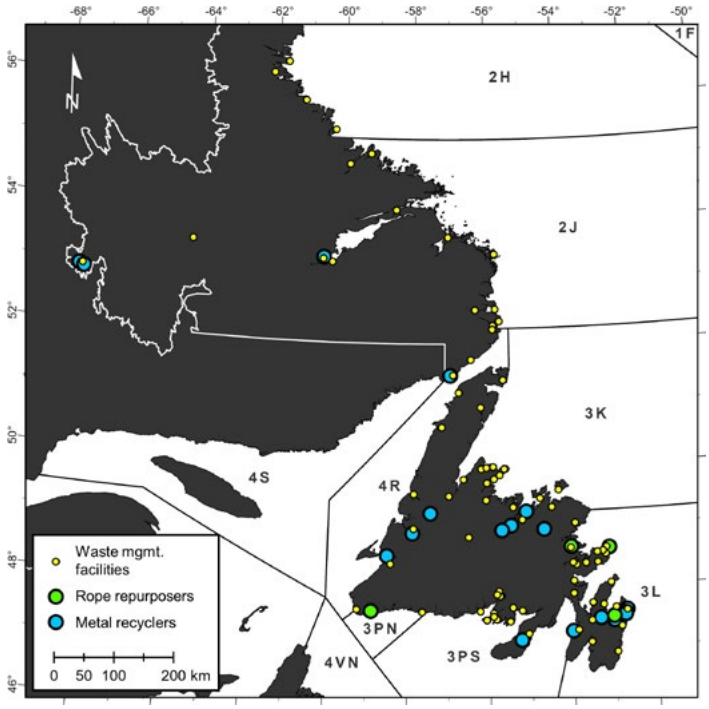

Figure 18. Waste management facilities, rope repurposers and metal recyclers in Newfoundland and Labrador. Map © Benjamin Misiuk.

In the fall of 2022, consultations were conducted by WWF-Canada and NCC with fish harvesters and port authority members of key communities in Southern Labrador. These communities included Port Hope Simpson, St. Lewis, Mary's Harbour, Charlottetown, Pinsent's Arm, Cartwright and William's Harbour (Figure 19).

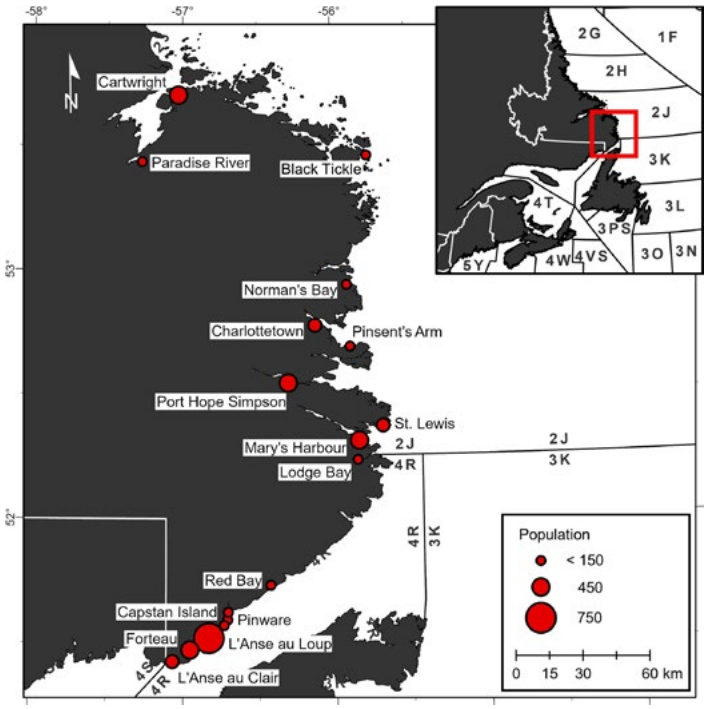

Figure 19. Locations and population sizes of communities in Southern Labrador. Map © Benjamin Misiuk.

Participants were asked for their thoughts on ghost gear in Southern Labrador through discussion of the following general topics:

- The magnitude of the ghost gear issue in Southern Labrador and worthwhileness to retrieve ghost gear (both sea-based and land-based);
- Suggestions on transportation, disposal and/or recycling of retrieved ghost gear;
- Experience using or testing sustainable gear types; and
- Port infrastructure improvements for end-of-life fishing gear collection and potential incentives.

Participants mentioned that removing ghost gear from land or marine waters is a good thing and benefits the environment, wildlife and community greatly. Several mentioned that the Gilbert Bay MPA is probably not a hot spot for ghost gear anymore as scallop draggers must have pulled up any ghost gear left on the seabed a long time ago. Ghost gear could be found (especially on land-based sites) all along the coast of Southern Labrador, and it is concentrated in areas such as Black Tickle.

In terms of recommendations to improve end-of-life fishing gear collection and ghost gear disposal and recycling options, there seemed to be difficulty in determining effective solutions. When participants were given information on current recycling and repurposing initiatives led by WWF-Canada (e.g., gillnet recycling pilot program, repurposed ghost gear craft workshop, etc.), they expressed their interest in and approval of the initiatives. As one participant said, "If there's a way to recycle the plastic webbing from gillnet, that's great."

Discussions regarding new sustainable gear types (e.g., ropeless gear) were welcomed. Fishers expressed their concern about the validity of new gear types, especially for use in Atlantic waters off the coast of Southern Labrador. Some fishers would be interested in testing ropeless gear technology if funding was provided and if strong research was conducted to ensure the gear would be very effective for their fishery. As they noted, it is very expensive and there have been occurrences when ropeless gear technology failed (which would be devastating to many Labrador fishers). Fishers were not interested in testing gear with breaking points for whale entanglements.

Lack of facilities at ports often posed a lack of gear disposal options for fishers. Figure 20 shows a local port in Southern Labrador where there is no end-of-life fishing gear collection. An effective solution brainstormed through discussions was to implement end-of-life fishing gear and ghost gear storage containers at major ports in Southern Labrador and nearby areas where fishers could drop off their gear, free of charge. The gear could then be transported to a waste disposal facility (i.e., local dump) or recycling facility (i.e., gillnet recycling in St. John's) once a year. We discussed these options with members of port and harbour authorities and they were also on board. Port authorities in communities such as Mary's Harbour, St. Lewis, Charlottetown and Port Hope Simpson would be interested in implementing modifications to current port infrastructure to include such options as end-of-life fishing gear and ghost gear collection bins and signage. Discussions between port authorities, NCC and DFO should be held to determine funding mechanisms for annual collection and transportation of gear to waste and recycling facilities, as well as long-term maintenance of bins.

Figure 20. Photo of a port authority (unnamed) in Southern Labrador with no current end-of-life fishing gear collection facilities.

CHALLENGES AND LESSONS LEARNED

FISHER AND GOVERNMENT RELATIONSHIP

Through consultations and engagement with fishers, it was clear that many fish harvesters in Southern Labrador, and perhaps throughout the province, have a strained relationship with the government. During consultations, some fish harvesters mentioned they would like to withhold information as they were concerned with how DFO would use information. It is important to restore this relationship between fishers and government in order to create significant progress on the front of ghost gear prevention, ghost gear management and other marine conservation issues.

TECHNOLOGY

Research Technology

The tools used to investigate ghost gear throughout the project were subject to a few discrepancies in data validity. The side-scan sonar did not produce imagery where ghost gear on the seabed floor could be easily identified. Through further research and consultations with folks from WWF-International (i.e., WWF-Germany), it was determined that moving forward, a towed sonar would be a better system to use when investigating ghost gear in deep ocean waters. In addition to sonar use, the use of underwater ROV could be accelerated with the addition of a GPS tracking feature, to accurately document transects of future surveys. This data can then be displayed on a map.

Sustainable Gear Technology

Discussions were held during consultations in fall 2022 with WWF-Canada, NCC and fish harvesters regarding new sustainable gear types (e.g., ropeless gear). Fishers expressed their concern about the validity of new gear types, especially for use in Atlantic waters off the coast of Southern Labrador. Some fishers would be interested in testing ropeless gear technology if funding was provided and if strong research was conducted to ensure the gear would be very effective for their fishery. As they noted, it is very expensive and there have been occurrences when ropeless gear technology failed (which would be devastating to many Labrador fishers). Fishers were not interested in testing gear with breaking points for whale entanglements.

INFRASTRUCTURE

Waste and recycling facilities in Southern Labrador face several challenges. Lack of adequate collection, disposal and recycling infrastructure within communities add additional barriers to effective ghost gear management in Southern Labrador. With current infrastructure, fishers are often left to dispose of their end-of-life fishing gear and ghost gear using one of two options: landfill or incinerating. Modifications to current infrastructure (port and waste management) can create more collection, disposal and recycling options for fish harvesters. In addition to infrastructure modifications, a transparent relationship between federal government, provincial government and port authorities and townships can accelerate new ghost gear management strategies.

REPORTING PROTOCOLS AND POLICY

During several conversations with fish harvesters and other environmental non-government organization (ENGO) group members, a flaw or gap in reporting protocols for lost gear was noted. Fish harvesters and other members from ENGO groups mentioned data retrieved from lost gear reports were not transparent to the public and did not appear to serve a purpose in ghost gear management. Fish harvesters noted their hesitance towards retrieving ghost gear identified on land or at sea as there are several permits and reports required to be completed in order to retrieve the gear. Further discussion between fish harvesters, NCC and DFO should be held in order to determine more effective and valuable means for ghost gear reporting protocols and ghost gear retrieval policy.

RECOMMENDATIONS MOVING FORWARD

Best management practices for the protection of golden cod and other valuable marine species in the Gilbert Bay MPA and ghost gear management should be determined between primary stakeholder groups. Applying best practices successfully can only be achieved with close collaboration of those primarily affected (Baltic Sea 2020, 2009). These suggestions should act as the starting point for conversations between DFO, NCC and fish harvesters in Southern Labrador.

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Recommendations for improved protection of golden cod, critical marine species, critical marine habitats, ghost gear management and mitigation of fishing pressures within the Gilbert Bay MPA include:

1. Improved engagement and consultation from federal government (i.e., DFO) to:
    a. Improve ghost gear reporting and retrieval policies;
    b. Discuss traditional fishery practices and how they can be modified to serve as a sustainable fishing practice today;
    c. Determine strategies to modify waste management and port infrastructure;
    d. Discuss incentives for lost gear reporting, ghost gear retrievals and sustainable gear testing;
2. Further research and design with sustainable gear manufacturers;
3. Further research and design of end-of-life fishing gear and ghost gear recycling technology;
4. Continued engagement with community members to maximize economic efficiency of repurposed ghost gear and end-of-life fishing gear products;
5. Continued collaboration with marine conservation and ghost gear experts locally, federally and internationally; and
6. Exploration of options to integrate more citizen science and knowledge sharing in future adaptive strategy development and research investigations.

CLOSING

The Gilbert Bay MPA remains a critical and valuable environment for various marine species, such as the golden cod. It appears that ghost gear remains a threat to marine wildlife and habitat in Southern Labrador. However, a large portion of this threat comes from the lack of disposal and recycling options, poor infrastructure (waste management and port), financial restrictions, indistinct lost gear reporting systems and research and technological gaps in new sustainable gear types.

It is imperative that strong conservation of the MPA continues through co-management with NCC and DFO, as well as sustained engagement with fish harvesters and local community members. It is through these collaborative efforts that the impacts from anthropogenic sources can be mitigated.

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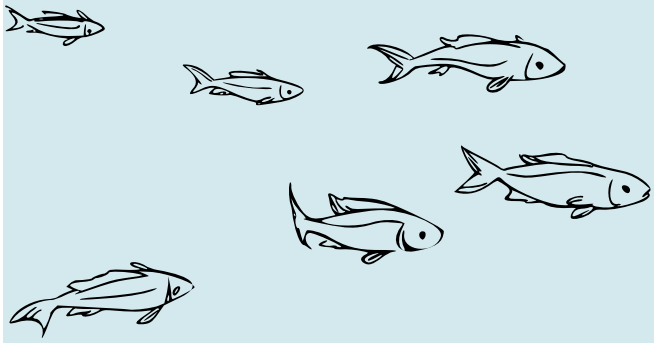
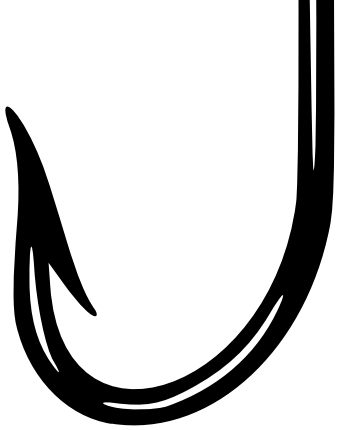
APPENDIX A: ABANDONED, LOST, AND DISCARDED FISHING GEAR MANAGEMENT IN NEWFOUNDLAND AND LABRADOR

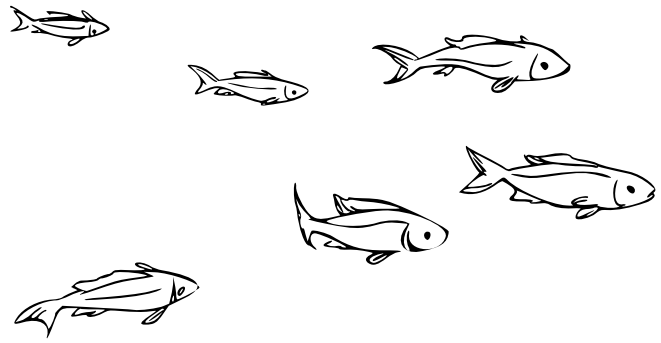
APRIL 2022

ABANDONED, LOST, AND DISCARDED FISHING GEAR MANAGEMENT IN NEWFOUNDLAND AND LABRADOR



Prepared by: Natalya Dawe
For WWF-Canada
April 2022





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EXECUTIVE SUMMARY

Abandoned, Lost, Discarded Fishing Gear Management in Newfoundland and Labrador expands on and summarizes the existing knowledge on abandoned, lost, and discarded fishing gear (ALDFG) and its end-of-life management in Newfoundland and Labrador. This report includes six chapters. Chapter 1 describes the regulations and licencing conditions surrounding ALDFG in Newfoundland and Labrador.

Chapter 2 summarizes the work various organizations have completed surrounding ALDFG in the province, as well as relevant research. Chapter 3 assesses gear loss in Newfoundland and Labrador: its causes, harms, and estimated annual fishing gear loss. Chapter 4 summarizes local and international methods to reduce fishing gear loss. Chapter 5 looks at the waste management of end-of-life fishing gear across the province, as well as the rate of fishing gear replacement. Chapter 6 focuses on Southern Labrador and the ways that end-of-life fishing gear is currently managed and how this could be improved in the future.

This report was written by Natalya Dawe for World Wildlife Fund Canada (WWF-Canada).

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INTRODUCTION

The information included in this report builds on past studies of abandoned, lost, discarded fishing gear (ALDFG) and its management in Newfoundland and Labrador, and Atlantic Canada more broadly. Primarily, this research expands on the work completed by the Fishing Gear Coalition of Atlantic Canada's (FGCAC) 2021 report "End-of-life fishing gear management in Newfoundland and Labrador" and Alexa Goodman's 2020 study "State of abandoned, lost, and discarded fishing gear in the Canadian Maritimes". This report aims to improve the understanding of commercial fishing gear loss, management, and disposal within Newfoundland and Labrador, and assess opportunities for the recycling and reuse of fishing gear within southern Labrador.

Newfoundland and Labrador commercial fish harvesters participate in multispecies inshore and offshore fisheries for shellfish, groundfish, and pelagic species. Commercial fishing occurs in North Atlantic Fisheries Organization (NAFO) Divisions 2GHJ, 3KLMNOPns, and 4R (Figure 1). The commercial fishing and aquaculture industries are important employers in the province, with 15,800 people in 400 communities directly employed by Newfoundland and Labrador's seafood industry (harvesting, processing and aquaculture) in 2020 (Government of Newfoundland and Labrador [Gov NL], 2020). Of those, 8,800 were registered fish harvesters. Newfoundland and Labrador seafood had a market value of $1.1 billion in 2020, with wild fisheries accounting for 91% of this (Gov NL, 2020).

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Some loss of fishing gear from commercial fisheries in inevitable (Drinkwin, 2022). Abandoned, lost and discarded (ALDFG) fishing gear, also known as ghost gear, is fishing gear that is lost or discarded at sea. An estimated 600,000-800,000 metric tonnes of ghost gear enter the world's oceans each year (Macfadyen, Huntington, & Cappell, 2018). Ghost gear causes environmental and ecological harm by continuing to capture harvestable fish stocks and other marine organisms after it has been lost. 90% of species caught by ghost gear are of commercial value, thereby causing economic losses for the fishing industry, damage to marine ecosystems, and entanglement marine mammals (Global Ghost Gear Initiative [GGGI], 2021; NOAA, 2015).

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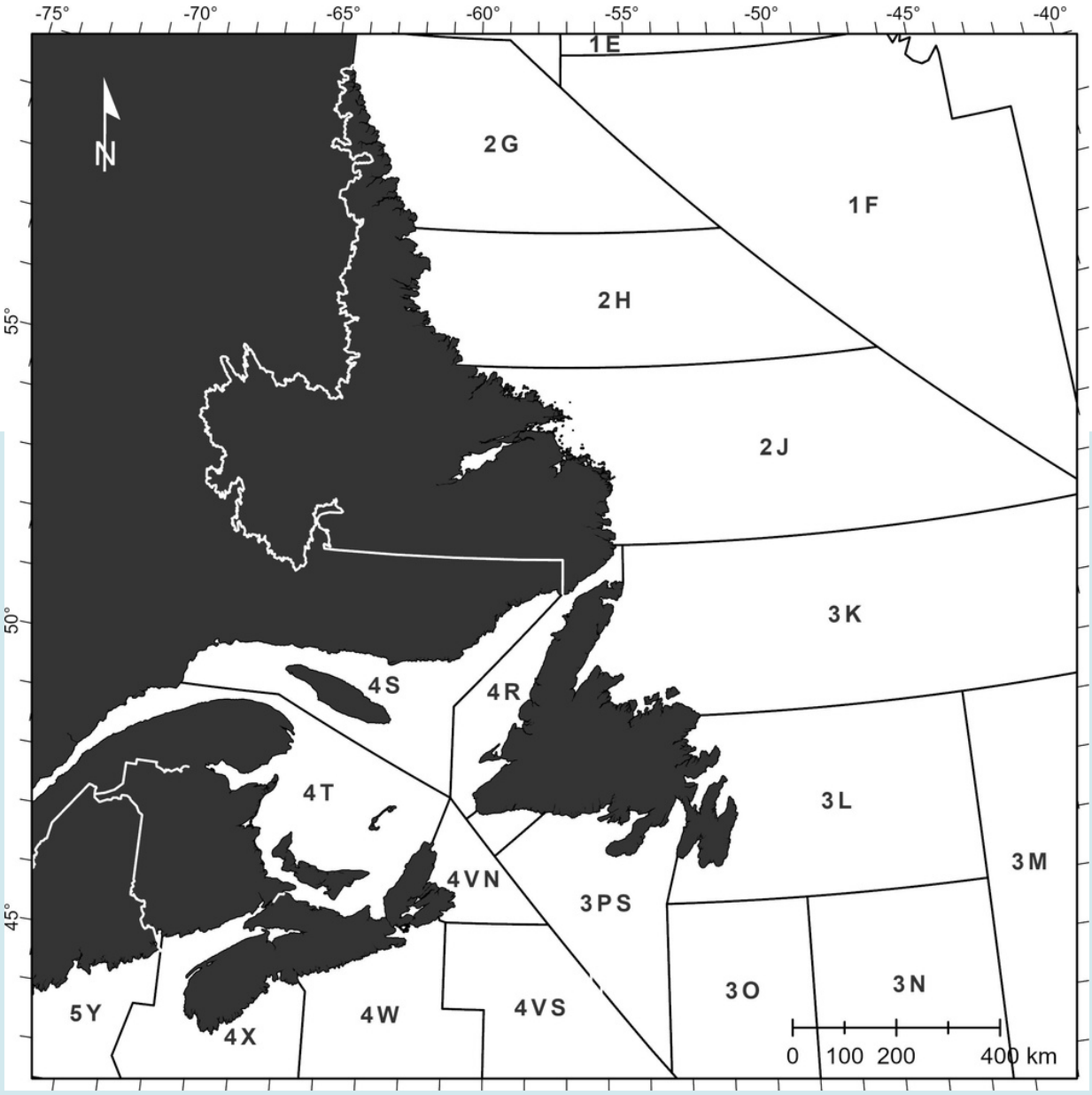
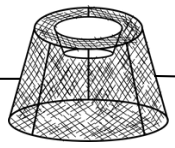


Figure 1. NAFO Divisions for Newfoundland and Labrador fisheries. Map credit: Benjamin Misiuk, 2021.

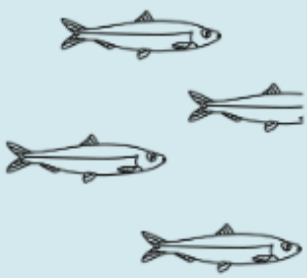
Table 1. Commercial fisheries in Newfoundland and Labrador and 2021 preliminary landed values (DFO, 2022b).

Fishery	Species (in order of value)	Landed Value (2021)
Crustacean	Snow crab, Northern shrimp, *Pandalus montagui* shrimp, lobster, scallops, sea cucumber, sea urchin, squid, whelk, other species	$872,066,418
Groundfish	Turbot (Greenland halibut), flounders (yellowtail flounder, American plaice, witch flounder), Atlantic cod, Atlantic halibut, redfish, white hake, skate, haddock, pollock, monkfish, other species	$106,402,283
Molluscs	Other molluscs, sea scallop, whelk, Iceland scallop	$56,694,103
Pelagics	Capelin, herring, mackerel	$23,565,422
Miscellaneous	Other miscellaneous, groundfish heads, Lumpfish roe	$7,795,835



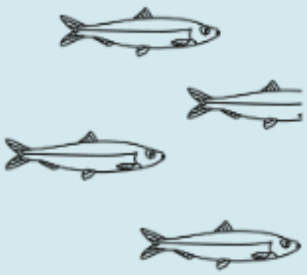
CHAPTER 1: REGULATION AND LICENCING CONDITIONS

Lost fishing gear is defined as “any active fishing gear previously set by the licence holder and fishing vessel operator which was sought but not found”. As part of their commercial fishing licence conditions, fish harvesters are required to report lost fishing gear and retrieved fishing gear that was previously reported as lost to Fisheries and Oceans Canada (DFO).



LOST GEAR REPORTING

Lost fishing gear is defined as any active fishing gear previously set by the licence holder and fishing vessel operator that was sought but not found (Beth Ann Hawco, personal communication, April 2022).
The fishing licence holder and fishing vessel operator must report any of their lost fishing gear to DFO within 24 hours of returning to port at the end of the fishing trip. Reports of lost gear must be submitted online using the Online Fishing Gear Reporting System (FGRS) or by completing an online “Lost Fishing Gear Form” (DFO, 2021). The information provided through these tools allows DFO to identify areas of frequent gear loss and its causes, and to help guide future lost gear retrieval efforts and solutions to gear loss (DFO, 2021).



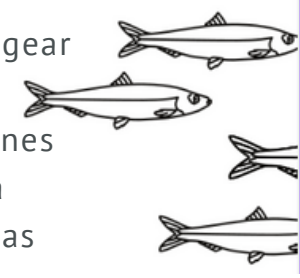
RETRIEVED GEAR REPORTING

Retrieved gear is defined as “any previously reported lost fishing gear by the licence holder and fishing vessel operator, that has been subsequently found”. The licence holder and fishing vessel operator must report the retrieval of any of their own previously reported lost gear within 24 hours of returning to port at the end of the fishing trip (Beth Ann Hawco, pers. comm., April 2022). Reports of retrieved gear must be submitted to Fisheries and Oceans Canada (DFO) through the Fishing Gear Reporting System (FGRS) or by completing an online form “ Retrieval of previously reported lost fishing gear”. Retrieval can only occur during the validity period of the applicable licence conditions and only in relation to the specific type of gear authorized to be used by these licence conditions (Beth Ann Hawco, pers. comm., April 2022).

GEAR RETRIEVAL REGULATIONS

The retrieval of ALDFG is authorized by the *Wrecked, Abandoned, or Hazardous Vessel Act (WAHVA)* and the *Fisheries General Regulations*. Gear retrieval work is permitted through WAHVA, as ALDFG is considered a “wreck” based on its definition under WAHVA (Beth Ann Hawco, pers. comm., April 2022). The Minister and Fisheries and Oceans can act to deal with wrecks that may pose a hazard as is defined under WAHVA. Authorization of gear retrieval work occurs through *Fisheries General Regulations* Section 52 permits.

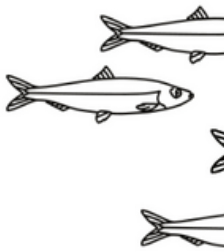
All gear retrieval activities require a Section 52 permit. Section 52 permits can be obtained by applying to Regional Ghost Gear Coordinators. Retrieval activities occur outside of the commercial fishing season and must be supervised by the authorized permit holder (Beth Ann Hawco, pers. comm., April 2022). Permit holders are also required to provide the locations of planned gear retrievals, hail out prior to starting retrieval operations, return all bycatch found in retrieved gear to the ocean, and report retrieved gear through data collection forms or through the FGRS. Permit holders are required to "adhere to requirements for transportation, storage, and responsible disposal of retrieved ALDFG" (Beth Ann Hawco, pers. comm., April 2022). Prior to the issuance of a section 52 permit the applicant must have a post retrieval storage and disposal plan. Tagged gear in good condition must be stored in a secure location until DFO can return the retrieved gear back to its owner. Untagged retrieved gear will be repurposed, reused, recycled, or disposed of, depending on its condition. Gear retrieved on shorelines and land do not require a Section 52 permit, unless a vessel is being used to transport gear, in which case as section 52 authorization is required (Beth Ann Hawco, pers. comm., April 2022).



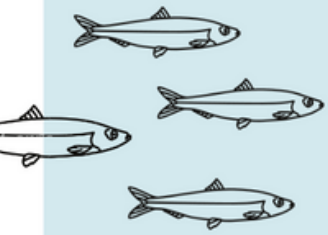
Marine Protected Area Regulations fall under the Oceans Act and subsequently these regulations need to be considered when planning retrieval activities withing these areas. The Gilbert Bay, Labrador MPA Regulations prohibit any activity that disturbs, damages, destroys or removes any living marine organism or part of its habitat (Government of Canada, 2019). There are exceptions that allow for certain activities that do not interfere with the achievement of conservation objectives.

Activities are not permitted in Marine Protected Areas (MPA) without a DFO approved MPA Activity Plan, as per the Oceans Act MPA Regulations, and without a signed letter of authorization from the Regional Director of Marine Planning and Conservation, NL Region, DFO (Beth Ann Hawco, pers. comm., April 2022; Government of Canada, 2019). If the activity is approved a Section 52 Permit may be issued for scientific research, monitoring, or educational activities. To gain authorization, applicants must submit an activity plan to DFO for approval from the Minister of Fisheries. The letter and the approved Activity Plan must both be attached to the section 52 licence (Beth Ann Hawco, pers. comm., April 2022).

GEAR TAGGING, MARKING, AND IDENTIFICATION



Gear marking is a requirement in many of the province's non-tended, fixed gear fisheries. This requirement is in place for all non-tended fixed gear fisheries in Eastern Canada (Withers, 2020). For Newfoundland and Labrador, this includes the lobster, snow crab, cod, longline and gillnet fisheries. As of 2020, harvesters are required to use rope that is interlaced with coloured twines to indicate the country, region, target species, and the lobster or snow crab fishing area (if applicable) (Withers, 2020). This marking is required on vertical lines - the ropes that attach fishing gear to the primary buoy. This marking requirement is used to improve tracking of gear by understanding the origin of gear and further identify management measures and threats to marine mammals, particularly North Atlantic Right Whales (Withers, 2020).



Gear tags are also used to mark fishing gear. These tags are available from approved tag suppliers and can be made from metal or polyurethane. In the Newfoundland and Labrador Region, gear tags are used in the lobster fishery (Lobster Fishing Areas 3-14) and in the crab fishery (Crab Fishing Areas 12 and 13) (DFO, 2021c; DFO, 2022a).

Furthermore, Section 27 of the *Fisheries (General) Regulations* states that (Government of Canada, 2022):

- 27 (1) 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.

- (2) The vessel registration number or name referred to in subsection (1) shall be painted on or otherwise securely affixed to a tag, float or buoy attached to the gear and be legible and readily visible at all times without the necessity of raising the gear from the water or, where the water is ice covered, without the necessity of removing any snow or ice.

CHAPTER 2: STATE OF KNOWLEDGE IN NEWFOUNDLAND AND LABRADOR

Information on ALDFG work and research completed in Newfoundland and Labrador was obtained from January to March 2022 through online literature reviews, conversations with DFO, and interviews with commercial fish harvesters and organizations that have completed ghost gear work in the province.

Much of the data on ALDFG research (Table 3) and associated coordinates (Figure 2) was sourced from the Civic Laboratory for Environmental Action Research's (CLEAR) dataset "Systematic literature review: Plastic pollution research in Newfoundland and Labrador, 1962-2019" (CLEAR, 2020). Additional information was gathered from 74 Harbour Authorities using online surveys (January-March 2022), as well as data collected by the Fishing Gear Coalition of Atlantic Canada's study on end-of-life fishing gear management in Newfoundland and Labrador (Dawe et al., 2021).

14 organizations have completed projects relating to ALDFG monitoring, prevention, and removal at various locations in Newfoundland and Labrador. These projects include gear retrievals, harbour cleanups, shoreline cleanups, citizen science data collection, and the management of marine debris (Table 2). A total of 27 studies (academic and grey literature) relating to ALDFG in Newfoundland and Labrador were completed from 1979-2021 (Table 3). This includes studies of plastic ingestion by marine organisms, marine debris in harbours and on shorelines, whale entanglements, fishing gear in seabird nests,

the development of more sustainable fishing gear, gear retrieval, and fishing gear waste management (Table 2).

Fishing effort in Newfoundland and Labrador is reflected in the marine debris found on shorelines, in harbour waters, and in the digestive tracts of marine species (CLEAR, 2020; Table 2). Large marine mammals are also affected by fishing gear in these waters, with an average of 3.2 Minke whales and 10 Humpback whales entangled in fishing gear each year (CLEAR, 2020). A finding of CLEAR's Regional report on plastic pollution in Newfoundland and Labrador, 1962-2019 is that the majority of plastic pollution in Newfoundland and Labrador's marine environment originates locally, and much of this waste can be traced to the province's commercial fisheries. Furthermore, fishing gear made up an average of 37% of plastics found on marine shorelines (CLEAR, 2021).

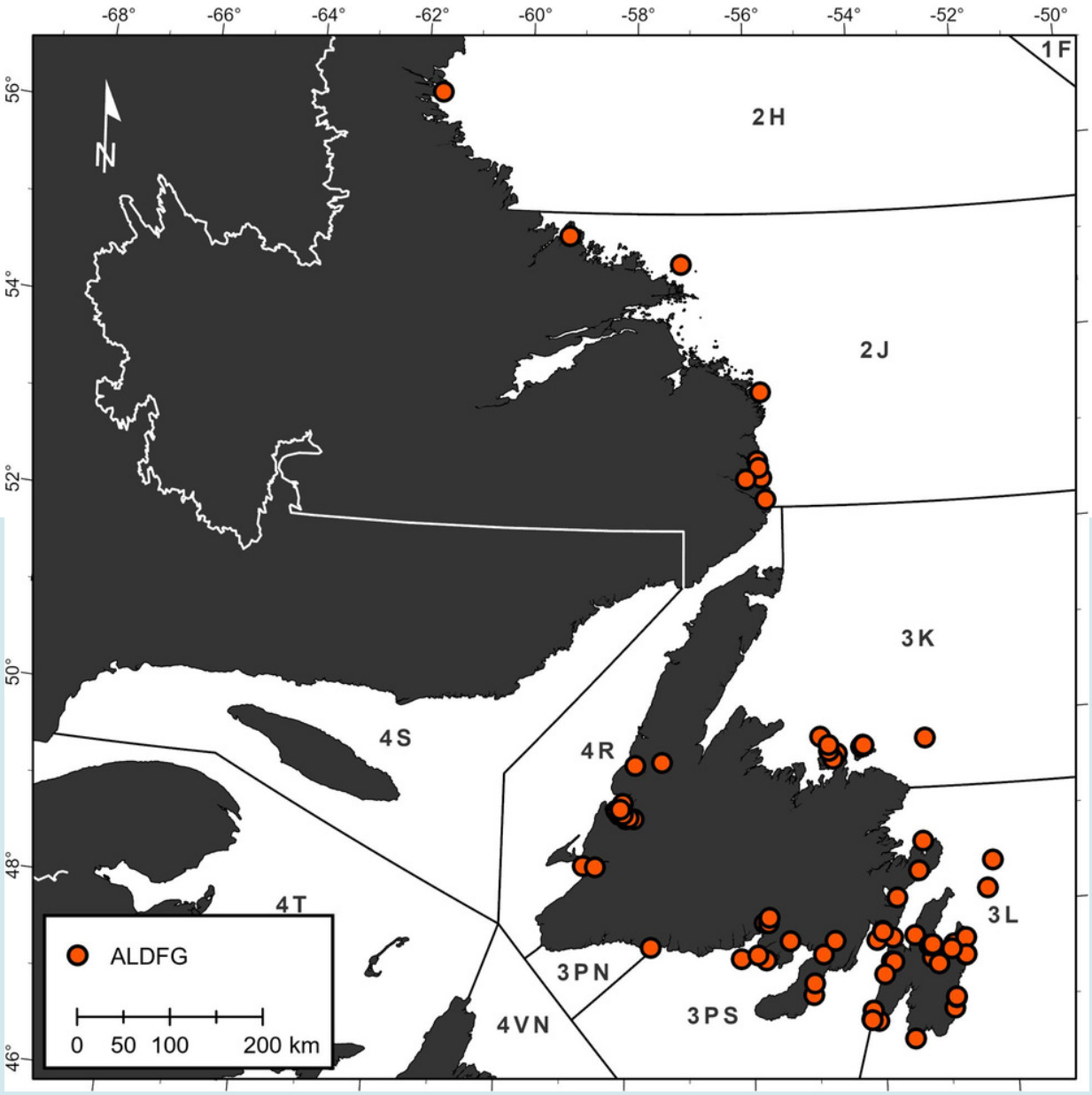
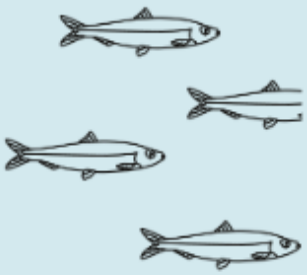
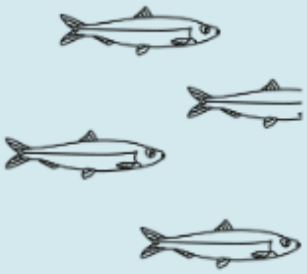


Figure 2. Locations of ghost gear retrievals, shoreline cleanups, harbour cleanups, and seabird nest studies where fishing gear was found. Some locations are approximate. Location data from CLEAR (2020) and supplemented by other research and projects included in this study. Map credit Benjamin Misiuk, 2022.



The 1992 cod moratorium in Newfoundland and Labrador influenced ALDFG in the marine environment, with declines in the number of whale entanglements and gillnets found in gannet nests following the fishery's closure (Liboiron et al., 2020). Moreover, plastics that were confirmed or suspected to originate from fishing activity have been found ingested by dovekies (*Alle alle*), Atlantic cod (*Gadus morhua*), porbeagle shark (*Lamna nasus* Bonnaterre), and sperm whale (*Physeter macrocephalus*) (Avery-Gomm et al., 2016; Joyce, 2002; Liboiron et al., 2016; Liboiron et al., 2017; Melvin, 2017; Richards, 2019; Saturno et al., 2020; Walker, 1989) (Table 3). Fishing gear has also been found incorporated in northern gannet (*Morus bassanus*) nests, and as likely microplastics in surface waters (Bond et al., 2012; CLEAR, 2020; Montevecchi, 1991). Aquaculture, commercial and recreational fisheries are responsible for fishing related marine debris in Newfoundland and Labrador.

Fishing gear is also an issue in harbour waters. Han et al. (2020), found that 23% of marine debris in surveyed harbours was from fisheries, and was likely the result of ocean dumping - particularly at wharf sites. Morris et al. (2016) found similar issues with fishing debris at wharf sites. These findings coincide with online surveys conducted as part of this study, as 39% of harbours stated that ghost gear is an issue in their area (Appendix 8).



Ghost gear identified as problematic in their area by Harbour Authourities and harvesters included: gillnets (12 respondents), crab pots (4 respondents), lobster pots (4 respondents), cod traps (3 respondents), rope (2 respondents), trawl warps (2 respondents). Cod traps have not been commonly used since before the 1992 moratorium, yet this gear continues to present problems in some areas – both on land and at sea. In some areas, old cod traps, fishing sheds, and wharves that were abandoned in communities, have or are at risk of collapsing into harbour waters, as these structures deteriorate with age.

Rouxel and Montevecchi (2018) assessed the sustainability of gillnets, handlines, and cod pots used in the inshore northern cod fishery. Their results indicated that although bottom-set gillnets are the most common; they are the least sustainable of the three gear types as they "substantially contribute to ecosystem and fish stock degradation" (Rouxel and Montevecchi, 2018). Gillnets also caught the lowest quality, and thus least valuable, cod. Handlines were the most sustainable method, followed by cod pots. Meintzer, Walsh, and Favaro (2018) found that cod pots using a Norwegian and modified NL design have a lower environmental impact, require less labour in removing catches, and result in higher quality and higher value fish than gillnets.

The Dawe, Kendall, Smith, and Davis (2021) report *End-of-life fishing gear management in Newfoundland and Labrador* found that disposal options for end-of-

life fishing gear are limited in Newfoundland and Labrador. While metals can be recycled, rope, wooden lobster pots, and other materials are often landfilled. Based on licencing and information from harvesters, they estimated that 52,046 lobster traps, 65,319 crab pots, and 2,974 km (202 tonnes) of rope are purchased, replaced, or built annually by Newfoundland and Labrador fish harvesters. These estimates assume that all crab and lobster licences are being actively fished (Dawe et al., 2021, see Chapter 3 – Rate of loss for Crab Pots).

Figure 3. Cod trap on a collapsed fishing structure. © Cameron Pye

TABLE 2. ALDFG monitoring, prevention, and removal work in Newfoundland and Labrador

Organization	Year	Type	Location (NAFO Div.)	Description
Clean Harbours Initiative	2018-	Harbour cleanup, shoreline cleanup	4R, 3KLPs	Harbour and shoreline clean-ups around Newfoundland. Includes harbours in Conception Bay, Trinity Bay, Notre Dame Bay, Placentia Bay, Bay of Islands, and the South Coast
Torngat Joint Fisheries Board	2020-2021	Gear retrieval	2GJ	Harvester interviews, investigation of ghost gear sites (Greenland halibut and snow crab). Attempted gear retrievals 2021 in northern 2J.
Newfoundland and Labrador Aquaculture Association	2020-2021	Gear retrieval	3Ps	Ghost gear retrieval at decommissioned mussel farm sites in Placentia Bay.
Petty Harbour Fishermens Cooperative	2020-2021	Gear retrieval	3L	Ghost gear retrieval along the eastern shore of the Avalon Peninsula (Cape Francis to Cape Pine).

Fish, Food & Allied Workers Union (FFAW-Unifor)	2020-2021	Gear retrieval	4R, 3KLPs, 2J	Ghost gear retrieval in areas around Newfoundland and Labrador - Placentia Bay, Fortune Bay, Bay St. George, Notre Dame Bay, Trinity Bay, and Gilbert Bay (Labrador)
WWF-Canada	2019-	Gear retrieval	2J	Ghost gear consultations, identification, retrieval and repurposing/management research in Gilbert Bay, Labrador
Ocean Quest (Dive Against Debris)	2019, 2020	Harbour Cleanup	3L	Harbour cleanups in the Holyrood Marina, Conception Bay.
CANADIVE (Dive Against Debris)	2013	Harbour Cleanup	4R	Diver cleanup in Shallow Bay, Gros Morne National Park
CPAWS-NL	-	Marine debris management	-	Ship to Shore program to manage and reduce marine debris in NL harbours
Fisheries and Oceans Canada	2019-2022; 2021-2023	Funding	All	Ghost Gear Fund; Whalesafe Gear Adoption Fund
Marine Debris Tracker	2014-	Monitoring	All	Open data citizen science focused on marine debris and plastic pollution.
Fisheries and Oceans Canada	1983-1984	Gear retrieval	3Ps	Lost gillnet retrieval project 1983–1984 (Barney, 1994)

Atlantic Healthy Oceans Initiative	2019-2021	Shoreline cleanups	4R	Shoreline cleanups in Gros Morne National Park.
Civic Laboratory for Environmental Action Research (CLEAR)	2017-	Monitoring	All	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.*
Placentia Bay Ocean Debris Survey (PODS)	2017-2021	Monitoring	3Ps	Survey of marine debris in Placentia Bay.

*Goodman, 2020.

Note: Gear retrieval refers to at-sea gear retrievals using a creeper (refer to Chapter 3). Harbour cleanups were completed by divers.

TABLE 3. Studies relating to ALDFG in Newfoundland and Labrador.

Title	Year Published	Description	Citation
Net entanglements of baleen whales in the inshore fishery of Newfoundland.	1979	Entanglements	Perkins, J. S., & Beamish, P. C. (1979).
Incidence and types of plastic in gannets' nests in the northwest Atlantic.	1991	Nest incorporation	Montevecchi, W.I.A. (1991).
Prevalence and composition of fishing gear debris in the nests of northern gannets (Morus bassanus) are related to fishing effort.	2012	Nest incorporation	Bond, A. L., Montevecchi, W. A., Guse, N., Regular, P. M., Garthe, S., & Rail, J. F. (2012).
Trace elements and ingested plastic debris in wintering dovekies (Alle alle).	2013	Ingestion (Seabird)	Fife, D.T., Robertson, G.J., Shutler, D., Braune, B.M. & Mallory, M.L. (2015).
Analysis of stomach contents of the porbeagle shark (Lamna nasus Bonnaterre) in the northwest Atlantic.	2002	Ingestion	Joyce, W. (2002).
Promoting conservation through the improvement of cod pots – a low impact fish*...	2018	Technology	Meintzer, P. (2018).

Analysis of beach litter volumes, sources, and movements on selected coastlines of the Avalon Peninsula, Newfoundland and Labrador.	2004	Shoreline study	Pink, D. (2004).
Lost or abandoned fishing gear in the Newfoundland aquatic environment.	1992	Gear retrieval	Brothers, G. (1992).
Lost gill net (ghost net) retrieval project	1977	Gear retrieval	Way, E. W. (1977).
Survey of marine debris ingestion by odontocete cetaceans	1989	Ingestion (Whale)	Walker, W.A. and Coe, J.M. (1989).
Incidence of plastic and other marine debris on the seabed, disposed in rural coastal harbours.	2019	Dive survey	Han, V., Morris, C.J., Gregory, R.S., Porter, D., & Sargent, P.S. (2019).
Rocky shoreline protocols miss microplastics in marine debris surveys (Fogo Island, Newfoundland and Labrador)	2018	Shoreline study	McWilliams M. , Liboiron M., Wiersma Y. (2018).
Investigating the role of fishing gear on plastic pollution: The occurrence of fishing gear related plastic ingested by Atlantic cod (Gadus morhua) and the fragmentation of polymer ropes	2020	Ingestion, technology	Saturno, J. (2020).
Comparing catch efficiency of five models of pot for use in a Newfoundland and Labrador cod fishery	2018	Technology	Meintzer, P., Walsh, P., & Favaro, B. (2018).

Comparing catch efficiency of five models of pot for use in a Newfoundland and Labrador cod fishery	2018	Technology	Meintzer, P., Walsh, P., & Favaro, B. (2018).
End-of-life fishing gear management in Newfoundland and Labrador.	2021	Waste Management	Dawe, N., Kendall, R.A., Smity, S., Davis, M. (2021).
Gear sustainability assessment of the Newfoundland inshore northern cod fishery	2018	Technology	Rouxel, Y.,Montevecchi, W. (2018).
Evaluating potential biodegradable twines for use in the snow crab fishery off Newfoundland and Labrador	2015	Technology	Winger, P.D., Legge, G., Batten, C., & Bishop, G. (2015).
Low plastic ingestion rate in Atlantic cod (Gadus morhua) from Newfoundland destined for human consumption collected through citizen science methods	2016	Ingestion (Fish)	Liboiron, M., Liboiron, F., Wells, E., Richard, N., Zahara, A., Mather, C., Bradshaw, H., & Murichi, J. (2016).
A study of wrecked Dovekies (Alle alle) in the western North Atlantic highlights the importance of using standardized methods to quantify plastic ingestion	2016	Ingestion (Birds)	Avery-Gomm, S., Valliant, M., Schacter, C. R., Robbins, K. F., Liboiron, M., Daoust, P. Y. , Rios, L.M., & Jones, I. L. (2016).
Regional Report on plastic pollution in Newfoundland and Labrador, 1962-2019.	2020	Regional Study	Liboiron, M., Duman, N., Bond, A., Charron, L., Liboiron, F., Ammendolia, J., Hawkins, K., Wells, E., Melvin, J, Dawe, N., & Novacefski, M. (2020).

Occurrence of plastics ingested by Atlantic cod (Gadus morhua) destined for human consumption (Fogo Island, Newfoundland and Labrador)	2020	Ingestion (Fish)	Saturno, J., Liboiron, M., Ammendolia, J., Healy, N., Earles, E., Duman, N., Schoot, I., Morris, T., & Favaro, B. (2020).
Low incidence of plastic ingestion among three fish species significant for human consumption on the island of Newfoundland, Canada	2017	Ingestion (Fish)	Liboiron M., Melvin J., Richárd N., Saturno J., Ammendolia J., Liboiron F., Charron L., & Mather C. (2017).
Plastic ingestion in Atlantic cod (Gadus morhua) on the east coast of Newfoundland, Canada results from a citizen science monitoring project, with policy recommendations for long-term monitoring	2017	Ingestion (Fish)	Melvin J. (2017).
Anthropogenic litter in marine waters and coastlines of Arctic Canada and West Greenland.	2021	Marine survey	Mallory, M.L. Baak, J., Gjerdrum, C., Mallory, O.E., Manley, B., Swan, C., & Provencher, J. F. (2021).
An analysis of ingested microplastics found in offshore Atlantic cod (Gadus morhua) and inshore capelin (Mallotus villosus) using scientific and citizen science methods.	2019	Ingestion (fish)	Richard, N. (2019).
Garbage in Newfoundland harbours	2016	Dive survey	Morris, C., Sargent, P., Porter, D., Gregory, R., Drover, D., Matheson, K., Maddigan, T., Holloway, C., & Sheppard, L. (2016).
Multi-Materials Stewardship Board (MMSB)	2020	Shoreline study	LeGresley, S., Finn, C., Saunders, D., Burke, A., & Ryan, G. (2020).

CHAPTER 3: QUANTIFYING ALDFG IN NEWFOUNDLAND AND LABRADOR

Information on ALDFG replacement and loss was obtained from online surveys and interviews with fish harvesters and Harbour Authorities conducted between January and March 2022. Data collected by the FGCAC in 2021 were also included (Dawe et al., 2021).

Many harvesters indicated that disposal of fishing gear at sea is uncommon, but it does happen. However, there are cases where gear disposal at sea seems to be prevalent, often due to the perceived minimal or non-existent environmental impacts of doing so, lack of disposal options, or a combination of these factors. The disposal of steel warps from otter trawls at sea is one such example. Disposing of steel warps at sea occurs as it is often viewed as an unharmful due to the steel eventually rusting away.

More commonly however, gear is unintentionally lost. Fishing gear is expensive to replace. As such, harvesters will typically spend a significant amount of time and effort trying to retrieve lost gear in hopes of avoiding the significant cost of replacing this gear. The exception is when a single crab pot is lost. A single pot can break off when hauling gear aboard for a variety of reasons. Harvesters stated that the water depth and strong currents at crab fishing grounds make it nearly impossible to retrieve a single lost pot. These single losses are often not reported. For many types of gear, retrieval is completed using a “creeper”, a small anchor or piece of metal with hooks attached. Creepers are dragged along the sea bottom until they snag the lost gear. Gear that is lost in shallower water, such as lobster pots, can sometimes be retrieved using a gaff (a pole with an attached hook).

Additionally, gear that is lost during storm events can sometimes be found on beaches, though it may no longer be in usable condition (eg. lobster traps). Fish harvesters will notify other harvesters in their area when they have lost gear, as this can aid in locating the lost gear and help others identify and avoid areas that may be problematic for gear loss . If another harvester accidentally snags on the recently lost gear while fishing, they will attach a buoy so the owner can retrieve their gear.

The likelihood of gear loss is influence by several factors:

- Environmental conditions: gear can be lost in storms; pots can become entangled in strong currents and then break off when trying to retrieve them. Strong wave action, icebergs, and sea ice cover can also lead to gear loss.

- Gear conflict: ·rocky seafloors can wear or hook ropes causing rope breaks and gear loss; entanglement with someone else's fishing gear can lead to it breaking off; and a higher concentration of fishing activity or marine traffic in an area can increase the likelihood of gear conflict.

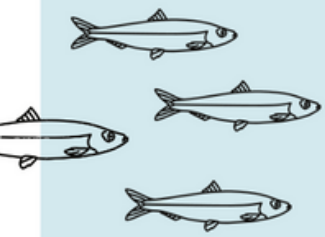
- Gear condition: old or overused ropes can break; different fisheries and fishing areas have different gear requirements – using ropes and gear in good condition and suitable for that fishery help prevent loss.

- Fishing effort: quota size and catch rates influence the amount of time spent fishing. Good catch rates and/or smaller quotas mean fewer fishing days and lower fishing effort, so less gear is in the water for a shorter amount of time, resulting in a lower risk of gear loss.

Some harvesters indicated that they do not want to set or haul their gear in poor weather or ocean conditions, but that it is not always possible due to the fishing season and quotas. For example, fish harvesters may have to start fishing when the season opens and sea ice is still present, or they risk the quota being caught and the fishery closing before the ice disappears). Additionally, harvesters also indicated that technological advances have reduced gear loss over the past 30+ years. Better quality gear is less likely to wear and break; improved forecasting means that harvesters are better able to protect their gear from loss in harsh conditions; and harvesters mark the location that they set their gear with their personal GPS, so they know where to look if gear is lost.

Gillnets and crab pots are the most common type of gear that continuing fishing (ghost fishing) when lost or discarded (NOAA, 2015). Gillnets are set vertically in the water column and consist of a monofilament net with weights at the bottom and floats at the top. Gillnets are a passive type of fishing gear: they are set and left to fish for a period of time before they are retrieved. This period of unmonitored fishing makes them more susceptible to becoming lost, where they can do significant harm, as the monofilament nets do not degrade (NOAA, 2015). The level of harm caused by lost gillnets is influenced by currents, tides, and water depth as these factors influence the openness of the net as it drifts through the water column. Lost nets in shallow waters with stronger tide and current conditions will ball up more quickly than those in deeper water with less tidal and current influence.

A net that remains open is likely to continue fishing (NOAA, 2015). The monofilament used in gillnets is very difficult for marine organisms to see in the water so it will continue to entrap them. Furthermore, nets can continue to fish for the life of the material; those buoyant in the water column impact pelagic species, while nets on the seafloor impact benthic species (GGGI, 2021).



A gillnet lost or discarded in shallow water may only ghost fish for months, while one lost in deeper water can continue to fish for years. The rate of ghost fishing tends to decline over time as marine organisms like algae begin to grow on the nets (biofouling), which increases the visibility and decreases the catching ability of lost nets (NOAA, 2015). Hareide et al. (2005) found that gillnets used in coastal waters of less than 200m are not considered to be a significant problem for ghost fishing, while those fishing in water depths of greater than 500m were much more likely to be lost due to larger net lengths, longer soak times, and gear stress. These findings align with information from interviewed fish harvesters, who indicated that permanent gillnet loss in the cod fishery is uncommon, but happens much more frequently in the offshore turbot fishery. Gear loss in Canadian Atlantic gillnet fisheries is estimated at 2% of nets per boat each year, and bottom-set gillnets are the most common gear used in the NL cod fishery (NOAA, 2015, Rouxel & Montevecchi, 2018).

There is significantly less data on gear loss and fishing mortality for longline, jigging, and bottom trawl fisheries (NOAA, 2015). However, it is known that longlines can continue to fish once lost and can cause mortalities by entanglement and hooking. Longlines consist of fishing lines with baited hooks, which can snag on the seabed and break off (Figure 8). The GGGI (2021) states, “the extensive use of longlines, their often extremely long-set configuration, and relatively low cost means that the overall quantity of longlines lost is likely to be high”. In Newfoundland and Labrador fisheries, longlines are set on the seafloor to fish cod and Atlantic halibut.

Crab pots used to fish snow crab consist of a conical steel frame covered with netting (Table 4, Figure 6). Multiple pots are set on the seafloor connected by groundlines, with lines attached to buoys at the surface that are used for retrieving gear (NOAA, 2015). Smaller conical pots can also be used in the toad crab and whelk fisheries, though whelk pots can also be made from plastic. Lobster are fished using wood or wire traps set as either single or multiple traps in a fleet. In most fishing areas, lobster is fished with single traps, but fleets may be used in areas where the fishery is more prominent (Dawe et al., 2021).

RATE OF LOSS FOR CRAB POTS

Generally, gear is most often replaced due to wear, rather than loss. Gear loss accounts for only a small portion of replacement, though storm events can lead to significant gear loss. Estimates on the yearly rate of gear loss were made based on the information provided by harvesters on the number of crab pots fished with and the average number of pots lost. Based on this rate, an estimate of the total number of crab pots lost in the province per year was made by calculating the maximum number of pots used (number of licences multiplied by the number of allowed pots), and then multiplying this number by the rate of loss. 2019 crab licence and trap information can be found in Appendix 1.

Based on the information collected during this study, the rate of crab pot loss is estimated to be 1.6% per year, with an average of 3.6 pots lost each year (range 0-20 pots lost per year). Assuming the trap limits were met, this would amount to ~9,738 crab pots permanently lost in Newfoundland and Labrador waters each year. Permanent loss means that these pots were not successfully retrieved.

It is important to note the limitations of this estimate. The rate of loss was calculated from a limited number of interviews, and harvesters may not use as many pots as they are permitted to use. The actual number of pots used depends on factors such as catch rates, vessel size, and capacity. Additionally, fishing effort varies each year with changes in trap limits, species abundance, and fishing seasons, so gear replacement will vary over time (DFO NL Region, pers.comm., March 2022).

Most of crab pot loss reported by harvesters was individual or small numbers of pots that were lost during pot retrieval (ie. hauling crab pots onboard the vessel). If a fleet of gear is lost it is often retrieved. Harvesters take the GPS coordinates on their personal devices when setting their gear. As such, if the gear goes missing the coordinates are used to search for the lost gear. Preventative measures are also taken to limit gear loss. In some areas, local harvesters agree to only set in a certain direction to avoid gear conflicts (eg. north to south). Other strategies include avoiding areas where the bottom or conditions are rough and replacing fishing ropes as needed.

CHAPTER 4: STRATEGIES TO REDUCE ALDFG

The federal government has invested in the investigation of a number of solutions to reducing fishing gear entanglements by large whales through the Whalesafe Gear Adoption Fund. This funding is aimed at technologies that prevent and reduce the severity and duration of entanglements through whalesafe gear. Whalesafe gear includes (DFO, 2022a):

- “Low breaking-strength or ‘weak’ rope, and/or various links that can be incorporated, to result in 1,700 lb or lower breaking strength;
- Equipment that permits hauling of buoy lines that incorporate low breaking strength rope and/or other weak components (e.g., hydraulic set limiter);
- Ropeless or rope-on-demand systems; and,
- Gear location marking systems supporting the operationalization of ‘ropeless’ fishing and the interoperability of different systems.”

Additionally, by 2023, all non-tended fixed gear fisheries are required to use whalesafe gear in Atlantic Canada and Quebec (DFO, 2021a). Multiple harvesters interviewed in this study indicated their concerns over these new requirements, particularly low-breaking strength ropes. Harvesters are concerned that these ropes are not designed for the ocean conditions and fishery characteristics in Newfoundland and Labrador, and will ultimately result in an increase in gear loss. This is as a result of strong ocean tides and heavy catch weights, particularly for fisheries such as turbot.

The Fish, Food, and Allied Workers Union (FFAW-Unifor) has also expressed its opposition to this requirement, which will impact more than 3000 fishing enterprises in the province. The union stated that the use of this gear could result in gear loss (FFAW-Unifor, 2021; VOCM, 2021). Additionally, while the harvesters interviewed stated that a significant amount of time and effort is spent trying to retrieve lost gear, retrieval is not always possible. Such situations can result in significant financial loss for harvesters, in addition to the environmental harm that can occur.

BIODEGRADABLE MATERIALS

The use of 3-ply cotton 96 thread twine has been a mandatory licence condition for snow crab fisheries in Newfoundland and Labrador since 2013 (Winger et al., 2015). This biodegradable twine is sewn into the crab pot mesh or used to attach the escape mechanisms to the pots. If the pot is lost, an opening for crab and other species is created as the twine degrades. Though lost pots will continue to ghost fish for a period of time after they are lost until the cotton twine degrades, the use of biodegradable materials greatly reduces the efficiency of ghost gear, as its ability to continue fishing is lost over time (NOAA, 2015). The incorporation of biodegradable twine in cod pots can also limit ghost fishing (Winger et al., 2015)

Some studies have also investigated the possibility of using biodegradable gillnets. While these nets can reduce ghost fishing, they have demonstrated catch efficiencies 10-40% lower than their nylon counterparts (Grimaldo et al., 2019). Less efficient nets lower catch efficiencies and increase the time, costs, and effort spent fishing. Thus, acceptance of these nets by commercial fish harvesters would be difficult (Grimaldo et al., 2019). Suuronen et al. (2012) suggest that efforts focus on avoiding gillnet loss and enabling swift recovery of lost nets.

GEAR MARKING

Gear marking and tagging requirement for Newfoundland and Labrador are outlined in Chapter 1. Gear marking was identified by the FAO's Voluntary Guidelines on the Marking of Fishing Gear (2019) as an important in the prevention and mitigation of ghost gear. Gear marking improves the visibility of gear and helps prevent gear loss, helps recovering lost gear, helps fish harvesters keep track of their gear, and aids in the identification of illegal fishing activity (GGGI, 2021). Gear visibility can be improved through enhanced buoy marking using lights, flags, reflectors or radar reflectors, and marking gear to identify its owner (Clean Nordic Oceans, 2020; GGGI, 2021). Newer methods of marking gear are being studied to assess their usefulness in various fisheries (GGGI, 2021; He & Suuronen, 2018). These include tags with QR codes, coded wire tags, electronic buoys and devices.

CHAPTER 5: WASTE MANAGEMENT OF END-OF-LIFE FISHING GEAR

There are 80 waste resource management facilities in the province (Fig. 3). This includes transfer stations, landfills, and incinerators. Information on fishing gear waste management was collected for 54 of these facilities through online surveys, phone interviews, and data previously collected by the FGCAC (Dawe et al., 2021).

37 of the 54 waste resource management facilities (68.5%) accept commercial fishing gear. 13 facilities did not accept commercial gear, and four facilities do not receive any fishing gear. Only seven of the 37 facilities that accept fishing gear set fishing rope aside for reuse by local community members. Most landfills in the province bury non-metal fishing gear such as rope and gillnets. Some sites, however, will burn some types of fishing gear. Burning of waste is currently permitted at 26 facilities in the province (Government of Newfoundland and Labrador, 2019).

Fishing-related metals include steel crab pots, wire lobster pots, and trawl warps. Crab pots are one of the most common fishing-related metals. One of the 13 facilities that did not accept fishing gear accepted fishing-related metals. 62% (23/37) of these facilities recycled crab pots. Five facilities accept crab pots but do not recycle them. The remaining nine facilities do not receive any crab pots.

There are multiple metal recyclers in the province (Appendix 10). Of these, Newco Metal and Auto Recycling (Newco Metals) is the largest. Newco Metals recycle metals around the province, collecting metals directly from waste facilities and from other companies that collect metals. Newco collects metals from communities that are serviced by a road network. They have nine collection yards and two processing facilities in the province.

Newco Metals collects metals from communities that are serviced by a road network. They also accept fishing-related metals and crab pots; however, all netting and rope must be removed for crab pots to be recycled. ~94% of waste management facilities that identified their current metal recycler used Newco Metals.

There is no large-scale recycling program for fishing gear in Newfoundland and Labrador. There are inconsistencies in the types of gear accepted and the preparation that is required for metal recycling, even in cases where waste management facilities use the same metal recycler (Dawe et al., 2021).

Harvesters typically dispose of fishing gear by bringing it to a waste facility, burning it, or repurposing it. Larger fishing vessels often fish farther from shore in stronger ocean conditions than smaller vessels. As a result, fishing gear must be in good condition to avoid gear loss. Conversely, gear condition standards are lower for those that fish smaller quotas closer to shore using smaller vessels. Thus, gear that is no longer suitable for offshore fisheries can often still be used for inshore fishing. As such, larger boat fish harvesters will often sell or give their gear that is no longer suitable for offshore fishing, to those that fish from smaller vessels (eg. Ropes and crab pots).

Occasionally, there was a disconnect between the information from Harbour Authorities or harvesters and the information provided by the waste facilities regarding the fishing gear they accept. This disconnect could result in the stockpiling or improper disposal of fishing gear even though there is a waste stream available.

Harvesters face problems with gear disposal in areas where waste facilities do not accept fishing gear. For example, Eastern Waste Management does not accept commercial fishing gear as it is considered special waste and requires special attention during disposal. The Robinhood Bay Waste Management Facility in St. John's is the only facility in the Eastern Waste Management Region that can accept commercial fishing gear. Both Harbour Authorities and fish harvesters in this region identified this as an issue, as the distance to the Robinhood Bay facility acts as a barrier to disposal for harvesters. For some, it would take over two hours to drive to the Robinhood Bay facility to dispose of their gear. Such barriers to proper disposal of fishing gear could contribute to improper disposal or stockpiling of old gear.

Gear is repurposed by harvesters themselves or given away to community members. Rope can be reused in many ways and is often given away to anyone who needs it. Old fishing gear is repaired when possible: nets are mended, crab pots and wire lobster pots that have been misshaped are forced back into a useable shape, and parts are salvaged for reuse on other gear. Some examples of the ways that fishing gear is reused are:

- Rope is used as fencing around animal pastures.
- The steel from crab pot frames is reused to make whelk pots.
- Steel from crab pots is used as rebar in cement structures.
- Wire lobster pots are filled with rocks and used as retaining walls to help prevent erosion on riverbanks.
- Wire from old lobster pots is used in the construction or repair of new lobster pots.
- Rope from crab pots is reused for gillnets.

Fishing rope is also reused for commercial purposes. Many mussel aquaculture farms in Newfoundland purchase end-of-life fishing rope from fish harvesters and use it for mussel lines and seed collection. There is also some reuse of rope to make items such as rope doormats, baskets, and swings. Waste Knot Want Knot in Conception Bay South, Mad Man Murrays Marine Rope Mats on Burnt Islands, and two individuals in Traytown and Elliston are repurposing rope in this way.

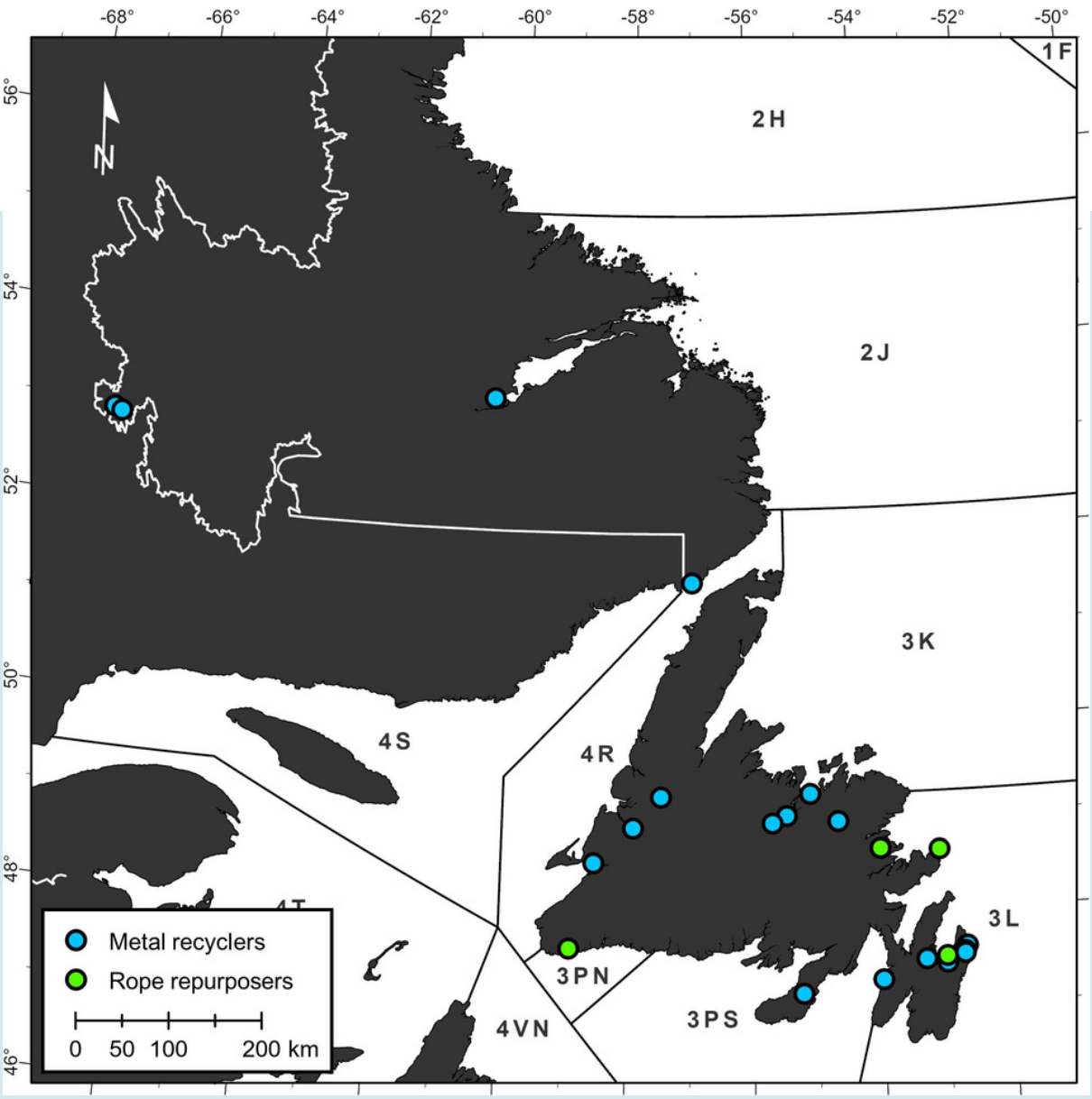


Figure 4. Waste management facilities, rope repurposers and metal recyclers in Newfoundland and Labrador. Map credit Benjamin Misiuk, 2022.

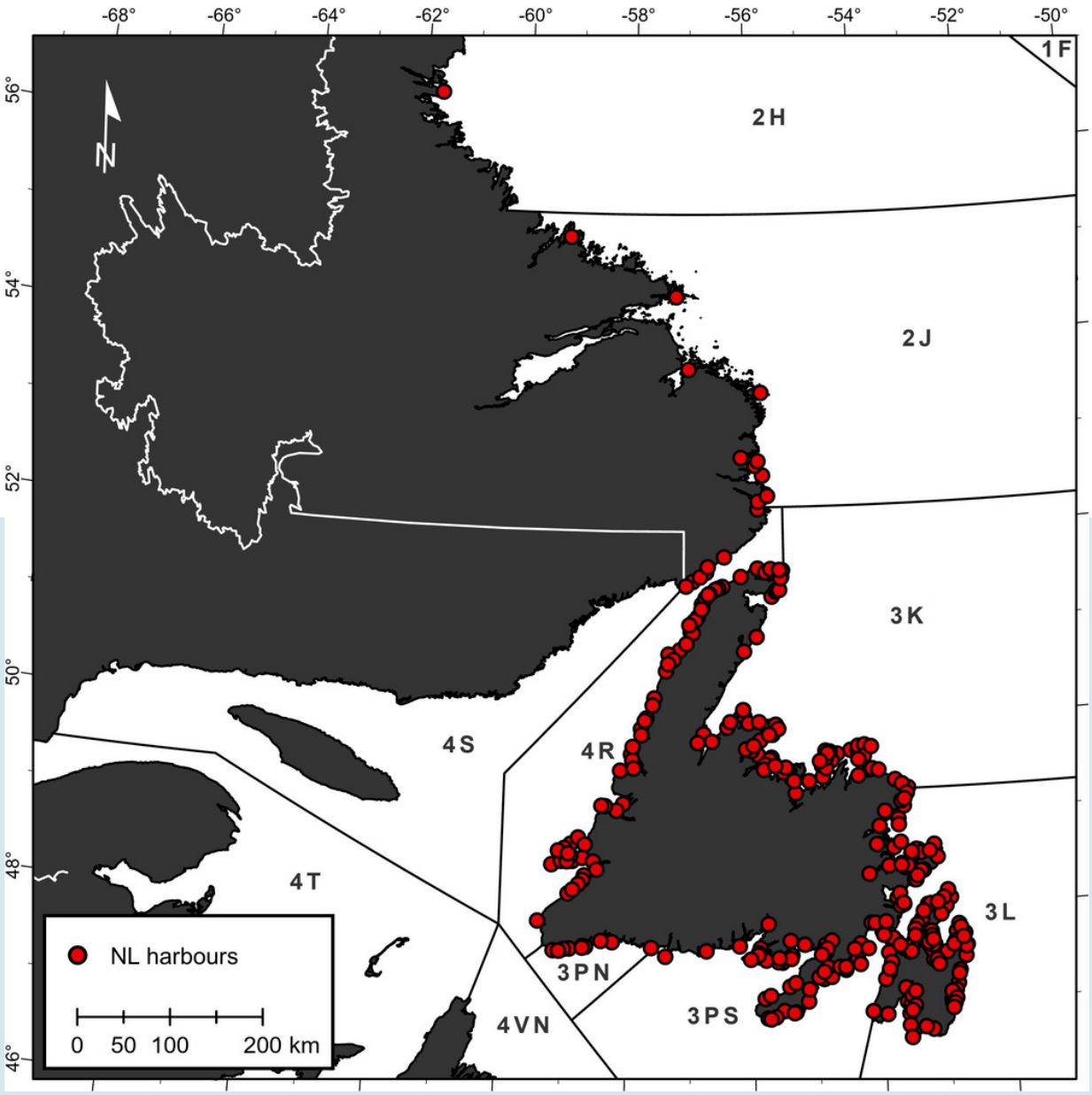
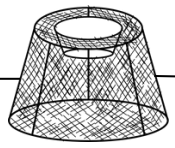


Figure 5. Locations of the 255 active core fishing harbours in Newfoundland and Labrador. Map credit Benjamin Misiuk, 2022.

Table 4. Commercial fisheries , commonly used gear, and its materials. Refer to figures 6-9 for additional information.

Fishery	Gear Used	Materials
Snow Crab	Conical crab pots (traps)	Steel frame, polyethylene netting, plastic cone, poly blend rope, polyform and styrofoam buoys.
Cod	Gillnets	Polyethylene monofilament gillnets, floats, buoys, rope, lead line
	Longline	Polypropylene/monofilament main line, Polypopyelene /nylon branch line, weights, steel swivels and hooks*
Shrimp	Otter trawl	Polyethylene netting, sorting grid, steel warps, floats, steel doors, weighted rollers
Turbot (Greenland Halibut)	Gillnets	Polyethylene monofilament gillnets, floats, buoys, rope, lead line

*Goodman, 2020.



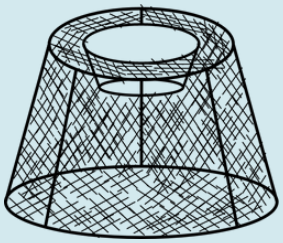


Figure 6. Conical crab pot

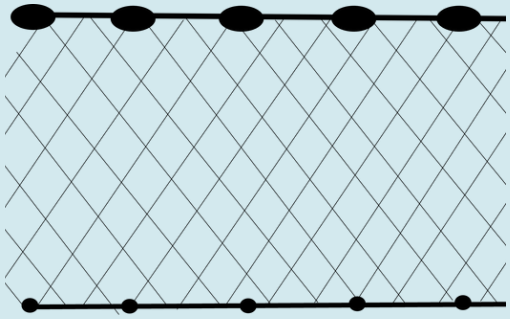


Figure 7. Gillnet

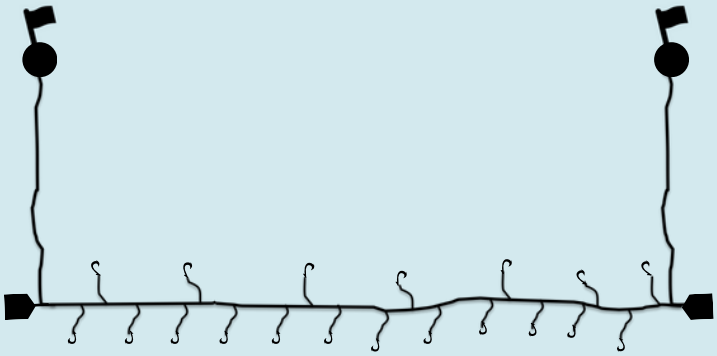


Figure 8. Demersal longline

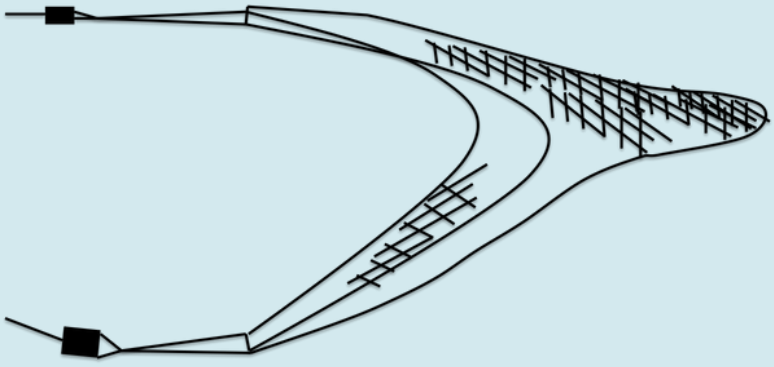


Figure 9. Otter trawl

REPLACEMENT RATES

Similar to gear loss, frequency of gear replacement is influenced by fishing effort and environmental conditions, which impact wear, and risk of damage (Appendices 1 and 2). Gear storage also influences the replacement rate. Many harvesters indicated that it is important to store fishing rope where it is protected from the sun, as it will degrade rope. Additionally, some harvesters will also rinse their gear with fresh water at the end of the season to help prevent corrosion. Most harvesters store gear on their own property (often covered with a tarp), or in their fishing sheds

Interview data gathered from commercial fish harvesters between January and April 2022 indicated that gillnet monofilament netting (commonly referred to as “webbing”) is, on average, replaced every 2.8 years. The ropes and other materials are reused for many years, but the netting is torn over time and needs to be replaced (Table 4).

The replacement rate for crab pots and rope no longer usable for fishing was also calculated through interview data (Appendix 5). The average replacement rate for crab pots was 13.4% per year, with a range of 5-150 pots replaced annually. Harvesters also replaced an average of 4.2 coils of rope each year.

Gillnets are used for multiple fisheries in Newfoundland and Labrador. This includes the fisheries for cod (*Gadus morhua*), turbot (Greenland Halibut [*Reinhardtius hippoglossoides*]), skate (*Rajidae*), monkfish (*Lophius americanus*), white hake (*Urophycis tenuis*), winter flounder (*Pseudopleuronectes americanus*), lumpfish (*Cyclopterus lumpus*), and bait licences (herring [*Clupea harengus*]

and winter flounder [*Pseudopleuronectes americanus*]). In 2021, there were 17, 925 licence holders for these fisheries in the province (DFO NL Region, pers. comm. May 6, 2022; Appendix 2).

The majority of the licence conditions allow for the use of gillnets, however, there are restrictions relating to the type and amount of gear that can be used in each fishery, fishing area, and during different times of the year (Appendix 2). Most cod fishing licences permit the use of gillnets, longlines, handlines, cod traps and/or pots, with the exception of fisheries in NAFO Subdivision 3Pn, where gillnets are not authorized. Bottom-set gillnets are the most common gear used in the cod fishery, though they are considered less sustainable than cod pots and handlines (Rouxel & Montevecchi, 2018). Additionally, there were 2,984 cod licence holders in the province. However, it is important to note that the number of licence holders listed in Appendix 2 does not represent the number of active licences, or those that are actively participating in the fishery. For this reason, these numbers cannot be used to estimate the number of gillnets that are used or replaced annually.

Thus, to gain a more accurate understanding of gillnet use and disposal in southern Labrador, attempts were made to contact all 15 Harbour Authourities in this region. 11 of these were interviewed. Harbour Authorities were asked about the number of active commercial cod licences that fish with gillnets, as well as the number of gillnets used per licence by harbour users (Appendix 3).

In southern Labrador, the cod fishery occurs in NAFO Div. 2J and 4R. Fishing effort in 4R (Labrador Straits region) is

seemingly lower than in 2J, as harvesters are only permitted to set six gillnets and the fishing season is shorter than in 2J.

Where a range was given for the number of active cod licences, the maximum was used. For each harbour, the maximum number of active cod licences was multiplied by the number of gillnets fished per licence to give an estimate of the total gillnets used by harbour users. The number of gillnets typically used by harvesters was unknown at one harbour. In this case, the average number of gillnets used for cod fishing in this area was applied (six gillnets per licence). For the 11 harbours interviewed, there is a maximum of 1,038 gillnets used in the commercial cod fishery. Assuming the average gillnet web replacement time of 2.8 years, a maximum of 384 gillnet webbings are replaced annually.

CHAPTER 6: MANAGEMENT OF END-OF-LIFE FISHING GEAR IN SOUTHERN LABRADOR

SOUTHERN LABRADOR

Southern Labrador encompasses two sub-regions: the Labrador Straits and Southeast Labrador. The Labrador Straits region includes the communities from L'Anse au Clair to Red Bay, while Southeast Labrador encompasses the communities from Lodge Bay north to Cartwright (Figure 5). Commercial fishing is an important industry in this region. Fisheries occur in NAFO Div. 4R (Labrador Straits) and 2J (Southeast Labrador). The main fisheries in southern Labrador are snow crab (*Chionoecetes opilio*), cod, northern shrimp (*Pandalus borealis*), and turbot. Other fisheries include herring, capelin (*Mallotus villosus*), whelk (*Buccinum undatum*), and scallop (*Chlamys islandica* and *Placopecten magellanicus*).

The Trans-Labrador Highway connects the Straits Region, Lodge Bay, Mary's Harbour, Port Hope Simpson, Cartwright and Paradise River with Happy Valley-Goose Bay, an important regional service centre in central Labrador. A section of the highway remains unpaved, but this expected to be completed in 2022 (Destination Labrador, 2021). The highway is not extended to St. Lewis, Charlottetown, or Pinsent's Arm, and the community of Black Tickle-Domino is located on an island only accessible by boat. Additionally, Lodge Bay and Black Tickle-Domino operate as Local Service Districts.

TABLE 5. Commercial fisheries based out of harbours in southern Labrador

Harbour	Fisheries
L'Anse au Loup to Red Bay (Straits Region)	Cod, herring, capelin, halibut, toad crab
Mary's Harbour	Snow crab, cod
St. Lewis	Snow crab, cod, turbot, whelk, herring
Square Islands and Pinsent's Arm	Snow crab, cod, whelk, scallop
Charlottetown	Shrimp
Black Tickle-Domino	Cod
William's Harbour	Crab, cod, whelk
Cartwright	Crab, cod

1. Goodman (2020).

Note: Information in this table was collected from fish harvesters, harbour authorities, or through online sources (Labrador Fishermen's Union Shrimp Company, 2014), as such all fisheries from each harbour may not be included.

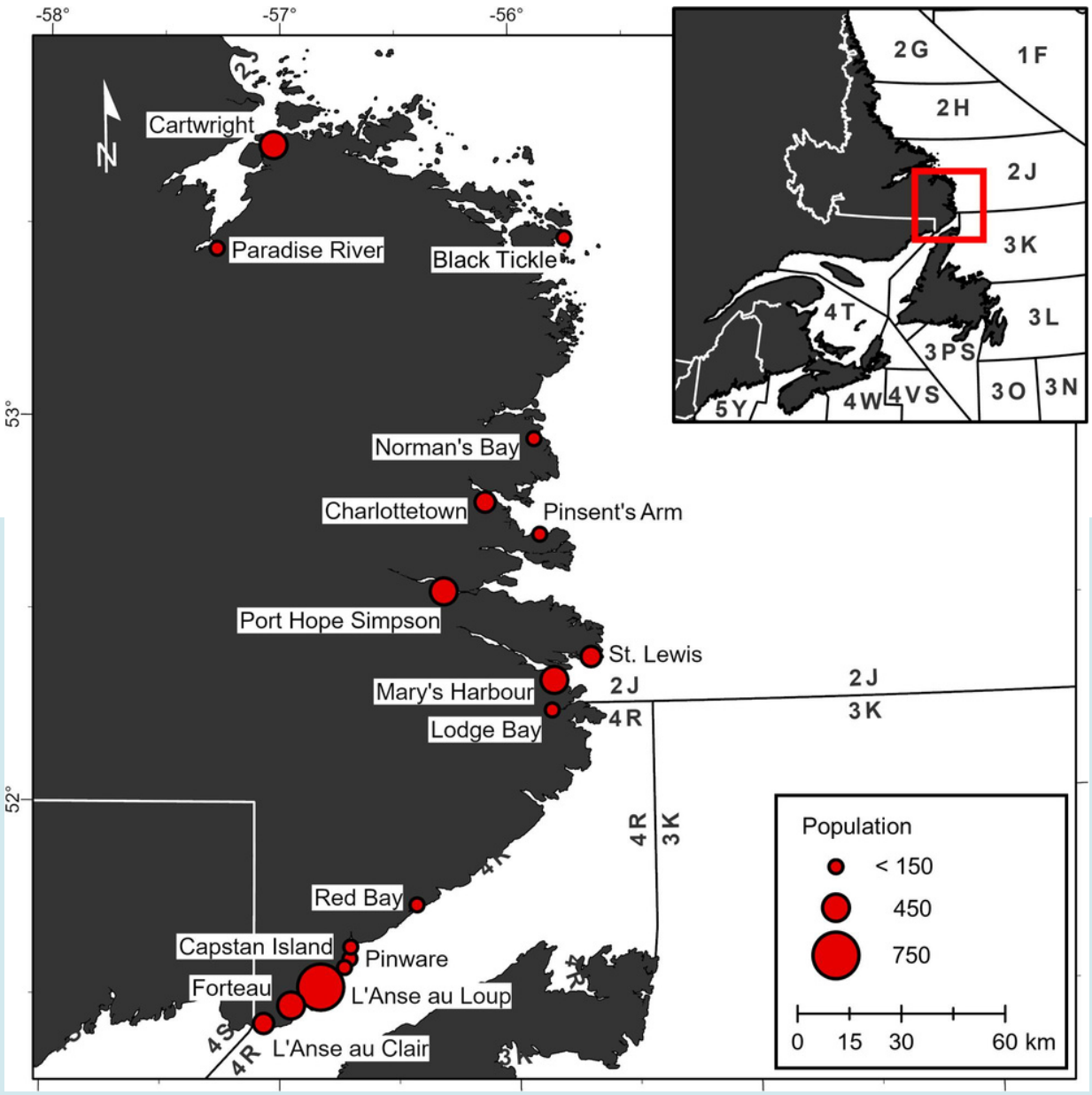


Figure 10. Locations and population size of communities in Southern Labrador. Map credit Benjamin Misiuk, 2022.

WASTE MANAGEMENT IN LABRADOR

There are 12 landfills in the Southern Labrador Waste Management Region, and each community in Eastern Labrador has its own landfill (Appendix 9). The landfill in Forteau services all communities in the Straits region except Red Bay. However, the Forteau landfill is at capacity and is overflowing (CBC News, 2016). The Provincial Waste Management Strategy planned to implement a centralized waste disposal site for all Southern Labrador, with a proposed site near Mary's Harbour, but strong local opposition has halted the development of this site (Gov NL, 2019). There is 408km from L'Anse au Clair to Cartwright, causing concerns surrounding the increased cost of waste disposal due to the cost of transportation, as well as concerns that winter road closures between Red Bay and Lodge Bay will impact the transport of waste from communities in the Straits Region to the regional landfill (Gov NL, 2019; Fang et al., 2011). There are also concerns from residents regardingthe environmental impacts of implementing this strategy. Residents are also concerned about the impact of proposed the waste disposal site on fishing rivers, and that the large distance from some communities to the regional landfill will increase illegal dumping (CBC News, 2016; Fang et al., 2011).

Attempts were made to reach all waste facilities in the Southern Labrador region via online surveys and phone interviews. Information was gathered for four of these landfills. The fishing gear that arrives at these sites is typically burned or buried. Newco Metals currently recycles the metals from these facilities, though not all facilities recycle crab pots.

OPTIONS FOR RECYCLING

FISHING ROPE

Several rope recycling options were investigated, though options for rope recycling are limited. This is due to the many challenges associated with rope recycling. Fishing rope can be made from many combinations of synthetic polymers, and this lack of standardization complicates the recycling process (Dawe et al., 2020). Additionally, recycling these materials is costly and finding a market for the recycled materials can be challenging. The main ropes used by harvesters in this area a blend of polypropylene and polyethylene.

There are a number of international companies that recycle fishing nets and rope. Attempts to reach two of these companies (PLASTIX Global and Nofir) as part of this study were unsuccessful. PLASTIX Global is a Danish company that recycle used nets, ropes, and rigid plastics from the fishing industry into new Green Plastic raw materials (PLASTIX, n.d.). Nofir are a Norwegian company that recycle and upcycle materials from the aquaculture and commercial fishing industries, including ropes, gillnets, purse seine and trawl nets.

Ackman's 2017 study, *Feasibility of Recycling Fishing Gear in Nova Scotia*, assessed Plastix Global options for the recycling of fishing gear from Nova Scotia. At that time, Ackman found that PLASTIX Global had not yet developed a method for economically recycling all fishing materials but were continuing to research this. Plastix Global also covered the cost of shipping of materials. At the time of Ackman's study (2017), Plastix Global had partnered with

harbours in England, and were looking to develop partnerships with North American harbours in the future. Plastix Global would take all of the fishing materials commonly used in Nova Scotia, though challengingly 20% of the material in each load would need to be nylon 6. Many of the fishing materials used in Nova Scotia are also commonly used in Newfoundland and Labrador (Dawe et al., 2020; Dawe et al., 2021).

SUSUTANE TECHNOLOGIES INC. (CHESTER, NS)

Sustane Technologies worked with Coastal Action and Goodwood Plastic Products Ltd. to collect and recycle a small amount of fishing rope from the lobster fishery in southwest Nova Scotia (Kevin Cameron, personal communication, March 15, 2022). Sustane is not capable of accepting more fishing rope at this time, as they need dedicated equipment to handle fishing gear. However, Sustane are in the process of upgrading their equipment, so this may provide future opportunities for recycling fishing rope from Newfoundland and Labrador fisheries (Kevin Cameron, personal communication, March 15, 2022).

GILLNETS

WWF-Canada has been working with a local company, Seaside Reclaimed, to conduct a pilot project to recycle monofilament gillnet webbing. The company currently operates a recycling program that recycles plastic bottle caps into clothing items. They work with other recycling companies to collect these bottle caps from around the province from existing MMSB Green Depots. Many of the harvesters contacted indicated that there would be local interest in a program to recycle fishing gear. One harvester indicated that a drop off location for old gillnet webbing would be needed in each community.

Webs could then be collected, at least twice a year, and consolidated in one area for recycling. Harbours may provide a convenient location for collection bins, and some Harbour Authourities indicated that they would likely have space or interest in implementing such a program through storage at the harbour. The majority of gillnet netting is replaced during the winter and early spring.

CRAB POTS AND OTHER FISHING RELATED METALS

As outlined in Chapter 5, 37 of the 54 waste management facilities (68.5%) accept commercial fishing gear. 62% (23/37) of these facilities recycled crab pots, and five facilities accept crab pots but do not recycle them. the largest metal recycler in Newfoundland and Labrador. Newco Metals collect metals directly from waste resource management facilities and other smaller metal collection companies around the province that are serviced by a road network. They have nine locations in the province, including one in Happy Valley-Goose Bay. Secondary processing of metals takes place on the island of Newfoundland (Dawe et al., 2021). Often, when landfills collect enough metal, they issue tenders to sell these metals. Newco Metals accept fishing-related metals and crab pots; however, all netting and rope must be removed for crab pots to be recycled (Dawe et al., 2021). Though ~94% of waste resource management facilities in this study identified their metal recycler as Newco Metals, crab pots and other fishing related metals are not accepted or recycled at all facilities. As some of the landfills are unmonitored, outreach may be needed to ensure that crab pots are being properly prepared for recycling.

CONCLUSIONS AND RECOMMENDATIONS

Ghost gear is a global problem that has environmental and economic impacts on the world's oceans and those that depend on them. Work to reduce the amount of ghost gear in Newfoundland and Labrador waters through gear retrievals, shoreline and harbour cleanups, and research to understand the ways that fishing gear and marine plastics are impacting marine habitats and species have occurred most frequently in recent years. Though the estimated annual rate of loss is low, the estimated annual trap loss of ~9,738 crab pots is significant, particularly over multiple years. The incorporation of biodegradable twine to limit the time that they continue fishing after loss is significant in reducing ghost fishing. However, biodegradable technologies are not used in all fisheries, as impacts on catch efficiency greatly reduce its practicality. Other efforts to reduce ALDFG and whale entanglements could result in an increase in ghost gear, as some whalesafe gear may be unsuitable for local fisheries.

Synthetic fishing rope is difficult and costly to recycle. While efforts are being made to find solutions for end-of-life fishing rope and gillnets, there are currently no large-scale recycling options available in Atlantic Canada. Very few waste management facilities have programs to reuse old fishing gear, and repurposing of rope for commercial purposes is limited. There are solutions for metal from the fishing industry, but coordination and education are required to ensure that they do not end up in landfills, stockpiled, or improperly disposed of at sea.

In addition, the infrastructure and community characteristics of southern Labrador present logistical and financial challenges for waste management and the recycling of fishing gear. While the Labrador Straits region is connected and has regionalized waste services, the landfill is at capacity.

The large distance between communities beyond the Straits region increases costs associated with waste disposal and recycling. As such, it is logical to use the waste management systems that are already in place to recycled or repurpose fishing gear, where possible. Many of the interviewed fish harvesters and Harbour Authorities were optimistic about the prospect of a recycling program for fishing gear in their community. Repurposing of fishing gear will not be able to divert all fishing gear waste from landfills as the condition of some rope and other materials will not always be useable. However, reuse and repurposing of fishing gear provide great opportunities for extending the life of fishing gear without large costs for communities in this region. Repurposed fishing rope items could be marketed towards tourists and retailed tourist areas such as Battle Harbour.

RECOMMENDATIONS

ALDFG PREVENTION AND REGULATIONS

- DFO should work with harvesters in Newfoundland and Labrador to develop and test solutions for ALDFG and whalesafe gear and/or biodegradable gear to ensure that they will work as intended in all fishing areas, and that they are well received by the fishing industry.

- DFO should conduct community outreach to improve reporting of lost gear and provide education on the importance of this data, how it is used, and how it improves the understanding of ALDFG in Newfoundland and Labrador. Consultations with fish harvesters to understand the ways that they are already documenting gear loss will aid in working efficiently together to prevent and remove lost gear.

- Community outreach should be conducted to encourage recycling of steel trawl warps, rather than disposal at sea. Small Craft Harbours should investigate the possibility of placing bins for metal recycling at wharves where this practice is pervasive.

- Further research to assess and potentially improve port infrastructure is needed to establish effective recycling programs for fishing gear.

- In consultation with the fishing industry, investigate the ways that ghost fishing gear can be reduced through gear marking methods.

- Work with industry to test the use of other technologies to prevent ALDFG such as increasing the visibility of gear in high marine traffic areas. Some examples include the use of reflectors or radar reflectors on buoys (Clean Nordic Oceans, 2020). Other solutions that may be helpful include the use of recovery sensors to locate gear.

WASTE MANAGEMENT, RECYCLING, AND REUSE

- Where possible, waste management facilities should set rope aside for community reuse or work with local crafters to provide them with access to these materials that would otherwise be burned or buried.

- Where rope is set aside for reuse, it should be covered to ensure that it does not degrade in the sun.

- Facilities that do not accept commercial fishing gear, such as the transfer stations in the Eastern Waste Management Region, should work with commercial fish harvesters to provide convenient options for fishing gear disposal and metal recycling. This could take the form of providing bulk garbage collection for commercial fishing gear or accepting these materials directly at transfer stations. A lack of convenient or inexpensive options can lead to illegal or improper disposal of this gear in a manner that can be harmful to the environment.

- Work with the waste management facilities that recycle metals but do not recycle crab pots to ensure that these and other fishing-related metals are not buried in landfills when there is a recycling option available.

- Work with existing infrastructure and recyclers, such as Newco Metals, to develop a recycling and repurposing program for fishing-related metals and rope in Southern Labrador.

- Waste facilities should provide community outreach, particularly at unmonitored landfills; to ensure that crab pots and other fishing gear is properly prepared for recycling (ie. All non-metal material removed prior to placement in the metal pile).

- Consult with fish harvesters and communities to determine the most viable solution to fishing gear recycling and reuse, and to ensure participation in this program.

- Compensate harvesters for gear, if possible, to offset costs of transportation. If harvesters do not see the benefit (i.e. cost of transport outweighs what they may receive in return) burning of fishing gear will continue.

- Communities in this area should continue to revisit the feasibility of recycling fishing rope as the industry grows and more options for recycling become available.

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APPENDIX 1

SNOW CRAB LICENCE AND TRAP INFORMATION (2019)

NAFO	FLEET	SINGLE ENTERPRISE	COMBINED ENTERPRISE	TOTAL LICENCES	MAX SINGLE ENTERPRISE TRAPS	MAX COMBINED ENTERPRISE TRAPS
2J	FULLTIME	1200	1200	4	2400	2400
	SUPPLEMENTARY	1200	1200	23	19200	8400
	INSHORE	200	400	48	7400	4400
3K	FULLTIME	800	800	22	0	17 600
	SUPPLEMENTARY	800	800	93	15200	59 200
	INSHORE 3A	150	300	56	6000	4800
	INSHORE 3B	150	300	64	7200	4800
	I NSHORE 3C	100	200	102	6300	7800
	INSHORE 3BC	150	300	21	1350	3600
	INSHORE 3D	100	200	196	10200	18 800
	AREA 4 INSHORE FLEET (>10 GRT)	200	400	6	600	1200
3L	FULLTIME	1200	1200	32	9600	28 800
	LARGE SUPPLEMENTARY	1200	1200	35	18000	24 000
	SMALL SUPPLEMENTARY	400	600	158	28800	51 600
	INSHORE 5A	150	200	166	14100	14 400
	INSHORE 6A	150	250	158	17550	10 250
	INSHORE 6B	150	250	116	10350	11 750
	I NSHORE 6C	200	300	91	11800	9600
	INSHORE 8A	200	300	51	6000	6300
	INSHORE 9A	300	300	22	5100	1500
3PS	SUPPLEMENTARY	400	600	62	10400	21 600
	11S/11SX	300	450	13	3000	1350
	INSHORE 10A	200	N/A	235	21400	N/A
	INSHORE 11E	100	N/A	220	22000	N/A
4R3PN	INSHORE 11W	150	N/A	8	1200	N/A
	OUTSIDE 8	250	N/A	58	14500	N/A
	INSHORE 12A - 12H	100	N/A	264	24800	N/A

Information from DFO 2019: https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/2019/index-eng.html

APPENDIX 2:

MAXIMUM USAGE OF GILLNETS IN NL FISHERY

Fishery	Number of Gillnets Permitted as per Licence Conditions	Number of Licences**	Notes	
3Ps Cod	• Areas a, b, and c, maximum 30 gillnets • Areas d, e, f, g, and h, maximum 80 gillnets	598	*Harvesters can use gillnets, longlines, handlines, cod traps and/or pots. Handlines and pots can be used when using gillnets or longlines.	*Note that this information is from 2021 Licence Conditions
4RS + 3Pn Cod	• Maximum 6 gillnets of no more than 50 fathoms each	675	*Gillnets are not permitted for use for cod in 3Pn. In 4RS, harvesters can use gillnets, longlines, handlines and/or pots. There are restrictions on combinations related to a latitude line (48 degrees 4' N, 59 degrees 9' W).	*Note that this information is from 2021 Licence Conditions
2J3KL Stewardship Cod (incl. 4R overlaps)	• July 25-August 28 – maximum 6 gillnets • August 29 onward – based on catch limit: Up to and incl. 4000 lbs = 9 nets 4000 – 8000 lbs = 12 nets 8000-16,000 lbs – 15 nets 16,000-24,000 lbs = 24 nets Greater than 24,000 lbs = 34 nets • 2J – maximum 34 gillnets	1711	*Harvesters can use gillnets, longlines, handlines and/or pots. Handlines and pots can be used when using gillnets or longlines.	*Note that this information is from 2021 Licence Conditions
3Ps Greenland Halibut (Turbot)	• Areas a, b, and c, maximum 30 gillnets • Areas d, e, f, g, and h, depths 100-400 fathoms, maximum 200 gillnets, depths >400 fathoms, maximum 500 gillnets (if fishing both areas, maximum 500 gillnets) *If fishing both depths in d, e, f, g and h then a maximum of 500 gillnets may be fished, but not more than 200 may be set in depths 100-400 fathoms.	1441	*Harvesters may use gillnets or longlines.	*Note that this information is from 2021 Licence Conditions
4R Greenland Halibut (Turbot)	• Maximum 90 gillnets	615	*Licence conditions are for gillnets only.	*Note that this information is from 2021 Licence Conditions
0B Greenland Halibut (Turbot)	• Maximum 500 gillnets	14	*Harvesters may use gillnets or longlines.	*Note that this information is from 2021 Licence Conditions
2GH Greenland halibut (Turbot)	• Depth 160-300 fathoms, maximum 120 gillnets (increased to 170 in September 2021) • Depth >300 fathoms, maximum 120 gillnets (increased to 170 in September 2021) *The maximum number of gillnets that can be fished at any one time cannot exceed the maximum number of nets permitted in the deepest water depth being fished by the enterprise.	1		*Note that this information is from 2021 Licence Conditions
2J Greenland Halibut (Turbot)	• Depth >400 fathoms, maximum 120 gillnets (increased to 170 in September 2021) • Depth >500 fathoms, maximum 160 gillnets (increased to 210 in September 2021)	132		*Note that this information is from 2021 Licence Conditions

	*The maximum number of gillnets that can be fished at any one time cannot exceed the maximum number of nets permitted in the deepest water depth being fished by the enterprise.			
3K Greenland Halibut (Turbot)	• Depth 300-500 fathoms, maximum 120 gillnets (increased to 170 nets in September 2021) • Depth >500 fathoms, maximum 160 gillnets (increased to 210 nets in September 2021)	2280	*The maximum number of gillnets that can be fished at any one time cannot exceed the maximum number of nets permitted in the deepest water depth being fished by the enterprise.	*Note that this information is from 2021 Licence Conditions
3LMNO Greenland Halibut (Turbot)	• Depth 300-500 fathoms, maximum 120 gillnets (increased to 250 gillnets in August 2021) • Depth >500 fathoms, maximum 170 gillnets (increased to 300 gillnets in August 2021)	47	*Harvesters may use gillnets or longlines. *Fishing with gillnets and longlines on the same trip is not permitted.	*Note that this information is from 2021 Licence Conditions
3NO Skate, Monkfish and White Hake	• When directing for white hake – maximum 100 nets • When fishing for skate and monkfish – maximum 300 nets • When fishing for skate, monkfish and white hake – maximum 300 nets	15		*Note that this information is from 2021 Licence Conditions
3Ps White hake	• Areas a and b: maximum 20 gillnets • Areas d, e, f, g, and h: maximum 100 gillnets	1441		*Note that this information is from 2021 Licence Conditions
3Ps Skate	• When fishing less than 19 Km from land: maximum 40 gillnets • When fishing more than 19 Km from land: maximum 200 gill nets	1450	*When fishing any authorized species of groundfish in 3Ps (a), (b) and (c) during the period of November 15 to February 28, a maximum of 30 gillnets is authorized for all licences combined.	*Note that this information is from 2021 Licence Conditions and Groundfish General Licence conditions
3Ps Monkfish	• When fishing less than 19 Km from land: maximum 40 gillnets • When fishing more than 19 Km from land: maximum 200 gill nets	1444	*When fishing any authorized species of groundfish in 3Ps (a), (b) and (c) during the period of November 15 to February 28, a maximum of 30 gillnets is authorized for all licences combined.	*Note that this information is from 2021 Licence Conditions
3Ps Winter Flounder (Blackback)	• Maximum 20 gillnets	1441		*Note that this information is from 2021 Licence Conditions
3KL Winter Flounder (Blackback)	• Maximum 20 gillnets, maximum length of 50 fathoms each	256		*Note that this information is from 2021 Licence Conditions

2J3KL + 4R + 3Psn Lumpfish	• Maximum of 50 gillnets	1997	*There is no lumpfish fishery in 3Pn as gillnets are not authorized to be used in this sub-Division.	Excluding 2J and Petty Harbour
Bait Licences (herring and Winter Flounder)	• Maximum two gillnets	2367		*Note that this information is from 2021 Licence Conditions

**It is important to note that the total number of licences in the third column is the number of harvesters who hold licences, not the number of active harvesters in any given year.

Information from DFO Nl Region, personal communication, March 2022.

APPENDIX 3:

SOUTHERN LABRADOR HARBOUR AUTHORITY SURVEY

Cod:

1. How many harbour users fish cod commercially?
2. How many active licenses for cod are there at your harbour?
3. Do they fish with mostly gillnets or other gear?
4. How many nets do most users fish with?

Turbot:

5. Do any harbour users fish turbot? If so, how many?
6. How many licenses actively fish turbot?
7. How many gillnets do most users fish with?
8. How often do turbot gillnet webs have to be replaced?

APPENDIX 4:

INTERVIEW QUESTIONS FOR GEAR RETRIEVAL PROJECTS

1.Where have you completed ghost gear retrieval?
2.How did you collect ghost gear (method used)?
3.How did you decide where to look for ghost gear?
4. What kinds of gear did you retrieve?
5.How much of each kind of gear did you retrieve?
6.Was any harm observed or reported to the environment (e.g. bycatch) or as a navigational hazard?

APPENDIX 5:

FISH HARVESTER INTERVIEW QUESTIONS

1. How long have you been a commercial fish harvester?
2. What species do you fish?

a. Lobster:
i. Where do you fish lobster?
ii. Do you use wood or wire pots? Do you set single or in a set?
iii. What kind of weight do you use in your pots?
iv. On average, how many pots do you lose each year?
1. Does that include the rope and float?
v. Are you able to retrieve them?
vi. How?
vii. On average, how many pots are permanently lost each year? Is this typical for harvesters in your area?
viii. Do you record the location of lost gear?
ix. Do you report it? How?
x. How many pots do you build or purchase each year? How many of those are replacing lost gear or gear that can no longer be used for fishing?
xi. What do you do with your old pots that can no longer be used for fishing?

b. Crab (and other pot fisheries):
i. Where do you fish crab? (inshore, offshore, depth)[ND1]
ii. How many pots do you set in a series?
iii. On average, how many pots do you lose each year?
1. Does that include the rope and float?
iv. Are you able to retrieve them?
v. How?
vi. On average, how many pots are permanently lost each year? Is this typical for harvesters in your area?
vii. Do you record the location of lost gear?
viii. Do you report it? How?
ix. How many pots do you build or purchase each year? How many of those are replacing lost gear or gear that can no longer be used for fishing (end-of-life gear)?

x. What do you do with your old pots that can no longer be used for fishing?
c. Gillnet fisheries (cod, turbot, others)
i. Where do you fish these species?
ii. Number and size of gillnets used?
iii. On average, how many gillnets do you lose each year?
1. Does that include the ropes, floats, and weights?
iv. Are you able to retrieve them?
v. How?
vi. On average, how many gillnets are permanently lost each year? Is this typical for harvesters in your area?
vii. Do you record the location of lost gear?
viii.Do you report it? How?
ix. How many gillnets do you dispose of each year? How many of those are replacing lost gear? What about gear that can no longer be used for fishing?
x. How often do you replace the webbing?
xi. What do you do with your old gillnets that can no longer be used for fishing?

d. Bottom longline (cod, halibut)
i. Where do you fish these species?
ii. Length of lines used?
iii. On average, how many longlines do you lose each year?
1. Does that include the ropes, floats, and weights?
iv. Are you able to retrieve them?
v. How?
vi. On average, how many longlines are permanently lost each year? Is this typical for harvesters in your area?
vii. Do you record the location of lost gear?
viii.Do you report it? How?
ix. How many gillnets do you dispose of each year? How many of those are replacing lost gear? What about gear that can no longer be used for fishing?
x. How often do you replace the webbing?
xi. What do you do with your old gillnets that can no longer be used for fishing?

e. Rope:
i. On average, how much rope do you lose each year?
ii. Are you able to retrieve it?
iii. How?
iv. On average, how much rope is permanently lost each year? Is this typical for harvesters in your area?
v. Do you record the location of lost gear?
vi. Do you report it? How?
vii. How many coils of rope do you dispose of each year? ? How many of those are replacing lost gear? What about gear that can no longer be used for fishing?
viii.What do you do with old rope that can no longer be used for fishing?
f. Do you have any problems with trying to dispose of your old fishing gear?

3. Have you ever come across lost gear while fishing that was not your own? What kinds?
a. Was there any damage to humans or the environment?

1.What do you do when you encounter lost gear?

2. Are there areas where you see lost gear more often?
a.Why does it happen in those areas?
7) Are there ways to prevent gear loss from happening? How?

8. Is there any disposal at sea or on land happening? Why is it happening?

9. Are there any stockpiles of old gear in the community (eg. Old, abandoned fishing sheds or wharves)?

10. Do you know of anyone that is reusing old fishing gear for any other purpose? Recycling it, making crafts, reusing it for something else.

11.Do you have any ideas or suggestions for ways that fishing gear can be better managed, repurposed, or recycled locally or within the province?

12.Is there anything else you would like to add?
13.May we reach out to you if we have any other questions?

APPENDIX 6:

WASTE FACILITY SURVEY QUESTIONS

1.Where is your landfill/waste management facility located?
2.Do you accept all kinds of fishing gear? (eg. Fishing rope, gillnets, crab pots, wooden lobster pots, wire lobster pots, fishing line, etc.)?
3.Are there any kinds of fishing gear you don't accept?
4.Why do you not accept this gear?
5.What are the most common types of fishing gear you receive?
6.What happens to the fishing gear your site receives? (eg. Buried, recycled, given away, stockpiled, repurposed, etc.)
a.Gillnets:
a.Rope:
b.Fishing line:
c.Crab pots:
d.Wooden lobster pots:
e.Wire lobster pots:
2.Do you charge tipping fees for fishing gear?
3.If so, how much?
4.Do you recycle metal?
5.Who recycles your metal?
6.Do you recycle crab pots?
a.If so, is any preparation required before they are recycled? (eg. Netting and rope removed). If so, what preparation is required?
7.Does fishing gear cause any problems at your site? (eg. Gear entanglement)
8.On average, roughly how much fishing gear do you receive each year?
9.Where is most of this fishing gear coming from? (eg. Fishing companies, commercial fishers, retired or inactive commercial fishers, etc.)
10. Do you know of any other ways that fishing gear is being disposed of in your area? (eg. Burned, improperly dumped on land or at sea, etc.)
1.Is there old fishing gear stored or stockpiled anywhere else in your area? (Eg. Old, unused fishing stages and wharves)
2.Do you know of any other ways that fishing gear is locally reused, repurposed, or recycled? (eg. Art, crafts, growing vegetables, etc.)
a.What is it being used for?

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1.Do you have any ideas or suggestions for ways that fishing gear can be better managed, repurposed, or recycled locally or within the province?
2.May we reach out to you if we have any other questions?

APPENDIX 7:

ROPE REPURPOSER INTERVIEW QUESTIONS

1. When did you start your business?

2. What products do you make from old fishing gear?

3. What kinds of fishing gear do you use to make these?

4. Is it mostly one type of rope? (e.g. used for crab fishing)?

5. Where do you get your rope from? Purchased or donated?

6. How much wear on the rope is acceptable?

7. How much rope do you use for each mat?

8. How much rope have you been able to repurpose since you started?

9. Where do you sell your products?

10. Anything else you would like to add?

APPENDIX 8:

HARBOUR AUTHORITY SURVEY QUESTIONS

5.What are the main fisheries based at this harbour? Select all that apply
a.Snow crab (Inshore)
b.Snow crab (Offshore)
c.Shrimp
d.Lobster
e.Cod
f.Scallop
g.Halibut
h.Turbot
i.Sea cucumber
j.Whelk
k.Capelin
l.Herring
m.Mackerel
n.Arctic char
o.Squid
p.Toad Crab
q.Other
6.If you selected "other" please describe:
7.What kind of gear is mainly used for the fisheries at this harbor? Select all that apply
a.Gillnets
b.Crab pots
c.Wooden lobster pots
d.Wire lobster pots
e.Whelk pots
f.Longline
g.Handline
h.Seine
i.Capelin traps
j.Other

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8.If you selected “other” please describe
9.Are you a commercial fish harvester?
10. Do harbour users store old, unusable fishing gear at your harbor?
11. Do you have garbage receptacles at your harbor?
a.Yes
b.No
12. Is fishing gear allowed in these receptacles? If so, what kinds of fishing gear are allowed?
13. Is there anything at your harbour specifically for the disposal of fishing gear?
14. What challenges do you face in dealing with old, unusable fishing gear at your harbour? (e.g. harbour users not properly disposing of it)
15. Do harbour users have difficulty disposing of old, unusable fishing gear? What obstacles do they face?
1.Does the Harbour Authority or anyone else in your area recycle or repurpose old gear? (e.g. used to make crafts, salvaged for parts, used for other purposes)
a.Yes
b.No
2.How do they recycle or repurpose old fishing gear (if applicable)?
3.Are there any other ways that users dispose of their gear? (e.g., burned, stockpiled, disposal at sea, taken to landfill)
4.Do you have stockpiles of rope or old/discarded fishing gear that you don't know what to do with?
5.Are there stockpiles of rope or old fishing gear in the community that no one knows what to do with?
6.In your opinion, is ghost gear (lost, discarded, or abandoned fishing gear in the marine environment) an issue in your area?
a.Yes
b.No
7.If so, what type of gear is it? Where is it located?
8.Do you have any ideas or suggestions for ways that fishing gear can be better managed, repurposed, or recycled locally or within the province?
9.Would you be interested in projects to recycle or repurpose old unusable fishing gear or ghost fishing gear?
a.Yes
b.No
c.Maybe

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1.Would harbour users be interested in projects to recycle or repurpose old unusable fishing gear or ghost fishing gear?
a.Yes
b.No
c.Maybe
2.Is there anything else you would like to add?
3.Would you be willing to discuss this survey with organizations outside of DFO that are working to understand the ways that old, unusable fishing gear and ghost gear can be reused, repurposed, and recycled in Newfoundland and Labrador?

APPENDIX 9:

WASTE MANAGEMENT FACILITIES IN NL

FACILITY NAME	WASTE MANAGEMENT REGION
ROBIN HOOD BAY	EASTERN
CENTRAL NEWFOUNDLAND REGIONAL LANDFILL	CENTRAL
CLARENVILLE TRANSFER STATION	EASTERN
BUCHAN'S JUNCTION TRANSFER STATION	CENTRAL
FOGO ISLAND TRANSFER STATION	CENTRAL
GANDER BAY TRANSFER STATION	CENTRAL
INDIAN BAY TRANSFER STATION	CENTRAL
NEW WORLD ISLAND/TWILLINGATE TRANSFER STATION	CENTRAL
POINT LEAMINGTON TRANSGER STATION	CENTRAL
TERRA NOVA TRANSFER STATION	CENTRAL
SOUTH BROOK REGIONAL LANDFILL (GREEN BAY WASTE AUTHOURITY)	BAIE VERTE/GREEN BAY
BAY BULLS WASTE RECOVERY FACILITY	EASTERN
BELL ISLAND WASTE RECOVERY FACILITY	EASTERN
CAVENDISH WASTE RECOVERY FACILITY	EASTERN
HARBOUR GRACE WASTE RECOVERY FACILITY	EASTERN
OLD PERLICAN WASTE RECOVERY FACILITY	EASTERN
PLACENTIA WASTE RECOVERY FACILITY	EASTERN
RENEWS-CAPPAHAYDEN WASTE RECOVERY FACILITY	EASTERN
ST. JOSEPH'S WASTE RECOVERY FACILITY	EASTERN

SUNNYSIDE WASTE RECOVERY FACILITY	EASTERN
WHITBOURNE WASTE RECOVERY FACILITY	EASTERN
WILD COVE WASTE TRANFER STATION	WESTERN
BURGEO WASTE TRANSFER STATION	WESTERN
SOUTHWEST COAST WASTE TRANSFER STATION	WESTERN
BAY ST. GEORGE WASTE TRANSFER STATION	WESTERN
LONG RANGE WASTE TRANSFER STATION	WESTERN
WHITE BAY SOUTH WASTE TRANSFER STATION	WESTERN
*GOOSE COVE-BOAT HARBOUR (NORTHERN PENINSULA WASTE MANAGEMENT REGION INFO ARE THE SAME)	NORTHERN PENINSULA
*MAIN BROOK-ENGLEE (NORTHERN PENINSULA WASTE MANAGEMENT REGION INFO ARE THE SAME)	NORTHERN PENINSULA
*EDDIE'S COVE EAST-CASTOR RIVER NORTH (NORTHERN PENINSULA WASTE MANAGEMENT REGION INFO ARE THE SAME)	NORTHERN PENINSULA
*EDDIE'S COVE WEST-RIVER OF PONDS (NORTHERN PENINSULA WASTE MANAGEMENT REGION INFO ARE THE SAME)	NORTHERN PENINSULA
MARYSTOWN	BURIN PENINSULA
TOWN OF WESTPORT LANDFILL	BAIE VERTE-GREEN BAY
TOWN OF BURLINGTON LANDFILL	BAIE VERTE-GREEN BAY
TOWN OF BAIE VERTE WASTE DISPOSAL SITE	BAIE VERTE-GREEN BAY
TOWN OF MING'S BIGHT LANDFILL	BAIE VERTE-GREEN BAY
TOWN OF PAQUET LANDFILL	BAIE VERTE-GREEN BAY
TOWN OF NIPPER'S HARBOUR LANDFILL	BAIE VERTE-GREEN BAY
SNOOK'S ARM LANDFILL	BAIE VERTE-GREEN BAY
TOWN OF LA SCIE LANDFILL	BAIE VERTE-GREEN BAY
LABRADOR WEST REGIONAL LANDFILL	LABRADOR WEST
LETHBRIDGE	DISCOVERY REGION
PORT CHARLESTON/SOUTHERN BAY	DISCOVERY REGION
PORT REXTON	DISCOVERY REGION
TRINITY BAY NORTH (CATALINA)	DISCOVERY REGION
BONAVISTA	DISCOVERY REGION
NEWMANS COVE	DISCOVERY REGION
KING'S COVE	DISCOVERY REGION

ST. JACQUES-COOMBS COVE	COAST OF BAYS
CONNE RIVER	COAST OF BAYS
GAULTOIS (REMOTE SITE)	COAST OF BAYS
TOWN OF HARBOUR BRETON	COAST OF BAYS
HERMITAGE-SANDYVILLE	COAST OF BAYS
MILLTOWN/HEAD OF BAY D'ESPOIRE SITE	COAST OF BAYS
MORRISVILLE	COAST OF BAYS
POOL'S COVE DUMP SITE	COAST OF BAYS
TOWN OF RECONTRE EAST LANDFILL (REMOTE SITE)	COAST OF BAYS
PASS ISLAND ROAD (SEAL COVE) LANDFILL	COAST OF BAYS
MCCALLUM (REMOTE SITE)	COAST OF BAYS
ST. ALBAN'S MUNICIPAL DISPOSAL SITE	COAST OF BAYS
FORTEAU	LABRADOR
RED BAY	LABRADOR
HAPPY VALLEY-GOOSE BAY	LABRADOR
MUSGRAVETOWN	DISCOVERY
CARTWRIGHT	LABRADOR
MARY'S HARBOUR	LABRADOR
MUD LAKE	LABRADOR
NAIN	LABRADOR
MAKKOVIK	LABRADOR
RIGOLET	LABRADOR
POSTVILLE	LABRADOR
HOPEDALE	LABRADOR
NATUASHISH	LABRADOR
PORT HOPE SIMPSON	LABRADOR
ST. LEWIS	LABRADOR
WILLIAM'S HARBOUR	LABRADOR
LODGE BAY	LABRADOR
CHURCHILL FALLS	LABRADOR
BLACK TICKLE-DOMINO	LABRADOR
VOISEY'S BAY	LABRADOR

APPENDIX 10:

METAL RECYCLERS IN NL

COMPANY NAME
NEWCO METAL AND AUTO RECYCLING*
AIM
DOMINION RECYCLING
MARITIME RECYCLING
EAST COAST METAL RECYCLING
CLUNEY'S SCRAP METALS
CENTRAL METALS
KEN'S AUTO SALVAGE - VIKING RECYCLING
MANUAL'S METAL RECYCLING LTD.
3D RECYCLING/DAVE'S TOWING NL
JIM'S GARAGE LTD.

**Includes Provincial Metal Recycling Ltd., Newco Argentia, and Rod's Auto Salvage Ltd.

Note that not all metal recyclers listed were contacted to confirm whether they recycle fishing gear.

APPENDIX B: FEASIBILITY STUDY AND ACTION PLAN FOR RESPONSIBLE DISPOSAL OF GHOST GEAR AND IMPROVED PORT INFRASTRUCTURE IN NEWFOUNDLAND AND LABRADOR

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Feasibility Study and Action Plan for Responsible Disposal of Ghost Gear and Improved Port Infrastructure in Newfoundland and Labrador

May 31, 2022

Prepared by Emily Blacklock and Jade Petritchenko As a

Fishermen and Scientist Research Society Contract

Funded by WWF-Canada

Agreement No.: C-0322-419-00-D

Report to: Thiviya Kana (WWF-Canada)

In collaboration with: Natalya Dawe

Proposed Work for Agreement No.: C-0322-419-00-D
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Prepared by Emily Blacklock and Jade Petritchenko

Introduction

Ghost Gear and the FSRS

Over the recent years, public awareness of ghost gear and marine pollution has improved nationally and globally. In response to this increased public awareness, Clean Foundation held their first Clean Ocean Summit in 2018. The event brought together fishing associations, NGOs (non-government organizations), industry personnel, Indigenous groups, and government representatives from across Atlantic Canada to collaborate on addressing marine pollution in our waters. At this summit, two areas concerning marine pollution were identified: single-use plastics and fishing gear. Working groups were formed for each of these areas of interest. The Fishermen and Scientists Research Society (FSRS) joined the fishing gear working group which determined that there was a general lack of knowledge about the distribution and severity of ghost fishing in Atlantic Canada.

The fishing gear working group established during the Clean Ocean Summit evolved into The Fishing Gear Coalition of Atlantic Canada. The Fishing Gear Coalition of Atlantic Canada identified end-of-life fishing gear management as a knowledge gap, which is necessary to understand when developing sustainable solutions for end-of-life fishing gear. The FSRS helped develop best practices when working with communities to complete focus groups, surveys of ghost gear and the availability of waste management facilities for end-of-life fishing gear.

One point of view that is often overlooked with respect to ghost gear is that of fishers. Our mandate at the FSRS is to create and maintain a partnership between fishers and scientists and to promote the long-term sustainability of the marine fishing industry in Atlantic Canada. Ghost gear is often the result of abandoned, lost, and discarded fishing gear (ALDFG). ALDFG is non-active fishing gear which continues to entangle or capture marine animals. Most ALDFG is generated as a result of storm events, conflict with other fishing gear (existing ALDFG or other harvesters gear) or conflict with difficult terrain. Commercial fishers in Canada must report lost gear to Fisheries and Oceans Canada. The goal of reporting lost gear is to facilitate the retrieval of lost gear, and the return of lost gear to the fish harvesters.

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Project Scope and Objectives

The project geographic scope will be regionally focused in the Maritime province of Newfoundland and Labrador and locally focused on remote communities surrounding the Gilbert Bay MPA within southern Labrador. The project will review existing port infrastructure resources, ghost gear management practices and ghost gear disposal/recycling options available to these communities. Priority communities involved in the analysis include William's Harbour, Port Hope Simpson, Charlottetown, Mary's Harbour, St. Lewis, and Pinsent's Arm. The geographical scope of work can extend to more northern and southern communities as well. Mixed methods will be used to gather quantitative and qualitative information, through literature reviews, surveys and interviews.

The background review and consultations will formulate a solution-oriented action plan to improve ghost gear disposal/recycling and port infrastructure surrounding the Gilbert Bay MPA and neighbouring areas in Southern Labrador. FSRS will work with WWF-Canada and appropriate partners to provide suggestions/action steps, which can be implemented prior to the fiscal year end of the project, as soon as they become available.

An objective of this project would be to gather local ecological knowledge pertaining to the composition, location and abundance of abandoned or lost fishing gear in Southern Labrador through focus groups with fishers. This information was utilized to address the gaps in disposal infrastructure at ports and methods in which old gear is repurposed within the communities. The goal of this project is to determine gaps in port infrastructure and help generate solutions for the future sustainable management and disposal of fishing gear. The objective of this research is to be utilized and integrated in a "Ghost Gear Efficient Management, Responsible Disposal, and Improved Port Infrastructure Action Plan." Feasible action items which can be implemented given capacity within these communities will be put forward in this Action Plan. It is anticipated that this research and Action Plan will inform future activities that will benefit the marine and terrestrial environments such as the reduction of plastic pollution and decreased risk to marine life from ghost fishing and entanglement through ALDFG removal efforts. Moreover, local community members and some local small-scale for-profit industries may benefit as waste management initiatives are explored and expanded upon

to close the fishing gear waste cycle. Fishers may also benefit from this project as a business model will be developed to find means of compensation for participating in ecologically friendly gear disposal.

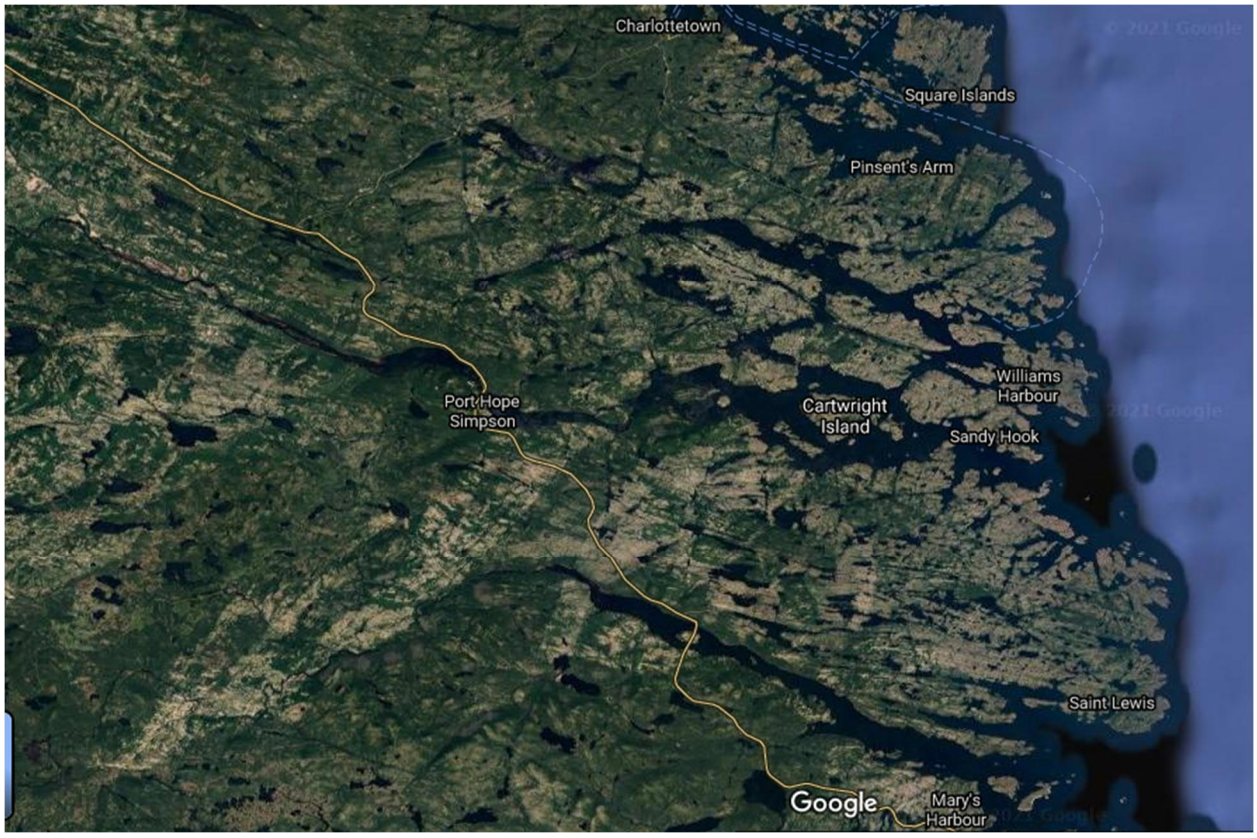

Figure 1. Study area for the collection of local ecological knowledge about the composition, location and abundance of abandoned or lost fishing gear in Labrador through focus groups.

Questions to be addressed in the research include:

1. What are the local gear disposal, storage and recycling facilities available to remote communities surrounding the Gilbert Bay MPA and within southern Labrador?
2. What is the extent of the capacity within current port infrastructure within remote communities surrounding the Gilbert Bay MPA and within southern Labrador, specific to fishing gear and ghost gear management?
3. What are the key issues and concerns related to ghost gear management and port infrastructure?

4. What are the key opportunities for development/improvement and/or possibilities for expansion to the above-mentioned items?

Methods

Background Search

A web search was completed to compile background information on the abundance, location and composition of abandoned, lost and/or discarded fishing gear (ALDFG) in the communities surrounding the Gilbert Bay MPA and within Southern Labrador. The web search also looked at the port infrastructure available for the disposal of ALDFG, methods of disposal and methods of repurposing. This information was utilized for survey production and the formulation of suggestions for the improvement of fishing gear disposal in the communities surrounding the Gilbert Bay MPA and within Southern Labrador.

Interviews and Surveys

Following the collection of background information through online resources, a survey was created and distributed to collect information from individuals who may be directly involved with the disposal of ALDFG, including: fishermen, port authorities, fishing organizations, clean-up organizations and community members. This survey was emailed to individuals and shared within community social media groups.

The survey was created using Google Surveys, a free survey platform accessible by all, to create an easy way for individuals to be involved. The survey appeared as follows and was made available at https://forms.gle/XV7z2rCVJ7XvZ4X29. The “other” option remained available in all questions in case an individual had an answer which they felt did not fit into a given category. The scripts and survey can be found in Appendix C and Appendix D.

The FSRS employs a snowballing approach to survey distribution and collection of information. First, heads of fishing organizations, indigenous communities and local community leaders are contacted and asked to distribute the survey to knowledge experts. In this instance, knowledge experts would be fish harvesters or port authorities who would observe end-of-life gear and ghost gear. Then, when knowledge experts complete the survey, they are asked to share the survey and ways to contact the FSRS with other members of their community. This

method of sourcing contacts for surveys should show exponential growth in the number of survey participants.

Following the surveys, the information will be collected and complied as a feasibility report. This information can then be used to make suggestions for the improvement of the management of lost or abandoned fishing gear in the communities surrounding the Gilbert Bay MPA and in Southern Labrador. There is an option in the survey to send the participants feedback and outcomes of the project to continue community engagement after the feasibility report has been completed.

Results

Location, Composition and Abundance of Lost and Abandoned Fishing Gear

Many grants and funds have now been used to find projects which are able to collect ALDFG. Although these projects are having success in removing lost and abandoned fishing gear in large amounts, they are not reporting the exact locations or composition of this fishing gear through the funding agency (i.e., Department of Fisheries and Oceans). The Petty Harbour Fisherman's Cooperative removed 5500 kg of fishing gear between Cape St. Francis to Cape Pine in 2020 ((News, 2021). The Fish, Food and Allied Workers Union removed 790 kg in 2020 around Newfoundland ("Ghost Gear Fund," n.d.).

Current Port Infrastructure for Fishing Gear Disposal

There is little information available on the port infrastructure currently available within the communities surrounding the Gilbert Bay MPA and in Southern Labrador. Previously, it has been illegal to bring in any ALDFG within Canada, as there was no way to know if it was truly lost or abandoned ("What lies beneath: Ghost gear in our oceans | Canadian Geographic," n.d.). Any fishers who did come across gear were obligated to leave it in the ocean, so previous port infrastructure would be limited to the disposal of one's own gear. Pilot projects have been initiated to bring in ALDFG in the off-fishing season; therefore, it is easy to distinguish that the gear is no longer "active fishing gear. A common issue in gear retrieval is determining where to

store and how to dispose of gear that has been retrieved. Current gear retrieval is often volunteer work from offshore fishing vessels for northern shrimp (Pandalus borealis) and halibut (Hippoglossus hippoglossus). If this is completed on a volunteer basis, an easy method of disposal or collection is needed to make voluntary initiatives feasible.

Disposal Methods for Fishing Gear

The principal fisheries in the study area in southern Labrador use different materials in their fishing gear. This poses additional challenges for management of end-of-life gear. The snow crab fishery uses traps composed of a metal frame with rope netting, marked with rope and buoys. Groundfish like cod, halibut and turbot are fished with longline and gillnets. Rope compositions vary greatly, with polypropylene, polyethylene, poly-blend, nylon, cotton and leaded rope. This results in challenges in rope recycling.

The available disposal methods for gear withing Labrador include transfer sites, landfill sites and incinerators. Not all landfill sites accept fishing gear, and some will accept only certain types of fishing gear. Metal recyclers may take crab pots if the rope has been removed from the frame. Other fishers expressed that end-of-life gear is still abandoned in the ocean. Others expressed that gear is collected on their property or at the wharf, sometimes as a permanent storage method or burned. In contrast, fish harvesters express that should recycling and repurposing methods become accessible, they would be interested in participating.

Repurposing Methods for Fishing Gear

There are no current large operations using ALDFG in the communities surround the Gilbert Bay MPA and in Southern Labrador. Within other areas of the Atlantic provinces, used gear has been repurposed into a variety of useful things. One company previously in operation was Goodwood Plastics (“plastic wood,plastic lumber - Good Wood Plastic,” n.d.). Although no longer in operation, Goodwood Plastic was one of the first companies to try to re-use the fishing gear for another purpose. With the large amount of funding available, more projects like this would be beneficial. Although some small-scale re-use of fishing gear has been observed, including repurposing rope into doormats or art, collection and repurposing of fishing gear on a community scale could have a greater impact. The collection and repurposing of gear into

sustainable building materials could incorporate marine waste back into the infrastructure of fishing communities through using recycled plastic as building materials.

Survey and Interview Results

No survey respondents were found to be in the correct survey area. There were only four respondents to the survey that fell within Newfoundland and Labrador, however none fell within the areas surrounding the Gilbert Bay MPA or Southern Labrador. Up to ten thousand fishers viewed the social media correspondence, and the survey was circulated to fishing associations and community leaders in the study area.

All respondents to the survey identified as fish harvesters, port authorities or both. They identified rope and gill nets as the most observed ALDFG. The participants also remarked that other litter associated with fishing activity can include lobster bands, bait bags and personal protective equipment. Respondents agreed that end-of-life fishing gear can be found at-sea, on the wharf and along shorelines. The survey participants noted that there is no infrastructure available for disposal of end-of-life gear within their communities. When asked if they reuse or repurpose their gear, respondents suggest that they clean, repair, and reuse gear whenever possible. Finally, when asked what infrastructure the respondents would like to have access to, they suggested metal and rope recycling facilities.

Discussion

From the background research on the communities surrounding the Gilbert Bay MPA and Southern Labrador, little is known about the composition, abundance and location in which ALDFG is found. There is also little information on the resources available for disposal or repurposing of fishing gear. Due to the lack of information, the surveys were intended to provide a better understanding.

A general understanding from the surveys suggests that individuals either, (1) do not have information on the selected research area, or (2) do not want to participate in the surveys. With the few responses received, it can be understood that end-of-life fishing gear is observed at sea, on the shore and at ports. This is a result of the deficiency in the available waste management facilities.

The greatest concern identified in the working group and through background research is that current legislation does not permit the retrieval of ghost gear by fish harvesters. It is illegal to be in possession of another fish harvesters gear, which is practical for theft prevention but prohibits the retrieval of lost or abandoned fishing gear. Permits are required to retrieve ALDFG. Organizations like the Petty Harbour Fishermen's Cooperative have developed models for retrieval of ALDFG and may provide advice on obtaining permits and facilitating community engagement.

Focus Groups

An effective method for canvasing rural communities is focus groups. The FSRS has had past success in gathering knowledge about ghost gear through focus groups A mandate of the FSRS is to create and maintain a partnership between fishers and scientists, to promote the long-term sustainability of the marine fishing industry in Atlantic Canada. One way to achieve this is through the collection of local ecological knowledge.

A fish harvester's perspective is critical to understanding long term changes in the marine environment; fishers gain extensive knowledge about the environment they live and work in through personal observation and sharing experiences throughout communities and across generations. Local ecological knowledge can be collected through focus groups. To initiate contact with participants, information about projects is shared with fishing associations, harbour managers and First Nations communities in areas of interest. Contacts are asked to identify knowledge experts on local fisheries and fishing grounds, and to circulate information concerning projects to prospective participants. Focus groups are organized with the aim to have at least three participants and no more than six. Once participants have been identified, focus groups are organized at locations and times that are convenient for all participants. Each focus group is attended by two FSRS representatives. One representative is responsible for focus group facilitation, while the other records participant responses. At the end of the meeting, participants are asked to identify other fishers who would be interested in contributing their perspective. Participants are also consulted about the questions asked in the focus group, to determine if all relevant questions have been considered.

After several focus groups are completed, participant responses provide a more comprehensive account of a fisher's perspective. The FSRS is committed to sharing this perspective, through facilitating and promoting effective communication between fishers, scientists, and the general public.

Past FSRS work in Ghost Gear

In previous ghost gear work completed by the FSRS, fisher respondents indicated that they would go to great lengths to retrieve lost gear. The gear is valuable, and fishers were concerned about the impact of their lost gear on the environment and the fishery. Fishers make others aware of the approximate locations of lost gear and work together to recover lost traps. Collaboration between fishers in retrieving lost gear and returning gear that has been found was a consistent theme throughout past focus groups.

In past workshops, fishers have expressed interest in recycling opportunities. Each meeting suggested convenient and accessible waste management facilities are critical to reducing the amount of ALDFG. Many waste management facilities do not accept all types of fishing gear and may have requirements for gear to be disassembled (e.g., removal of concrete ballast or rope from lobster or snow crab traps). Suggestions for management of end-of-life fishing gear include collection and transport sites, or a fishing gear pick-up day modelled after large garbage pick-up days, to be scheduled after the fishing season.

Repurposing end-of-life fishing gear

Historically, deficiencies in infrastructure have resulted in creative ways of repurposing end-of life gear. In past discussions with fishers, many alternative uses for end-of-life gear have been proposed. Gillnets and rope are often used by farmers to make fences, or for climbing plants. Metal from crab and lobster pots are used to strengthen retaining walls or cement structures. Lobster pots are used to make deer and moose hunting paths safer, while rope and nets can be used in hunting blinds. Wire traps are used to build retaining walls on shorelines and riverbeds to prevent erosion. Lobster traps have been used in the Bernart maze to create maze walls. Other artists weave fishing rope to make doormats, tapestries and bowls. Rope has been woven into boat fenders by fishers. Wooden lobster traps are purchased by tourists to

display in their homes and gardens. Colourful metal lobster traps have been assembled into porch furniture, including rocking chairs and porch swings. End-of-life fishing rope can find new life collecting spat for bivalve aquaculture.

GGWG

A ghost gear working group (GGWG) was hosted by WWF-Canada and facilitated by the FSRS on March 17th, 2022. The meeting minutes from this working group are found in Appendix A. Challenges to disposing of end-of-life gear and working in remote communities were identified by the working group. Minutes from the GGWG are found in Appendix B.

FGCAC

The Fishing Gear Coalition of Atlantic Canada (FGCAC) was founded to develop sustainable solutions to end-of-life fishing gear and ALDFG. The FGCAC outlines regional and national efforts to mitigate ALDFG. FSRS contributed to the FGCAC best practices for researching and managing ALDFG. The FGCAC outlines how Extended Producer Responsibility (EPR) could be implemented to involve fishing gear producers in the waste management strategy. The inclusion of fishing gear producers in the disposal of end-of-life fishing gear could promote innovation of new strategies for reusing or recycling products and invite more industry stakeholders to provide solutions for fishing gear waste management.

Ship-to-shore

Ship-to-shore is a program developed by the Clean Foundation, that was designed to be adapted based on community need. The ship-to-shore model works with fish harvesters and harbour authorities to reduce marine debris through encouraging community members to bring all their waste to shore to be disposed of properly. It also was intended to be applied on a case-by-case basis, working with stakeholders to implement infrastructure that will be sustainable within each community. This award-winning program has been successfully implemented in harbours across Nova Scotia, and in 2017 was implemented in Petty Harbour, Newfoundland.

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Recommendations for Ghost Gear Management and Port Infrastructure Improvement Action Plan

Short-term recommendations

- Organize in-person focus groups with fish harvesters, indigenous community members, gear manufacturers, and waste management companies in Southern Labrador to collect more comprehensive local knowledge of stakeholders.
- Work with waste managers to incentivize and promote the collection and storage of end-of-life fishing gear. This includes expanding acceptance of fishing gear in existing waste management facilities and creating transfer stations for waste from remote communities.
- Implement a seasonal fishing waste collection day that is modelled after large garbage collection days.
- Conduct workshops to promote or incentivize bringing end-of-life gear to shore and encourage more widespread adoption of current reuse and recycling strategies for end-of-life gear.

Long-term recommendations

- Innovate new technologies for recycling materials from fishing gear including rope and metal trap frames.
- Improve existing waste management infrastructure, making it more accessible to remote communities.
- Work with remote communities to implement gear recovery and fishing waste collection programs.
- Innovate new technologies that prevent gear loss and facilitate gear recovery to mitigate and recover ALDFG.

References

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Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Appendix A: Proposed preliminary research

Questions to be addressed in the research includes:

1. What is the local gear disposal, storage and recycling facilities available to remote communities surrounding the Gilbert Bay MPA and within southern Labrador?
2. What is the extent of the capacity within current port infrastructure within remote communities surrounding the Gilbert Bay MPA and within southern Labrador, specific to fishing gear and ghost gear management?
3. What are the key issues and concerns related to ghost gear management and port infrastructure?
4. What are the key opportunities for development/improvement and/or possibilities for expansion to the above-mentioned items?

Focus for the FSRS

- Understand the location, composition and abundance of abandoned or lost fishing gear
- Understand the current infrastructure available for fish gear and ghost gear management
- Understand the current methods for disposal of fishing gear and ghost gear
- Understand the current methods for repurposing of fishing gear and ghost gear
- Propose improved infrastructure for fishing gear and ghost gear management within the constraints found in communities surrounding the Gilbert Bay MPA and within Southern Labrador
- Propose improved methods for disposal and repurposing of fishing and ghost gear within the constraints found in communities surrounding the Gilbert Bay MPA and within Southern Labrador

Report Objectives

To outline the current infrastructure available for fishing and ghost gear disposal as well as methods for disposal within Newfoundland and Labrador, Canada, with specific focus on remote communities surrounding the Gilbert Bay MPA and within Southern Labrador. Following the outline, methods for improved infrastructure and disposal can be proposed to help fill gaps which may exist in the infrastructure and disposal methods.

Methods

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Understanding the Lost and Abandoned Fishing Gear

1. Online review of current research discussing the composition, abundance and location of abandoned and lost fishing gear within the research area.
2. Discussion with stakeholders in the current knowledge about the composition, abundance and location of abandoned and lost fishing gear within the research area, including:
    - Fisheries organizations
    - Fishers
    - Indigenous groups
    - Shoreline clean up organizations
    - Port Managers
    - Fishing companies
    - Other parties who wish to contribute

Current Infrastructure

- Online search of current infrastructure available at ports in the desired research area
- Discussions with stakeholders in the current infrastructure available, including:
- Fisheries organizations
- Fishers
- Indigenous groups
- Shoreline clean up organizations
- Port managers
- Fishing companies
- Other parties who wish to contribute

Current Methods of Disposal

- Online search of current disposal available in the desired research area
- Discussions with stakeholders in the current disposal methods available, including:
- Fisheries organizations
- Fishers
- Indigenous groups
- Shoreline clean up organizations
- Port managers
- Fishing companies
- Waste management companies

- Department of Natural Resources
- Non-Profit “Clean Up” organizations
- Other parties who wish to contribute

Current Methods of Repurposing

- Online search of current methods of repurposing in the desired research area
- Discussions with stakeholders in the current repurposing methods used, including:
- Fisheries organizations
- Fishers
- Indigenous groups
- Shoreline clean up organizations
- Port managers
- Fishing companies
- Waste management companies
- Department of Natural Resources
- Non-Profit “Clean Up” organizations
- Other parties who wish to contribute

Proposed Infrastructure Improvements

Following the investigation of the current infrastructure, methods can be proposed to improve this based on:

- Input from stakeholders
- Infrastructure available at other ports
- Current regulatory framework within the research area
- Current resources available in the research area

Proposed Methods of Disposal and Repurposing

Following the investigation of the current disposal methods, other disposal methods can be proposed to improve the disposal methods in the area based on:

- Input from stakeholders
- Disposal methods which have been seen to work in other similar areas
- Repurposing methods which have been seen to work in other similar areas
- Current regulatory framework within the research area

- Current resources available in the research area
- Current other needs which could be met through the use of end-of-life fishing gear

Preliminary Research

Understanding the Lost and Abandoned Fishing Gear

- Online review of current research discussing the composition, abundance and location of abandoned and lost fishing gear within the research area

Current Infrastructure

- Online search of current infrastructure available at ports in the desired research area

Current Methods of Disposal

- Online search of current disposal available in the desired research area

Current Methods of Repurposing

- Online search of current methods of repurposing in the desired research area

Appendix B: Ghost gear working group meeting agenda and minutes

Location: Online (MS Teams, access via link or QR code)
https://teams.microsoft.com/l/meetup-join/19%3ameeting_MmJiOGFmMWQtNDUyNS00MDM2LTg0YTEtYzMzZTE1MjMyMjNj%40thread.v2/0?context=%7b%22Tid%22%3a%2298989c20-3122-4280-9e5a-10e509045141%22%2c%22Oid%22%3a%22341e7a4a-992d-41c3-8a7a-f0c506467714%22%7d

Date: Thursday, March 17th, 2022

Facilitators: Jade Petritchenko (FSRS), Emily Blacklock (FSRS) & Thiviya Kana (WWF-Canada)

Time: 1:00 – 2:45 pm, NDT

Minutes by Emily Blacklock (FSRS)

INTRODUCTION	
1:00 PM	Welcome - Jade asks individuals to keep their mics off when not presenting or asking a questions - Jade introduces herself and Emily - Thiviya introduces herself - Jade informed everyone that the meeting will be recorded

1:05 PM	Introduction & Agenda Review
	
	Introductions in Chat
	
	- Craig Taylor, Fisheries Analyst, Torngat Secretariat, Labrador
	- Harry Chang – Ghost Gear Hunter (Hong Kong)
	- Sigrid Kuehnemund, WWF Canada VP, Wildlife and Industry
	- Remi Brine, Atlantic Marine Mammal Hub, DFO, Dieppe, NB
	- Lisa Chen, Master of Marine Management, Dalhousie University
	- Sonia Smith, Fishing Gear Coalition Atlantic Canada
	- Marquita Davis, Project Manager End of Life Fishing Gear Management, Fishing Gear Coalition of Atlantic Canada
	
	Number of people present:
	
	- Presenters (8)
	  o Emily Blacklock
	  o Cam
	  o Gordon So

	o Beth Ann Hawco o Jade Petritchenko o Natalya o Sigrid Kuehnemund o Thiviya Kana - Attendees (18) o Bill Lee o Remi Brine o Danica Brockwell o Julien Cormier o Craig Taylor o Darrell Green o Harry Chan o Jessie McIntyre o Kathleen Blanchard o Keith Moore o Leah Fulton o Lisa Chen o Denise MacLeod o Marquita Davis o Nina Lantinga o Lindsay Randell o Sonia Smith o Marilyn Sweet o Trevor Bessette o Heather Rodriguez 1. What is your level of knowledge regarding ghost gear and ghost gear management? a. None: “What is ghost gear?” (0%) b. Novice: some knowledge (9%) (1) c. Well equipped: Participated in a ghost gear project or two (63%) (7) d. Ghost Gear Wiz: Lives, breathes, sleeps ghost gear (27%) (3) 2. Why are you interested in the ghost gear working group? a. To learn more about general ghost gear issues/practices (7%) (1) b. Gain insight from other ghost gear initiatives and see how it can be applied in respect to one’s personal projects (30%) (4) c. Participate in tangible actions which can improve ghost gear management in your region (15%) (2)

	d. Find opportunities to work collaboratively with others in similar ghost gear projects (46%) (6) e. Provide expert advice on ghost gear projects (0%) (0) Review of Agenda - Jade reviewed agenda - Jade asked individuals to hold questions until question periods are offered
GHOST GEAR FEASIBILITY STUDIES	
1:10 PM	Natalya Dawe – Ghost Gear Management Feasibility Study in NL - Presentation by Natalya - Notice in chat that one individual was only able to see a blank screen and we tried to find a solution (Beth Ann Hawco) - Discusses the methods of disposal for fishing gear in NFLD
1:20 PM	Trevor Bessette (Seaside Apparel/ Recycle on the Rock) – Gillnet Recycling Pilot Program - Images were not working so Trevor just chose to talk - Fast fashion and plastic pollution: all clothing made from plastic bottoms and cotton scraps - Collected bottle caps through waste collection and made new products from those - Now trying to do it with gillnets to make garbage cans, etc.
1:25 PM	Q&A - Jade: what are the biggest challenges you have found working with remote fishing communities? o Natalya: the challenges on their end on managing the waste o Trevor: NLFD is so spread out so it's a challenge for waste management companies. On the economic side it is a huge challenge to have the infrastructure needed. Transporting the materials is a challenge especially on a large scale with small communities. - Bill Lee: how are you cleaning the ghost gear for use? o Trevor: right now, small scale and in pilot stage. High pressure power washer and a test of variety of cleaning agents. End products also do not have to be clean and pure. Less hoops to jump through as it won't be food safe. So, for now different

	cleaners and chemicals and pressure washers for now until we go larger scale. o Suggestion from Bill – something with sand and water might help get the seaweed off. Could also take this stuff to make some good compost. - Danica Brockwell: how does the transport factors work for the movement of the bottle caps with the remoteness? o Trevor: partnership with a recycling company (Heberts?) but also use shipping boxes. Green depot act as hubs for collection. Partnerships are the main way right now. o Danica – company in the US utilize return shipping on seas and it works well. Try to piggyback on existing infrastructure. Trevor shared his contact information in the chat: info@seasidereclaimed.com Natalya shared her contact information in the chat: Natalya.Dawe@gmail.com
GHOST GEAR IN SOUTHERN LABRADOR	
1:30 PM	Cameron Pye (Marine Institute at MUN) – Ghost Gear in Gilbert Bay MPA - Presentation by Cameron - Using Adaptive Management Through Community-Based Stewardship to Investigate the Presence of ALFG to protect Golden Cod in the GBMPA - Reviewed the project including interviews and field work - Presented results from interviews - Presented results from field work showing how gear was found and retrieved Cameron shared his email cbp013@mun.ca
1:40 PM	Jade Petritchenko & Emily Blacklock (Fishermen and Scientists Research Society) – Port Infrastructure Feasibility Study - Presentation by Jade - Presented the objectives, methods, results and challenges from the work - Jade corrected the email used in the survey (thank you)

	Jade's email: kjpetritchenko.fsrs@gmail.com
1:50 PM	Q&A - Bill Lee: fishermen are not allowed to bring gear and I think WWF should work on changing it. This is something we need to lobby to change. o Marilyn Sweet: (FAO – Ghost Gear program). This is a grey zone and we do know of this challenge. It is being looked into and we are trying to fight the challenge. It is good to know there is support for this. - Kathleen Blanchard: harvesters about bait box liners. Very much about logistics and hard to find these solutions remotely. It can also be viewed in an organic way. We developed a bin for disposal, and some said it was too big or too small. It is all about logistics and human resources. You kind of dive into it and it is idiosyncratic.
REGIONAL GHOST GEAR INITIATIVES	
1:55 PM	Billy Lee (Petty Harbour Fishermen's Co-op) – Eastern Avalon Retrieval Work - 2 years ago, started the project - Knew there was ghost gear but not the extent until we started - 15 tons of gear landed last year - Showed video which was made of the project (7:41) *** Note: a lot of people were going in and out of the meeting due to issues with the Teams program*** Bill Lee shared his email leebilly22@gmail.com

2:00 PM	Q&A
	- Jade: how can we incentivize stakeholders to get involved?
	  o Billy: most fishers don't want to see it in the water. But education is key. We want to get a website up and running to educate people so that once they learn they can get involved.
	- Jessie: (coastal action NS) also running ghost gear action projects. Financially compensated the fishers for fuel and time. Were these fishers financially compensated?
	  o Billy: absolutely! They went through $1200 fuel a day so the wear and tare on the boats and fuel were compensated.

INTERNATIONAL GHOST GEAR INITIATIVES	

2:05 PM	Gordon So (WWF-Hong Kong) – Ghost Gear Management in Hong Kong - Invited Harry Chen to speak for 1 min as he is the "ghost gear hunter" - Spoke about the diving protocols had made for divers to recover ghost gear during dives - Citizen science project - Allows for mapping of ghost gear locations
2:15 PM	Q&A - Billy: how deep is the water? o Gordon: 20-30 m o Harry and Gordon had good back in forth discussing but I got caught up in the information and couldn't type fast enough - Trevor: you looked into recycling the gear, have you had any success? o Gordon: no, we have not. Lots of challenges in Hong Kong. Nylon makes up a lot of the gear which can affect air quality when processed. With the gear being made of so many different materials it is hard to separate and sort. Even outside of Hong Kong there are challenges with export and import regulations. End of life fishing gear is banned on importation lists. Gordon shared his email: gordonso@wwf.org.hk
CLOSING	
2:20 PM	Ghost Gear Working Group General Discussion • GGWG Proposed Approach o Establish community o Exchange information o Identify priorities, goals and opportunities for collaboration o Build a formal approach • What are our biggest challenges? o Billy Lee – regulations, fisheries regulations o Trevor Bessette – disconnect between producers and recyclers o Jade read the brainstormed challenges o Trevor Bessette – we need more policy makers in the meeting o Billy Lee – smell from ghost gear, ended up having to freeze it. We are not allowed to wash ghost gear off when its on the wharf.

	▪ Kathleen Blanchard - Excellent comment, Billy. You have a great project. In our experience with lobster bait box liner collection, local support for a project drops quickly if there is a smell generated that is not dealt with quickly. o Danica Brockwell - Gear manufacturers are definitely a needed missing piece in these discussions, and it would be good to have representatives from recycling facilities in the province o Gordon So – the recycling of this does not make money. Fishing gear marking: required to have license number of fishing gear all over the gear so they are more careful about how they fish. o Lisa Chen - I agree with the financial aspect to ghost gear and how to finance this work beyond government funding • What are some achievable goals? o Thiviya moved on due to time. • What are the most effective actions we can take to better manage Ghost Gear or mitigate impacts? o Jade moved it on. • Next Steps? o Thiviya addressed
2:35 PM	Beth Ann Hawco (Department of Fisheries and Oceans) – Ghost Gear Fund - The Ghost Gear Program Overview - Goal is to get gear back to the owner - Thiviya: where can this tool be found online? o Beth: Here is the link: Reporting requirements for commercial fisheries (dfo-mpo.gc.ca) - Thiviya: can non-fishers use this tool? o Beth: I will have to look into this Beth shared her contact information bethann.hawco@dfo-mpo.gc.ca
2:45 PM	Note from Danica Brockwell - I am with Small Craft Harbours (SCH) DFO, we have a Harbour Authority (HA) Seminar at the end of October where all HAs, SCH, and other exhibitors get together over a weekend for multiple activities (i.e.: networking, training, future planning, updates, challenges, etc.). I am working on a presentation to inform Harbour Authorities across the entire province about all ghost gear efforts and anything they can do to get involved (provide them with material to disseminate information to harvesters at their harbours, hosting bring back your gear events either on a large scale with arranged transportation to recycling facilities or strategies to re-purpose the

	materials at the community level, all in keeping with building a circular economy). A lot of what was discussed today would be very beneficial to share with Harbour Authorities and there may be opportunities for some folks to attend and have their own workshops at the seminar. Please contact me at Danica.brockwell@dfo-mpo.gc.ca if you have any interest in this or information that you would like me to share with them. Adjournment 3:47 pm Adjournment time was later than expected () as meeting ran long during the presentation by both Cam and Jade.

Access GGWG feedback survey here:
https://docs.google.com/forms/d/e/1FAIpQLSd7JaqcKY70jos_2sid8KBTohmL-4TzBigd5drRxpZBvP_01Q/viewform?usp=sf_link

Appendix C: Survey questions

Fishermen and Scientist Research Society - Investigation of Resources for Lost and Abandoned Fishing Gear

The Fishermen and Scientist Research Society is doing an investigation on behalf of the World Wildlife Foundation to investigate the existing port infrastructure resources, ghost gear management practices and ghost gear disposal/recycling options available to communities in the area of surrounding the Gilbert Bay MPA within southern Labrador.

This project aims to formulate a solution-oriented action plan to improve ghost gear disposal/recycling and port infrastructure surrounding the Gilbert Bay MPA and neighbouring areas in Southern Labrador. To be able to achieve this goal, we are looking for input and would like the opportunity to ask you a few questions.

If you prefer, you can contact us by email at: Emily.Blacklock@dal.ca to further discuss this project.

Thank you for your time.

How do you identify?

- [ ] Fishermen
- [ ] Community Member
- [ ] Port Authority
- [ ] Fishing Organization
- [ ] Other...

Where are you located?

Short answer text

What type of lost or abandoned fishing gear do you most commonly see?

- [ ] Rope
- [ ] Crab Traps
- [ ] Lobster Traps
- [ ] Gill Nets
- [ ] Other Types of Nets
- [ ] Personal Gear (eg. pants, coats, gloves)
- [ ] Bait Bags
- [ ] Lobster Bands
- [ ] Other...

Where do you see lost or abandoned fishing gear?

- [ ] On the shore
- [ ] At wharfs
- [ ] At sea
- [ ] Other...

What kind of infrastructure is available at ports for you to dispose of lost or abandoned fishing gear?

Short answer text

What kind of infrastructure would you like to see at ports for disposal of lost or abandoned fishing gear?

Short answer text

What kind of infrastructure would you like to see at ports for disposal of lost or abandoned fishing gear?

Short answer text

What are ways you are able to dispose of lost or abandoned fishing gear?

- [ ] Garbage
- [ ] Recycling
- [ ] Companies who collect gear for other purposes
- [ ] Other...

What ways do you currently repurpose fishing gear?

Short answer text

What ways would you like to see lost or abandoned fishing gear reused?

Long answer text

Appendix D: Survey sollicitation

Email Correspondance

The email correspondence sent to organization was as follows:

Hello,

My name is Emily and I work for the Fishermen and Scientist Research Society. We are doing an investigation on behalf of the World Wildlife Foundation to investigate the existing port infrastructure resources, ghost gear management practices and ghost gear disposal/recycling options available to communities in the area of surrounding the Gilbert Bay MPA within southern Labrador.

This project aims to formulate a solution-oriented action plan to improve ghost gear disposal/recycling and port infrastructure surrounding the Gilbert Bay MPA and neighbouring areas in Southern Labrador. To be able to achieve this goal, we are looking for input and would like the opportunity to ask you a few questions, including:

- What type of abandoned and lost fishing gear have you found in your area? Where do you most commonly see this gear?
- What infrastructure is currently available at ports in your area for the disposal of lost or abandoned fishing gear?
- What methods are currently available for disposal of lost or abandoned fishing gear in your area?
- What methods are available for repurposing of lost or abandoned fishing gear in your area?

Please let me know if you have the time to speak, or if you prefer, you can respond to any of the above questions in via email or through our Google Survey (https://forms.gle/qJsrSZQ9hB9dJgBn6). If there is anyone else who you think may be beneficial to this project, please feel free to pass on my contact information or this email.

Thank you for your time,

Emily Blacklock
Project Lead
Fishermen and Scientist Research Society

Social media correspondence

The social media correspondence was as follows:

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

My name is Emily and I work for the Fishermen and Scientist Research Society. We are doing an investigation on the existing port infrastructure resources, ghost gear management practices and ghost gear disposal/recycling options available to communities in the area of surrounding the Gilbert Bay MPA within southern Labrador.

This project aims to formulate a solution-oriented action plan to improve ghost gear disposal/recycling and port infrastructure. To be able to achieve this goal, we are looking for input and would like the opportunity to speak to any individuals willing.

Please let me know if you have the time to speak, or if you prefer, you can respond to any of the above questions in via email (Emily.Blacklock@dal.ca) or through our Google Survey (https://forms.gle/qJsrSZQ9hB9dJgBn6).

We are looking to know information on:

- What infrastructure is currently available at ports in your area for the disposal of lost or abandoned fishing gear?
- What methods are currently available for disposal of lost or abandoned fishing gear in your area?
- What methods are available for repurposing of lost or abandoned fishing gear in your area?

Thank you for your time!

Phone script

The phone correspondence was scripted as follows:

Hello,

My name is _____ and I work for the Fishermen and Scientist Research Society. We are doing an investigation on the existing port infrastructure resources for the disposal of fishing gear in the area of surrounding the Gilbert Bay MPA within southern Labrador and I was hoping to be able to ask you a few questions if you have some time.

Just so you are aware, this research is being used in collaboration with the World Wildlife Fund Canada to formulate a solution-oriented action plan to improve gear disposal, recycling and port infrastructure.

*The surveyor then goes through the questions available in the survey as appropriate for the individual contacted and can ask leading question if needed. *

Proposed Work for Agreement No.: C-0322-419-00-D
Prepared by Emily Blacklock and Jade Petritchenko

Thank you for your time and have a wonderful day!

APPENDIX C: GHOST GEAR REPURPOSING CRAFT WORKSHOP MINUTES (NOVEMBER 2022)

Ghost Gear Workshop hosted by WWF-Canada and NunatuKavut Community Council

November 15–16, 2022

Minutes prepared by Ariel Smith, Coastal Action

Workshop Summary

From Coastal Action's perspective, this workshop was incredibly valuable in connecting the issue of ghost gear with tangible community participation. Abandoned, lost and discarded fishing gear in Atlantic Canada is an expansive problem in scope and impact, and therefore it is often difficult to convey meaningful solutions to the public and local communities. This workshop helped bridge that divide in an engaging and interesting way. Workshop activities included presentations on ghost gear work in Newfoundland and Labrador as well as Nova Scotia and provided opportunities to participate in several craft tutorials. Connecting the materials found in the marine environment with materials used in the workshop for craft and artisan purposes was a great avenue to discuss the global issue of ghost gear on a local scale. Including a discussion portion of the workshop was also valuable. This allowed participants to provide their local perspectives that are often not heard in the environmental space and opened up a great dialogue between presenters and the community.

Day One (November 15)

- Presentation by Thiviya Kanagasabesan and Kristen Milbury on WWF-Canada and NunatuKavut Community Council's joint ghost gear project in the Gilbert Bay Marine Protected Area
- Crafts included rope coasters and plant holders
- Gillnets recycling discussion (Trevor Bessette; Seaside Apparel and Recycle on the Rock)
    - Started this work back in 2018, using a model and methods from the Netherlands.
    - Melting plastics and debris into new things such as soap dishes, key chains.
    - Question: How much net does it take to create these items?
        - Trevor didn't have exact weight per piece but will look into it.
    - Question: Is this new work?
        - Yes, Trevor spent the last couple years working on this and is learning as he goes.
    - Often folks will turn plastics into nurdles (plastic pellets) and melt those into pieces, so this is a new process being used and more work across Canada and the world is being done that we can learn from.
    - Question from Thiviya Kanagasabesan: A rep from Hong Kong was describing that a lot of the fishing gear that is being recycled can be quite foul smelling, making it difficult to use the materials. Is that the case here?
        - Trevor replied that yes, that is definitely an issue. The water and chemicals needed to clean and wash can be quite energy intensive, so recently they are leaning towards finding a large open outdoor space to let the gear dry and decay and have the soil, wind and rain clean the gear before it is recycled. This would save energy in the long term.

Discussion Questions

1. General thoughts on ghost gear in Southern Labrador:
    - Finding a lot of rope along shores, washing up debris on shorelines.
    - Pots and traps: Some of these, but not a primary source.
    - Petty Harbour: Rope and traps — recycle metal scraps from these traps.
2. What are some long-term solutions? (e.g., port infrastructure)
    - Fishers should record and report gear when it's lost with the location.
    - Often there are honest mistakes and accidents, but there is a lot of effort to retrieve that gear.
    - Should be required but not penalized for reporting.
    - Fishers are hard-working and don't want to lose gear.
    - Should have an easy drop-off at a reasonable price; better waste management on land.
    - Right now it's difficult to drop off with gas, resources and time causing fishers not to recycle gear.
    - Easy reporting system needed (e.g., app, maps) so people who are out can retrieve.
    - Question: Is it illegal to dump crab pots?
    - Need for equipment to sort the gear into landfill and recycling:
        - Lifting and moving; expensive machinery
        - Disassemble
    - Some at dump in Port Hope collect metal, 1–2 times a year to separate.
    - Many fishers use everything from their gear and reuse things as they can.
3. Next steps (e.g., gaps in information, perspectives needed, etc.):
    - Knowing what ghost gear is (community members, fishers), who to contact and what to do with old gear — making this readily accessible.
    - Garbage and a lot of other litter is along shoreline, not just fishing gear.
    - Facebook for sharing info opportunities.

Day Two (November 16)

- Craft demonstrations included:
    - Woven Rope Mat
    - Rope scenery Paintings
    - Beaded twine bracelets (from cod trap)

Discussion Questions

1. What were your favorite crafts made?
    - Enjoyed all of the activities.
    - Quite a few noted that they loved the beading craft activity.
2. What materials do you think are best/worst to work with? (Including others we may not have used.)
    - Found it difficult to work with the fishing rope.
    - Found that the beading was surprisingly easy.
3. Ghost gear repurposing: What is the feasibility of crafting using ghost gear? Do you think there is a market for this? What would profits look like?
    - Time-consuming, but could work well with practice.
    - Could be used in Christmas decorations and for a Christmas tree with net and lights, etc.
    - Question: How long does it take to make Kathy's items (beading)?
        - Around 15 to 30 minutes depending on what she's working on.
4. General comments/feedback
    - Found it valuable to run the workshops; had conversations with others who have gear, etc., that could be used in these crafts.
    - Thought it was a great way to connect to the issue.
    - Could be intergenerational and continue at other times.
    - Storytelling — using the history as a piece to weave into crafting like this.
    - Bringing in different perspectives with other workshops would be interesting.
    - Found it to be educational.

Continued Collaboration and Next Steps

- To support WWF-Canada's work in Newfoundland and Labrador, Coastal Action is interested in working to build capacity for gear recycling and repurposing in the region, for example supporting and contributing to the work from Trevor Bessette at Seaside Apparel and Recycle on the Rock to recycle gillnet.
- As NCC and WWF-Canada's work wraps in the region on ghost gear specific activities, there is potential to continue efforts with new groups, specifically on the issue of recycling efforts in western Newfoundland. Coastal Action is preparing a proposal to DFO's Ghost Gear Hurricane Fiona Relief fund to retrieve ghost gear at sea in Cape Breton, PEI and Newfoundland and is interested in building off the great work of WWF-Canada. This project would begin April 2023 and wrap on March 31, 2024. More details can be pursued in the coming month.

Ghost Gear Craft Workshop

Date: Tuesday, November 15th & Wednesday, November 16th

Location: The Museum in Port Hope Simpson, Labrador

Time: 4:00 pm – 8:30 pm

Hosts: Thiviya Kanagasabesan (WWF-Canada) & Kristen Milbury (NCC)

Draft Agenda - DAY ONE, NOV 15th

Time	Item	Presenter
4:00 pm	Welcome	
4:15 pm	Opening Remarks	Thiviya, Kristen & Ariel
4:20 pm	Demonstration: Ghost Gear Coasters	Sami Elsayed
5:30 pm	Break, Refreshments	
5:40 pm	Presentation: Ghost Gear in Southern Labrador	Thiviya & Kristen
6:00 pm	Discussion • Thoughts on ghost gear in southern Labrador • What are the long-term solutions? I.e., port infrastructure? • Next steps	Ariel
6:20 pm	Catered Supper	
6:50 pm	Demonstration: Ghost Gear Plant Holders	Sami Elsayed
8:00 pm	Seaside Apparel: Gillnet Recycling Pilot Program	Trevor Bessette
8:20 pm	Closing Remarks and Raffle Prize Giveaway	Thiviya & Ariel
8:30 pm	Adjournment of Day One	

Minutes recorded by: Ariel Smith (Coastal Action)

Draft Agenda – DAY TWO, NOV 16th

Time	Item	Presenter
4:00 pm	Welcome	
4:10 pm	Opening Remarks & Thoughts from Day One	Thiviya & Facilitator
4:20 pm	Demonstration: Rope & Net Art A. Woven Rope Mat B. Gillnet String Art C. Rope scenery Paintings	Ariel & Thiviya
5:20 pm	Break, Refreshments	
5:30 pm	Demonstration: Ghost Gear Beaded Jewelry	Kathy Russel
6:40 pm	Catered Supper	
7:10 pm	Creative Crafting Challenge	ALL
7:50 pm	Craft Idea Presentations	ALL
8:10 pm	Closing A. Discussion on Ghost Gear Repurposing (feasibility of crafting using ghost gear, is there a market for this? What would profits look like? What are our favorite crafts made today? What materials are best/ worst to work with?) B. Crafting Challenge – Award of Prizes	Facilitator
8:30 pm	Adjournment of Day Two	

Minutes recorded by: Ariel Smith (Coastal Action)

APPENDIX D: MEDIA LINKS

Title of Media	Source	Link
"The Gilbert Bay Marine Protected Area Ghost Gear Project"	NunatuKavut Youth Community Engagement Project (NYCEP)	https://youtu.be/ABxmf743wj4
The Broadcast with Paula Gale (July 11, 2022)	CBC Radio	https://www.cbc.ca/listen/live-radio/1-122/clip/15924435
Labrador Morning (July 15, 2022)	CBC Radio	https://www.cbc.ca/listen/live-radio/1-31/clip/15925594
CBC Newfoundland Morning with Bernice Hillier, Martin Jones (November 14, 2022)	CBC Radio	https://www.cbc.ca/listen/live-radio/1-210-cbc-newfoundland-morning/clip/15948485-getting-crafty-ocean-trash...we-hear-craft-night-southern

APPENDIX E: GILLNET RECYCLING PILOT PROGRAM REPORT

Recycle on the Rock
ALDFG Recycling Pilot Project
in Collaboration with
WWF-Canada

Final Report on the Viability of Recycling "Ghost Gear" Gillnets in Newfoundland & Labrador

June 30, 2023

Created By

Trevor Bessette

Owner and Operator

Seaside Reclaimed & Recycle on the Rock

Presented To

Thiviya Kanagasabesan

Specialist, Marine Conservation and Fisheries

WWF-Canada

Table of Contents

Executive Summary

In January 2022, ROTR & WWF-Canada launched a recycling pilot project to determine the feasibility of transforming gillnet into new products. The pilot project fell under an objective of WWF-Canada's "Using adaptive management techniques to mitigate fishing impacts on Golden Cod in the Gilbert Bay Marine Protected Area," project, which was funded by Fisheries and Oceans Canada under the CNFASAR grant (Canadian Nature Fund for Aquatic Species at Risk). This report outlines the project's progress to date.

Project Background

Recycle on the Rock (ROTR) is a Newfoundland based plastic recycling company. The company focuses on creating recycling solutions for overlooked waste plastics that are not currently addressed by Newfoundland's recycling systems. ROTR collects, recycles, and transforms these overlooked waste plastics into unique new products that are sold alongside Seaside Reclaimed products.

In recent years, thanks in large part to Canada's Ghost Gear Fund (GGF), "Ghost Gear" retrieval projects have been growing in numbers. These projects tackle ocean plastic pollution & "ghost fishing" by removing large amounts of abandoned, lost or discarded fishing gear (ALDFG) from Canadian waters. The recovered fishing gear can vary greatly in its state of decay & useability. Currently, there are three main options for recovered gear.

1- Gear that is in working order & that has appropriate identification tags can be returned to the owner.
2- Good gear that does not have any tags can be sold or auctioned to local fisherman.
3- Recovered gear that cannot be used by fisherman is sent to landfill or accumulates in large piles awaiting an "end-of-life" solution.

Since 2020, ROTR has been interested in expanding its recycling capacity to provide Atlantic Canada with an end-of-life solution for collected ALDFG. Within the next 5 years, ROTR's goal is to be able to give new life to all of the ALDFG collected in Atlantic Canada; and to utilize its recycling process & infrastructure to tackle "normal" end-of-life fishing gear as well.

In the fall of 2021, Thiviya Kanagasabesan, the marine conservation and fisheries specialist from WWF-Canada, approached ROTR to discuss the possibility of collaborating on a ghost gear recycling project that focused on gillnets. This pilot project would fall under an objective of WWF-Canada's "Using adaptive management techniques to mitigate fishing impacts on Golden Cod in the Gilbert Bay Marine Protected Area," project, funded by Fisheries and Oceans Canada under the CNFASAR grant (Canadian Nature Fund for Aquatic Species at Risk). WWF-Canada had identified the importance of pursuing a gillnet recycling study, as prior to this project, there were no means to recycle gillnet in Atlantic Canada. The lack of recycling infrastructure for gillnet was worrying, as previous studies had shown that gillnets were a very common type of ghost gear, and that these nets were very difficult to deal with. In January 2022, an agreement was finalized between ROTR & WWF-Canada, and the recycling pilot project was launched.

Methodology

Overview & Goals

To test the viability of recycling gillnet, ROTR had to accomplish 4 main tasks: transport the gear from the collection point to the ROTR recycling workshop in Colliers; wash the gear to remove dirt & marine debris; cut or shred the gear into small manageable pieces; and melt the plastics without excessive burning & in a way that leads to the creation of new products. As this was a small-scale pilot project, each of these steps had to be accomplished with as little capital expenditure as possible.

The pilot project's main goal was to determine if the gillnet could be turned into new products using an adapted/upgraded version of Recycle on the Rock's current recycling system. The main system upgrade was the addition of a large plastic sheet press that we determined had a high chance of success and that would be a versatile long-term asset.

Other goals include:

- Determining points of friction & substantial obstacles.
- Calculating required production capacity based on incoming ghost gear volumes.
- Determining effectiveness & feasibility of gillnet recycling using proposed methodology.
- Brainstorming solutions for increasing the efficiency & cost-effectiveness of the process.
- Determining a hierarchy of importance for implementing proposed solutions.

Collection & Sorting

Ghost gear or ALDFG investigations and retrievals was a collaborative effort between WWF-Canada, NunatuKavut Community Council (NCC) and the Fisheries and Marine Institute of Memorial University of Newfoundland (MI), led with a common goal to mitigate the impacts of fishing on golden cod and other vulnerable species within and adjacent to the Gilbert Bay Marine Protected Area (MPA). Ghost gear hot-spots were identified through knowledge-holder interviews in Southern Labrador. All hot-spots were identified visually and with underwater sonar and camera equipment. Gear was retrieved from shallow-based sea sites and additional land-based sites.

Once the ALDFG had been collected from the ocean floor, it was stored in a large shipping container in Port Hope Simpson. Generally, gear that is in good condition can be returned to its owner using ID tags. If the owner cannot be found, such gear can be donated or sold at auction. Gear that is not in working order can be used by local artisans to create rope mats or art installation, and metal crab pots can often be sold to metal recyclers. Beyond this, much of the gear (especially gillnet) ends up in landfills.

The ALDFG was supposed to be pre-sorted before transport but had not yet been completely sorted. We did our best to focus primarily of gill nets, but the material was entangled with rope, sea debris and other material. At the workshop, using electric pruners and gloves, the gillnet was separated from the ropes and nets.

The electric pruners were hit or miss. Sometimes they did a good job cutting the material & other times they struggled. They were used primarily to separate the gillnet from entangled rope, and to quickly size reduce the nets into smaller more manageable pieces.

The inconsistent performance of the pruners led to exploration of other tools that might help to efficiently sort & separate entangled ghost gear. Various manual cutters and electric tools (like a Sawzall, a jigsaw, a hacksaw, and a cut-off tool) were all tested. When possible, different blade types were also tested. By far, the cut-off tool equipped with a diamond blade was the most efficient. The manual "guillotine" style cutters also performed well.

Going forward, the M12 cut-off tool will be ROTR's tool of choice for sorting & untangling ghost gear. The tool was also very useful for the initial size reduction of gillnets before utilizing the bandknife. It's a very compact tool that can easily be used with one hand. This is helpful because it is more effective to cut the gillnet when it is under tension.

Figure 1: Shoveling snow to gain access to the ALDFG

Figure 2: Sorting the ALDFG for transport. Our focus was on gillnets.

Figure 3: Loading up the trailer with the ALDFG.

Figure 4: Utilizing a variety of cutting tools to separate and untangle rope from the gillnet. The M12 tool (far right) was the most efficient.

For this project, we decided to transport the ALDFG from Port Hope Simpson ourselves. The journey from Colliers to Port Hope Simpson proved to be more expensive than anticipated due to bad weather and increasing fuel prices. Although the ALDFG was successfully transported back to the recycling

workshop in Colliers, future projects will require better transportation methods and/or transportation during summer months.

For small quantities of material, there may be an opportunity to partner with cargo trucks that have additional or excess room. This approach might yield more cost-effective transportation and would reduce carbon emissions. For larger quantities, ROTR could invest in a bigger trailer and travel when snow/ice isn't an issue.

Figure 5: Arriving in Labrador #1

Figure 8: Arriving in Labrador #2

Figure 6: Covering full trailer load of ALDFG for transport back to Colliers

Figure 7: Off-loading ALDFG at recycling workshop in Colliers

Gear Assessment & Totals

In March 2022, ROTR made its first trip to Labrador. During this trip, we transported a full trailer load of retrieved gillnet from Port Hope Simpson to Colliers.

In November 2022, ROTR made a second trip to Port Hope Simpson. During this trip, ROTR attended a Ghost Gear Crafting workshop organized by WWF-Canada & NCC. ROTR did a presentation about gillnet recycling and was able to offer participants prizes (keychains & earrings) made from gillnet. A second trailer load of gillnet was transported back to Colliers.

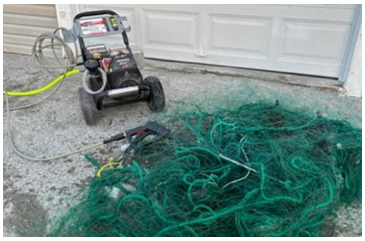
The gillnet was retrieved primarily from shorelines which explains why it was relatively clean and free of marine debris. ROTR expects most of the future gear it will be recycling to be much dirtier.

Washing

Washing the ghost gear is one of the most challenging steps of the recycling process. Dirty plastic can burn inside recycling machines causing lower product quality and tough-to-clean messes. Ghost gear is

usually covered in marine debris, making it very dirty and stinky. Long-term, a multi-step cleaning process involving a large industrial shredder will likely be necessary.

For the purposes of the pilot project, the washing was done using two methods: a) Using a pressure washer, stock tank and appropriate cleaning solutions, & b) leaving the gear outside to be cleaned via natural weathering. It's important to note that the gillnets used in this project were found primarily on land which made them cleaner than usual.



Figures 9, 10 & 11: Gillnet was left outside to be cleaned naturally by bugs, rain, and snow. Before processing, the nets were washed thoroughly with a powerful pressure washer.

The gear was quite clean to begin with so no additional cleaning agents were used for the initial tests.

Cutting & Shredding

Normally, Recycle on the Rock utilizes a small shredder to convert plastic bottle caps into small flakes. The flakes are then processed into new products using an injection moulding machine. The ROTR shredder is designed for hard plastics such as bottle caps and was unlikely to work efficiently for long fibrous materials such as ropes and nets.

For the purposes of the pilot project, two new tools (electric pruners and band saw with knife blade) were tested and utilized to cut the nets and rope into small pieces (2-3" long) that could be placed directly into the sheet press machine without being shredded. As part of the experimentation process, these smaller pieces were also tested in the ROTR shredder to see if they could be further size reduced.

Long-term, a large shredder with an input conveyor will be required. These large shredders significantly reduce the manual labour associated with the size reduction step and provide a very consistent output. The shredded material can then be sent to a cleaning tank or system to get cleaned a second time. Another solution may be to utilize a large extrusion machine and pelletizing system to transform the gillnet into pellets first. It's possible that some extruders could be able to use full, un-cut nets as in-feed material.

Figure 12 & 13: ROTR purchased a King Canada bandsaw and swapped the traditional blade with a unique "single edge" knife blade. This setup mimics "bandknife" machines used in foam & garment cutting factories. The single edge knife blade was used to prevent "snagging" and improve efficiency.

For this project, the focus was to test out the viability of using a band saw equipped with a special "band-knife blade" to cut the gillnet into smaller pieces. This method was more effective than expected & turned out to be a great option for size reducing the gill net. For large amounts of gill net, this method would be too time consuming, but for this scale it worked very well.

Next, we wanted to test out the viability of using Recycle on the Rock's small 1HP shredder to further size reduce the material. The shredder was able to further size reduce a small amount of the gillnet but ultimately proved to be too weak to be viable. The shredder design was also prone to jamming when the fibers were too long. Specialty shredders do exist that could handle this type of material. For large scale recycling, an efficient shredder is crucial.

Product Creation

ROTR products are created using an injection moulding machine. The machine uses high heat and pressure to melt plastic that is then forced into product moulds. The machine is operated manually and has a limited output capacity.

Recycle on the Rock attempted to utilize its injection moulding machine to create small products from the gillnet. This method was not the primary recycling strategy of the project, but it did provide a way to create a proof of concept. The small pieces of cleaned gillnet were slowly loaded into the heated injection barrel where they began to melt. After 10 minutes, a mould was attached to the barrel nozel and by applying pressure to the barrel rod, the molten plastic was forced into moulds. As shown below, the test was a success. We were able to prove and demonstrate that gillnets can be melted & remolded into new shapes.

Figure 14: Recycle on the Rock products made from gillnets retrieved by WWF-Canada & NCC. These products were created using an injection moulding machine.

The lightweight fibrous nature of the gillnet made it difficult to load the material into the injection barrel. The process was very time consuming and is not a feasible long-term solution for recycling gillnet. That being said, ROTR will be exploring the possibility of building an injection moulding machine better designed for fibrous input. A larger diameter barrel would make it easier to load the material into the machine. Combining this with either a "vacuum suction" or "fan blowing" in-feed system, could make injection moulding a more feasible option for gillnet.

The main recycling solution for this project involved utilizing a large heated sheetpress. ROTR purchased a 4' x 5' sheetpressing machine from Citizen Scientific Workshop. The machine is based on the Precious Plastic press design that has been built and used around the world to recycle plastic. Normally, this machine is used to recycle common plastics like HDPE, LDPE and PP. These common plastics have a lower melting point than Nylon (gillnet) which makes them easier to recycle. ROTR's goal was to see if the sheetpress technology could be used to recycle size reduced Nylon gillnet pieces.

Figure 15: Sheetpress loaded with the fibrous gillnet pieces. (Before compression)

Figure 16: Sheetpress loaded with the fibrous gillnet pieces. (After compression)

Figure 17: Sheetpress loaded with plastic bottle cap flakes.

One of the main benefits of a sheetpress design is that the “sheet moulds” can easily be filled with layers of fibrous gillnet pieces. The pieces can simply be laid & spread out by hand throughout the sheet mould, and then the mould cab be loaded into the heated press. The 4’ x 5’ press plates should allow for large quantities of the gear to be melted and recycled at the same time.

Depending on your moulds, the produced sheets can be anywhere from 1/8” to 2” thick. These sheets can then be treated like “plywood” and can be used in a wide variety of applications. For example, a 1/2” thick 4’ x 5’ sheet can be cut into 6” x 5’ boards that can be used for short fences, garbage can boards or planter boxes. You could create two 1/4” thick 4’ x 4’ sheets to use as interior wall finishing instead of gyprock or you can even take 1/8” thick sheets and cut them into tiles to be used in kitchen and bathroom renovations. The first sheets produced will likely be utilized as unique art pieces.

The sheetpress manufacturing timeline was much longer than quoted and unfortunately, the electronics controller was not shipped until December 6th. Once received, the machine was assembled and tested. Throughout February, March & April, ROTR spent time troubleshooting, fixing, improving, and testing the press. There were many issues with the press but the most significant was that the press could not reach the 230C temperature required for melting Nylon. (A full description of these challenges and problems can be found in SCHEDULE C & D accompanying this report.)

As a result of these delays and challenges, Recycle on the Rock has not yet been able to produce a recycled sheet from gillnet. Below are some photos of various attempts.

Figure 18: The result from the first test. The machine was heated as much as possible & was left running for several hours but failed to reach the melting temperature of Nylon. The result was a compressed mass of gillnet. Some areas of the net were burnt (likely from debris or dirt) but no melting was visible.

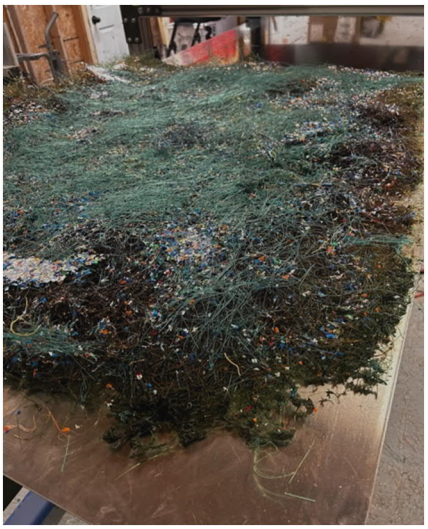


Figure 19: The dark base of the rough “sheet” is compressed gillnet from earlier testing. After making some more adjustments to the press, ROTR wanted to see if the addition of plastic cap flakes & more gillnet would make a difference upon re-pressing. After re-heating and pressing, some of the plastic cap flakes had melted but it was clear that it did help the melting or binding of the gillnet. The sheet was only left in the press for around 15 minutes. A longer melting window will be needed.

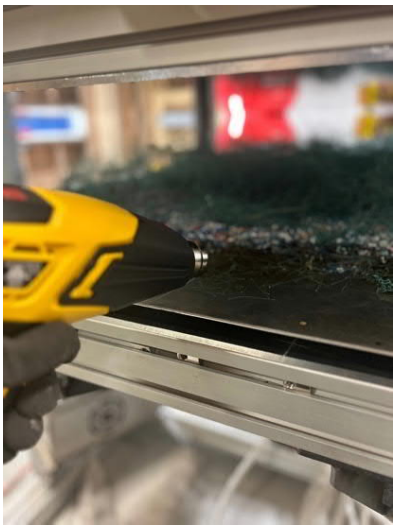


Figure 20: The melted edges of the "rough sheet" were achieved using a heat gun. ROTR had hoped that a heat gun might help the press reach Nylon melting temperatures, but this was not the case.

Figure 21: A mixture of compressed gillnet, plastic bottle cap flakes and unpressed gillnet about to be tested in the sheetpress.

Summary

As of May 8th, 2023, Recycle on the Rock has not yet been able to produce a plastic sheet made from retrieved gillnet. Significant manufacturing and shipping delays meant the machine arrived much later than expected. Moreover, once assembled, the machine had several issues that required troubleshooting & fixing. Unfortunately, the machine still can't reach the 230°C melting point of Nylon (gillnet material). The late arrival and troubleshooting reduced the amount of time available to experiment with the Nylon melting process.

ROTR still believes that with some adjustments, the sheetpress could be used to efficiently transform gillnet into compressed plastic sheets. Ideally, the machine would produce at least 1 sheet per hour, and various moulds could be used to adjust the shape & thickness of those output sheets.

The main issue that needs to be addressed is the maximum heat produced by the press. Currently, the press is struggling to reach 200°C. ROTR will be making modifications to attempt to reach the 230°C mark. Next steps include updating the machine code, improving the workshop environment (insulation & humidity control), and re-configuring the electronics.

Once the machine is operating as desired, the experimentation will re-commence. ROTR will explore different ways of loading and unloading the press, the effect fiber size has on melting time, various mould designs, and post-press processing techniques. The goal will be to produce strong and consistent sheets. Once produced, these sheets will be transformed into benches, tables, garbage cans and a wide variety of other products.

Some initial insights for the focus areas proposed at the beginning of this report are listed below. Please note that more insight will be gained once ROTR produces its first sheet.

Determining points of friction & substantial obstacles:

- Our experience so far has revealed the importance of the size reduction step. Efficiently size reducing the ghost gear makes storage and handling much easier. The methods used in this project would not be viable for a large-scale operation. Ultimately, a large industrial shredder will be necessary to scale Recycle on the Rock's ability to recycle ghost gear.
- UPDATE: Recycle on the Rock has received funding from Canada's Ghost Gear Fund to purchase a large commercial shredder specifically designed for fibrous materials. This shredder will be pivotal for the long-term viability of fishing gear recycling in Newfoundland.
- Exploring pelletizing systems will be an important next step. If the size-reduced gear can be easily loaded into a large extruder and converted into pellets, those pellets can more easily and efficiently be transformed into products. Moreover, these pellets could be sold to other recyclers around the world if ROTR cannot produce & sell products quick enough.
- The gear used in this project was cleaner than usual. More research will be required to determine how clean the material must be before it can be recycled.

Calculating required production capacity based on incoming ghost gear volumes:

- Once ROTR begins producing sheets, we will be able to calculate how quickly a given weight of gear can be transformed into sheets. This will help determine capacities and growth plans.
- It will be worth exploring the possibility of pelletizing the nets. If pellets can be efficiently produced, they would likely produce higher quality products. Pelletizing also greatly improves ROTR's ability to store and recycle large volumes of net. Ideally, these nets could be fed directly into an extrusion machine, making size reduction less important.

Determining effectiveness & feasibility of gill net recycling using proposed methodology:

- The proposed methodology has worked well for the scale of this project. ROTR was particularly impressed with the bandknife's ability to size reduce gillnet and the M12 cut-off tool's versatility for untangling many types of gear.
- As the volume of gillnet increases, it will be necessary to explore commercial shredders, post size-reduction cleaning systems, more efficient transportation, and stackable storage solutions.
- Unfortunately, ROTR has not yet been able to produce a recycled sheet from gillnet, but we remain optimistic that this technology can be used to efficiently recycle gillnet.

Determining a hierarchy of importance for implementing proposed solutions:

1. Upgrade the sheetpress so that it can reach 230°C in 2 hours.
2. Explore commercial shredders.
3. Explore systems for pelletizing gillnet. (Some extrusion machine setups may be able to use full nets as feeder material.)
4. Explore post size-reduction cleaning systems.
5. Explore stackable storage solutions.
6. Explore larger, more efficient transportation.

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