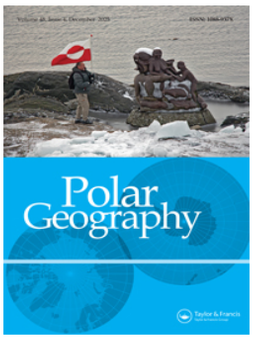

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Ongoing changes in distribution of fish species and challenges to fisheries regulations in Isfjorden, Svalbard

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ABSTRACT

Changing environmental conditions in Isfjorden impact the abundance and composition of fish species in this major fjord system in Svalbard. New commercially attractive species have already entered and will expand in Svalbard waters. Based on knowledge from different sources, this paper explores and discusses how fisheries may develop in Isfjorden. We found a mismatch between the current regulatory framework, which is too fragmented and complex to address increasingly intricate fisheries matters, and the extent of ongoing changes that may result in larger opportunities for fishing activities in Svalbard waters. Drawing on the situation in Porsangerfjorden, a fjord system in Northern Norway with a boreal character, we emphasize the importance of fisheries resource management. Finally, we surmise that pressure to open fish-landing facilities on Svalbard may increase in connection with the abundance of new species of commercial interest and a stronger interest in consuming local fish products in Longyearbyen.

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Introduction

Arctic fisheries are important for the supply of seafood to countries across the Circumpolar North and further south, including EU countries. Transboundary fish stocks are at the center of inter-state negotiations for fishing quotas in the North Atlantic, and many countries consider access to attractive fishing areas to be strategic (Østhagen, 2013). Jurisdictional claims over certain ocean areas and tensions around fishing quotas leading to disputes between diverse actors have been highlighted in the literature (Lebel & Nilsson, 2024; Østhagen & Raspotnik, 2018; Spijkers et al., 2018).

In parallel with changing climate conditions (AMAP, 2018), warmer waters (Fossheim et al., 2015) and retreating sea ice (Schlegel et al., 2023), the distribution of fish species has quickly evolved in Arctic waters in recent years. Many species are moving northwards and expanding into new areas, while others may increase in abundance. This results in the reorganization of fish communities as Arctic specialists are replaced by other species with boreal distributions, a phenomenon described as 'borealization' (von Biela et al., 2022). This redistribution of fish species, including the entry of new species, affects the local ecosystems and

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comes with challenges and opportunities for fisheries to access and exploit these resources (Misund et al., 2016; Siwertsson et al., 2024). The west coast of Svalbard is particularly affected by such changes, and the inflow of warmer Atlantic waters in the fjord systems has significant consequences for the entire food web (Bengtsson et al., 2020; Søreide et al., 2021).

The Svalbard archipelago falls under Norwegian jurisdiction through the Spitsbergen Treaty of 1920 (implemented in 1925, referred to as the Svalbard Treaty). According to the Treaty, all signatory states have equal rights to engage in commercial activities, namely fishing, hunting and mining (Traité Concernant Le Spitsberg, 1925). However, the interpretation of certain provisions of the Treaty has led to disputes regarding access to ocean resources (e.g. the snow crab) in the maritime zone beyond Svalbard (Østhagen, 2021; Østhagen & Raspotnik, 2018). Disagreements about the geographical extent of the application of the Treaty imply that several states consider that the provisions regarding equal access to ocean resources in the territorial waters around the archipelago should also apply to the Fisheries Protection Zone (FPZ) that Norway established beyond these territorial waters in 1977. Although there is limited commercial fishing in the territorial waters of Svalbard, a likely increase in commercially attractive fish species in Svalbard fjords may come with similar challenges due to diverging interests and complex regulations.

The idea for this paper originated in the EU Horizon 2020 FACE-IT project (www.face-it-project.eu) about the future of fisheries in Svalbard given the changing climate and associated consequences for ocean temperatures and ecosystems in the Arctic. The focus of this exploratory paper is the future fisheries in Isfjorden, one of the main fjord systems on the western Svalbard coast (see Figure 1). While we make the connections between the northward expansion of commercial fish species and current regulations, we do not carry out a thorough assessment of fisheries regulations and the associated quota allocation systems. We focus on Longyearbyen, but our analysis is relevant and applicable to Barentsburg. To better understand Isfjorden, we introduce Porsangerfjorden (*Porsáŋgguvuotna* in Northern Sámi, and *Porsanginvuono* in Kven) as a proxy for what fisheries may look like in future given the process of borealization, and for the local consequences of fisheries management. Porsangerfjorden is located at 70° N on the mainland in Northern Norway and has a long history of commercial and subsistence fisheries. Three research questions are thereby guiding our work. First, how may the fisheries evolve in Isfjorden in connection with environmental changes and the borealization process, and what can we learn from a comparison with Porsangerfjorden? Second, is the regulatory framework adequate for handling expected developments and balancing the interests of commercial fishing vessels, sport fishing by tourists, and the local population? Finally, what significance may a more extensive fishery have for Longyearbyen, given the regulatory challenges and the increased focus on sustainability in the local community?

This is an inter- and transdisciplinary paper in that we include knowledge from different scholarly, official, and local stakeholder sources, as well as analyzing a range of different data to explore and discuss how fisheries may develop in Isfjorden. We applied a mixed method approach, starting with a review of scholarly literature and reports focusing on fish species and environmental changes in Svalbard waters to gather background knowledge about key fish species and more recent developments and challenges in Isfjorden. Second, we carried out semi-structured interviews with different stakeholders in Longyearbyen, including researchers, the Norwegian Fishermen's Sales Organization (*Norges Råfisklag*), a restaurant employee, and a local fisher. We addressed topics ranging from the changes in fish species and environmental conditions, possible future developments, the role of fisheries and their

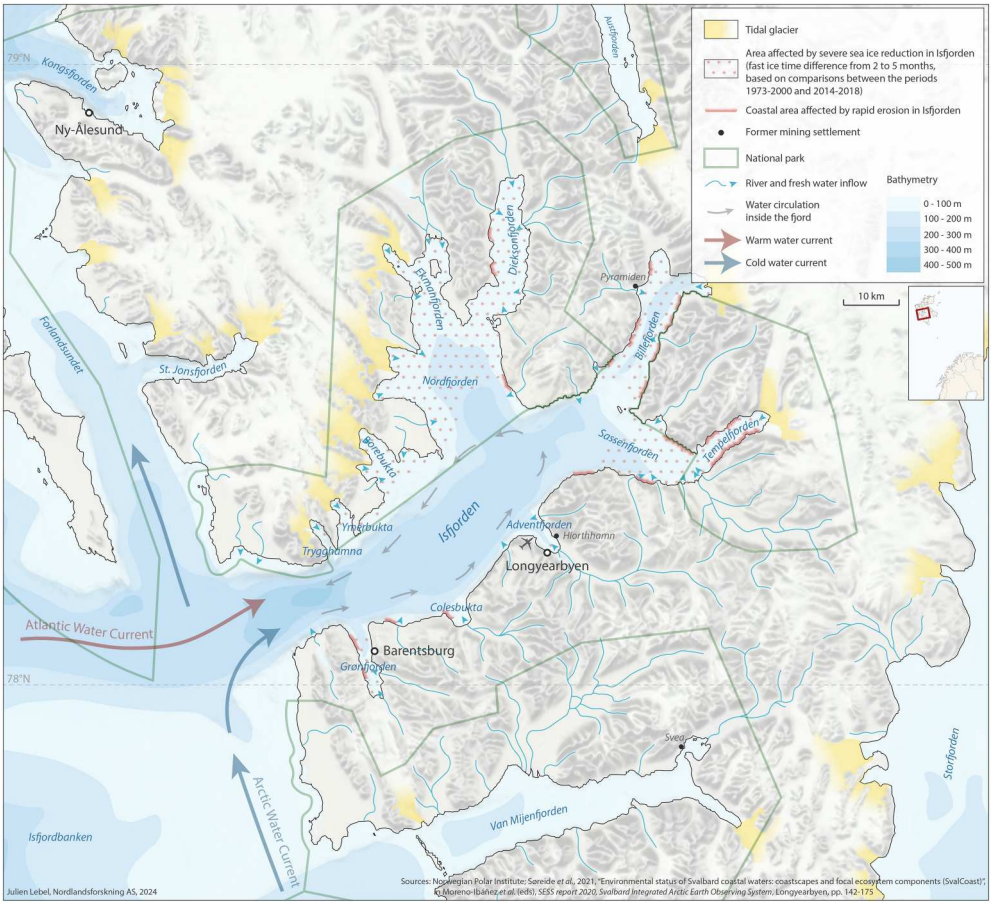

Figure 1. Map of Isfjorden, a High Arctic fjord system in transition.

connection with the local community in Longyearbyen, and regulatory issues. Third, we analyzed fisheries data to identify fish species that tend to move northwards and may become commercially relevant in Svalbard territorial waters.

The article begins with a description of the environmental and climatic changes affecting Isfjorden that may create favorable conditions for borealization of fish communities and result in a further expansion of commercially attractive species in Svalbard waters. In this section, we also present data on expansion trends of fish stocks in the Barents Sea, highlighting key species and the potential role of kelp in supporting the development of fish stocks in Arctic fjord systems. When we focus on commercial fisheries, we mainly use stock name (sometimes different from species name) as the identifier in this article. Second, the article presents the case of Porsangerfjorden – a fjord with a boreal character in Northern Norway – where poor fisheries management has had a severe impact on the local fisheries. Focusing on the situation in Porsangerfjorden can help to foresee both consequences of ongoing environmental changes and challenges regarding fishery management and regulations in Isfjorden. Third, the paper focuses on regulatory aspects in Svalbard waters. In this section we provide an introduction to the main regulations affecting fisheries in the region, the dispute over snow crab fishing rights, and some local aspects regarding environmental regulations and recreational fishing.

The discussion addresses the potential development of fisheries for Longyearbyen and policy-relevant impacts related to the increase of commercially attractive species in Isfjorden. We point to a mismatch between the current rate and magnitude of changes in climate and fish species on the one hand, and current regulations and management that do not provide an accessible framework for fishing activities in Svalbard on the other. We also note that the Norwegian government has recently decided to not establish fish landing and processing facilities on the archipelago, due to geopolitical and environmental considerations. These constitute major barriers for developing further fisheries in Svalbard and establishing an attractive food system based on local fish products for both the residents and the tourists in Longyearbyen.

Environmental changes and ongoing changes in fish stocks in Isfjorden

Isfjorden is the largest fjord system in Svalbard, roughly 24 km wide and about 100 km long from the mouth of the fjord to the head of Billefjorden (Figure 1). It is an open and deep basin and thereby heavily influenced by the intrusion of warm Atlantic water, which results in the borealization of marine communities in the fjord (Born, 2020; Søreide et al., 2021). Pronounced environmental changes have consequences for species composition at all trophic levels. Although Arctic water flows northwards along the western coast of Svalbard, which usually prevents intrusion of warm Atlantic water in the fjords, this Arctic front weakens under the influence of Atlantic water temperature and wind patterns at the surface (Fraser et al., 2018; Pavlov et al., 2013). According to Born (2020) the current trend of 'atlantification' of the water masses might strongly affect the marine community and cause the disappearance of a hydrographical barrier that separates Arctic and boreal species.

An increase of 2°C in the ocean temperature has been recorded in the past 20 years in the fjord system, and observations indicate that the most significant changes occur in winter (Cottier et al., 2019). Skogseth et al. (2020) suggest that, since 2006, Isfjorden has been evolving from an Arctic to an Atlantic water state. Although the shallower arms of the fjord system still freeze in winter, a significant reduction of the sea-ice season has also been recorded, by up to five months in some areas (Søreide et al., 2021).

Coastal erosion has increased in many areas due to rising temperatures and the thawing of in-ground ice along the coastline (Søreide et al., 2021). Together with faster glacial melt and increased river runoff, this leads to a wider presence of terrigenous materials in coastal waters, known as the 'browning of the Arctic', which impacts the penetration of light in the water (Søreide et al., 2021). Some consequences of these changes are still uncertain as the intrusion of warm Atlantic water in Isfjorden would reduce the CO_2 uptake capacity in the area, while an increase in the amount of glacial meltwater reaching the fjord system would have the opposite effect (Ericson et al., 2018).

Many boreal fish stocks in the Barents Sea are migrating northward, influencing the location of fishing activities (Stocker et al., 2020). The most important commercial fish stock in the Barents Sea, Northeast Arctic (NEA) cod (*Gadus morhua*), is experiencing both a northeasterly stock shift and an overall stock decline. Since 2022, fishing quotas of NEA cod has been significantly reduced due to low spawning stock biomass (Howell et al., 2022; JRN-AFWG, 2024). Observations of demersal fish such as cod and haddock (*Melanogrammus aeglefinus*), as well as pelagic species such as capelin (*Mallotus villosus*), herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) have become increasingly

common in the fjords on the west coast of Svalbard (Berge et al., 2015; Hop & Gjøsæter, 2013; Misund et al., 2016). There has also been an increase in catches of Greenland halibut (*Reinhardtius hippoglossoides*), Atlantic halibut (*Hippoglossus hippoglossus*), ling (*Molva molva*), wolffishes (*Anarhichas spp*) and tusk (*Brosme brosme*) in Svalbard waters (Misund et al., 2016). Interviewees confirm the expansion of cod and emphasize that this species arrives in Isfjorden earlier every year. They also mention that wolffish is common bycatch when fishing for cod. This species is somewhat controversial when served in local restaurants because it is listed as endangered in some parts of the world, but not so in Svalbard waters.

The major fisheries in the Barents Sea and adjacent waters harvest transboundary stocks such as NEA cod, NEA haddock, NEA saithe, Norwegian spring-spawning herring, and capelin, which perform large-scale seasonal migrations within the region (Olsen et al., 2010). Studies of the fish fauna from Porsangerfjorden (Mérillet et al., 2022) and fisheries for Isfjorden (Berge et al., 2015) show that while commercial fish species such as herring, haddock, and cod are established in both fjords, other commercial species like saithe (*Pollachius virens*), European plaice (*Pleuronectes platessa*), and whiting (*Merlangius merlangus*) were only recorded in significant numbers in Porsangerfjorden.

Ongoing since 2004, the joint IMR-PINRO autumn ecosystem survey (BESS) in the Barents Sea enables tracking of spatiotemporal dynamics of fish stocks (Eriksen et al., 2018). Below we present survey data from the BESS demersal trawl showing 20-year latitudinal distribution trends of five fish species (Figure 2). The distribution pattern of these five fish species illustrates the potential for future fisheries in Isfjorden. Saithe, whiting, and blue whiting (*Microstumus poutassou*) all have commercial quotas. Roughhead grenadier (*Macrorus berglax*) and lemon sole (*Microstomus kitt*) are currently only caught as bycatch in the Barents Sea, although both are considered high quality fish and have a commercial potential. The mode (where the highest biomasses are) and upper latitude of distribution of commercial fish caught by the BESS trawl west of 26° E reveal that three of the five species (roughhead grenadier, blue whiting, and saithe) have made a significant northward shift in distribution over the last two decades and may expand into Isfjorden at 78° N (Porsangerfjorden is at 70–71° N).

Roughhead grenadier is a benthopelagic species seldom caught in the Barents Sea, but its distribution now extends northwards. Blue whiting is a pelagic species, abundant in the Norwegian Sea and currently expanding in the Barents Sea. Except for 2004, when some catches were taken as far north as Bjørnøya (74° N), whiting's distribution has remained quite stable and below the latitudes of Isfjorden. Similar stability is found for lemon sole, although this species is more seldom in the Barents Sea.

Saithe occurs mainly along the Norwegian coast, with some records offshore in the Barents Sea. The biomass of saithe peaked in 2010–2013 and has declined since, but remains above the long-term average for the time series dating back to 1960 (ICES, 2020). During recent years, some saithe have been caught at increasingly northern latitudes, although the bulk of the population has remained consistently around 71° N over the last decade. Since larvae can drift further north than where adults are recorded, it is an open question whether saithe will find spawning areas further north that may also provide the proper life conditions for a commercial stock.

Local conditions in the fjord systems of Svalbard can support fish communities, and kelp constitutes an important supporting element of marine ecosystems. These big brown algae, which form a complex 3D structure in shallow rocky shore sites and need hard substrate to

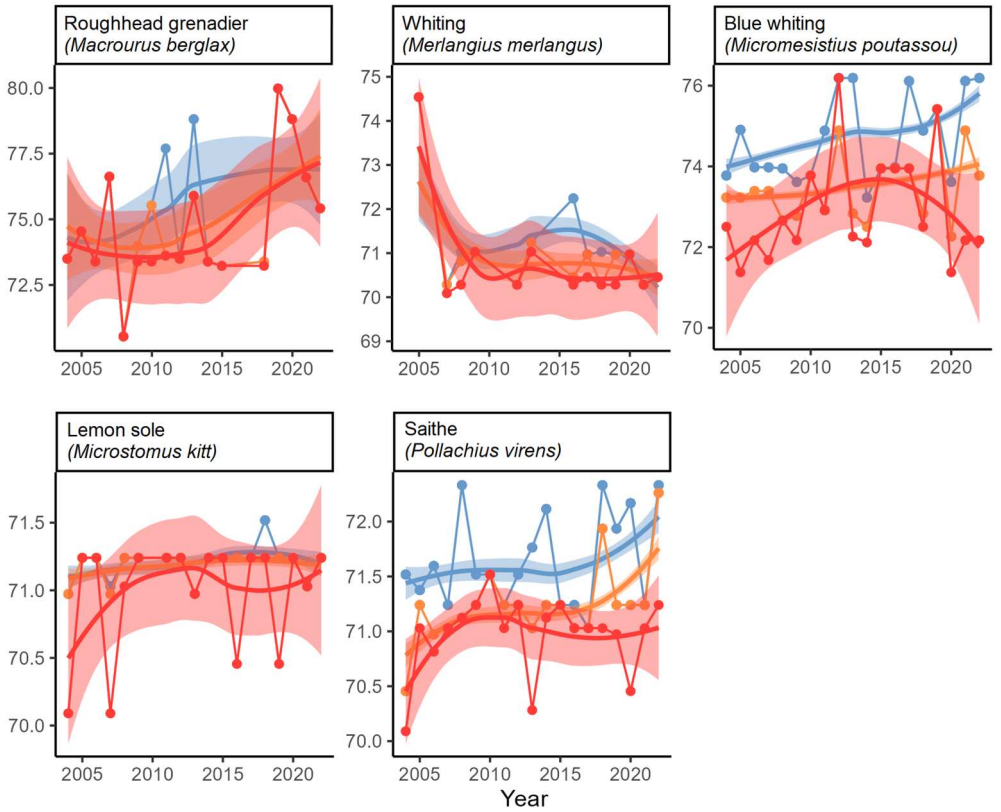

Figure 2. Latitudinal distributions for five species, as sampled at the BESS stations with Campelen 1800 bottom trawl, in autumn, and west of 26° E. Data from the Norwegian Institute of Marine Research. Distributions are described through three descriptors: the weighted mode (latitudinal position of the maximum of the density distribution weighted by biomasses, in red) and weighted 75th (orange) and 90th (blue) quantiles (northernmost limit for 75% and 90% of the biomass respectively).

flourish, have been identified to host a variety of fish species, worldwide and in the Arctic (Bodkin, 1988; Brand et al., 2023). Depending on the habitat characteristics, the fish assemblages vary. Bertoci et al. (2015) reviewed the consistency of a mostly positive kelp-fishery relationship, but the Arctic remains an understudied region in that field. A large-scale disturbance study in Norway simulating kelp harvesting showed the multi-trophic effect of reduced kelp cover and the severe impact on fish (Norderhaug et al., 2020). Another similar study revealed that the number of juvenile gadid fish became drastically reduced and persisted over at least a year (Lorentsen et al., 2010), highlighting macroalgae forests as particularly important habitats for juvenile fish (Brand & Fischer, 2016).

The coast of Isfjorden is characterized by rocky substrates or sea cliffs over wide areas (Søreide et al., 2021), and harbors kelp forest patches of variable size and depth extension (Triginer et al., 2024). In Kongsfjorden – a fjord located on the western coast of Svalbard, a few dozen kilometers north from Isfjorden (see Figure 1), juvenile sculpins (*Cottoidea*) and cod are associated with the kelp forests (Brand & Fischer, 2016). The browning of Arctic waters induces the retreat of kelp to shallower water depths (Düsedau et al., 2024) and might negatively influence the conditions for juvenile fish in Svalbard fjords. Additionally, although the specific relationship between kelp and fish occurrence in Isfjorden and

Porsangerfjorden is unknown, establishing marine reserves that include kelp forests in Svalbard waters could contribute to conserving fish populations against exploitation, as observed in other regions (Paddack & Estes, 2000), thereby also stabilizing the associated food web (Lorentsen et al., 2010). This is highly relevant in discussing and regulating a northward expansion of fish species.

Comparing Isfjorden with Porsangerfjorden: common geographical attributes, different societal contexts

Although the climatic and environmental changes are affecting the whole Arctic region, the magnitude and rate of impact, and the cascading and cumulative effects, vary significantly at the local level. Nevertheless, we see merit in comparing some aspects of Porsangerfjorden, a fjord with a boreal character, with Isfjorden, which is highly likely heading towards borealization. The purpose of comparing the two fjord systems is to better understand the observed and projected changes in Isfjorden and what this may mean for fishery management and regulation. Akin to Isfjorden, Porsangerfjorden has an outer fjord system and an inner basin with Arctic qualities. The inner part of Porsangerfjorden is shallower and colder than the rest of the fjord, giving it a polar character with living conditions for Arctic and benthic species, notably a local capelin stock and a deepwater shrimp population (*Pandalus borealis*). Several fish-landing facilities, predominantly in the outer fjord, are available for an active fishing fleet in Porsangerfjorden (Figure 3).

In the first half of the twentieth century, Porsangerfjorden had active small-scale fisheries, also for subsistence. The emergence of a fishing fleet with more efficient gear in the 1950s led, however, to the depletion of both transboundary stocks (e.g. the herring collapse) and local stocks of coastal cod (distinct from NEA cod), haddock, and saithe (Strand et al., 2020). Catches were significantly reduced during the second half of the century, and the coastal cod was severely depleted by the late 1980s. At the same time, an increase in sea urchins depleted the vital kelp forests in the fjord (Norderhaug & Christie, 2009). These changes have led to fish-poor conditions in Porsangerfjorden (Andersen & Persen, 2011; Strand, 2019), and an inapt management response failed to curb stock depletions.

Since 2010, the coastal cod population has started to recover in Porsangerfjorden, but the local saithe stock shows little sign of recovery (Broderstad & Eythórsson, 2014). Plans are underway to rebuild the lost cod stock, with the establishment of spawning pens and a kelp park for increased juvenile survival, as well as marine protected areas to preserve the larger fish (Strand, 2019). The most significant new driver of change in Porsangerfjorden in the last two decades is probably the expansion of red king crab (*Paralithodes camtschaticus*), first observed in the inner basin in 2011, but much earlier further out in the fjord (Strand et al., 2020). This fishery has quickly developed into an economically valuable activity, although the entry requirement (200,000 NOK revenue from fish catch) means that quotas are harder to come by for small-scale fjord vessels and young fishers (Bivdu, 2021). This raises questions of both the sustainability and equity of the crab fishery.

While we find it useful to compare fisheries in Isfjorden and Porsangerfjorden, the socioeconomic conditions are not equally comparable. Porsangerfjorden has been settled for thousands of years by the Indigenous Sea Sámi, Kven and Norwegians, while Isfjorden consists of two main 'company town' settlements, Longyearbyen and Barentsburg, administered respectively by Norway and Russia, in addition to Pyramiden where the facilities are nowadays used for tourism. In Longyearbyen, mining has been replaced by tourism,

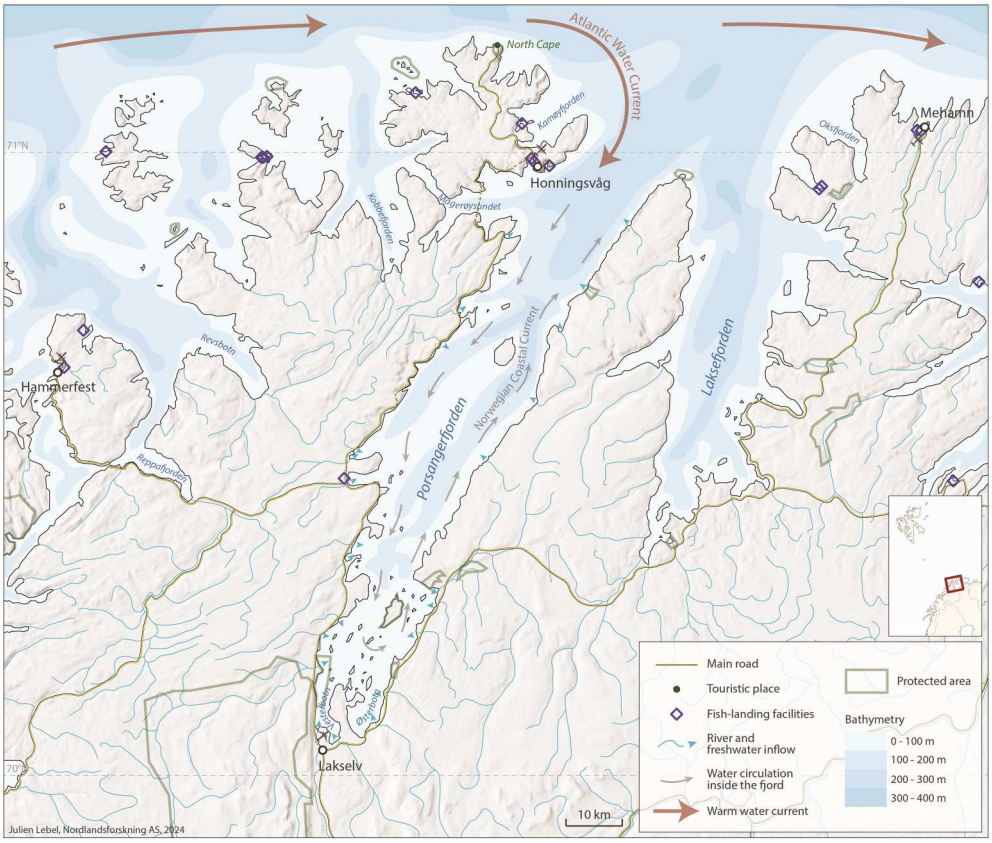

Figure 3. Map of Porsangerfjorden, a fjord system with boreal character in Northern Norway.

research, and education as economic activities. This has led to an expansion in restaurants and hotels and with them an interest in local products.

The Sea Sámi culture and settlements with a strong attachment to marine resources remain important for Porsangerfjorden, where the fjord and the surrounding area have been crucial for livelihood adaptation through centuries (Andersen & Persen, 2011). The fjord is closely associated with quality of life, sense of belonging and well-being for the inhabitants. Even though the average length of residency in Longyearbyen is only about four years, we find similar shared attachments to place and nature among the residents in Svalbard, where fishing, hunting and recreational nature use are unifying activities (Hovelsrud et al., 2020).

Regulatory aspects and challenges regarding current fisheries in Svalbard

As one of the richest fishing grounds in the world, the Barents Sea is home to some of the most commercially valuable fisheries in Europe (Dolgov et al., 2011). Most of the Barents Sea is covered by Norwegian (the Norwegian Exclusive Economic Zone (NEEZ) and the Svalbard Fisheries Protection Zone (FPZ)) or Russian jurisdiction (the Russian EEZ (REEZ)) (Figure 4). The major commercial fish stocks are managed bilaterally through the Joint Norwegian-Russian Fisheries Commission (JNRFC) (Hønneland, 2012). Beside

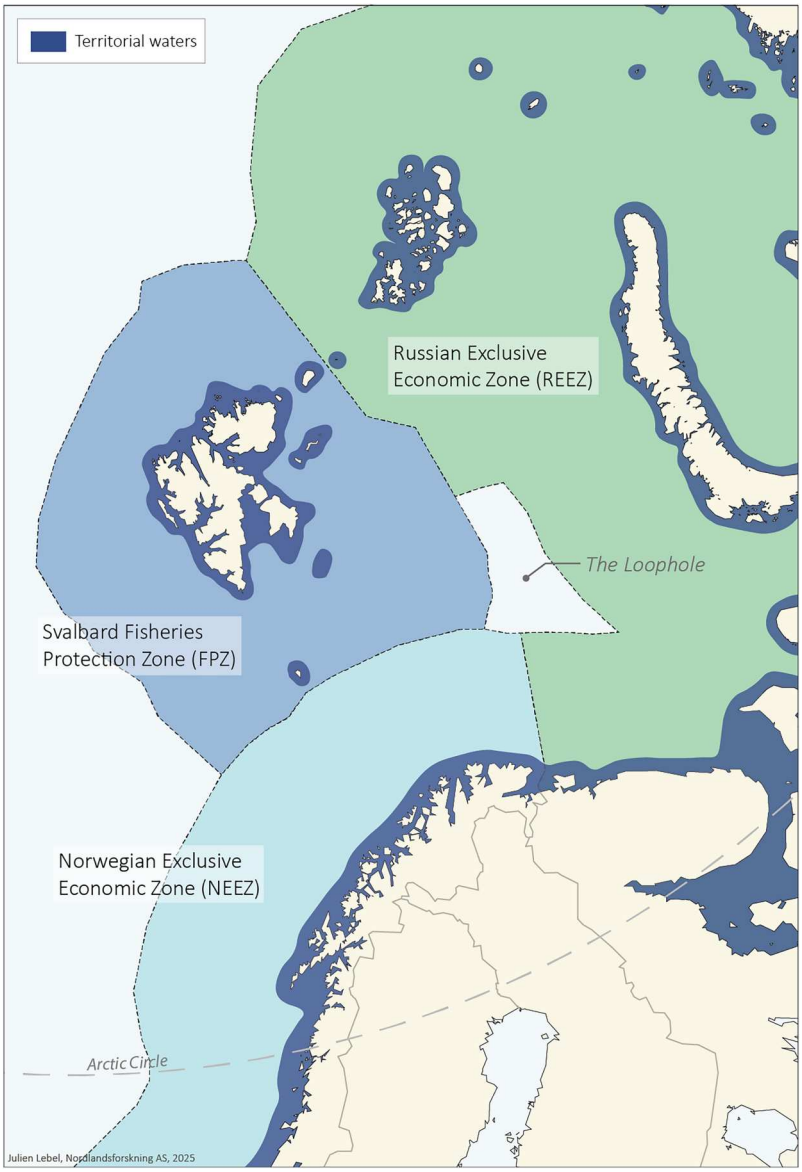

Figure 4. Map of the Svalbard Fisheries Protection Zone (FPZ), the Norwegian Exclusive Economic Zone (NEEZ) and the Russian Exclusive Economic Zone (REEZ).

Norway and Russia, some other countries – Denmark, Estonia, Faroe Islands, France, Germany, Greenland, Poland, Portugal, Spain, Belarus and the UK (ICES, 2021) – fish in the Barents Sea, through bilateral agreements with the coastal states or in the international waters in 'the Loophole' (Hønneland, 2012).

In Svalbard waters, i.e. in the territorial waters of the archipelago (12 nm from the baseline) and the FPZ, fishing is – like in the Barents Sea at large – dominated by Norwegian and Russian vessels (Misund et al., 2016). Fishing in both the territorial waters and the FPZ is regulated by the Norwegian Marine Resources Act (Havressurslova, 2009) and the same rules apply in regard to e.g. reporting of catch and gear regulations (Meld St. 32,

2015–2016). Fisheries in the FPZ is additionally regulated through the Economic Zone Act (our translation; Økonomiske soneloven, 1976) whereas fishing in the territorial waters is regulated by provisions under the Svalbard Act (Svalbardloven, 1925).

The main commercial fisheries in Svalbard waters target cod, haddock, capelin, Greenland halibut, redfish (*Sebastes mentella*), herring, snow crab (*Chionoecetes opilio)* and shrimp (Meld St. 32, 2015–2016; Meld. St. 10, 2023–2024). NEA cod, haddock, capelin, Greenland halibut and beaked redfish are managed jointly by Norway and Russia through the JNRFC, where foreign actors (i.e. not Norwegian or Russian) are allocated third-party quotas annually (Jørgensen & Østhagen, 2020). Norway allocates quotas for the FPZ for these joint stocks and nationally managed stocks like Norwegian spring-spawning herring. In the territorial waters, shrimp trawling is the main commercial fishing activity, open to states with historic shrimp fisheries, namely Norway, Russia, Canada, the Faroe Islands, Greenland, Iceland, the EU (Forskrift om rekefisket ved Svalbard, 1996). The fishing vessels naturally congregate where the catch opportunities are optimal, thereby increasing the pressure on these areas (Misund et al., 2016). Isfjorden is one of the main targeted areas for shrimp fishing.

Norway's sovereignty of Svalbard through the Svalbard Treaty is undisputed, though when it comes to the FPZ, there is a longstanding dispute around the legal interpretation of the Svalbard Treaty in line with the law of the sea. The Treaty gives Norway full sovereignty of the Svalbard archipelago and its territorial waters, while the signatory states (currently 46) have non-discriminatory access to Svalbard's resources according to Article 2 (Traité Concernant Le Spitsberg, 1925). Norway's official stance is that the Treaty text must be interpreted literally, meaning that the non-discriminatory access for signatory states applies to the land area and the territorial waters (Jensen, 2020). Beyond the territorial waters, Norway has the sovereign right as a coastal state to establish maritime jurisdiction zones in accordance with UNCLOS (United Nations Convention on the Law of the Sea) provisions (Pedersen, 2008).

The opposing argument is that the Treaty needs to be updated to interpret its original intention in line with law of the sea developments and that this would extend the coverage of the Treaty to the surrounding 200 nm zone as well as Svalbard's continental shelf (Pedersen, 2008). Treaty signees including Russia, the UK, Iceland and EU countries like the Netherlands and Spain have been vocal in this interpretation of the Treaty (Jensen, 2020). Due to these disputes, Norway established a 200 nm fisheries protection zone in 1977 in lieu of an EEZ (Pedersen, 2008). The FPZ is defined as a non-discriminatory zone in that Norway recognizes fishing rights and allots quotas based on historical activity (Jørgensen & Østhagen, 2020).

Compared to other Treaty states, Russia is in a special position given the longstanding fisheries cooperation with Norway. The cooperation remains highly prioritized from both parties despite complex geopolitical and management-specific circumstances (Bjørdal, 2023). Through the bilateral management regime, fishing vessels from the two countries have access to each other's jurisdictional zones, thereby giving Russia access to the FPZ (Hønneland, 2006). Officially, Russia does not acknowledge the FPZ and opposes its legal underpinning (Jensen, 2020). Despite this, Russia has not outright challenged Norway over the FPZ and largely comply with Norwegian enforcement, likely due to Norwegian regulation largely falling in line with Russian interests (Hønneland, 1998; Jørgensen & Østhagen, 2020).

The expansion of commercially attractive species into the new areas will require updated international fishing agreements, as illustrated by the 2014 mackerel deal between the EU,

Faroe Islands, and Norway (Berge et al., 2015). Such developments imply new challenges for the management of fisheries and other marine resources, throwing the discussion of Norwegian jurisdiction over the maritime zone around Svalbard further into the mix (Østhagen, 2021). The status of the FPZ and access to marine resources have been a highly contentious issue for years. With the northward expansion of snow crab, tensions recently reached new heights. Norway's jurisdiction of the FPZ and the Svalbard continental shelf has been extensively challenged, particularly by the EU (Jensen, 2023; Østhagen & Raspotnik, 2018). In 2023, the Supreme Court of Norway ruled that Articles 2 and 3 of the Treaty do not cover the continental shelf, i.e. supporting Norway's legal interpretation of the Treaty (Supreme Court of Norway, 2023).

Fisheries in the territorial waters are, additionally, indirectly regulated through local environmental regulation that supports the Svalbard Environmental Protection Act (SEPA, 2002/2012/2025). This targets specific areas and defines rules for protected areas by, for example, obliging vessels to sail at least 300 m away from bird reserves and forbidding trawling in water shallower than 100 m (Forskrift om nasjonalparkene og naturreservatene på Svalbard, 2014; Øseth et al., 2016).

While all commercial fishing vessels in Norwegian waters, including Svalbard, are required to report catch and activity data (Forskrift om fiske i fiskevernsonen, Svalbard, 2010), the reporting has different requirements and formats depending on the nationality of the fishing vessel and whether the catch is landed in Norway. Importantly, Russia does not report catch data for the FPZ specifically, given their official position of not acknowledging the FPZ (Jørgensen & Østhagen, 2020). Because there are no fish-landing facilities on Svalbard, no commercial catches are landed on the archipelago, and data on catch from Svalbard waters are therefore not readily available. Recent attention has been given to Russian fish transshipment/reloading in Svalbard fjords (Pettersen et al., 2024). The covert practice, while not illegal, lacks official data. Aggregating comprehensive fishing activity data for Svalbard waters on catch, location, and vessel nationality is beyond the scope of this paper. Instead, we are concerned with the fact that fishing activities in Svalbard territorial waters are governed through a mosaic of regulations that are not easy to navigate. In the long term this may also affect recreational fishing in Svalbard, which is projected to increase alongside increasing demand for local fish and seafood products in Longyearbyen, if restrictions and/or limitations are implemented to regulate recreational fishing activities.

Most of the fish products that are consumed on Svalbard originate from other regions and are (re)exported from mainland Norway to the archipelago, often by plane. Currently it is not mandatory for recreational fishers to report their catches. Only one fisher based in Longyearbyen is active during summer months and reports the catch they sell to local restaurants. Their catch far from covers the local demand for fish products in Longyearbyen, and there is a growing interest among both locals and tourists in consuming fish that are caught locally (Lorentzen et al., 2025). Several inhabitants of Longyearbyen and Barentsburg fish in Isfjorden, but the extent of their catch is unknown. The same applies to sport fishing activities organized by tourism operators. With borealization effects and the increase of commercially important and recreationally interesting species, the regulations appear both too complex and insufficient to ensure sustainable resource management, differentiate the activities between fishing vessels, tourists and inhabitants, limit the impacts on the environment, and monitor the catch in Svalbard fjords.

Discussion

A warming ocean is clearly affecting the migratory pattern and feeding areas of commercially interesting fish stocks, and an increase of new species into the Barents Sea and northwards towards Svalbard appears inevitable. In exploring what the borealization of fish communities may mean for Isfjorden, we have revealed a complex picture of environmental, social and regulatory character due to warmer waters, the mosaic of regulations affecting fisheries and navigation both around the archipelago and within the fjords, and interest in consuming fish that is caught locally. By using the heavily overfished Porsangerfjorden as a proxy, we illustrate the importance of a locally relevant regulatory framework.

In this paper we have highlighted how fisheries in Isfjorden are affected by and linked to several environmental factors including the consequences of climate change for ocean warming, sea-ice retreat, ecosystem changes, erosion and runoff, and the browning of the coastal waters. These changes will likely increase the ongoing northward shift and expansion of key commercial fish stocks. Retreating sea ice drives new opportunities for the fisheries sector, as well as shipping and tourism (Stocker et al., 2020).

Even though subarctic conditions may become dominant in Svalbard fjords in the future (Dahlke et al., 2020), the archipelago will remain a region with vulnerable ecosystems. While the Svalbard fjords experience relatively low pressure from human activities when compared with fjords in Northern Norway (Kujawa et al., 2021) such as Porsangerfjorden, the increasing development of human activities will nevertheless be challenging. Safety at sea is one major aspect to consider when accessing the areas previously covered in sea ice, due to their remoteness from search and rescue (SAR) resources and because of unpredictable weather conditions. This is relevant for both expedition cruise vessels (Stocker et al., 2020) and fishing vessels that are now increasingly fishing in such previously inaccessible waters. Further, erosion in coastal areas constitutes a threat for existing infrastructure, while the accumulation of sediments in shallow waters could make it more difficult to navigate in some near-shore zones (Jaskólski et al., 2018).

Greenhouse gas (GHG) emissions and pollution (e.g. noise, microplastics) from cruise and expedition ships, fishing vessels, recreational vessels, snow scooters on sea ice and other human activities are a direct threat to the ecosystem in Isfjorden (Søreide et al., 2021). A growing number of fishing vessels would very likely result in increased pollution and GHG emissions. The ban on heavy fuel oil (HFO) around Svalbard – and as of June 2024 in the whole Arctic – and the revisions of the SEPA (SEPA, 2002/2012/2025) will likely have little influence on commercial fisheries. HFO is primarily used by larger vessels, such as cargo, tanker, and passenger ships (DNV, 2013), and the revised SEPA pertains mainly to marine tourism and recreational activities.

As illustrated through the Porsangerfjorden case, the expansion of commercially attractive species and increase in abundance of fish stocks can create both opportunities and challenges. The fisheries sector in Porsangerfjorden has benefited, in the past, from abundant stocks, before getting depleted due to overfishing. More recently, the red king crab has become a commercially attractive species and attracted large interest from the local fishers. Still, the long-term sustainability of this fishery may be questioned. In the meantime, the recovery pace of the depleted fish stocks is relatively slow or only shows little sign of progress. The outer part of Porsangerfjorden, still closed for commercial trawling in

response to this situation, is therefore a stark example of what may occur without careful management and monitoring. With its abundant resources, Isfjorden is also vulnerable to extensive overfishing and overexploitation. Additionally, any increase in trawling activity would significantly impact seafloor communities in Svalbard fjords (Øseth et al., 2016). These issues illustrate the importance of adequate regulations to ensure sustainable management of fish stocks and safeguarding biodiversity.

Yet, our analyses show that the fisheries regulations for Svalbard are difficult to navigate and appear to be lacking in locally relevant details. Moreover, in connection with the potential increase in marine traffic, tensions regarding access to marine areas may develop between different stakeholder interests, such as fishing vessels, tourist organizations, and research activities. Interviewees highlight, for example, that the lack of comprehensive regulations of recreational fishing activities is beneficial for Longyearbyen residents, as they currently can fish relatively freely. This may change if increased fishing from tourists and commercial vessels leads to stricter regulations for all, although the recent white paper (Meld. St. 26, 2023–2024) and the amended and stricter SEPA distinguish between residents and visitors when it comes to access and travel on Svalbard. Access and traffic restrictions in some areas have been extended and are being discussed for new areas, and GHG emissions mitigation has led to restrictions on certain types of vehicles (Hovelsrud et al., 2023). Moreover, a ban on fishing activities in Kongsfjorden was, for example, strengthened in 2007 to protect the interests of the research community in the area (Andersen, 2014).

The observed trends of northward expansion of commercially attractive species and changes in abundance of existing stocks, combined with easier access due to reduced sea ice, will likely lead to increased pressure from Treaty states to take part in fishing activities. This could fuel further disputes regarding Norway's interpretation of the Svalbard Treaty and international legal scrutiny of the Norwegian Supreme Court ruling from 2023. Yet, the geopolitical situation following Russia's all-out war against Ukraine has resulted in a relative shift of focus, with Norway and the EU unwilling to create further tensions around fisheries in the Svalbard zone, but rather promote general stability in the region (Lebel & Nilsson, 2024). However, this does not imply that Norway and the EU come to any agreement on fisheries issues. In the meantime, the fisheries cooperation between Norway and Russia in the Barents Sea has remained remarkably stable, despite tensions due to the geopolitical situation and Russia not acknowledging the FPZ. The cross-border management of fish stocks in the region is essential to ensure its sustainability, and any disruption in this bilateral cooperation would have major consequences for the fisheries sector and the biodiversity in the Barents Sea, including the Svalbard zone.

The current issues we have highlighted, combined with the potential future challenges linked to fisheries in the Svalbard zone, may warrant a regulatory framework that addresses fishing activities by what may be more and different stakeholders with increased tourism and local fisheries in the Svalbard territorial waters. Such a framework would benefit from being sensitive to the interests of the different stakeholders that are currently active in fisheries. The involvement of stakeholders would, moreover, benefit from a better and regular monitoring of fish species in Isfjorden. Gathering these data would allow the forecasting of how and where fisheries might develop, the tracking of ecologically key species in important areas like Isfjorden, the more efficient regulation of access to marine resources, and a reduced risk of interstate disputes.

Due to changes in fish stock abundance and species composition, commercial fisheries that are already lucrative in the Barents Sea and Svalbard territorial waters, including

Isfjorden, may further increase. We find a growing interest in locally sourced fish and seafood among residents and tourists in Longyearbyen, which will likely increase fisheries activities by local fishers. Further, there are currently no landing facilities for fish and seafood in Longyearbyen, reducing information about the commercial catch in the area and creating a barrier for the expansion of local fisheries.

Discussions about such landing facilities have taken place in both Longyearbyen and Barentsburg, but the Norwegian government has sharpened its position on the topic and currently shows no intention to enable such infrastructure, citing the lack of basic infrastructure for fisheries on Svalbard (Meld. St. 26, 2023–2024). In its previous white paper on Svalbard, the Norwegian government was nevertheless more positive to developing the fishing industry on the archipelago, making a clear connection between this sector and interests for both tourism and local food (Meld. St. 32, 2015–2016). The Russian government has been encouraging the establishment of landing and processing fish facilities in Barentsburg, with the objective to diversify local activities, mainly based on coal mining. A Russian-owned company was initially created to carry out this plan and lead preliminary assessment work, in cooperation with the Russian state-owned company Trust Arktikugol for renting an estate (Ylvisåker, 2020). It did, however, not manage to obtain final permission, as plans for fish landing facilities in both Longyearbyen and Barentsburg have been put on hold in 2021 (Ylvisåker, 2021). Ambitioning to strengthen the Norwegian presence on Svalbard and accordingly managing more closely developments on the archipelago, the Norwegian government does not consider the establishment of fish landing facilities in line with its interests for now. Issues regarding compliance with environmental regulations when it comes to economic development on Svalbard are also emphasized by the authorities (Meld. St. 26, 2023–2024).

Even though both geopolitical and environmental considerations can explain the current stance of the Norwegian government, we surmise that if borealization results in an abundance of new species of commercial interest, increased pressure for a landing facility in Longyearbyen may result. This comes with its own challenges for the local harbor, processing, and transport of catch, which would require adjusting infrastructure in the community. More importantly perhaps is the need for a landing facility for local fishers who are interested in supplying sought-after local fish products to Longyearbyen. Increased local commercial fisheries could benefit Longyearbyen (and Barentsburg) in terms of new job opportunities for residents, and support further the diversification of local activities.

The expansion of the snow crab is being closely followed by scientists and the local communities, since it could potentially become a valuable local fishery, as is the case with the red king crab in Porsangerfjorden. As tourism has become a major activity in the archipelago, providing local fish products could become a part of the experiences that are offered to the visitors. Moreover, the establishment of a fishing industry in Svalbard could be an efficient way to reduce the reliance on food imports from the mainland and the related GHG emissions caused by their transport over long distances. Local fish products are currently unable to satisfy local demand, due to the reliance on catch from residents that is limited. Considering the growing debate around sustainability on the archipelago regarding topics like tourism, energy, and transport (Hovelsrud et al., 2020, 2023), one wonders whether an increase in commercial fish catch from Isfjorden and the surrounding area could spur the establishment of a food system in Svalbard principally based on local fish products rather than imports.

Conclusion

Characterized by growing anthropogenic impacts, Isfjorden is in transition. Ongoing environmental changes are affecting the local communities, and the fjord's biodiversity is evolving with new ecological conditions. The borealization of fish communities is one of the consequences of these environmental changes, impacting fisheries by bringing not only new opportunities but also challenges. In connection with its ongoing transition, Isfjorden is a forerunner for the impacts of the evolving ecological conditions that will affect other Svalbard fjord systems in the coming years. Considering fisheries management practices from fjord systems in Low Arctic regions with a boreal character that have experienced developments in fishing activities in the past decades, such as Porsangerfjorden, is relevant in identifying possible challenges in High Arctic fjords.

With the expansion of commercially attractive species in Svalbard waters, one can expect an increase in fishing activities and increased pressure from foreign (non-Norwegian) vessels of countries holding fishing quotas in the FPZ and/or being part of the Treaty to access areas where the application of the Svalbard Treaty is contested. Moreover, comprehensive and accessible regulations are lacking to address specifically fisheries matters in the territorial waters. Tourism operators, commercial vessels and inhabitants have different interests when it comes to fisheries and could be impacted unequally if the regulations were adjusted without differentiating the actors. Adequate regulations and monitoring of key fish species are needed to develop fishing activities in a way that will achieve sustainable harvesting, limit environmental impacts, and reduce the risk of interstate disputes. However, the Norwegian authorities' stance is challenged by various stakeholders and risks lagging behind in efficiently addressing ongoing changes and issues linked to fisheries in Svalbard waters.

There is a growing interest in Longyearbyen to develop a robust food system based on local fish products that could benefit both locals and tourists. Yet, establishing fish landing facilities on Svalbard is not encouraged by the Norwegian government for the time being, due to both geopolitical and environmental considerations. Along with a possible increase in commercially relevant species and changes in abundance of fish stocks in Svalbard waters, developing a fishery industry on the archipelago would nevertheless help reduce the dependency on food imports and be in line with a stronger focus on sustainability.

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