

Key issues affecting coastal aquatic ecosystems and changing coastal conditions in Nunavut:

A comparative assessment of communities in the Kivalliq region.

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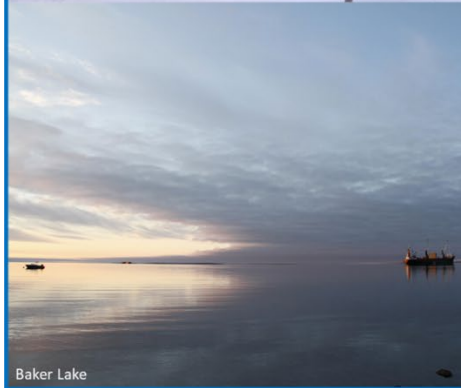
Arviat



Chesterfield Inlet



Coral Harbour



Baker Lake



Nauyasat



Whale Cove

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Executive Summary

The Coastal Restoration Nunavut (CRN) project draws on Inuit Qaujimajatuqangit (IQ) to document and address the health and condition of marine species and their habitats. The objective of the research project is to identify and implement physical interventions to mitigate the stressors impacting aquatic species in each of Nunavut's 25 communities. Under the Oceans Protection Plan (OPP), the Government of Canada has identified coastal restoration as a key priority to address threats to aquatic ecosystems and marine biodiversity loss. "Coastal restoration" is defined as the action of returning something to its former condition; improving its current condition; or protecting it from further or future harm. "Coastal" refers to any area where marine and terrestrial processes meet and interact.

This technical report presents the findings of the CRN team visits to six communities (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, and Whale Cove) in the Kivalliq region. In each of the communities, team members held participatory mapping workshops with the Hunters and Trappers Association, Hamlet staff, elders, and other resource users requesting to share their knowledge on coastal health and changing coastal conditions. The data collected represents a snapshot in time and are not a comprehensive inventory of all the coastal issues or priorities within a community.

A scan of the literature identified the following coastal topics as being relevant to the Kivalliq region. The most frequently mentioned environmental themes were 1. Seasonal and weather events, including winds, and the unpredictability of the weather; 2. Ice changes observed in relation to variations in thickness, ice and glacier melt, and late ice formation; and 3. Decreasing freshwater levels and the impacts this is having on fish migration. The top three most frequently mentioned ecosystem themes were related to 1. Birds, Fisheries, and Whales; 2. Seals; and 3. Polar bears. The literature focused mainly on changes in population abundance, sightings of new species, and the health and quality of these species, including changes in the taste, texture, and colour of the meat. Literature sources used in this review include the Nunavut Coastal Resource Inventories (Government of Nunavut, various dates), Arctic Corridors and Northern Voices reports (Carter et al., various dates), government documents and websites, and news articles.

From the perspective of the Kivalliq knowledge holders, the most noted environmental and ecological changes, and hence the top coastal priority were related to species population abundance and health (n=24), decreasing water levels (n=21), and erosion at different sites and areas (n=11). There were no specific responses to the issue of decreasing water levels, which is most likely a systematic impact of climate change, and beyond the control of the communities. However, knowledge holders identified key management interventions to address char fisheries issues in Whale Cove, whereas in Coral Harbour, the residents would like to explore potential fisheries options; assess and mitigate the impact of rockfalls; and address access road issues. The Baker Lake community requires management interventions to mitigate the impact of sewage on the lake. In Naujaat, residents are concerned about the impact of a potential diamond mine, which could be located close to the town, and the quality of the main local drinking supply.

Drawing from the literature, the top two research categories were fisheries development and community engagement and monitoring, followed by shipping and transportation studies, remediation and restoration of sites, economic development, and ecological monitoring and testing. From the knowledge holders' perspectives, Naujaat members would like research conducted on the health, abundance, and migration patterns of marine species. They would also like testing for contamination of the lake from the sewage lagoon. Baker Lake residents are requesting fish and water quality studies between Baker Lake and Chesterfield Inlet as they have observed a decrease in sea mammals once the Meadowbank mine opened in 2010.

The report concludes with a section that describes several examples of projects, guidelines, research, and reports from Nunavut and other Canadian provinces and territories that focus on similar issues as those identified by the Kivalliq communities during the CRN team visits. Based on the findings in this section, there are already quite a few strong initiatives in Nunavut that could be replicated and/or built upon. Moving forward, it will be important to share these examples with other communities and learn from the implementation of these initiatives to further build on our current knowledge base.

1.0 Introduction

Under the Oceans Protection Plan (OPP)¹, the Government of Canada has identified coastal restoration as a key priority to address threats to aquatic ecosystems and marine biodiversity loss. Established in the 2017-2018 fiscal year, the Coastal Restoration Fund (CRF) is a five-year grants and contributions program focusing on projects that (a) address the impacts of historical development; (b) mitigate the results of increased marine shipping; (c) contribute to the recovery of species that are considered threatened, endangered or at risk; and (d) build local capacity to restore and maintain coastal habitats². In this context, “Coastal restoration” is defined as the action of returning something to its former condition; improving its current condition; or protecting it from further or future harm. “Coastal” refers to any area where marine and terrestrial processes meet and interact.

The Coastal Restoration Nunavut (CRN) project draws on Inuit Qaujimajatuqangit (IQ) to document and address the health and condition of marine species and their habitats³. IQ is defined as the indigenous knowledge of the Inuit and as it encompasses all knowledge, cannot be defined in one word (Government of Nunavut, CLEY 1999). In collaboration with communities, the objective of the research project is to conduct feasibility studies to identify and mitigate the stressors impacting aquatic species in each of Nunavut’s 25 communities. The project is committed to implementing at least three physical interventions identified as priorities by communities, one in each administrative region within the territory. The project also aims to strengthen capacity at the community level via local training; to document IQ; and to support each community in environmental restoration and stewardship initiatives.

The project builds on the successful baseline and monitoring programs developed and delivered by the Government of Nunavut, such as the Nunavut Coastal Resource Inventory (NCRI) and the Nunavut Community Aquatic Monitoring Program (N-CAMP).

The purpose of this report is to present a comparative analysis of the findings of the CRN team visits to the six communities (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, and Whale Cove) in the Kivalliq region. In each of the communities, team members held participatory mapping workshops with the Hunters and Trappers Association (HTA), Hamlet staff, elders, and other resource users requesting they share their knowledge on coastal health and changing coastal conditions. Community workshops and meeting discussions sought to learn more about the knowledge holders’ perspectives on the following:

1. Coastal areas, if any, that show historical or potential signs of degradation and/or contamination
2. Impacts on social, economic, and cultural activities and practices from changes to the coastal environments
3. Community coastal restoration priorities and needs, and
4. Approaches to address these priorities and needs

Based on the knowledge shared during these workshops, community driven restoration projects were identified, feasibility studies conducted, and coastal restoration activities funded, as per the recommendations of the feasibility studies.

The report first presents an overview of the Kivalliq region, followed by the short summary of the methods used to collect and analysis information drawing from both the literature and workshops. The following sections then address each of the research questions noted above. The report concludes with a summary of the main findings.

2.0 Kivalliq region overview

Nunavut has three administrative regions (Figure 1) - Kitikmeot (Cambridge Bay, Gjoa Haven, Kugaaruk, Kugluktuk, Taloyoak); Kivalliq (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, Rankin Inlet, Whale Cove); and Qikiqtaaluk (Arctic Bay, Kinngait, Clyde River, Grise Fiord, Sanirajak, Iqaluit, Igloodik, Kimmirut, Pangnirtung, Pond Inlet, Qikiqtarjuaq, Resolute Bay, Sanikiluaq).

¹ <https://tc.canada.ca/en/initiatives/oceans-protection-plan>

² <https://www.dfo-mpo.gc.ca/ae-ve/evaluations/20-21/crf-frc-eng.html>

³ For further information visit <https://www.coastalnunavut.ca/>



Figure 1: The three administrative regions of Nunavut

The Kivalliq is one of three administrative regions of Nunavut, Canada. The region includes the mainland to the west of Hudson Bay, Southampton Island and Coats Island. The seven communities are Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, Rankin Inlet, and Whale Cove. Prior to Nunavut becoming a Territory in 1999, the Kivalliq Region existed under slightly different boundaries as the Keewatin Region, Northwest Territories⁴. **Figure 2** shows the location of the six communities that were visited and is followed by a short description of each site.

⁴ <https://www.kivalliqinuit.ca/>

be found in the water near town. Different cultural groups have relocated from the Kivalliq mainland, the Baffin Island area, and Northern Quebec.

Naujaat (ᑎᑭᑭᑦᑎᑦ, “Nesting place for seagulls”): Naujaat is at the north end of Roes Welcome Sound, which separates Southampton Island from the mainland. On the east side of Naujaat, Frozen Strait leads east to Foxe Channel. The Hamlet (previously known as Repulse or Repulse Bay) is located exactly on the Arctic Circle, on the north shore of Naujaat and on the south shore of the Rae Isthmus. Naujaat is known for its artists, especially carvers as well as jewelry and crafts. The community continues to rely on sealing, fishing, hunting, trapping, and carving for livelihoods, together with tourism.

Whale Cove (ᑎᑭᑭᑦᑎᑦᑎᑦ, Tikirarjuaq, “Long point”): Whale Cove is located on the western coast of Hudson Bay, in the Kivalliq region of Nunavut. The Hamlet is approximately 70 km southwest of Rankin Inlet and 150 km northeast of Arviat. The community dates from the 1950s and is known for its abundance of beluga whales that congregate in nearby waters every fall.

3.0 Methods

3.1 Literature synthesis

The literature review was conducted by four graduate research assistants from the Marine Affairs Program, Dalhousie University. Database sources and search engines included Google Scholar, Novanet⁵ and Research Gate. Literature used in this review was drawn from peer-reviewed articles, the Nunavut Coastal Resource Inventories (NCRI), Arctic Corridors and Northern Voices reports, government documents and websites, and news articles/websites (e.g., Nunatsiaq, CBC).

Search strings followed the categories identified in NCRI reports. Examples of these search strings included “community name” + “contaminants”, “mine”, “char”, “climate change”, “environmental change”. “sea level rise”, “erosion”, “seals”, “shipping”, “community name” + “narwhal”; “beluga”, “bowhead”, “walrus”, “fisheries”, “arctic char” and “polar bears”. Profiles⁶ for each of the 25 communities were then developed and provide an overview of environmental and ecological changes, gaps in the literature, and information documented at the workshops.

Challenges: Two of the main challenges were finding information on community specific information, for example commercial fisheries and quotas in each community, and updates on specific projects, such as infrastructure development. Related to this challenge was that many of the peer-reviewed articles (especially for species) focused on a regional level, and as the scope of the review was at a community level, these reports were omitted, unless there was specific mention of a community(s). Another challenge was the variation in the number of articles/studies/reports and types of sources available for each community. For example, Gjoa Haven had limited publications, hence information was drawn more from unpublished/grey literature, whereas Pond Inlet had an abundance of information available. Reconciling the different forms of information available with a profile that aims to be relatively consistent with others (but also recognizing the unique characteristics of each community) was difficult.

Through this literature review process, it was evident that a lot of research is happening in the North, and while much of it may be directly benefiting communities, it appears there is no central place for access to this information. Some of the questions raised at the community workshops could be answered using the information available in the literature. However, because the information is found throughout many different documents/sources, and often consists of technical jargon, it is not easy for the wider population to access. These profiles, compiled with what the community needs/values/interests and priorities are, could potentially be an important source for both communities and researcher. It should also be noted that these profiles are snippets in time and will need to be updated as community situations and priorities change, and/or new information becomes available.

⁵ Novanet is a partnership of the university and community college libraries in Nova Scotia that share a combined library catalogue.

⁶ Profiles for the 20 visited communities can be viewed and downloaded from <https://www.coastalnunavut.ca/>

3.2 Community workshops

Data collection: In each community, one focus group was conducted at the HTO and/or Hamlet council, and one-on-one interviews were conducted with Hamlet staff and HTO members with each participant list approved by the HTO board of directors beforehand. The interviews were conducted in person, with all interviews and the selection of knowledge holders coordinated through the community HTO. Focus groups and focus group attendees were coordinated through the respective HTO and Hamlet

Communication between the CRN team and engaged communities began at least two months in advance of travel. Flexibility on behalf of the research team was required to adapt to scheduling conflicts and/or availability changes on the ground. The CRN research team was composed of a lead interviewer, as well as a local note taker and interpreter when possible. The data collected represents a snapshot in time and are not a comprehensive inventory of all the coastal issues or priorities within a community. Table 1 provides a summary of the data collection.

Table 1: Summary of data collection details

| Community | Team visit | No. of Knowledge holders | Session length |
|--------------------|---------------|--------------------------|----------------|
| Arviat | March 2018 | 8 | 2 hrs |
| Baker Lake | February 2020 | 8 | 2 hrs |
| Chesterfield Inlet | March 2018 | 6 | 2 hrs |
| Coral Harbour | March 2018 | 8 | 2.5 hrs |
| Naujaat | February 2020 | 8 | 2 hrs |
| Whale Cove | March 2018 | 2 | 1.5 hrs |

Data analysis (participatory maps): Using participatory mapping and semi-structured interviews, knowledge holders were asked to identify changes, damages and risks to species, habitats and coastal activities over time, and the causes of and impacts from said changes. These questions led to community-identified restoration priorities and/or potential interventions. Information from the interviews was then coded and themed by the data collection team.

Data analysis (themes): Using the codes created for the maps and assigned field notes, the information was then themed into the following four categories: General observations; Environmental changes, Ecological changes; and Actions needed to address key coastal restoration issues. The general observations category did not specifically address a research question but was used to describe mapping codes/information that did not fall into any of the other three themes. Actions needed to address key coastal restoration issues was further grouped into five sub-themes: (a) fisheries management interventions, (b) cleanup of contaminated sites, (c) environmental research and monitoring, (d) restoration of key fishing areas, and (e) ecological research and monitoring. Environmental research and monitoring are actions that focus on water quality, fish health due to contamination sources, and physical and/or chemical environmental assessments. Whereas ecological research and monitoring focus on species abundance, migration patterns, habitat changes, etc. Table 2 provides a summary of the primary data sources used to address specific research questions.

Table 2: Research questions, sources for themes, and theme categories

| Research questions | Source for themes | Theme categories |
|--|---|--|
| 1. What are the community perspectives on coastal restoration needs? | Community field notes | <ul style="list-style-type: none"> • Actions needed to address key coastal restoration issues |
| 2. What coastal areas, if any, show historical or potential signs of degradation and/or contamination? | Mapping codes and community field notes | <ul style="list-style-type: none"> • Environmental changes • Ecological changes |

| | | | |
|---|--|---|---|
| 3 | How have socio-economic and cultural activities been impacted by changes to the coastal environment? | Mapping codes and community field notes | <ul style="list-style-type: none"> • Environmental changes • Ecological changes • Actions needed to address key coastal restoration issues |
| 4 | What should be done to address these impacts? | Community field notes | <ul style="list-style-type: none"> • Actions needed to address key coastal restoration issues |
| | Setting the context | Mapping codes | <ul style="list-style-type: none"> • General observations |

Lessons learned:

From a data collection perspective, lessons learned include prioritizing open, transparent, translated, and weekly communication with the respective communities before and after the research takes place; additional review of data, map locations and place names prior to departure; and receipt of contact details from all knowledge holders in case follow-up information is needed.

From the data analysis perspective, having an ongoing working code book developed after the first few visits have been completed can help in standardizing the information being collected. Debriefing meetings after visits also contribute to clearer interpretation of the data and highlight the potential to adjust approaches if needed. Also ensuring that there is a clear understanding and documentation of the methods being used by team members collecting the data and those doing the analysis (if different) help to ensure a smooth transition in the event of changes in team personnel. From a project management perspective, clear definitions for team member roles are essential, especially for new personnel taking on positions held by previous team members.

4.0 Environmental and ecological changes

4.1 Literature synthesis

Drawing from the literature, the most frequently mentioned environmental themes relevant to the six communities (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, and Whale Cove) were: **1.** Seasonal and weather events, including winds, and the unpredictability of the weather; **2.** Ice changes observed in relation to variations in thickness, ice and glacier melt, and late ice formation; and **3.** Decreasing freshwater levels and the impacts this is having on fish migration. The three most frequently mentioned ecosystem themes focused on: **1.** Birds, Fisheries, and Whales; **2.** Seals; and **3.** Polar bears. Studies tended to center on changes in population abundance, sightings of new species, and the health and quality of these species, including changes in the taste, texture, and colour of the meat.

4.1.1 Environmental changes

Seasonal and weather: In the literature examined, community members noted that the winds had become stronger, and the direction has changed from what they had experienced in the past. For example, in Arviat, communities reported fewer blizzards and warmer spring-like weather in the middle of winter of 2017-2018 (Government of Nunavut, 2018a). The Arviat community have also observed stronger winds, and that the prevailing winds are changing direction (used to be from the north-west, now north-east or direction of the ocean). Changes in the timing of seasons, such as spring coming earlier have been noted by residents in Arviat (Government of Nunavut, 2018a), Coral Harbour (Government of Nunavut, 2014), and Naujaat (Government of Nunavut, 2011). Whale Cove residents have also observed that the sun seems to be getting stronger and that on average, it was much warmer nowadays (Government of Nunavut, 2018b).

Sea and freshwater ice: Changes in sea and freshwater ice are an issue for the Kivalliq region. For example, in Arviat, lake ice is much thinner now, ice freeze is much later in the year, and it does not freeze up as before (Government of Nunavut, 2018a). Baker Lake residents had also noticed ice was thinner and took longer to freeze, (Government of Nunavut, 2010). The glacier on the north side of Schultz Lake was also diminishing (The Hudson Bay Consortium, 2019). In 2015, Naujaat residents observed that it took longer to freeze, and ice melted earlier in the spring, but lakes did not seem to be affected (Government of Nunavut, 2011). Whale Cove residents also described sea ice as melting much faster in the spring, and the flow edge was getting closer to shore every year (Government of Nunavut, 2018).

Freshwater levels: Decreasing water levels on migrating fish stock and access to fishing sites are major issues for communities in this region. For instance, water levels are dropping in all three major heritage rivers that flow into Baker

Lake (The Hudson Bay Consortium, 2019). The community has been monitoring these levels since August 2018 as other lakes are also drying up (The Hudson Bay Consortium, 2019). In Chesterfield Inlet, the summer of 2008 was considered to have been relatively dry that resulted in lower water levels in lakes and rivers, and within the Inlet. In addition to warm lake temperatures (considered unhealthy for cold-adapted fish), lower river levels also reduced spawning by limiting upstream migration (Government of Nunavut, 2010). In 2010, Naujaat, community members also observed reduced water levels in their lakes and rivers (Government of Nunavut, 2011). However, in a much earlier report, one benefit gained from the lowering of water tables noted by Naujaat community members was the increased access at low tide to small islands, thus giving greater access to caribou hunting areas (Arctic Climate Impact Assessment, 2004).

4.1.2 Ecological changes

Bird species: In most communities, residents have noticed changes in species and population numbers. For example, in Arviat, bald eagles are becoming more common and can be seen along the coast in groups (Government of Nunavut, 2018). Similarly, in Baker Lake, community members noticed an increase in bald eagles, which are seen nesting and feeding on char; the presence of new ducks in the area; and fewer geese, although they used to previously nest there (Government of Nunavut, 2010). Chesterfield Inlet residents have noted a decrease in ptarmigan and tundra swan numbers; however, snow geese appeared to have increased (Government of Nunavut, 2010). In 2010, Naujaat, native bird species had decreased and were replaced by non-native bird species (Government of Nunavut, 2011).

Fish species: Arctic char is an important food and economic source for the Kivalliq. In most of the communities, the literature cited residents have noticed changes in species and population numbers, which has also reduced the number of locations for good fishing sites. For example, Arviat residents noted an increase in populations of burbot in the lakes, which is making it harder to catch lake trout (Government of Nunavut, 2018a). In 2010, Chesterfield Inlet community members stated that fish numbers were decreasing, while others noted that aside from some yearly variability, there were no changes (Government of Nunavut, 2010). Personal observations also reflect specific places and times when the fish were caught, such as the color of char flesh varies depending on the river system where it was taken from (Government of Nunavut, 2010). In 2011, Naujaat, residents noted that the taste and texture of char and lake trout had changed, with some members suggesting that this was because the fish have switched to different prey species (Government of Nunavut, 2011).

Seal species: In 2013, Arviat community members noted the increased presence of harp seals, leading to the displacement of ring and harbour seals in the area (Nunavut Planning Commission, 2013). A few years earlier, Chesterfield Inlet residents also reported that ringed seal numbers were decreasing, and the animals appeared to be in poor health (Government of Nunavut, 2010). However, in Naujaat, ringed seal numbers were abundant, but the size and proximity of the population and their fat content fluctuated according to floe edge distance (Nancarrow & Chan, 2010). More recently, Whale Cove residents observed that they were seeing fewer seals over the last two to three years and assumed this was due to human-induced marine disturbances (Government of Nunavut, 2018b). Some residents suggested that this might also be due to warmer weather, whereas others thought blasts from oil exploration ships may be killing both the seals and prey species, including capelin (Government of Nunavut, 2018b).

Walrus species: In 2010, Coral Harbour community members reported that in addition to Walrus, Bencas and Coats islands, a small population of walrus live year-round in Roes Welcome Sound. Variable currents usually prevented extensive land-fast ice formation in winter, and ice floes persisted throughout the summer allowing the animals to haul out during the entire year (Government of Nunavut, 2014). In Arviat, the population appeared to be increasing (Government of Nunavut (2018a), whereas in Whale Cove, animal numbers were thought to be decreasing (Government of Nunavut, 2018b).

Whale species: The literature on belugas, narwhales, orcas, and bowhead indicate that some species numbers are increasing, whereas others are decreasing. For example, in 2010, residents from Chesterfield Inlet observed that beluga numbers were declining, which could be related to shipping noise and near-shore blasting (Government of Nunavut, 2010). Whereas in Arviat, shipping traffic was the main impact on decreasing beluga populations (Government of Nunavut, 2018a). In Whale Cove, residents observed that beluga were returning later than before, which could be due to the delayed ice breakup around the Churchill area (Government of Nunavut, 2018b). In Naujaat (Government of Nunavut, 2011) and more recently in Arviat (Government of Nunavut, 2018a) orcas were seen more frequently, and

residents were worried about the impact changes might have on other whale species. In Arviat (Government of Nunavut, 2018a) and Coral Harbour (Government of Nunavut, 2014), narwhals and bowhead whales were observed closer to shore.

Polar bear species: At different time periods, most communities in the Kivalliq region have reported an increase in polar bear numbers in their areas. For example, in Chesterfield Inlet, polar bears were very abundant in mid-November 2008, which may have been due to incomplete freezing of the Inlet and lack of sea ice, which inhibited the bears’ northern migration (Government of Nunavut, 2010). Although there has been an increase in numbers, residents of Coral Harbour noted that compared to previous years, the bears appeared thinner and more aggressive (Government of Nunavut (2014). More recently, in Arviat (Government of Nunavut, 2018a) and Whale Cove (Government of Nunavut, 2018b) more bears were being seen around the communities. Due to safety issues, people were limited in their land and hunting time, resulting in less food and younger people not getting enough traditional hunting and fishing experience (Government of Nunavut, 2018b).

4.2. Community workshop perspectives

4.2.1 Environmental and ecological changes to coastal areas

This section describes the environmental and ecological changes and concerns that were raised by knowledge holders from the six communities during the workshops. Information was drawn from the mapping codes and field notes, and themed as “*environmental and ecological changes*”. Changes were noted to have occurred within the lifetime of the person describing the event, species, or area. Figure 3 describes the main environmental and ecological changes as noted by the knowledge holders. The most frequently mentioned changes were species population numbers and animal health, decreasing water levels, and erosion. Appendix 1 presents community-specific maps depicting the spatial extent of related observations.

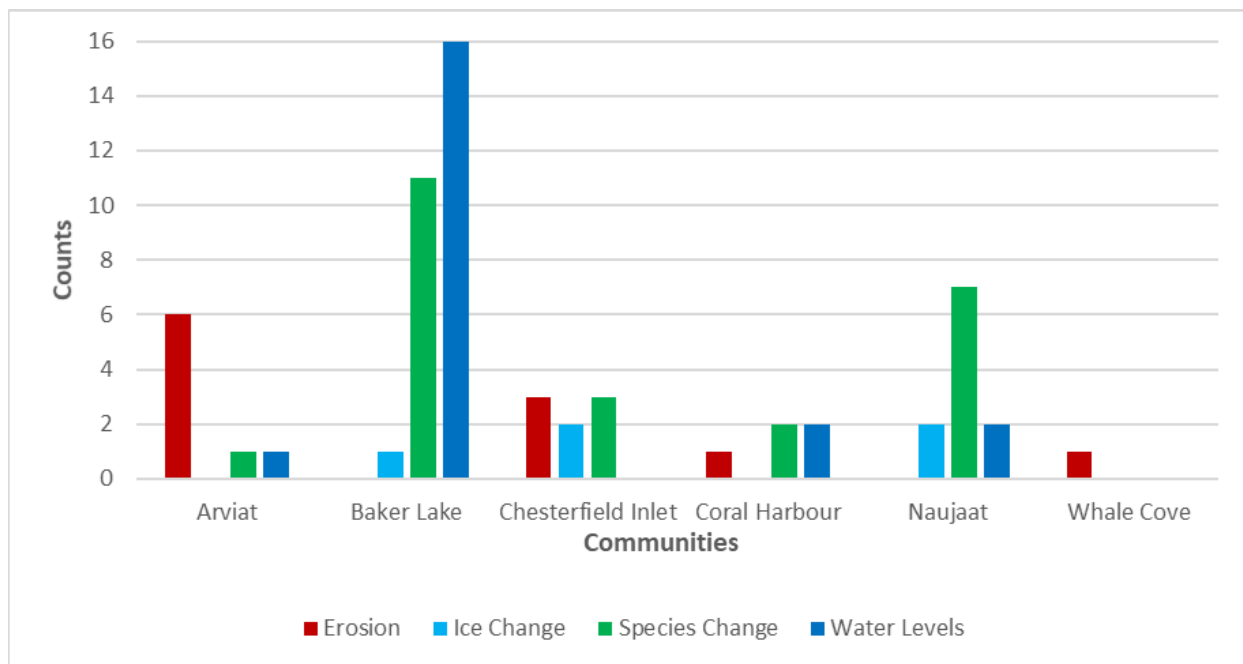


Figure 3: Environmental and ecological changes in the coastal areas (n=61)

Changes in species population abundance and health were the most frequently mentioned observations (comments n=24). Examples included:

- **Arviat:** there have been less fish seen compared to previous years. Arctic char numbers are lower because of warmer, shallower waters, and are suspected to be moving north. Other fish species are also moving north to cooler, deeper waters. Killer whales were now appearing in higher numbers, or closer to shore, forcing belugas into deeper water.
- **Baker Lake:** Arctic char from Hudson Bay area is now very skinny, potentially from increased marine traffic. Fish are staying in lakes now and not migrating anymore. There has also been an increase in other species (sculpin); animals that have not been seen for a while (e.g., pike), and new species (ivitaroq: the fish that watches you, like

char but longer and skinnier). Char is also disappearing from some areas, and/or fish seem to be unhealthy (big heads with small bodies).

- **Chesterfield Inlet:** Belugas appear every second year or so and tend to follow shipping traffic. During shipping season, all the seals leave the bay and move north along the coast to avoid disturbances. There is also an excess of seaweed with a bad smell. Fishing is still plentiful and accessible (still close to the community)
- **Coral Harbour:** Fish are showing signs of skin problems after cabins blew into the lake. Habitats such as grasses and bird areas are being lost.
- **Naujaat:** Arctic char are increasing, but the quality of the fish is not as good anymore, and the community is not sure why this is happening. More char has recently been seen in the North Pole River and upstream runs are very abundant (late August). There has been a decrease in the bay of seal populations due to increased marine and air traffic. Narwhals used to come right into the bay but there are too many boats in the ice-free season now, but they still go to the floe edge during the winter.

Decreasing water levels were the second most frequently mentioned issue (n=21). Impacts mentioned include:

- **Arviat:** All waters are shallower, especially past fishing sites. Although old traps can still be found at a specific site, this location is now too shallow to fish. An island 60 miles east off the coast has disappeared, removing a beaching location for walrus.
- **Baker Lake:** The main impacts are water levels decreasing every year, and more land being exposed. With lakes and rivers drying up, fish are not able to return to these sites and/or community members are unable to navigate to these sites. One specific river area was near a mine. Fish are also moving to deeper waters.
- **Coral Harbour:** Gravel filling and shallow water was impacting an old road. Although Pinch point is still a good fishing site, it has been getting shallower over the last five to six years. It could also be impacted by a road crossing. Coates Island rivers are also drying up and getting too shallow to dock. In the past 10 years the harbour in Coates Island has been covered with seaweed, so access is impossible at low tide.
- **Naujaat:** Rivers were drying up and becoming too shallow for navigation/fish runs.

Erosion at different sites/areas was the third most noted issue (n=11). Impacts and causes identified in the following communities were:

- **Arviat:** Road crossings and bridges being undersized, and bridge or culvert washouts.
- **Chesterfield Inlet:** Checkers Lake has become very muddy as of 2-3 years ago, with increased sedimentation. There was also an old washed-out culvert, and the community is trying to build a new bridge.
- **Coral Harbour:** A rockfall has caused blockage of an important migratory route/fishing area. The community is pursuing a new bridge to address the increased use of ATV crossings (roads bisecting rivers), which may have a negative impact on fish habitat
- **Whale Cove:** High traffic river crossing is causing erosion and degradation of important habitats for fish.

Ice changes were mentioned by community members in Baker Lake (glacier disappeared between 2005-2007), Chesterfield Inlet (permafrost melting and ice melting from below thought to be due to currents), Coral Harbour (The sea ice is thinner in recent years, and Coast Guard icebreakers impact ice melt speeds by accelerating the melt), and Naujaat (changes in the floe edge from December/early January until late July when compared to the early 2000s).

4.2.2 General observations

In addition to specific environmental and ecological changes, another category represents information drawn from the mapping codes and themed as “*general comments*”. These were comments about specific areas, species, and infrastructure. In most instances comments are neither positive nor negative, but more a statement of what is there and the potential relevance to the person providing that information. Figure 4 presents the themes that related to general observations.

The top three themes highlighted by communities that were visited related to: harvesting (42 mentions), contaminated areas (26 mentions), and fish migration areas/routes (22 mentions). Harvesting sites focused mainly on Arctic char, although there were also mentions of trout, clams, and mussels. In Baker Lake, knowledge holders noted that char was caught by kakivak in June/July; and the char is still very healthy and tasting like saltwater as these were sea-run fish.

Other comments described a popular jigging spot where local and spring char are caught. In Naujaat, community members noted important fishing lakes/sites for summer char gill netting, migration routes, and areas used for fishing derbies (char and trout).

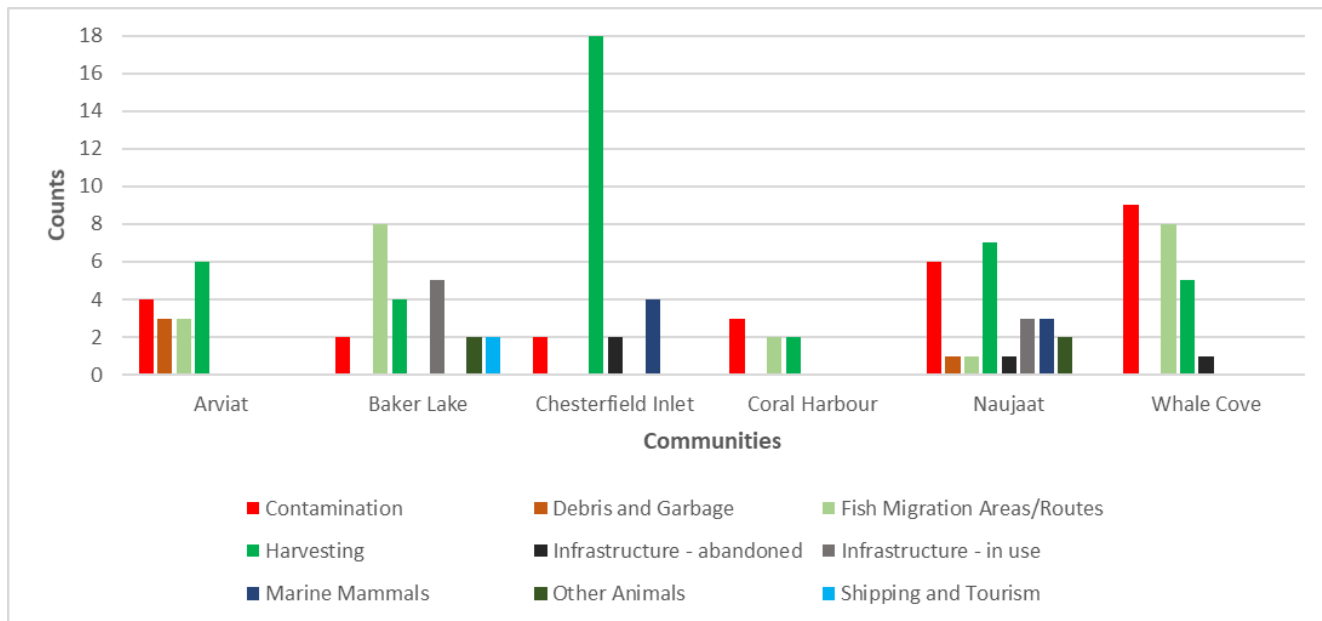


Figure 4: General observations (n=119)

Contaminated areas and sources included sewage and dump overflows, abandoned fuel barrels, mining sites (e.g., old Borealis and Inco exploration sites and camps in Whale Cove), and sunken vehicles. For example, in Arviat, barrels and garbage were found spread along the coast, possibly carried by the Maguse River currents. Sunken vehicles were noted in Arviat, Baker Lake (barge), and Whale Cove. Oil barrels and sewage overflows were the main sources of contaminants in Naujaat (testing for contaminants has not been conducted), Coral Harbour (near walrus basking areas), and Chesterfield Inlet.

Fish migration/routes also focused on Arctic char. In Baker Lake, community members described overwintering sites, migration routes, and where the fish gathered before going to sea. Other comments referred to trout and unknown fish species.

Abandoned infrastructure included an old cannery site and DFO Fisheries research site (Chesterfield Inlet), old water supply (Naujaat), and tents and other structures left from what was possibly an 11-year-old inactive caribou boundary (Whale Cove). In-use infrastructure included a bridge, cabin (hunting), mine, sewage lagoon, and a water source for drinking (Baker Lake) and dump, sewage lagoon, and water supply (Naujaat).

Debris and garbage areas were reported for Arviat (empty barrels have been found near the river fork, at the edge of the map, at an old missionary sitemap, and old cabin), and Naujaat (old fishing tags for char probably from previous sampling as this site may have been used in 1980s).

Marine mammals were noted in Chesterfield Inlet and Naujaat. In Chesterfield Inlet, belugas were observed to migrate from Marble Island northward in packs. Around Table Island, walrus were seen basking year-round. This is also a walrus migration route.

Sharks have been spotted when the water is calm, potentially Greenland sharks (Baker Lake). At Beach Point (Naujaat), there are lots of birds and duck eggs (eider duck, snow geese). Fat caribou were also noted in the area.

Community members at Baker Lake noted that at a specific mother ship docking area, 4 or 5 ships would anchor at the same time during the ice-free season (July to October). This is also a mother ship route.

5.0 Impacts of environmental and ecological changes on social, economic, and cultural activities and practices

This section discusses the impacts of environmental and ecological changes on the social, economic, and cultural activities of the communities visited by the CRN team. This section begins with a synthesis of the literature, followed by the perspective of the knowledge holders present at the community workshops.

5.1 Literature synthesis

Seasonal changes, unpredictable weather patterns and changes in ice thickness/shorter seasons: Prior to 2010, Naujaat community members were able to travel overland during the spring, but because snow melts earlier and freeze up is much later now, it is challenging for hunters and harvesters to accurately plan and travel to specific hunting areas (Nancarrow & Chan, 2010). Earlier, in 2000 & 2001, an influx of stormy weather impacted Naujaat hunters, especially boat owners who were not able to reach camps outside of the community (Smol & Douglas, 2007). Warmer days also have impacted traditional practices such as drying meat. For example, previously Whale Cove residents were able to keep caribou meat in the house overnight but now it rots more quickly (Government of Nunavut, 2018b). In 2010, thinner ice and shorter ice freeze periods made travelling very dangerous for Baker Lake residents (Government of Nunavut, 2010). Similarly, in Coral Harbour the ice floe edge was noted to have become much more hazardous for traveling (Government of Nunavut, 2014). In Baker Lake, changes in seasonal patterns and ice thickness may also have a negative impact on species and habitats such as polar bear denning areas (Government of Nunavut, 2010).

Freshwater levels: In Baker Lake, a 2010 report noted navigating the Lower Thelon river in autumn was difficult because of lowering water levels with only small aluminum boats being able to access these areas. Wayfinding remains possible only because boat drivers stayed within deep water channels (Government of Nunavut, 2010). In Naujaat, lowering of water tables has also created issues when accessing certain rivers, and fishing spots. Water level changes could also have a negative impact on the health and structure of invertebrate populations, and essential habitats for wildlife and migratory birds, thus affecting local food supply (Smol & Douglas, 2007).

Bird populations: An increase in geese and duck populations had been good for Arviat hunters in 2010 (Sullivan & Nasmith, 2010). At both Baker Lake (Government of Nunavut, 2010) and Naujaat (Nancarrow & Chan, 2010), communities were concerned about the potential of birds like ptarmigan bringing diseases to the area. Naujaat residents also reported ptarmigan population numbers were lower and body size smaller, however there were more ravens, geese, and swan, hence the increased potential for food (Nancarrow & Chan, 2010). In Coral Harbour, between 2004 and 2007 several common eiders deaths were reported. These incidents coincided with an avian cholera outbreak in the northeastern Hudson Bay, Hudson Strait, and Ungava Bay area (Henri et al., 2018). Fluctuations in population numbers and the high potential of diseased animals had an impact on food sources for communities.

Fisheries: Whale Cove has reported a summer fishery that contributes to the overall Nunavut Truly Wild Arctic Char brand. It has also made value-added products like char candy and char jerky recognizable Nunavut products that are consumed both within and outside of the territory (Government of Nunavut, 2016). As noted in section 3, natural changes in the diversity and population numbers have had an impact on what species residents are able to catch (e.g., the increase in burbot in some Arviat lakes make it harder for the community to catch lake trout). Whereas Naujaat residents have commented on differences in the taste and texture of char and lake trout (thought to be due to changes in the diet of the fish) (Government of Nunavut, 2011).

Marine mammals (seals, walrus, and whales): The most frequently mentioned impacts on communities, from a food security and sovereignty perspective is the impact on the taste and health of seals and walrus, and the impact of shipping traffic on whales, specifically beluga. For example, the Nunavut Coastal Resource Inventory (2010) documented reports from Chesterfield Inlet residents who said that seals were not as tasty as before, and that it was unhealthy to eat walrus killed in the vicinity of Rankin Inlet, due to runoff from mining activities in that area (Government of Nunavut, 2010). Community members in Naujaat also described seals as being more diseased and they were concerned about the quality of the meat (Government of Nunavut, 2011). In Baker Lake community members noticed an increase in beluga whales, which might have been because the animals follow the sealift barges when they travel in the area (Government of Nunavut, 2010a). Whereas in Arviat, since 2013/2014, residents are noticing fewer beluga whales in the area and

assumed this was because of an increase in shipping traffic (Government of Nunavut, 2018a). Similarly, members of the Whale Cove community have also noticed fewer whales (since 2015) and believe this is due to human-induced marine disturbances (Government of Nunavut, 2018b).

Polar bears: Coral Harbour residents noted that polar bears captured and tagged for research purposes were thinner (Government of Nunavut, 2014), more aggressive, and their meat did not taste good (Shannon & Freeman, 2009). In 2011 and 2018 there has been an increase in polar bears and Naujaat community members were concerned about their safety and wanted additional quota to account for defense kills (Government of Nunavut, 2011). Although polar bears appeared to be in overall decline, there has been an increased number of animals seen around Whale Cove. Due to safety issues, people were limited in their land and hunting time, resulting in less food and younger people not getting enough hunting and fishing experience (Government of Nunavut, 2018b).

5.2 Community workshop perspectives

Perspectives of knowledge holders at the community workshops also reflected those identified in the literature. Table 3 summarizes the coastal concerns identified by the communities, and the impacts that these issues are having on social, economic, and cultural activities and practices.

Table 3: Concerns and impacts on the social, economic, and cultural activities and practices

| Coastal concerns | Impacts on the community |
|--|--|
| Changes in species population numbers, diversity, and health | <ul style="list-style-type: none"> • Decrease in fish species is concerning from a food security and sovereignty perspective • Species health and reduced quality of the meat • Loss of habitats and species – food security and food sovereignty issue • Changes in species diversity – new species being seen, impact on country foods |
| Changes in water levels | <ul style="list-style-type: none"> • Fishing areas becoming too shallow to use/navigate/access • Impacts on fish and other species’ migration routes, fish moving to deeper waters – concern for food security and food sovereignty • Impacts of access roads on migratory routes |
| Increased erosion sites/areas | <ul style="list-style-type: none"> • Rockfalls and other infrastructure changes have had impacts on navigational and fish migratory routes • High traffic on river crossings is causing erosion and degradation of important habitats for fish – concern for food security and food sovereignty |
| Increased shipping and marine traffic | <ul style="list-style-type: none"> • Harvesting areas are being impacted by increased ship traffic • Impacts on resting and feeding habitats of species • Changes in the migratory patterns of marine mammals and other species • Overall concern for food security and food sovereignty. |

Shipping and maritime transport were noted by knowledge holders to have the most significant impacts on marine mammals and other species. For example:

- **Baker Lake:** Residents noted that a specific area used to be an important crabbing site since 1965, but the population had decreased (late 1960s onwards) since mother ship traffic increased. Some seals and walrus still appear if there is not too much ship noise. Killer whales and belugas also follow mother ship traffic near the community into the lake.
- **Chesterfield Inlet:** Shipping is hard on the community, impacting caribou and pushing them further inland. Walrus were also moving to avoid shipping traffic.
- **Coral Harbour:** Ship traffic including zodiacs were disturbing walrus basking areas and habitat.

Other impacts on habitats and species were from abandoned infrastructure/garbage and debris (Chesterfield Inlet), road crossings (Coral Harbour), and discarded research equipment In Arviat. It was noted that in 2016 a boat dropped a device (possibly monitoring equipment) that disturbs belugas and other mammals. A similar event also happened in Naujaat in 2017, when acoustic boxes were dropped by non-residents, disturbing and scaring away marine mammals.

6.0 Coastal restoration priorities and actions

6.1 Literature synthesis

Drawing from the literature, coastal restoration priorities for the six communities are categorized into four clusters: (a) Environmental research and monitoring, (b) Ecological research and monitoring, (c) Fisheries management interventions, and (d) Restoration of key fishing areas. Environmental research and monitoring studies focus on water quality, fish health due to contamination sources, and physical and/or chemical environmental assessments. Whereas ecological research and monitoring programs focus on species abundance, migration patterns, habitat changes, etc. Fisheries management interventions centered mainly on feasibility studies for the expansion of a fishery or the development of a new fishery.

Environmental research and monitoring

- **Baker Lake:** Water near the mine (Agnico Eagle Meadowbank) sites appeared to be contaminated and community members had seen oil and gas spills in the area (Government of Nunavut, 2019). Community members were concerned about the impact that these spills would have on the environment, and they would also like to see the meat of fish and birds tested for contamination (Government of Nunavut, 2019).
- **Naujaat:** There is a need to build capacity to address emergencies related to oil tankers delivering oil and gas, especially in the context of protecting wildlife and food security (The Hudson Bay Consortium, 2019).

Ecological research and monitoring

- **Arviat:** Community members identified the need for an assessment of Arctic char population numbers and changes in char meat color. Communities would also like to know more about the quality and safety of meat from beluga and walrus (Government of Nunavut, 2018a).
- **Whale Cove:** Residents have requested more research on the health of animals that are consumed within the community such as caribou, fish, and seal. Research should also focus on fostering Inuit Qaujimajatuqangit (IQ) transfer/mobilization, and the use of this knowledge when making management decisions about the resources (Government of Nunavut, 2018b).

Fisheries management interventions

- **Arviat:** Community members have requested a feasibility study for a whitefish commercial fishery (Government of Nunavut, 2018a).
- **Baker Lake:** North of Baker Lake, and in the rivers to the east there are large char that community members feel could be harvested commercially and would like additional studies done to support this fishery (Government of Nunavut, 2019).
- **Chesterfield Inlet:** An experimental scallop fishery study conducted in the early 2000 noted the potential to develop this fishery further (Government of Nunavut, 2010). However, there does not seem to be any further mention of further studies relating to this fishery in the literature.

Restoration of key fishing areas

- **Coral Harbour:** The permafrost slumps along the Canyon river are an issue for Arctic fish migrations. There is an urgent need for river enhancements so that fish will be able to travel upstream to the lakes to spawn (The Hudson Bay Consortium, 2019).

6.2 Community workshop perspectives

From the perspective of the community knowledge holders, general coastal restoration priorities focused on (a) the restoration of key fishing areas, (b) ecological research and monitoring, (c) environmental research and monitoring, and (d) clean up of contaminated sites. An additional category relating to infrastructure was also identified (Table 4). At the

time the Baker Lake and Naujaat communities were visited, no urgent general community restoration priorities were identified.

Table 4: Comments relating to general community priorities

| Community | Priorities | Restoration priority |
|--------------------|---|---------------------------------------|
| Arviat | Replacement of community bridges | Infrastructure |
| | Removal of a sunken bombardier | Cleanup of contaminated sites |
| | Rehabilitation of shallow rivers. | Restoration of key fishing areas |
| Chesterfield Inlet | A deep seaport for the community; | Infrastructure |
| | Mitigation of impacts from shipping | Ecological research and monitoring |
| Coral Harbour | The establishment of mandatory shipping lanes - should go south of Coates Island rather than between Walrus Island and Coates Island; | Ecological research and monitoring |
| | Water level monitoring for tides and major lakes with commercial fisheries or char spawning | Environmental research and monitoring |
| | Investigate the impact of road crossings (due to silt buildup, chemicals, etc.), which may hamper and/or delay fish migration | Environmental research and monitoring |
| | The removal of a rockslide on Canyon River | Restoration of key fishing areas |
| Whale Cove | The restoration of key fishing rivers. All the rivers are drying up, and small-scale remediation such as the rearrangement of boulder gardens will be required. | Restoration of key fishing areas |

In addition to the summary presented in Table 4, knowledge holders also identified specific priorities for their communities which are also documented on the community maps (Appendix 1). Table 5 describes information drawn from the field notes and themed as “*actions needed to address key coastal restoration issues*”. Like the coastal restoration priorities, these are grouped into five sub-themes: (a) fisheries management interventions, (b) cleanup of contaminated sites, (c) environmental research and monitoring, (d) restoration of key fishing areas, and (e) ecological research and monitoring. These actions do not always directly relate to a specific priority that was listed in Table 4. It should also be noted that two sites in Naujaat, where there had been debris and garbage issues have now been resolved.

Table 5: Comments relating to specific sites

| Community | Description from field notes | Action required | Site and map icon |
|---------------|--|---------------------------------------|---------------------|
| Baker Lake | Fish and water quality testing desired between Baker Lake and Chesterfield Inlet; sea mammals decreased once mine opened in 2010 | Environmental research and monitoring | 49 (contamination) |
| | Sewage travels along route; community members want sand around the lagoon, so it does not leech into the lake | Cleanup of contaminated sites | 58 (contamination) |
| Coral Harbour | Potential fisheries sites | Fisheries management interventions | 7 & 3 (harvesting) |
| | 3 sites approved for commercial fishery that have been impacted by rockfall | Restoration of key fishing areas | 11 (harvesting) |
| | Access road limit, river crossings not being done properly. The community is pursuing a new bridge to address the | Restoration of key fishing areas | 19 (infrastructure) |

| | | | |
|------------|---|---------------------------------------|------------------------------|
| | increased use of ATV crossings (roads bisecting rivers), which may have a negative impact on fish habitat | | |
| Naujaat | Contaminants testing desired | Environmental research and monitoring | 2 (Contamination) |
| | Abandoned oil barrels (1950s) but cleaned up in 1980s (30-40 jerry cans) – two sites | Cleaned up | 19 & 40 (debris and garbage) |
| | Potential diamond mine (only ten miles from town and very close to local water supply) | Environmental research and monitoring | 35 (building and structure) |
| | Monitoring of marine species desired (health, abundance, migration patterns) | Ecological research and monitoring | 7 (species change) |
| Whale Cove | Char overfished by Hudson Bay Company, none left, could be restocked | Fisheries management interventions | 21 (harvesting) |
| | Being overfished by another community | Fisheries management interventions | 10 (harvesting) |

The general priorities that have been identified by the knowledge holders (Table 4), combined with the actions needed at specific sites (Table 5), and supported by the literature, suggest that the most important coastal restoration priorities and actions needed are:

- a. Restoration of key fishing areas (Arviat, Coral Harbour, and Whale Cove)
- b. Environmental research and monitoring (Baker Lake, Coral Harbour, Naujaat)
- c. Ecological research and monitoring (Chesterfield Inlet, Coral Harbour, Naujaat)
- d. Fisheries management interventions (Coral Harbour and Whale Cove)
- e. Cleanup of contaminated sites (Arviat and Baker Lake)

Based on the literature and what the team heard from the knowledge holders, some of these priorities have been an ongoing issue. For example, in Baker Lake the issue of contamination from the mine (Agnico Eagle Meadowbank gold mine) has continued since 2010. In another example, the restoration of key fishing areas is noted in both the literature, and by Coral Harbour knowledge holders (general and specific priority). As such, it could be assumed that many of these changes and resulting impacts on the communities will continue to increase if not addressed. Species population numbers also fluctuate naturally, however changes in environmental conditions and increased human disturbances could also influence the amount of variation in numbers and changes to migration trends.

7.0 Approaches to address priorities and support coastal restoration

This section provides a brief overview of projects, guidelines, research, and reports from Nunavut and other Canadian provinces and territories that could inform the research needs and management interventions identified by the Kivalliq communities. The information in this section is derived from the Kitikmeot report⁷. Approaches to address these issues are grouped into five main areas: 1. Restoration of key fishing areas, 2. Environmental research, specifically on water quality and fish contamination from mining activities, 3. Ecological research on population changes in Arctic char and other important food species, 4. Fisheries management interventions, including stock assessments, fishing quotas and gear restrictions, and 5. Cleanup of contaminated sites.

⁷ Wilson, L., Owen, J., Bishop, B. and Fanning, L. (2021). Key issues affecting coastal aquatic ecosystems and changing coastal conditions in Nunavut: A comparative assessment of five communities in the Kitikmeot region (Marine Affairs Program Technical Report #17). Available at Marine Affairs Program: <https://www.dal.ca/faculty/science/marine-affairs-program/research/map-technical-series-reports.html>

7.1 Restoration of key fishing areas

On February 6, 2018, Fisheries and Oceans Canada introduced proposed amendments to restore lost protections and incorporate modern safeguards into the Fisheries Act. On June 21, 2019, the new Fisheries Act received royal assent and became law⁸. Prior to 2012, the Fisheries Act provided broad protection for fish and fish habitat throughout Canada. In 2012, changes were made so that only fish and habitat related to a commercial, recreational, or Aboriginal fishery were protected. Some of the key elements of the modernised Fisheries Act include the protection against the ‘death of fish, other than by fishing’ and the ‘harmful alteration, disruption or destruction of fish habitat’, requirements that Indigenous knowledge must inform habitat decisions, consideration of the adverse effects of decisions on the rights of Indigenous peoples, the protection for Indigenous knowledge when provided in confidence to the Minister, and the ability to enter into agreements with Indigenous governing bodies and any body established under a land claims agreement, as well as provinces and territories (Fisheries and Oceans Canada, 2021, April 14). Specifically focused on coastal restoration, the Coastal Restoration Fund, launched in 2017, is part of the national Oceans Protection Plan. Appendix 5 provides a broad overview of projects that have been funded under this program.

One often cited example of coastal restoration work in Nunavut is the Bernard Harbour project in Kugluktuk. Historical evidence describes large char runs in the summer and significant Inuit use of Bernard Harbour (Golder Associates Ltd., 2014). However, community members noted declines due to low water and ‘blockages’ in the creek. The Kugluktuk Hunters and Trappers Association (HTA) originally proposed stream restoration initiatives at Bernard Harbour beginning in the early 2000s and since then the HTO has since worked closely with Golder Associates and other partners (e.g., Environment Canada, GN Department of Environment) to advance this work. From 2010 to 2013, Golder designed, coordinated, and led a study to address community concerns and collect novel scientific information on char at Bernard Harbour. Community involvement was a crucial component of the project and was accomplished through the incorporation of Inuit knowledge and local expertise, and the engagement of HTO summer students and residents of Kugluktuk to facilitate youth education and encourage community stewardship (Golder Associates Ltd., 2014). In June 2014, an agreement to complete stream restoration work as a mining offsetting project was signed with Sabina (Sabina Gold & Silver Corp., 2015). Other examples of coastal restoration initiatives are provided in Table 6.

Table 6: Examples of coastal restoration initiatives.

| Province / Territory | Summary | Contact/Reference Links |
|----------------------|---|---|
| General | <p>Aquatic Habitat Canada is a national network supporting aquatic habitat protection and restoration. Aquatic Habitat Canada works to encourage and assist governments, local communities, Indigenous organizations, industry stakeholders and conservation organizations to protect and restore aquatic ecosystems to ensure they are healthy, resilient to the effects of changing climate and environmental conditions and provide ecosystem services to their full potential more effectively. Four core themes of the network are: 1. Restoration planning and prioritization, 2. Resources and capacity-building, 3. Knowledge synthesis and transfer, and 4. Policy and program. In addition to technical guides and success stories, other useful resources include a 2020 review of aquatic habitat restoration regulations and policies under the Fisheries Act, and funding opportunities, both Canada-wide and province specific.</p> | <p>More information can be found on the network’s website: https://aquatichabitat.ca/.</p> |

⁸ <https://www.dfo-mpo.gc.ca/campaign-campagne/fisheries-act-loi-sur-les-peches/introduction-eng.html>

| Province / Territory | Summary | Contact/Reference Links |
|----------------------|--|---|
| NU | <p>Coastal Restoration Nunavut - Restoration projects in Clyde River & Coral Harbour. The community of Clyde River (Qikiqtaaluk Region) is located on the northern shore of Patricia Bay, Baffin Island. The mouth of the Clyde River enters the bay to the east of the community. An old road crosses the river about 2,000 m upriver from its mouth. A boulder riprap (human-built structure) had been placed in the river to reduce the water depth and allow traffic to cross. Community members noted that Arctic char were impacted by these changes, as it restricted their migration routes from the ocean to freshwater. In 2018, a plan to remove the riprap structure and return the river to a more natural flow was put into place. Working with the assistance of Dalhousie University, and the Government of Nunavut, the HTO has also developed an upstream migration monitoring plan to assess and share information about the river and char runs. This plan includes a counting fence structure and a video recording system to reduce stress on the fish.</p> | |
| NU | <p>The community of Coral Harbour (Kivalliq Region) is on Southampton Island in Hudson Bay. Residents have noted that Coates Island rivers are drying up and getting too shallow to dock. A rockslide occurred on Canyon River in 2017 and the community wished to remove boulders from the area to free the channel, as there is less fish in the lakes. Commercial fishing for Arctic char occurs in the lakes as well as year-round subsistence fishing, but due to the rockslide, fishing sites are difficult to access. Harvesters also hunt seals and beluga there. Six members from the Aiviit Hunters and Trappers Association (HTO) travelled to the site in spring 2020 and restored approximately 10 m² of the river habitat. This work supports local fish populations, habitat health, and subsistence fishing and food sovereignty. Work continued in spring 2021 to maintain this important area. An additional 10 m² was restored.</p> | <p>For more information see: https://www.coastalnunavut.ca/ or email crn@dal.ca.</p> |
| NU | <p>Preserving Arctic char habitat and Indigenous fisheries in Western Hudson Bay. This project addresses issues such as isostatic rebound that has reduced water levels resulting in the emergence of physical obstacles like rocks that impede fish migration. Climate change has also impacted these areas and has increased the risk of permafrost slumping which may create new barriers (either physical or chemical) in the future. The plan includes simple, mechanical methods to improve migration opportunities (e.g., pry bars and come along) following examples of other similar restoration initiatives such as those used to successfully restore Nulahugyuk Creek near Bernard Harbour. Inuit will be trained to collect data inputs to habitat occupancy modeling during restoration activities in year two (2020), and as part of follow up monitoring in year three (2021).</p> | <p>For more information see: Nesbitt et al., 2019 https://bit.ly/3xa6C2I</p> |
| QU | <p>The Nepihjee river Arctic char fishway restoration project. The organisation is conducting a project to continue the minor restoration work initiated in 2019. The objective of this project is to remove debris in the river, allowing for a clear path for Arctic char to migrate upriver. The project is being funded by a \$46,157.96 grant from the Climate Change Preparedness in the North program for 2020-2021. Another project is focused on the restoration of fish habitat affected by mining activities in the north, in collaboration with MiraNor.</p> | <p>More information about these projects can be obtained by contacting the Makivik Corporation https://www.makivik.org/contact/</p> |
| NFL | <p>Parker's Brook restoration. In 2020 the Pistolet Bay Parker's Brook char association partnered with WWF-Canada to organize the Parker's Brook: Then and Now workshop. The event brought together community members, resource managers, and science and engineering experts to share information on the Parker's Brook aquatic system and its ecologically unique population of Arctic char, Atlantic salmon, and brook trout. The project encouraged community engagement in the planning of</p> | <p>Several resources can be found on the association's website: https://bit.ly/3yW2ipM</p> |

| | | |
|-----|---|--|
| | restoration actions and long-term stewardship of the river and its aquatic resources. | |
| NWT | <p>Beaufort Sea Coastal Restoration Project, Northwest Territories.</p> <p>This study focuses on sites in the Galiptat Area, Imnaqpaluk, and Tuktoyaktuk Island. The sites were chosen in consultation with the Tuktoyaktuk Hunters and Trappers Committee. The objectives of the study are to use historical aerial photographs and satellite imagery to map the progression of coastal erosion and thaw slumping (1967 to 2004 to 2018), study the progression of thaw slumping at these three sites, examine these effects on water quality and run-off into the Kugmallit Bay, and investigate methods by which plant species native to Tuktoyaktuk region can be used to restore disturbed coastline.</p> | <p>Further details on the approach and preliminary results can be found on the project's website: https://nwtresearch.com/beaufort-sea-coastal-restoration-project.</p> |

7.2 Environmental research, specifically on water quality and fish contamination from mining activities

The Northern Contaminated Sites Program⁹, under Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), and the Northern Contaminants Program¹⁰ (NCP) are two of the most relevant federal programs pertaining to this issue. The objective of the Northern Contaminated Sites Program is to manage contaminated sites to reduce or eliminate, where possible, risks to human and environmental health, and to decrease the federal environmental liability associated with contaminated sites in the North. Policies associated with the Northern Contaminated Sites Program include the Northern Affairs Program Environment, Health and Safety Policy; the Mine Site Reclamation Policy for the Northwest Territories; and the Mine Site Reclamation Policy for Nunavut.

At the territorial level, the Nunavut General Monitoring Plan (NGMP)¹¹ provides for the collection, analysis, and reporting of information on the long-term conditions of Nunavut's environment, people, communities, and economy. General monitoring is a requirement under the Nunavut Agreement and is founded within the Nunavut Agreement and the Nunavut Project Planning and Assessment Act (NuPPAA). The NGMP is managed and operated by the NGMP Secretariat and overseen and governed by the NGMP Steering Committee, consisting of representatives from the Nunavut Planning Commission (NPC), Nunavut Tunngavik Inc. (NTI), the Government of Nunavut (GN), and Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) on behalf of the Government of Canada. The NGMP Secretariat is housed within CIRNAC.

Selected projects funded and/or supported by these three programs include the Tłıchq Aquatic Ecosystem Monitoring Program, Understanding and predicting fish mercury levels in the Dehcho region, and the Community-based monitoring program for the Baker Lake/Chesterfield Inlet Ecosystem (Table 7).

⁹ <https://www.rcaanc-cirnac.gc.ca/eng/1100100035301/1537371472183>

¹⁰ https://science.gc.ca/eic/site/063.nsf/eng/h_7A463DBA.html

¹¹ <https://www.ngmp.ca/eng/1363792048577/1363792058944>

Table 7: Community-led environmental research, specifically on water quality and fish contamination from mining activities.

| Province/ Territory | Summary | Contact/Reference Links |
|------------------------|---|--|
| NU | <p>Community-based monitoring program for the Baker Lake and Chesterfield Inlet ecosystem and other areas.</p> <p>The Baker Lake and Chesterfield inlet ecosystem is a three-year project (2019-2021) funded by the Nunavut General Monitoring Plan. The project is being implemented by ARCTIConnexion, a community science group. This project focuses on the development of local capacity to monitor water quality and quantity, fish, shipping activities, and the presence of marine and terrestrial wildlife to collect independent and community-owned information that can guide future actions. The communities also perform landscape and watershed analysis with satellite imagery. Local observations and perspectives are documented in the communities through mapping and group discussions.</p> | <p>For more information see: Nunavut General Monitoring Plan https://bit.ly/3v47Xqp ARCTIConnexion https://arcticconnexion.ca/</p> |
| NWT | <p>Tłjchq Aquatic Ecosystem Monitoring Program (TAEMP).</p> <p>The Wek'èezhii Renewable Resources Board (WRRB) is a wildlife co-management authority established by the Tłjcho Agreement. The TAEMP is implemented by the WRRB and has the objective of building and developing a successful community-based monitoring program that meets the needs of the Tłjchq people in determining whether fish, water, and sediment quality are changing, and whether fish and water remain safe to consume. The program started in 2010, with the most recent report produced in 2018.</p> | <p>For more information see: https://www.wrrb.ca/about-wrrb</p> |
| NWT | <p>Understanding and predicting fish mercury levels in the Dehcho region.</p> <p>The focus of this project is to better understand why fish mercury levels are relatively low in some lakes yet not elsewhere, and why fish mercury levels are increasing in some lakes, but stable in others. This study builds on previous work by the University of Waterloo in partnership with the Dehcho First Nations. Fish, water, other small animals, and plants were sampled from eight Dehcho lakes between 2013 and 2015, and it was found that some fish mercury levels can be predicted from water quality measurements and fish age.</p> | <p>For more information see: Swanson & Low, 2017 https://bit.ly/2Te8hWg</p> <p>Online open access Dehcho Region water quality data set (2019) (https://bit.ly/2R6u1To)</p> |

7.3 Ecological research on population changes in Arctic char and other important food species

Arctic char is an important fishery for Nunavut. In 2015, over 72,000 kg of char were caught commercially for a market value of \$1.8 million (Department of Environment, Fisheries and Sealing Division, 2016). The Truly Wild Arctic Char brand and valued-added products such as char candy and char jerky are well known within and outside of Nunavut.

Communities such as Naujaat, Coral Harbour, Igloolik, and Qikiqtarjuaq fish more in the winter, whereas Pond Inlet, Whale Cove, Rankin Inlet and Cambridge Bay fish in the summer months. Most fishing is done using gill nets, but at two rivers in the Cambridge Bay area, fishing is done with weirs. The Kitikmeot communities are the only region to use air transport to move char to the processing plant as fishers in other regions transport their catch to town by snowmobile and qamutik, or by boat (Department of Environment, Fisheries and Sealing Division, 2016). Other examples of community-led projects addressing ecological research on Arctic char population changes are provided in Table 8.

Table 8: Community-led projects addressing ecological research on Arctic char population changes.

| Province/ Territory | Summary | Contact/Reference Links |
|------------------------|--|--|
| NU | <p>Science and Inuit Qaujimaqatugangit join forces to better understand iqalukpiit / Arctic char in the Kitikmeot region. In 2013, a collaborative project between Fisheries and Oceans Canada and the Ocean Tracking Network was initiated to utilize acoustic telemetry to track the migrations of Arctic char (marine and freshwater) in the region. Local youth were trained to conduct semidirected ethnocartographic interviews to document the IQ of nine individuals from the community. In August 2016, a week-long Elder-youth knowledge exchange camp that also included biologists and social scientists was held at Ekalluk River (an archaeological site used for over 4,000 years) to exchange and share knowledge about Arctic char.</p> | <p>For more information see: Thorpe, et al., 2018 https://bit.ly/3gpjHPb</p> |
| NFL, NWT, NU, QU | <p>Linking Inuit and scientific knowledge and observations to better understand Arctic char (<i>Salvelinus alpinus</i>) community monitoring. The research explored community-based monitoring factors and parameters across Inuit Nunangat that is needed to provide information for local resource users and decision-makers to make informed choices for managing Arctic char populations. This research is helpful in that it identifies Arctic char environmental parameters that could be monitored for species and habitat health. What is also interesting about this research is the exploration of different aspects of community-based Arctic char monitoring, including the establishment of the programs, monitoring schedules and parameters, partnerships, funding, inclusion of IQ, and knowledge dissemination.</p> | <p>For more information see: Knopp, 2017 https://bit.ly/359CkB7</p> |
| QU | <p>Community-based monitoring of Arctic char from the Nepihjee river system and other areas. Makivik Corporation is the legal representative of Quebec's Inuit, established in 1978 under the terms of the James Bay and Northern Quebec Agreement. This monitoring program includes direct counting, measuring, and monitoring of Nepihjee River Arctic char to estimate the size of the population, understand size structure and growth over time, and track movement and migration patterns. Recently, the research branch secured \$62,416.25 from the Indigenous Community-Based Climate Monitoring program for 2020-2021.</p> | <p>For more information see: https://bit.ly/3zfScQE</p> |

7.4 Fisheries management interventions

Fisheries and Oceans Canada (DFO) and the Canadian Coast Guard are responsible for fisheries management and the safeguarding of Canadian waters¹². A number of acts support and guide these responsibilities, including the *Oceans Act*, *Fisheries Act*, *Species at Risk Act*, *Coastal Fisheries Protection Act*, *Canada Shipping Act, 2001* (which is led by Transport Canada), and the *Fishing and Recreational Harbours Act*. Other initiatives that fall under DFO, which might be of interest to communities are the Integrated fisheries management plans (IFMP), Aboriginal aquatic resource and oceans management (AAROM) program, and the Sustainable fisheries solutions and retrieval support contribution program, or Ghost gear fund.

The purpose of the IFMPs is to guide the conservation and sustainable use of marine resources, support the management of sustainable fisheries, and combine science and Indigenous knowledge on fish species with industry data to determine best practices for harvest¹³. The IFMP is not a legally binding instrument, cannot form the basis of a legal challenge, can be modified at any time, and does not fetter the Minister's discretionary powers set out in the Fisheries Act. The AAROM Program¹⁴ supports Indigenous groups to establish and maintain aquatic resource and oceans management departments that can provide fisheries, habitat, science, and oceans related services along a watershed.

¹² <https://www.dfo-mpo.gc.ca/about-notre-sujet/mandate-mandat-eng.htm>

¹³ <https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/index-eng.html>

¹⁴ <https://www.dfo-mpo.gc.ca/fisheries-peches/aboriginal-autochtones/aarom-pagrao/index-eng.html>

The program also supports community participation in advisory and co-management processes and decision-making related to aquatic resources and oceans management. The ghost gear fund¹⁵ focuses on actions to reduce plastic in the marine environment through four main areas: 1. ghost gear retrieval, 2. responsible disposal, 3. acquisition and piloting of available technology, and 4. international leadership. Other examples of fisheries management interventions are provided in Table 9.

Table 9: Examples of fisheries management interventions

| Province / Territory | Summary | Contact/Reference Links |
|----------------------|---|---|
| NU | <p>Coastal Restoration Nunavut</p> <p>The communities of Kugluktuk, Taloyoak and Kugaaruk have requested assistance with a community-wide net exchange. All the communities identified the need for strategic fishing methods to support the health and sustainability of the subsistence char fishery, which is mostly fished by gill net. A successful net exchange was first implemented by the community of Kugluktuk in the nineties to prevent high stock exploitation and a potential recruitment failure due to diminished stock size. To conduct a net exchange, fishers exchange old nets with nets of a larger mesh size. One objective of the mesh size approach is to influence the sustainable yield in the long-term. Other reasons are to protect juvenile fish from capture and to ensure that enough fish survive to maturity.</p> | <p>For more information see: https://www.coastalnunavut.ca/ or email crn@dal.ca.</p> |
| NU | <p>Integrated Fishery Management Plan (IFMP) - Cambridge Bay Arctic Char, <i>Salvelinus alpinus</i>, Commercial Fishery, Nunavut</p> <p>The Arctic Char commercial fishery addressed in this plan occurs on Victoria Island, near the community of Cambridge Bay. The IFMP was developed to be relevant over a long period of time and has no fixed end date. Through regular reviews by the IFMP Working Group and stakeholders, updates and amendments will be provided to the NWMB and Minister of Fisheries and Oceans for approval, as required. The IFMP was made effective in 2014, with a 2021 review currently underway. Examples of best practices that are currently in place in the commercial fishery focus on the reduction of any potential impact to spawning populations. These include measures such as the release of spawners if captured in the gillnet fishery if still alive, all spawning char released in a manner that causes them the least harm, and when encountered in a weir fishery, all spawners should be released unharmed.</p> | <p>For more information see: https://bit.ly/3g6GgsY</p> |
| NWT | <p>Paulatuk Char Fisheries Management Plan</p> <p>The Paulatuk Char Working Group (PCWG) was formed in 1996 with the goal to establish a community fishing plan for Arctic char from the Hornaday River population. The community was concerned about the numbers and size of Arctic char and saw the need for a fisheries management plan. Voluntary community-based harvest surveys were conducted to enumerate fish and marine mammal subsistence harvests. These measures continue to support sustainable management of Arctic char populations in the area.</p> | <p>For more information see: Lee, 2020: https://bit.ly/3w6Zc0h Paulatuk community conservation plan: https://bit.ly/3pBzj63</p> |

¹⁵ <https://www.dfo-mpo.gc.ca/fisheries-peches/management-gestion/ghostgear-equipementfantome/programme/projects-projets-eng.html>

| Province / Territory | Summary | Contact/Reference Links |
|----------------------|--|---|
| AB | <p>Native Trout Recovery Program</p> <p>Alberta's Native Trout Recovery Program is a comprehensive, long-term fish conservation initiative aimed at monitoring and recovering populations of native trout and whitefish in the watersheds of the Eastern Slopes. The Native Recovery Program's focus is to recover the species through understanding the threats to its survival, through co-ordinated action, and through the support of stakeholders, the public, and multiple levels of government. As a component of the integrated provincial fisheries management approach, the recovery program focuses on Westslope cutthroat trout, bull trout and Athabasca rainbow trout recovery planning processes; a watercourse crossings remediation program; and Whirling disease and invasive species management.</p> | <p>For more information see: https://bit.ly/2Spdhax</p> |

7.5 Cleanup of contaminated sites.

Waste management at the community level usually addresses municipal solid waste, referred to as “recyclables and compostable materials, and includes garbage from homes, businesses, institutions, and construction and demolition sites” (Environment & Climate Change Canada, 2017). The Government of Canada also defines a contaminated site as “one at which substances (usually a petroleum product or a metal) occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long-term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations” (Treasury Board of Canada Secretariat, n.d.). Based on the responses from the knowledge holders, the focus of this section will be mainly on waste management for debris and garbage. Examples of regulations that are relevant to this issue include: the Canadian Environmental Protection Act, the Transportation of Dangerous Goods Act, the Fisheries Act, the Arctic Waters Pollution Prevention Act, the National Fire Code, and the Explosives Act. Provincial and territorial governments each have their own legislation and regulations relating to environmental protection, water resources, municipalities, public health, and sanitation (Oceans North, 2021; Song, 2016).

Nunavut does not have legislation that pertains directly to solid waste management, nor is there a specific strategy for solid waste management (Oceans North, 2021). However, several regulations provide guidance on waste management (Song, 2016). These include: The Nunavut Agreement that establishes the Nunavut Water Board; Nunavut Waters and Nunavut Surface Rights Tribunal Act, SC 2020c10 (use of water and disposal of waste in waters in Nunavut); Arctic Water Pollution Prevention Act, RSC 1985cA-12 (deposit of waste in Arctic waters); Fisheries Act, RSC 1985, cF-14 (activities harmful to fish, disposal of prejudicial/deleterious substances in waters where fishing is conducted); Environmental Protection Act, RSNWT 1988, c E-7, s.5 (discharge of contaminant into the environment); General Sanitation Regulations R.R.N.W.T 1990, c. P-16 Public Health Act (insanitary conditions, accumulation and deposit of garbage, municipalities responsibilities); and various environment guidelines issued by the Nunavut Department of Environment pertaining to the disposal of various types of waste (Song, 2016).

In 2014, a fire, dubbed Dumpcano, engulfed the 150 m² dump. The fire lasted for four months and cost the city \$3 million to extinguish. It also created up to 2000°C of heat and released chemicals into the air, resulting in health warnings and the closure of schools for several days (WWF, 2020). In July 2018, the city announced a new waste management plan that involves closing the old site and creating a new waste transfer station that aims to reduce landfill waste by 44 per cent through recycling of tires and scrap metal, among other waste diversion initiatives (Oceans North, 2021). In 2021, Iqaluit began constructing a new landfill, with additional plans to develop a recycling and eco-centre and alternative collection methods for residential, commercial, and industrial waste (WWF, 2020).

Other examples of reports, guidelines, and programs addressing solid waste management are provided in Table 10.

Table 10: Examples of reports, guidelines and programs addressing solid waste management.

| Province/ Territory | Summary | Contact/Reference Links |
|------------------------|--|---|
| National | <p>The Great Canadian Shoreline Cleanup presented by Loblaw Companies Limited, and Coca-Cola Canada is one of the largest direct action conservation programs in Canada. Netsilik School (Taloyoak, Nunavut) has been organising clean-ups since the early 90's. In 2016, Taloyoak was one of the top 5 clean-up communities with the largest number of knowledge holders. The organiser of the event noted that "Avatittinnik kamatsiarniq" or "environmental stewardship" is a key value of Inuit Qaujimatugangit (IQ) and it is important that the youth realize from a young age that they need to carry on the tradition of looking after the land, water and air for generations of humans and animals to come.</p> | <p>For more information see: www.ShorelineCleanup.ca Netsilik School story: https://bit.ly/3w8OohV</p> |
| NU | <p>Coastal Restoration Nunavut</p> | <p>https://www.coastalnunavut.ca/ or email crn@dal.ca.</p> |
| QU | <p>Practical guide for the dismantlement, clean-up, and remediation of outfitting camps on the JBNQA/NEQA territory. The Kativik Regional Government, northern Quebec (2019) has produced a practical guide for the dismantlement, clean-up, and remediation (DCUR) of outfitting camps in the James Bay and Northern Québec Agreement territory. These guidelines focus on safely and effectively conducting DCUR activities, in accordance with applicable laws, regulations, funding agreements and contracts, reducing threats to ecosystem and human health, treating contaminated areas, removing debris and hazardous materials, and transferring knowledge through the participation of Nations and their communities.</p> | <p>For more information see: https://bit.ly/3gottRk</p> |
| NFL, NWT, NU, QU | <p>Towards a Waste-Free Arctic: This report provides an overview of waste management in Inuit Nunangat (Inuvialuit Settlement Region - NWT, Nunavut, Nunavik - northern Quebec, and Nunatsiavut - northern Labrador). Highlights of the report note that although Inuit communities do not accumulate more waste than communities in other parts of Canada, they are faced with managing similar quantities of waste with inferior infrastructure, limited services and programming, extremely poor access to eco-alternatives and fewer economic, educational, and capacity resources to develop lasting solutions. The report provides recommendations for how the private sector, civil society and all levels of government can address these issues.</p> | <p>For more information see: Oceans North (2021) https://bit.ly/2SoJsXD</p> |
| NU, NWT, YT | <p>Solid waste management for northern and remote communities: planning and technical guidance document. Focusing on managing residual waste in a landfill cell within the community's solid waste facility, the guidelines provide a four-step continuous approach to waste management planning: 1. Conduct a community waste assessment; 2. Set waste management priorities for the community; 3. Identify and evaluate options, and develop a plan; and 4. Implement, evaluate, and improve the plan.</p> | <p>For more information see Environment and Climate Change Canada (2017). https://bit.ly/3pAg8JW</p> |

8.0 Summary.

Drawing from the literature review and community field and workshop notes from the six communities, this section summarizes the main findings in the context of the projects research focus:

- Coastal areas, if any, that show historical or potential signs of degradation and/or contamination
- Impacts on social, economic, and cultural activities and practices from changes to the coastal environments
- Community coastal restoration priorities and needs, and
- Approaches to address these priorities and needs

8.1 Coastal areas that show historical or potential signs of degradation and/or contamination

From the perspective of the knowledge holders in Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, and Whale Cove the major coastal issue identified related to changes in species populations and health. Other priorities focused on decreasing water levels, and increased erosion (Figure 5). Figure 6 shows the extent and type of spatial observation in these six communities.

The main ecological changes in the literature focused on species (birds, fish, seals, walrus, whale, and polar bear) population numbers and health. Community members also prioritized changes in population numbers and species behavior, with fish and whale species being of key concern due to the negative impact reduced numbers have on food security, sovereignty, and cultural activities and practices. In this context, food security is when all people, always have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences to lead a healthy and active life (FAO, 2006). NGOs and Civil Society Organizations have expanded this concept to food sovereignty and refer to the six pillars of food sovereignty¹⁶ (e.g., Food Secure Canada, 2012). Here food security is the goal, whereas food sovereignty is the approach used to reach the goal (Food Secure Canada, 2012).

The literature and the workshops both noted changes in size, health, and quality of the meat, specifically for Arctic char as a key issue. One difference in the literature relates to polar bears, which were described as increasing and concerns had been raised by community members in relation to safety and restricted time on the land. From the community workshops this did not seem to be a priority issue, but this might have occurred because the workshop topics was primarily on coastal area species and restoration needs.

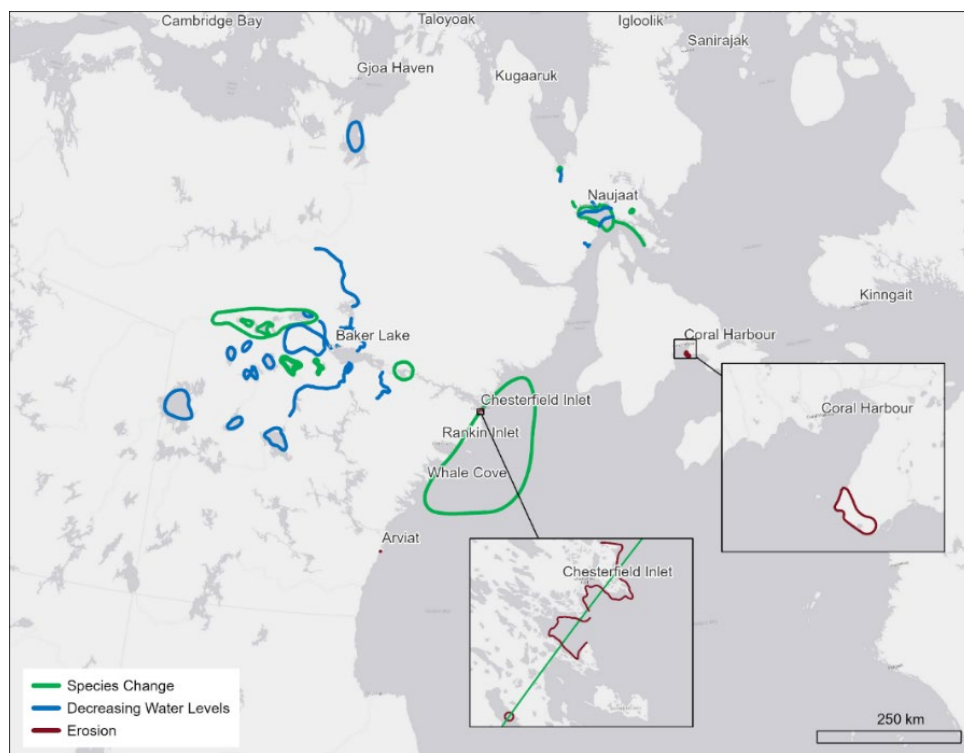


Figure 5: Kivalliq region coastal areas showing historical or potential signs of degradation and/or contamination, thought to have led to changes in species populations and health, decreasing water levels, increased erosion, and ice changes.

¹⁶ <https://foodsecurecanada.org/who-we-are/what-food-sovereignty>

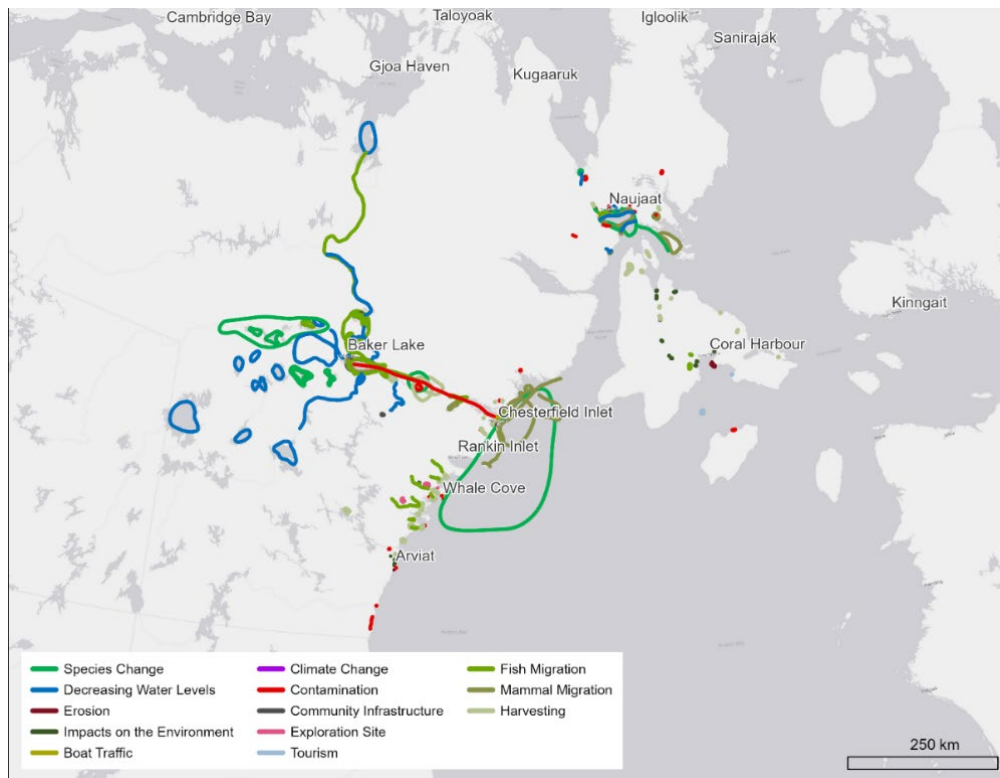


Figure 6: Representation of the extent and type of spatial observations in these six communities within the Kivalliq region.

8.2 Impacts on social, economic, and cultural activities and practices from changes to the coastal environments

Impacts on social, economic, and cultural activities and practices from environmental and ecological changes, as noted in the literature related to (a) food sources, (b) capacity to travel and access harvesting sites, (c) community health, potentially linked to the quality and health of the animals, and (d) the ability to maintain cultural practises (intergenerational learning). The impacts on social, economic, and cultural activities noted by community knowledge holders also reflected those identified in the literature. Environmental and ecological changes had impacts on (a) food sources, and (b) access to fishing and harvesting areas. A third factor identified was the impact of increased shipping and marine traffic on marine mammal migratory routes and harvesting areas. These impacts and concerns have also been documented in the Arctic Corridors and Northern Voices project reports for Arviat (Carter et al., 2017) and Coral Harbour (Carter et al., 2019).

Seasonal changes, unpredictable weather patterns and changes in ice thickness/shorter seasons has impacts on community travel, access to hunting and harvesting areas, and safety. Environmental changes can also influence the presence and/or migratory routes of different species, including important prey species, which in turn has the potential to disrupt larger food chains. Environmental impacts may also increase and/or create coastal erosion and infrastructure issues, further impacting the migratory routes of species such as Arctic char and their habitats. Issues relating to the lowering of freshwater levels are noted in both the literature and community workshops and are linked to impacts on species (disruptions to migratory routes) and community access (navigation) to fishing and harvesting sites. Communities are also concerned about the impact increased shipping and marine traffic will have on marine animals (abundance, habitats, migratory routes), the surrounding environment, and their ability to respond to an oil spill or initiate search and resecure operations due to existing capacity and training.

8.3 Community coastal restoration priorities.

Contamination from the Agnico Eagle Meadowbank gold mine and the impacts this has on the environment and food sources is a key concern for Baker Lake residents. This has been an ongoing issue since the mine opened in 2010.

Monitoring of ecological resources and fisheries development studies were priorities identified by more than one community (Arviat, Baker Lake, Chesterfield Inlet, and Whale Cove). Coastal restoration through river enhancements of areas along the Canyon river that have been impacted by permafrost slumps was an important priority for Coral Harbour residents. This issue was also mentioned during the community workshop.

During the community workshops, knowledge holders noted the restoration of key fishing areas as a priority for Arviat, Coral Harbour, and Whale Cove. In Arviat the rehabilitation of shallow rivers was an identified need, whereas in Coral Harbour, community members are working to remove a rockslide on Canyon river, and monitor/resolve the issue of a road crossing that was blocking important fish migration routes. Environmental research and monitoring studies were needed in Coral Harbour (water level monitoring for tides and major lakes with commercial fisheries or char spawning) and ecological research studies and programs to monitor shipping lanes and impacts on marine mammals were identified priorities for Coral Harbour and Chesterfield Inlet. In Arviat, the cleanup of a contaminated site (removal of a sunken bombardier) was noted by community knowledge holders, whereas infrastructure development was requested in Arviat (replacement of community bridges and Chesterfield Inlet (building of a deep seaport).

In addition to the priorities noted above there were also specific site related requests. The Baker Lake community requires the cleanup of contamination from sewage in the lake. They are also requesting environmental studies and monitoring programs for areas between Baker Lake and Chesterfield Inlet, as hunters have noticed a decrease in marine animals and believe this is because of contamination from the Agnico Eagle Meadowbank mine. In Naujaat, environmental research and monitoring is being requested as residents are concerned about the ongoing quality of the main local drinking supply, and the potential impact of a diamond mine, which could be located close to the town. In Whale Cove, fisheries management interventions are being requested to restock char that had been overfished by the Hudson Bay Company, and to address issues at a specific site which was being overfished by another community.

8.4 Approaches to address community priorities and needs

The brief overview of regulations and policies (section 7.0) reveals the siloed governance approach to addressing the priorities identified by the communities. However, from an applied perspective, most if not all projects and programs reviewed in section 7.0 included an Inuit-centered approach and a coming together of IQ and Western science knowledge. On a positive note, though, a few policies and regulations are slowly shifting towards a similar approach as seen in the development of the integrated fisheries management plans and waste management guidelines.

Several strong initiatives in Nunavut are noted that could be replicated and/or built upon in different communities. For example, the coastal restoration projects being conducted by Clyde River and Coral Harbour communities (CRN projects), community-based monitoring programs being implemented in the Baker Lake and Chesterfield Inlet communities, led by ARCTIConnexion, and best practices that have emerged from the Integrated Fishery Management Plan (IFMP) for Arctic char, in Cambridge Bay. National studies such as the “Linking Inuit and scientific knowledge and observations to better understand Arctic char (*Salvelinus alpinus*) community monitoring project (QU, NU, NWT, NFL) and the “Towards a Waste-Free Arctic” study (NU, NWT, YT) provide opportunities to compare findings and learn from experiences in communities across different provinces and territories. Moving forward, it will be important to share these examples with other communities, learn from the implementation of these initiatives, and further build on our current knowledge base.

9.0 Conclusion.

This technical report presents the findings of the CRN team visits to six communities (Arviat, Baker Lake, Chesterfield Inlet, Coral Harbour, Naujaat, and Whale Cove) of the seven communities in the Kivalliq region. During these workshops, knowledge holders shared their knowledge and experience on topics relating to, environmental and ecological changes, impacts on their social, economic, and cultural activities and practices, coastal restoration priorities and needs, and approaches to address these priorities and needs.

The most noted environmental and ecological changes, and hence the top coastal restoration priorities, were related to species population abundance and health, decreasing water levels, and increased erosion. Increased shipping and marine traffic were also noted as a key concern due to the current and future impacts on marine animals. Environmental

and ecological changes have had impacts on social, economic, and cultural practices, especially those relating to food security (and food sovereignty), community travel and navigation, and intergenerational learning.

From a coastal restoration perspective, the priorities and actions needed to address these changes and potentially mitigate these impacts, are as follows:

- a) Restoration of key fishing areas (Arviat, Coral Harbour, and Whale Cove)
- b) Environmental research and monitoring (Baker Lake, Coral Harbour, Naujaat)
- c) Ecological research and monitoring (Chesterfield Inlet, Coral Harbour, Naujaat)
- d) Fisheries management interventions (Coral Harbour and Whale Cove)
- e) Cleanup of contaminated sites (Arviat and Baker Lake)

A brief review of the literature has identified several strong coastal restoration initiatives from Nunavut and other provinces and territories that could be further explored and adapted as needed. Although policies and regulations tend to be siloed, many of the applied projects and program include an Inuit-centered approach that uses both IQ and western science.

The CRN team would like to sincerely thank all the knowledge holders who very generously shared their time, experiences, and knowledge.

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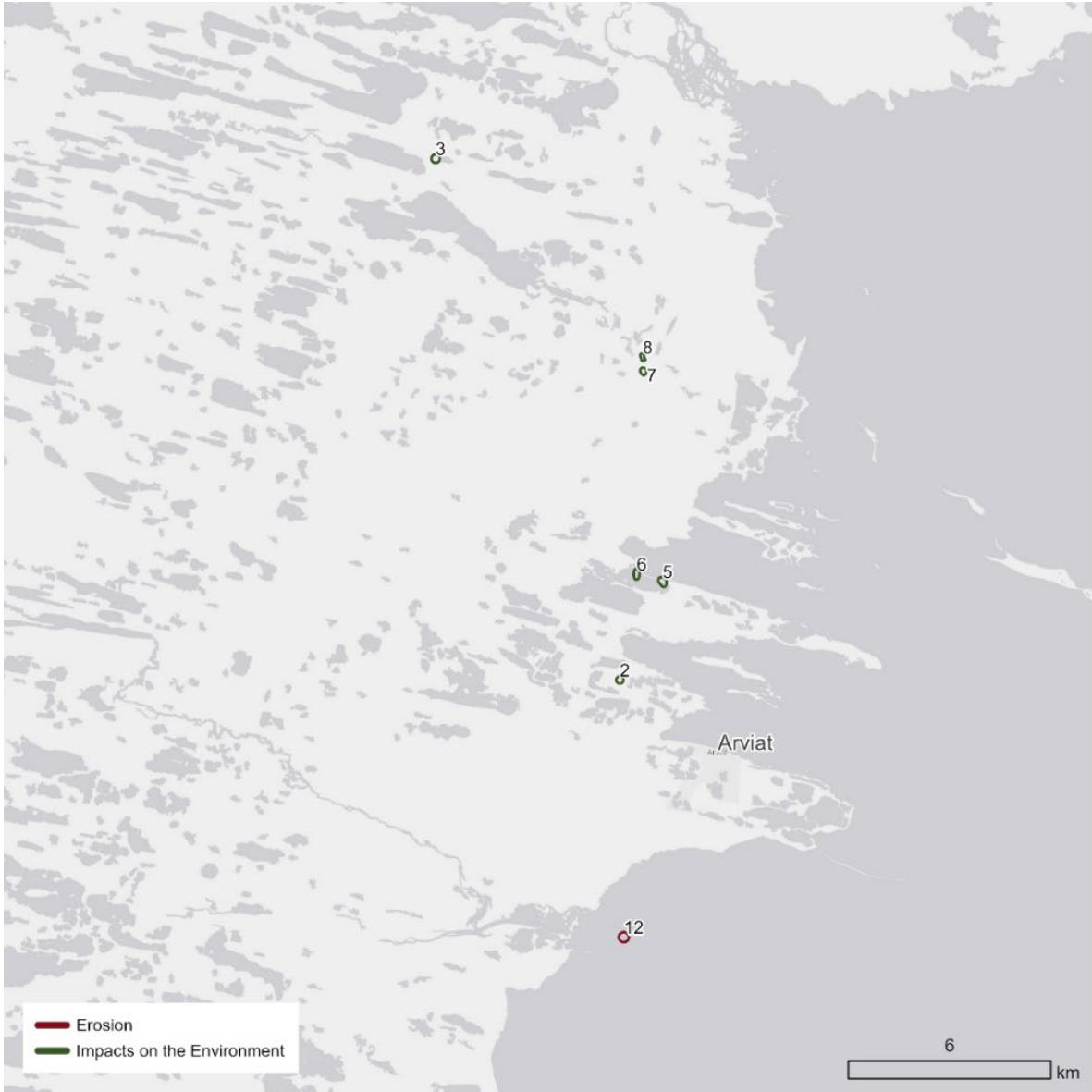
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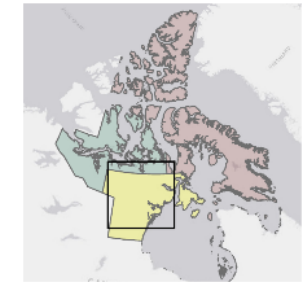
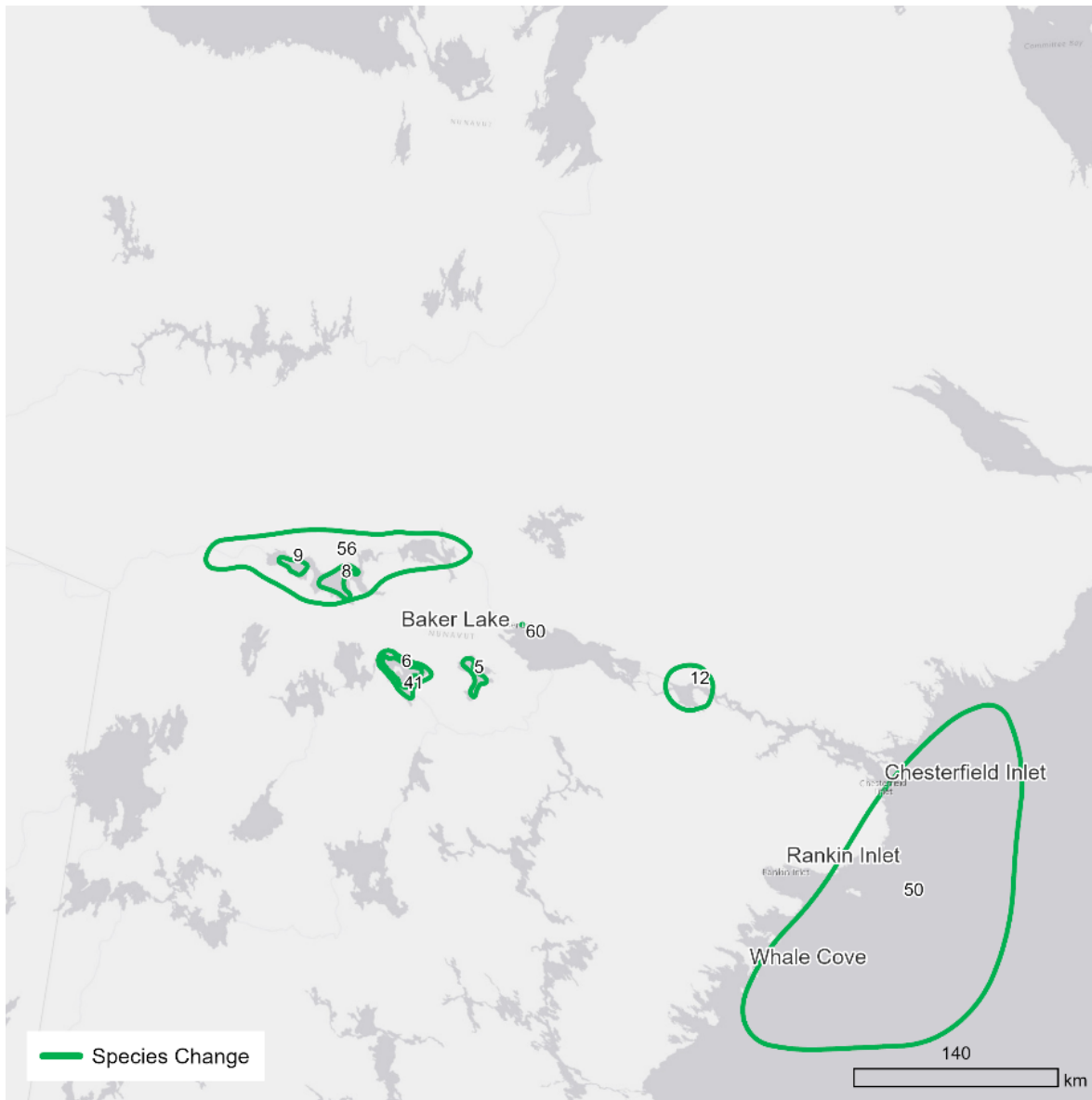
Appendix 1: Community observations of environmental and ecological change

These maps show community-specific observations of the most frequently noted factors contributing to environmental and ecological coastal change. These maps represent what was recorded by participating individuals, and do not reflect the full extent of potential coastal change in the region.

Figure 2a: Arviat



- 2 Road crossing, bridge washout
- 3 Road crossing, bridge undersized
- 5 Road crossing, culvert washout
- 6 Road crossing, culvert washout
- 7 Road crossing, bridge washout
- 8 Road crossing, bridge washout
- 12 Old arctic char location, now too shallow. Old traps can still be found



- 5 Unknown fish species since 2014 (pike)
- 6 Unknown fish species since 2014 (pike)
- 8 Unknown fish species since 2014 (pike)
- 9 Unknown fish species since 2014 (pike)
- 12 Crabbing area since 1965, but decreasing since mother ship traffic increasing (late 1960s onwards)
- 41 Sick fish, big heads with small bodies
- 50 Arctic char from Hudson Bay area very skinny now, maybe from increased marine traffic
- 56 New species (ivitaroq; the fish that watches you); like char but longer and skinnier
- 60 Used to be char but now gone

Figure 2a: Baker Lake 1

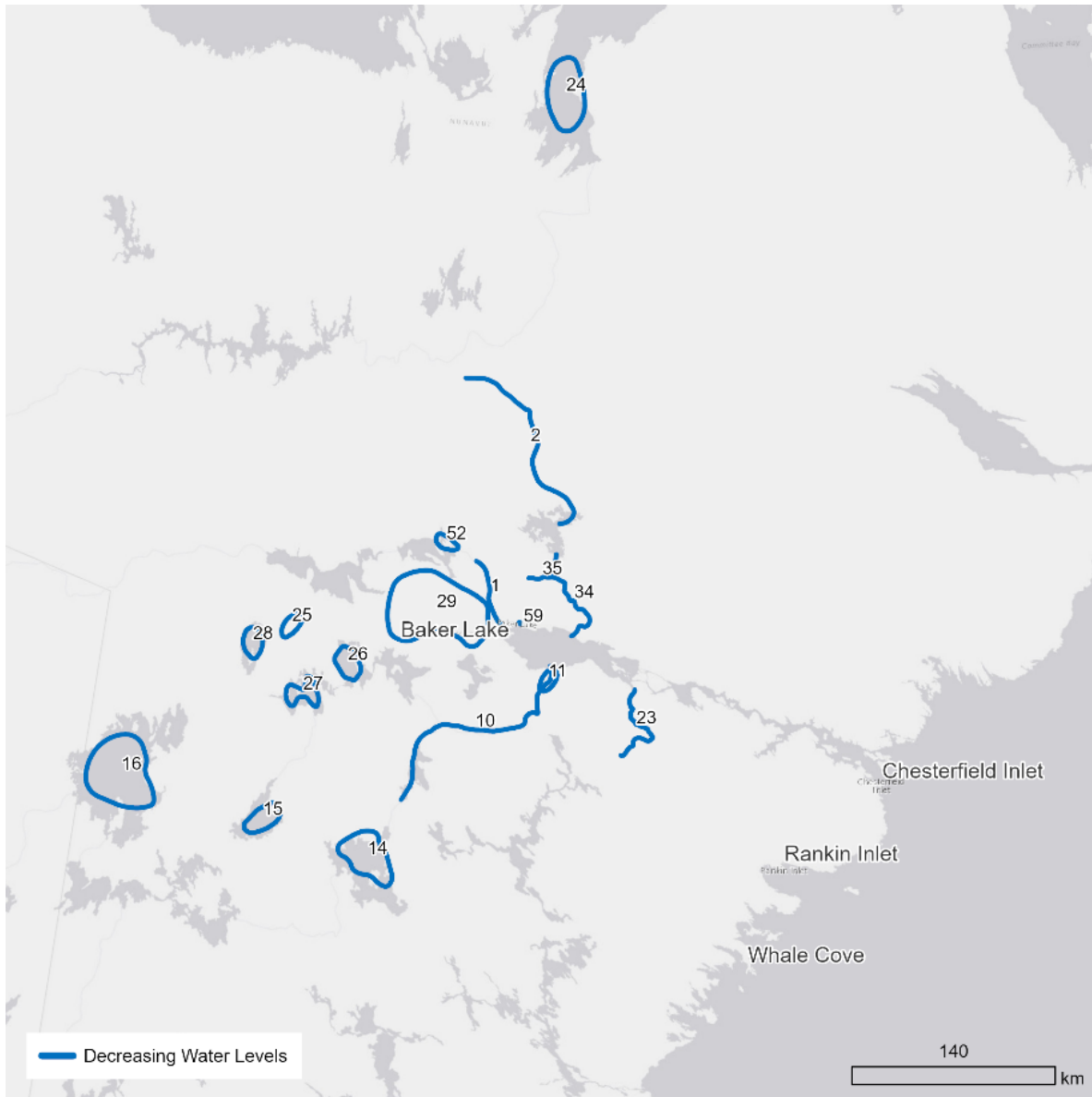
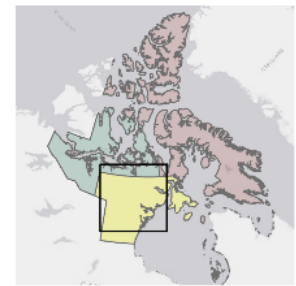
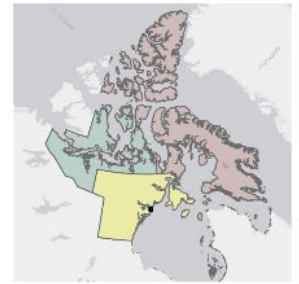
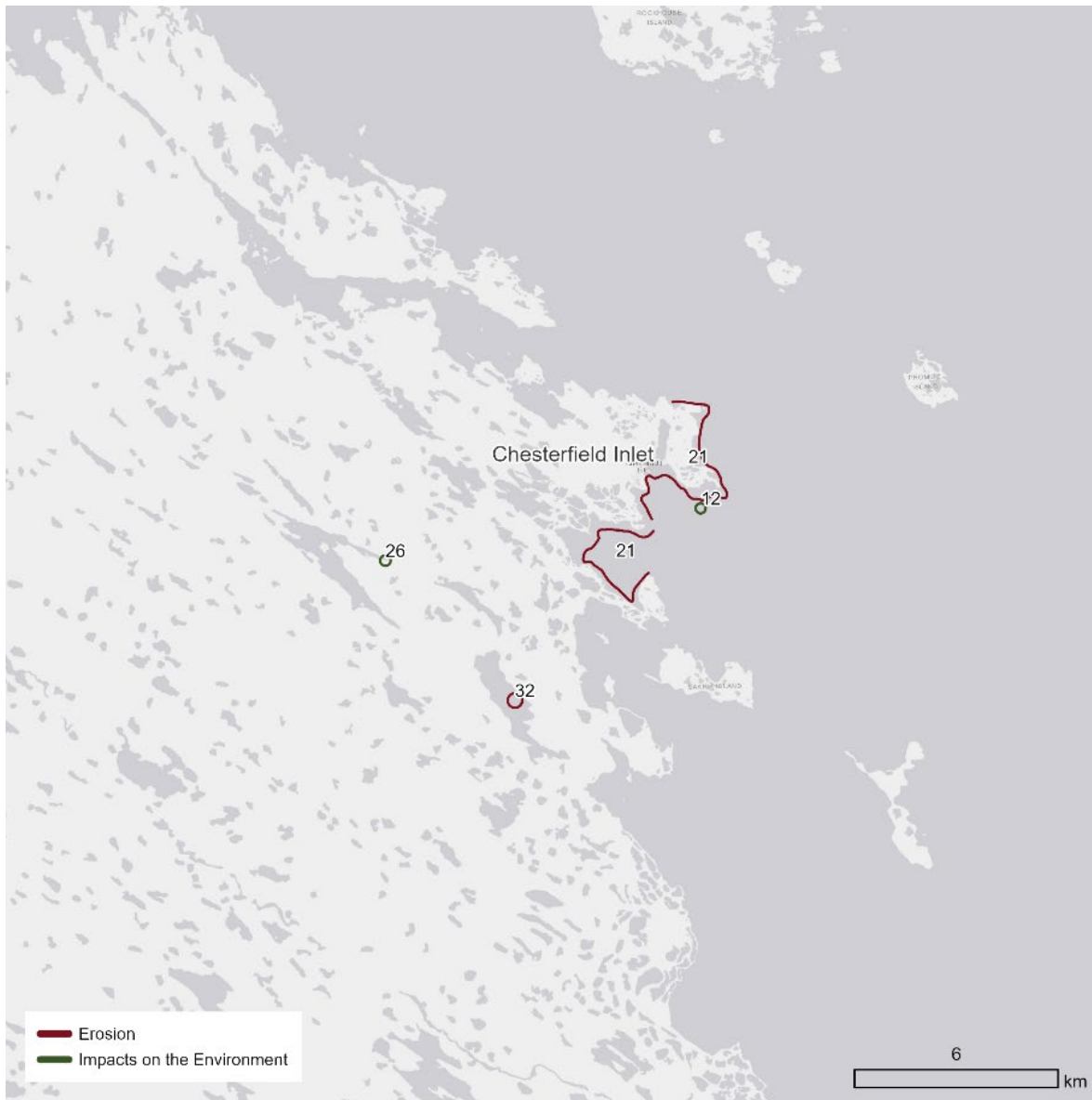


Figure 2b: Baker Lake 2

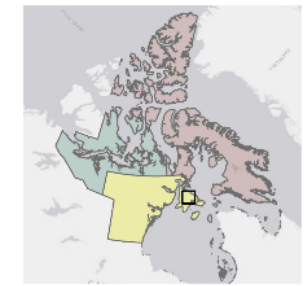
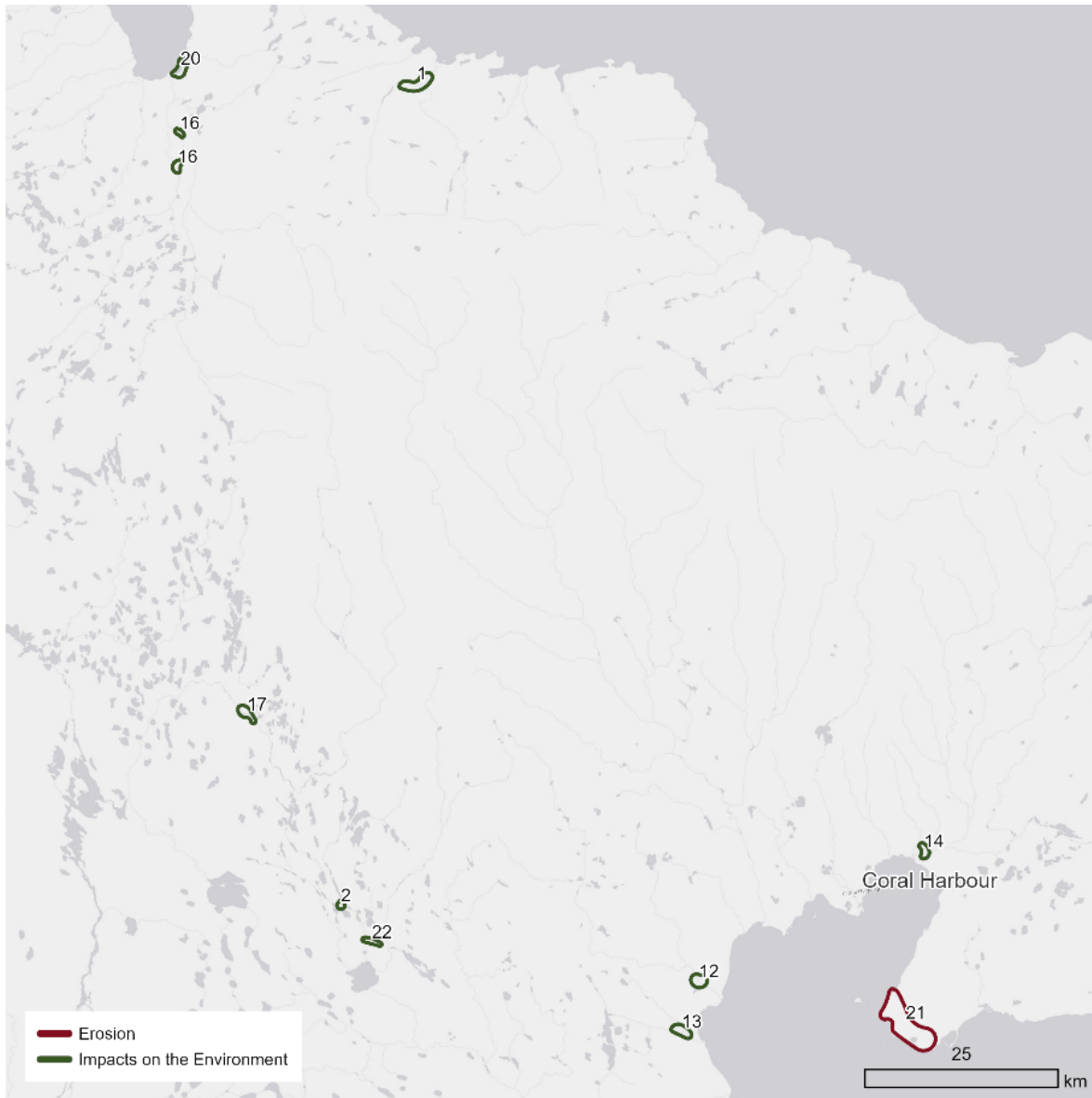


- 1 Too shallow, can't navigate by boat anymore
- 2 Water levels decreasing, so fish moving to deeper waters
- 10 Can still navigate by boat
- 11 Water levels decreasing every year, land is rising
- 14 Fish leaving lakes but not returning as water becomes shallower
- 15 Fish leaving lakes but not returning as water becomes shallower
- 16 Fish leaving lakes but not returning as water becomes shallower
- 23 Water drying up
- 24 Becoming land only as water completely dries up
- 25 Becoming land only as water completely dries up
- 26 Becoming land only as water completely dries up
- 27 Becoming land only as water completely dries up
- 28 Becoming land only as water completely dries up
- 29 Rivers, lakes drying up; char not returning
- 34 Rivers from mine, but drying up
- 35 Rivers from mine, but drying up
- 52 Glacier disappeared between 2005-2007
- 59 Water levels low because of lagoon



- 12 Sock washout with armour rock slipping
- 21 Excess seaweed with bad smell
- 21 Excess seaweed with bad smell
- 26 Old washed out culverts, hamlet trying to build new bridge
- 32 Very muddy as of 2-3 years ago, increased sedimentation

Figure 2c: Chesterfield Inlet



- 1 Blockage from rockfall
- 2 Pinch point, shallow area over the last 5-6 years, fishing still good in the area, road crossing
- 12 Metal structures rusting out, river mouth has changed
- 13 Road Crossing
- 14 Road Crossing
- 16 Road Crossing
- 16 Road Crossing
- 17 Old road, gravel filling and shallow water
- 20 Plane debris, potential fuel contamination
- 21 Grasses lost, bird habitat
- 22 Road

Figure 2d: Coral Harbour

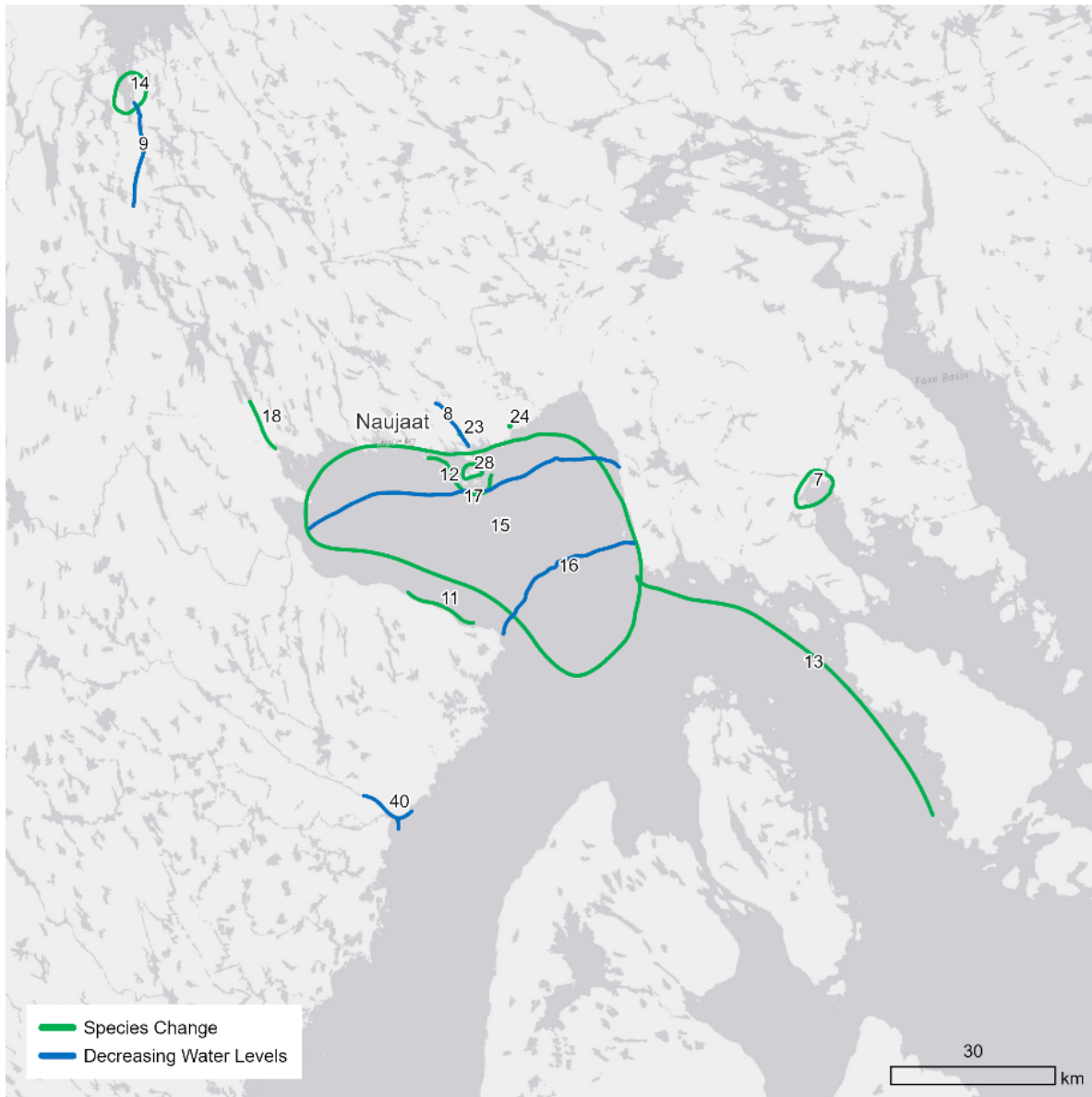
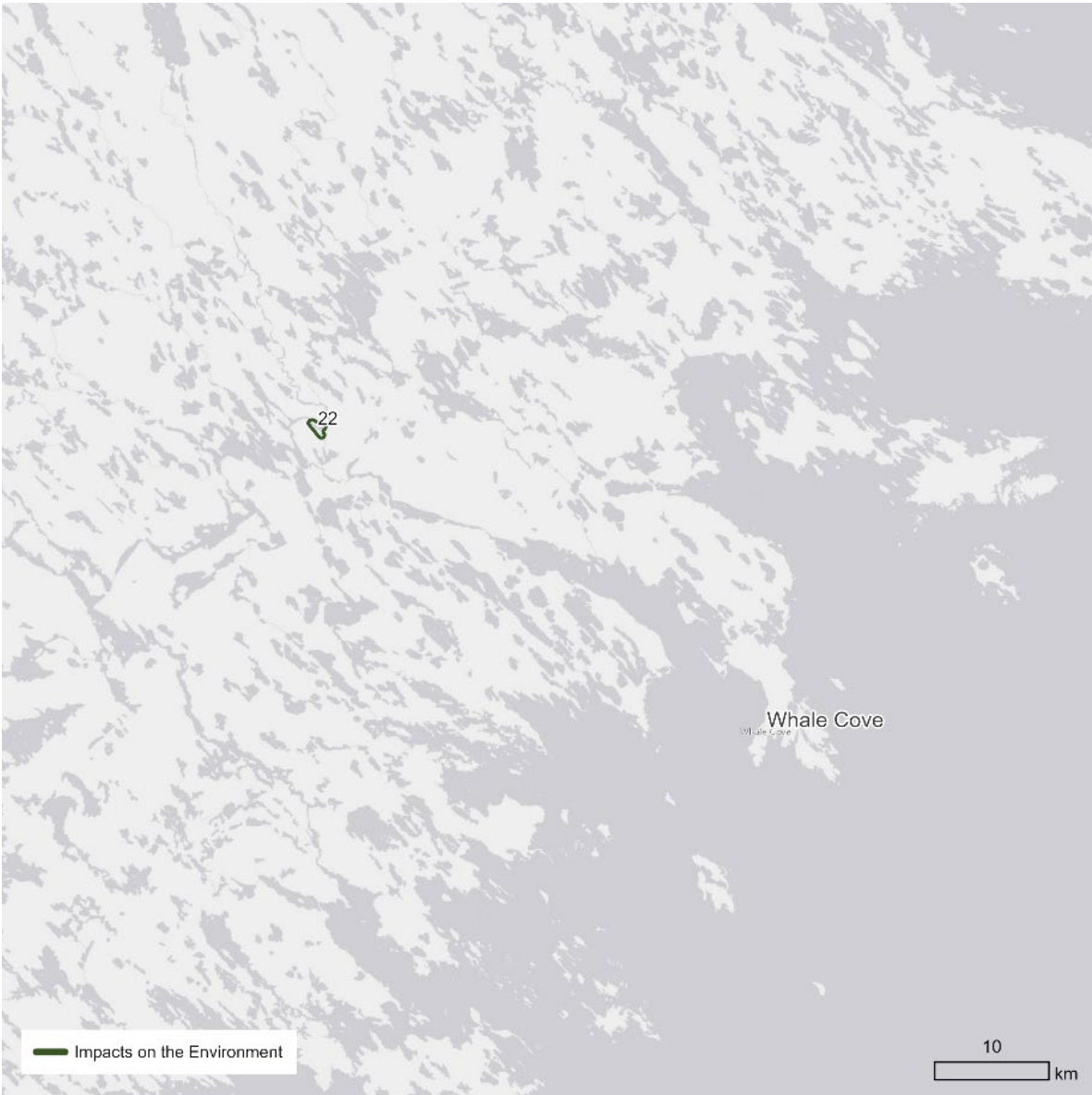


Figure 2e: Naujaat



- 7 Monitoring of marine species desired (health, abundance, migration patterns)
- 8 River drying up, too shallow for fish migrating upstream
- 9 River drying up
- 11 2017: acoustic boxes dropped by non-resident, disturbing and scaring away marine mammals
- 12 2017: acoustic boxes dropped by non-resident, disturbing and scaring away marine mammals
- 13 2017: acoustic boxes dropped by non-resident, disturbing and scaring away marine mammals
- 14 Char quality not as good anymore, reason unknown
- 15 Declining seal populations in the bay due to increased marine and air traffic
- 16 Floe edge form December/ early January until late July (early 2000s)
- 17 Floe edge form December/ early January until late July (early 2000s)
- 18 More char recently in North Pole River
- 23 Abundant char, numbers increasing
- 24 Abundant char, numbers increasing
- 28 Key hunting site
- 40 Abandoned oil barrels (1950s) but cleaned up in 1980s (30-40 jerry cans)



22 High traffic river crossing

Figure 2f: Whale Cove

Appendix 2: Examples of projects funded under the Oceans Protection Plan.

| Location | Project title and details | Lead agency | Aim | Activities | Website/references examples |
|--------------------------|---|---------------------------------------|---|--|---|
| Nunavut, Kugluktuk | Restoration of anadromous Arctic char (<i>Salvelinus alpinus</i>) and Dolly Varden (<i>Salvelinus malma malma</i>) near Kugluktuk. Time frame: 5 years. Fund allocation: \$1,261,890 | University of Waterloo, Heidi Swanson | To identify migratory patterns and overwintering habitats used by Arctic char and/or Dolly Varden in the Coppermine and adjacent river systems. It will also develop restoration plans for 1-2 high-priority streams which support these species fisheries and are subject to low-flow events and fish stranding. | <ol style="list-style-type: none"> 1. Fish tagging 2. Placement of acoustic telemetry receivers 3. Water samples 4. Collection of otoliths 5. Collection of fin clips | Nunavut impact review board (https://bit.ly/3b3fzSW) CBC news article: https://bit.ly/2QN4uPa |
| Hudson Bay and James Bay | Hudson Bay and James Bay strategic planning for coastal habitat restoration Time frame: 2 years Fund allocation: \$220,000 | Arctic Eider Society | The goal of this project is to work through the collaborative framework of the Hudson Bay Consortium to coordinate on identifying restoration priorities and planning for coastal ecosystems in the Greater Hudson Bay and James Bay region | Activities between 2017-2020 <ul style="list-style-type: none"> • Forums, working groups, identified priority areas, and actions. | Project site: https://hudsonbayconsortium.com/ HBC – 2020 progress report (https://bit.ly/33fVwMN) Focus is on coastal restoration, stewardship, research, and monitoring. |
| Nunavut | Assessment of the current state of coastal restoration needs across Nunavut. Time frame: 5 years Fund allocation: \$2,129,522 | Dalhousie University Lucia Fanning | This project will conduct community consultations and feasibility studies to identify and mitigate the stressors impacting aquatic species in each of Nunavut's 25 communities. | It will be followed by working with Nunavut communities to develop coastal restoration plans on a case-by-case basis. At least 3 restoration projects will be implemented over the 5-year funding period. | Project site: https://www.coastalnunavut.ca/ |
| Nunavut | Addressing existing migratory barriers that increase stress on culturally and economically important Arctic char populations in the Kivalliq Region. Time frame: 3 years Fund allocation: \$420,000 | Kivalliq Inuit Association | Aim to address existing migratory barriers that increase stress on culturally and economically important Arctic char populations in the Kivalliq Region. | | News article https://bit.ly/3eN4CG0 |

Appendix 3 cont.: Relevant Projects funded under the Oceans Protection Plan.

| Location | Project title and details | Lead agency | Aim | Activities | Website/references examples |
|---------------------------------|--|--|--|--|---|
| Northwest Territories and Yukon | The Inuvut, Inikputlu Project Time frame: 3 years Fund allocation \$680,000 | Dalhousie University Claudio Aporta | To conduct community consultations and feasibility studies to identify: important aquatic species for local communities within the Inuvialuit Settlement Region; the stressors impacting each of these aquatic species; culturally important coastal areas impacted by environmental degradation; and potential mitigation strategies for each of the communities. | Uses an approach to coastal restoration that focuses on the relationships that connect people with their environment rather than on discrete and biophysical spaces that have typically been the focus of coastal restoration projects. | Project site: https://inuvutinikputlu.ca/ |
| Newfoundland and Labrador | Riverbank restoration Miawpukek First Nation Time frame: 2 years Fund allocation: \$404,100 | Mi'kmaq Alsumk Mowimsikik Koqoey Association | Restoration of riverbank and stabilization of embankment toe on the Conne River | The area has been severely eroded by extreme weather conditions and a lack of total ice cover in winter. The work will help prevent sediment, tree roots and debris from previous development activities from falling into the water. The project will benefit Atlantic salmon as the area is a known migration route for the species. | News article: https://bit.ly/3b4CcGx |
| Newfoundland and Labrador | Stewarding coastal habitats monitoring and restoration for priority species Time frame: 5 years Fund allocation: \$3,789,720 | WWF-Canada | Its goal is to identify data gaps on coastal habitats for priority species, particularly capelin, but including salmon, trout, and char. | The project will build on the momentum of a successful restoration of capelin habitat at Ship Cove, NL by the WWF. | Nunatukavut site https://bit.ly/3eIXWjr News article https://bit.ly/3uqiooM |
| Northwest Territories | Beaufort Sea coastal restoration: Using native plant species to stabilize coastline affected by permafrost thaw slumping. Time frame: 5 years Fund allocation: \$410,000 | Aurora College Aurora Research Institute Erika Hille | This project will examine the effects of thaw slumping on the nearshore waters of the Beaufort Sea coast, with a focus on the region of Kugmallit Bay. It will use this research to create a plan to mitigate these effects using native plant species. | The Aurora Research Institute will work closely with the community of Tuktoyaktuk and the Tuktoyaktuk Hunters and Trappers Committee, who play a pivotal role in the study design. Local Indigenous knowledge will be used to identify study sites close to significant fishing locations. | Project site: https://bit.ly/3teLNRg CBC news article https://bit.ly/3un1RSr |