Traditional Ecological Knowledge and Local Observations of Capelin (*Mallotus villosus*) in Darnley Bay, NT

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ABSTRACT

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Capelin are an important fish species in marine habitats because they serve as a prey source for marine mammals, predatory fish, and sea birds in sub-Arctic waters and in parts of the Arctic. In the Beaufort Sea, Capelin are less abundant than in southern waters and have been observed at a limited number of locations, primarily outside of the Mackenzie River Delta. However, warming temperatures and reduction of sea ice are expected to facilitate an increase in presence and abundance of Capelin in the Canadian Arctic. By observing specific locations that have supported multiple spawning events, we can better understand the reproductive ecology of Capelin in a warming Arctic and how their interactions with other species may change in the future. There are few reports in the scientific literature of Capelin in the Canadian Arctic. Recent observations and knowledge of aquatic biota over the long-term, however, are acquired by Indigenous peoples and are usually achieved and transferred orally across generations. This traditional ecological knowledge (TEK) provides a valuable information source that has been minimally documented for Capelin. Additionally, local observations of this species in recent years provide valuable information which can be used to identify ecological change. Capelin have been observed spawning in Darnley Bay, NT for multiple years by community members of Paulatuk, Northwest Territories (NT). The objective of this study is to document historic observations of Capelin made by the community members of Paulatuk and determine: 1) How long capelin have been observed in Darnley Bay; 2) Where in the bay they have been observed; 3) If capelin are present in the diet of subsistence species (i.e., Arctic Char); and, 4) If Capelin were ever harvested for consumption. Environmental information, spawning characteristics, and food web interactions gathered from TEK will extend the current understanding of this species' ecology and is a tangible example of how local and traditional knowledge can be used to establish baseline distribution and ecology of species in remote locations. Together, TEK and increased scientific knowledge will increase understanding of Capelin biology and allow for predicting shifts in food web dynamics as climate changes.

RÉSUMÉ

McNicholl, D.G., Wolki, B., and Ostertag, S. 2017. Traditional ecological knowledge and local observations of Capelin (*Mallotus villosus*) in Darnley Bay, NT. Can. Manuscr. Rep. Fish. Aquat. Sci. 3144: vi + 20 p.

Les capelans représentent une importante espèce de poissons dans les habitats marins, car ils servent de source de proies aux mammifères marins, aux poissons prédateurs et aux oiseaux de mer dans les eaux subarctiques et dans certaines régions de l'Arctique. Dans la mer de Beaufort, les capelans sont moins abondants que dans les eaux du sud et ils ont été observés en un nombre limité d'endroits, principalement à l'extérieur du delta du fleuve Mackenzie. Cependant, des températures à la hausse et une réduction de la glace de mer devraient favoriser une augmentation de la présence et de l'abondance du capelan dans l'Arctique canadien. En observant les endroits qui ont été le théâtre de plusieurs événements de frai, nous pouvons mieux comprendre l'écologie reproductive du capelan dans un Arctique qui se réchauffe et comment ses interactions avec d'autres espèces pourraient changer dans l'avenir. On trouve dans la documentation scientifique quelques rapports sur le capelan dans l'Arctique canadien. Toutefois, les récentes observations et les connaissances du biote aquatique acquises de longue date par les peuples autochtones sont habituellement transmises oralement d'une génération à l'autre. Ces connaissances écologiques traditionnelles (CET) constituent une excellente source d'information sur le capelan qui n'a été que très peu documentée. En outre, les observations locales des dernières années apportent de précieuses informations qui peuvent servir à repérer les changements écologiques. Des capelans ont été observés frayant dans la baie Darnley (Territoires du Nord-Ouest) depuis plusieurs années par des membres de la collectivité de Paulatuk, dans les T.N.-O. L'objectif de l'étude est de documenter les observations historiques du capelan faites par les membres de la collectivité de Paulatuk et de déterminer : 1) depuis combien de temps a-t-on observé le capelan dans la baie Darnley; 2) les endroits dans la baie où il a été observé; 3) si le capelan fait partie du régime d'espèces de subsistance (p. ex. l'omble chevalier); 4) si le capelan a déjà été capturé aux fins de consommation. Les renseignements sur l'environnement, les caractéristiques de frai et les interactions au sein de réseau trophique colligés à partir des CET élargiront la compréhension actuelle de l'écologie de cette espèce en plus d'être un exemple concret de la façon dont les connaissances locales et traditionnelles peuvent être utilisées pour établir la répartition de référence et l'écologie d'espèces dans des endroits isolés. Combiner les CET aux nouvelles connaissances scientifiques élargira la compréhension de la biologie du capelan et permettra de prédire les changements dans la dynamique du réseau trophique au fil des changements climatiques.

1.0 INTRODUCTION

Northward geographic range expansions of sub-Arctic fishes have recently been observed throughout the Arctic (Rose 2005; Dunmall et al. 2013). Capelin (*Mallotus villosus*) are a mid-trophic level forage fish found throughout boreal waters of the northern hemisphere, and have recently been reported in greater abundance in Arctic regions (Dempson et al. 2002; Gaston et al. 2003). This species is considered to be an indicator for warming climate in the northern marine ecosystem (Rose 2005). Few scientific studies have documented the occurrence of Capelin in the western Arctic, and much of the traditional ecological knowledge (TEK) of this species is disseminated orally and has not been documented in a written form to date. By gathering both scientific and traditional knowledge, the information gaps that exist with respect to Capelin and their possible emerging role as a key forage fish species can be better understood. This can further be supplemented by the addition of local observations from recent years to confirm the current distribution and life history of Capelin.

Dietary shifts have been observed among predators in the eastern Arctic away from Arctic-associated prey sources (e.g., Arctic Cod (*Boreogadus saida*) and invertebrates) to boreal prey items such as Capelin (Dempson et al. 2002; Gaston et al. 2003; Yurkowski et al. 2016). In the western Arctic, it is unclear if predators that rely on Arctic prey sources are shifting in diet towards sub-Arctic adapted forage fishes that may be increasing in abundance. Capelin have been observed nearshore in Darnley Bay, NT for multiple years by the community members of Paulatuk, and were recently collected through scientific sampling in large aggregations in the centre of the bay (McNicholl et al. 2016). Top-level predators, including Beluga (*Delphinapterus leucas*), Ringed Seal (*Pusa hispida*), Bearded Seal (*Erignathus barbatus*) and anadromous fishes such as Arctic Char (*Salvelinus alpinus*), are typically harvested for subsistence by the community members of Paulatuk in Darnley Bay (KAVIK-AXYS 2012). Changes in climate and warming of the coastal habitat in the Beaufort Sea appear to have contributed to increased presence of boreal-adapted species, such as Pacific salmon (*Oncorhynchus* spp., Dunmall et al. 2013), in the area. Observations of Capelin in the Arctic are generally few and sporadic (Carscadden and Frank 2002) and have been geographically limited, yet historic observations have been recorded in the Beaufort Sea and into Coronation Gulf (McAllister 1962; RL&L Environmental Services and Golder Associates Ltd. 2003). Although Capelin are already present in the Arctic ecosystem, their abundance and extent of distribution are expected to increase in the Arctic (including the Beaufort Sea), likely in response to shifts in marine temperatures (Rose 2005). These responses will also likely increase their prominence in marine food webs.

Traditional knowledge and local observations made by community members are important for identifying recent changes in the regional ecology of Darnley Bay. Knowledge obtained from community members supplements ongoing coastal monitoring programs and facilitates a greater understanding of ecosystem function over a longer period of time. Observations made in this region by community members while harvesting fishes, such as char, can be used to infer if dietary shifts of predators may be occurring in Darnley Bay. In turn, such shifts may be connected with possible environmental drivers. Accordingly, to better understand ecosystem structure and function environmental information, spawning characteristics, and food web interactions gathered from local knowledge will reinforce the current understanding of the

ecology of this species and promote development of future hypotheses as climate changes. In order to predict and understand the structure of Arctic marine systems in the future, changes associated with shifting distributions and ecological implications must be further investigated. In the hamlet of Paulatuk, the importance of forage fishes as a prey source for subsistence predators is well known orally, but poorly documented in written form outside of the community. These fishes are aptly named “cigar-fish” after their small cigar-shaped bodies. The harvesters of Paulatuk have a unique opportunity to observe the diet and identify changes in trophic relationships between predators and their prey.

The objective of this study is to provide written documentation of historic observations of Capelin made by the community members of Paulatuk and determine 1) How long Capelin have been observed in Darnley Bay; 2) Where in the bay they have been observed; 3) If Capelin are present in the diet of subsistence species (i.e., Arctic Char); and, 4) If Capelin were ever harvested for consumption. Environmental information, spawning characteristics and food web interactions gathered from traditional ecological knowledge will extend the current understanding of this species’ ecology. Together, TEK and increased scientific knowledge will increase understanding of Capelin biology and possibly stimulate predictions related to ecological change and future states of the ecosystem.

2.0 MATERIALS AND METHODS

2.1 STUDY SITE

The community members of Paulatuk spend much of the summer at established camps along the coastline of Darnley Bay (Figure 1). During the summer, Arctic Char are harvested in Argo Bay, Tippitiuyak, the Hornaday River, Lessard Creek and along the coast to Pearce Point. Beluga are harvested within the Anguniaqvia Niqiqyuam marine protected area (ANMPA) generally between Argo Bay and Brown’s Harbour. Given the large spatial coverage for harvesting, observations made over many years by the hunters and fishers of Paulatuk provide important information regarding the regional ecology over longer periods of time.

The ANMPA was designated as a Marine Protected Area (MPA) in 2016 due to its importance for subsistence harvesting and as a migratory corridor for coastal fishes and marine mammals (Community of Paulatuk et al. 2008). The MPA includes a large portion of the Cape Parry Peninsula coast, which supports seals, Beluga, coastal fishes and a sea bird sanctuary at its northernmost end. The southern end of the bay is generally warmer, less saline and predominantly sandy along the shore. The shoreline changes towards the northwestern end and is dominated by steep bluffs and bed rock where waters are generally colder and more saline due to influence from the Amundsen Gulf (Paulic et al. 2012). Additionally, the eastern side of the bay (which is not included in the MPA) contains two Ecologically and Biologically Significant Areas (EBSAs) located at Pearce Point and the Hornaday River, that provide the region’s most substantive freshwater input. The Hornaday River and Brock River (including Lessard Creek) are the two primary river systems that drain into the bay and these systems support anadromous fishes such as Arctic Char (Harwood 2009; Harwood and Babaluk 2014; Harris et al. 2016).

These fishes are of particular significance for subsistence harvesting by community members of Paulatuk.

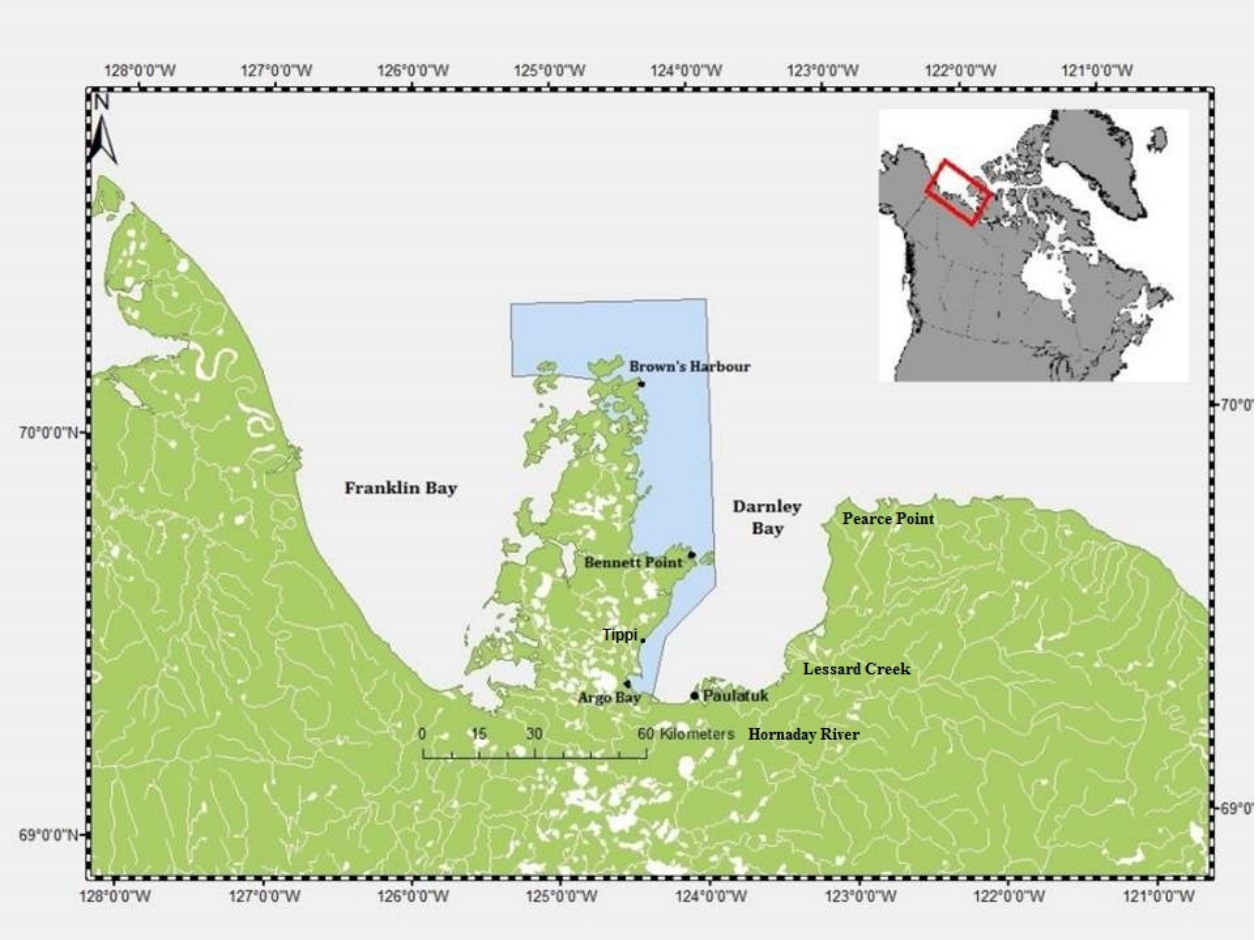

Figure 1. Map of Darnley Bay and the Anguniaqvia Niqiqyuam marine protected area (blue shading).

2.2 TRADITIONAL ECOLOGICAL KNOWLEDGE INTERVIEWS AND LOCAL OBSERVER QUESTIONNAIRE

Gathering of TEK occurred through an interview process involving identified knowledge holders and a structured questionnaire (Appendix II). Similarly, local observers participated in a structured questionnaire (Appendix I), but on a voluntary basis.

The Paulatuk Hunters and Trappers Committee (PHTC) chose five TEK holders to participate in the interviews based on their experience at Cape Parry and along the Darnley Bay coast during the summer season. The TEK holders referred to in this study are individuals who agreed to share their historic knowledge of the area in the interviews. Additionally, five local observers volunteered to participate in the questionnaire after the project was advertised by the PHTC. These individuals shared their knowledge of the area from recent years. The TEK holders

provided information they have obtained over many years of living in the region, while the local observer questionnaire was aimed at identifying recent observations over the last few years.

A youth chosen by the PHTC (Brianna Wolki) distributed instructions, questionnaires, consent forms and conducted interviews that were completed in July of 2015 in the community of Paulatuk. This promoted youth engagement with ongoing research in the ANMPA and allowed traditional knowledge to be shared among members of the community. Participation in this study was voluntary and participants could choose to remain anonymous or withdraw at any time in which case the information they provided would not be used. Additionally, any participant younger than 18 years of age was required to have consent from a parent or guardian.

Five individuals were asked to fill out a local observer questionnaire (Appendix I) that was developed under the ethics guidelines outlined by the Tri-Council Policy: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS2: CORE) and reviewed and approved by the University of Manitoba Joint-Faculty Research Ethics Board, Aurora Research Institute (ARI) and the PHTC in June of 2015. The purpose of the questionnaire was to identify the general distribution of Capelin in Darnley Bay and the locations where they potentially spawn. A map of Darnley Bay was provided and participants were asked to mark on the map where they had observed Capelin. The questionnaire also included questions related to the temporal and seasonal variation in sightings (are they observed every year, and if so during what months of the year) and the timing of ice breakup during that year. Participants were also asked if they have ever seen Capelin in the stomach contents of harvested seals, Beluga or Arctic Char. Finally, a photograph of a spawning shoal of Capelin from Katovik, AK was shown and participants were asked if the Capelin they had observed displayed the same spawning behavior, and if so, upon which type of substrate.

Ten participants provided local knowledge for this study (five questionnaires and five TEK interviews completed). Background information about the TEK holders is summarized in Table 1 and questionnaire participants are listed in Table 2.

Table 1. Names of TEK holders from interviews conducted in July 2015 and their response to how many years they have lived in Paulatuk and if they lived at any other location within the Inuvialuit Settlement Region (ISR).

Interviewee Name	Years lived in Paulatuk or elsewhere in the ISR
Noel Green	Since 1964 in Paulatuk and at Cape Parry
Olga Ruben	Moved from Cape Parry to Paulatuk in 1964/1965
Peter Ruben	Since 1959
Liz Kuptana	Lived at Cape Parry from 1959-1970s, before moving to Paulatuk
Ruben Green	Moved from Cape Parry to Paulatuk in the 1970s

Table 2. Questionnaire participants for local observations of Capelin in Darnley Bay.

Ian Green
Joe Illasiak
Frances Wolki
Bill Wolki Sr.
Melanie Wolki

The participants of this study were asked to share their knowledge on how long they have observed Capelin in Darnley Bay, where they were observed, if they were observed in the stomachs of other harvested animals or if there were any traditional uses for harvested Capelin.

Traditional Ecological Knowledge interviews were conducted in order to gather more detailed information about Capelin ecology in Darnley Bay. These interviews were conducted by the same youth who distributed the questionnaires. The interview itself was approximately 45 minutes and a digital recording of the interview and subsequent dialogue were produced by the interviewer.

The information obtained was verified and transcribed by the hired youth and the PHTC. Once the questionnaires were completed the interviewer and PHTC were asked to review the information provided and verify that the TEK was accurate to the best of the TEK holders knowledge. The results of this program were presented to the PHTC and Fisheries Joint Management Committee in January of 2016.

3.0 RESULTS

3.1. IDENTIFYING CAPELIN

Local observers and TEK holders indicated that they had seen shoals of forage fish in Darnley Bay as seen in Figure 2, however when these interviews and questionnaires were conducted a photo of Capelin spawning at Kaktovik, AK (Appendix I) was used. Few species of forage fishes that are present in Darnley Bay form spawning aggregations on shore, as do Capelin. Therefore, this is a good indication that it was, in fact, Capelin that were observed, rather than other forage fish species such as Pacific Sandlance (*Ammodytes hexapterus)*, Pacific Herring (*Clupea pallasii*) or Arctic Cod (*Boreogadus saida*).

The participants in this section were asked to identify which fish were considered “cigar-fish” as this is a local term used to describe forage fishes that are prey for subsistence species. Participants identified Capelin (male and female), Pacific Sandlance, Rainbow Smelt (*Osmerus mordax*) and Pond Smelt (*Hypomesus olidus*) as cigar-fish. Other superficially similar fishes such as Pacific Herring, Arctic Cisco (*Coregonus autumnalis*) and Saffron Cod (*Eleginus gracilis*) were not considered to be cigar-fish by anyone who participated.

Figure 2. Spawning shoal of Capelin at Argo Bay, July 2017.

All participants indicated that cigar-fish are “smaller” and “skinnier” than most fishes. One individual indicated that they also have “smaller eyes, more rounded snout, long dorsal fin, skinny, and shiny in the water” while another described cigar-fish as being “close to the beach, long, skinny [and] travel in big schools”, which is consistent with Capelin spawning behaviour.

The existence of Inuvialuktun names for the relevant fish species (Appendix III) indicates that local knowledge holders differentiate among species. Thus, knowledge is high regarding the differentiation of Capelin from the collective group of ”cigar-fish” and other forage fish species.

3.2 PAST OBSERVATIONS OF CAPELIN

3.2.1. Distribution and Abundance of Capelin

The distribution of Capelin in Darnley Bay, based on local observers from recent years and TEK holders, is presented in Figure 3. All the TEK holders indicated that they had seen Capelin, or large schools of small forage fish in the past. The earliest observation noted was at Cape Parry near the DEW Line (Distance Early Warning Line radar base) site in 1963 or 1964. Peter Ruben indicated that he had seen Capelin in 1990, “on the island” in reference to Green’s Island. On this same island, another interviewee stated that they had seen Capelin in “huge schools” 8-10 years ago and the kids would run and pick them up with their hands; however, they have not seen them in such large numbers for a few years.

Three out of five questionnaire responses indicated that Capelin had been observed every year. Those that had seen Capelin answered that they had seen Capelin for the past few years, or in

one case the past six years. One observer also indicated that these observations were always in the summer. Capelin were primarily observed in July (four out of five participants), but also observed in August and September. There was no indication of Capelin presence in June or during the fall into October.

Most of the participants did not notice anything unusual during periods when Capelin were observed. However, Ruben Green observed ‘white eggs’ on the beach during one of the years he observed the schooling fishes.

3.2.2. Environmental conditions associated with Capelin

Three out of the five local observer respondents indicated that the ice broke up earlier than usual during the years that Capelin were observed. This ranged from mid-June to the end of June, which was earlier than the typical July breakup. Observations made about connections between the environment (e.g., wind, ice, temperature) and Capelin varied among respondents, although generally warm, calm conditions were consistent among participants. Responses included “calm winds and waters, warm temperatures, and ice gone”, ”sunny, warm conditions, calm waters”, and “west winds were strong, no ice, warm water (warmer than usual), warm conditions”. Additionally, one local observer indicated that “Capelin can be seen best in glassy waters or by the beach”.

Generally, the TEK holders observed warmer conditions when Capelin were seen, with the exception of one observation of colder conditions and westerly winds. Capelin were seen at Cape Parry, at the end of July into the first week of August during one warm year. Observations regarding ice breakup during years of Capelin observation varied among participants. Some participants did not notice any changes, and noted that around Egg Island (Argo Bay), where they observed Capelin, the ice can change throughout the spring. Two others reported warm years, where the ice melted very quickly and most of ice had disappeared by the time Capelin showed up. The particular years of these observations are unknown.

Only one respondent had not seen aggregations of Capelin, shown in Figure 2 and Appendix I. Those who had observed such aggregations, all indicated that the substrate was sandy. There was one indication that Capelin also gather on rocky substrates and another that suggested they aggregate in deeper water.

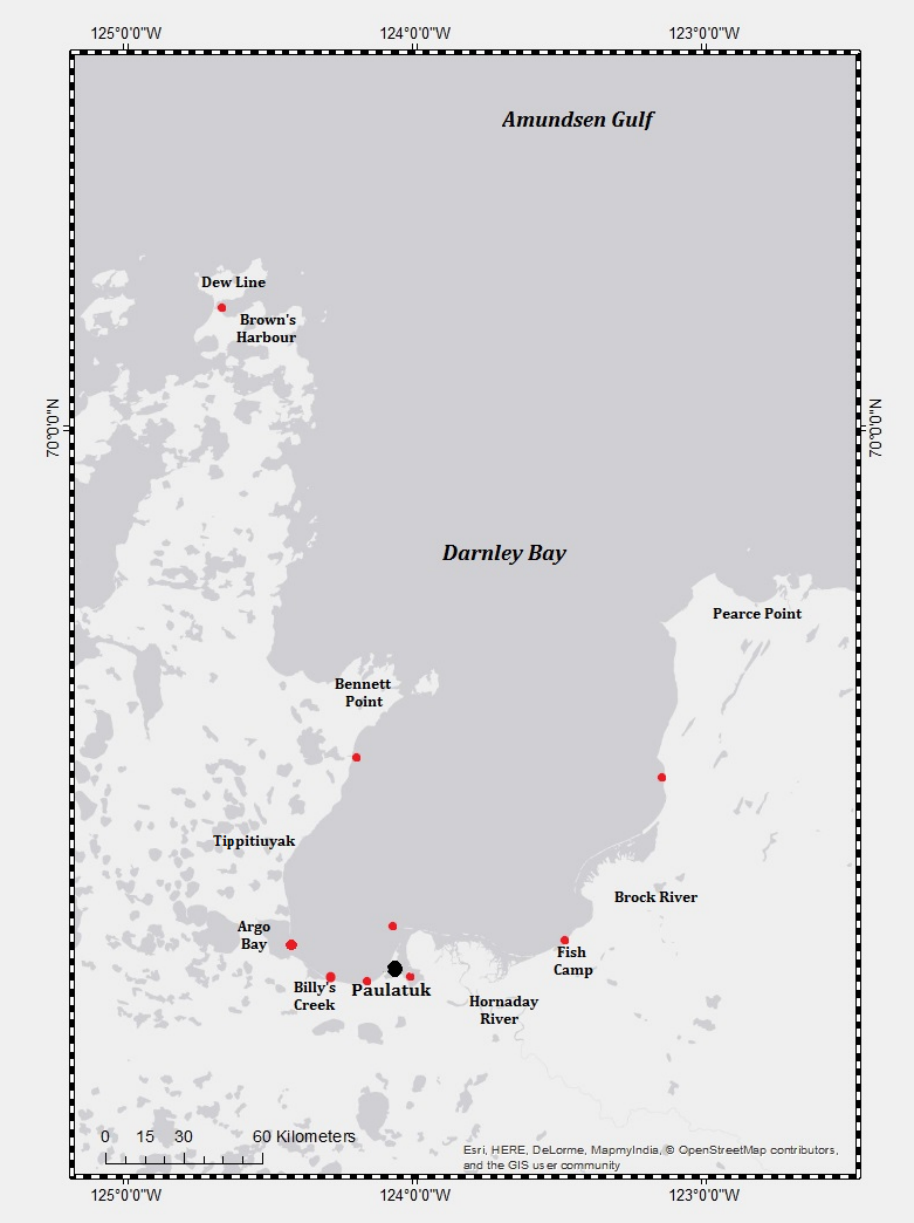

Figure 3. Map of Darnley Bay with locations where Capelin had been observed by TEK holders and recent observers in Paulatuk. Locations are combined from questionnaire and interviews conducted in July 2015, from ten participants.

3.3 CAPELIN AS PREY SPECIES

All local observation respondents indicated that they have observed Capelin in the stomach contents of harvested predators, particularly char. Four out of five participants indicated that when they saw Capelin in the stomachs there were few other prey items, with the exception of krill or tom cod (i.e., Saffron Cod). There was also a note made that Beluga stomachs are usually empty when they are harvested.

Three out of the five TEK holders had observed Capelin or other forage fishes in the stomachs of harvested Arctic Char. In some cases the char were "loaded" with small fishes that are believed to be a main food source for char in the area. Char were observed with Capelin and cigar-fish in their stomachs at Egg Island and, although Broad Whitefish are also present here, one participant stated that he has only ever seen Capelin in the stomachs of Arctic Char.

The colour of char flesh that was observed by participants varied from red, dark pink, pale pink to white, during the years that they observed Capelin. This is relevant, given that red/pink char flesh is an indication that they are feeding on invertebrates, whereas paler flesh suggests they are feeding primarily on forage fishes. Some observed "fat, really healthy, nice red meat" while another reported that the flesh of the char was "very pale" in late June and July, "because they came out of the Hornaday River, [the flesh] wasn't orange". One observer noted that the char with pale flesh were also thinner. The individuals who observed red-fleshed char stated that the fish tasted normal and tasted good. Alternatively, those who observed pale, or light-coloured flesh in their char believed it did not taste as good.

Noel Green recalled the following observation:
"Last summer [2014] *we watched seals, sea gulls and loons following a big pot of fish. We were observing it from Billy's Creek, we looked with binoculars, it was just a huge black area. The seals and all the sea birds were after them. They start from Suvuk and they end up just outside here, not far from the beach. They're important to our char, and all the other sea mammals."*

3.4. HARVESTING CAPELIN

The TEK interviews suggest that Capelin captured in subsistence harvest were primarily used for feeding dogs. The Capelin would be collected from shore at Cape Parry when large schools were observed. However, four out of the five interviewees also suggested that Capelin were collected for food. In some cases, Capelin were collected to be pickled or fried, when they were in large quantities, even when char and whitefish were also available.

Answers varied according to the last time that the participants prepared Capelin, from eight years ago to the summer of the previous year. Two participants indicated that they prepared them while fishing in Argo Bay (Egg Island) by either frying them or pickling them. The Capelin could be collected in large schools all along the shoreline of where they were camped.

All participants were able to collect Capelin from shore using only a bucket, dip net, pan or hands to scoop up fishes. In one case a participant referenced their experience at Cape Parry when they were young: "Ever since I was a kid, we did the same thing in Cape Parry. All we did was use buckets. They were all in the shore, thousands of them".

3.5. MONITORING

3.5.1 Importance of monitoring

TEK holders shared their perspective on what aspects of the physical environment they considered valuable to monitor with regards to Capelin presence in Darnley Bay. Similar to the

monitoring of Arctic Char and Beluga, the occurrence of Capelin and their role in the diets of other predators is an integral ecosystem component at the centre of the food web. Answers varied among participants, and responses included that “it’s important to know about our fish and mammal’s ecology”, or “it will help deal with climate change”, and “because they are an integral part of the food chain for bigger marine mammals to live off”. Finally these observations were considered important because “the information is important for us to know about the Belugas or, other fish’s prey, and the changes of Capelin”.

Each interviewee reiterated the importance of observations in the context of managing subsistence fish stocks, and understanding the local ecology. One interviewee noted that when the char monitoring program was first established, the numbers were very low and the char were smaller, but with monitoring the community would be able to know the abundance and size distribution of the chars. Without monitoring programs one TEK holder also felt that the community would be “out of char by now”, and another felt that the fish are less abundant than they used to be.

3.5.2. Suggestions for monitoring program

Three out of the five TEK interviewees indicated that they would like to see monitoring programs continue, including that for Arctic Char, but also those of other fish. Individuals indicated that it’s important to monitor forage fishes because of their importance as a prey source for char, seals and other mammals as well as for monitoring the colour and condition of fishes (paler flesh). In addition to fish monitoring, a TEK holder also suggested monitoring the level of chemicals or contaminants in the ocean and streams.

Three out of the five local observer questionnaire participants believe that the coastal monitoring programs are running well and they should continue in the future. One participant suggested the use of a weir net in order to make counting fish easier, while another suggested that monitoring should continue on an annual basis rather than two to three years (i.e., continuous rather than episodic) of operation.

All TEK interviewees stated that they would like to see TEK projects continue. In one interview a TEK holder suggested that science would benefit from local knowledge because community members grew up in the area, “know where the fish are and know what they eat”. In another case, a participant expressed hope that TEK would continue in any future research in the area.

3.5.3. Questions about Capelin and coastal monitoring

Questions listed below are combined from all participants based on aspects of Capelin ecology they would like to know more about in the future and if there was anything else they would like to add.

- Why is it that they do not show up every year?
- Do they spawn every year?
- What are their actual numbers?
- Are Capelin numbers low because something is consuming them?

- Do they process Capelin just like they process sardines?
- What do Capelin eat, do they eat plankton?
- What will happen if the Capelin are gone?
- If Capelin are gone what will the char eat? What will they survive on?
- Do Capelin spawn in cycles and why does the location change?

4.0 SUMMARY

Local observations and TEK gathered over long periods of time provide valuable insight into the ecological trends and anomalies present in an environment. Traditional knowledge plays an important role in identifying integral ecosystem components and drivers that support coastal ecosystems. Based on the information obtained from the local observer questionnaires and TEK interviews in this study, Capelin are considered to be an important prey source for marine mammals, sea birds and char and have been observed in Darnley Bay, at least since the 1960s. Understanding the presence of this species and how it interacts with predators will help to better predict changes to ecosystem function in coastal environments of the Arctic as the climate continues to change.

Observations indicate that based on the schooling nature of dark, small bodied fishes on beaches during the summer, and indication of eggs on the sand, it is likely that Capelin were observed during these events. Although, other forage fishes are present and are difficult to distinguish from Capelin (e.g., Pacific Sandlance) they do not aggregate on shore in such large numbers. The term ‘cigar-fish’ was used to describe small, skinny fishes found in Darnley Bay, and was applied to Capelin, Pacific Sandlance, Pond Smelt and Rainbow Smelt. Thus, it is difficult to determine if cigar-fish found in the stomachs of seals or char are Capelin or another forage fish. Other cigar-fish have been observed less frequently in Darnley Bay (e.g., Pond Smelt and Rainbow Smelt), while Pacific Sandlance appear to also be an important prey source for coastal predators and are the most likely species to be misidentified as Capelin in stomach contents. However, the importance of cigar-fish as a primary prey source for predators was emphasized by community members, and is distinct given that it has a unique Inuvialuktun name relative to other forage fishes. Therefore Capelin are likely to influence foraging and distribution of predators that feed on them.

These results are consistent with those recorded in a traditional knowledge study conducted in 2012 (KAVIK-AXYS 2012) in which “black clouds” of small fish were observed from shore during warm years near Paulatuk, Egg Island and around Cape Parry. The 2012 study also identified that these forage fishes were preyed upon by Arctic Char. Although it is not possible to confirm the species of the fish observed in 2012, the large aggregations of dark-bodied forage fishes spawning on beaches suggest that these fish were most likely Capelin. Participants in this study suggest that Capelin can be found throughout the coastal environment of Darnley Bay including embayments at Cape Parry, and are not restricted to sand-dominated substrates for spawning at the southern-most end. Generally, participants also observed Capelin during periods when temperatures were above normal, and when the beaches were free of ice. Although the specific temperature and environmental conditions for spawning in Darnley Bay are unclear, it

can be expected that as temperatures continue to warm, the conditions for spawning, and for early life history stages may improve for Capelin.

Among the interviews, TEK holders expressed support for continued research in Darnley Bay and the inclusion of traditional knowledge. However, there are still many unanswered questions, specific to Capelin, with regards to variability in abundance, spawning characteristics, foraging habits, and their influence on predators such as Arctic Char. Future research will address current knowledge gaps and increase understanding regarding the future role of this ecologically-important species in the coastal Beaufort Sea.

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APPENDIX I: Local Observation Questionnaire

Observations about Capelin or “cigar-fish” in Darnley Bay, NT

Observer Name: _____
Date: _____

Please share the following information about the Capelin that you observed:

Section 1: Past Observations of Capelin

1. Have you observed Capelin in Darnley Bay? ☐ Yes ☐ No

2. Please mark on the Map 1 where you have seen Capelin.

Map 1: Darnley Bay

3. Did you ever see fish swimming in groups along the beach like in Picture 1? ☐ Yes ☐ No

4. Do you see Capelin every year? ☐ Yes ☐ No
    a. If Yes, How many years have you seen Capelin?: _____

5. Which months have you seen Capelin?
    ☐ May ☐ June ☐ July ☐ August ☐ September ☐ October

6. Did the ice break up earlier than usual when you observed Capelin? ☐ Yes ☐ No
    a. If Yes, when did it break up? _____

7. Have you ever seen Capelin in the stomachs of beluga, seals or char? ☐ Yes ☐ No
    a. If Yes, did you see mostly Capelin or other prey?: _____
    _____

8. Did you see large groups of Capelin from the beach like in Picture 1 below?
    ☐ Yes ☐ No
    If Yes, was it ☐ Sandy ☐ Rocky ☐ Other: _____

Picture 1: Shoal of fish

Section 2: Capelin and Cigar-Fish

9. Would you call the fish in the picture below cigar-fish? Please check the boxes beside fish you would call cigar-fish

Picture 1: Cigar-fish? ☐

Picture 2: Cigar-fish? ☐

Picture 3: Cigar-fish? ☐

Picture 4: Cigar-fish? ☐

Picture 5: Cigar-fish? ☐

Picture 6: Cigar-fish? ☐

Picture 7: Cigar-fish? ☐

Picture 8: Cigar-fish? ☐

10. Do you have a different name for the fishes in the pictures above? ☐ Yes ☐ No
    a. If Yes, what do you call them?:
       Picture 1._____ Picture 2. _____
       Picture 3._____ Picture 4. _____

Picture 5._____ Picture 6. _____
Picture 7._____ Picture 8. _____

b. If Yes, how are they different than other fish?
_____
_____
_____
_____

11. Are there any other observations about Capelin or cigar-fish that you would like to have included in this study? If so, please provide them here:
_____
_____
_____
_____
_____

Section 3: Future work

12. What observations could be made about the environment (wind, ice, temperature) that might be connected to where and when Capelin are seen?
_____
_____

13. Why do you think that these are important observations to include in monitoring coastal fish?
_____
_____

APPENDIX II: Traditional Ecological Knowledge of Capelin Interview Questions

Inclusion of Local Observations and Traditional Ecological Knowledge of Capelin

1. For how many years have you lived in Paulatuk?
2. Before you lived in this community, did you live elsewhere in the ISR?
3. For how many years have you observed Capelin or cigar-fish?
4. Did you ever harvest Capelin for food or to feed your dogs?
5. What types of observations would you like to have included in monitoring of fish?
6. Why do you think that these are important observations to include in fish monitoring?
7. How would you like to see Traditional Ecological Knowledge included in coastal monitoring?
8. When was the last time you prepared Capelin?
9. How did you collect Capelin or how was the Capelin collected for you?
10. Did you observe anything unusual about the area you collected Capelin in? Was there a slimy substance on the sand?
11. What was the weather like when you observed Capelin?
    a. Was it a warmer year?
    b. What was the ice like that year during spring breakup?
12. If you harvested Arctic Char, did you ever see Capelin in their stomachs?
13. Are there any observations you can recall about the condition of the char during the years you observed Capelin?
    a. What was the colour of char flesh?
    b. Did the char taste normal?
14. What suggestions or ideas do you have for making the coastal monitoring and research program better in the ISR?
15. Do you have any questions about Capelin or coastal monitoring that you would like to ask the research team?

APPENDIX III: **Inuvialuktun, common and scientific names of fishes described in this report.**

Inuvialuktun Name	Common Name [local name]	Scientific Name	
Iqalukpik	Arctic Char	*Salvelinus alpinus*	
Piquatitaq	Pacific Herring [Blue Herring]	*Clupea pallasii*	
Iqalusaaq	Pond Smelt	*Hypomesus olidus*	
Iqaluaqat	Pacific Sandlance	*Ammodytes hexapterus*	
Iqalugaq	Capelin	*Mallotus villosus*	 (male)  (female)
Qaaqtaq	Arctic Cisco [Herring]	*Coregonus autumnalis*	
Iqaluaqat	Rainbow Smelt [Stink Fish]	*Osmerus mordax*	
Uugak	Saffron Cod [Tom Cod]	*Eleginus gracilis*