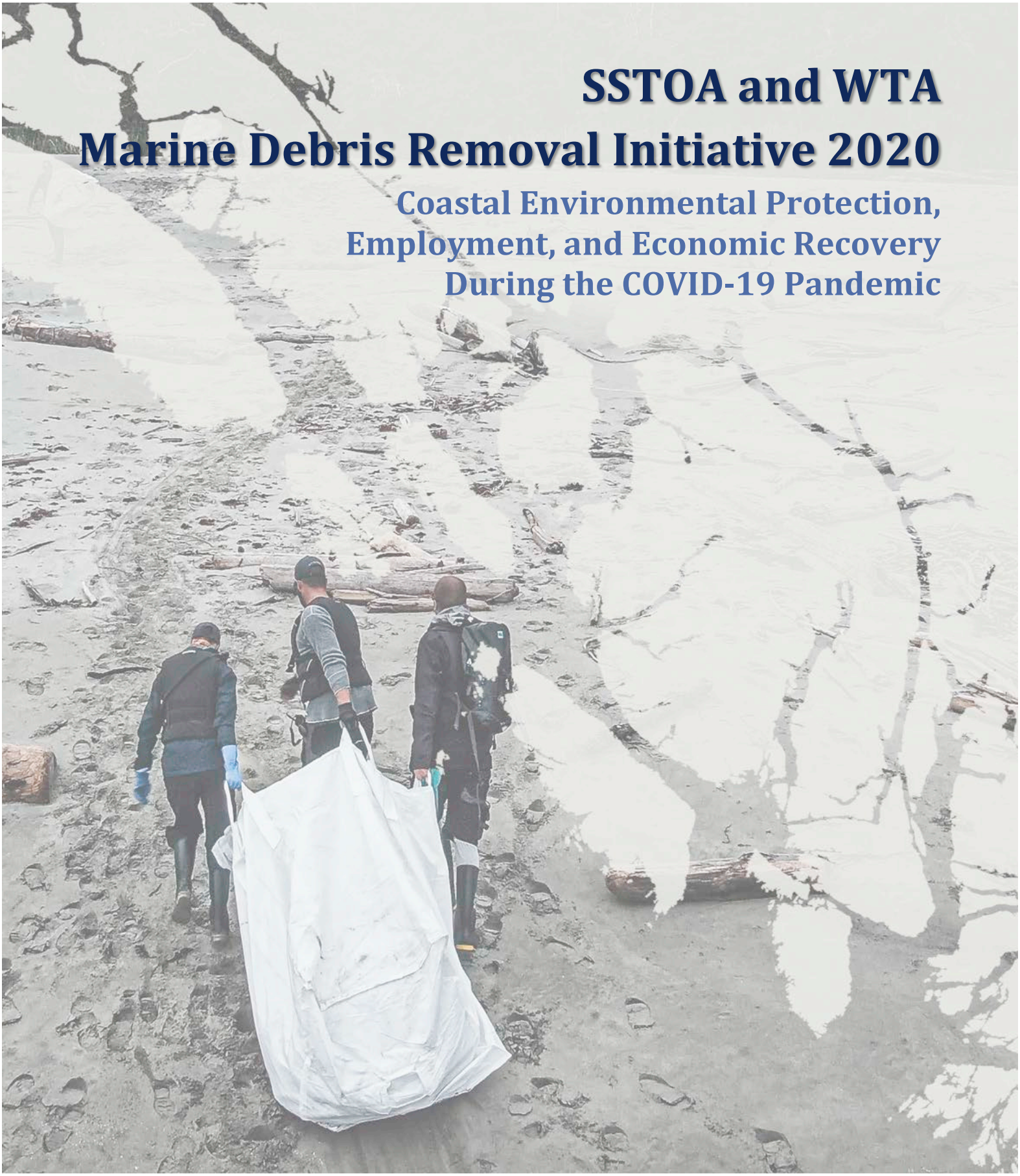
SSTOA and WTA
Marine Debris Removal Initiative 2020
Coastal Environmental Protection, Employment, and Economic Recovery During the COVID-19 Pandemic



SMALLSHIP
TOUR OPERATORS ASSOCIATION OF BRITISH COLUMBIA

WILDERNESS
TOURISM ASSOCIATION OF BC

Funded by

The Government of British Columbia's Clean Coast, Clean Waters Initiative Fund (CCCW)

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Gitga'at First Nation
Wuikinuxv First Nation
Nuxalk First Nation

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Submission Date

December 18th, 2020

BLUEWATER ADVENTURES

OUTER SHORES EXPEDITIONS

Maple Leaf ADVENTURES

GREAT BEAR II
Ocean Adventures

MOTHERSHIP adventures INC

Gitga'at Nation

Heiltsuk Nation

KITASOO/XAI'XAIS NATION

Wuikinuxv Nation

Nuxalk Nation

Preface

As the events of the **COVID-19 pandemic** unfolded in the spring and early summer of **2020**, and domestic and international travel and tourism came to a halt, the **Small Ship Tour Operators Association of BC (SSTOA)** embarked upon seeking First Nations support and Federal and Provincial government funding to conduct a large-scale marine debris removal initiative on British Columbia's Central and North Coast. If funded, this initiative would support the financial survival of BC's iconic small ship-based expedition travel industry, re-employ more than **100 seasonal and full-time employees**, and result in substantial benefits to coastal wildlife and marine ecosystem health.

On **August 31, 2020**, the BC Government formally announced that it had funded the SSTOA's proposal from the **Clean Coast, Clean Waters Initiative Fund (CCCW),** as part of its Pandemic Response and Economic Recovery Initiative to support all sectors that have been hard hit by the **COVID-19** public health and financial crisis.

The intent of this report is two-fold. **First**, this report provides the BC Government, and all British Columbians, a detailed accounting of what this highly successful initiative accomplished, including the removal of marine debris and resulting environmental benefits, the economic benefits of sustaining this sector, and the benefits of enhanced community stability as a result of employment.

Secondly, this report aims to contribute to the information needed by all levels of government and the public to address the crisis of marine debris and ocean plastic pollution that is currently unfolding on the BC coast, and around the world. We provide a detailed description of the composition and sources of the marine debris we encountered and removed while conducting this project and attempt to place our findings in the broader context of the BC coast and North Pacific Ocean as well as globally. Ultimately, we hope that our findings and this report will serve as a resource that can be used to facilitate similar initiatives and contribute solutions towards the ongoing ocean plastic pollution crisis and its increasing threats to marine ecosystems, coastal wildlife, fisheries, economies, food security, and human health.

Acknowledgements

The owners and operators of the **Small Ship Tour Operators Association** member companies that participated in the **Central Coast Marine Debris Removal Initiative 2020** extend our heart-felt appreciation and thanks to the enormous number of people, organizations, and levels of government who supported this project. During this unimaginably difficult year due to the ongoing COVID-19 pandemic, the level of teamwork, collaboration, positivity, and mutual support that embodied this initiative from start to finish has been deeply inspirational. In particular, we acknowledge and offer our appreciation:

To the **BC Government and Premier John Horgan** for funding this project through the Clean Coast, Clean Waters Initiative Fund, and for the foresight to commission **MLA Sheila Malcolmson** and her report ***What We Heard On Marine Debris In BC*****,** to assess the state of marine debris on the BC coast. **To Environment Minister George Heyman** for moving swiftly to support this Marine Debris Removal Initiative. To **Ministry staff** for their understanding of the needs, the opportunity and benefits of supporting bold action.

To the **First Nations**, their leadership, and Emergency Operations Committees (EOCs) who supported this initiative despite the ongoing threats and challenges caused by the COVID-19 pandemic. In particular, we thank those individuals with whom we worked closely on numerous approval processes and operational logistics, including **Danielle Shaw, Andra Forney, Calen May-Tobin, Lena Colins (Wuikinuxv Nation), Bernie Elkins (Nuxalk Nation), William Housty, Harvey Humchitt Sr., Kelly Brown, Kevin Starr, Diana Chan (Heiltsuk Nation), Doug Neasloss, Evan Loveless, and Rosie Child (Kitasoo/Xai'xais Nation), and Simone Reece and Chris Picard (Gitga'at Nation)**. We also thank **John Czornobja (General Manager, Spirit Bear Lodge),** who worked closely with the SSTOA planning team and coordinated Kitasoo/Xai'xais clean-up crews, and the **Coastal Guardian Watchmen and community members** who participated in Heiltsuk and Kitasoo/Xai'xais Nation clean-up crews.

To all the individuals and companies with whom we worked closely on our operational logistics, including **Pierre Theriault, Russell (Rusty) Snow, Travis Olinger (Heiltsuk Horizon Maritime Services), Paul Tosczak (Air Span Helicopters), Greg Fox (Fox Disposal), James Furney (Furney Distributors), Vida Friesen (Shearwater Marine, Port Hardy), Patrick Donaghy (Mt. Waddington Regional District Landfill Services), and Burnaby Bag & Burlap.** We wish to particularly thank our amazing **helicopter crew (Jason Leslie and Nolan Edwards) and captain and crew of the towing vessel *Gulf Rival* (Captain Lorne Bentley, Robert Johnson, and George (Rudy) Elluk)** for their exceptional professionalism, enthusiasm for this initiative, and flexibility throughout.

To **Scott Benton, Executive Director of the Wilderness Tourism Association of BC** for all the time, experience, wisdom, and guidance you provided us during innumerable phone calls, emails, and video conferences throughout this journey, including administration of the project funding. Thank you.

To **Kathy McRae, Executive Director of the Commercial Bear Viewing Association of BC** for your tireless efforts and positivity to help guide our companies and industry to navigate the dark and turbulent months of the COVID-19 pandemic, including being an incredible spokesperson for our industry and liaison with government.

To **Deirdre Campbell and Vanessa Johnson (Beattie Tartan)** for your generous support of this initiative, our industry, and the BC coast for guiding us through the world of media, public relations, communications, and digital story telling.

We also thank all of the photographers and videographers who shared their images and videos to allow us to tell the story of this MDRI, including, but not limited to, **Jack Plant at Spirit Bear Lodge**, **Simon Ager**, **Eddy Savage**, **Jeff Reynolds**, **Kevin Smith,** and **Oriana Smy.**

And finally, to all of our **MDRI crews** who did the actual heavy lifting, cutting, digging, carrying, dragging, weighing, and packaging of **127,060 kg of marine debris** along the treacherous wave-exposed rocky shores of the Central Coast and Queen Charlotte Sound. You honoured each of us, our companies, our vision for this industry, and the BC coast with your passion, professionalism, and determination. Thank you.

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Executive Summary

In response to the events of the COVID-19 pandemic causing a complete shutdown of their industry, the **Small Ship Tour Operators of BC (SSTOA)** proposed an unprecedented marine debris removal initiative (MDRI). On **31-August, 2020,** the BC Government formally announced **$3.5-million of funding** for the **SSTOA MDRI** from its **Clean Coast, Clean Waters Initiative Fund (CCCW)**. With the support of the **Wuikinuxv, Nuxalk, Heiltsuk, Kitasoo/Xai'xais, and Gitga'at First Nations**, **two 21-day MDRI expeditions** took place between **18-August and 28-September, 2020** along the outer shorelines of **BC's Central Coast and Queen Charlotte Sound**.

The MDRI expeditions included **a fleet of nine ships and 17 skiffs**, and **employed 111 SSTOA crew members** and **69 First Nation community members**. Collectively, **127,060 kg (1029 m^3) of beach-cast marine debris** was collected and removed via helicopter, tug, and barge, from **401 sites** and **540.5 km of shoreline** between Cape Calvert and northern Aristazabal Island. **More than 50% of the marine debris collected consisted of derelict or "ghost" fishing gear**.

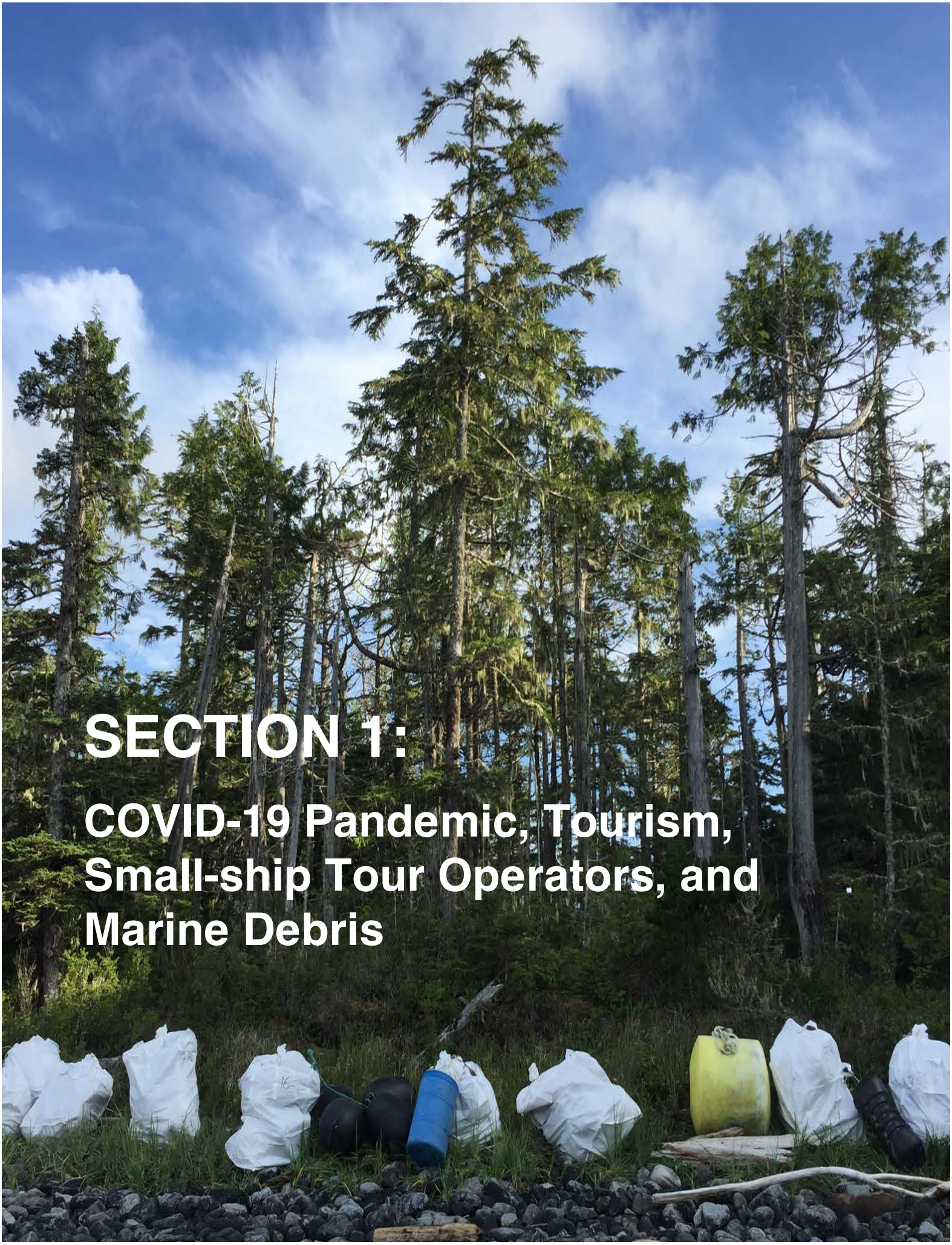
The CCCW funding directly paid for **4,115 employment days** during the **42-day marine debris removal initiative**, including **958 employment days for First Nation community members**. This funding indirectly supported an **additional 5,405 employment days for SSTOA employees** in kind prior to and following the MDRI expeditions.

The success of this industrial-scale marine debris initiative was ultimately due to:

- Project support and participation by local First Nation governments, which were enabled by long-standing collaborative agreements between these Nations and SSTOA members.
- Economies of scale achieved by a fleet of nine ships accommodating a mobile work force of 180 personnel continuously located on site.
- Organizers having the experience to provide the high level of planning and coordination required to safely access the project area and efficiently remove debris.
- Well-trained, experienced personnel who were highly motivated, and physically capable of safely cleaning up the environment.

Following from the outcomes and insights gained during this initiative, the SSTOA concludes this final report with **six key recommendations**, including:

- Mitigation of derelict/ghost fishing gear
- Mitigation of polystyrene foam
- Funding for ongoing marine debris removal initiatives
- Funding for marine debris research and monitoring
- Funding for marine debris recycling facilities and capacity
- Prioritizing MPAs for future removal initiatives



SECTION 1:

COVID-19 Pandemic, Tourism, Small-ship Tour Operators, and Marine Debris

COVID-19 and Impacts to Tourism

The ongoing coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was declared a pandemic in March 2020. As of November 2020, COVID-19 has been responsible for more than 1.25 million deaths globally. Ensuing quarantines, travel restrictions, and other infection prevention and control measures (Chinazzi et al. 2020), have caused the most severe disruption of the global economy since World War II, with domestic and international tourism being exceptionally hard hit (Gössling et al. 2020). Widespread and ongoing impacts to tourism-based industries and economies have forced companies and industries to "pivot" to new markets where possible, engage in alternative activities for generating revenue, and seek emergency financial aid in the form of government loans and grants.

In the province of British Columbia (BC), Canada, pristine wilderness, abundant wildlife, deep cultural heritage, and a wide diversity of recreational opportunities support a rapidly growing Tourism industry that is a primary economic driver and employer. In 2018, Tourism in BC contributed $8.3 billion to the economy and contributed more to GDP than any other primary resource industry including Forestry ($1.8B), Agriculture and Fishing ($3.2B), Oil and Gas ($4.9B), and Mining ($5.2B) (Destination BC, 2018). In the same year, Tourism supported 19,328 businesses and 161,500 people were employed by tourism-related businesses (Destination BC, 2018). In 2019, BC's Tourism industry had another exceptional year, with a total of 6,213,752 overnight international visitor arrivals to the province, including 3,980,733 visitors from the US, 1,348,676 from Asia Pacific, and 607,807 visitors from Europe. However, with the onset of the COVID-19 pandemic, adventure tourism-generated revenues have declined by more than 83% in 2020 (WTA 2020, unpublished survey).

Small Ship Tour Operators Association of BC

The Small Ship Tour Operators Association of British Columbia is composed of seven 100% Canadian-owned and operated, small-ship expedition travel companies that specialize in providing niche, nature-based wilderness travel experiences for small groups of 6-24 passengers, throughout the BC coast. In particular, they operate in Northern Vancouver Island, Haida Gwaii, and the Great Bear Rainforest. Although diverse in terms of the size and types of vessels they operate, SSTOA members share the core values of sustainable tourism and proudly embrace their roles in emerging conservation-based economies. They are fundamentally conservation-minded entrepreneurs and have chosen these career and business paths because of their dedication and passion for protecting and sharing the wonders of the BC coast.

The SSTOA works closely with numerous industry organizations and associations, including the Wilderness Tourism Association of BC (WTA), the Commercial Bear Viewing Association of BC (CVBA), Gwaii Haanas Tour Operators Association (GHTOA), and the North Island Marine Mammal Stewardship Association (NIMMSA). Many members are carbon-neutral certified, and financially support a wide range of conservation initiatives and organizations on the BC coast and beyond.

As a result of the COVID-19 pandemic, SSTOA members eventually lost their entire 2020 operating seasons (April through October), resulting in the loss of approximately 15,000 visitor nights, 140 direct employee jobs, and annual gross revenues of approximately $15,000,000. However, as the events of the pandemic unfolded, SSTOA members began working together to find ways to cooperatively support their industry, companies, employees, and families through this financial crisis, ultimately by developing an ambitious initiative designed to give back to the coast they depend on and care so much about. The SSTOA envisioned and proposed to the Government of Canada and the Government of British Columbia a marine debris removal initiative (MDRI), that would be unprecedented in both scale and the area in which it would take place – BC's Central and North Coast, also known as the Great Bear Rainforest.

The SSTOA proposed to conduct two 21-day expeditions to the wave-exposed, outer-coast shorelines of this region, where due to severe logistical challenges, large scale clean-ups of beach-cast marine debris had never previously been attempted. If funded, this initiative would result in the complimentary benefits of 1) making a significant positive contribution towards mitigating the ongoing crisis of ocean plastic pollution on the BC coast; 2) re-employing more than 100 crew members and expedition support staff laid off due to the pandemic; and 3) supporting the SSTOA companies and niche small-ship travel industry in BC.

First Nation Support and Participation

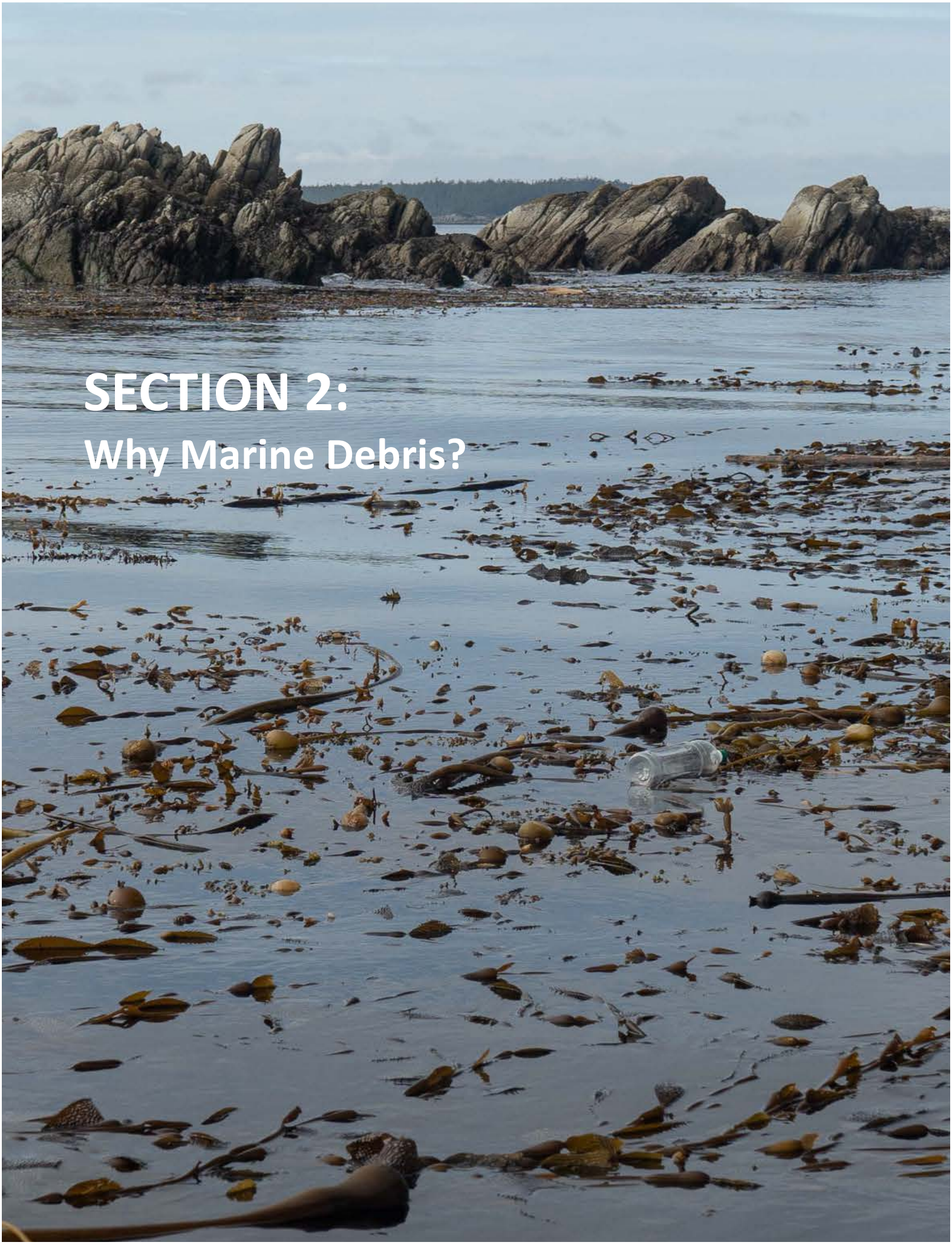
Critically, the SSTOA proposed to conduct this initiative only with the support of the Wuikinuxv, Nuxalk, Heiltsuk, Kitasoo/Xai'xais, and Gitga'at First Nations, in whose traditional territories this proposed activity would take place. The SSTOA companies and owners participating in this initiative have a long history of working closely with these Nations, formalized in the form of Memorandums of Understanding and Tourism Protocol Agreements. Collaborating on this initiative was a natural extension of long-standing working relationships based on shared interests and mutual respect.

The SSTOA's proposal included funding for these Nations to participate in this project if possible. The general vision for this collaboration was that while the SSTOA would focus their clean-up efforts on outer coast areas, participating Nations would collect marine debris at locations close to their communities, or other culturally or ecologically sensitive areas where it would be inappropriate for SSTOA crews to visit. The SSTOA would provide helicopter lift bags to First Nation clean-up crews, and, at the end of each expedition, utilize and coordinate the SSTOA's contracted helicopter, tug, and barge as well as the SSTOA ships and ground crews to remove the marine debris collected by Nations, which would otherwise normally be logistically and financially prohibitive.

With respect to the COVID-19 pandemic, travel restrictions, and Indigenous State of Emergency community closures at the time, a critical element of the SSTOA proposal was that MDRI vessels and crews would be completely autonomous, would not visit Indigenous communities for any reason, and would have no direct contact with the clean-up crews of participating Nations. Ultimately, the SSTOA received exceptional support from the Wuikinuxv, Nuxalk, Heiltsuk, Kitasoo/Xai'xais, and Gitga'at First Nations, and with this support the SSTOA engaged with the Government of British Columbia to request a grant to fund this environmental, employment, and economic recovery initiative.

CleanBC Plastics Action Plan

Ultimately, the SSTOA MDRI proposal fit closely with the BC Government's priorities of addressing marine debris on the BC coast, *Plastics Actions Plan*, and supporting BC's tourism sector through the COVID-19 pandemic. On 31-August 2020, Special Advisor for Marine Debris Protection and Parliamentary Secretary for Environment Sheila Malcolmson formally announced that the BC Government was providing $3.5 million dollars from the *Clean Coast, Clean Waters Initiative Fund (CCCW),* part of the BC Government's far-ranging Pandemic Response and Economic Recovery initiative supporting all sectors that have been hit hard by the COVID-19 crisis, to fund the SSTOA proposed MDRI on BC's North and Central Coast.



SECTION 2:
Why Marine Debris?

Why Marine Debris?

For those unfamiliar with the subject of marine debris and ocean plastic pollution, a reasonable question is simply to ask "*Why marine debris?"* This section is intended to provide the broader context of the SSTOA marine debris removal initiative, as well as present some essential terms and concepts used throughout this report.

What is Marine Debris?

Marine debris is a major environmental crisis occurring throughout the world's oceans and shorelines, including the relatively remote and pristine coast of British Columbia. The term *marine debris* is typically used when referring to larger items (>5 cm) of marine litter (i.e., garbage) that are floating at the surface or have been washed ashore, or *beach-cast*. Although marine debris includes items made of natural products, such as wooden structures drifting at sea, the vast majority of marine debris consists of items produced from synthetic organic polymers (i.e., *plastic*), and which may or may not be found floating at the ocean surface.

As of 2017, the annual global production of plastics had increased to 348 million metric tons (Mt) /year (Ostle et al. 2019, Geyer et al. 2017). Moreover, of the annual global production of plastics, an estimated 19 to 23 Mt is currently entering the world's freshwater and marine ecosystems as macroscopic litter (i.e., marine debris) and microplastic particles (i.e., microplastics) resulting from a wide range of industrial, residential, and single-use plastics (Borrelle et al. 2020, Worm et al. 2017, Jambeck et al. 2015); As such, the term *ocean plastic pollution* generally refers to all sizes and sources of plastic entering the world's oceans.

In contrast to large and conspicuous (i.e., *macroscopic*) items of marine debris and ocean plastics, very small plastic particles are known as *microplastics*. *Microplastics* are small plastic particles, fragments, or fibres in aquatic environments, and may be found floating at the surface, suspended in the water column, or settled on the seafloor. The following terms refer to specific sizes of these plastic particles: *nanoplastics* (<1 µm); *microplastics* (1 µm-5 mm); *mesoplastics* (5-200 mm); and *macroplastics* (>200 mm) (reviewed by Worm et al. 2017). In general, *microplastics* (and these other sizes of plastic particles) are increasingly receiving a lot of attention due to their alarming abundance throughout the world's oceans. Microplastics are broadly produced in two ways.

1. ***Primary microplastics*** are purposely produced as the raw materials of industrial plastic manufacturers that use them to build larger plastic items and are accidentally released into the environment during production and transportation. For example, ***nurdles*** are typically clear plastic pellets <5 mm in diameter that are produced by the billions each year to manufacture plastic products globally. Similarly, ***microbeads*** are manufactured solid plastic particles **<1 mm** diameter that are used in exfoliating personal hygiene productions, such as toothpaste, face washes, and other cosmetics. As these products are washed off of our bodies, microbeads find their way into freshwater and marine ecosystems where they cause ***plastic particle***

***water pollution*.** Fortunately, microbeads have recently been banned in both Canada and the USA, and several other countries around the world.

The term ***microfibre**s* refers to synthetic polymers, such as polyester, acrylic, and nylon that are used in spinning textile fibres and manufacturing approximately **60%** of clothing materials worldwide. Unfortunately, as clothing made from these synthetic materials is worn and washed, it loses microscopic plastic fibres **(<5 mm),** called ***microfibre**s* that also end up in the ocean and cause ***microfibre pollution***.

2. By contrast, ***secondary microplastics*** originate from larger plastic items **(i.e., marine debris)** that have been introduced into aquatic environments and subsequently degraded into smaller pieces by the action of sun, temperature variations, waves, shorelines, and marine life (Lebreton et al. 2018; Worm et al. 2017). Herein lies one of the key values of coastal clean-up efforts aimed at the removal of beach-cast marine debris before it can be degraded into microplastics.

Impacts on Wildlife and Implications for Human Health

As levels continue to increase, ocean plastic pollution represents a major threat to wildlife, biodiversity, and ecosystem function due to its abundance, durability, and persistence in the marine environment, and has increasingly serious implications for human health.

The direct and gruesome impacts of plastic pollution on marine wildlife are well known, particularly for seabirds (Wilcox et al. 2015), sea turtles, and marine mammals (Panti et al. 2019), and are reviewed in detail by Worm et al. (2017). These impacts include but are not limited to; starvation due to gastrointestinal obstruction and stomach perforation (seabirds); impediment of hatchling movement toward the sea, gastrointestinal distress and starvation, and blocked and injured cloaca impedes laying of eggs (sea turtles); and bioaccumulation of particulate plastic from prey fish, stomach rupture and starvation, and entanglement-caused mortality (marine mammals). Similar mechanisms have been described for marine fish and invertebrates.

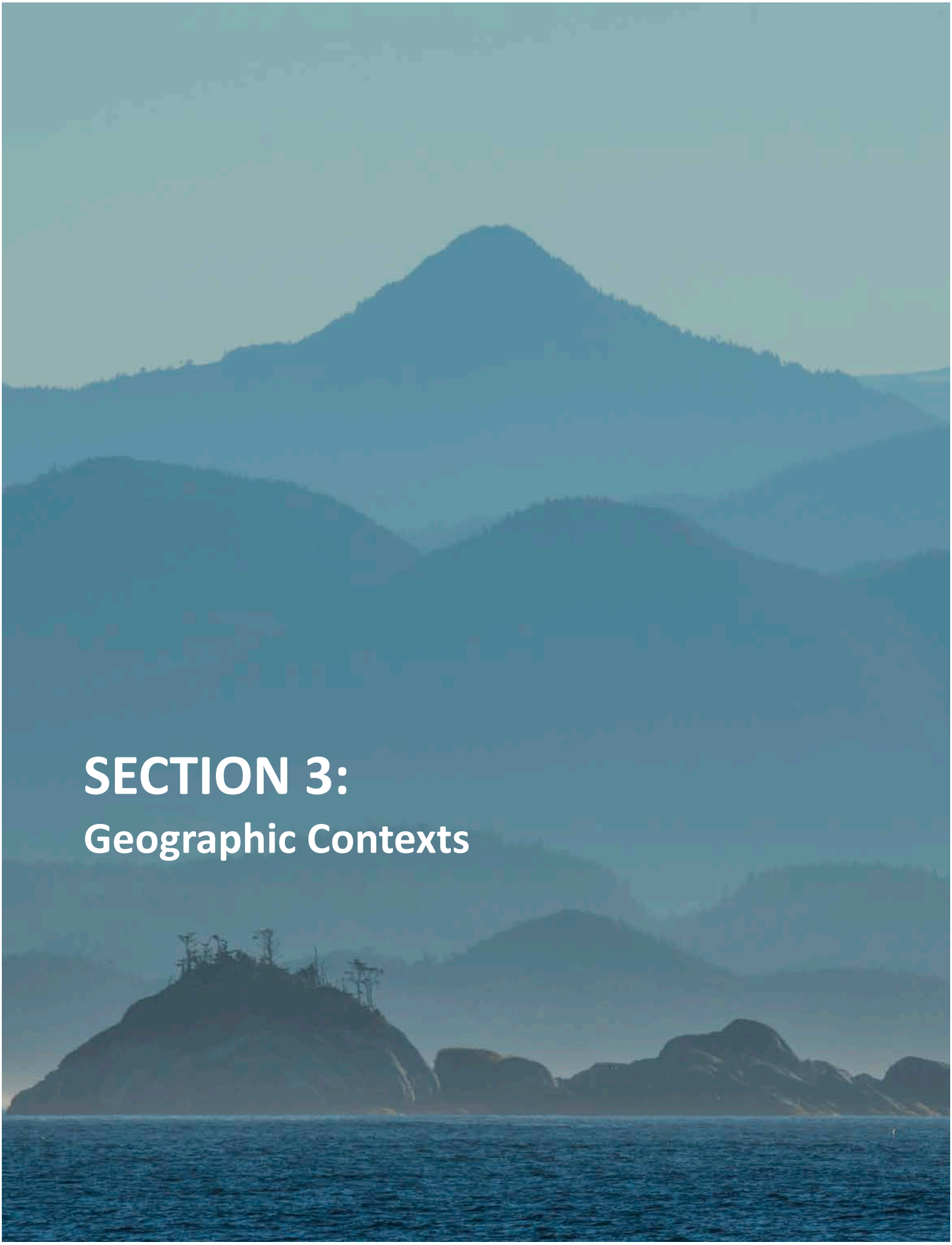
Less well known are the negative effects of toxic substances in plastics, including monomer residues, plasticizers, coloring agents, and flame retardants, that can be released upon ingestion and accumulate in fatty tissues (reviewed by Worm et al. 2017). Compounding these effects greatly, plastic fragments, particles, and fibres also have the capacity to adsorb both organic and metal pollutants from the environment and concentrate these up to 1,000,000x relative to concentrations found in seawater (Mato et al. 2001). In this way, ingested plastics and the chemical pollutants they contain are increasingly known to bioaccumulate and move through food webs to higher-order consumers, including humans (Worm et al. 2017). A well-studied example comes from shellfish aquaculture in Nova Scotia, Canada, where farmed mussels

accumulate plastic microfibers and other particles from the water column and transfer them to human consumers (Mathalon and Hill 2014). As a result, commercial, recreational, and Indigenous fisheries, and all consumers of seafood products, are vulnerable to ocean plastic pollution, the disproportionately high concentrations of toxins they can carry, and the significant risks to human health they may pose. Most recently, microplastics and the plastics additives they carry have been found inside human placentas and may be associated with adverse effects on pregnancies, including preeclampsia and fetal growth restrictions (Ragusa et al. 2021).

Marine Debris and Ocean Plastic Solutions

In 2018, the Governments for Canada, France, German, Italy, the United Kingdom, and the European Union signed the Oceans Plastics Charter in a commitment to move towards a more resource-efficient and sustainable approach to the management of plastics. Coastal and Shoreline Action is a key focus of this charter, in particular: raising public awareness, collecting data, and removing debris from coasts and shorelines globally. The Ocean Plastics Charter closely supports Canada's commitment to the United Nations 2030 Agenda for Sustainable Development, particularly Goal #14, Life Below Water.

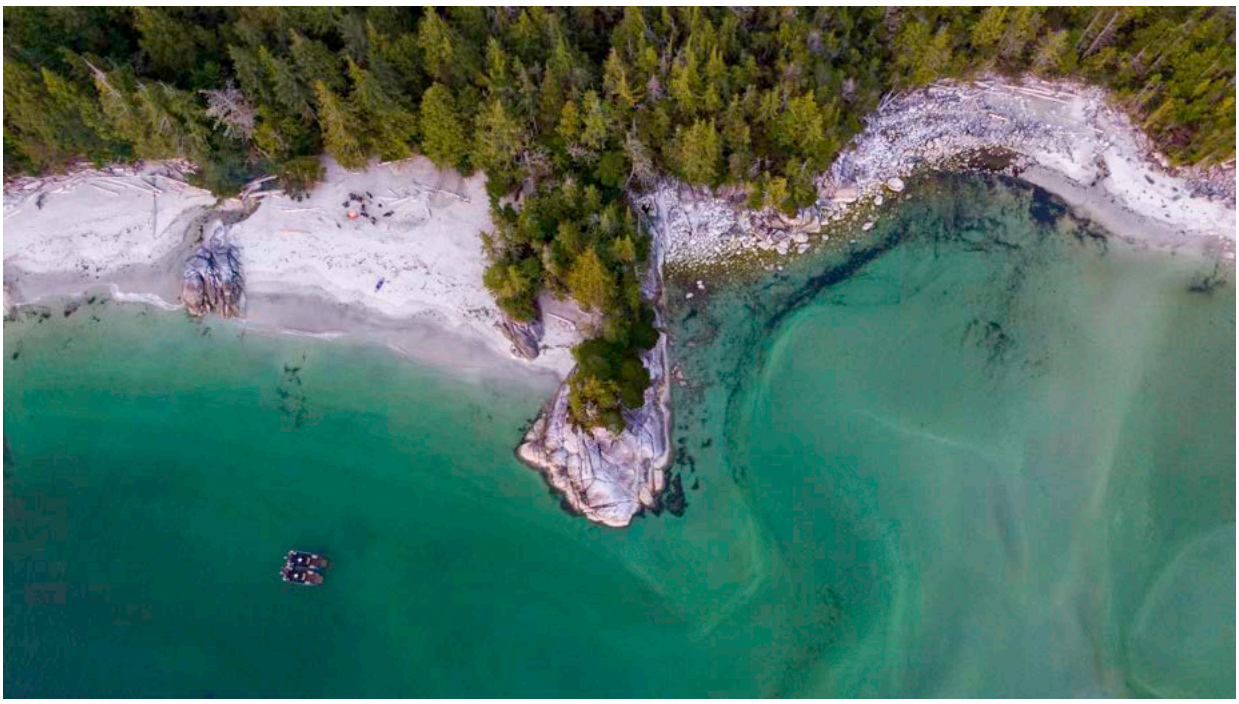
In British Columbia, despite being sparsely populated and relatively inaccessible, the accumulation of vast amounts of marine debris, derived both domestically and internationally, are increasingly a source of alarm and great concern**.** In April 2019, Premier John Horgan tasked Sheila Malcolmson, MLA for Nanaimo, Special Advisor for Marine Debris Protection, and Parliamentary Secretary for Environment, with finding solutions to the issues of abandoned vessels, marine debris, and marine-sourced plastics on the BC coast. Her resulting February 2020 report, entitled *What We Heard On Marine Debris In BC*, highlights the many challenges facing the removal of marine debris on the BC coast, including the logistics, costs, and complexities of collection, transportation, recycling, and disposal. This is especially true for BC's remote and inaccessible Central and North coasts.



SECTION 3:
Geographic Contexts

British Columbia's Central and North Coast

The central and northern portions of the BC coast are collectively referred to as the North Coast, which includes the large offshore archipelago of Haida Gwaii, and three large semi-enclosed basins (Dixon Entrance, Hecate Strait, and Queen Charlotte Sound). Coastal depressions, numerous inlets and fjords, and a complex network of islands and interconnected channels along the mainland shore are the result of an extensive history of glaciation (Burd et al. 2019, Cannings et al. 2011). As the result of a post-glacial hinge, sea level has remained relatively stable along the Central coast region (McLaren et al. 2018a), and as a result First Nations have continuously inhabited this region for at least the past 14,000 years (Mackie et al. 2018; McLaren et al. 2018b, McLaren et al. 2015).



The marine component of the North Coast is also referred to as the *Northern Shelf Bioregion* and is currently the focus of the *Marine Protected Area Network* planning process and the collaborative implementation of sub-regional marine plans through the *Marine Plan Partnership*. The Northern Shelf Bioregion supports a wide range of critical habitats (e.g., glass sponge reefs, eelgrass meadows, kelp forests), and species (marine mammals, seabirds, rockfishes, forage fishes, and salmon), and commercial, recreational, and Indigenous fisheries (reviewed by Burd et al. 2019). Finally, the terrestrial component of the North coast region is widely known as the *Great Bear Rainforest,* famous for being the largest remaining intact coastal temperate rainforest in the world, and home to wild Pacific salmon, grizzly bears, "sea wolves", and the iconic "spirit bear."

Marine Debris and Oceanography of the BC Coast

Marine debris and ocean plastics are transported throughout the world's oceans by global patterns of wind and ocean current circulation. Unfortunately, the oceanography of the North Pacific Ocean predisposes the west coast of British Columbia to the delivery of vast amounts of marine debris and ocean plastic pollution from sources throughout the North Pacific.

Gyres (pronounced "*jai-ur*") are large circulating ocean current systems associated with global atmospheric wind patterns and the rotation of the earth. When introduced into oceans, buoyant plastic items are frequently captured and transported vast distances by these major ocean current systems. As they rotate (much like a vortex), *gyres* accumulate and concentrate ocean plastics and other marine debris in accumulation zones that have become known as ocean *garbage patches*. For example, the *Great Pacific Garbage* Patch is located in the eastern part of the *North Pacific Subtropical Gyre*, between Hawaii and California. This garbage patch is approximately 1.6 million km^2 in size and contains an estimated 1.8 trillion pieces of *microplastics* (Egger et al. 2020; Lebreton et al. 2018).

The North Pacific Subtropical Gyre is a clockwise-rotating circulating ocean current system, located between the equator and ~50^o N, and formed by four ocean currents. The North Equatorial Current flows from east to west along the equator; the Kuroshio Current flows north along the west coast of Japan before turning west; and the North Pacific Current (NPC) (also known as the "Pacific" or "Westward" drift) flows from west to east between 30^o N and 50^o N. Approaching the west coast of North America, the NPC splits into the north flowing Alaska Current and the south flowing California Current in a transition zone that varies annually between approximately 42^o N and 52^o N (Cummins and Freeland 2007; Thompson 1981).

As a result of the North Pacific Subtropical Gyre, the outer coasts of BC are subject to a slow but persistent delivery of marine debris coming from the western Pacific (i.e., from Indonesia, Philippines, China, Taiwan, Korea, Japan, and Russia). Notably, annual variation in the north-south positioning of the NPC and Alaska Current holds implications for both biological productivity (Hristrova et al. 2019, Sydeman et al. 2011), and the delivery of marine debris to the BC coast. For example, in 2004-2008 the NPC came ashore off the coasts of Washington and Oregon States, but in 2002 it came ashore near southeast Alaska, and in 2003 extended directly into British Columbia's Queen Charlotte Sound (Sydeman et al. 2011).

Impacts to Wildlife on the BC coast

Despite being sparsely populated and inaccessible, the accumulation of marine debris and its threats to marine wildlife and ecosystems are increasingly being recognized on the BC coast. For example, Williams et al. (2011) mapped the overlap of plastic marine debris and 11 marine mammal species on the BC coast, and found that areas of highest overlap were concentrated on the North Coast where there is a high abundance of fin (*Balaenoptera physalus*) and humpback (*Megaptera novaeangliae*) whales. Surface-feeding pelagic seabirds, such as albatrosses, petrels, and fulmars, are particularly vulnerable to ingesting plastic items and fragments. Avery-Gomm et al. (2012) examined the stomach contents of beached northern fulmars (*Fulmarus glacialis*) in Queen Charlotte Sound and found plastic ingestion to be among the highest recorded globally and increasing markedly over the past 40 years.

2011 East Japan Earthquake and Tsunami

Finally, no discussion of marine debris on the BC coast, or the west coast of North America, would be complete without consideration of the 2011 East Japan earthquake. On March 11th, 2011, a magnitude 9.0 megathrust earthquake struck off the Tōhoku coast (northeast Honshu), generating a massive tsunami that reached 38.28 m in height (Carlton et al. 2017). Widespread coastal devastation resulted in an estimated 5 million tons of items being carried into the Pacific Ocean, much of which was transported by the North Pacific Current to the west coast of North America (reviewed by Clarke Murray et al. 2018). This single event increased debris deposition rates and loads on Hawaii and the west coast of North America to unprecedented levels, including many large items such as materials from broken homes, ships, and floating docks.

After Hawaii, British Columbia received the highest influx of tsunami debris between 2012 and 2015, driven by high numbers of large pieces of polystyrene foam arriving on Haida Gwaii.

During the same period, marine debris at monitoring sites in northern Washington State increased 10-fold (Clarke Murray et al. 2018). Debris from the 2011 tsunami continued to arrive from California to Alaska and Hawaii as late as 2017 (Carlton et al. 2017) and is expected to continue to arrive for decades to come as it is intermittently released from the North Pacific Subtropical Gyre. On BC's Central and North coasts, few data are available with respect to 2011 tsunami debris; however, some larger items are known to have arrived (e.g., a Japanese fishing skiff near Klemtu), and the remote and west-facing shorelines of Queen Charlotte Sound are expected to have received substantial but unknown levels of tsunami-generated marine debris.

SECTION 4:
What We Did and How We Did It

Expedition Region – Queen Charlotte Sound

The SSTOA MDRI expeditions focused on the outer islands and west-facing shorelines of Queen Charlotte Sound (Fig. 4.1). Queen Charlotte Sound is partially enclosed by the Haida Gwaii archipelago, Vancouver Island, and the mainland coast of Canada. It is bounded offshore by a line drawn between Cape Scott and Cape St James and merges into Hecate Strait to the north along a line that is not well defined but could run from Cape St. James to the southern tip of Aristazabal Island. Queen Charlotte Sound has a surface area of approximately 24,000 km^2 and a maximum width of 140 km (Crawford et al. 1985).

The outer coastlines of Queen Charlotte Sound consist of relatively low-lying rocky shores adjacent to high wave-energy environments. Beaches are rare, small and mostly made up of pebble-cobble size material. The tides in this region typically range from 3-5 m and are mixed-semidiurnal. The wind regime has two seasons, an upwelling-dominated season driven by northwesterly winds that last from April to September and a downwelling-dominated season driven by southeasterly winds that lasts from September to April. Notably, it is during this downwelling-season when surface waters are moved onshore that the majority of marine debris arrives onto the BC coast. Twenty-meter waves are not uncommon in Queen Charlotte Sound from November to February (Thomson, 1981, 1989).

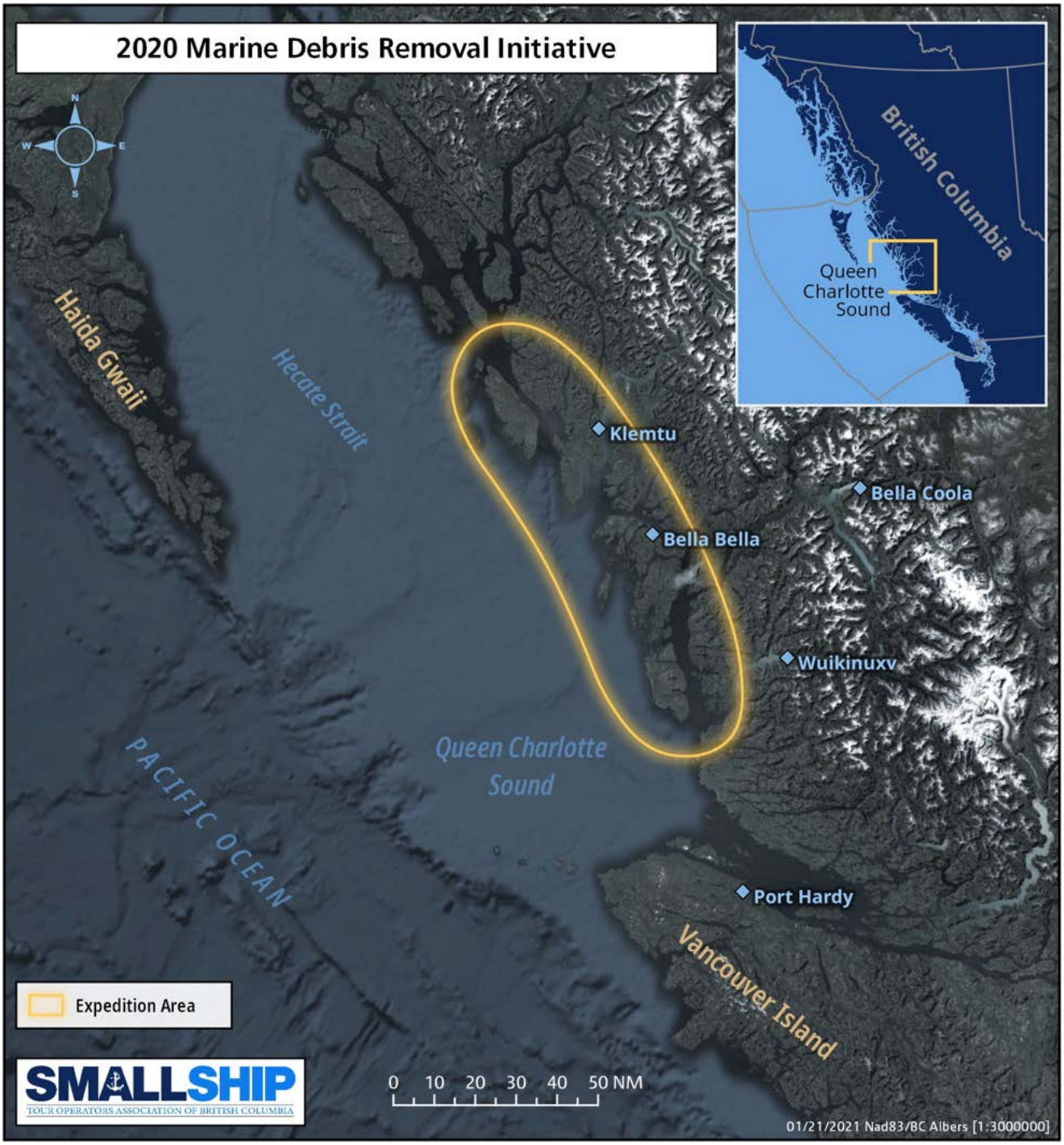


Figure 4.1 *Context map of BC's Central and North coasts and Queen Charlotte Sound.*

Expeditions Vessels and Personnel

Two 21-day MDRI expeditions were carried out by five participating SSTOA companies in the late summer and early fall of 2020: Expedition #1 (August 18-Sept 7, 2020), and Expedition #2 (Sept 8-26, 2020). The SSTOA fleet consisted of nine ships, 17 skiffs, and ~75 personnel on each expedition. Ships ranged in size and nature including a 54' fibreglass long range cruiser (M/V *Great Bear II*), a 140' steel motor catamaran (M/V *Cascadia*), 68'-82' fibreglass motor-sailing vessels (S/V *Island Roamer,* S/V *Island Odyssey*, S/V *Island Solitude*), and classic wooden ships (M/V *Columbia III*, M/V *Swell*, *Schooner Maple Leaf*, and *Schooner Passing Cloud*). All vessels were Transport Canada certified passenger vessels and exceptionally well outfitted for extended, long range, and autonomous expedition cruising.

Due to the ongoing COVID-19 pandemic, the SSTOA fleet took exceptional precautions to ensure the safety of their crews and the Indigenous communities in the regions in which they would be working, including: 1) all crew members were required to self-isolate and/or test negative for the virus prior to departure; 2) strict onboard health assessments, sanitation protocols, social distancing/mask rules, and evacuation plans were implemented; and 3) expedition provisioning, refuelling, and turnarounds were carried out in Port Hardy, on northern Vancouver Island. In addition, crews quarantined themselves onboard, and vessels remained independent of one another, for the first 14 days of each expedition.

Marine Debris Collection and Removal

During each expedition the MDRI vessels and crews systematically worked their way through each region in a coordinated manner. Each day ground crews traversed assigned areas, inspecting shorelines and removing debris wherever it was possible to safely land, primarily (but not exclusively) using 5-6m rigid hull inflatable boats (i.e., RHIBs).

Our general approach to collection and removal of beach-cast marine debris was to establish lift sites where helicopter lift bags were filled with debris and lifted off the shore by helicopter at the end of each expedition. Lift bags were purchased from Burnaby Bag and Burlap, either 37” x 37” x 60” or 35” x 35” x 52”, and with duffle top, chute bottom, 5:1 safety ratio, and 1,000 kg safe working loads. Depending on the difficulty of the terrain and the abundance of marine debris, crews dragged, carried, and assembled debris from the same location (i.e., beach or bay), and/or transported debris via skiff from nearby areas where it was impractical to establish lift sites. In the latter case, this involved crews collecting debris, loading it into their skiffs, transporting it to nearby lift sites (sometimes 1-2 kms away), unloading debris as close as possible to the lift sites, and once again carrying/dragging debris up the shore for packaging into lift bags. Large items often needed to be cut into pieces to be moved and packaged.

Lift site locations had to be located well above the high-water levels due to tides and storms. In order to minimize helicopter flight time, ground crews endeavoured to place as many lift bags as possible at each lift site. Lift site coordinates, and the numbers, weights, and descriptions of lift bags, hitchhikers, and additional items were reported and compiled by the fleet nightly.

At the end of each expedition, a Bell 206B Jet Ranger helicopter (Air Span Helicopters, Sechelt) was used to lift all collected marine debris onto a tug-towed barge (Heiltsuk Horizon Maritime Services, Bella Bella). Coordination among vessels, ground crews, helicopter crews, and the

tug/barge required the highest degree of planning, safety, and professionalism. Upon completion of helicopter-lifting operations, the loaded barge was towed to Port Hardy, where it was off-loaded and transported (Fox Disposal, Port Hardy), to Mt. Waddington Regional District Landfill.

Estimation of Shoreline Cleaned

We utilized a post-expedition methodology to estimate the length of shorelines cleared of marine debris during this initiative. BC Parks ARCGIS and navigation software with chart overlay was used to measure total distance for each shoreline/island or island group generally inspected. Straight line mapping was done at 1:12000 to 1:35000 scale depending on chart quality with each waypoint spaced greater than 0.25 nm to achieve an estimate of shoreline length. Actual expedition procedures for efficiently working a given shoreline were incorporated so as to provide reasonable approximation of on the ground effort.

In general, the areas worked on both MRDI expeditions of outer coast were comprised of 30% steep exposed headlands and 30% low rocky zones. In both these habitat types it is understood that as debris arrived it either ended up high in the forest fringe or more likely was washed back to sea and moved along the shoreline. Therefore, it was the remaining 40% of total shoreline (small coves, surge channels, bays, beaches, and bights) where we found the vast majority of accumulated beach-cast marine debris. These we generally also the same areas where it was possible to land skiffs and establish lift sites.

Lift Bag Packaging and Debris Composition

Packaging of marine debris into lift bags entailed two key steps – weighing debris and quantifying the composition or source of debris. The maximum lift weight for the helicopter contracted by the SSTOA was 330 kg. As such, all debris was weighed using mechanical spring scales as it was placed into lift bags. Due to the nature of marine debris being relatively high-volume and low weight (i.e., fishing floats and polystyrene foam), debris volume typically superseded debris weight when filling lift bags. For this reason, crews regularly attached large items (e.g., large plastic barrels or bundles of fishing floats), to the outside of lift bags, which were referred to as *hitchhikers*. Often large stand-alone bundles of debris were lashed together, independent of lift bags, which we referred to as *additional items*. The weights of all lift bags, hitchhikers, and additional items were determined and recorded so that at the time of helicopter lifting, ground crews could string together combinations of items with total weights of not more than 330 kg.

Description of Debris Composition/Source

The composition of marine debris was described and recorded using three methods: *lift-bag*, *burlap*, and *weigh-all*.

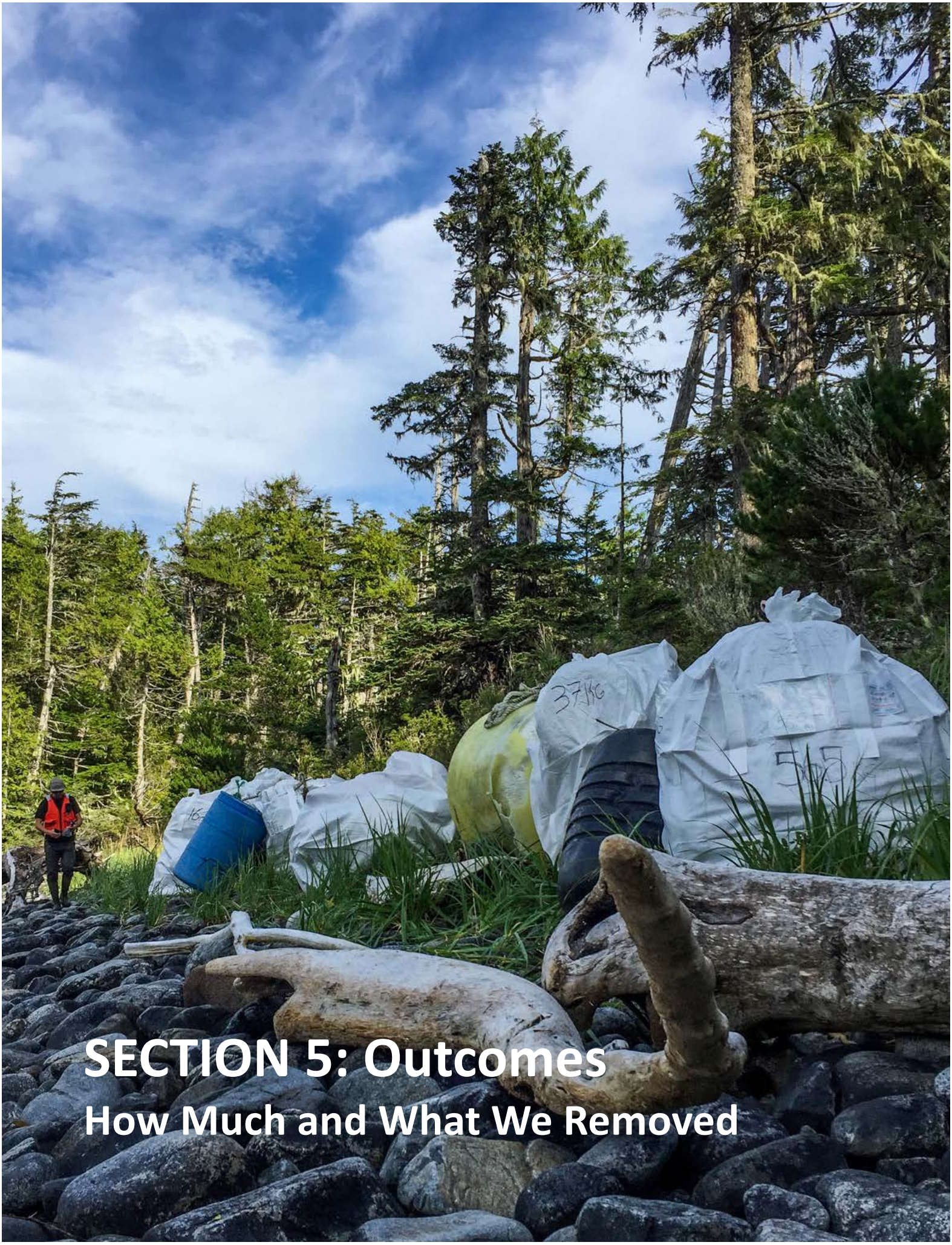
Using the *lift-bag method*, ground crews simply made note of the types of debris that were placed into each lift bag during packaging. Upon completion, a visual estimate of the percentage of the total volume of each lift bag that was occupied by six broad categories of marine debris (Table 4.1) was recorded.

We employed the *burlap method* to obtain more precise visual estimates of the volume of debris categories and higher-resolution information regarding the composition of marine debris. Using this method, ground crews carried burlap sacks while searching shorelines, filling them as they went with relatively small items of marine debris (e.g., plastic water bottles, chunks of foamed polystyrene, small pieces of net and line, and various single-use plastics). Filled burlap sacks and a wide variety of larger items were assembled at lift sites for packaging as described previously. In contrast to the lift-bag method, ground crews weighed each burlap sack using mechanical spring scales before emptying their contents into lift bags, and visually estimated the percent volume of each debris category for each burlap sack. It is important to note the burlap method focused on relatively small items of marine debris (i.e., those that could be easily stuffed into burlap sacks). The weights and categories of all other items were determined and recorded as they were placed into lift bags, added as hitchhikers, or bundled into additional items.

The *weigh-all method* was used in tandem with the burlap method and involved weighing and describing all large items as they were placed into lift bags or packaged into hitchhikers or additional items. Descriptions of all items were recorded in the field and subsequently assigned to 14 categories of marine debris (Table 4.1). Importantly, this method also included determining the weights of filled burlap sacks as they were emptied into lift bags, along with larger items, but did not attempt to weigh or describe the contents of burlaps.

Table 4.1. *Primary and secondary categories of marine debris, and definitions and examples, used during SSTOA MDRI.*

Primary Categories	Definitions and Examples	Secondary Categories
Fishing and Aquaculture	*Line/Rope (i.e., associated with hooks, nets, commercial floats, etc.); nets; hard plastic floats (e.g., dragger balls); other fishing floats (Styrofoam, plastic, gillnet floats, crab gear); fishing gear/equipment (rods, lures, flashers, hardware, other equipment); Aquaculture gear (blue barrels, black plastic trays), etc.*	Fishing Industry Aquaculture Industry Fishing Floats Fishing Nets/Lines/Floats (Mixed) Fishing Nets
Line/Rope	*Any line/rope that could not be distinguished as fishing gear (i.e., not associated with nets, hooks, commercial floats), or any other specific industry.*	
Polystyrene Foam	*Polystyrene blocks (e.g., floatation for docks); rounds/cylinders; miscellaneous fragments; etc.*	
Marine Activities	*Fuel containers (i.e., jerry cans), oil pans/buckets, life rings/PFDs, moorings/floats/fenders, deck brushes; ABS/PVC pipes, plastic pallets; etc.*	Plastic Baskets/Crates/Bins Plastic Buckets/Jugs Plastic Pallets Plastic Pipes
Consumer Goods	*Water/beverage bottles, soap, oil, milk jugs bottles, plastic bags, food containers, lighters, shoes/sandals/boots, cigarette tips, shotgun shells; vehicle tires/wheels; appliances; electronics; tarps/sheet plastic; etc.*	Plastic Beverage Bottles Rubber Tires
Hard Plastics	*Any hard plastics not clearly associated with other categories; unidentified fragments; etc.*	
Metal	*Aluminum/tin cans, aerosol cans, signs/building materials, other*	



SECTION 5: Outcomes

How Much and What We Removed

How Much and What We Removed

Sites, Weights, Volumes, and Lengths

Over the course of two 21-day expeditions the SSTOA MDRI fleet and participating First Nations collected a total of 127,060 kg (~1025 m^3) of beach-cast marine debris from an estimated 291.5 nm (540.5 km) of shoreline. A total of 186.5 nm (345 km) of shoreline was inspected and cleaned within provincial parks and conservancies (Tables A1 and A2).

During Expedition #1 ground crews established 184 lift sites between Cape Calvert and Cape Mark (Fig. 5.1) and removed a total of 60,825 kg of marine debris from an estimated 167 nm (309 km) of shoreline (Table A1).

Only one lift site was established throughout Fitz Hugh Sound (located between the east site of Calvert Island and the mainland) despite MDRI crews scanning and clearing all shorelines between the Penrose Islands and Ontario Point/Warrior Bay, including Welch Island, Peirce Bay, Addenbroke Point, Convoy Passage, Addenbroke and Blair Islands, Corvette Islands, Savage Island, McClusky Bay, Illahie Inlet, Green Island Anchorage to Kwakume Point, Kwakume Inlet to Koeye, Koeye to Ontario Point (Table A1). With the exception of the one lift site in Pierce Bay, the relatively small amounts of marine debris encountered and collected in this region was transported to lifts sites near Adams Harbour on the north end of Calvert Island, highlighting stark differences in the abundance of marine debris between areas exposed to Queen Charlotte Sound and the open Pacific Ocean, and those shielded by outer islands (Figs. 4.1 and 5.1).

During Expedition #2 MDRI crews established 217 lift sites between the south end of Price Island and the entrance to Kettle Inlet on the west coast of Aristazabal Island (Fig. 5.2), removed a total of 66,235 kg of marine debris from an estimated 81.5 nm (151.5 km) of shoreline (Table A2).

Notably, as a result our increased emphasis on building more additional items during the second expedition rather than filling lift bags, 372 lift bags were used during Expedition #1 while only 309 lift bags were used during Expedition #2 despite collecting more debris on the second expedition.

Following Expedition #1 Fox Disposal transported 27 sea cans/truck loads (~425 m^3) of debris to the 7-Mile Landfill (Port McNeill), and 23 sea cans/truck loads (~575 m^3) following Expedition #2. After both expeditions a large (but unquantified) number of hard plastic fishing floats were removed from these collections and re-purposed for the Heiltsuk Nation's herring spawn on kelp industry.

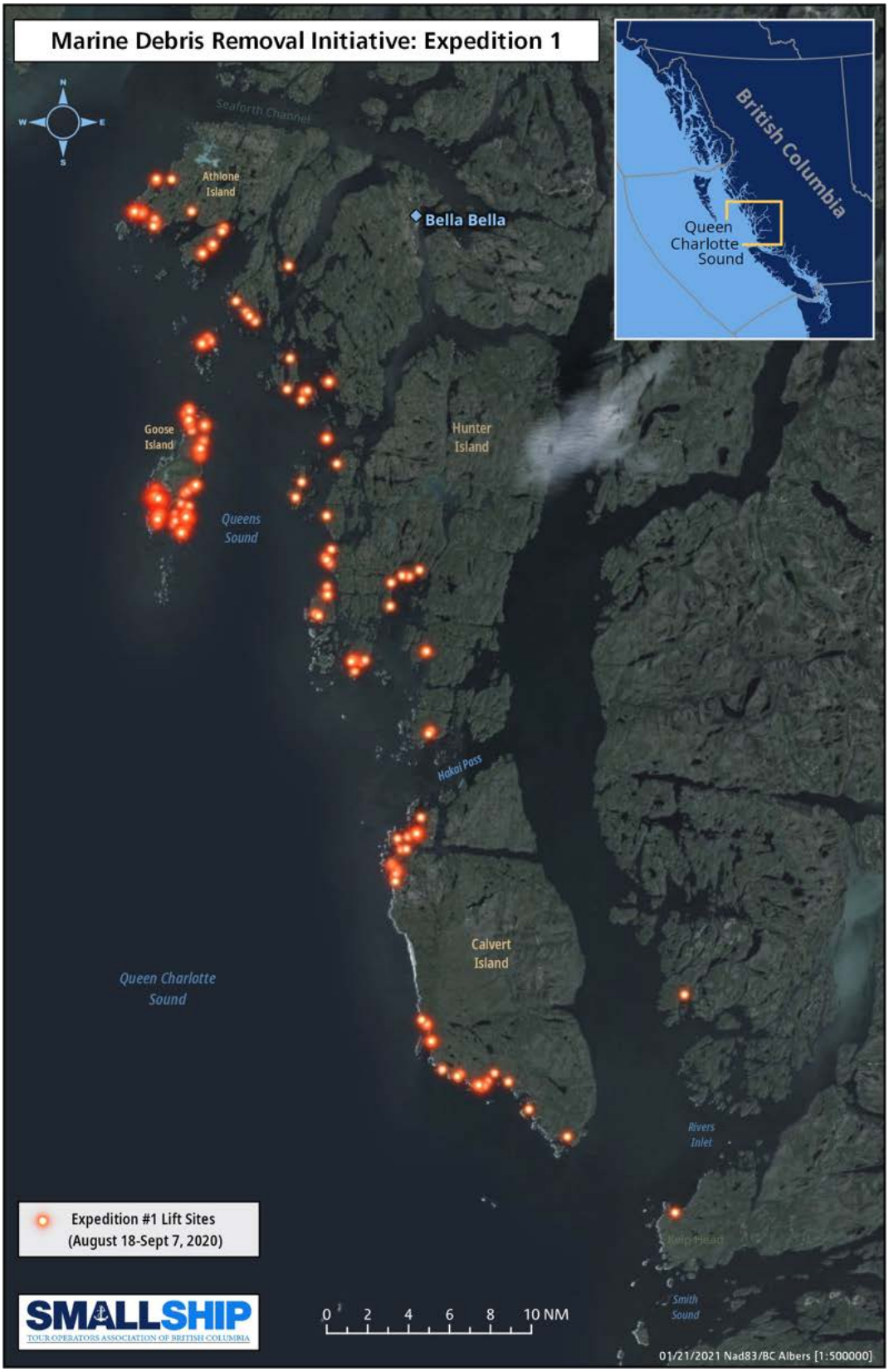


Figure 5.1 *Map of Expedition #1 marine debris helicopter lift sites.*

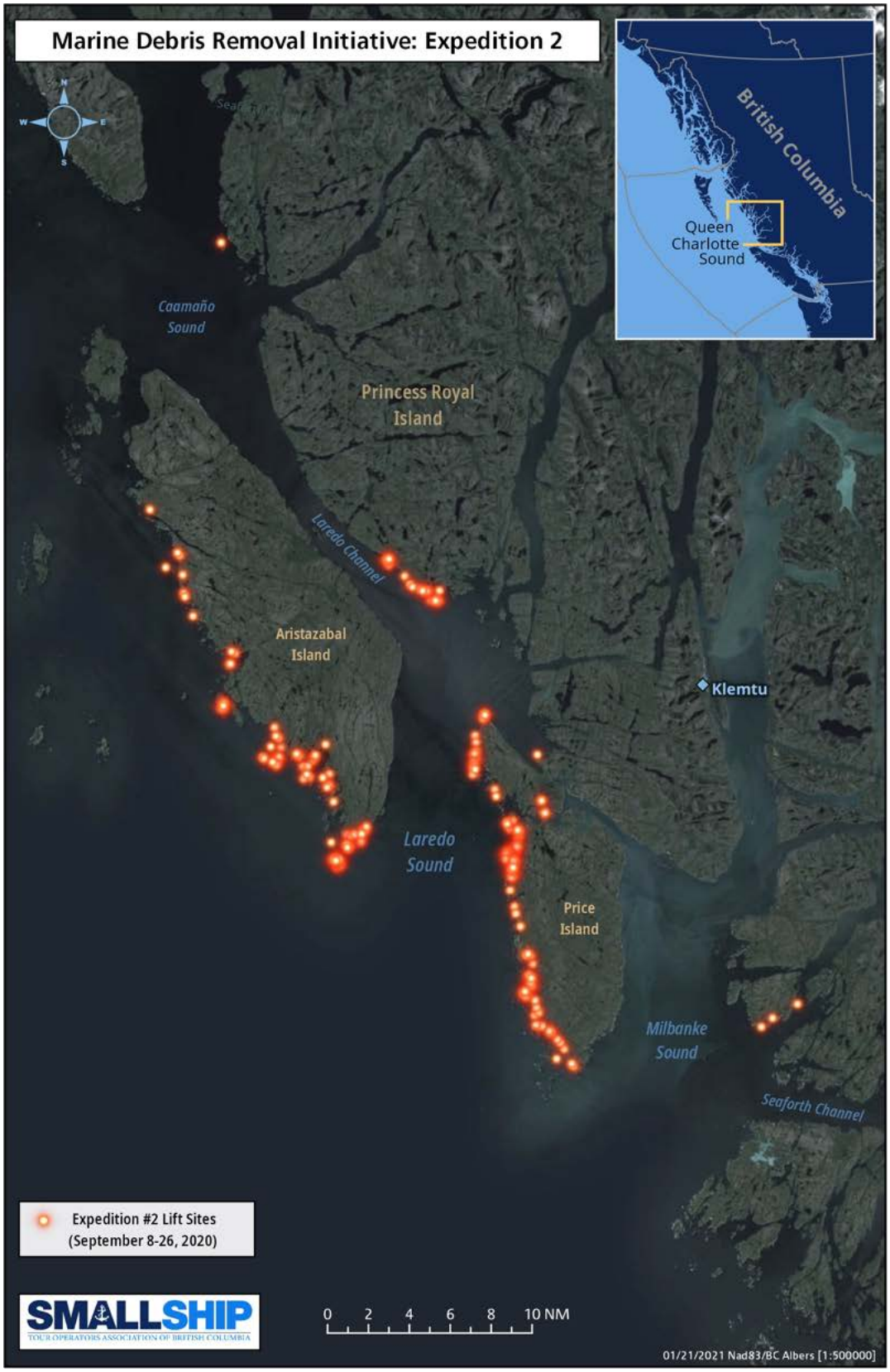


Figure 5.2 *Map of SSTOA Expedition #2 marine debris helicopter lift sites.*

Composition and Sources of Marine Debris

Lead time prior to the MDRI expeditions was severely limited, and therefore crew training with respect to marine debris collection and removal routines, and composition assessment had to be developed in the field. Necessarily, emphasis was initially placed on establishing safe and efficient routines for collecting and packaging debris and establishing lift sites. Methodologies for quantifying the composition and sources of the marine debris being collected, including the categories being used, was refined during Expedition #1 and implemented by the fleet more broadly during Expedition #2. For these reasons, comparable composition data was collected for 25% of the 60,825 kg of debris collected during Expedition #1, and 55% of the 66,235 kg of debris collected during Expedition #2.

Lift-Bag Method

During Expedition #1, of the total 60,825 kg collected, 15,206 kg of marine debris was packaged into 76 lift bags and additional items and composition described using the lift-bag method (Fig. 5.3). Using this method, we found that Fishing/Aquaculture accounted for the largest percent volume (median = 35%), followed by Single-Use Plastics (median = 20%), and Polystyrene Foam (median = 15%). Unidentified Rope/Line accounted for just 2.5% of lift bag volumes and Hard Plastic and Metal had median values of 0%.

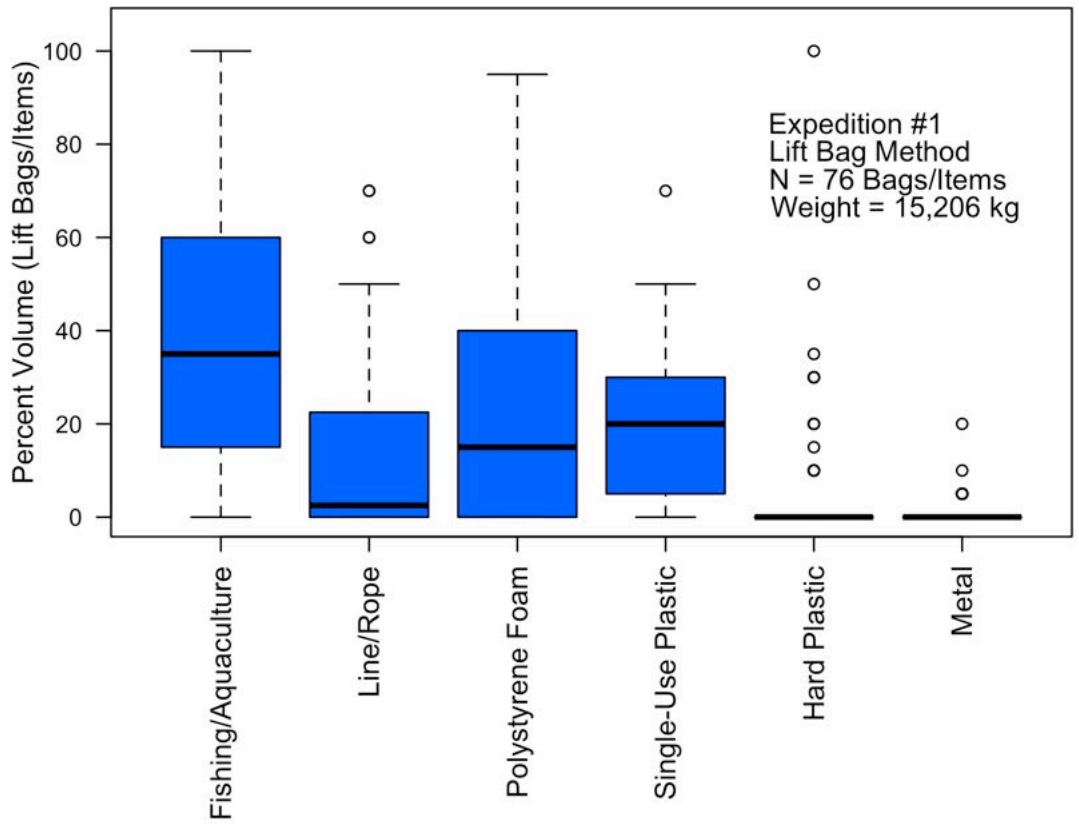


Figure 5.3 *Percent volume of marine debris categories determined using the lift-bag method during Expedition #1. Black bars represent median values (i.e., the middle number of 50% of the data, represented by the upper and lower ends of each box).*

During Expedition #2, of the total 66,235 kg collected, 36,210 kg of marine debris was collected, packaged into 210 lift bags and additional items and described using the lift-bag method. Using this method, we found that Fishing and Aquaculture accounted for the largest percent volume (median = 35%). Rope/Line that could not be assigned to a specific industry had a median value of 10%, but had outlier values of 80-100%. Similarly, the percent volume of Polystyrene Foam had a median value of 10% but ranged as high as 100%. Consumer Goods were the fourth most common source of marine debris identified using the lift-bag method, with a median value of 6% (Fig. 5.4).

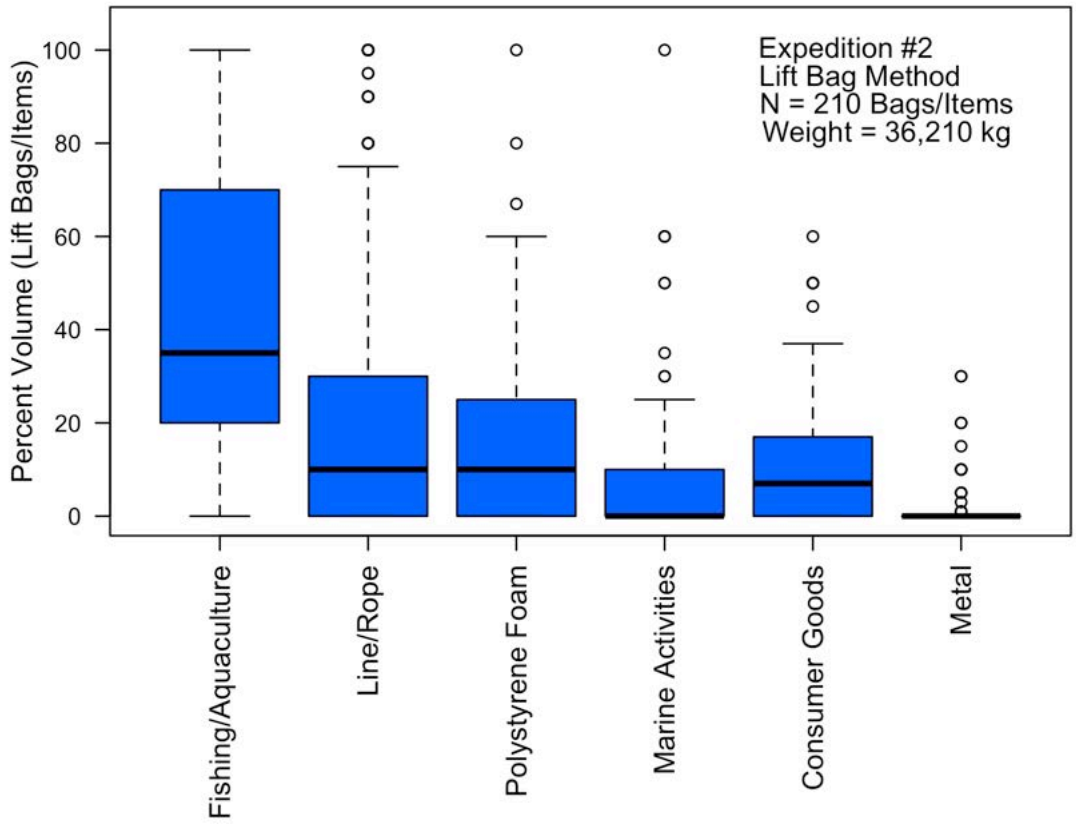


Figure 5.4 *Percent volume of marine debris categories determined using the lift-bag method during Expedition #2. Black bars represent median values (i.e., the middle number of 50% of the data, represented by the upper and lower ends of each box).*

Weigh-All Method

The weigh-all method was applied to a total of 527 items with a total weight of 7,571 kg. These items were collected by one MDRI crew during the end of Expedition #1 and all of Expedition #2 (specifically, Sept 1-16), at sites located between southern Stryker Island and the entrance to Kettle Inlet on the west coast of Aristazabal Island (Figs. 5.1 and 5.2), and therefore are considered representative of the broader MDRI area.

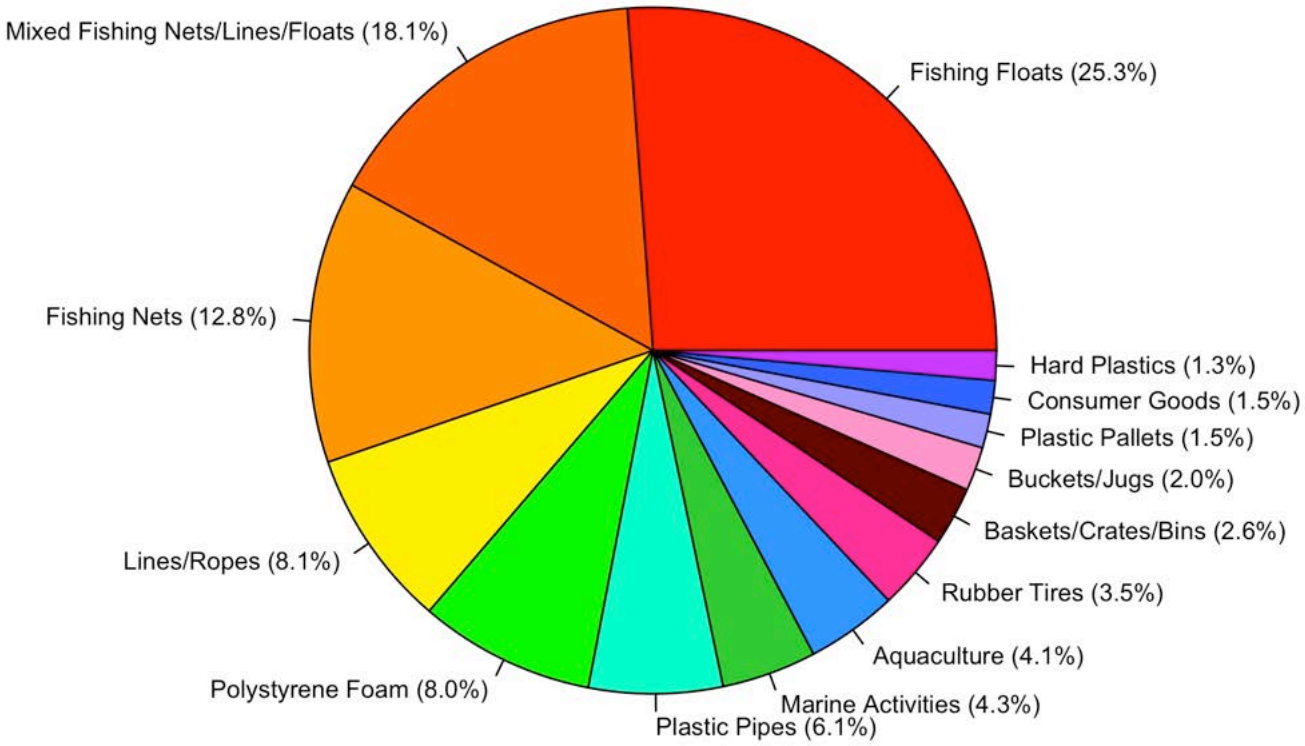


Figure 5.5 *Pie chart showing the proportions of the weight of marine debris categories relative to the total weight of 7571 kg (N=526 items) using the weigh-all method during Expedition #1 and Expedition #2 (Sept 1-16; Stryker Island to Kettle Inlet/Aristazabal Island).*

Collectively, Fishing Floats (primarily hard plastic "dragger balls"), Mixed Fishing Nets/Lines/Float, and Fishing Nets accounted for 56.2% of all marine debris collected and assessed using this method (Fig. 5.5). Lines/Ropes accounted for 8.1% of the total weight. Despite having much lower density (and therefore much higher volume) compared to fishing gear and lines/ropes, Polystyrene Foam accounted for 8.0% of the total weight of this sample.

Burlap Method

Similar to the weigh-all method, the burlap method was applied to a total of 269 burlaps with a total weight of 2,463 kg. These items were collected by one MDRI crew during the end of Expedition #1 and Expedition #2 (specifically, August 29 – Sept 16), at sites located between the

McMullin Group Islands and the entrance to Kettle Inlet on the west coast of Aristazabal Island (Figs. 5.1 and 5.2), and therefore are also considered representative of the broader MDRI area.

The burlap method produced complementary and additional insights to those provided by the lift-bag and weigh-all methods. The percent volumes of marine debris from Fishing and Polystyrene Foam were similarly and prominently represented in these samples (median values = 15% and 20%, respectively); however, using this method the abundance of Plastic Beverage Bottles was separated from the broader category of Consumer Goods (Fig. 5.6) and was also highly represented in these samples (median = 25%).

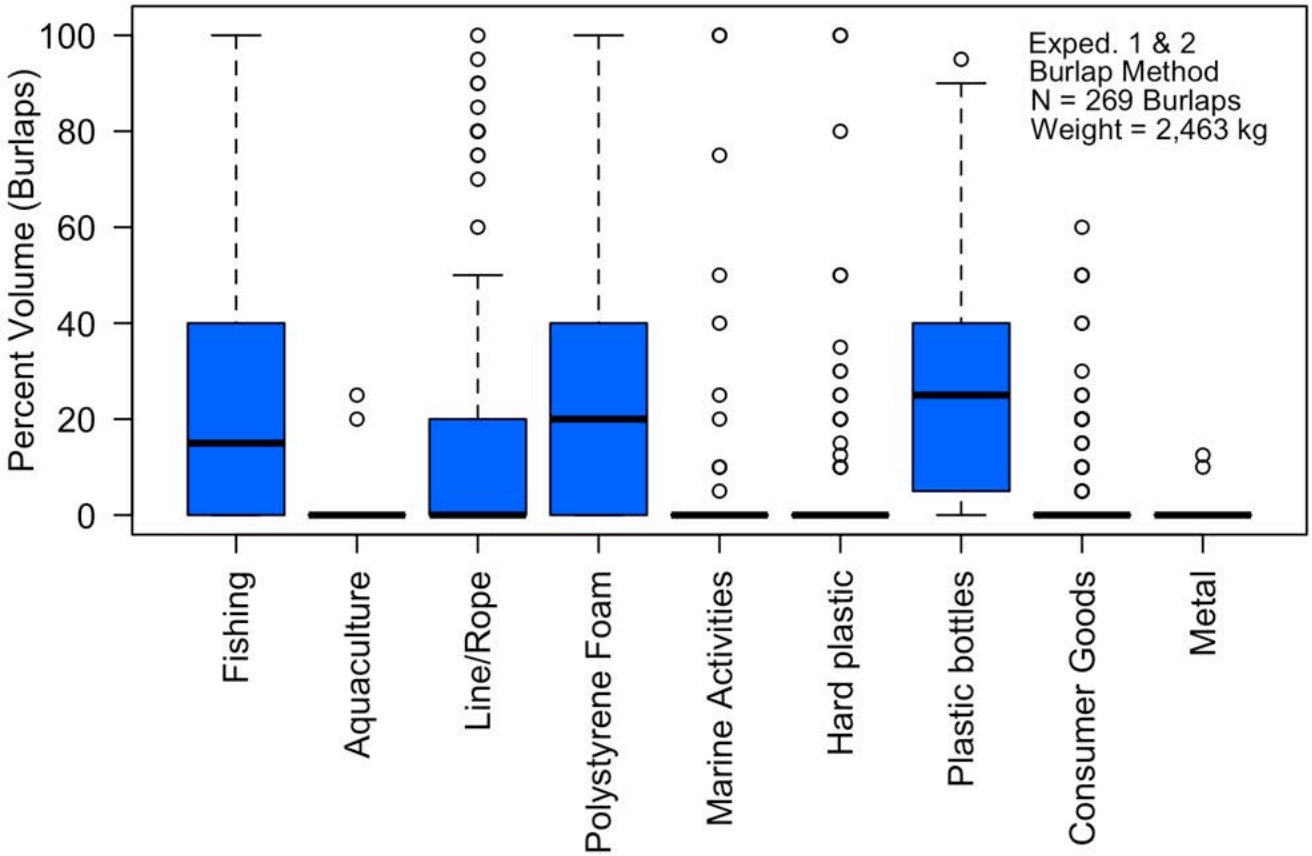


Figure 5.6 *Box plot showing percent volume of marine debris categories determined using the burlap method during Expedition #1 and Expedition #2 (Aug 29 – Sept 16; McMullin Group Islands to Kettle Inlet/Aristazabal Island). Black bars represent median values (i.e., the middle number of 50% of the data, represented by the upper and lower ends of each box).*

SECTION 6:
What It All Means

What It All Means

An Industrial-Scale Marine Debris Removal Initiative

The marine debris removal initiative undertaken by the SSTOA was an industrial scale clean-up effort involving 9 ships, 17 skiffs, and a total of 180 crew members. Over the course of 42 expedition days, SSTOA and First Nation MDRI crews safely collected and removed 127,060 kg (279,400 lbs) of beach-cast marine debris from the outer islands and wave-exposed shores of Queen Charlotte Sound on BC's Central and North coasts, far exceeding our pre-departure goal of collecting 25,000-30,000 kg. Importantly, because the materials removed were almost entirely composed of plastics, this initiative will result in substantial and long-lasting benefits to coastal wildlife and marine ecosystems by reducing the risks of consumption, entanglement and the production of secondary microplastics.

BC's Remote and Inaccessible Shorelines

The majority of British Columbia's ~25,000 km of coastline is remote and inaccessible except by boats. Remote shorelines that are inaccessible to clean-up groups and infrastructure are known to be areas that are most heavily impacted by accumulation of marine debris (Gall and Thompson 2015). Further, remote areas with high debris loads are likely to become secondary sources of debris as it is re-distributed by tides and storms, and continually degraded into secondary microplastics.

The SSTOA initiative focused on the remote and inaccessible outer coast shorelines of Queen Charlotte Sound, on BC's Central and North coasts, where no large-scale coordinated clean-up initiative has ever previously been conducted. As a result, we encountered high accumulations of marine debris, almost entirely plastics, some of which dated to the 1960s and early 1970s. Unfortunately, ocean plastics have been arriving and accumulating on the BC coast since plastics first came into widespread production and use in the early 1950s and have been increasing exponentially ever since.

Throughout this initiative MDRI crews encountered enormous amounts of beach-cast marine debris along the outer shorelines of Queen Charlotte Sound, particularly derelict fishing gear, polystyrene foam, and plastic beverage bottles (described below); however, the diversity of plastic products we collected and removed (whenever possible) is difficult to describe here but cannot be understated. As examples, in addition to fishing gear, foam, and plastic beverage bottles, our crews found; flip flop sandals, freezer boots, other footwear; hockey equipment, sports balls of all kinds, and other sports equipment; shipwrecks and pieces of airplane fuselage; forestry equipment; mooring and navigation buoys; refrigerators and freezers; scientific and

oceanographic equipment; plastic children's toys; large water or septic tanks; full barrels of petrol and buckets labeled "poison"; and much more. The sad truth is that anything that is made of plastic and floats can now be found as beach-cast marine debris along BC's outer shores.

Abandoned, Lost, or Otherwise Discarded Fishing Gear

The most striking finding during this initiative was the magnitude and ubiquity of abandoned, lost, or otherwise discarded (a.k.a. "ghost" or "derelict") fishing gear. An estimated 6.4 million tons of fishing gear is lost in the world's oceans annually and as a result constitutes a major component of ocean plastic pollution (Wilcox et al. 2015, Macfayden et al. 2009). Ocean gyres are known to create accumulation zones, such as the Great Pacific Garbage Patch, where derelict fishing nets represent more than 46% of the total load of marine debris and ocean plastics (Lebretton et al. 2018). The advent of synthetic (plastic) fibres used to construct fishing nets and lines, and its ability to persist in marine environments, results in derelict fishing gear that can continue to entangle and kill marine wildlife for decades.

Using the weigh-all method, we found that fishing floats, nets, and lines readily identifiable as fishing gear comprised 56.2% of our total collection of 127,060 kg of marine debris. By this estimate, MDRI crews may have collected and removed as much as 71,374 kg of derelict fishing gear from the shores of Queen Charlotte Sound. However, this figure almost certainly underestimates the contribution of fishing gear in our collection due to the unknown origins of several of our categories, including Lines/Ropes (8.1%), Marine Activities (4.3%), Baskets/Crates/Bins (2.6%), Buckets/Jugs (2.0%), and Plastic Pallets (1.5%), collectively representing another 18.5% of our weigh-all subsamples.

Based on the languages and manufacturer labels of the hard plastic fishing floats we found, the majority of derelict fishing gear we encountered appears to be originating from Western Pacific nations, including Japan, Korea, Taiwan, and China. The extent to which domestic fisheries (i.e., California to Alaska) contributed to the derelict fishing gear found by our initiative is unknown; however, one example of domestic derelict fishing gear that is heavily represented is commercial Dungeness crab fisheries, well-known for their entanglement incidents involving large baleen whales (Santora et al. 2020). MDRI crews found the distinctive tangles of floats and lines of these fisheries on virtually every shoreline we visited in Queen Charlotte Sound, frequently with their rubber license tags listing vessel names, owner names, and phone numbers required by the California, Oregon, and Washington Departments of Fish and Wildlife.

Polystyrene Foam

Expanded or foamed polystyrene (i.e., Styrofoam™) is used extensively for a wide range of marine industries and activities, including commercial fishing, aquaculture, and floatation for docks, floats, and moorings. As a result, formed polystyrene represents a major component of floating and beach-cast marine debris globally. For example, Erikson et al. (2014) found that foamed polystyrene items comprised 26% of macroplastic items observed during at-sea visual surveys during 24 expeditions throughout the world's oceans. In Taiwan, Chen et al. (2018) describe "*snowlines on shorelines*", caused by foamed polystyrene particles generated by the oyster aquaculture industry there. And on Triangle Island, off northwest Vancouver Island, BC, Hipner et al. (2018) found that 48.1% of beach-cast items were composed of polystyrene foam.

Our MDRI crews found that foamed polystyrene blocks, fishing floats, fragments, and particles were conspicuous and ubiquitous along all the exposed shorelines of Queen Charlotte Sound. On some beaches where physical characteristics (i.e., aspect, slope, and sediment type), facilitate degradation and retention of foamed polystyrene particles, we found extensive and deep "*foam middens*" consisting of mixtures of foam pellets, gravel, sand, and organic debris. We also frequently encountered large blocks of foam polystyrene that had been washed into the margins of coastal rainforests where they were now covered with decades of vegetation growth, including Sitka spruce, Western Red cedar, Salal, and Salmonberry.

While using burlap sacks to collect relatively small items, foamed polystyrene accounted for 20% of the volume of burlaps sacks. Using our weigh-all method, foamed polystyrene accounted for 8% of the total weight of this subsample (7,571 kg, N=526 items). However, using our lift bag method, in which percent volumes were estimated visually for entire lift bags, foamed polystyrene accounted for just 15% and 10% (Expedition #1 and Expedition #2, respectively) Methodological differences may explain the differences we observed in this study, as well as comparison among studies of beach-cast marine debris in general (Browne et al. 2015). We note the many challenges associated with measuring volumes and/or weights of items in the field, and the shortcomings of simply reporting item counts.

The volume of marine debris is of particular interest during collection and removal initiatives like this one, due to space limitations of helicopter lift bags and barges, as well as subsequent transportation, storage in recycling facilities, or disposal in landfills. Foamed polystyrene has an exceptionally low density (50 kg/m^3), compared with high-density polyethylene (940 kg/m^3), used to create most hard plastic items (e.g., hard plastic fishing floats). That is, foamed polystyrene occupies 18.8 times more volume per unit weight compared to hard plastics. Therefore, despite representing only 8% of the total weight of our weigh-all subsample, we expect that foamed polystyrene accounted for the greatest volume of this subsample and our overall collection of 127,060 kg. We expect that our relatively low percent volume estimates of foamed polystyrene (lift bag method) may stem from inconsistencies associated with assigning items to the overlapping categories (e.g., foam polystyrene fishing floats), as well as the challenges of conducting visual estimates at the scale of entire lift bags.

Plastic Water/Beverage Bottles

Around the world, an estimated 480 billion plastic beverage bottles are produced each year; one million are purchased each minute; and 20,000 are produced every second (Laville et al. 2017). Unfortunately, vast numbers of plastic beverage bottles are not disposed of appropriately and find their way into the world's oceans and the most remote corners of the planet (Ryan et al. 2018, Laver and Bond 2017). Consistent with most studies of beach-cast marine debris around the world, MDRI crews found that water and other plastic beverage bottles were abundant and ubiquitous along the wave-exposed shores of Queen Charlotte Sound, and comparable to our percent volume estimates of fishing gear and foamed polystyrene when using the burlap method.

Based on languages and manufacturer marks, our crews observed that the majority of plastic beverage bottles we collected originated in Japan, China, Korea, Russia, Philippines, and Indonesia. Based on the ageing categories of Ryan et al. (2018), many of the bottles we collected were 1 to 3 years old; however, similar to foamed polystyrene, at some locations we found "*water bottle middens*" at the shore zone-rainforest interface. Based on embrittlement and surface crazing (Ryan et al. 2018), we estimated that many of these bottles were >10 years old, and possibly much older.

Operational Keys to Success

The success of the SSTOA marine debris removal initiative was the result of 1) the range and capacity of our vessels and fleet; 2) the professionalism, experience, and collective capacity of our crews; and 3) the organisational experience of our companies and leadership.

The SSTOA vessels involved in this initiative had the capacity to safely operate with adequate fuel, water, provisioning, and accommodation for 21-30 days. This capacity was essential for providing access to the remote and otherwise inaccessible Central and North coasts and allowed for exceptional efficiencies associated with ships and crews continually being on site and not requiring travel time between land-based infrastructure. Importantly, all vessels involved were Transport Canada certified passenger vessels that meet or exceed the highest standards of vessel safety. Similarly, vessel crews were highly trained and certified, and have extensive experience operating on the Central and North coasts, and beyond.

The collection and removal of industrial-scale amounts of marine debris requires large numbers of physically fit and highly motived personnel with diverse skill sets including vessel operation, maintenance, and repair; navigation; knowledge of weather and tides; and wilderness first aid and marine emergency duties training, certification, and experience. In total, 180 personnel participated in the two MDRI expeditions, the majority of which were normally employed by the small-ship expedition industry, as well as the expedition sea kayaking and guided bear-viewing industries, and as a result possessed the requisite skills and experience. Commendably, the

MDRI crews were both highly motivated and grateful for the employment this initiative offered, as well as the opportunity to contribute to the health and well-being of the BC coast.

Finally, the capacity and experience of the companies and owner/operators involved enabled an exceptional level of organizational expertise and professionalism. Operating extended ship-based wilderness expeditions to the furthest reaches of the BC coast, and managing associated operational logistics is the speciality of the SSTOA companies involved and contributed heavily to the success and efficiencies of this initiative. As an example of this, due to the expense associated with helicopter operations, the SSTOA fleet successfully coordinated vessels, ground crews, and the tug and barge such that the helicopter was able to complete one lift (barge-lift site-barge) in 3-5 minutes. In addition, one larger vessel was able to reduce flight time further by having its crews transport lift bags back to the mothership and lifting them with its 2,500 kg crane onto a large heli-deck for storage and later lifting them onto the barge once it was anchored nearby.

Conclusions

Marine debris and ocean plastic pollution are impacting oceans and coastlines, wildlife, ecosystems, and economies globally. Fisheries, food security and human health are increasingly at risk as a result of microplastics and the additives and environmental chemicals they carry finding their way into human food supplies, and humans themselves.

This initiative has shown that British Columbia's remote and relative unspoilt shorelines are not immune to this crisis. Rather, oceanographic processes pre-dispose the outer islands and shorelines of our coast to receiving high loads of ocean plastics and other marine debris from the open Pacific Ocean. In addition, the inaccessible nature of the BC coast greatly increases the complexity and costs of clean-up initiatives, making it particularly vulnerable to the environmental impacts of marine debris accumulation.

The scale of ocean plastic pollution and marine debris along the outer islands and shorelines of the Central coast and Queen Charlotte Sound far exceeded the expectation of the SSTOA MDRI planning team, particularly the abundance of derelict fishing gear. Despite removing an enormous quantity of marine debris, this project touched just a fraction of the marine debris that has accumulated on the BC coast over the past ~60 years, and more continues to arrive daily from the open Pacific Ocean. As such, there is much more work to be done in terms of clean-up initiatives, preventing or reducing the production of marine debris, developing the capacity to recycle and repurpose marine debris.

In addition to the environmental benefits of removing of 127 metric tonnes of marine debris (almost entirely plastics), including reduced risk of ingestion and entanglement by wildlife and reduced production of microplastics via degradation of larger plastics items, our findings with respect to the composition and sources of marine debris may provide valuable insights that can be used to inform mitigation strategies and clean-up initiatives in the future.

Using multiple methodologies across large spatial scales, we found that derelict or "ghost" fishing gear comprised as much as 56% of our total collection of beach-cast marine debris. We emphasize that we expect that this number underestimates the real contribution of fishing-related marine debris due to being unable to identify and wide range of items, particularly line/rope and a wide range of hard plastics. This result highlights the fact that mitigation of fishing-industry generated ocean plastics and marine debris, both domestically and internationally, is paramount.

Ultimately, ocean plastics and marine debris is an international problem that will require all levels of government and concerted engagement with international partners to reduce ocean plastic pollution and mitigate ongoing environmental and economic impacts, the costs of clean-up efforts, and the increasing risks to economies, food security and human health.

SECTION 7:
Employment & Economic Report

Employment and Economic Report

SSTOA Employment

A central objective of the SSTOA marine debris removal initiative was to provide employment for their specialized and largely seasonal workforce. The BC government's Clean Coast Clean Waters Initiative (CCCW) funding enabled SSTOA companies to hire a total of 111 personnel and participating First Nation partners hired an additional 69 personnel, to participate in the two 21-day MDRI expeditions, resulting in a total of 4,115 employment days (Table 7.1).

During Expedition #1 there were 74 SSTOA personnel onboard nine vessels. Expedition #2 started with 77 personnel but dropped to 73 with the pre-planned departure of one vessel on September 20th (Table 7.1). Because many crew members were only able to participate in one MDRI expedition there were a total of 111 personnel hired for both expeditions.

In addition to the direct employment provided by CCCW (i.e., 42 marine debris removal expedition days), the SSTOA companies provided an additional 8,562 days to their employees prior to and following the MDRI expeditions. This employment included proposal and funding processes, planning and preparation, vessel commissioning and decommissioning, and vessel repositioning (Table 7.1)

First Nation Participation and Employment

Five Central and North coast First Nations supported the SSTOA marine debris removal initiative; however, only three were able to actively participate. Both the Wuikinuxv Nation (community of Wuikinuxv) and the Nuxalk Nation (community of Bella Coola) are situated at the heads of fiords approximately 50 km or more from the outer coast areas where this initiative was focused. As such, it was logistically challenging for members from either community to travel to outer coast areas, or for the SSTOA to divert their vessels, crews, tug/barge, and helicopter long distances inland. Although offers for employment contracts were made to both the Wuikinuxv and Nuxalk Nations, after careful consideration they were declined due to these logistical challenges, late notice of the MDRI project approval, and availability of crews who were not currently committed to other projects.

The Heiltsuk (community of Bella Bella), Kitasoo/Xai'xais (community of Klemtu), and Gitga'at (community of Hartley Bay) Nations, were able to participate despite extremely short notice for hiring crews and coordinating operational logistics, providing 958 total employment days (Table 7.1). Unfortunately, Heiltsuk Nation MDRI crews were only able to work for 10 days before the community of Bella Bella had to go into a 14-day lockdown due to a COVID-19 outbreak (which fortunately was contained).

Table 7.1 *Summary of employment resulting from CCCW funding of the SSTOA Central Coast Marine Debris Removal Initiative, 18-August to 28-September 2020.*

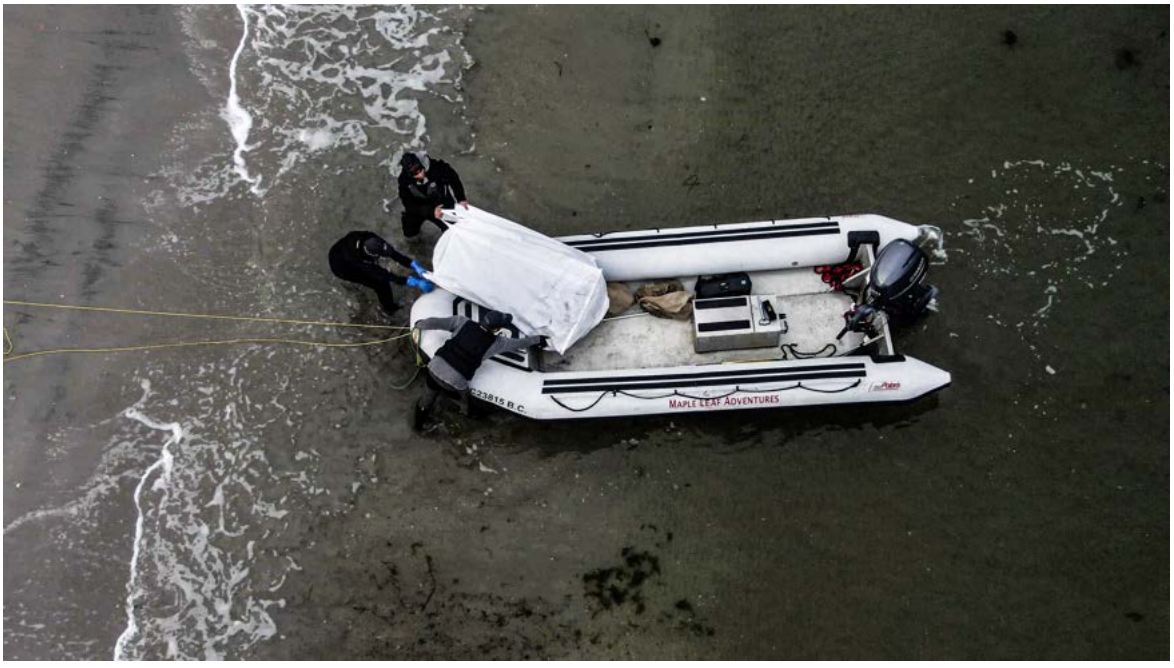
SSTOA & Participating First Nations	Dates	Total # of Employees Working	Total # of Days Worked	Total Employment Days
Proposal/Planning/ Coordination	May, June, July	**17**	**281**	**4,777**
Vessel Commissioning	Aug 10-13	**24**	**4**	**96**
Provisioning/Pre-Departure	Aug 14-15	**32**	**4**	**128**
Repositioning North	Aug 16-17	**67**	**2**	**134**
Expedition #1 (21 Days)	Aug 18-Sept 7	**74**	**21**	**1,554**
Changeover Day (1 Day)	Sept 8	**99**	**1**	**99**
Expedition #2 (11 Days)	Sept 9-19	**77**	**11**	**847**
Expedition #2 (9 Days)	Sept 20-28	**73**	**9**	**657**
Gitga'at Nation	Sept 14-Sept 20	**18**	**9**	**162**
Kitasoo/Xai'xais Nation	Aug-30-Sept 19	**26**	**21**	**546**
Heiltsuk Nation	Aug 21-Sept 12	**25**	**10**	**250**
Repositioning South	Sept 28-30	**35**	**2**	**70**
Vessel Decommissioning	~Oct 1-5	**20**	**10**	**200**
Employment days provided in kind by members companies of the SSTOA				**5,405**
Employment days paid by CCCW 42-day contract				**4,115**
Total Employment Days				**9,520**

Economic Impact: Sustaining Skilled Workers and a Tourism Sector

The SSTOA MDRI achieved several economic objectives.

First, the MDRI improved the value of a public good: clean shorelines and a reduction of items that could endanger wildlife or be degraded into secondary microplastics. Clean beaches and healthy marine ecosystems are an economic asset owned by our citizens, generating interest and activity from world travellers who learn of our relatively unspoiled coast. The MDRI 2020 effort showed that the issue of marine debris on the BC coast is worse than feared, but that tackling all of it is practical and viable. Importantly, this initiative greatly raised public awareness of the urgent issues of marine debris and ocean plastic pollution, to date generating over 50 news articles by media outlets throughout Canada and the United States (Table A3).

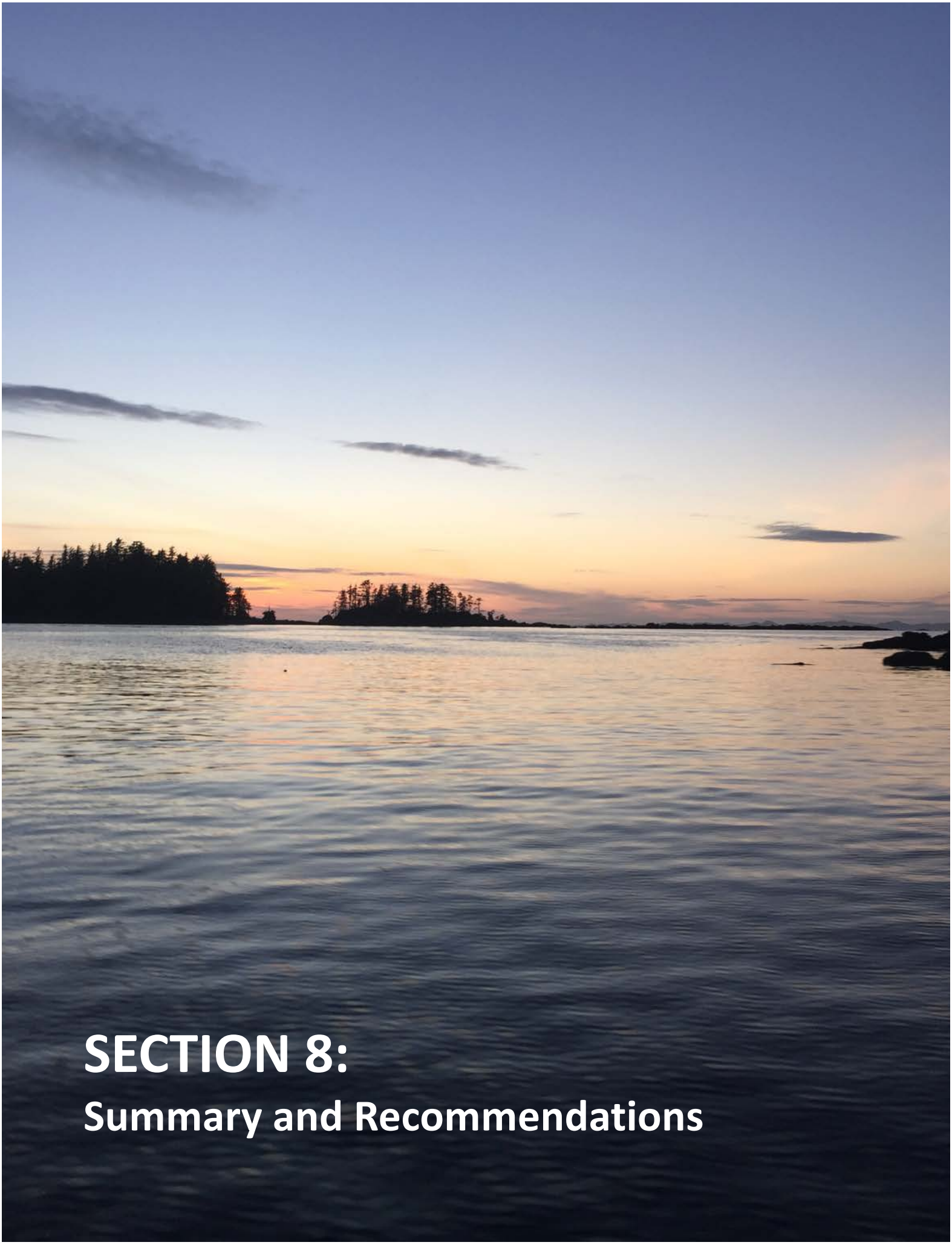
Second, the MDRI generated activity for vessel assets that, even while idled, were generating costs that put BC tourism operators in a dangerous financial position. This fledgling small ship tour industry is Canada's answer to the international cruise ships that take paying guests past our coast without stopping. Still unconsolidated, its growth has followed a pattern of a promising new sector: small operators innovating quickly, with glimpses of good margins, word-of-mouth growth, and stories of unfulfilled demand. British Columbia's Central and North coast are emerging as a world-class destination for non-mass-market travel, which is compatible with the goals of creating a conservation-based economy in the Great Bear Rainforest. This small ship tour industry is the right model for the region and efforts to sustain it through the COVID-19 crisis will provide outsized benefits that will become clear in the years to come.



Third, the economic spinoff benefits of the small ships are larger than for some other industries because they operate in remote areas not sustained by other industries (i.e., outside the Greater Vancouver and Greater Victoria regional districts). A recent study of economic multiplier effects (GSGislason and Associates 2007) predicts a 2.0 economic multiplier and a 1.72 employment multiplier. **Examples include:**

- Many of our employees reside in remote communities. For example, the professional salary of a ticketed marine technician from Campbell River or Quadra Island will have a measurable effect in her community.
- We typically buy logistics, food, fuel and other services through remote communities.
- Purchases of coast-region marine repair and supply services, which maintain business infrastructure that has been reeling from the downturn in commercial fishing.
- Our guests arrive and leave through coastal communities, often staying a night or more at local hotels.
- We work with First Nations in each traditional territory we visit, collaborating to develop guiding opportunities and hiring community members as crew when possible; members of these communities, which were closed to tourism this year, received employment from this initiative.

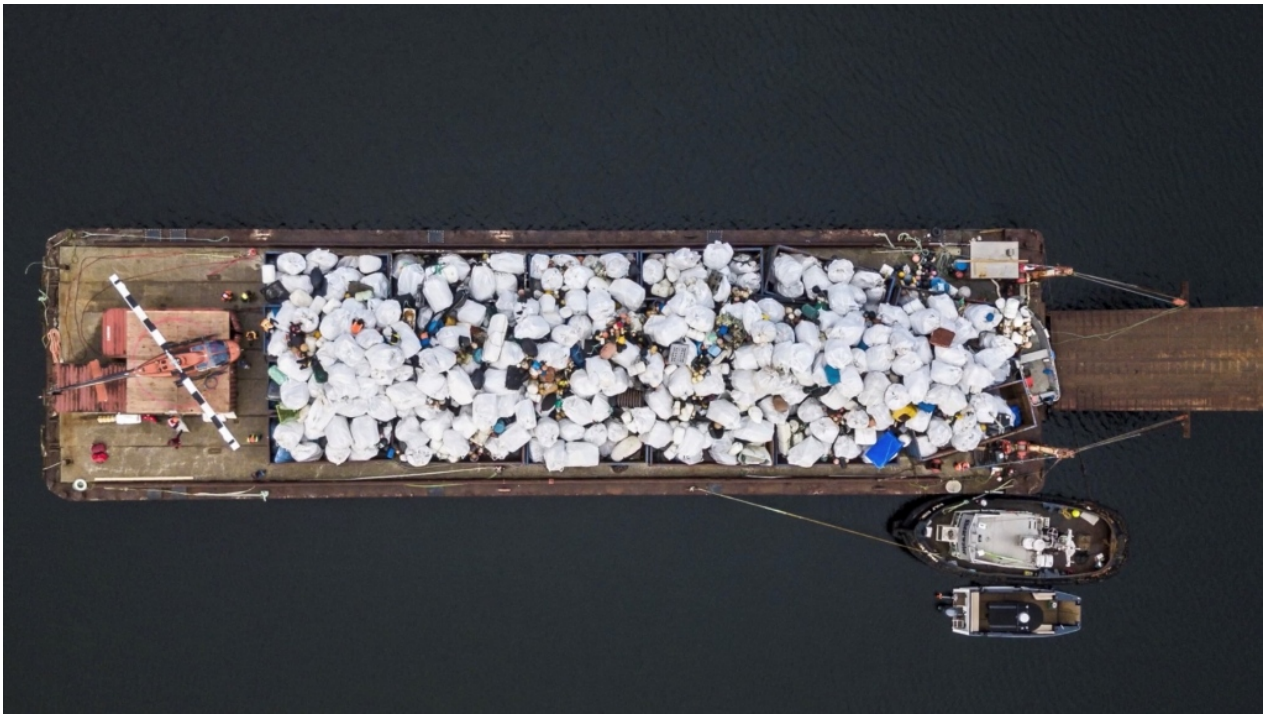
Fourth, this MDRI supported skilled workers (expedition guides, professional mariners, chefs, naturalists) to remain in this desirable tourism sector, rather than leaving to find another career path. This benefit accrues to the workers and the companies, both of whom have invested in training and education specific to the sector. Keeping workers in the sector enables companies to re-start tourism operations more quickly and more successfully when the time comes. In a post-MDRI survey of the participating crew, of those unemployed before the expedition a third were planning to find a job in another sector. Of the remainder, 40% planned to remain on CERB/EI and a little less than a third were unsure of their job plans.



SECTION 8:
Summary and Recommendations

Summary and Recommendations

Summary



The SSTOA Marine Debris Removal Initiative 2020, funded by the BC Government's Clean Coast, Clean Water Initiative Fund, was focused on two key objectives: 1) contributing impactful solutions to the urgent environmental crisis of marine debris and ocean plastic pollution on the BC coast; and 2) supporting the survival and recovery of BC's tourism sector through the COVID-19 public health and financial crisis. On both accounts, the SSTOA initiative and CCCW funding were highly successful.

The CCCW funding and the SSTOA's unique vessel and personnel capacity, allowed this initiative to efficiently collect and remove industrial-scale amounts of marine debris (127,060 kg/279,532 lbs), from the remote and inaccessible shorelines of BC's Central and North coasts. This outcome was achieved in partnership with Central and North coast First Nations, working separately but together, despite the on-going threat of COVID-19. This initiative and funding also provided industry-saving financial relief for SSTOA businesses that lost 99% of their 2020 operating season, and directly and indirectly supported nearly 10,000 employment days, including 958 employment days in First Nation communities.

Recommendations

Although the SSTOA initiative removed an unprecedented amount of marine debris, enormous amounts are still found throughout the BC coast, and more continues to arrive each day. In addition to ongoing collection and removal initiatives, reducing and ending the production of marine debris and ocean plastic pollution must necessarily be the focus of long-term planning and mitigation strategies. Based on what the SSTOA crews encountered and learned throughout this initiative, and the results of our debris composition analyses, we make the following recommendations:

1. **Ghost Fishing Gear Mitigation** – More than 50% of the beach-cast marine debris this initiative collected and removed was made of up lost, abandoned, or otherwise discarded fishing gear (i.e., ghost gear), from both domestic and international fisheries. Given the abundance of this source of marine debris and the risks it poses to wildlife and ecosystems, we encourage the BC Government to work with their federal counterparts in the Ministry of Fisheries and Oceans Canada, and the Ministry of Environment and Climate Change Canada, to work with industry and international organizations to reduce and mitigate the impacts of ghost fishing gear.

2. **Expanded Polystyrene Foam Mitigation** – We found blocks, chunks, particles, and middens of expanded polystyrene foam (i.e., Styrofoam^{TM}) throughout the Central coast. Extensive literature from around the world has demonstrated that polystyrene foam is ingested by marine wildlife (including commercially and culturally important species such as salmon, lingcod, and halibut), and releases toxic chemical leachates into the environment. The major domestic sources of polystyrene foam pollution on the BC coast are the polystyrene foam floatation used for commercial and recreational docks and marinas, and moorings for commercial aquaculture industries. We recommend that the BC and Federal Governments works with these industries and the public to; 1) require that all new projects use alternative forms of floatation; and 2) develop legal and financial frameworks for facilitating the refitting of existing installations with alternative forms of floatation.

3. **Funding for ongoing marine debris removal initiatives** – Despite the large amounts of marine debris collected and removed by this initiative and others, enormous amounts still remain along BC shorelines and continue to threaten marine wildlife, ecosystems, commercial, recreational, and Indigenous fisheries, aquaculture industries, tourism values, food security, and human health. We encourage the BC and Federal Governments to provide ongoing funding for coordinated and effective large-scale marine debris removal initiatives.

4. **Funding for marine debris research and monitoring** – To our knowledge, no estimates currently exist for the total amount of marine debris currently on the shorelines of British Columbia, nor do estimates of debris deposition rates. Without this critical

information it is difficult to develop the strategies, capacity, and budgets for shoreline cleanup initiatives. We recommend that the BC and Federal Governments make funding available to: 1) facilitate research initiatives aimed at estimating the current abundance and distribution of marine debris on the BC coast; and 2) establish a coast-wide network of marine debris index sites that could be readily monitored by community organizations, Coastal Guardian Watchman programs, tourism operators, and other citizen scientists to establish how much marine debris is arriving onto the BC coast each year and its sources.

5. **Funding for marine debris recycling facilities and capacity** – A significant short coming of the SSTOA marine debris removal initiative was our inability to divert the debris we collected from landfills due to the lack of recycling facilities on the BC coast that can accommodate marine debris. Although the recent progress with the establishment of marine debris recycling facilities in Ucluelet and Powell River is extremely positive, we encourage the BC and Federal Governments to continue developing this capacity in all regions throughout the BC coast.

6. **Prioritize Marine Protected Areas for removal initiatives –** The incredible size and length of BC's shorelines will require that a prioritization, or triaged, approach to future marine debris removal initiatives. Marine Protected Areas (MPAs) are generally areas that have high ecological, biodiversity, cultural, tourism, and fisheries values, and therefore environmental impacts resulting from marine debris accumulation may be disproportionally large. For this reason, we recommend that the BC and Federal Governments prioritize the clean-up and restoration of MPAs on the BC coast, including BC Parks and Conservancies, Ecological Reserves, Marine National Wildlife Areas, National Park Reserves, National Marine Conservation Areas, and Indigenous Protected and Conserved Areas (IPCAs).

Appendix 1:

Measurement of Shorelines Cleaned of Debris

Table A1. *Shoreline measurement segments for MDRI Expedition #1. Shaded green denotes BC Parks and Conservancies.*

Name of Protected Area or General area	Geographic Description	Approx. Length of Shoreline Cleared		Notes
		(nm)	(km)	
Cranstown Point Conservancy	Entire shoreline – beaches and headlands	3	5.5	
Penrose - Ripon Conservancy	Generally exposed outer shores facing Fitz Hugh Sound plus bays and coves	8	15	
Penrose Island Marine Park	Generally exposed outer shores facing Fitz Hugh Sound plus bays and coves	14	26	
Fitz Hugh Sound - mainland side	Welch Island, Pierce Bay, Adddenbroke Point into Convoy Passage; Addenbroke Island and Blair Island	22	40.5	Wuikinuxv and Heiltsuk
Fitz Hugh Sound - mainland side	Corvette Islands, Savage Island, McClusky Bay, Illahie Inlet, Green Island Anchorage to Kwakume Point	21	39	Wuikinuxv and Heiltsuk
Fitz Hugh Sound - mainland side to Koeye Conservancy	Kwakume Inlet to Koeye, Koeye to Ontario Point/Warrior Bay	7	13	
Calvert Island Conservancy	West Coast of Calvert Island from Clark Point West to Carrington Reef.	17	31.5	
Hakai / Luxvbalis Conservancy	West Coast of Calvert Island from 7th beach to West Beach	3	5.5	
Hakai / Luxvbalis Conservancy	West Coast of Calvert Island North Beach to Adams Harbour	3	5.5	
Hakai / Luxvbalis Conservancy	Hakai Pass and Kilditdt Sound generally exposed outer shores plus bays and coves	30	55.5	
Hakai / Luxvbalis	Spider Anchorage excluding Triquet	26	48	

Conservancy	Island. Generally exposed outer shores plus bays, coves and channels			
Hakai / Luxvbalis Conservancy	Spitfire Channel North to Safe Passage generally exposed outer shores facing Queens Sound plus bays and coves	12	22	
Hakai / Luxvbalis Conservancy	Goose Group excluding IR's and west side of Duck and Goose Islands	15	28	
Outer Central Coast Islands Conservancy	Prince, Admiral and Tribal Groups	14	26	
Outer Central Coast Islands Conservancy	McMullin Group and south Stryker Island	7	13	
Outer Central Coast Islands Conservancy	SE Princess Alice Island, southern bays of Athlone Island plus Wurtele Island and St John Harbour	6	11	
Lady Douglas-Don Peninsula Conservancy	Southern Lady Douglas Island – Lang Point area	2	4	Heiltsuk led area
TOTAL BC Parks and Conservancies shoreline cleared		**167**	**309**	
TOTAL shoreline scanned and cleared		**210**	**389**	

Table A2. *Shoreline measurement segments for MDRI Expedition #2. Shaded green denotes BC Parks and Conservancies.*

Island or Protected Area	Geographic Description	Approx. Length of Shoreline Cleared		Notes
		(nm)	(km)	
West coast Price Island	Day Island to Rudolf Bay – exposed and accessible outer shores as well as outer island / islet groups. Also coves, bays and inlets	20	37	
West coast Price Island	Rudolf Bay to Grant anchorage – exposed and accessible outer shores as well as outer island / islet groups. Also coves, bays and inlets	9	17	
Higgins Passage Kitasoo Spirit Bear Conservancy	Passage East of Grant Anchorage	3.5	6.5	Kitasoo/Xai'xais area organised by Spirit Bear Lodge.
West coast Swindle Island – Kitasoo Spirit Bear Conservancy	Grant anchorage to Wilby Point – exposed and accessible outer shores as well as outer island / islet groups. Also coves, bays and inlets	6	11	
Kitasu Bay Swindle Island – Kitasoo Spirit Bear Conservancy	Marvin Islands	1	2	Kitasoo/Xai'xais area organised by Spirit Bear Lodge
Princess Royal Island – Kitasoo Spirit Bear Conservancy	Monk Bay North West to Disju IR exposed and accessible outer shores as well as outer island / islet groups. Also coves, bays and inlets	6	11	Kitasoo.Xai'xais area organised by Spirit Bear Lodge
Aristazabal Island	Prior Passage and Munro Island	7.5	14	
Aristazabal Island	Weeteeam Bay and Arrianga Islands	18	33.5	
Aristazabal Island	Normansell Islands to Kettle Inlet	7.5	14	
Campania Island Lax Ka'gaas/Campania Conservancy	McMicking Inlet	3	5.5	Gitga'at led cleanup
TOTAL BC Parks and Conservancies shoreline cleared		**19.5**	**36**	
TOTAL shoreline scanned and cleared		**81.5**	**151.5**	

Appendix 2:

Collected Media Coverage of MDRI and CCCW Funding

Table A3. *Media coverage of the SSTOA MDRI and CCCW funding through November 30th, 2020.*

Date	Outlet	Title	Author	Link
Aug 31, 2020	Victoria Buzz	B.C. employs small ship tour operators with $3.5 million fund to clean up coastline	Tim Ford	https://www.victoriabuzz.com/2020/08/b-c-employs-small-ship-tour-operators-with-3-5-million-fund-to-clean-up-coastline/
Aug 31, 2020	CTV Vancouver Island	B.C. announces $3.5M ocean garbage cleanup project	Adam Chan	https://vancouverisland.ctvnews.ca/b-c-announces-3-5m-ocean-garbage-cleanup-project-1.5086341
Aug 31, 2020	Canadian Press	B.C. announces $3.5-million fund to clean up shores of central coast	Canadian Press	https://www.prpeak.com/b-c-announces-3-5-million-fund-to-clean-up-shores-of-central-coast-1.24195306
Aug 31, 2020	North Island Gazette / Black Press	Tourism operators pivot from guiding to beach cleaning	Zoe Ducklow	https://www.northislandgazette.com/news/tourism-operators-pivot-from-guiding-to-beach-cleaning/
Aug 31, 2020	Radio Canada	La Colombie-Britannique annonce un grand nettoyage de son littoral	Geneviève Lasalle (accéder à la page de l'auteur)	https://ici.radio-canada.ca/nouvelle/1730514/cote-eau-ocean-dechets-plastique-environnement-
Aug 31, 2020	Wilderness Tourism Association	Marine Debris Removal Initiative	Wilderness Tourism Association	https://wilderness-tourism.bc.ca/marine-debris-removal-initiative/
Aug 31, 2020	CHEK News	B.C. announces $3.5 million fund to clean up remote shorelines	CHEK News	https://www.cheknews.ca/b-c-announces-3-5-million-fund-to-clean-up-remote-shorelines-696696/
Aug 31, 2020	Alaska Highway News	B.C. announces $3.5-million fund to clean up shores of central coast	Canadian Press	https://www.alaskahighwaynews.ca/b-c-announces-3-5-million-fund-to-clean-up-shores-of-central-coast-1.24195306
Aug 31, 2020	Indigenous Business and Finance Today	BC Government: Shoreline clean-up funds create jobs, protect coastal waters	TBFToday	https://ibftoday.ca/bc-government-shoreline-clean-up-funds-create-jobs-protect-coastal-waters/
Aug 31, 2020	Environmental Journal	Unique Partnership Announced to Support Shoreline Cleanups on West Coast	Connie Vitello	https://environmentjournal.ca/unique-partnership-announced-to-support-shoreline-cleanups-in-bc/
Aug 31, 2020	Victoria Times Colonist	B.C. announces $3.5-million fund to clean up shores of central coast	Canadian Press	https://www.timescolonist.com/b-c-announces-3-5-million-fund-to-clean-up-shores-of-central-coast-1.24195306
Aug 31, 2020	The Star	B.C. announces $3.5-million fund to clean up shores of central coast	Canadian Press	https://www.thestar.com/news/canada/2020/08/31/bc-announces-35-million-fund-to-clean-up-shores-of-central-coast.html
Aug 31, 2020	MSN.Com	B.C. announces $3.5-million fund to clean up shores of central coast	Canadian Press	https://www.msn.com/en-ca/news/canada/bc-announces-dollar35-million-fund-to-clean-up-shores-of-central-coast/ar-BB18yOd9
Sept 1, 2020	Victoria Times Colonist	Idled tourism-ship crews clear garbage from coastline	Darron Kloster	https://www.timescolonist.com/idled-tourism-ship-crews-clear-garbage-from-coastline-1.24195575

Sept 1, 2020	CKPG Today	Largest shoreline cleanup on Central B.C. Coast	CKPG Today	https://ckpgtoday.ca/2020/09/01/largest-shoreline-cleanup-on-central-b-c-coast/
Sept 1, 2020	The Northern View / Black Press	B.C. coastal cleanup includes Great Bear Rainforest	K-J Millar	https://www.thenorthernview.com/news/b-c-coastal-clean-up-includes-great-bear-rainforest/
Sept 1, 2020	Water Canada	Partnership Aims to Reduce Marine Debris Along B.C.'s Central Coast Shoreline	Simran Chattha	https://www.watercanada.net/partnership-aims-to-reduce-marine-debris-along-central-coast-shoreline-in-b-c/
Sept 1, 2020	Nation Talk	Largest shoreline cleanup on Central B.C. Coast – CKPGToday.ca	CKPG Today	https://nationtalk.ca/story/largest-shoreline-cleanup-on-central-b-c-coast-ckpgtoday-ca
Sept 1, 2020	Seafood News	'Tons and Tons of Fishing Equipment': B.C. Tour Operators Clean Up Ocean Debris During Pandemic	Seafood News	https://www.seafoodnews.com/Story/1180645/Tons-and-Tons-of-Fishing-Equipment-BC-Tour-Operators-Clean-Up-Ocean-Debris-During-Pandemic
Sept 1, 2020	CFNR Network	Provincial government announces funding to clean shoreline	Christian Apostolovski	https://www.cfnrfm.ca/2020/09/01/provincial-government-announces-funding-to-clean-shoreline/
Sept 2, 2020	CFAX	(Interview with Scott Benton)	Al Ferraby	
Sept 2, 2020	CBC - All Points West	(Interview with Maureen)	Megan Thomas	
Sept 4, 2020	Indigenous Lands and Resources today	Coastal First Nations take action to protect coastline from marine waste	ILR Today	https://ilrtoday.ca/coastal-first-nations-take-action-to-protect-coastline-from-marine-waste/
Sept 4, 2020	GOVT Monitor / Environment & Climate Change Strategy	Coastal First Nations take action to protect coastline from marine waste		https://www.govtmonitor.com/page.php?type=document&id=1852
Sept 5, 2020	The Daily Scrum	Coastal First Nations $1.33M Initiative To Protect Marine Waters	The Daily Scrum	https://www.thedailyscrum.ca/2020/09/05/coastal-first-nations-1-33m-initiative-to-protect-marine-waters/
Sept 8, 2020	Water Canada	Coastal First Nations in B.C. to Protect Coastline from Marine Debris	Simran Chattha	https://www.watercanada.net/coastal-first-nations-in-b-c-to-protect-coastline-from-marine-debris/
Sept 9, 2020	Coast Funds	First Nations Take Action to Steward and Protect Coastlines	Coast Funds	https://coastfunds.ca/news/first-nations-take-action-to-steward-and-protect-coastlines/
Sept 10, 2020	Yahoo News	Heavy plastics, abandoned fishing nets and tsunami debris part of coastal clean-up haul	Andrea Smith	https://ca.news.yahoo.com/heavy-plastics-abandoned-fishing-nets-224846384.html
Sept 11, 2020	Travel Industry Today	CLEAN MACHINE: BC small ship ops tackle trash on coast	Travel Industry Today	https://travelindustrytoday.com/clean-machinebc-small-ship-ops-tackle-trash-on-coast/
Sept 11, 2020	Prince George Matters	Nine First Nations share $1.3M funding for cleanup of B.C. coastline	Andrea Smith	https://www.princegeorgematters.com/local-news/nine-first-nations-share-13m-funding-for-cleanup-of-bc-coastline-2705993
Sept 11, 2020	Prince George Citizen	Plastics, fishing nets and tsunami debris part of coastal clean-up haul	Andrea Smith	22 tonnes of ghost gear to be retrieved from Canada's richest fishing grounds
Sept 11, 2020	Victoria News	Inside the ongoing mission to scrub clean B.C.'s wild beaches	Zoe Ducklow	https://www.vicnews.com/news/inside-the-ongoing-mission-to-scrub-clean-b-c-s-wild-beaches/
Sept 15, 2020	Narwhal	'Tons and tons of fishing equipment': B.C. tour	Matt Simmons	https://thenarwhal.ca/bc-tour-boat-operators-clean-up-ocean-debris-coronavirus/

		operators clean up ocean debris during coronavirus pandemic		
Sept 15, 2020	ATTA - Newsletter	How British Columbia is Saving its Beaches and Small Ship Tourism with a Marine Debris Clean-up in the Great Bear Rainforest	ATTA	https://www.adventuretravelnews.com/how-british-columbia-is-saving-its-beaches-and-small-ship-tourism-with-a-marine-debris-clean-up-in-the-great-bear-rainforest
Sept 17, 2020	Victoria News	Remote B.C. tourism lodge staffed for coastal clean-up instead of wilderness tours	Zoe Ducklow	https://www.vicnews.com/news/remote-b-c-tourism-lodge-staffed-for-coastal-clean-up-instead-of-wilderness-tours/
Sept 18, 2020	Canadian Geographic	Small ship tourism saving B.C. beaches with marine debris cleanup	Angelica Haggert	https://www.canadiangeographic.ca/article/small-ship-tourism-saving-bc-beaches-marine-debris-cleanup
Sept 22, 2020	Globe and Mail	Stepping Up: With season cancelled, ecotourism group tackles marine waste	Diane Selkirk	https://www.theglobeandmail.com/canada/article-stepping-up-with-season-cancelled-ecotourism-group-tackles-marine/
Sept 22, 2020	Pacific Yachting	Marine Debris Cleanup on BC's West Coast	Rick Hudson	https://www.pacificyachting.com/7099-2/
Sept 22, 2020	Coastal First Nations	Coastal Cleanups Provide Jobs, Protect Shorelines	CFN	https://coastalfirstnations.ca/coastal-cleanups-provide-jobs-protect-shorelines/
Sept 2020	Tourism Industry Association of BC	Newsletter mentions (2 or 3 different times)	TIA-BC	
Nov 2020	Cowichan Valley Voice		Oriana Smy	https://cowichanvalleyvoice.com/
Oct 2	Radio Canada	Follow on article on MDRI (French)	Frederik Xavier Duhamel	https://ici.radio-canada.ca/nouvelle/1738452/pollution-bouteille-plastique-styromousse-filet-peche-kitasoo-xaixais
Oct 12	CBC News	Follow on article on MDRI	Frederik-Xavier	
Oct 15, 2020	Travel Courier		Ann Ruppenstein	http://travelcourier.ca/coverstory-oct-15-2020/
Oct 15, 2020	Douglas (Victoria monthly biz magazine)	Maple Leaf Adventures Pivots to Save Beaches	Danica Jeffrey	https://www.douglasmagazine.com/maple-leaf-adventures-pivots-to-save-beaches/
Nov 13, 2020	Canadian Geographic online	Expedition report: The great B.C. coastal cleanup of 2020	Dr. Jackie Windh	
Oct 27, 2020	Boating Industry Canada	Small Ship Tour Operators Assoc of BC Collects 127 Tonnes of Marine Waste		https://boatingindustry.ca/featured-articles/8344-the-small-ship-tour-operators-association-of-bc-operators-collect-127-tonnes-of-marine-waste-impacting-the-great-bear-rainforest
Nov 20, 2020	Pique Newsmagazine	RANGE ROVER: Waste not, want not (Opinion)	Leslie Anthony	https://www.piquenewsmagazine.com/opinion/waste-not-want-not-2890494
Dec 2020	Comox Valley Collective	Feature by one of the crew, with photos	Oriana Smy	https://cvcollective.ca/read-online/
	Western Mariner (magazine)	Feature by one of the crew, with photos	Damien Dawson	
Jan 2021	BC Magazine	COVID triggers massive BC cleanup	Rick Hudson	https://view.imirus.com/1200/document/13472/page/9

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