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## Marine Biodiversity and Greenlandic LEK

*With new contributions from the Ammassalik area, East Greenland*

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# Marine Biodiversity and Greenlandic LEK: With new contributions from the Ammassalik area, East Greenland

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## Executive Summary

Local Ecological Knowledge (LEK) and Indigenous Knowledge (IK) is a particularly rich source for understanding environmental changes in Arctic areas from a holistic, ecosystem perspective. However, the vast scope and the in-depth character of LEK and IK in Greenland is not particularly accessible to outsiders, including the international science audience. The first part of this ECOTIP deliverable 4.4. presents an identification and synthesis of written sources of LEK/IK on the marine environment in Greenland from 2010-2025, conducted by means of a desktop-study and personal knowledge/network by the lead author. In conclusion, written sources concerning fish include some highly informative accounts, but they are few in numbers (9 sources were identified). ECOTIP deliverable 4.1 sought to fill this knowledge gap with a LEK study of recent changes experienced in the coastal fishery in West-Greenland as well as the offshore fishery in West- and East Greenland.

The second part of this ECOTIP deliverable 4.4 seeks to fill the knowledge gap further, adding a report on a LEK interview study conducted in the Ammassalik area in spring/summer 2024. Eight fishers from the area shared their knowledge and observations of changes in their area, including not least their reflections on how various processes tie together. The report provides elaborating details which can be summarized into the following highlights:

### **Physical changes:**

The interviews conducted with local fishers in East Greenland reveal the profound and multifaceted impact of glacial melting and climate change on both the environment and traditional ways of life. Through the experiences of local fishers, it becomes evident that melting glaciers significantly alter the marine ecosystem and thus human activities. Glacial meltwater intensifies sedimentation in fjords, presenting challenges to fishing due to increased presence of stones and mud. Significant alterations to sea ice over the years have been observed, including declines in duration, thinning, and earlier formation and early melting of drift ice. Fishers recall thicker and more stable sea ice in their youth, contrasting it with the thinner, less persistent formations of recent times. The disappearance of inland ice over the past five decades and visible changes in sea ice patterns serve as examples of rapid environmental shifts, affecting traditional activities like fishing and hunting. Moreover, the interviews shed light on the observed increase in storms in East Greenland over recent years, profoundly impacting fishing activities. Fishers note sudden and drastic weather changes, with storms arriving unexpectedly and causing equipment damage and safety risks. However, amidst these challenges, there are also intriguing observations, such as weaker winds following a year with intense storms. Discussions about the effects of global warming on weather patterns and fish phenology highlight the interconnectedness of environmental changes and traditional livelihoods. The insights gathered from the interviews emphasize the need for adaptive strategies in the face of climate change, emphasizing the importance of understanding and mitigating its impacts on both local communities and ecosystems.

### **Changes to marine environment:**

Fishers in East Greenland also provide insights into significant changes occurring in the marine environment, particularly concerning seaweed abundance and the dietary habits of key fish species.

Fishers recall colder waters in the past, where seaweed would be frozen beneath the ice, contrasting with the present absence of such occurrences. Speculation arises regarding the reduced salt content affecting seawater's nutrient levels, potentially impacting marine ecosystems. Furthermore, smaller seaweed sizes in past times, contrast with current observations of larger seaweed sizes and increased distribution, which pose challenges for fishers. Despite variations in personal experiences, there is a consensus on the changes to seaweed abundance in certain areas, indicating potential ecological shifts. Moreover, the interviews highlight a notable shift in the dietary habits of Arctic char, cod, and Greenland halibut over the past decade. Previously uncommon prey items such as small squids, lumpfish, and shrimp are now frequently found in the stomachs of these fish, suggesting changes in prey availability or distribution possibly influenced by environmental factors. Fishers attribute these shifts to warming waters, indicating broader ecological implications. Overall, the interviews highlight the importance of continued ecosystem monitoring and research to understand and mitigate the impacts of environmental changes on marine ecosystems in East Greenland.

### **Changes to fish species:**

During the interviews, the fishers shared their experiences with the complex changes in fish species within their fishing areas, documenting shifts in population dynamics and ecological interactions over time. Polar cod, once plentiful in Greenlandic fjords, have experienced a significant decline since the late 1900s, prompting concerns among the local fishers. Factors such as warming sea temperatures, predation by other species, and the arrival of new fish varieties were identified by the fishers as contributing factors of this decline. Observations of Atlantic cod populations reveal a contrasting narrative, with fluctuations in abundance over the years, recently with a recent resurgence attributed to environmental factors such as changing sea temperatures and prey availability. Greenland halibut appears stable and some fishers even notice increasing sizes of fish and stocks. Arctic char populations are observed to increase, engaging many households and fishers locally during its season. Detailed insights into Arctic char behaviour and diet, including squid and small shrimp, indicate changes in prey availability and ecosystem dynamics shedding light on broader ecosystem shifts. Lumpfish emergence in Kuummiut Fjord and increasing presence of crabs in Sermiligaaq Fjord signals broader ecological transformations which prompts adaptations in fishing practices and discussions about fishery development. Lastly, capelin shows seasonal presence and holds economic promise as a bait source and its potential as commercial trade.

The fishers shared observations on the arrival of new fish species, such as 'Arctic char variants' (presumably pink salmon, *Oncorhynchus gorbuscha*), mackerel, and cod, which were previously uncommon. The fishers attributed these changes to factors like rising sea temperatures and shifting migration patterns due to climate change. They also noted sightings of unfamiliar species, including a new type of shark with triangular teeth (presumably porbeagle shark, *Lamna nasus*). The fishers anticipated both challenges and opportunities in adapting to these changes, emphasizing the need for updated equipment and infrastructure to support future fishing activities.

### **Changes to marine mammals:**

The fishers have observed significant changes in mammal populations, particularly focusing on whales, seals, and polar bears in the Ammassalik area. They report a notable increase in whale sightings, including species that were previously rare in the area. Causes such as changes in migration patterns, prey availability, and sea temperatures are cited as possible reasons for this increase. However, the

growing presence of new whale species can affect fisheries for periods through competition for prey or direct predation on target fish. With advancements in vessel technology, fishers are now more confident in pursuing larger marine mammals like orcas. So, while the increase in whale species sparks interest among fishers, it also disrupts fishing activities and indicates ecosystem changes affecting the local community. The fishers identify various locations significant for seal hunting, but also note declines in seal populations, particularly of ringed seals and hooded seals. They observe thinner seal pups and fluctuations in blubber thickness, possibly influenced by changes in snowfall and competition with whales for food. Knowledge passed down through generations helps fishers anticipate seal arrivals, but environmental disturbances like diesel leaks and temperature changes impact seal abundance. While not extensively discussed in these interviews, polar bear hunting remains important for sustenance and traditional knowledge. Anecdotal evidence implies a shift in polar bear diet, with observations of bears consuming seaweed, raising questions about their traditional carnivorous habits.

All in all, the LEK from the Ammassalik area offers holistic and synthesizing accounts of change, many of which speaks directly to scientific interest in understanding paradigm change and cascading effects from the physical environment, onto marine environment and eventually, having detectable effects fish and mammals.

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## 1. Introduction

The deliverable at hand was originally intended as a ‘state-of-the art’ desk top review of recent (10-15 years) local ecological knowledge (LEK) observations of marine biodiversity changes. It was intended as a synthesis of existing sources that could be retrieved prior to the commencement of the ECOTIP WP4 interviews with fisheries and fishery stakeholder. The review constituted one of the initial analytical exercises in WP4 (2021) and served as a starting point for the LEK interviews and stakeholder engagement to follow (2022 – 2024). As it turned out, the desk search for LEK sources back in 2021 only yielded few results when it came to the registration of LEK/IK observations of fish and lower trophic levels in Greenland; the main foci of Greenlandic LEK/IK research have been directed towards marine mammals and birds.

In the meantime, the deliverable was (for practical reasons) postponed towards the end of the ECOTIP project, and its purpose has been expanded to communicate the results of a LEK study from the Ammassalik area in east Greenland.

During the progress of the ECOTIP project, significant ECOTIP results pointed to an environmental regime shift taking place in East Greenland (Heide et al. 2022). As the ECOTIP project progressed (2023-2024), WP4 therefore sought for opportunities to include LEK perspectives from East Greenland as well. New opportunities for local cooperation and cross-disciplinary integration developed with 1) recruitment of a team of local research assistants from Tasiilaq (2023) 2) workshop cooperation with the ICES Working Group on Integrated Ecosystem Assessment of the Greenlandic Sea (WGIEAGS) at Greenland science week (2023) 3) and participation in fishery seminar organized in Tasiilaq by the Greenlandic Ministry of Fisheries and Hunting, including an opportunity for further feed-back and dialogue with fishers from the area (2024).

The deliverable is organized to that it firstly presents the results of the ‘state of the art’ desk-top review of LEK observations. Subsequently, a report follows presenting in detail the LEK shared by fishers in the Ammassalik area.

## 2. Review of LEK observations of marine and fishery changes in Greenland: 2010 - 2025

The ECOTIP review included literature search in the scientific databases Web of science 2010-2025 using the following key words: Greenland AND indigenous knowledge; Greenland AND local ecological knowledge. The literature search aimed to include all Greenlandic studies working with LEK/IK observations of changes in marine ecosystems. Title and abstracts of all the resulting articles were subsequently reviewed to identify research focusing on marine species and environments specifically.

In supplement, a search for sources was conducted based in the researchers' personal knowledge of and communication with research projects with LEK/IK elements, including not least the Greenlandic community monitoring data base *Pisuuna* and the *Piniariarneq* co-operative mapping project. The literature search also included some unpublished research reports as well as unpublished interviews by the lead author. An overview of the identified sources (n=22) is listed in table 1. Of all these sources, only 9 contained actual information on climate-change induced changes in fish resources.

In summary, the review eventually identified only 9 studies and LEK/IK records of (assumed) climate change induced changes in fisheries. Holm's comprehensive review of climate change observations in Greenland from 2010 identified LEK/IK themes that has continued to surface since throughout the identified LEK/IK studies, including changing seasons and weather, warming sea temperatures and changing sea ice conditions. However, Holm's review contained were no specific reports on fish.

The Attu community (Disco Bay) of fishers and hunters had registered a decrease in cod in 2020, observing many small cods and only large cods once in a while. The sea around Attu was very fresh in 2020, probably causing the cod to go somewhere else. The cod seemed to swim down to deeper water, where the salt content is greater. In 2020 lumpfish had also decreased, only to be found in certain places. Interviews conducted in 2019 with fishers and hunters from Ilulissat Ice fiord by Schjøtt et al. (2022) reported on changing fishing sites and seasons due to decrease of sea ice and increased cod fisheries. The report by Hendriksen (2019) documents a small but growing fishery for Greenland halibut, which is also adapting to changes in sea ice formation. An unpublished fieldwork report from Northern Greenland in July 2018 by Hansen reported on a general assessment by local communities that fishing opportunities are increasing and fishing sites are expanding, especially for Greenland halibut but also for new species like cod. Capelin has been mentioned in different sources. In Arsuk, it was reported that capelin were larger and plenty in 2019, and that they had stayed for longer (until July). In Kullorsuaq, it had been reported that capelin had started to appear more in coastal waters in Kullorsuaq (time period for observation unknown) (Anastario et al. 2021).

In a recent Inuit Knowledge study of polar cod, Bouchard et al. (2022) fishers from Uummannap Kangerlua and Sullorsuaq generally report that abundance polar cod will normally vary from year to year. Meanwhile, Arctic cod is also observed to prefer the (changing) fresh melting water and being more absent where and when the sea temperature is warmer. By July 2022 the fishers had had a year with unusually few Arctic cod. An interview study from 2014 (Hedeholm, Jacobsen and Nielsen 2016) with cod fishers in the Nuuk fiord recorded LEK/IK observations of increase of cod, expanded gill-net cod fishing season and warming waters in the Nuuk fiord system. An unpublished interview by the author (2018) with the local chairman of fishery and hunter organisation in Narsaq, South Greenland, reported that it has not been possible to catch the cod down south, while other fishers say there are many cod up north. He also reported on changes in the fiord system, with fish staying out of the fiord (beyond the



reach of small coastal boats) and key prey species (small capelin) going down on deeper waters. A Greenland-wide survey of the Greenlandic populations' perception of climate change conducted in 2018-2019 by Minor et al. (2019). The survey allowed for comments and among these, reports are made of a warming sea resulting in halibut and shrimp moving north. A Greenland halibut fisher also reported on 'cod getting in the way'. There was also one report on more fish in the rivers in South Greenland. No sources of LEK/IK observations from East Greenland were identified with respect to fish specifically.

Table 1

Source	Region	LEK/IK reports on observed changes in fish resources (yes/no)
Schiott, S; Tejsner, P and Rysgaard, S. 2022. Inuit and Local Knowledge on the Marine Ecosystem in Ilulissat Icefjord, Greenland. Human Ecology.	Ilulissat Ice fiord	Yes
Minor et. Al. 2019. Greenlandic Perspectives in Climate Change 2018-2019: Results from a national survey (2018)	All of Greenland	yes
www.pisuna.org (Attu 2018-2020)	Disco Bay, Attu community	yes
Hendriksen, K. 2019. Isfiskeriet af hellefisk i Qaanaaq – kvalitet, udvikling og anbefalinger (Ice fishery for Greenland halibut in Qaanaaq – quality, development and recommendations). DTU Byg, Danmarks Tekniske Universitet report. <a href="https://www.dtu.dk/Files/000000000/190714_Notat_om_hellefisk_i_Qaanaaq.pdf">190714 Notat om hellefisk i Qaanaaq.pdf (dtu.dk)</a>	Qaanaq, North Greenland	Yes
Hansen, A. 2019. Notat. Lokale holdninger til fiskeri, bæredygtighed og fremtid i Nordvest Grønland (Local opinion on fishery, sustainability and future in Northwest Greenland). Unpublished report.	North Greenland (Upernavik, Innarsuit, Tasiusaq, Nutaarmiu, Nuussuaq, Savissivik, Moriusaq, Qaanaaq, Ilulissat)	Yes
Jacobsen, R.B. 2013 Torsken i Nuuk fjord. Fortalt fra fisker-perspektiv. (The cod in Nuuk. Told from a fisher perspective). Unpublished report.	Nuuk fiord	Yes
Hedeholm, RB; Jacobsen, RB and Nielsen, EE. (2016). Learning from 'apparent consensus' in TAC disputes: Exploring knowledge overlaps in LEK and genetic categorization of Atlantic cod. Marine Policy 69; pp. 114-120	Nuuk fiord	Yes
Bouchard, C., Farnole, P., Lyng-Pedersen, K., Dahl, PE., Christiansen, H. 2023. Arctic cod ( <i>Boreogadus saida</i> ) in fjord and glacial habitats: a collaborative study with Uummannap Kangerlua fishers. Arctic Science 9: 781–795.	Uummannap Kangerlua and Sullorsuaq, Northwest Greenland	Yes
Anastario, M., Rink, E., Reimer, GA., Peterson, M. 2021, More-Than-Human Intimacies and Traditional Knowledge among Hunting Families in Northwest Greenland. ARCTIC ANTHROPOLOGY, Vol. 58, No. 1, pp. 54–65	Kullorsuaq, Northwest Greenland	yes

<p>Holm, L.K. 2010. Sila-Inuk: Study of the Impacts of Climate Change in Greenland. In: Igor Krupnik, Claudio Aporta, Shari Gearheard, Gita J. Laidler, and Lene Kielsen Holm (Editors). 2010. SIKU: KNOWING OUR ICE; DOCUMENTING INUIT SEA-ICE KNOWLEDGE AND USE. Dordrecht: Springer.</p>	South, west and North Greenland	No
<p>The Piniariarnek Project: Inughuit hunters map their important hunting areas. Kasper Lambert Johansen, Janne Flora, Mads Peter Heide-Jorgensen, Anders Mosbech, Astrid Oberborbeck Andersen. Department of Ecoscience - Arctic Environment Department of Ecoscience - Marine Mammal Research 1Arctic Research Centre - Arctic Research Centre, Roskilde .</p>	East Greenland	No
<p>Jorgensbye, H and Wegeberg, S. and Kaiser, M. 2018. Mapping of marine sediments on the Greenland West Coast: contributions of fishers' ecological knowledge. ICES journal of marine science 75 (5) 1768-1778.</p>	West Greenland	No
<p>ICC atlas: Arctic char presence <a href="https://panda.maps.arcgis.com/apps/MapSeries/index.html?appid=8c2ab42be1ad4bab961d7fe88b279456">https://panda.maps.arcgis.com/apps/MapSeries/index.html?appid=8c2ab42be1ad4bab961d7fe88b279456</a></p>	Pikialasorsuaq (North Water Polynya)	No
<p>ICC (2017): People of the ice bridge: The future if the Pikialasorsuaq. Report of the Pikialasorsuaq Commission. November 2017.</p>	Pikialasorsuaq (North Water Polynya)	No
<p>Qikiqtani Inuit Association (2018). Qikiqtaaluk Inuit Qaujimagatuqangit and Inuit Qaujimajangit Iliqqusingitigut for the Baffin Bay and Davis Strait Marine Environment. Prepared by Heidi Klein, Sanammanga Solutions Inc. for submission to the Nunavut Impact Review Board for the Baffin Bay and Davis Strait Strategic Environmental Assessment. <a href="https://www.nirb.ca/publications/strategic%20environmental%20assessment/190125-17SN034-QIA%20Final%20IQ%20Baseline%20Report%20for%20Baffin%20Bay%20and%20Davis%20Strait-IEDE.pdf">https://www.nirb.ca/publications/strategic%20environmental%20assessment/190125-17SN034-QIA%20Final%20IQ%20Baseline%20Report%20for%20Baffin%20Bay%20and%20Davis%20Strait-IEDE.pdf</a></p>	Baffin Bay and Davis Strait, Nunavut	No
<p>Laidre, KL., Northey, AD and Ugarte, F. 2018. Traditional Knowledge About Polar Bears (Ursus maritimus) in East Greenland: Changes in the Catch and Climate Over Two Decades. Frontiers in Marine Science</p>	East Greenland	No
<p>Schiott, S., Jensen, MR., Sigsgaard, EE., Moller, PR., Avila, MD., Thomsen, PF, Rysgaard, S. 2023. Environmental DNA metabarcoding reveals seasonal and spatial variation in the vertebrate fauna of Ilulissat Icefjord, Greenland. Marine Ecology Progress Series 706; 91-108</p>	Ilulissat Icefiord	No
<p><a href="#">Nielsen, MR &amp; Meilby, H.</a> 2013. Quotas on Narwhal (Monodon monoceros) Hunting in East Greenland: Trends in Narwhal Killed per Hunter</p>	East Greenland	No

and Potential Impacts of Regulations on Inuit Communities. Human Ecology, Vol. 41, No. 2. pp. 187-203.		
Stirling, I; Laidre, KL and Born, EW. 2021. Do Wild Polar Bears ( <i>Ursus maritimus</i> ) Use Tools When Hunting Walruses ( <i>Odobenus rosmarus</i> )? Arctic, 2021-06, Vol.74 (2), p.175-187.	All of Greenland	No
Lennert, A.E. 2015. What happens when the ice melts? Belugas, contaminants, ecosystems and human communities in the complexity of global change. Marine Pollution Bulletin 107(1) pp. 7-14	Nuuk fiord	No
Rosing-Asvid, A., Löytynoja, A., Momigliano, P., Hansen, RG., Scharff-Olsen, CH., Valtonen, M., Kammonen, J., Dietz, R., Rigét, FF., Ferguson, SH., Lydersen, C., Kovacs, KM., Holland, DM., Jernvall, J., Auvinen, P., Olsen, MT. 2023. An evolutionarily distinct ringed seal in the Ilulissat Icefjord. Molecular ecology 32 (22) 5932-5943	Ilulissat Icefiord	No
Idrobo, CJ. & Berkes F. (2012). Pangnirtung Inuit and the Greenland Shark: Co-producing Knowledge of a Little Discussed Species. Human Ecology 40 (3) , pp.405-414.	Greenland	No

Having identified considerable gaps in the available LEK sources, WP4 subsequently engaged with the fishing industry and fishing communities throughout the west-coast of Greenland to provide an updated LEK-based account of ‘the most significant’ changes observed in Greenlandic fisheries in the context of changes in the wider marine ecosystem. The first results were published in D4.1 (2022) and related to the offshore fishery and the coastal fishery on the west-coast of Greenland, including an analysis of the adaptation capacity in the fisheries. The East-coast had not been included in the original research design and D4.1.

Subsequently, a LEK study was added for the Ammassalik area in East Greenland.

### 3. Recent changes in Ammassalik area – knowledge shared by Ammassalik fishers in 2023

#### 3.1 Ammassalik fisheries

The East Greenland coastline is 2.700 km long. Roughly 3.000 people inhabit the area, concentrating in the settlement areas of Ammassalik and Ittorqqortormiit. Most people live in the Ammassalik area, which consist of Tasiilaq town (counting 1.904 inhabitants in 2023) and 5 villages: Sermiligaaq (189), Isertoq (63), Kulusuk (226), Tiliqilaaq (93) and Kuumiut (250). The population number has been slowly declining with 110 persons since 2020 (Nalakkersuisut 2024). Hunting has a long tradition in both Ammassalik and Ittorqqortormiit where the mixed subsistence/cash economy is still very present. Commercial fisheries, on the other hand, is a more recent story and landings are rather low compared to West Greenland. In 2018-2022 the number of fishers landing catches to the one landing site in the Ammassalik area (the Arctic prime Fisheries' landing site in Kuumiut) fluctuated between 57 and 82. They were primarily landing cod and Greenland halibut, though also some capelin and catfish. Most fishers (60%) made less than 50.000 DKR per year from the fisheries, assumingly engaging in a mixed economy with other income sources e.g. from hunting. The Greenlandic government launched a development plan for fishery in the region in 2024, aiming to "...secure an economic, social and scientifically sustainable development of the fishery, which can contribute to self-support, self-sufficiency and employment in East Greenland" (Nalakkersuitust 2024;28). In 2023, Royal Greenland has started to build a fish factory in Tasiilaq.

The scientific exploration of coastal fishery resources in East Greenland is very sparse, and so are the results from the few private 'exploratory fishing' excursion in the area (Nalakkersuisut 2024). A report however shows, that when H.C. Petersen and H. Siegstad back in 1988 interviewed local hunters to 'register the living ressources' in the area (mapping also wind patterns and fish locations) they identified various mammals and the following fish ressources: Atlantic cod (*Gadus morhua*), Polar cod (*Boreogadus saida*), Uvak (*Gadus ogac*), Greenland halibut (*Reinhardtius hippoglossoides*), Atlantic halibut (*Hippoglossus hippoglossus*), catfish (*Anarchichas minor*), Arctic Char (*Salvenus alpinus*), salmon (*Salomo salar*), redfish (*Sebastes marinus* and *Sebastes mentella*). In addition, American Plaice (*Hippoglossoides platessoides*) was known to the area and squids were observed in the stomach of seals and narwhales (Petersen no year).

The ECOTIP interviews with fishers in 2023 provide further details on ecology of the area with a special focus on the changing nature of fish resources and environment. Coastal fishers shift between multiple species according to season, physical and technological accessibility as well as marketing options and landing prices. Generally, the interviewed fishers engage in various hunting activities (whales, seals and polar bear) and combines this with a long-line fishery for Greenland halibut and cod for sale and own consumption. Some fish capelin for bait and Arctic char for own consumption.



Figure 1: Map of Ammassalik area, Greenland.

### 3.2 Method

The interview study was designed in cooperation with the interviewers, Mathane Namminersortoq and Anna Burdenski, local inhabitants and fishers in the Ammassalik area. Furthermore, the interview guide included questions about Polar Cod specifically which were co-designed by Caroline Bouchard from the Greenland Institute of Natural Resources. All interviews were conducted in the fishers' first language (East- og West Greenlandic) and synthesized into Danish resumes by the interviewers. Fishers were contacted prior to the interview, informed about the purpose of the interview which included sharing of knowledge with research communities, managers and media. Interviewees were presented with the semi-structured interview-guide (see appendix A) prior to the interviews and all fishers have been promised anonymity.

The interview study eventually included 8 fishers from throughout different towns in the Ammassalik area: Tasiilaq, Ammassalik, Tiilerilaaq, Kuummiut. The sample of fishers was sometimes based on a 'collective selection' in which some local fishers declined the invitation to interview and referred to what they perceived as the most knowledgeable fishers in their area, who then agreed to participate in the interview. In this way, fishers collectively sought to increase the validity of the local ecological knowledge through the inclusion of the – in their opinion - most knowledgeable fishers.

The interviews were conducted in May-July 2023. WP4 researchers subsequently attended a 3-day fishery seminar in Tasiilaq in April 2024 to acknowledge and present the outcome of the study and to inform about how the local knowledge is shared. 9-12 fishers participated in this seminar, including some of the interviews. The seminar was an excellent opportunity to continue the dialogue and so for example, more information was shared and more (improvised) mapping were provided by fishers, which has been included in this report.

The report synthesizes observations across all the interviews and dialogue that has been had, organizing the knowledge into distinct (yet interconnected) accounts of changes to different phenomena – starting from the physical landscape and weather, to marine environment and eventually, a broad range of locally relevant fish and mammal species.

### 3.2 Physical changes

#### Observations of glaciers

In the Ammassalik area, placed within the fjords of East Greenland, the locals have long relied on the cyclic phases of nature for their livelihoods. Among the various natural phenomena that shape their lives, the glaciers hold a particularly significant role. For generations, locals have observed the behavior of the glaciers, noting subtle changes that have occurred over time. The interviews offer a firsthand account of the observable impacts of glacial melting on a coastal community in East Greenland. Through the lens of local fishers, it highlights the multifaceted consequences of climate change on both the marine ecosystem and human activities.



A local fisher talks about the observed consequence of the ice sheet melting; “regarding the melting glacier, there is now more mud in Sermiligaaq Fjord”. As noted in the interviews, one of the primary effects of the melting of the glacier, is the increased sedimentation in the fjords, to which a second fisher replies, “I have noticed near rivers that there is so much mud coming out into the sea (...) When that much mud comes out, it can reach the towns beach”. Another fisher points to the same topic that “as the ice sheet melts, soft mud is found at the seabed at a depth of around 200 meters”. As the glaciers melt, they release an abundance of sediment into the fjords, altering the marine environment. The melting ice from the inland glaciers carries sediment downstream, depositing it on the bed of the fjords. The increased presence of stones and mud makes it challenging for fishers to operate their long lines effectively. Near the river mouths, the influx of sediment into the sea is particularly pronounced, further complicating fishing activities. One fisher describes that, “when the glaciers break apart, big rocks come to surface, so when it melts, the big rocks sink to the bottom, making it hard to fish there. Now I go elsewhere in Sermilik Fjord. It’s the same at Ikaasatsivaq, there are many rocks in the water from the glacier”. The perspective of the challenges to fishing practices is also shared by another fisher; “I’ve tried the long line at Sermilik Fjord, but there are lots of stones at the bottom of the water, so I couldn’t get the long line up again”.

The melting inland ice also causes changes in wind patterns. The interviews reveal how over the past two decades, the predictability of weather patterns has diminished. They highlight the unpredictability and suddenness of weather changes, attributing them partly to the melting of the inland ice sheet. One fisher shares his observations with the melting of the glacier and the observed effects on the wind; “The melting of the ice sheet has made the winds more sudden, and the direction has changed”. Another fisher talks about how predictability and forecasting of weather means a lot for his ability to plan his workday; “before weather forecasting, we just looked at the sky and estimated what the weather was going to be like”. Another fisher joins in on this point by saying that; “our weather here in East Greenland has changed. I mean, it's always changing, but even though I usually know the weather, it has become more difficult for me to foresee weather changes, because it happens so quickly”.

### Observations of changing sea ice

In connection to observed changes to sea ice, several topics were revealed during the interview; decline in sea ice duration, thinning of ice, early formation and melting of drift ice, and impact on traditional activities.

In 2023, a fisher noticed a significant difference in the amount of sea ice compared to the previous year. He described how in 2023, the sea ice seemed thicker and vaster, than what is usually the case for the area. This observation evoked memories of past days when the sea ice extended all the way into the fjords around Tasiilaq; “when I was young, I started going with hunters when they went on hunting trips. The sea ice then came in late November or early December. And it was very thick sea ice at that time. But now, things are different”. The first time one of the fishers remembers the sea ice starting to change was about 40 to 30 years ago. Back then, it wasn't uncommon for the sea ice to fill the fjords, and it was thick enough to sled on with dogs as early as November or December. The fisher shared that; “in the 1980s sea ice came into our fjord. But in the early 90s, we only briefly had sea ice. We would have it for about 1 month, and then it would be gone”. Likewise, another fisher states that the sea ice has seen significant changes in the past years; “when we were younger, we would go dog sledding in June, and the sea ice towards Tunu wouldn't break up until July”. Thus, the ice was considerably thicker and more

**D4.4. Marine Biodiversity and Greenlandic LEK: With new contributions from the Ammassalik area, East Greenland**  
stable, lasting longer. Drift ice used to form as early as October or November and wouldn't disappear until midsummer.

But since the 90s, there has been a noticeable change. The interviews revealed that, in recent years, significant changes have been observed in the behavior of sea ice; “since the early 2000s, it can take until January before the sea ice forms, and when spring comes, the sea ice melts very quickly”. Reflecting on the changes witnessed in his lifetimes, a fisher recalled a time when sea ice would persist until late into the summer months. However, since the turn of the millennium, the disappearance of sea ice has accelerated, with once-thick ice giving way to thinner formations that melt at an increasingly rapid pace, signalling a departure from historical patterns. Now, from the early 2000s, the drift ice disappears as early as June and the ice isn't as thick as it used to be. The sea ice is only present for a short time around the coast, where it enters the fjord for about a month before disappearing again. It's no longer possible to rely on the ice lasting the whole winter. The fisher remembered how he, in recent times, have been able to sail his boat in June, as the sea ice formation typically arrive late during January, and starts to melt quicker throughout the spring. In some areas, such as near the settlement of Kulusuk, inland ice has vanished entirely over the past five decades, revealing previously unseen terrain beneath. To this, a fisher shared; “there is an ice sheet near Kulusuk called Apusiaaik, the ice sheet has completely melted over the last 50 years. When I first sailed into the Apusiaaik Fjord, it was only possible to an island near the coast because the inland ice sheet was bigger back then. Now there is no longer inland ice in the sea, everything is on land and when there is low tide, you can see the sea floor”. This observation indicates a significant reduction in the overall duration of sea ice cover together with the retreat of glaciers on land.

The interviews highlight significant changes in sea ice patterns observed by the fisher over the years. The disappearance of inland ice over the past five decades, and the visible changes to the sea ice formation serves as a stark example of the rapid physical changes occurring in East Greenland. Such changes are by the fishers presented as having far-reaching implications for both local communities and the broader ecosystems. The comparison between the past and present underscores the severity of the alterations in sea ice dynamics. The changes in sea ice patterns have significant implications for traditional activities like fishing, hunting, and transportation. But in the face of these changes, the locals seem to adapt, drawing on their skills and knowledge to navigate the uncertainties of a changing landscape. Yet, even as they adjust their practices, they remain ever mindful of the profound impact that the changing climate continues to exert on their way of life.

The recent retreat of glaciers is illustrated in the map in figure 2 by red dotted lines. At the fishery seminar in April 2024 the fishers began, at their own initiatives, to ‘update’ the glacier fronts on the printed maps available in the room. The data for the printed map are primarily from the summer months between 2017 and 2021.





Figure 2: Glacier retreats illustrated by red dotted lines.

## Observations to weather patterns in East Greenland

In recent years, there has been observed an increase in storms in East Greenland. Sometimes, storms lasting a whole week occur, greatly impacting fishing activities. These storms appear suddenly, forcing fishers to abruptly halt their fishing trips. A fisher explained his observations; “during the last 10-15 years, the weather has changed a lot. Sometimes it can suddenly become windy and vice versa. I've noticed the weather has started to change much faster than before and this causes problems for us fishers as ocean currents shift, and sea temperatures change”. Another fisher shared how one moment it rains, the next the sun shines, and then something entirely different occurs. Likewise, he shared that; “it started with stronger storms in the last few years. Sometimes there is a whole week of storm piteraqaq and neqqajaq, so it is difficult to go fishing. The storms also come faster, so you suddenly must go home from the fishing trip”. In one interview, the sudden and drastic change to the weather illustrates the profound impact on the fishing industry in East Greenland, affecting fishing as it becomes more difficult to plan fishing trips under such conditions. During the transition from autumn to winter the wind sometimes reaches hurricane force. A fisher shared that; “during the last 10-15 years, the weather has changed a lot. Sometimes it can suddenly become windy and vice versa.”. Another fisher shared his experience with the risk to their livelihood, experiencing sudden gusts of wind, risking the loss of their fishing gear; “as I said, there can be unexpected winds, such as piteraqaq. Last year in Tasiilaq, a lot of equipment was lost, it's like a catastrophe. Greenland's weather has changed a lot”. The fisher emphasizes the challenges faced by fishers, including damage to the equipment and risks to safety due to weather. The interviews depict a sense of concern among fishers regarding the significant alterations and extreme character of weather patterns, which according to them have intensified over the past decade.

However, in the year of 2023, the weather seemed different than in recent years. The winds have been observed as weakened and fishers can sense that the storms are not as intense as in previous years, however more of them is occurring. A fisher observed that; “winds have become weaker this year, when piteraqaq is happening you can feel it is not as strong as last year”. Hence, fishers are also very alert to the year-to-year variation, including underlying dynamics driving local weather patterns.

### Observations of a warming sea

Interviewees touch upon the warming of ocean currents affecting fish populations. One fisher reflected on the connection between warming currents and new species: “I think it is possible to feel climate changes. The sea current has become warmer and other types of fish are arriving, other types of salmon for example”. Another fisher reflected on the role of warmer currents and cod, today and historically: “I think the warmer currents are getting closer and that is why the fiords do no longer freeze around Tasiilaq. Maybe this is also the reason why, again, more cod is coming – because of warmer currents. When I was a child, there was a lot of cod everywhere around here, even though it was very cold here. Maybe the sea was warm even though the weather was cold?”. One fisher shared that he primarily experienced global warming in connection to the sea: “(...) I haven't noticed the climate itself changing much, but mostly I've noticed the sea, which has gotten much warmer” Thus, the fishers share the observation, that one can feel the climate change in phenomena like the warming of the sea, the sudden changing and intensification of winds, and changes to the arriving of different fish species in their coastal area.

## Summary

The interviews conducted with local fishers in East Greenland reveal the profound and multifaceted impact of glacial melting and climate change on both the environment and traditional ways of life. Through the experiences of local fishers, it becomes evident that melting glaciers significantly alter the marine ecosystem and thus human activities. Glacial meltwater intensifies sedimentation in fjords, presenting challenges to fishing due to increased presence of stones and mud. Significant alterations to sea ice over the years have been observed, including declines in duration, thinning, and earlier formation and early melting of drift ice. Fishers recall thicker and more stable sea ice in their youth, contrasting it with the thinner, less persistent formations of recent times. The disappearance of inland ice over the past five decades and visible changes in sea ice patterns serve as examples of rapid environmental shifts, affecting traditional activities like fishing and hunting. Moreover, the interviews shed light on the observed increase in storms in East Greenland over recent years, profoundly impacting fishing activities. Fishers note sudden and drastic weather changes, with storms arriving unexpectedly and causing equipment damage and safety risks. However, amidst these challenges, there are also intriguing observations, such as weaker winds following a year with intense storms. Discussions about the effects of global warming on weather patterns highlight the interconnectedness of environmental changes and traditional livelihoods. The insights gathered from the interviews emphasize the need for adaptive strategies in the face of climate change, emphasizing the importance of understanding and mitigating its impacts in terms of safety, vessel technology and weather forecasting as well.

### 3.3 Changes to marine environments

#### Observations of seaweed

In the interviews, several observations by the fishers portray significant changes in marine environments in East Greenland. Regarding observations to seaweed, the interviewees shared insights into temperature shifts, salinity and nutrient content, seaweed growth and distribution changes.

One fisher recalled colder waters in the past, sharing how his father would tell stories about how they would venture out onto the icy waters to gather seaweed by cutting through the ice to reveal the seaweed frozen below. Nowadays, however, the frozen seaweed is nowhere to be seen; “my father, when I was a kid, used to tell stories - when you cut open the sea ice to harvest seaweed, it used to be completely frozen. Maybe back then the sea was very cold, but it's not like that anymore”. The fisher speculates about reduced salt content affecting the seawater's nutrient levels, as he says that changes in salinity can disrupt the balance of marine ecosystems, affecting the growth and distribution of marine flora and fauna. He notes that during winters with less rainfall, he finds fine seaweed beneath the ice.

During the interviews, the fishers shared how the older generations would share tales about marine plants, including seaweed, which has seen a change in growth and longevity; “the previous generation tell us about the many plants from the sea, such as seaweed, which back in the days was only about 20 cm at its longest. But today's seaweed can reach up to 50 cm. You could maybe say that the plants in the sea are starting to live longer”. Likewise, one fisher shared, that; “in the past, when we sailed north to Kangerlussuaq, we never observed seaweed. But today there is seaweed everywhere and it's getting longer and longer”. Seaweed's distribution thus has expanded significantly, evident from its presence even in areas previously devoid of it. A fisher explains that there is a lot of seaweed in the fjord, and during autumn, large amounts of seaweed emerge; “it becomes very difficult to put out nets because



there is so much seaweed”. Thus, fishers experience difficulties setting their nets because they get entangled in the seaweed in the fjord.

Though several of the interviewees shared their experience with the growing amount of seaweed and the plant’s physical changes, a fisher explains, that he himself has not experienced changes to the sea plants. However, he has knowledge of places where people go and harvest sea plants such as seaweed, and that these people observe a lesser amount of seaweed than before; “there are places where people collect and catch seaweed where there is not much left”. He also explained that; “I also don't know how fast seaweed grows, but I don't think seaweed grows very fast because I can see seaweed and plants are not very abundant where people usually come and collect them”.

### Observations of prey/predator relationships

During the interviews, evolving dietary habits of Arctic char and other fish species were communicated. There seems to be a noticeable shift in the diet of Arctic char, cod, and Greenland halibut over the past decade. Previously uncommon prey items like small squids, lumpfish, and shrimp are now frequently found in the stomachs of these fish. As the Arctic char return to the lakes in the autumn, east Greenlandic fishers observe a change to the fish’s stomach content. A Fisher explains how he has fished for Arctic char and found their stomachs packed with this newfound prey; “about 10 years ago, it was new to us that the fish had small squid, small lumpfish, and shrimp in their stomachs”. Another fisher said that he doesn't typically inspect the stomachs of the fish he catches, but while observing the Arctic char caught near the islands between Kulusuk and Sermiligaaq he noted that; “when we catch Arctic char in the fall, when it's on its way back to the lakes, we see it has small squid and small lumpfish in its stomach. There are also usually some small shrimps in the stomach of the Arctic char, we just don't know if they will be big. I’m sure the squids and lumpfish are coming closer and becoming more. Because Arctic char is frequently caught with lumpfish and squid in the stomach”. These accounts suggest changes in the availability or distribution of prey species, potentially influenced by environmental factors.

Yet, it's not just the Arctic char experiencing these dietary shifts. Other fish, like cod and Greenland halibut, have also seen changes in their feed preferences. Traditionally, fishers would find mainly shrimp in the stomachs of cod and Greenland halibut. A fisher shared that; “cod and Greenland halibut, they usually have shrimp in their stomach”. But now, even the cod's menu seems to be evolving as a fisher shared that; “the cod's stomach contains small squid and small shrimp; this hasn't changed for several years. But I've noticed there are now more and more shrimp in the stomach because it's getting warmer and warmer”. Thus, the fisher speculates on potential causes for these dietary shifts, such as warming waters leading to an increase in shrimp populations. The observation of changes in food abundance adds depth to the narrative of ecological shifts, prompting to consider broader ecosystem changes. In particular, the role and increase of small shrimps, lumpfish and squid.

### Summary

The interviews with fishers in East Greenland provide insights into significant changes occurring in the marine environment, particularly concerning seaweed abundance and the dietary habits of key fish species. Fishers recall colder waters in the past, where seaweed would be frozen beneath the ice, contrasting with the present absence of such occurrences. Speculation arises regarding the reduced salt content affecting seawater's nutrient levels, potentially impacting marine ecosystems. Furthermore, smaller seaweed sizes in past times, contrast with current observations of larger seaweed sizes and

increased distribution, which pose challenges for fishers. Despite variations in personal experiences, there is a consensus on the changes to seaweed abundance in certain areas, indicating potential ecological shifts. Moreover, the interviews highlight a notable shift in the dietary habits of Arctic char, cod, and Greenland halibut over the past decade. Previously uncommon prey items such as small squids, lumpfish, and shrimp are now frequently found in the stomachs of these fish, suggesting changes in prey availability or distribution possibly influenced by environmental factors. Fishers attribute these shifts to warming waters, indicating broader ecological implications. Overall, the interviews highlight the importance of continued ecosystem monitoring and research to understand and mitigate the impacts of environmental changes on marine ecosystems in East Greenland.



Figure 3: Stomach content and whale observations.

### 3.4 Changes to fish species

#### Observations of polar cod

The interviews with local fishers to east Greenlandic waters, suggests a significant decline in polar cod populations in Greenlandic fjords since the late 1900s. The interviewees unfolded as a story charged with questions about the once abundant polar cod, an important fish for the fishing industry, leaving the local fishers from these coastal communities contemplating the whereabouts of this species.

Seasoned fishers from settlements such as Kuummiut and Sermiligaaq explained about past times when polar cod was a common species to catch; "when I was a child, we used to catch a lot of polar cod just outside Kuummiut, just below Kuummiut, in the small fjord (He pointed to the pink line in the map). But they are no longer there, they just disappear. Maybe you can find them elsewhere. I have heard that you can still catch them in the Isertoq area". The questions about the polar cod's whereabouts are shared by another fisher as he linked the routes of the polar cod to the warming of the sea; "For the past 30 years there have been polar cod close to Kuummiut, mostly caught during winter. But as soon as spring arrives, the polar cod move to colder waters, probably because the sea temperature rises in the summer. In recent times one doesn't catch as many polar cod anymore". Another fisher explained; "as I said, there was a lot of polar cod around Kulusuk a long time ago. Back then, when we go seal hunting, we can see lots of polar cod in the sea. But right now, you can't spot the polar cod". The fishers observed that polar cod is hardly fished in the area anymore, further contributing to the picture of a polar cod (fishery) that has becoming a shadow of its former presence.

Polar cod exhibit distinct seasonal patterns in their distribution and behaviour, being observed to typically be present from February to March and then disappearing with the arrival of capelin in April-May. A fisher shared in length and detail the progress of the polar cod's presence and how they from 10 years ago were no longer to be found as before; "in the past, we ate a lot of polar cod, but we used it mostly as bait. When the polar cod was to be found here, it mostly showed up during February-March. In April-May, when the capelin arrived, the polar cod disappeared. When the polar cod was here, you could catch them in very deep water and some of them would stay at the edge of the ice, at the surface of the water. You just had to sink the hook just below the surface. But some polar cod can dive down to around 40 meters. If we look back 10 years, the polar cod was no longer to be found in the fjord. It has become increasingly rare to catch polar cod in this area. I have never seen the polar cod spawn, only a few times I have tried catching polar cod with roe. I don't know where they breed". The fisher noted polar cod's ability to inhabit both deep waters and surface ice edges, with variations in depth ranging from surface-level to depths of up to 40 meters.

Historical accounts from the fishers offer a glimpse into the ecosystem of the region. Polar cod, once a staple catch just like Greenland halibut and redfish, now rarely get into the fishers' nets. To this a fisher shared that his own experience was, to stop fishing for polar cod, as it is not worth the work; "we used to fish polar cod with nets because we use them as bait, but in recent years we haven't caught as much as we used to, so we've stopped fishing them. And we don't bother trying to fish polar cod in the winter because it's not worth the effort". The following explanations showcase how the different fishers have each of their personal experience with fishing for polar cod. Some explain that they always know where to find the polar cod and others that they simply don't go for them anymore. One fisher shared that; "I don't know what to tell about polar cod, because I don't usually fish them anymore. I only know two

places (he points to the pink line on the map) where I always find them, at Isertoq and Sermiligaaq. There I can always find them if I want to, but I don't usually go for them". Another fisher shared a different perspective, where he explains that he no longer knows where the polar cod has moved to; "in the past, when we used to fish with gillnet, we sometimes caught the big polar cod, but it was rare. I usually use the polar cod as bait because the Greenland halibut love polar cod, and after that, it's cod meat and catfish meat. We also use freshly caught capelin as bait. I used polar cod mostly as bait when I fished for Greenland halibut. But I'm not sure where the polar cod has moved to, as you can no longer catch them". He further adds to the discussion on the apparent disappearance of the polar cod, by explaining that nothing about its whereabouts can be said with certainty; "they may have moved to a colder place. When one sails north to catch seals, the seals have some polar cod in their stomachs as well as small lumpfish. It's mostly in the surrounding area of Kuummiut that I usually catch polar cod. (...) We can't say the polar cod has disappeared, but it has become very rare that we catch polar cod. Maybe the polar cod have moved to deeper waters where the Greenland halibut feeds on them".

Though the causes behind this decline are a matter of speculation among the fishers, many attribute it to the warming of the sea, suggesting that the polar cod may be seeking refuge in colder waters as temperatures rise during the summer months. Others point to predation by cod and Greenland halibut, which prey upon the decreasing polar cod. A fisher shared in detail; "the last couple of years not many polar cods are left, they almost disappear because cod eat so many of them or they move north to colder places where there are also not many cod. I used to fish polar cod all over the area of Ammassalik Island. Not anymore, but I still see them at Helheim Glacier, maybe because of the cold from the ice coming down from the glacier, but maybe also because the cod are usually not there". The fact that cod and Greenland halibut eat polar cod and that this could be an answer to the questions regarding where the polar cod is going and why, is supported by the fisher's knowledge about fish habitat; "there are a few Greenland halibut and cod that eat polar cod, even if the Greenland halibut is on deep water. So, it's safe to say that the polar cod is also in the deep waters".

The disappearance of polar cod coincides with the arrival of new, unfamiliar fish species; "when I was younger, Greenland halibut, polar cod and redfish were very common. But in recent years, new fish species, that we've never seen before, have arrived. He and his fellow fisheries colleagues' observations, signal a broader ecological transformation unfolding beneath the surface of East Greenland's seas, indicating broader shifts in Arctic marine ecosystems. This reflects the complex interplay between species within marine food webs and the ripple effects of changing ice habitats. Statements like these from the fishers on environmental factor pushing the polar cod's habitat, aligns with broader trends of climate change impacting Arctic ecosystems.

Despite efforts to adapt, such as shifting focus to other bait sources like capelin, fishers find themselves facing future adaptation to their fishing practises. Traditionally, polar cod served as an essential food source and bait for Greenlandic communities. Fishers utilized polar cod for subsistence, with leftovers often fed to sled dogs; "when I have caught polar cod, we eat it and when there are leftovers, the dogs eat it". The decline in polar cod populations has also impacted traditional fishing practices, with fishers resorting to alternative bait sources and targeting other commercially valuable species. A fisher shared that; "we've lost track of where the polar cod has gone, as we've started to focus on capelin as our priority for bait", and; "in the 1970s, there was a lot of polar cod which we used as bait. Today, one can't catch polar cod at all". Another fisher adds to this by sharing observations to the size of the polar cod; "polar cod in this area, as I said in the beginning of the interview, they have become smaller and smaller.



I used to be able fish them in Sermiligaaq fjord and Kuummiut fjord, but there are almost none left. I no longer catch them. It's rare that polar cod get caught on my fishing line or hook. I can't even remember the last time it happened. When they come as bycatch, I usually use it as bait. But because I don't fish for them anymore, I can't say anything about good or bad years, I just don't usually see them anymore, maybe they're in the depths where it's colder?". These firsthand experiences and observations explain the human dimensions of environmental change already foregone, emphasizing the interconnectedness between natural resources, cultural practices, knowledge, and livelihoods in East Greenlandic contexts.

## Observations of cod

Within the historical scope of the fishers' reflection on cod in East Greenlandic waters, a contrast emerges between past abundance, and the abrupt decline experienced in the 1990s. Cod fishing has long been a crucial aspect of East Greenland's economy and culture, and over the years, fluctuations in cod populations have had significant impacts on the livelihoods of local fishers and the wider community.

Ammassalik fishers' recollections from the 90s witness the fluctuating cod dynamics in East Greenland. In detail, three fishers explained how cod has a history of disappearing from the waters, while not for long. They depicted a period of absence, with decreasing cod numbers, followed by an increase and abundance after 5 years; "20 years ago, the cod disappeared, but after 4-5 years they came back, and they were very abundant", and "cod sometimes disappears, in the 90s there was almost no cod, only very small amounts, but they come back in abundance". Likewise, a third fisher shared that; "Ever since the 1960s there have always been spawning cod here, but it started to disappear during the 90s. But after 2010, the big cod returned to the fjords and the population grew and grew. For the past 5 years, you can always find cod in the area". Thus, the fishers observed how cod has increasingly returned, marked by the return of sizable cod to the fjords in 2010.

This rebound has been particularly notable in the autumn months and during the interviews, the fishers explained how they had noticed how the cod places itself into specific waters; "during our childhood cod were everywhere, but in the past years, I've noticed some specific places where the cod is, mostly in the fall. I've also noticed cod have started to reside in our fjord, not very big cod. I've noticed, that in the last 5-10 years the cod have returned in the area. And during fall we have lots of cod here in the area". Another fisher shared that; "cod has come back well after 2015, but mostly in the autumn and I think it would be a good idea to start selling other fish species, such as Arctic char and salmon".

These experiences point towards a discussion of environmental factors, which play a key role in shaping the distribution, feeding, spawning, growth, and abundance of cod stock(s) in East Greenland. A fisher experienced that; "in the 1950s and 60s, they were only about 60 cm long. In the last couple of years, they reach 1 meter. The cods come from the deep waters and feed well on capelin when the capelin is on their way to deeper water". To this another fisher supported with observation of the size of the cod; "the cod stock is increasing, I have heard there are more and more cod (...) But you can definitely feel that the cod population is returning also the size itself, some of them grow very large". A fisher adds to this perspective, by reflecting on environmental factors for the abundance and placement of cod; "when I was younger, there was lots of ice and everything was frozen, not anymore (...) I think the warm currents are getting closer, so it might not freeze in the fjords around Tasiilaq anymore. Maybe that's why there are more cod again, because of warm currents". The fishers' accounts highlight the impact of changing climatic conditions on fish behaviour, as warmer temperatures and shifting currents are through

observations believed to have influenced the return of cod to the region. The receding sea ice cover in recent years has coincided with increased cod sightings, suggesting a correlation between temperature rise and cod distribution. Likewise, alterations in prey availability, such as the findings of small shrimp in cod stomachs, or the observations of the locations of the cod, also give insight into the complex ecological dynamics at play. A fisher explained; “when I think about the last 30-40 years, there was cod all year round in the whole area, especially a lot at Kuummiut fjord - where the cod usually eat polar cod, because there is some special thing in it, for the cod”. This experience from the fisher hints at potential shifts in migration patterns or feeding habits in connection to the fish that cod feed on.

Cod fishing holds deep economic significance for the communities of East Greenland, rooted in trade practices throughout many years. The resilience of East Greenlanders in navigating shifts in fish populations reflects a profound connection to their maritime heritage and an attitude of resourcefulness in the face of uncertainty. However, the fishers’ experiences are not lacking cautionary undertones. In the backdrop looms the presence of environmental change, manifested in shifting ice patterns and warming currents, observed by the fishers as a challenge to both their livelihoods and ecological integrity. A fisher shared that; “the cod arrives sometimes quite early in the year, mostly when it has not been very cold during April and May, then they arrive to our area already in the middle of July”. His experience highlights, that even the smallest changes to seasons have a great impact on fishing and hunting practices in his community. The recent diesel spill from the local airport also serves as a reminder of the interconnectedness between human activities and ecological realities. To this, a fisher shared that the abundance of cod may be affected by this recent event; “I’m not sure if there will be so many (cod) this year because of the diesel spill from the airport. It’s going to be interesting”.

### Observations of Arctic char

During the period spanning from June to September, the Arctic char emerges as a significant target species within Ammassalik fisheries. Following the fishers’ observations, within this temporal window, the Arctic char’s presence is abundant in several locales across large areas. One fisher explained how the population of Arctic char seems to grow and how more and more locals are now fishing for Arctic char; “I’ve noticed the population of Arctic char has increased significantly, there are more people catching and fishing Arctic char. It’s best to fish and catch Arctic char when the season starts until the Arctic char arrive in the lakes in the mountains in the fall. But you can easily catch Arctic char all summer long. People think they taste the best when the Arctic char have put on weight in July and August”.

A local fisher gave his detailed description of when and where to fish for Arctic char; “Arctic char can be caught from June to September. Arctic char can be caught everywhere, in many different places; each (fisher) has their favorite spot – for example, Ningerduluk – all the way up there, you can catch Arctic char – people usually do it from Sermiligaaq, also all the way south to Skjoldungen, a deserted village further south from Isertoq”. With Arctic char fishing in Greenland spanning from June to September, coinciding with their migration patterns and availability in different bodies of water, the fishers mention numerous fishing spots across the span of Greenland’s waters, with distinctive places emerging as favoured fishing grounds, exemplified by Ningerduluk and Sermiligaaq in the northern parts of the Ammassalik area, and extending southward to the area of Skjoldungen. Navigating the elaborate fjord systems, one fisher explains about fishing grounds such as Naddiviit, Kaporniakkad, and Qiddalikka ernivia and into the Sermilik fjord. In details he explained the extensive area for fishing; “people from

Sermiligaaq usually go to Kangerlussuatsiaq to catch Arctic char. There are also places like Ningerdulu and Duddili. I also go to Kuummiut (fjord) to fish Arctic char in Tiaqqa. Naddiviit is the place I have sailed the furthest to catch Arctic char, my friend Bent has sailed all the way to Skjoldungen to fish and catch Arctic char.

Insights into the migration and feeding habits of Arctic char provide valuable information for understanding their ecology and their diet throughout its migratory journey from oceanic depths to inland lakes. A fisher has observed how; “the Arctic char in Kulusuk might have a certain route when they enter the ocean, then they swim around and get fat until they swim back into lakes. I think most Arctic char areas are like that. I've noticed the Arctic char in Kulusuk, they swim down into the ocean, get fat, and come back up to the lake where they came from”. In connection to the migratory route for the Arctic char, the fishers give insight into Arctic char’s diet, including capelin and small shrimps, shedding light on prey item’s role within the local ecosystem. One fisher has observed that; “when we catch Arctic char in the fall, when it's on its way back to the lakes, we see it has small squid and small lumpfish in its stomach. There are also usually some small shrimps in the stomach of the Arctic char, we just don't know if they will be big”. The observations of Arctic char consuming squid and lumpfish during their migration back to lakes in the fall is by the fisher attributed to; “squid and lumpfish are getting closer to us”, pointing towards these prey items and Arctic char to reside the same places. Another fisher supported this observation by explaining; “I haven't tried to feel the stomachs of the fish I've caught, but when I caught Arctic char at the islands between Kulusuk and Sermiligaaq I noticed their stomachs contained small squid. The Arctic char was at sea, and they were eating 1-2 cm long squid. I don't know where the Arctic char caught the small squid and at that time, I noticed that many Arctic chars had squid in their stomachs”.

Notable mentions from the fishers, of new Arctic char variants, points towards at broader ecological changes occurring in East Greenland's waters. A fisher speculate on the reasoning for the growing size of Arctic char and on new Arctic char variants arriving; “I've noticed the size of the Arctic char has gotten bigger since restrictions have been put in place. You've also noticed the temperature rising. There are more species of Arctic char and more species of salmon arriving in September”. Beyond the immediate utility of Arctic char as a food resource as explained by fishers, the importance of the fish transcends into broader socio-economic spheres; “when we catch Arctic char, we put them in freezers and some of them are hung to dry. We also eat them while they are fresh” and “I usually catch them in Sermilik Fjord, Kuummiut Fjord, but I like it best when their fillets are very red. Of course, all taste good, but the ones with strong red colored meat are the best”. Preservation techniques, ranging from freezer storage to air-drying, facilitate prolonged utilization of Arctic char resources, thereby fostering food-security and resilience within East Greenlandic communities reliant on traditional subsistence practices.

The discussion extends beyond ecological dynamics to encompass economic considerations and sustainability concerns. Suggestions to diversify fishing practices by targeting species like Arctic char highlight the potential for economic growth within the fishing industry. To this a fisher explained; “when I catch Arctic char, I usually save them for winter, and I usually use some of them as bait for cod”. Likewise, another fisher points to the possibility to expand on the trading of different fish species, including Arctic char; “cod has come back well after 2015, but mostly in the autumn and I think it would be a good idea to start selling other fish species, such as Arctic char and salmon. Greenland halibut, catfish, and redfish can also be traded. I imagine if you could start trading Arctic char and salmon, it would be a great advantage for fishers”. These opinions point to the importance of developing new

## Observations of lumpfish

Through the experiences and reflections of local fisher, it becomes evident that the ecosystem is undergoing some transformations impacting fish species, and habitats, observed as driven by climate change and other environmental factors. One fisher offered insights into the shifting ecological dynamics within Kuummiut Fjord; “I also think you can feel the climate changes. The current has become warmer so other kinds of fish come, other kinds of salmon for example. In recent years, lumpfish have arrived to Kuummiut Fjord, I had never seen them there before”. The fisher explains how lumpfish may seek warmer waters, thus arriving at the fjord systems where they previously have not been residing before. Another fisher gives his support to this observation by saying that; “about 10 years ago, it was new to us that the fish had small squid, small lumpfish, and shrimp in their stomachs”, and “over the past 10 years, lumpfish have been laying eggs in the fjords, which is something new for us”. As explained by the locals, this presumably new presence of lumpfish may suggest broader shifts in oceanic currents or temperature of waters, making the fjord a suitable habitat for new species to colonize. This is also supported by another fisher, who has observed that; “when I was younger, Greenland halibut, polar cod and redfish were very common. But in recent years, new fish species, that we've never seen before, have arrived. We've also started catching lumpfish with rods, maybe there are a lot of lumpfish in the fjord?”. Thus, this observed ecological shift holds noteworthy consequences for local communities reliant on marine resources for livelihoods. The fisher’s mention of catching lumpfish with rods suggests a potential new fishing opportunity, diversifying the local economy. However, it also raises questions about the sustainability of such practices and the need for informed management strategies. To this, a fisher suggested; “we know there are lumpfish in this area, we just don't know where they are. If there was funding for lumpfish surveys, we could investigate it further”.

The presence of squid in the diet of Arctic char, as well as in the stomachs of seals, further emphasizes the changing species composition within the ecosystem, and how this composition may stem from changing environmental transformations; “when we catch Arctic char in the fall, when it's on its way back to the lakes, we see it has small squid and small lumpfish in its stomach. (...) I'm sure squid and lumpfish are getting closer to us, and there will probably be more of them, as Arctic char is caught more often with lumpfish and squid in their stomachs”. These observations lead to a discussion about changes in the feeding behavior of key species, such as Arctic char and seals. A fisher shared that; “when one sails north to catch seals, the seals have some polar cod in their stomachs as well as small lumpfish”. These findings of small squid, lumpfish, and shrimp in different animals’ stomachs could imply shifts in prey availability or distribution. This could reflect changes in the abundance or migratory patterns of prey species, which according to the locals could possibly be driven by environmental factors such as warming temperatures or altered oceanic currents. To these observations, a fisher also shared that; “at the moment it's the lumpfish, which we find strange, and if we look in deeper water in this area, we also have crabs that seem strange. In september-october we also start to see strange animals”. His observations of marine life in Kuummiut Fjord by mentioning the presence of strange crabs and the emergence of "strange animals" in september-october, suggests ongoing adaptation and colonization processes in East Greenlandic fjords. Such changes, point to the dynamic nature of the local ecosystems and the capacity of animals to respond to environmental change. However, it also highlights a need for

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ongoing monitoring and research to understand the long-term implications of these shifts and inform effective conservation and management strategies.

## Observations of crabs

In recent years there has been a noticeable change in the Sermiligaaq Fjord ecosystem, characterized by the increasing presence of crabs, including the Red King crab and other species. These observed changes have prompted reflections among fishers, who have witnessed first-hand the implications of these changes on their traditional fishing practices and the broader marine environment.

Throughout the interviews, the local fishers explained their recent focus on crab hunting in the Sermiligaaq fjord. Through one fisher's accounts, we get an insight into local presence of crabs and how rising sea temperatures may give way to changes in the future; "we have had crabs in this area for many years, those who try to catch crabs have been successful. I also believe the Red King crab population will grow as the sea temperature is rising". The fisher's speculations on the growth of the Red King crab population due to rising sea temperatures connects to former explanations on the broader impact of climate change on local ecosystems in East Greenland.

The shared experiences from the fishers, encountering crabs both within the fjord and offshore, point towards an abundance of crabs in the surrounding area. They account for successful catches recorded using both crab traps and longlines; "we've seen crabs offshore and we've seen some in the Sermiligaaq fjord. If we have crab traps, then we have the opportunity to try to catch some crabs. When Siggie from Kuummiut tried, he caught a trap full of crabs east towards Tasiilaq. Someone caught crabs when fishing with a longline (...)". On the topic of longline, crabs are observed to have started to consume bait intended for Greenland halibut when fishing with longlines, a fisher shared that; "we have only caught crabs a few times with longline, and I have also noticed that small shrimp and crabs have started to eat our bait when we fish Greenland halibut with longline". His experiences suggest a notable change to crab behavior, signaling potential shifts in the fjord's ecosystem.

Observations connected to the recent emergence of unfamiliar crab species, with mention of crabs with thin, long legs, which also appear different from those typically caught on the west coast, support the discussion on the changes to crab species and habitats; "there's also crab, a different kind of crab - they have thin long legs - it is different from what they catch on the west coast. I don't usually catch them. I have however caught them while I'm fishing for Greenland halibut with the long line out in Sermiligaaq Fjord, at the entrance to Johan Petersen Fjord. At that time, they seemed were scary to look at because we had never seen anything like that before". This fishers' newer and seemingly scary accounts with strange looking crabs, indicate ongoing discoveries from the fishers' side, within their marine environment. Their encounters with these newer forms of crab species may indicate shifts in marine biodiversity or the introduction of new species to the Ammassalik area, and thus give way for a discussion of opportunities for local fishers and the adaptation of fishing techniques and practices to accommodate these changes.

## Observations of Atlantic halibut

Through the interviews with the local fishers, we gain insight into the balance between exploitation and conservation, tradition, and innovation, that defines the local's existence in fishing communities of Greenland.

For generations, fishers have navigated the East Greenlandic waters in their hunt for Greenland halibut, not just a profession but a way of life for many fishers. But in recent years, a shift has been observed. A fisher retells a story of his father, who had fished for Atlantic halibut, casting his nets and lines; "my father, he is 59 now, when he was young, about 15 years old, he used to fish for Atlantic halibut, but we can no longer find this kind of fish". The fisher explains how in the present day, the Greenland halibut seem to have vanished from their familiar haunts, leaving the fishers to adapt to new strategies and locations. Thus, the once reliable fishing spots now require daily consideration, a constant weighing of risks and rewards for the fishers' work. Subsequent follow-up conversations indicate, however, that Atlantic Halibut is present further offshore.

## Observations of Greenland halibut

The Greenland halibut seems to be stable in its abundance. A fisher shared; "for the past 10 years, there has been no change in the Greenland halibut's range, just now you can follow the Greenland halibut which is heading out from the edge of the ice sheet in late June and early July. The Greenland halibut chases the capelin, they feed well on the roe. And in the fall the Greenland halibut places itself in deeper water areas, in September, and in the spring in May or late April it starts laying eggs in fjords. What I mean is that the big ones come into the fjords and lay eggs. We always follow their path and fish them". Another fisher shared his optimism regarding the future of the Greenland halibut; "I'm sure Greenland halibut will not disappear, there might be a little less for a year, but they're always there". One of the fishers also explains that he does not see much change to the amount of available Greenland halibut, however he has observed changes to the size of the fish itself; "in the places I fish there hasn't been much change to the amount of Greenland halibut available, the size of Greenland halibut is growing. In the past, when July came around, we didn't catch very big Greenland halibut. But this year they are bigger." However, to this, another fisher disagrees; "the cod stock is increasing, I have heard there are more and more cod, as well as with Greenland halibut where you also notice the stock is on the rise". Likewise, he shared; "there is also Greenland halibut in the Sermiligaaq fjord". Throughout the changing seasons, the fishers adjust their techniques and fishing places to the shifting habits of the Greenland halibut; "In spring, in the month of May, I catch Greenland halibut (...) I usually fish for Greenland halibut near Sermiligaaq, but this year it is more tempting to fish near Kuummiut. It always depends on how much I can catch, as there is more to catch at Kuummiut, I fish there this year." The fisher shared that the preferred technique to be long lines; "we start fishing Greenland halibut from January until the summer, (...) I mostly catch Greenland halibut with the longline".

In addition, narwhals are told to disrupt the traditional hunting grounds of the Greenland halibut, sending them fleeing for days on end. To this a fisher shared; "every time you go out, you look for the best spots of the day in these areas. For example, when narwhals arrive, the Greenland halibut usually disappear for a long time, maybe 14 days, so I have to fish elsewhere". The presence of narwhals



disrupting Greenland halibut patterns underlines the complex interplay between different species in the Arctic ecosystem. This disruption necessitates constant adaptation on the part of fishers, who must navigate these shifting dynamics to ensure their livelihoods.

The fluctuating prices of Greenland halibut across different regions of Greenland reflect the influence of market forces on the fishing industry. Competition between factories drives prices higher in some areas, creating disparities that impact fishers' earnings and deprive them of motivation to land Greenland halibut to the fish factories. One fisher shared his lack of interest in selling the Greenland halibut because of low prices; "but with cod and Greenland halibut - it's just a waste of time for me because I work with tourists as well. But as food for the family, it's still important. I don't sell to the factory anymore because the price I get is too low. There should be a factory when it goes really well for the with shrimp, Greenland halibut, cod, and other species". Another fisher supports this statement regarding the economic challenges with the landing of fish in the area and why he sells the Greenland halibut: "I fish Greenland halibut and cod because that's what you can land in the factory. So that's the opportunity I have to make money from my fishing. But it's difficult because the price is very low, so I don't make much money from fishing". The fishers' explanations points in the direction of the Greenland halibut fisheries being because of the ability to retail, rather than choosing this species because of other factors. A fisher shared his opinions on his future possibilities for him staying a part of the fishing industry in East Greenland; "If I want to survive as a fisher for the next couple of years, Greenland halibut on longline is the way to go (...) We can usually catch capelin, sculpin, Arctic char, as well as Greenland halibut, wolffish and redfish that we eat well from. But we mostly sell Greenland halibut to the factories".

Beyond its economic value, the Greenland halibut holds cultural significance for the fishers, serving as a staple food source and a link to tradition. The fishers' commitment to securing enough Greenland halibut for winter sustenance reflects the deep-rooted connection between their way of life and the sea; "I usually save a lot for winter, enough to have Greenlandic food all year round. For example, for fall, I usually fish enough Greenland halibut for the winter. When I'm done fishing it, then I fish another kind that I can save for the winter. If I don't have enough Greenland halibut after one day, I go out again and fish more to make sure I have enough for the whole year, only then do I catch another kind of fish or seals for example".

Despite the challenges the fishers face with low prices and changes to the Greenland halibut's habitats, the Greenland halibut is a focus specie for fishers when discussing future commercial prospects.

### Observations of capelin

Capelin, a key specie in the coastal ecosystem, arrives to the area around May, sounding the start of spring; "in May, the capelin arrives, especially in Kuummiut fjord. It's also a sign that spring is beginning, meaning the ice is opening up, and one can head towards Sermiligaaq fjord, where we usually fish throughout the summer". The fishers states that the capelin stays around until august, and that; "capelin is normally here, we always get them in Kuummiut and at Tiniteqilaaq". The fishers also shared that; "the shrimp, capelin and squid breed at the end of May". However, the fishers have no detailed explanations to the routes of the capelin, as they have not explored the capelins whereabouts in the area; "we haven't investigated which routes capelin use when they are on their way into the area. But now we have learned when they can be caught, so we drive with the dog sleds and catch the first capelin. There is capelin throughout the Tasiilaq area".

Capelin is a very popular prey item for the Greenland halibut and cod, which feed on the roe of the capelin, and also draws attention from whales that wait for capelin to come out of the fjord. A fisher shared; “mammals such as humpback whales and common minke whale are abundant when the capelins are on their way out of the fjord, as they feed on them”. He also states that; “the cod come from the deep waters and feed well on capelin when the capelin is on their way to deeper water”.

Freshly caught capelin has become an important fish to use as bait, as the polar cod has become more difficult to get. A fisher shared; “we’ve lost track of where the polar cod have gone, as we’ve started to focus on capelin as our priority for bait. We can pick up some capelin, small squid and herring in the factory and use them as bait”. He also explains about the possibility to use capelin in another, more commercial way benefitting the economy of the fisher and adding to the list of fish landed to the factory; “if we think about what season we are in, there is also the possibility of catching capelin, which on average are 18-20 cm long. It would be great to sell these abroad”.

In the interviews, we get an insight into the capelin as a fish playing a seasonal key role in coastal food chains. It is a fish which the fishers have succeeded in turning into bait and which – they hope - may be able to function in commercial trade.

### New species in the fishery

The fishers provided insights into the changing biodiversity of marine life as they explained observations from several encounters of new fish species to their fishing areas including the arrival of new species such as Arctic char variants, mackerel, and cod species. A fisher shared; “when I was younger, Greenland halibut, polar cod and redfish were very common. But in recent years, new fish species, that we’ve never seen before, have arrived”. This observation is supported by another fisher; “when I was growing up, there weren't that many different species of fish, but in the last year there have been so many different species. Like the Icelandic fish, which is rarely caught in this area(..) there is also a new species that has arrived, the humpback salmon”. Several of the fishers have observed the unknown Icelandic fish with a particular appearance; “there are more species of Arctic char and more species of salmon arriving in September. An Icelandic fish with orange-coloured eye rims has also arrived. In our fjord, we have also noticed 2-3 new fish species”. Observations of mackerel was also shared: “then there is also the mackerel, which is a new species in this area. Another Arctic char species has also arrived. A new species of cod, which is very rare, has also appeared. Likewise; “we have heard some catch a few other species of Arctic char or mackerel. When we set out the salmon nets, one can catch mackerel”. The newly arrival of mackerel is supported by another fisher; “there are more species than before, of whales and fish, including mackerel. It hasn't been that long since mackerel arrived”. Still, mackerel and herring are considered very rare species in the area; they are only caught now and then when fishers fish for salmon with fishing nets.

The fishers’ suggestion of the influence of climate change on marine biodiversity, by rising temperatures, observed changes in fish behaviour and migration patterns, and the arrival of species typically found in warmer waters, all points towards an impact of environmental shifts on Arctic ecosystems. Observations of more species arriving is also supported with sightings of more bizarre species; “now that you mentioned global warming, more and more species are showing up. Some of them are bizarre, and which have never been in the Tasiilaq area. And I think there will be more and more strange species coming to



the area". A fisher shared that he has heard from other fishers and observed by himself, a new type of shark with a taste for Greenland shark; "we have also seen the shark that originates from warmer countries. The Greenland shark is gray with straight teeth, but the new species that has arrived has triangular teeth. I saw a Greenland shark that was bitten by a shark from the warmer countries with triangular teeth for the first time 10 years ago, and from now on, it's getting caught more and more often". Regarding new species showing up from different parts of the globe, a fisher shared his observation on a species of Arctic char, normally seen in Canada; "some fishers have caught another species of Arctic char originating from Canada with black spots and sharp teeth in rivers near Kulusuk. I also caught that type of Arctic char in Kangerlussuatsiaq 2 years ago. I have also caught this Arctic char species between the islands near Kulusuk". Based on the description and subsequent dialogue at the fishery seminar in Tasiilaq indicates that the 'new Arctic char' is likely to be pink salmon (*Oncorhynchus gorbuscha*).

The Fishers are encountering new challenges and opportunities as they adapt to the evolving marine environment. For instance, the unexpected catches of mackerel while setting salmon nets and how present-day vessels makes it easier to travel farther offshore to find whales: "if I was still young, I would like to go shrimp fishing. Today's fishers need adapted equipment, such as a boat/cutter. Today's boats are fine, but future generations will need more equipment as more and more species are arriving. Tasiilaq needs a factory with landing possibilities". The fishers thus touch upon the infrastructure requirements for supporting future fishing activities in the area by explaining the need for development in equipment and how this will support fishing activities in the future. All of the interviewed fishers echoed this call for another fish factory, and at the time of the interview, Royal Greenland had indeed decided to start building said factory, supplementing the fish factory of Arctic Prime Fisheries in Kuumiut. Furthermore, the Greenlandic Ministry of Fisheries and Hunting has formulated a development plan for the East Greenlandic with input from the fishers. Through this plan, the Greenlandic Self-government fishery aims to support the development of the east Greenlandic coastal fisheries. In other words, there is a strong momentum for coastal East Greenlandic fisheries.

## Summary

During the interviews, the fishers shared their experiences with the complex changes in fish species within their fishing areas, documenting shifts in population dynamics and ecological interactions over time. Polar cod, once plentiful in the area, have experienced a significant decline since the late 1900s, prompting concerns among the local fishers. Factors such as warming sea temperatures, predation by other species, and the arrival of new fish varieties contribute to this decline. Observations of cod populations reveal a contrasting narrative, with fluctuations in abundance over the years, recently with a recent resurgence attributed to environmental factors such as changing sea temperatures and prey availability. Arctic char populations are presented as increasing, presenting opportunities for local fishers. Detailed insights into Arctic char behaviour and diet, including squid and small shrimp, indicate changes in prey availability and ecosystem dynamics shedding light on broader ecosystem shifts. Lumpfish emergence in Kuummiut Fjord signals broader ecological transformations, posing both opportunities and challenges for local communities. Similarly, the increasing presence of crabs in Sermiligaaq Fjord prompts adaptations in fishing practices and discussions about climate change impacts. Reflections on Greenland halibut fishing highlight stable abundance, with fishers noticing

**D4.4. Marine Biodiversity and Greenlandic LEK: With new contributions from the Ammassalik area, East Greenland** changes in the size of Greenland halibut and disruptions caused by narwhales followed by economic challenges driving fishers to adapt their techniques and priorities. Despite challenges, Greenland halibut remains culturally significant and economically important for local fishers. Lastly, capelin shows seasonal presence and holds economic promise as a bait source and its potential as commercial trade.

The fishers shared observations on the arrival of new fish species, such as Arctic char variants, mackerel, and cod, which were previously uncommon. The fishers attributed these changes to factors like rising sea temperatures and shifting migration patterns due to climate change. They also noted sightings of unfamiliar species, including a new type of shark with triangular teeth. The fishers anticipated both challenges and opportunities in adapting to these changes, emphasizing the need for updated equipment and infrastructure to support future fishing activities.

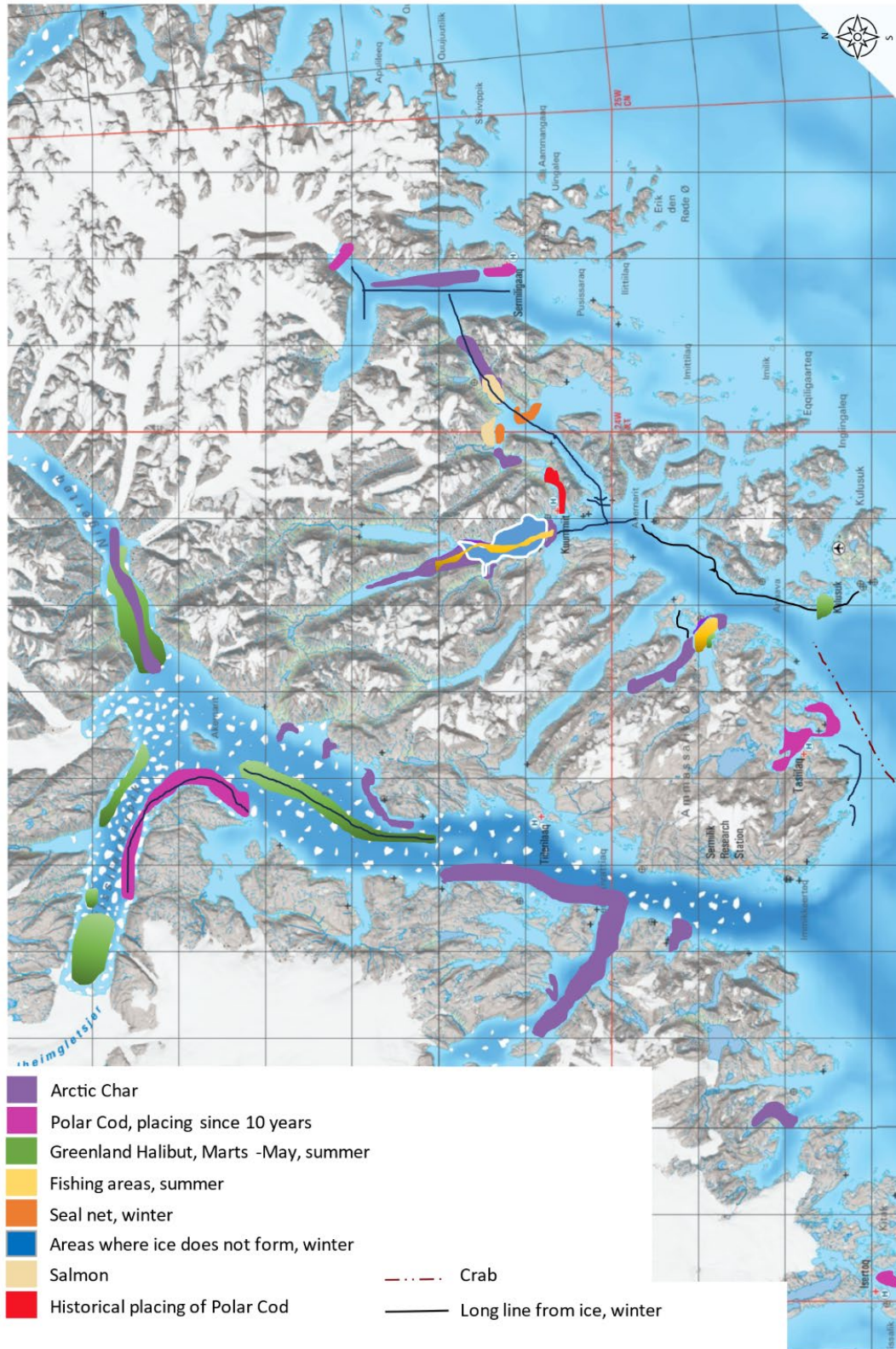


Figure 4: Observation of fish species.





Figure 5: Observation of Fish species.

### 3.5 Changes to mammals

#### Whales

Throughout the interviews a notable increase in whale sightings is cited. This increase could be attributed to various factors such as changes in migration patterns or availability of prey, or to the changes to sea temperatures, as observed by the fishers. Historically, many of the new whale species that the fishers now observe, were rarely seen in the area; “in my younger days, orcas, pilot whales and porpoises were very rare species in the area. Now they are here during the summer”. One of the fishers also shared his observations of more whale species coming to his area and why this is seen as a problem for his fishing practices; “more species of whales have arrived, such as sperm whales and pilot whales. So many different whales have arrived in the last few years, there are also many humpback whales that have come near Tasiilaq. Humpback whales eat cod and polar cod, so it's a big problem. Global warming affect whales which come closer to the coast.”. He further adds; “if we look back ten years, there are now more species of whales. Such as the Faroese pilot whale and porpoise/dolphin. Normally, white-beaked dolphins are in this area (...) There have been porpoises/dolphins in the area for many years, but in recent years they have been spotted in fjords and the population is growing”. Another fisher also shared his experience with the difficulties the presence of whales has on his work as a fisher; “in some places there is not much to catch, in some places there is a lot. When there isn't much catch during the summer, whales can be the reason. Because there have been so many more species of whales. Especially the orca, it can eat anything”. The encounters with several new whale species to the areas, and the growing of whale populations, together with their explanation of how the whales feed on cod and polar cod, reveal the implications of the changes to the ecosystem and the effects it has on the local community. It becomes evident that the local ecosystem is experiencing changes that affect the fishers' hunting and fishing practices.

Traditionally, there was a fear of hunting larger marine mammals like orcas due to limitations in vessel technology. However, with the arrival of larger boats, this fear has diminished, enabling fishers to pursue such species more confidently; “there have always been orcas, but we don't usually hunt them, because back in time we only used kayaks and small boats, so we were afraid of them. But now we can, we are not afraid of them anymore, with our bigger boats we can now catch them. When I was a child, there were not many whales because everybody used to catch them around the world, so there were not so many in our areas, but different species of whales come to our areas now, so we can catch them”. He further describes; “we have noticed that many whales are to be found out by the ocean, so we usually go out there. In the past, we didn't go fishing out there because we didn't know if there was anything to be found. Also, because the vessel was not big enough. Usually we find whales out there, but we spend many hours trying to find them. Maybe there were many whales to be found out there, but we just didn't sail out”. While a nuisance to the fisheries, the increase of known and less known whales are also met with increased interest by the fishers in the Ammassalik area.

#### Seal

The fishers described several locations significant for seal hunting, each with its own characteristics and purposes. For one fisher, Tunu, in the Kuummiut fjord, is the preferred location for setting seal nets, especially when the ice arrives in December; “In the fall, we always wait for the ice to come. When the ice arrives in December, I use a sled to set seal nets, at Tunu, which is further up in the Kuummiut fjords (he points to the orange dots on the map). At the same time, there are many places where seals can be

found, depending on what is reachable with the ice and where there is open water. We usually sled out to the ice edges, and that's where we set seal nets". Other fishers mention Sermiligaaq fjord, Tasiilaq, and Kulusuk as their important spots for seal hunting; "in Sermiligaaq fjord, we leave the long line out for a day because there are not as many sharks, and we try to catch some seals while waiting to pull up the long line again" and "in the summer, I mostly catch seals in Sermiligaaq Fjord or just outside Tasiilaq and Kulusuk, or around Sermiligaaq" (he points to the yellow spots on the map as the summer fishing area). The fishers' descriptions indicates that sea ice, access, competition from other species (see below) and by-catch risks influence their particular usage of a diverse set of hunting grounds.

The fishers provided detailed insights into the changes in the seal population and their physical characteristics in the fjords over the years. The fishers note a significant decline in the population of certain seal species arriving in their areas, namely ringed seal, and hooded seal. This decline is evident in the reduced number of seals entering the fjord compared to previous years. Ringed seal pups entering the fjord in the fall are described as thin, and they struggle to gain weight due to unknown reasons. However, those that remain in the fjord year-round tend to gain weight in the spring. The thickness of seal blubber varies seasonally, with seals seeming thicker when spring arrives, but being thinner than usual during winter. This seasonal variation affects their resilience, causing them to sink even during winter where there are supposed not to; "before the 1980s, there was an abundance of mammals such as ringed seal pups and hooded seals in the fjord. But in recent years, there are not many of them left, with only a few seals entering the fjord. Ringed seal pups that enter the fjord in the fall seem very thin, and we keep catching them with nets, so the ringed seal pups don't gain much weight. But when a ringed seal pup stays in the fjord all year round and spring begins, we see they usually gain weight. I've noticed hooded seals don't stay in our fjords anymore, it's usually out in the ice when the drift ice is heading south. I've noticed only a few hooded seals come into the fjord. The seal, which is slightly larger than the ringed seal, has also become rare in the area".

A fisher shared in length and details his experience with the decrease in seal populations and how knowledge is handed down from his ancestors, giving him insights into knowing if and where the seals will arrive; "I also notice there are fewer ringed seals in the area. There used to be a lot of ringed seals and hooded seals. I can see there are fewer hooded seals, there used to be hooded seals from winter to spring. There were a lot of hooded seals in the fjords towards Kuummiut, but not many after the diesel leak. There is a certain place where the snow gathers during the winter, even when it's spring, it can snow there. Our ancestors have told us about this place. If the snow melts, there won't be many seals in the summer. If it snows a lot, there will be a lot of seals in the summer. If half of the snow falls, there won't be as many seals in the summer either. This statement may be true this year, half of the snow fell, and we have noticed that there are not so many seals, especially the hooded seal. When July begins or June ends, there are plenty of hooded seals at the beach. This year there are not so many". The fisher notes a decline in the abundance of hooded seals in recent years, attributing it to potential factors such as changes in temperature that affects snow fall or environmental disturbances like the diesel leak. Additionally, another fisher shared his observations on the presence of whales and highlighted it as a factor influencing seal abundance, suggesting these interactions play a significant role in shaping ecosystem dynamics while also having an impact to his hunting practices; "when whales are present, the seals are not, and also the fish disappears from the water, so one has to wait a few days before the fish and seals come back or sail to other places. And because there are more and more whales coming, it happens more and more, it affects my fishing". The observation of seals competing with whales for food underlines the balance of predator-prey relationships and competition in the Arctic food web. According

to a fisher, the competition seems to impact the condition of the seals: “I think that whales, the ones that we can't catch, they eat the same things as seals, but the seals don't disappear, even though there are a lot of whales, seals are still there. Some of the seals just sink even though it is winter, but they've gotten thinner because they compete for food with whales”.

The fishers also describe noticeable differences in the physical condition of seals observed throughout the years. This seasonal pattern still remains largely unchanged according to one fisher; “there are not many changes to the seals' blubber. They get thinner in summer so when you shoot them, they sink. But when autumn comes, the seal becomes fatter. I have not experienced seals before that have become very thin. The bearded seal always sinks no matter what season we are in. The bearded seal is fattest in spring, I have noticed they always sink. I think it is the same with hooded seal. I have not noticed if the blubber has become more or less. But they mostly sink in summer since seals are not so fat in summer.”

The sealing experience by local fishers and hunters offer valuable insights into the dynamic interplay between environmental changes, biodiversity shifts, and sealing practices in the Arctic. The diminishing arrival of hooded seal and ringed seal into the Ammassalik area may represent one of the major biodiversity shifts occurring in East Greenland, possibly resulting from dynamics pertaining to the East Greenlandic drift ice.

## Polar bear

Most interviewees will pursue polar bear hunting when the opportunity emerges and quotas are available and as one interviewee explains, hunting of mammals will most likely remain an important source of food and traditional knowledge: “not only do we have the opportunity to catch different species of fish, but there are also polar bears, seals, narwhals, and various whales, depending on what season we are in. We have been eating Greenlandic food for many generations, everything from sea to land mammals. I expect that I will continue to hunt Greenlandic animals and pass on information to future generations”. Interviews focused mostly on fish resources, and little was asked about polar bears directly (for LEK studies of polar bear, please refer to Laidre et al. 2018). Nevertheless, one fisher shared a mysterious observation of polar bear's changing diet; “(...) as biologists say, the population is in a dangerous situation of extinction because polar bears eat seals. But upon closer examination of the polar bear's stomach, I've noticed it can contain seal meat and blubber, and if it goes on land, it can contain flowers, blueberries, and plants. But this is the first time I've seen plants from the sea where the polar bear itself is very thick. Nothing but plants from the sea. As I find this very mysterious, I've said that I will never eat polar bear meat again”. The fact that polar bears has taken to eating plants from the sea is seemingly considered completely unprecedented, invoking some degree of scepticism towards the intake of polar bear meat.

## Summary

The fishers have observed significant changes in mammal populations, particularly focusing on whales, seals, and polar bears in the Ammassalik area. They report a notable increase in whale sightings, including species that were previously rare in the area. Causes such as changes in migration patterns, prey availability, and sea temperatures are cited as possible reasons for this increase. However, the growing presence of new whale species, especially species like humpback whales that feed on cod, poses

**D4.4. Marine Biodiversity and Greenlandic LEK: With new contributions from the Ammassalik area, East Greenland** challenges for fishing practices. With advancements in vessel technology, fishers are now more confident in pursuing larger marine mammals like orcas. So, while the increase in whale species sparks interest among fishers, it also disrupts fishing activities and indicates ecosystem changes affecting the local community. The fishers identify various locations significant for seal hunting, but also note declines in seal populations, particularly of ringed seals and hooded seals. They observe thinner seal pups and fluctuations in blubber thickness, possibly influenced by changes in snowfall and competition with whales for food. Knowledge passed down through generations helps fishers anticipate seal arrivals, but environmental disturbances like diesel leaks and temperature changes impact seal abundance. While not extensively discussed in these interviews, polar bear hunting remains important for sustenance and traditional knowledge. Anecdotal evidence implies a shift in polar bear diet, with observations of polar bears consuming seaweed, raising questions about their traditional carnivorous habits.



## References

Nalakkersuisut 2024. Udviklingsplan for fiskeriet i Østgrønland 2024-2030. Departement for Fiskeri og Fangst.

H.C. Petersen. No year. Ammassalik kommune. Registrering af levende naturværdier. Rapport nr. 16. Grønlands Hjemmestyre.

## ECOTIP Interview guide

Briefing: Tak fordi du vil dele din viden om havet med os – den viden du har som fisker/fanger er en vigtig 'brik' i forhold til at forstå, hvad klimaforandringer betyder for Tasiilaq området.

Vi vil gerne høre dig fortælle om de forandringer du har oplevet og observeret. Både i havet generelt og i forhold til specifikke arter. Hvis du har nogle teorier/tanker om, hvorfor dyrene ændrer adfærd, føde, ruter - så vil vi også meget gerne høre om dette!

Den viden du deler i dette interview, vil blive anonymiseret (samtalen bliver skrevet ned, men vi skriver ikke navnet på personen). Derefter vil det du fortæller blive delt med forskere på Aalborg Universitet (Rikke Jacobsen) og forskere fra Grønlands Naturinstitut (Caroline Bouchard). Vi vil gerne have lov til at kommunikere din viden i rapporter og artikler, som fortæller om klimaforandringer i Grønland.

Er du OK med dette og har du stadig lyst til at deltage?

## Spørgsmål

### 1. Dit fiskeri

H1: Vil du starte med at fortælle lidt om din fiskeri/fangst her i området? Hvad går du efter i løbet af året/hvad er dine sæsoner?

### 2. Ændringer i dit fiskeri

H2: Har dine sæsoner og fiskepladser ændret sig siden du begyndte at fiske? (Spørg ind til årsagerne til disse ændringer)

### 3. Spørgsmål direkte til nye arter specifikt?

H3: Har du observeret 'nye arter'? Fisk, skaldyr eller pattedyr, som ikke plejede at være så meget i området dengang du var barn/for 10 år siden/for 20 år siden?

### 4. Spørgsmål til polartorsk

H4: Har du observeret polar torsk i området – hvad kan du fortælle om polartorsken i Tasiilaq området? *(vær sikker på at I taler om polartorsk: vis billede af Boregadus)*

I. Fisker du polartorsk? - går du efter den, eller kommer den i nettet når du fisker efter andre arter?

II. Hvad gør du med den polartorsk du fanger: hvad bruger du den til?

III. hvornår på året ser du polartorsk i dit fiskeri?

IV. i hvilke områder ser du polartorsk?

V. Foretrækker polartorsken bestemte områder eller dybder?

VI. Hvem spiser polartorsken her i området? Og hvad går polartorsken selv efter? (er det f.eks. lodde?)

VII. Er der kommet mere eller mindre polar torsk de sidste 5-10 år? Er der 'gode' og 'dårlige' år for polar torsk?

VIII. Har du observeret gydende polartorsk i området – hvor?

### 5. Øvrige observationer af ændringer i fiskeriet og økosystemet

H5. Hvad de vigtigste ændringer du har lagt mærke til de sidste 10 år? (forfølg de emner, fiskerne selv tager op som det første! Brug derefter listen som 'check-liste')

- I.Arter som der er kommet mere eller færre af? (lodde, torsk, krabbe, hellefisk, makrel/sild, andet?)
- II.Islag, ferskvandslag, Saltindhold, Strøm, temperatur
- III.Alger og mudder pga. gletsjer smelt?
- IV.Små fødekilder for dyr og fisk (mavesække – er der ændringer i hvad de spiser?)
- V.Fisk- og fangstdyrenes tilstand (fedtlag, pels, lever, størrelse mm.)
- VI.Nye steder, hvor fisk og dyr mv opholder sig? (teori: især grundet islag, men også flugt/fødesøgning)
- VII.Vejr og storm – gode/dårlige fiskedage?

## 6. Spørgsmål til fiskeriets betydning for dig og for Tasiilaq

H6. Hvad er dine største bekymringer og håb i forhold til fremtidens fiskeri i Tasiilaq?

- I.Hvad har du brug for som fisker, for at kunne fortsætte dit fiskeri i fremtiden?
- II.Hvad har Tasiilaq eller din bygd brug for, for at kunne få gavn af fiskeriet i fremtiden?

