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ACCESS
Arctic Climate Change
Economy and Society

Policy Brief n°3

Seafood Production in a Changing Arctic

Fishing, aquaculture, hunting for marine mammals and fish processing provide food and incomes for Arctic communities. Arctic fishing and aquaculture enterprises are an important source of seafood for the European Union (EU) and global markets. The impact climate change will have on the functioning of Arctic marine ecosystems and the services they provide is uncertain. The direct impacts from climate change on the Arctic seafood industry, however, seem to be relatively modest in the broad context of the next 40-year period. Indirect effects, such as climate change impacts on other sectors and authorities' interventions and regulations, may have greater bearing on the seafood industry and communities in the Arctic region.

Introduction

Some of the world's most productive fisheries are in the sub-Arctic marine regions (Figure 1). Arctic seafood production covers a wide variety of activities. Here we consider the area north of the Arctic Circle. In addition to fisheries, Norway, Greenland and Iceland participate in whaling; and seal hunting is carried out by Canada, Norway, Russia and Greenland. But by far, most seafood production stems from fisheries and aquaculture, plus the products made there from. By seafood production, we mean yields for direct human consumption, thus excluding reduction fisheries used to make fish oil and fishmeal for animal feeds.

In 2012, capture fisheries worldwide harvested an estimated 80 million tonnes, of which some 5 % (about 4 million tonnes) were caught in Arctic areas, mostly in the Northeast Atlantic (FAO, 2014) (Figure 2). Russia, Norway and Iceland – all substantial fishery nations in the Northeast Atlantic – are among the world's largest fishing nations (i.e., 5th, 11th and 17th largest respectively). In the sub-Arctic portion of the northeast part of the Pacific Ocean, Alaskan pollock is the dominant species. The main species in the sub-Arctic Pacific and Atlantic Oceans — Alaskan pollock, Atlantic herring and cod — are also among the major species in capture fisheries; a list dominated by smaller pelagic species – fish living neither close to the bottom nor near the shore – often targeted by the reduction fishery industries. Moreover in 2012, Norway was the largest marine finfish aquaculture producer and the

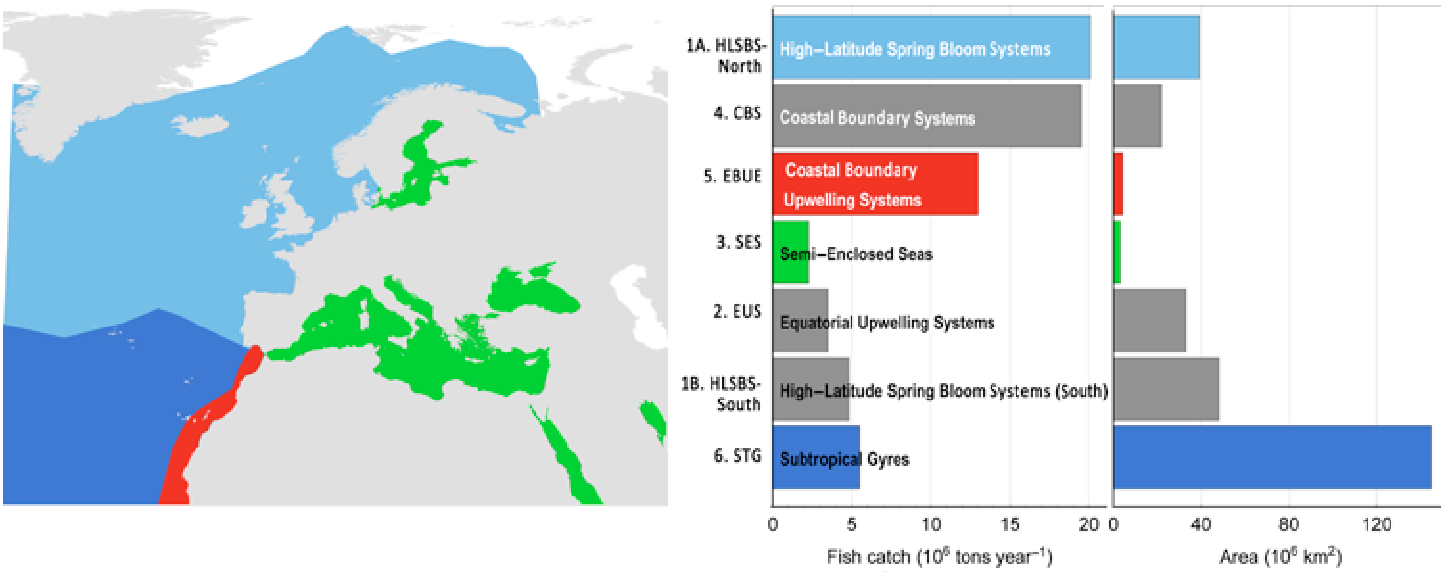

Figure 1 - Sub-regions (Northeast and Northwest Atlantic) as part of the Northern High-Latitude Spring Blooming Systems (HLSBS-North). According to the IPCC a "northward expansion of plankton, invertebrate, and fish communities with sea warming and increase of fish biomass at high latitude fringes" is highly probable. Furthermore, "increased fish catches at high latitude fringes with economic disruption and jurisdictional tensions as some fish stocks shift distribution". Source: IPCC (2014, pp.1663, 1699 and 1700).[1]

1 - IPCC (2014), Climate Change 2014: Impacts, Adaptation, and Vulnerability Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, US.

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Seafood Production in a Changing Arctic

6th largest aquaculture nation worldwide. Aquaculture is also found in Iceland, Canada, Russia, Alaska (US), Sweden and Finland, but – apart from Canada – they only generate modest volumes compared with Norway. For the EU, about 30 % of total seafood imports in 2013 (roughly 5 million tonnes with a value of EUR 19.3 billion) was from Norway, Russia or Iceland. The total landing from fisheries in Norway, Iceland, Greenland and northwest Russia (including catches below the Arctic) were more than 4.3 million tonnes with an ex-vessel value of nearly EUR 3.5 billion.[2] In addition, the farm-gate value of Norwegian salmonoid aquaculture alone reached EUR 5.1 billion in 2013.

Arctic fisheries include a vast diversity of activities, from artisanal small-scale multi-purpose and multi-target species vessels to large trawlers with on-board processing as well as pelagic purse seiners. Also, the degree of utilization of the fish varies from whole fresh or frozen fish to fishmeal and fish oil production as well as ready-to-cook consumer packages. Today, Arctic seafood is exported worldwide in a wide variety of products. Seafood is by value the largest food sector in international trade, and Arctic fishing nations like Norway export the lion's share of their production. In Norway – the world's second-biggest seafood export nation – this share is estimated to be about 95%, similar to that of Iceland and the Faroe Islands. Other fishery nations, where a higher proportion of the harvest is consumed domestically are not likely to have the same export level. Nonetheless, fish are a highly traded commodity and have high value. As much as 37 % of the world's fishery production is expected to be traded at increasing prices in the coming decade (OECD-FAO, 2014).[3]

Fish have become an ever more important ingredient in the diet of an expanding global population and seafood production growth has outpaced that of the global population. A main reason is that aquaculture production now accounts for 50 % of total fish consumption by humans. In terms of average protein intake of people around the world, fish accounted for 6.5 % in 2010. With production outpacing population growth, increased trade and urbanisation, fish have potential to become an even more important protein food component for the global population. Arctic seafood production has the potential to contribute more to global seafood production, especially through aquaculture, but besides uncertainties related to climate effects in the Arctic other challenges also exist (i.e. related to resources and markets).

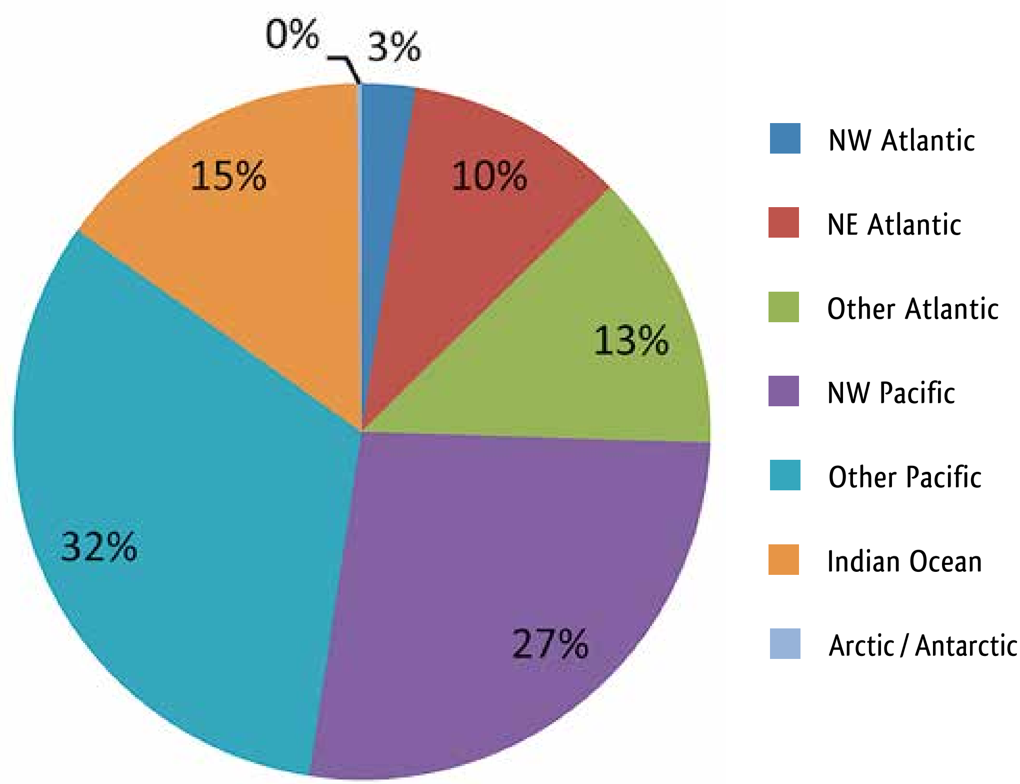

Figure 2 - Marine capture fisheries by region, percentage of 2012 global harvest (~80 million tonnes).
Note: "Other Atlantic" includes the Mediterranean and Black Seas.
Source: FAO, 2014.

2 - The ex-vessel value is the value of the catch received at the first purchase of commercial harvest.

3 - OECD/FAO (2014), *OECD-FAO Agricultural Outlook 2014*, OECD, *http://dx.doi.org/10.1787/agr_outlook-2014-en*

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Climate Change in the Arctic

The Intergovernmental Panel on Climate Change (2014) foresees great changes affecting the world's oceans and coastal areas. Some will indisputably affect marine ecosystems in the Arctic and the ability to harvest from wild fish stocks and / or alter the conditions for aquaculture. Among these we note ocean warming, which in the Arctic may affect ice coverage, ocean acidification, dissolved oxygen and sea levels. This will also affect coastal areas, in addition to more frequent extreme weather (wind and waves), freshwater input and freshwater runoff from land. These predicted effects are uncertain in terms of when they will take place and how pronounced they will be. Here, we scrutinize some of the most realistic climate change effects on Arctic ecosystems, fisheries, aquaculture and markets (factor markets and fish markets). Indicated pathways represent realistic scenarios of expected development for the decades to come to 2040 based on research carried out within the framework of ACCESS and the best currently available knowledge.

Expected changes for Arctic fisheries

Climate change will increase sea temperatures and sea levels, reduce ice coverage, change primary production and possibly cause shifts in zooplankton communities.

Both subsistence fishers and fishing industries in the high-Arctic and sub-Arctic are characterised by a high capacity to adapt to changes in the resource base and other environmental variations. This resilience enables the industry to function during high level of natural fluctuations in climate conditions and under significant variations within and between years. This adaptive capacity is a buffer towards abrupt decline in profits and catch quantities caused by climate change, but it also represents a possibility to take advantage of new opportunities that the changing environment may provide (responding to change).

The largest fisheries in the European sub-Arctic take place on or close to shallow shelf areas, the most important being the Norwegian and Barents seas. Demersal species – those living on or near the bottom – are restricted by the sea floor topology which remains unchanged under climate change. Cold water in eastern shelf areas, some covered by ice, may reach temperatures that allow the area of demersal species to expand eastward, but significant changes in the distribution areas of these species are not expected in the next few decades (Eide, 2014).[4]

The distribution areas of pelagic species are by nature less constrained, also reflected in the previous history of large changes in distribution areas. Stock size and food availability in addition to suitable physical environmental conditions, together with exploitation patterns, are the main factors determining the spatial distribution of these species. It is difficult, however, to tell which factor is dominating. These are often shared stocks where changes in spatial distribution, temporal or lasting, represent challenges for joint management agreements between coastal nations. This is not a new problem and today it is not clear how much more pronounced the problem will be in future due to climate change.

For both demersal and pelagic fisheries in the sub-Arctic, there are a number of tools and management procedures available today that by design should be able to function with the climate change consequences that we currently foresee. Established Harvest Control Regimes (HCR) may quickly adjust to changing conditions and increased knowledge, providing a manager with a much more flexible tool than in the previous model-based framework of fisheries resource management. International treaties, multilateral and bilateral management agreements are evolving and developing, not only driven by environmental changes and improved understanding, but also as a consequence of the arrival of new stakeholders and increased public interests. Some of the political processes aiming to get involved in the development of sub-Arctic fisheries management are better understood in this context than in the context of climate change impacts. This development is likely to increase independent of climate change effects because of the increased political interest in the Arctic region. What consequences this will have for the sub-Arctic fisheries are yet to be seen.

4 - Eide, A. (2014), "Modelling Spatial Distribution of the Barents Sea Cod Fishery", in J.Was, G. Sirakoulis and S. Bandini (eds.) *Lecture Notes in Computer Science*, ACRI 2014; Volume 8751, Springer, Verlag, Switzerland. ISSN 0302-9743.pp 288 - 299.s doi: 10.1007/978-3-319-11520-7.

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Expected changes for Arctic aquaculture

Arctic aquaculture is relatively small in terms of the global seafood supply. At about 1.3 million tonnes (mainly Atlantic salmon) with a value of USD 1.9 billion, it constitutes about 2% of both world production and value (Hermansen and Troell, 2012).[5] The vast majority is salmon culture in the Norwegian sub-Arctic region, taking advantage of comparatively high sea temperatures and sheltered locations that allow low-cost technology to be employed. Although small by global standards, it is an important source of livelihoods in several rural areas. Arctic aquaculture that takes place in Iceland, Russia, Sweden and Finland is small compared with Norwegian production.

Being a key parameter for aquaculture in general, rising sea temperatures will have several impacts on the activity. Several of these, however, are difficult to project. More predictable impacts are related to fish growth and farm productivity, areas biologically and physically suitable for aquaculture and opportunities for new species. Existing aquaculture in the Arctic generally operates in lower than optimal sea temperatures, and will benefit in terms of fish growth and productivity from the temperature increases that scenarios predict for the medium term. Today, some sub-Arctic areas are unavailable for aquaculture, primarily due to sea-ice and icing conditions. These will gradually be accessible for aquaculture, thus extending the potential area and production capacity. Likely to be of most importance are areas in the Russian sub-Arctic. Here, both low temperatures and current ice conditions render large areas unsuitable for cage-based aquaculture. While some warming could in the future provide conditions for aquaculture in the Kola Peninsula, it is unlikely that marine aquaculture will take place outside of the sub-Arctic, e.g. Svalbard or further east, for example the Kara Sea coast, as ice and low temperatures will still prevail.

Aquaculture legislation and official management in Norway is relatively mature, although with room for improvement. As used for capture fisheries, an ecosystem-based approach to management has been proposed for aquaculture. At present, Russia lacks systematic legislation and practices related to aquaculture. Combined with general business difficulties and strong military restrictions on many attractive areas, this could be a major hindrance for exploitation of aquaculture opportunities in Russia.

With aquaculture taking place in both Norway and Russia, trans-boundary governance problems can arise. Legislation, operating standards and practices, particularly on hygiene and pathogen transfer, should be co-ordinated to limit the risk of disease development and transfer. Coupled with the present and expected rapid growth in Russian aquaculture, this issue is of strong importance.

Successful aquaculture of salmon takes place at a relatively wide temperature range. Coupled with the projected changes related to climate change, this illustrates the importance of good management for the industry's long-term sustainability and growth. To a large extent, climate conditions define where aquaculture is biologically and economically sustainable. However, local authorities define where it is allowed, considering also other stakeholders and values. Hence, industry growth and adaptation is dependent on these legal and institutional processes.

Of the less predictable effects, climate change is likely to effect the distribution of pathogens. For economic sustainability, sound management of such risks is of particular high importance. Here, governance both from the industry itself and the authorities have important roles. Technical standards and monitoring of compliance, sound farm location principles to limit risks of disease and parasite transfer between farms and wild organisms, and sufficient allocation of resources for vaccine and treatment research and development are examples of important areas for effective governance.

These are also linked to potential climate change effects through, for example, storm strength and frequency impacts and pathogen habitats. Another area that illustrates the considerable importance of management is how negative impacts from aquaculture on other sectors, such as fisheries and tourism are handled in terms of facilitating aquaculture industry growth. At present, strong emphasis is being placed on precautionary approaches. Growth has been restricted in a period when the demand to expand aquaculture is strong. For instance, current restrictions related to relocating aquaculture farms in Norway, if unchanged, will restrict the industry's ability to adapt and take advantage of changing sea conditions and hence possibly lower the economic output and welfare generated.

5 - Hermansen, Ø. and M. Troell (2012,) *Aquaculture in the Arctic: A Review*, Report no. 36, Nofima, Tromsø, Norway.

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Future Role of the Arctic in Global Food Supply

The Arctic, with its weather and climate conditions that impede productive agriculture, represents one of the harshest landscapes for humans. However, existing fishery resources and aquaculture production make up the most productive waters for marine resources worldwide. Fisheries and aquaculture industries have developed adaptive strategies since local conditions normally vary significantly and climate change has the potential to enhance this variability. On a general level, however, the most transparent and obvious effects from climate change on Arctic seafood production seem to imply positive — rather than negative — effects, in the medium term to 2040. However, it is important to realize that aquaculture in the Arctic is also dependent on climate change effects in other parts of the world since the industry depends on markets related to global fisheries.

The density of the sub-Arctic human population is among the lowest in the world. There are no permanent settlements north of the population in Svalbard, and the entire area probably has only about four million people living along the Arctic and adjacent oceans. Less than 10% of the population is identified as indigenous people, most located in Canada and the United States.

The sub-Arctic population depends heavily on the utilisation of local natural resources. Fisheries are economically important in most populated areas, but modern fisheries do not employ a large share of the population. Only a minor share of the marine food production in the area is consumed in the sub-Arctic, the rest is traded on regional and global markets. There is no indication of declining production as a consequence of climate change. Rather, there are reasons to expect growth in production of both capture fisheries and aquaculture to continue and possibly increase over the period envisaged in the scenarios to 2040.

The spectacular natural landscapes and indigenous cultural riches of the far North also have economic value for tourism enterprises. Tourism will probably be an expanding economic activity in the coming years and it could limit areas for seafood production such as aquaculture expansion. Increased fish farming locations also need to be assessed in terms of interactions with local communities, indigenous peoples and other business sectors.

Enormous quantities of marine protein are available in the lower trophic levels of the sub-Arctic marine ecosystems. The Calanus genus includes zooplankton species that are key components of the Arctic and sub-Arctic food web, producing about 300 million tonnes of biomass per year, of which about 80 million tonnes are consumed by fish populations in the region. Calanus biomass is expected to expand and increase their growth in a warmer climate. A smaller share of this biomass could possibly be harvested without jeopardizing the resource or the function it provides from an ecosystem perspective.

27 participants and 10 European countries involved in ACCESS project

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For further information about ACCESS please visit our website at www.access-eu-org

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