R&D-Report

Blue Fisheries & Aquaculture. Fisheries and Aquaculture in Alaska and North Norway

AlaskaNor WORK PACKAGE III

Gergana Stoeva
Apostolos Tsiouvalas
Malte Humpert
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Nord University
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Fisheries and Aquaculture in Alaska and North Norway

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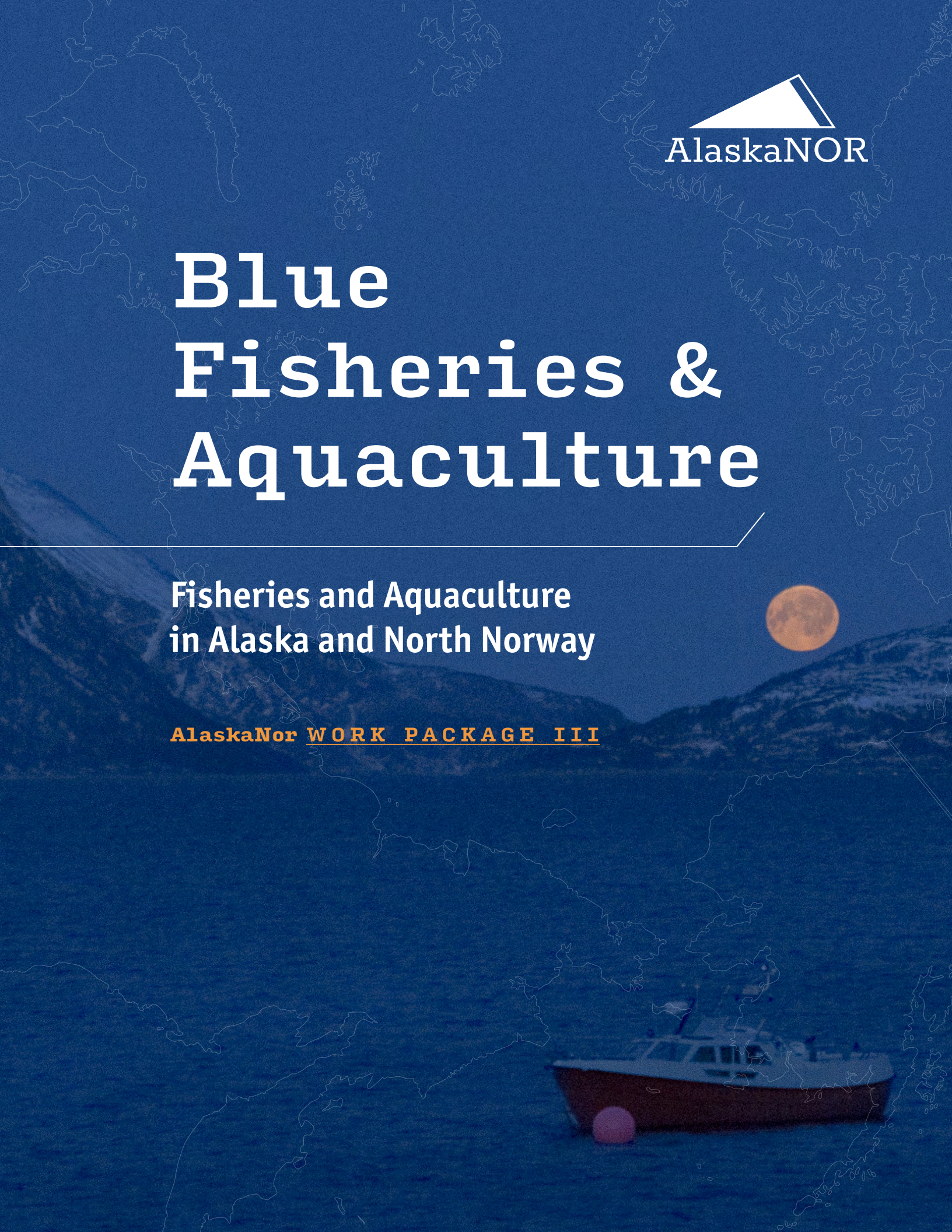

AlaskaNOR

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The figures, estimates, forecasts, and recommendations contained in this report were primarily collected and devised prior to the global Covid-19 pandemic. Due to the global economic impact of the pandemic, some estimates and forecasts may no longer represent the most likely scenarios and timelines may have to be adjusted to reflect new economic realities.

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List of Abbreviations

AFSC	Alaska Fisheries Science Center
CDQ	Community Development Quota
EEZ	Exclusive Economic Zone
ESSPR	Economic and Social Sciences Research Program
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
HAB	Harmful Algal Blooms
H&G	Headed and gutted
nm	Nautical mile
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
NPRB	North Pacific Research Board
NSS-herring	Norwegian Spring spawning herring
PSP	Paralytic shellfish poisoning
SDG	United Nations Sustainable Development Goals

A Blue Future for Alaska and North Norway

The Arctic, or the "High North," as this area is usually called in Norway, is one of the world's regions with the greatest prospects for economic value creation. With so much of the Arctic consisting of ocean, the area's potential is heavily dependent on the "blue economy," referring to the sustainable use of the ocean and its various resources for growth and improved livelihoods, in a way that preserves the health of the ecosystem.

The Arctic is changing, and it is changing fast, creating both new opportunities and responsibilities. So far, we know too little about these changes, which may be environmental, technological, and social in nature. Therefore, new knowledge must be created through serious and independent research focused on how to sustainably exploit the ocean's resources and ensure that residents of the region benefit equitably. We also need dialogue between different the Arctic stakeholders, openly sharing and discussing knowledge and experiences internationally.

The AlaskaNor Project aims to develop and communicate knowledge concerning the blue economy potential in Alaska and North Norway and make this knowledge available for relevant stakeholders and decision-makers. Alaska and North Norway are important regions in the Arctic and have extensive experiences and competence connected to business and societal challenges. Some of these experiences are held in common, such as commercial development of offshore oil and gas, management of commercial fisheries, support of operations in national and international defense activities as well as in maritime rescue and emergency preparedness activities. Others, such as approaches to fish farming, tourism, and Indigenous stakeholder involvement in business ventures are unique in each jurisdiction. Until now, sharing of these experiences has not been done in a systematical way. AlaskaNor tries to develop platforms and networks for improving this.

For those like us living in the Arctic, the region is a natural treasure, supporting traditional resource utilization, developing new industries, and home to a diversity of fish and wildlife. And yet, we are increasingly faced with challenges connected to urbanization, demographic trends and climate change. There is a strong and growing need for more knowledge and sharing experiences where initiatives have worked well and where they have not. In particular, we need to understand how implementing management frameworks and policy formulation can help promote positive development and secure the potential for sustainable value creation and social development in the years ahead.

In the AlaskaNor Project, we focus primarily on four areas: offshore energy, fisheries and aquaculture, Arctic shipping and maritime transportation, and regional and international governance. Based on the studies and analyses of these areas, the aim is to give valuable input both for business activities and policy making, and strengthen cooperation within the blue economy between North Norway, Alaska, and the Arctic in general.

As highlighted in the last Business Index North (BIN) report, the spread of the Covid-19 virus and efforts to bring it under control, will most certainly affect activities and sustainability of the Arctic regions. The descriptions and analyses done in the AlaskaNor reports will also be valuable in analyzing the consequences of Covid-19 on the blue economy in the Arctic.

There are many who have been involved in drafting our four AlaskaNor reports, and we wish to thank each of them for this important work. We hope the reports will be of value for many in realizing value-creating opportunities in the blue economy, and strengthen cooperation between Alaska and North Norway.

BODØ (NORWAY) AND ANCHORAGE (UNITED STATES), FEBRUARY 2022

FRODE MELLEMVIK

Director, High North Center
Nord University

JON ISAACS

Chair, Board of Directors
Institute of the North

Alaska and North Norway: At a Glance

The United States and Norway have been allies for over 70 years, enjoying bilateral diplomatic relations since 1905. Many Norwegians have cultural ties to the U.S. From 1825 until the early 20th century alone, approximately 800,000 Norwegians emigrated westwards and over the Atlantic Ocean. Today, nearly five million Americans claim Norwegian ancestry, supporting the two countries' close economic, political, and cultural relationship.

(Maps not to proportionate scale)

		Alaska	North Norway
GEOGRAPHY	**Coastline**	25,148 km	12,020 km
	Area	1,717,856 km^2	112,975 km^2
GOVERNMENT	**Organization**	State: 16 boroughs and unorganized region	2 counties (Nordland, and Troms and Finnmark) and 87 municipalities
	Capital	Juneau	Bodø (Nordland) Tromsø (Troms and Finnmark)
	Largest cities	Anchorage (291,845), Fairbanks (95,898), Juneau (31,986)	Tromsø (76,974), Bodø (52,357), Mo i Rana (26,184)
PEOPLE	**Population (2020)**	731,007	483,632 • 240,896 (Nordland) • 242,736 (Troms and Finnmark)
	Indigenous Groups	Aleut, Alutiiq, Athabascan, Eyak, Tlingit, Haida, Tsimshian, Inupiaq, Yup'ik, Cup'ik (15,6% of population)	Sámi (50,000-100,000)* *In Norway, there is no clear legal definition of who is Sámi. Therefore, exact numbers are not possible
ECONOMY	**GDP (2018)**	$54,61 billion (Alaska) $20,54 trillion (US)	$25,26 billion $359,299 billion (Norway)
	GDP/capita (2018)	$74,454 (Alaska) $62,639 (US)	$51,950 (North Norway) $67,640 (Norway)
	Major industries	Oil and gas production, mining, fisheries (incl. aquaculture), timber, tourism, agriculture	Oil and gas production, fisheries (incl. aquaculture), shipping (incl. ship building), pulp & paper products, metal, chemical, timber, mining
	Natural resources	Petroleum, natural gas, timber, zinc, gold, silver, fish, shellfish,	Petroleum, natural gas, iron ore, copper, lead, zinc, titanium, nickel, fish, timber, hydropower
	Unemployment rate (2020)	5,4% (Alaska) 6,6% (U.S.)	2,5% (Nordland) 2,7% (Troms & Finnmark) 3,5% (Norway)
	Main export commodities	Petroleum, zinc, seafood, lead, gold	Petroleum (and related products), seafood, machinery and equipment, metals
	Key values of export commodities (2019)	$5 billion	$5 billion (50,48 billion NOK)

SOURCES: Alaska State Department of Labor and Workforce Development, Business Index North, City Population, Norwegian Labour and Welfare Administration (NAV), OECD, Statistics Norway, U.S. Census Bureau, U.S. Department of Commerce Bureau of Economic Analysis

Preface:

WHAT IS THE BLUE ECONOMY?

Charles Colgan

The term “blue economy” has come into widespread use to denote an expansion of economic wealth derived from the oceans and coasts in such a way as to maintain or improve the natural systems upon which economic systems depend. The origin of the term is obscure; though some attribute it to the Rio +20 U.N. Conference in 2012, examples of the term can be found earlier. As a guide to policy, it has been used in quite different ways. Developed countries such as the United States or those in Europe have focused on a “blue technology” focused definition. Developing countries have paid particular attention to the challenges of over-and illegal fishing.

The blue economy does descend from decades of discussion about sustainability, which is also an imprecise term. The “blue economy” captures the definition of sustainability as meeting the needs of the present without sacrificing the ability to meet the needs of tomorrow. There are also links to the idea of sustainability as finding the right balance among the intersection of the economic, environmental, and social aspects of society.

Since these general ideas about sustainability were developed more than thirty years ago, much progress has been made in developing theoretically consistent and empirically viable ways to understand the complex socio-ecological interactions that define the blue economy. The result has been that the blue economy can be understood as something towards which changes can be directed and away from which changes are to be avoided. Two supporting ideas have also come to be essential: expanding the definition of capital and the emerging development of better data on both the physical ocean and the economy of the ocean.

Traditional economic development has focused on expanding investment in physical capital such as buildings, equipment, boats, etc. This capital is used to produce goods and services sold to customers; the income earned, including the income of the labor that uses the physical capital is then measured in national income and product accounts. These accounts are being expanded to take into account natural capital- the value of services created by appropriately functioning natural systems. The value of natural resources such as fisheries and minerals are now counted, as are the services provided by complete ecosystems. From this point of view a blue economy should increase the output of goods and services related to the ocean without reducing the ability of physical or natural capital to sustain growth.

To see the blue economy in these terms also requires greatly improving information about how physical changes in economic and environmental resources are connected to changes in the value of these resources. With respect to the former, many countries are now developing "ocean satellite accounts" to track the contribution of oceans to the output of goods and services. With respect to the latter, expanded oceanographic research, such as that scheduled for the upcoming U.N. Decade of Ocean Science for Sustainable Development (2021-2030) and the expansion of the Global Integrated Ocean Observing Systems provide foundations for understanding the changes in the economic values of the environmental and ecosystem resources upon which the blue economy depends.
These features of a blue economy ultimately represent a much closer integration of the contributions to economic output with changes in the environment. In this sense the blue economy is not defined as a binary condition ("blue"/"not blue") but an ongoing process of seeing the ocean's resources in new ways in order to set goals and measure progress towards those goals. This requires:

1. A means of accounting for the contribution to the regional and national economies from ocean related activities including output, employment, and wages.
2. Support of innovations in technologies and services that can yield gains in output and employment at reduced environmental costs. This tracking of innovation is key to tracking changes in capital.
3. Resource accounts for renewable and nonrenewable resources based on measures of changes in physical stocks (e.g., fish stocks, oil and gas reserves).

4. Ecosystem services inventory and processes for establishing values over time. The relevant ecosystems and their services vary by location, so an initial step is to inventory the relevant ecosystems, including what is known of their current conditions. The economic values of the ecosystem services are usually not known so plans to develop this information are needed.
5. There are two essential governance elements. The first is that there need to be processes to set and update the goals of the blue economy based on the information available.
6. The second is to create institutional structures that integrate consideration of economic and environmental dimensions at the operational levels of both public and private organizations. The standard organizational structures based on narrow definitions of expertise will not be capable of seeing the integrated physical/economic relationships.

Keeping those ultimate goals in mind, this report – and the AlaskaNor Project in general – seeks to identify the economic and social effects of the fisheries and aquaculture sectors in Alaska and North Norway, while keeping an account of their crucial interaction with and dependence on the environment. Understanding that this is a long path, an improved exchange of knowledge and encouraging cooperation between relevant institutions and stakeholders is an important step towards a blue economy.

Executive Summary

In the Arctic, the sustainable blue economy is gaining ever increasing importance. This entails utilizing ocean-based resources to the benefit of the global population, the Arctic states and their local communities, while doing that in accordance with sustainability objectives. Obvious lessons concerning resource utilization and local adaptation are, however, not shared between Arctic regions. Limited coordination of knowledge when it comes to challenges and opportunities that arise as the blue potential unfolds should be further explored. This is what this report – as part of the AlaskaNor Project – sets out to do in the context of fisheries and aquaculture in the Arctic United States (Alaska) and North Norway.

This report is the end-product of Work Package (WP) 3, titled "Fisheries and Aquaculture". With a focus on fisheries and aquaculture/mariculture management in both regions, this report aims at a) illustrating a comprehensive assessment of the status quo and challenges that these sectors face in both regions; b) drawing parallels among fisheries and aquaculture management; c) envisioning common goals and collaboration in the context of sustainable and blue governance structures.

In light of global anthropogenic issues such as climate change, and ongoing challenges that the world's markets have been facing, it is imperative to realize that Arctic fisheries and aquaculture may provide a prominent arena for dialogue. Disregarding their geographical distance, Alaska and North Norway are both characterized by a strong dependence on marine living resources. In this report, we are addressing why fisheries and aquaculture/mariculture are important for the development of the blue economy in both Alaska and North Norway. Against this background the following three dimensions have been explored throughout this project: current status and governance, current and future challenges to development, and potentials for dialogue and collaboration.

In this endeavor, the following actors have been involved under the umbrella of WP3:

HIGH NORTH CENTER FOR BUSINESS AND GOVERNANCE, NORD University, Bodø, Norway

ALASKA OCEAN CLUSTER, Anchorage, United States

BODØ MUNICIPALITY, Bodø, Norway

CENTER FOR THE BLUE ECONOMY, Monterey, United States

JUNEAU ECONOMIC DEVELOPMENT COUNCIL, Juneau, United States

THE ARCTIC INSTITUTE, Washington, D.C., United States

YTTERSTAD FISKERISELSKAP, Vesterålen, Norway

Discovering Fisheries in the Blue Arctic Ocean

Gergana Stoeva, Apostolos Tsiouvalas and Andreas Raspotnik

The global oceans are not only vital for human wellbeing as climate-regulator and oxygen producer (through the plants such as phytoplankton, kelp, and algal plankton that live in it), but also provide invaluable ecosystem services, contribute to global food security, and offer opportunities for economic growth and development.[1] Valued at $1,5 trillion in 2010 – about 2,5% of the world's gross economic value – the economic value of the ocean outputs could be doubled by 2030, reaching over $3 trillion and approximately employing 40 million full-time jobs.[2]

The Arctic and the Arctic Ocean marginal seas, where important commercial fisheries take place (such as the Barents Sea, Norwegian Sea, Beaufort Sea, Bering Sea, etc.) hold the potential to become a key region in contributing to these developments as three factors are currently transforming the region with astonishing speed: climate change, technological advances and the forces of economic development. Although these factors individually and/or in combination are set to change the Arctic in the years and decades to come, change will affect the region and its inhabitants at different rates.[3] This holds particularly true for Arctic fisheries as its (economic) role is distinct and different for the Arctic Ocean coastal states. On a global scale, some of those are major fishing nations. For 2018, Russia ranked 4th (4,8 million tons; 4,4 million metric tons), the United States 5th (4,7 million tons; 4,3 million metric tons), Norway 9th (2,5 million tons; 2,7 million metric tons), Iceland 17th (1,3 million tons; 1,8 million metric tons), Denmark 23rd and Canada 24th with both catching 0,8 million tons (0,7 million metric tons) according to FAO's (the United Nations' Food and Agriculture

[1] OECD (2019). OECD work in support of a sustainable ocean. Retrieved 28 October 2019 from https://www.oecd.org/ocean/OECD-work-in-support-of-a-sustainable-ocean.pdf

[2] OECD (2016). The Ocean Economy in 2030. OECD Publishing, Paris, 27 April 2016, pp. 13-14. Retrieved 28 October 2019 from https://www.oecd.org/environment/the-ocean-economy-in-2030-9789264251724-en.htm

[3] Atkisson, A., et al. (2018). Getting it right in a new ocean: Bringing Sustainable Blue Economy Principles to the Arctic, pp. 10-11. Retrieved 28 October 2019 from https://wwf.panda.org/our_work/oceans/publications/sustainable_blue_economy_reports.cfm

Organization) list for global marine catches.[4] Altogether, these Arctic states catch some 15 million tons (13,6 million metric tons) in their marine fisheries, amounting to around 18% of the global marine catch of 84,4 million tons (76,6 million metric tons) in 2018. In addition, aquaculture becomes increasingly important for Canada, Denmark (the Faroes), Iceland, Norway and Russia. Norway, for example, produced 1,355 thousand tons of fish, which are 1,6% of the world's total, via aquafarming.[5]

For all those countries, a significant part of their total marine catch stems from Arctic/Northern waters. The fisheries in Alaska, for example, are among the most important in the United States, as are the Barents Sea fisheries in Norway. Although difficult to delineate, Northern/Arctic fish catches or landings account for about 6-7 million tons (5,4 to 6,3 million metric tons), making Arctic fish an important export commodity for the Arctic states, as well as subsistence activity for regions and Indigenous communities in Alaska, Greenland and Russia.[6]

Generally, these states have well-developed management regimes and score high in global assessments of related management performance with most fisheries being certified by international eco-labelling schemes.[7] In Alaska and North Norway, the fisheries and aquaculture industries are among the best-managed and most sustainable in the world, counting for a substantial number of landings and production in the United States and Norway, respectively. Between one half and two thirds of the catch are taken in the cold but highly productive waters off Alaska and North Norway – the Bering Sea, the Gulf of Alaska, the Norwegian Sea and the Barents Sea. Today, most of the stocks in these areas are in good condition, largely thanks to prudent management in recent years.

[4] FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome, p. 13. Retrieved 1 July 2020 from https://doi.org/10.4060/ca9229en

[5] FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome, p. 33. Retrieved 1 July 2020 from https://doi.org/10.4060/ca9229en

[6] Hoel, A. H. (2018). Northern fisheries. In M. Nuttall, T. R. Christensen, & M. J. Siegert (Eds.), The Routledge Handbook of the Polar Regions, p. 397. Routledge.

[7] Hoel, A. H. (2018). Northern fisheries. In M. Nuttall, T. R. Christensen, & M. J. Siegert (Eds.), The Routledge Handbook of the Polar Regions, p. 393. Routledge.

AQUA- OR MARICULTURE?

The word 'aquaculture' is normally used to describe the art, science and business of producing aquatic plants and animals; often also confusingly referred to as 'mariculture'.[8] However, globally, it is difficult to distinguish between coastal aquaculture production and mariculture with the latter often referred as a specialized branch of aquaculture. According to the Food and Agriculture Organization of the United Nations (FAO), marine aquaculture is practiced in the sea, in a marine water environment, while coastal aquaculture is practiced in completely or partially human-made structures in areas adjacent to the sea, such as coastal ponds and gated lagoons.[9] In the AlaskaNor project, and due to national and local usage of the terms, we use them interchangeably. However, often we refer to 'aquaculture' when discussing the North Norwegian case and 'mariculture' when referring to Alaska.

Alaska

…It's hard to take my eyes away, but there are fish to be caught: Can it be true this land was once for sale and was for seven million dollars bought? [10]

While some labeled the purchase of Alaska from Russia in 1867 as "Seward's icebox," others knew that this icebox was packed with fish. With over 3 million lakes, 3,000 rivers and 34,000 miles of coastline bordering three different seas (Arctic Ocean, Pacific Ocean and Bering Sea), Alaska is one of the richest fishing regions in the world, producing a wide variety of seafood.[11] All five species of Pacific salmon, four species of crab, many kinds of groundfish, shrimp, herring, sablefish, pollock, and Pacific halibut have always been dominant in Alaska's waters, gradually making the region one of the world's leading stakeholders in the seafood industry.

The history of fisheries in Alaska's territory, though, dates back to long before the arrival of Russians or European settlers in the region. The Aleuts, together with the Athabascans, Alutiiqs, Haidas, Inupiat and Yup'ik, Tlingits, Tsimshians and many other Indigenous groups have been living in the region currently known as Alaska since time immemorial.[12] The majority of these native communities has traditionally relied on subsistence activities such as sealing, whaling, fishing, and gathering, developing local informal economies based on customary and traditional use of natural resources.[13]

[8] Roderburg, J. (2011). Marine Aquaculture: Impacts and International Regulation. Australian and New Zealand Maritime Law Journal, 25(1), p. 161.

[9] FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome, pp. 25-26. Retrieved 1 July 2020 from https://doi.org/10.4060/ca9229en

[10] The segment was traced from a Troll fisherman's poem for the Fairweather Grounds, SE Alaska. The poem can be found in Caldwell, F. (1986) Land of the Ocean Mists: The Wild Ocean Coast West of Glacier Bay. ProStar Publications, Inc.

[11] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 6 May 2020 from https://www.akrdc.org/fisheries

[12] Alaska Department of Fish and Game. Subsistence in Alaska. Overview: Definition, Responsibilities and Management. Retrieved 6 May 2020 from https://www.adfg.alaska.gov/index.cfm?adfg=subsistence.definition

[13] Alaska Department of Fish and Game. Subsistence in Alaska. Overview: Definition, Responsibilities and Management. Retrieved 6 May 2020 from https://www.adfg.alaska.gov/index.cfm?adfg=subsistence.definition

From 1799 onwards, Russian colonization was directed in North America, administered by the Russian-American Company. Rapidly, numerous Russian settlements were founded across the region, while the Russians forced native hunters to work directly for their companies, using military force and mandatory conscription.[14] The Russian-American Company, which gradually consolidated the Russian monopoly over hunting and fur trade in the region, was modeled after other commercial monopolies of the day (e.g. the Hudson's Bay Company).[15] Russian monopoly in the region was continued until 1867, when Alaska was purchased by the United States short after the end of the American Civil War.[16]

American rule brought little change to the region, which initially held limited interest for the United States due to its great size, remoteness, and challenging climate which discouraged capital investments for development.[17] Only after WWII and Alaska's recognition as the 49th State of the U.S. in 1959, the region witnessed an accelerating growth of population and related developments in the fisheries sector, which soon became the State's most profitable industry, putting mineral resource extraction into second place. A milestone in the United States' fisheries policy was the devolution of the Alaskan fisheries management to the State of Alaska in 1960.[18] Since the State assumed the responsibility for fisheries management from the federal government, commercial fishing was driven by the principle of sustained yield, an idea reaffirmed also in Alaska's Constitution (Article 8, section 4).[19] Soon, the State, together with coastal communities and local fishermen, fostered the development of an innovative mariculture program grounded on hatchery production. While finfish farming is forbidden by Alaskan law,[20] Alaska's first hatcheries were designed to supplement wild stock production and led the way into the dominance of Alaskan salmon in markets both in the U.S. and abroad.[21] In addition, the enactment of the Magnusson Stevens Act that followed in 1976 established a 200 nautical mile (nm) Exclusive Economic Zone (EEZ) off the coasts of the United States, dawning a new era in U.S. fisheries

[14] Lightfood, K. (2003). Russian Colonization: The implications of mercantile colonial practices in the North Pacific. Historical Archaeology, 37(4), pp. 14, 21.

[15] Lightfood, K. (2003). Russian Colonization: The implications of mercantile colonial practices in the North Pacific. Historical Archaeology, 37(4), pp. 14, 16.

[16] Treaty concerning the Cession of the Russian Possessions in North America by his Majesty the Emperor of all the Russias to the United States of America; Concluded March 30, 1867; Ratified by the United States, May 28, 1867; Exchanged June 20, 1867; Proclaimed by the United States, June 20, 1867. (15 Stat. 539).

[17] Naske, C. M. & Slotnik, H. E. (2014). Alaska: A History. Norman: University of Oklahoma Press, pp. 2-3.

[18] Naske, C. M. & Slotnik, H. E. (2014). Alaska: A History. Norman: University of Oklahoma Press, p. 4.

[19] The Constitution of the State of Alaska, adopted by the Constitutional Convention February 5, 1956, ratified by the People of Alaska April 24, 1956, became Operative with the Formal Proclamation of Statehood January 3, 1959.

[20] Alaska Statutes Title 16. Fish and Game § 16.40.210. Finfish farming prohibited.

[21] Salmon Hatcheries for Alaska. Retrieved 10 May 2020 from https://www.salmonhatcheriesforak.org/

history.[22] The State of Alaska established jurisdiction (and can enjoy the royalties of resource development) up to 3 nm, and the federal government exercises authority beyond that.[23]

Under these circumstances, the Bering Sea/Aleutian Islands pollock fisheries soon became the world's largest whitefish fishery, while salmon fisheries became a nearly ubiquitous activity across Alaska, followed by other fishing industries such as the halibut, herring, sablefish and king crab one.[24] Since early 1990's, a remarkable shellfish farming industry has also been flourishing.[25] In 2018, total Alaska's harvest accounted for more than 61% of total U.S. seafood harvests, while Alaska's offshore fisheries had an average wholesale value of nearly $4,5 billion a year. To date, Alaska's fisheries are considered to be among the best-managed and most sustainable industries in the world, while the region's resources provide jobs, opportunities and food security for the United States, supporting also environmental sustainability, as well as the continuation of the traditional way of life for Indigenous and local coastal communities.[26]

North Norway

If cod forsake us, what would we then have? What carry to Bergen to barter for gold? [27]

Few impressions manage to describe North Norway's relation to fishery better than the words of the Norwegian priest and poet Petter Dass. Determining settlement and most economic growth in coastal communities in the region for centuries, the immediate access to the sea has provided the local populations with food, transportation and source of income, and has played a crucial role in the formation of their culture and mindset. Local populations have acknowledged and relied on the rich sea throughout history, while earliest fishing activities in North Norway can be traced back to 6000 years ago, as recorded on petroglyphs around Alta in Finnmark.[28]

Comprising of the two northernmost counties in Norway – Nordland, Troms and Finnmark (Troms and Finnmark merged as a single country on 1st January 2020), North Norway accounts for a substantial part of the whole Norwegian fisheries and

[22] The Magnuson-Stevens Fishery Conservation and Management Act [Public Law 94–265, Approved Apr. 13, 1976, 90 Stat. 331].

[23] Durfee, M. & Johnstone, R. L. (2019). Arctic Governance in a Changing World. Lanham: Rowman & Littlefield Publishers, p. 183.

[24] Naske, C. M. & Slotnik, H. E. (2014). Alaska: A History. Norman: University of Oklahoma Press, p. 8.

[25] Alaska Department of Fish and Game. Aquatic Farming. Retrieved 6 May 2020 from https://www.adfg.alaska.gov/index.cfm?adfg=fishingaquaticfarming.main

[26] NOAA Fisheries. Alaska. Retrieved 6 May 2020 from https://www.fisheries.noaa.gov/region/alaska

[27] Dass, P. (1735). The Trumpet of Nordland

[28] Alta Museum: https://www.altamuseum.no/no/bergkunst

aquaculture sector. Bordering the Barents Sea, regarded as a "global food chamber" [29] in the North, and being hit by the warmer Gulf Stream from the South, the region has immediate access to highly productive coastal and offshore waters, providing fruitful conditions for the whole marine ecosystem. In combination with the rugged sheltering coastline, these rich waters support a great number of commercially important fish species such as cod, pollock, saithe, halibut, and pelagic species such as mackerel and herring.

Most importantly, the Barents Sea is home to the largest stock of Northeast Atlantic cod (*gadus morhua*), also known as *skrei*. Being the main target species of the "Lofotfisket," the large scale Lofoten fishery taking place every winter uninterruptedly since the 10th century, this stock has been a fundamental factor for the development of local communities and has been benefiting it economically until today.

This rich fishery, coinciding with the North Norwegian winter, created excellent conditions for the first large and longest maintained export from North Norway. "Tørrfisk" or stock fish, has been valued by the locals as their "money,"[30] with which they were able to afford supplies such as corn products. Dried in the cold air and wind, but above freezing temperatures, stock fish was suitable for transportation and storage over longer periods, and over time has become Norway's ambassador into the world. Turned into a commodity during the Viking era, the stock fish and other fish products such as cod liver oil and clip fish, were initially traded internally, and later became invaluable export goods. First exported by the Vikings to England, brought to Central and Southern Europe through the Hansa Union, stock fish gained further importance in Europe during the Christian lent periods. This only expanded its markets and it became an integral part of many traditional cuisines in the Mediterranean region. Later, during the 18th century, it became the foundation of the trade relations between the Pomors in Northwest Russia and North Norway, representing an important income source for communities in the region.

During more recent times, fisheries in North Norway have been undergoing technical, organizational and regulatory changes, characterizing the sector with greater capacity, effectiveness and sustainability, as well as establishing markets around the globe. As a result, in 2018, 991,000 tons of wild fish was landed in the then three northernmost counties, representing around 40% of the total amount landed in Norway, while it has to be acknowledged that the respective waters also provide even greater quantities landed and value generated in the rest of the country or abroad. The significance of the marine living resources for North Norway has not least been manifested at Norway's

[29] Sunnanå, K. (2015). Barentshavet – et globalt spiskammer. Tidsskriftet Ottar 304(1), pp. 3–8.

[30] Drivenes, E., Hauan, M. & Wold, H. (1994). Nordnorsk kulturhistorie. 2: Det mangfoldige folket, p. 89.

1994 referendum for European Union (EU) membership, when over 70% of region's votes were "against" (with 52% votes "against" on a national basis).[31]

Simultaneously, with the exponential development of aquaculture since the 1970s, farmed salmon accounted for 1/3 of the seafood produced in the region in 2018, with according growth in employment opportunities. With the prospects for potential growth in produced volume of traditional seafood as well as its projected increase in value, with the promising development of rest raw materials and resources lower in the food chain, North Norway holds the potential to grow its fisheries and aquaculture sector even further.

[31] Jaklin, A. (2006). Historien om Nord-Norge, p. 409.

Fisheries and Mariculture in Alaska

Apostolos Tsiouvalas and Malte Humpert

In total, Alaska produces more than half the fish caught in waters off the coast of the United States, having an average wholesale value of nearly $4,5 billion a year.[32]

In 2018, the seafood industry contributed more than $172 million in taxes and fees to the State, municipalities and a wide spectrum of state and federal agencies, providing numerous opportunities for the State's population.[33] Approximately 58,700 people work in the seafood industry, ≈25,000 of whom are employed as processor workers – 7,400 Alaskans and 17,450 non-residents.[34] Annual seafood harvest in Alaska consistently accounts for about 60% of total U.S. seafood harvests, while more than 9,000 vessels are home-ported in Alaska, delivering fish to over 120 shoreside processing plants.[35] The commercial fisheries off Alaska take place in two major areas: the Bering Sea and Aleutian Islands and the Gulf of Alaska.[36] No commercial quotas have yet been granted in the Chukchi and Beaufort Seas.

In this context, large harbors have been developed around Alaska's coasts, facilitating the State's exports. Six of the U.S.' ten largest fishing ports are located in Alaska and Dutch Harbor/Unalaska has been the country's largest in terms of volume for much of the past three decades. Through Dutch Harbor, more fish arrive than anywhere else in the State.[37] Dutch Harbor and Kodiak are the top two U.S. fishing ports in landed volume, while they rank #2 and #3 in U.S. economic value.[38] Seafood from Alaska is distributed in several markets around the world and has historically been one of Alaska's top export commodities. The export value over the past decade has averaged $3,3 billion annually.[39] Alaska's main exports are pollock,

[32] NOAA Fisheries. Alaska. Retrieved 9 September 2020 from https://www.fisheries.noaa.gov/region/alaska

[33] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[34] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[35] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[36] Björnsdóttir, B & et al. (2021). Blue Bioeconomy in the Arctic Region. Retrieved 5 August 2021 from https://sdwg.org/what-we-do/projects/blue-bioeconomy-in-the-arctic-region/

[37] Sobel, Z. (2018). Dutch Harbor Remains Nation's Top Port For 21st Consecutive Year. KUCB, 13 December 2018. Retrieved 15 August 2019 from https://www.kucb.org/post/dutch-harbor-remains-nations-top-port-21st-consecutive-year#stream/0

[38] McDowell Group (2017). The Economic Value of Alaska's Seafood Industry (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2. Retrieved 28 August 2019 from https://www.mcdowellgroup.net/wp-content/uploads/2017/10/ak-seadfood-impacts-sep2017-final-digital-copy.pdf

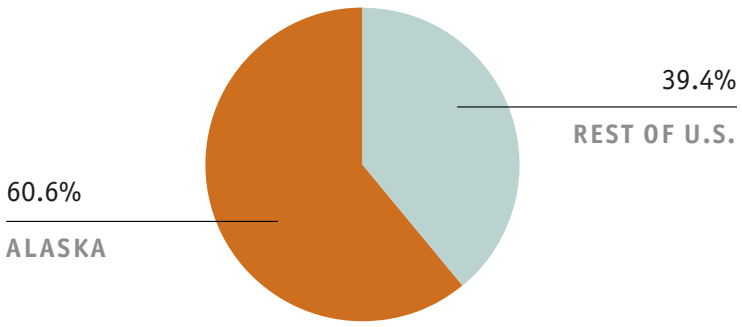
[39] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

surimi, and fillets – a combined $845 million – and frozen sockeye salmon ($313 million).[40] The largest market for Alaskan seafood is the United States, followed by China, Japan, South Korea and the EU.[41] In 2018, exports to China accounted for 32% of Alaska's seafood sales and 23% of the value.[42] However, due to the ongoing trade war, exports have dropped, to date, about 20%.[43] That includes a 54% drop in Alaska salmon exports and a 49% decrease for crab sales to China.[44]

TABLE 1: Total fish landings Alaska and the rest of the U.S., 2016-2017[45]

	2016	2017
ALASKA	2,540,117	2,721,554
REST OF U.S.	1,814,369	1,769,010
TOTAL	4,354,486	4,490,564

FIGURE 1: Total fish landings Alaska and the rest of the U.S., 2016-2017



[40] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[41] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[42] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[43] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[44] Resource Development Council for Alaska. Alaska's Fishing Industry. Retrieved 9 September 2020 from https://www.akrdc.org/fisheries

[45] National Marine Fisheries Service (2017), Fisheries of the United States, 2016. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2016. Retrieved 19 August 2019 from https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states and National Marine Fisheries Service (2018) Fisheries of the United States, 2017. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2017. Retrieved 19 August 2019 from https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states

TABLE 2: Commercial Fishery Landings at Top 5 Alaskan Ports (in tons)[46]

DUTCH HARBOR	ALEUTIAN ISLANDS (EXCLUDING DUTCH HARBOR)	KODIAK	ALASKA PENINSULA	NAKNEK
348,812	250,382	240,403	121,562	84,821

SALMON FISHERIES (HATCHERIES)

In total, the seafood industry of Alaska adds yearly about $5,6 billion to the State's economy.[47] Most of this revenue can be attributed to the abundance of wild salmon in its waters. Among all species in the Alaskan seafood industry, salmon has the greatest economic impact (jobs, income, and total value), mainly thanks to the recent development of hatcheries and the sustainable management of salmon stocks. However, salmon fisheries have not always been the primary source of revenues generated from the Alaskan fisheries sector. The boom of Alaska salmon industry dates to the early 1970s, when, after a historically low salmon abundance in Alaska waters, the first modern hatchery program was initiated.[48] Alaska's salmon hatchery program was designed to supplement and not replace sustainable natural production and has been nowadays still flourishing.[49] Alaska hatcheries do not grow fish to adulthood, but instead incubate fertilized eggs and release resulting progeny as juveniles (i.e., fry or smolt).[50] In 1974, the Alaska Legislature expanded the hatchery program, authorizing private non-profit corporations to operate salmon hatcheries.[51] In 1980s, when the first adult salmon were returning to newly built hatcheries, Alaska accounted for nearly half of the world salmon supply, and larger harvests in Alaska generally meant lower prices to fishermen.[52] It was believed that the increasing hatchery production in

[46] National Marine Fisheries Service (2018) Fisheries of the United States, 2017. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2017. Retrieved 19 August 2019 from https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states

[47] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[48] Smoker, W. W. & Heard W. R. (2017) Productivity of Alaska's Salmon Hatchery Ocean Ranching Program and Management of Biological Risks to Wild Pacific Salmon. In T. Bert (Ed.), Ecological and Genetic Implications of Aquaculture Activities, pp. 361-381, Springer.

[49] Alaska Department of Fish and Game (2013) (by Lorraine Vercessi). Alaska Salmon Hatcheries: Contributing to Fisheries and Sustainability. Retrieved 9 September 2020 from https://www.adfg.alaska.gov/static/fishing/PDFs/hatcheries/2013_ak_hatcheries.pdf

[50] Alaska Department of Fish and Game (2013) (by Lorraine Vercessi). Alaska Salmon Hatcheries: Contributing to Fisheries and Sustainability. Retrieved 9 September 2020 from https://www.adfg.alaska.gov/static/fishing/PDFs/hatcheries/2013_ak_hatcheries.pdf

[51] National Research Council (1992). Marine Aquaculture: Opportunities for Growth. Washington, DC: The National Academies Press. Retrieved 9 September 2020 from https://doi.org/10.17226/1892

[52] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

some parts of the State was depressing salmon prices in others.[53] However, the salmon marketplace changed drastically in the 1990s, a time when the hatchery program was intensified.[54] It was not before 1996, when salmon farming started to rapidly expand around the globe; the wild salmon harvest was surpassed for the first time and wild salmon prices declined precipitously as year-round supplies of fresh, high quality farmed salmon flooded the marketplace in the U.S., Europe, and Japan.[55] To respond to the competition, the Alaskan fishing industry improved further the quality of its products and promoted sustainability, implementing intensive marketing efforts to differentiate Alaska salmon from farmed salmon, and moving part of the processing sector to China.[56] Eventually, these efforts paid off through increasing demand and prices.[57]

Over the past decade (2009–2018), hatcheries contributed an annual average of about 1/3 of the total Alaska commercial salmon harvest.[58] Thanks to the combination of favorable environmental conditions and successful management schemes, the total salmon catches were gradually boosted, with recent commercial salmon harvests (2009–2018) annually averaging 177 million fish (374, 000 tons; 340,000 metric tons) – an increase of 800% in comparison to the 1973 and 1974 harvests.[59] Yet, today Alaska typically accounts for just 12–15% of the global supply of salmon, and the State needs to find solutions in order to further increase its influence on the world's major salmon markets.[60]

[53] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[54] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[55] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[56] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[57] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[58] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 19. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[59] Alaska Department of Fish and Game (2020) (by Lorna Wilson). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 3. Retrieved 5 August 2021 from https://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2020.04.pdf

[60] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 27. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

The hatcheries industry comprises 31 hatcheries (30 commercial + 1 research hatchery) operating in Southeast Alaska, Prince William Sound, Cook Inlet, and Kodiak regions, harvesting mainly chum and pink salmon.[61] The top 5 hatchery harvests have occurred since 2005, with the largest hatchery harvests in 2013, 2015 and 2017.[62] In 2019, hatcheries contributed about 50 million fish to commercial fisheries, making up 25% of the statewide commercial salmon.[63] Chum made up 40% of the ex-vessel value of the commercial hatchery harvest, followed by pink (36%), sockeye salmon (13%), coho (8%) and Chinook (3%).[64]

Although the implications of hatchery salmon production to native salmon population is minimal compared to the challenges posed to wild salmon by mariculture in other places, hatcheries may also pose challenges to aquatic ecosystems. By design, hatcheries operations pose a threat to a healthy spread of genetic diversity. All salmon have the chance of straying, returning to a location other than their origin. Straying salmon could affect the genetic pool of natural runs and can lead to genetic swamping where the gene pool of the natural population is permanently altered.[65] Finally, climatic changes may also pose risks to returning mature salmon populations. This has recently become of greater concern with the presence of "The Blob" (an abnormally warm body of water that has been circulating the coast of Southeast Alaska and British Columbia). Warm water bodies tend to be less nutrient-rich and have less dissolved 02. State officials have drawn connections between "The Blob" and decreased salmon returns in recent years.[66]

GROUNDFISH FISHERIES

The second most profitable fishery for the State and the largest single species of U.S. fishery, by volume, is this of Alaska pollock (*Gadus chalcogrammus* or *Theragra*

[61] Alaska Department of Fish and Game (2020) (by Lorna Wilson). Alaska Salmon Fisheries Enhancement Annual Report 2019. Regional Information Report No. 5J19-01, March 2020, p. 33. Retrieved 5 August 2021 from https://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2020.04.pdf

[62] Alaska Department of Fish and Game (2019) (by Mark Stopha). Alaska Salmon Fisheries Enhancement Annual Report 2018. Regional Information Report No. 5J19-01, March 2019, p. 1 and 3. Retrieved 11 September 2020 from http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf

[63] Alaska Department of Fish and Game (2020) (by Lorna Wilson). Alaska Salmon Fisheries Enhancement Annual Report 2019. Regional Information Report No. 5J19-01, March 2020, p. 11. Retrieved 5 August 2021 from https://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2020.04.pdf

[64] Alaska Department of Fish and Game (2020) (by Lorna Wilson). Alaska Salmon Fisheries Enhancement Annual Report 2019. Regional Information Report No. 5J19-01, March 2020, p. 12. Retrieved 5 August 2021 from https://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2020.04.pdf

[65] Loew, C. (2019). Hatchery programs likely causing weakening of wild salmon populations. Seafood Source, 2 October 2019. Retrieved 1 January 2020 from https://www.seafoodsource.com/news/environment-sustainability/hatchery-programs-likely-causing-weakening-of-wild-salmon-populations

[66] Maguire, S. (2019). Two fishery resource disasters declared for Alaska, 'The Blob' could be a factor in both. Alaska's News Source, 26 September 2019. Retrieved 1 January 2020 from https://www.alaskasnewssource.com/content/news/Two-fishery-resource-disasters-declared-for-Alaska-The-Blob-could-be-a-factor-561376351.html

chalcogramma). Pollock is the most abundant wild whitefish species on the planet and, together with the rest of groundfish fisheries, makes up more than 80% of Alaska's total catch accounts.[67] Alaska pollock fisheries accounted for 44% of global supply in 2015, while in 2018 Alaska pollock was the second caught species in the world after Anchoveta, surpassing skipjack tuna catches.[68] In 2018, commercial landings of Alaska pollock from the Bering Sea and Gulf of Alaska totaled more than 3.36 billion pounds and were valued at more than $490.8 million.[69] Much of the value is added through processing, which occurs both shoreside and at-sea.[70]

Besides pollock, Alaska's groundfish fisheries include five more major species (complexes); Pacific cod, sablefish, Atka mackerel, the flatfish complex, and the rockfish complex, plus Pacific halibut (although is not a federally managed species as the rest of the groundfish).[71] The fisheries for these species are distributed across two regions: the Bering Sea and Aleutian Islands, and the Gulf of Alaska. The groundfish fisheries off Alaska are an important segment of the U.S. fishing industry: In 2016, they accounted for 51% of the weight of total U.S. domestic landings and 17% of the ex-vessel value of total U.S. domestic landings. In 2017, the aggregate ex-vessel value of the Fishery Management Plan[72] groundfish fisheries off Alaska was $947 million, corresponding to 47% of the ex-vessel value of all commercial fisheries off Alaska in 2017.[73]

The fisheries for Pacific cod (*Gadus macrocephalus*) are the second largest by volume in the State with a retained catch of 298,000 metric tons (293,000 tons) in 2017. Although Alaska's Pacific cod harvests lack in comparison to the more valuable Atlantic cod species, and are confronted with strong competition in global markets, particularly against the Barents Sea cod (*gadus morhua*),[74] pacific cod is an important

[67] Fissel, B. & et al. (2019). Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic Status of the Groundfish Fisheries off Alaska, 2017. NOAA Fisheries, 17 April 2019. Retrieved 24 December 2019 from https://www.fisheries.noaa.gov/resource/data/2017-economic-status-groundfish-fisheries-alaska

[68] FAO (2020). The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome, p. 13. Retrieved 1 July 2020 from https://doi.org/10.4060/ca9229en

[69] NOAA Fisheries (2021). Alaska Pollock. Retrieved 5 August 2021 from https://www.fisheries.noaa.gov/management-plan/groundfish-gulf-alaska-management-plan and https://www.fisheries.noaa.gov/species/alaska-pollock#overview

[70] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 4. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[71] Pacific halibut fisheries are jointly managed with Canada via the International Pacific Halibut Commission.

[72] The Fisheries Management Plan covers fisheries for all stocks of finfish except salmon, steelhead, Pacific halibut, Pacific herring, and tuna; see NOAA Fisheries (2021). Groundfish of the Gulf of Alaska Management Plan. Retrieved 5 August 2021 from https://www.fisheries.noaa.gov/management-plan/groundfish-gulf-alaska-management-plan

[73] Fissel, B. & et al. (2019). Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic Status of the Groundfish Fisheries off Alaska, 2017. NOAA Fisheries, 17 April 2019, p. 1. Retrieved 24 December 2019 from https://www.fisheries.noaa.gov/resource/data/2017-economic-status-groundfish-fisheries-alaska

[74] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 29. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

commercial food species. Pacific cod is processed into a number of different product forms for wholesale markets, the two most important of which are fillets and headed and gutted (H&G).[75] The at-sea sector produces mostly H&G products, while the shoreside sector produces fillets, H&G, and other product forms.[76]

As a result of pacific cod and pollock H&G processing, Alaska produces an estimated 1 billion pounds of fish heads per year.[77] It is believed that heads account for the majority of processing waste created by Alaska commercial fisheries. However, some fish heads are used in meal/oil production, while approximately 1% are sold as frozen heads. The exact volume of heads discharged each year is unknown but corresponds to a substantial amount of raw material.[78]

Similarly, to the heads, the internal organs removed after H&G processing are usually discharged or used as raw material for fish meal or oil production, thanks to their important value in omega-3 fatty acids. In total, Alaska processors produce approximately 70,000 metric tons (69,000 tons) of fishmeal and 90,000 metric tons (89,000 tons) of fish oil mainly used as a diesel fuel substitute.[79] While most meal/oil is currently produced by large fishing ports, it is estimated that there is much more meal/oil which could be collectively produced from smaller ports (and/or those with more seasonal landings). Yet, industry experts believe that meal/oil production has nearly reached its maximum feasible limit in Alaska, whereas creating new meal/oil plants could become a rather costly and complex process.[80]

Finally, halibut, black cod, and crab fisheries have also significant value for the economy of the State. Although these three species traditionally account for only 2% of the total harvest volume,[81] as of 2015 they contributed to 19% of the labor income and economic output (including multiplier effects) produced by the

[75] Fissel, B. & et al. (2019). Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic Status of the Groundfish Fisheries off Alaska, 2017. NOAA Fisheries, 17 April 2019, p. 3. Retrieved 24 December 2019 from https://www.fisheries.noaa.gov/resource/data/2017-economic-status-groundfish-fisheries-alaska

[76] Fissel, B. & et al. (2019). Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands Area: Economic Status of the Groundfish Fisheries off Alaska, 2017. NOAA Fisheries, 17 April 2019, p. 4. Retrieved 24 December 2019 from https://www.fisheries.noaa.gov/resource/data/2017-economic-status-groundfish-fisheries-alaska

[77] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 1. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[78] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 1. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[79] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 1. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[80] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 1. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

[81] Alaska Seafood Marketing Institute (ASMI) (2020). The Economic Value of Alaska's Seafood Industry, January 2020, p. 12. Retrieved 30 June 2020 from https://www.alaskaseafood.org/industry/seafood-market-info/economic-value-reports/

Alaskan seafood industry.[82] Alaska king (*Paralithodes camtschaticus*) and snow crab (*Chionoecetes opilio*) accounted for 29% of global supply for 2015, paling though in comparison to foreign competitive productions such as the Canadian and Russian.[83] Crab and other arthropods shells contain chitin, a rather valuable material used in a variety of industries.[84]

MARICULTURE

A relatively new but rapidly developing and high potential sector in Alaska is mariculture. While fish farming in Alaskan waters is prohibited, many organisms have been produced and sold from Alaska mariculture operations over the last three decades, though some at a very small scale. Since 1990, production has included Pacific oyster (*Magallana gigas*), geoduck (*Panopea generosa*), blue mussel (*Mytilus trossulus*), green sea urchin (*Strongylocentrotus droebachiensis*), littleneck clam (*Leukoma staminea*), pink scallop (*Chlamys rubida*), purple-hinged rock scallop (*Crassadoma gigantea*), spiny scallop (*Chlamys hastata*), red ribbon, sea cucumber (*Holothuroidea*), bull kelp (*Nereocystis luetkeana*), and sugar kelp (*Saccharina latissima*).[85]

Today, mariculture production in Alaska is primarily focused on oysters. As of a 2020 report, the shellfish and aquatic plant aquatic farming industry in Alaska is comprised of 58 aquatic farms, 8 nurseries and 4 hatcheries, with overall 70 permitted operations for 2019 – 42 in southeast Alaska, 22 in Prince William Sound and Kachemak Bay, and 6 around Kodiak.[86] Information recorded in 2016, reports that the overall sales of shellfish and aquatic plants for all permitted operations, reached $1,2 million.[87] In the same year, according to the State of Alaska, 29 of the aquatic farm operations had sales and sold over 1,32 million Pacific oysters, 42,695 pounds of Pacific geoduck, and 4,975 pounds of blue mussels, with a total farm gate value of $1,23 million.[88] At a regional level, Southern Southeast operations

[82] Norwegian Ministry of Climate and Environment, Meld. St. 20 (2019–2020) Helhetlige forvaltningsplaner for de norske havområdene — Barentshavet og havområdene utenfor Lofoten, Norskehavet, og Nordsjøen og Skagerrak: https://www.regjeringen.no/no/dokumenter/meld.-st.-20-20192020/id2699370/

[83] Alaska Seafood Marketing Institute (ASMI) (2017). The Economic Value of Alaska's Seafood Industry, September 2017, p. 31. Retrieved 3 January 2019 from https://uploads.alaskaseafood.org/2017/12/AK-Seafood-Impacts-September-2017.pdf

[84] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[85] Alaska Mariculture Task Force (2017). Alaska Mariculture Initiative: Economic Analysis to Inform a Comprehensive Plan, Phase II, November 2017. Retrieved 28 October 2019 from https://www.afdf.org/projects/current-projects/alaska-mariculture-initiative/

[86] Alaska Department of Fish and Game (2020). Aquatic Farming Permitted Operations Status Report, p. 1. Retrieved 5 August 2021 from https://www.adfg.alaska.gov/static/fishing/PDFs/aquaticfarming/2020_af_permitted_op_status_report.pdf

[87] State of Alaska (2018). Alaska Mariculture Development Plan, p. 68. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/Alaska-Mariculture-Development-Plan-v2018-03-23-small-single-pg-view.pdf

[88] State of Alaska (2018). Alaska Mariculture Development Plan, p. 68. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/Alaska-Mariculture-Development-Plan-v2018-03-23-small-single-pg-view.pdf

succeeded over 52% of all sales statewide, followed by Kachemak Bay (31%), Prince William Sound (14%), and Northern Southeast (3%).[89]

Notwithstanding the rapid growth of mariculture in Alaska, both industry and policymakers have often been criticized for not understanding the potential economic impact that a fully developed mariculture industry may bring to the State.[90] Existing State policies and strict regulations make entry rather difficult. In that regard, the 2015 Economic Analysis to Inform the Alaska Mariculture Initiative was published drawing on best practices and characteristics from the Alaska salmon and king crab industries, as well as from successful mariculture cases across the world, and highlighting the need to mobilize stakeholders and agencies in order to facilitate the development of further mariculture initiatives in Alaska.[91] Similarly, the Alaska Mariculture Task Force (AMTF) has also identified dozens of areas for improving the situation, believing that in just 20 years, Alaska's mariculture industry could grow up to a $100 million through workforce development, improved State policies and regulations, education, and market development.[92]

[89] State of Alaska (2018). Alaska Mariculture Development Plan, p. 68. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/Alaska-Mariculture-Development-Plan-v2018-03-23-small-single-pg-view.pdf

[90] Northern Economics (2015). Economic Analysis to Inform the Alaska Mariculture Initiative: Case Studies. Prepared for Alaska Fisheries Development Foundation, p. ES-1. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/1c-Economic-Analysis-to-Inform-AMI-Phase-I-Case-Studies.pdf

[91] Northern Economics (2015). Economic Analysis to Inform the Alaska Mariculture Initiative: Case Studies. Prepared for Alaska Fisheries Development Foundation, p. ES-1. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/1c-Economic-Analysis-to-Inform-AMI-Phase-I-Case-Studies.pdf

[92] State of Alaska (2018). Alaska Mariculture Development Plan. Retrieved 25 November 2020 from https://www.afdf.org/wp-content/uploads/Alaska-Mariculture-Development-Plan-v2018-03-23-small-single-pg-view.pdf

Fisheries and Aquaculture in North Norway

Gergana Stoeva and Malte Humpert

With just under half a million people living in the two (former three) northernmost counties today, representing slightly above 9% of the whole population, the region generates a substantial part of the sea food produced in Norway.[93] Fisheries are traditionally one of the most important marine industries in the region because of the highly productive coastal waters, and the access to offshore sea areas in the Norwegian and Barents Sea, more than 5 times larger than the land area. It has been also acknowledged that the large fish stocks in these waters are being harvested within stable biological limits and managed in accordance to the sustainability objectives.[94]

Many of Norway's largest fish stocks are to be found exactly in these waters. Target species such as the North-East Atlantic cod, haddock, saithe, Norwegian Spring spawning herring (NSS-herring) and capelin are the cornerstones of large fisheries with crucial importance for the entire coastal region. In addition, fisheries for certain species in smaller volumes, having a lesser significance for the region as a whole, have been contributing for increased welfare for local communities, maintaining settlement and employment in sparsely populated areas. Those include for example shrimp fisheries in North Troms and red king crab fisheries in East Finnmark.[95]

North Norway accounts for a substantial amount of fishery landings. While Norway's total catch has decreased by around 25% over the past two decades, North Norway's amount has remained stable. The overall volume of wild capture landed in North Norway during 2019 was 889 648 tons (807 075 metric tons), with an estimated landed value of 13,3 billion NOK ($1,5 billion).[96] Importantly, this represented 38% of all wild capture fish landed on a national level, while 55% of it was carried out by

[93] Statistics Norway. Befolkning i fylka og endring over tid. Population data. Retrieved 11 November 2020 from https://www.ssb.no/befolkning/statistikker/folkemengde/aar-per-1-januar

[94] Meld. St. 20 2019–2020 Helhetlige forvaltningsplaner for de norske havområdene. p. 18 https://www.regjeringen.no/no/dokumenter/meld.-st.-20-20192020/id2699370/

[95] SINTEF (2013) (by Winther, U. et al.). Sektoranalyse for de marine næringene i Nord-Norge - statusbeskrivelse og fremtidsutsikter. 21 May 2013, p. 26. Retrieved 1 December 2019 from https://sintef.brage.unit.no/sintef-xmlui/handle/11250/2467876

[96] Statistics Norway. Fisheries (discontinued), 12847: Catch, by landing county and main group of target species (C) (closed series) 2014 - 2019. Retrieved 1 January 2021 from https://www.ssb.no/statbank/table/12847/tableViewLayout1/

vessels registered in one the two northernmost counties. In addition, it is estimated that a substantial part of the fish caught in the according sea areas is landed in North Norway, creating further employment and value in related industries. Additional value creation from fisheries in North Norway was estimated to be 5,9 billion NOK ($600 million) during 2016, equivalent to 42% of the national total.[97]

TABLE 3: Commercial Fishery Landings in North Norway, 2000-2018[98]

	2000	2005	2010	2014	2015	2016	2017	2018
NORDLAND	358,602	373,206	517,340	348,846	329,478	319,773	360,247	336,085
TROMS	336,973	223,272	365,534	384,742	355,176	352,101	347,077	352,538
FINNMARK	300,876	176,766	255,320	234,867	250,977	265,688	273,023	288,546
NORTH NORWAY TOTAL	996,451	773,244	1,138,194	968,455	935,631	937,562	980,347	977,169
NORWAY TOTAL	3,023,876	2,285,578	2,653,784	2,243,693	2,238,426	2,104,572	2,333,652	2,295,492

[97] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 8. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[98] Statistics Norway. Fisheries: Catch, by fishing vessel's landing municipality and main group of target species (M) (closed series) 2000 - 2018. Retrieved 1 December 2020 from https://www.ssb.no/en/statbank/table/08868/

FIGURE 2: Commercial Fishery Landings in North Norway, 2000-2017

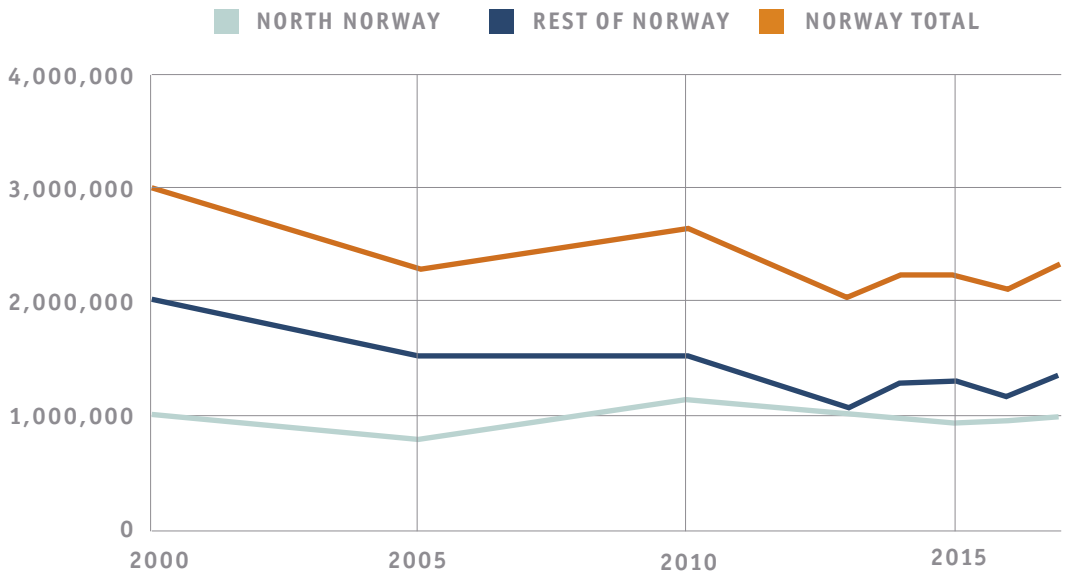
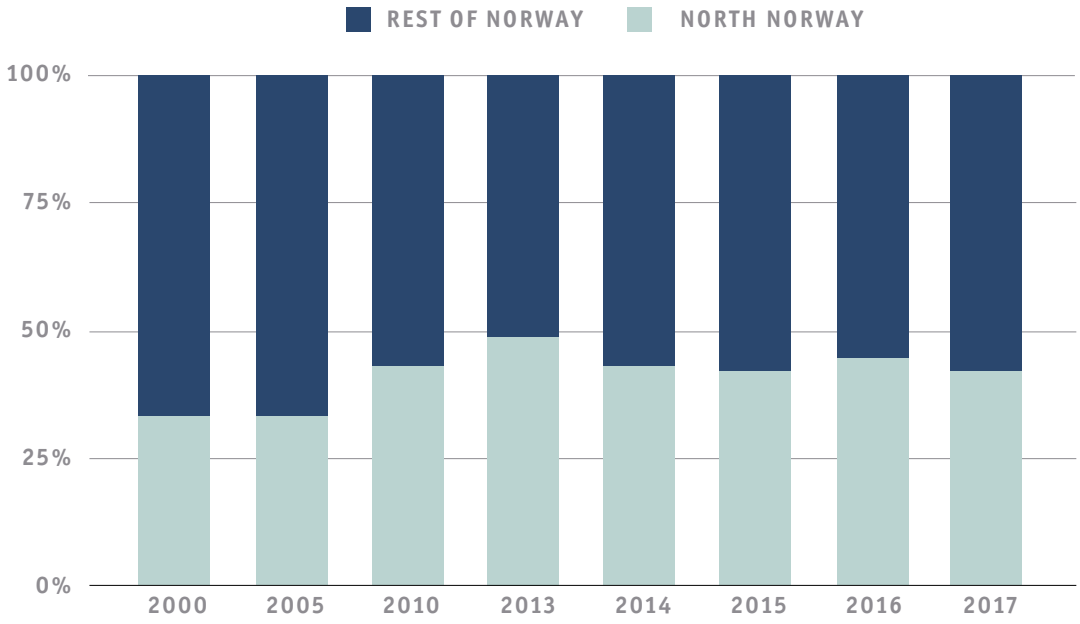
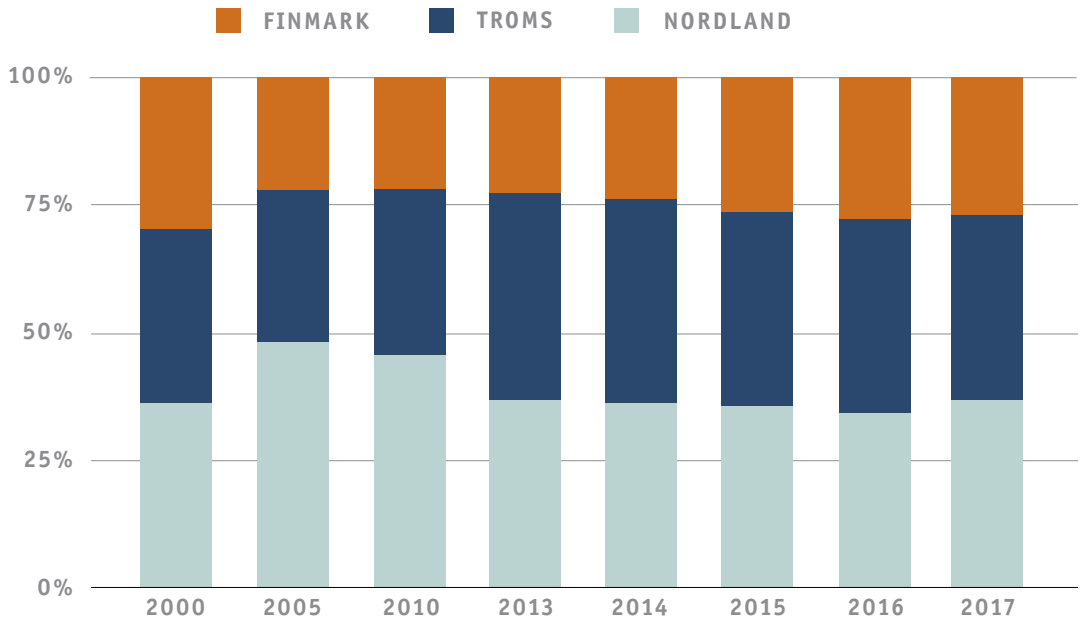


FIGURE 3: Share of Commercial Fishery Landings in North Norway, 2000-2017



Annual catch volume was fairly evenly distributed between the (then) three counties, with Finnmark county accounting for 27%, Troms representing 35% and Nordland constituting 38%. Nordland's share has decreased from nearly 50% in 2005 to below 40% primarily at the expense of Troms county.

FIGURE 4: Share of Commercial Fishery Landings by North Norwegian Region, 2000-2017



Six of the fifteen-largest fishing ports in Norway are located in North Norway, led by Tromsø, which is the country's second-largest with more than 245,000 tons in 2017. Together these six ports account for more than 490,000 tons representing 20% of Norway's total.

TABLE 4: Largest Fishing Ports in North Norway by Tons, 2017[99]

TROMSØ	BÅTSFJORD	LØDINGEN	SORTLAND	ØKSNES	HAMMERFEST
245,581	94,820	38,830	38,494	37,177	36,280

Norway's fishing fleet accounts for more than 70% of traffic in Norway's northern waters, operating as far as 81 degrees northern latitude. As of 2019, North Norway is home of 3,257 fishing vessels.[100]

[99] Statistics Norway. Fisheries (discontinued), 08868: Catch, by fishing vessel's landing municipality and main group of target species (M) (closed series) 2000 – 2018. Retrieved 1 December 2020 from https://www.ssb.no/en/statbank/table/08868/

[100] MARPART Project Report 1 (2016). Maritime activity in the High North -current and estimated level up to 2025, Nord University. Retrieved 24 July 2019 from https://nordopen.nord.no/nord-xmlui/bitstream/handle/11250/2413456/Utredning72016.pdf?sequence=5&isAllowed=y

Fisheries in coastal waters operate year-round and are responsible for around 50% of all coastal traffic in the region.[101] Future traffic volume and patterns depend in large part on the movement of fish stocks, with general trends indicating a North- and Westward migration of fish resources. In addition, burgeoning aquaculture has also resulted in, and will continue to do so, new coastal traffic flows.

With a continually decreasing amount of sea ice surrounding the archipelago of Svalbard during the winter months, fishing activity continues virtually year-round, albeit at a smaller scale during the months of January through May. The fishing fleet varies from 10-20 during this first part of the year to a peak of 50-60 vessels during the months of September to December.[102] While Svalbard does not prominently feature in statistics about commercial fishery landings, fishing vessels operating in its waters account for more traveled distance as those fishing vessels in Nordland county.

Main Markets and Exports

It has been estimated that 95% of the seafood produced in Norway is exported, while only 5% remains for internal consumption.[103] As North Norway is responsible for the production of large parts of the fresh fish and other products, it also stands for a substantial share of the exported amount. The dominating export products are salmon, cod fish and pelagic species, exported primarily fresh, while around one third is exported frozen, salted or dried. Wild capture fish constitutes a greater quantity of the export, while farmed fish stands for almost 72% of the export value.

Due to the geographical proximity and current transport infrastructure, the most important markets for North Norwegian seafood are the EU, receiving more than half of the amount, followed by Russia, U.S., Japan and others. Most of the seafood is exported by sea, trailers or train connections through Sweden and Finland, or transported by plane to more remote markets.[104] Responsible for further promotion

[101] MARPART Project Report 1 (2016). Maritime activity in the High North -current and estimated level up to 2025, Nord University. Retrieved 24 July 2019 from https://nordopen.nord.no/nord-xmlui/bitstream/handle/11250/2413456/Utredning72016.pdf?sequence=5&isAllowed=y

[102] MARPART Project Report 1 (2016). Maritime activity in the High North -current and estimated level up to 2025, Nord University. Retrieved 24 July 2019 from https://nordopen.nord.no/nord-xmlui/bitstream/handle/11250/2413456/Utredning72016.pdf?sequence=5&isAllowed=y

[103] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 47. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[104] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 47. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

of Norwegian seafood abroad is the Norwegian Seafood Council.[105] A public company, owned by the Ministry of Trade, Industry and Fisheries, it works together with the Norwegian fisheries and aquaculture sector with the goal to develop demand and markets for Norwegian seafood, and increase its value.

Cod Fishery

North Norwegian fisheries have traditionally been characterized by and dependent on the species comprising the largest share of wild capture in North Norway – the cod fish, and its related whitefish species saithe and haddock. The waters outside of its coast are home to the Northeast Atlantic cod – the largest cod fish stock in the Atlantic Ocean. Around 74% of the wild capture volume landed in the region consisted of cod and its related white fish species.[106] In addition, it is estimated that more than 85% of the total whitefish catches nationally are landed in Lofoten or further North, and amounted to 581,557 tons (527,579 metric tons) during 2019.[107] A gradual increase in catch value of cod fish has been experienced during the period 2009-2018, which has been linked to a recent decrease in the landed volume.

With regards to first hand sales, 95 whitefish purchaser or producer companies have been in operation in North Norway, with more than half of them located in Nordland, and the rest equally divided between Troms and Finnmark. Around 50 additional companies have been engaged in further processing for local products in the whole region.[108]

The greatest part of the total cod catches is exported, while only limited amounts are designated for internal consumption. During 2017, around 215,000 tons (195,000 metric tons) cod has been exported from Norway with a landed value of 9 billion NOK ($960 million), while around half of the amount is reported to be of North Norwegian origin.[109] The EU is undoubtedly the most important market for the North Norwegian cod, and during 2016 it received 77% of the total quantity exported from Norway as a whole. The main receivers of Norwegian cod are Portugal, Denmark, the United Kingdom and Italy, followed by the U.S., China and Brazil.

[105] Norwegian Seafood Council: https://en.seafood.no/

[106] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 8. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[107] Statistics Norway. Fisheries (discontinued). Retrieved 1 January 2021 from https://www.ssb.no/jord-skog-jakt-og-fiskeri/statistikker/fiskeri

[108] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 53. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[109] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 54. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

Pelagic Species

The NSS-herring, the Barents Sea capelin and the Northeast Atlantic mackerel are the pelagic species with significance to the North Norwegian fisheries sector, and, historically, also their stocks have been highly fluctuating, subject to overfishing and related collapses.[110] The herring is usually accounting for the largest share with more than 150,000 tons (136,000 metric tons) landed volume during 2018. The pelagic species together constituted around 22% of the landed wild capture volume in North Norway. After a significant decrease in the volume of pelagic fish catches in the period 2010-2013, the quantity has been growing since 2016. North Norway has been contributing to the overall volume of around 200,000 tons (181,000 metric tons), amounting to around 1 billion NOK ($110 million) landed value, or just under one sixth of the value on a national level.[111]

Crustaceans and Mollusks

Although representing only around 4% of the overall wild catch, crustaceans and mollusks caught and landed in North Norway constitute up to 77% of the landings on a national basis. Most of the fishery is carried out in the Barents Sea, reaching Svalbard to the North, as well as along the coast of Finnmark. Most of the quantity is harvested and brought into Troms and Finnmark, and despite the limited volume compared to other target species, crustaceans are subject to a growing demand and value.[112]

RED KING CRAB

The Red King crab, an invasive species introduced by Soviet scientists from the North Pacific to the Barents Sea during the 1960s, reaching the Northeast coast of Norway, has been causing changes to the marine ecosystem and impacting the stocks of important species such as the cod fish. It is classified as an alien and invasive species of "high risk" with a great potential for negative impacts on the local environment.[113] The more abundant distribution of the Red King crab in North Norway is currently limited within the coast of Finnmark, where it has been developed as a commercial

[110] Dominoeffekter i Barentshavet; prosessene rundt svingningene i loddebestanden Gro I. van der Meeren, Maria Fossheim, Svein-Håkon Lorentsen, and Per Arneberg Naturen pp 252 - 257 (2009) https://www.idunn.no/doi/10.18261/ISSN1504-3118-2009-05-04

[111] Kunnskapsparken Bodø (2019). Sjømatens veier fra Nord-Norge. 12 April 2019. Retrieved 1 January 2021 from https://www.kbnn.no/artikkel/sjomatens-veier-fra-nord-norge and Fiskeridirektoratet (2019). 2018 Economic and biological figures from Norwegian fisheries. Retrieved 28 October 2020 from https://www.fiskeridir.no/English/Fisheries/Statistics/Economic-and-biological-key-figures

[112] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 8. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[113] Nærings- og fiskeridepartementet (2015). Meld. St. 17 (2014-2015): Evaluering av forvaltningen av kongekrabbe, p. 24. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/meld.-st.-17-2014-2015/id2403472/

fishery since 2002, whereas only occasional observations have been made as South as Troms and the Lofoten area.[114]

Highly valued as food nowadays, the "unexpected immigrant from the East"[115] provides a diversification of the traditional target species, seasonal stability and economical uplift for local fishermen in East Finnmark, where the commercial fishery takes place. The management plan for the red king crab is twofold, with its overarching objective to limit the crab's further distribution westward into Norway's marine areas, keeping its stock at a minimum outside of the zone for commercial fishery.[116] In addition, it shall be carried out in a manner maintaining a long-term commercial fishery, facilitating socioeconomic growth in the region, and not least "compensating" fishermen for the potential losses caused by the crab's impact on commercially crucial ground fish species.[117] In order to achieve the management objectives, the fishery is carried out within two zones – a quota regulated one and a free one.[118] The quota regulated zone covers the coastal waters and fjords of East Finnmark, while the free zone is outside of its limits. Monitoring studies have shown that the overall volume and spreading rate have indeed been decreased as a result of the main objective of the management plan.[119]

Currently, only local vessels registered in East Finnmark, or the municipalities of Porsanger and Nordkapp, are eligible to take part in the fishery for red king crab, securing local economic development in accordance with the first objective of the management plan. In addition, the vessels shall fulfill a minimum length of 6 meters, guaranteeing that they are appropriately and safely equipped for independent catch, increased animal welfare under transportation and lower animal mortality rates. It has been noted by red king crab exporters, that the short distances between the fishing areas and the landing stations in combination with the relatively small size of the fishing vessels are factors increasing the value, appeal and competitiveness of

[114] Lorentzen, G. et al. (2018). Current Status of the Red King Crab (Paralithodes camtchaticus) and Snow Crab (Chionoecetesopilio) Industries in Norway. Reviews in Fisheries Science & Aquaculture, 26(1), p. 44.

[115] Tomassen, J. H. (2018). «Vil noen ta imot oss?». NRK, 13 November 2018. Retrieved 1 August 2019 from https://www.nrk.no/tromsogfinnmark/xl/_vil-noen-ta-imot-oss__-1.14249336

[116] Nærings- og fiskeridepartementet (2007). St.meld. nr. 40 (2006-2007): Forvaltning av kongekrabbe, p. 63 and 68. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/stmeld-nr-40-2006-2007-/id480559/ and Nærings- og fiskeridepartementet (2015). Meld. St. 17 (2014-2015): Evaluering av forvaltningen av kongekrabbe, p. 9. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/meld.-st.-17-2014-2015/id2403472/

[117] Nærings- og fiskeridepartementet (2007). St.meld. nr. 40 (2006-2007): Forvaltning av kongekrabbe, p. 63. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/stmeld-nr-40-2006-2007-/id480559/

[118] Nærings- og fiskeridepartementet (2007). St.meld. nr. 40 (2006-2007): Forvaltning av kongekrabbe. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/stmeld-nr-40-2006-2007-/id480559/

[119] Klima- og miljødepartementet (2020). Meld. St. 20 (2019–2020): Helhetlige forvaltningsplaner for de norske havområdene — Barentshavet og havområdene utenfor Lofoten, Norskehavet, og Nordsjøen og Skagerrak, p. 26. Retrieved 2 January 2021 from https://www.regjeringen.no/no/dokumenter/meld.-st.-20-20192020/id2699370/

Finnmark's red king crab, since it reaches the markets in a better quality. Currently, around 600 vessels are licensed for red king crab catches in Finnmark.[120]

The total catch from both zones together reached 2,600 tons (2,358 metric tons) during 2016. The majority of the catch is exported (2,200 tons, 1,995 metric tons),[121] with around half of the exported amount transported live, primarily to South Korea, and in frozen condition mainly to the EU and Japan. The total value of the exported goods reached more than 530 million NOK ($56 million), a value estimated to have increased by 49% from 2015 to 2016 not least because of the relatively limited amount of catch and increasing demand.[122]

SNOW CRAB

The snow crab has also been acknowledged as an important new species for future development as a commercial fishery. With its distribution further North in the Barents Sea and characterized by uncertainty of abundance, the snow crab currently renders a small fishery, with around 50 vessels licensed for it. However, the snow crab has been denoted as the quickest growing resource in the Barents Sea.[123] The main opportunities for growth in both the red king and snow crab fisheries depend on the development of optimized utilization of byproducts, as well as improvement of transportation conditions and logistics of the live catch, minimizing animal mortality rates.[124] Forecasts predict annual catches of up to 20,000–50,000 tons (18,000–45,000 metric tons). In 2014, Norwegian vessels harvested 4,000 tons (3,600 metric tons) at a value of more than 100 million NOK ($11 million).[125]

NORTHERN PRAWN

The Northern prawn, as it is referred to the shrimp species located in the North Atlantic, is the most important crustacean species in these waters, and target

[120] Fiskeridirektoratet (2021) Kvotefaktorer og fartøykvoter for fangst av kongekrabbe https://www.fiskeridir.no/Yrkesfiske/Nyheter/2021/kvotefaktorer-og-fartoykvoter-for-fangst-av-kongekrabbe-i-2021

[121] Lorentzen, G. et al. (2018). Current Status of the Red King Crab (Paralithodes camtchaticus) and Snow Crab (Chionoecetesopilio) Industries in Norway. Reviews in Fisheries Science & Aquaculture, 26(1), p. 50

[122] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[123] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 12. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[124] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/ and Lorentzen, G. et al. (2018). Current Status of the Red King Crab (Paralithodes camtchaticus) and Snow Crab (Chionoecetesopilio) Industries in Norway. Reviews in Fisheries Science & Aquaculture, 26(1), pp. 42-54.

[125] McBride, M. M., et al. (2016). Joint Norwegian - Russian environmental status 2013. Report on the Barents Sea Ecosystem. Part II - Complete report. IMR/PINRO Joint Report Series, 2016 (2), pp. 85-87. Retrieved 28 October 2019 from http://www.barentsportal.com/barentsportal/index.php/en/89-general-description-of-the-barents-sea/biotic-components/589-

species of two fisheries: the coastal small-scale fishery and the larger offshore fishery carried out further North in the Barents Sea.[126]

The coastal shrimp fishery in North Norway has been historically significant especially in North Troms, where during the 1970s it created the basis for industrial production, benefitting the coastal communities in the region. Through modernization and increased efficiency, the resource found in abundance in the local fjords was harvested and further processed for consumption within Norway, or for export. Nowadays, this fishery represents just a small part of the overall harvesting of the species, with coastal shrimp stocks reported to be in serious decline.

Currently, the most significant part of the fishery on a national basis is carried out further North in the Barents Sea and landed in North Norway. The processing takes place already on board, and depending on the distance between the harvesting areas and the targeted markets, the raw shrimp is cooked or frozen. The freshly cooked product is usually designated for distribution on internal markets within Norway, while shrimp harvested in more remote waters is frozen on board. Meanwhile, only few companies in North Norway operate reception facilities for fresh or frozen shrimp for further processing, such as peeling, as most of the production is carried out offshore.[127]

Although varying in stock size, the Northern prawn in Norway is denoted as harvested in sustainable rates, also reflected in the 2019 ICES recommendation stating that catches may be increased.[128] During 2018 the quantity of landed catch was 28,000 tons (25,000 metric tons), a significant increase compared to recent years. The landed value amounted to more than 1 billion NOK ($110 million) during 2018 and represented more than half of the value of all landed crustaceans in Norway. Most of the frozen product is then exported with key markets in Sweden, Denmark and the United Kingdom.[129]

[126] Kolle, J., Havelin, T., Rudi, T.O., Lorentsen, E., Jensen, P., Rasmussen, D. and Berg, Ø., 2002. Fiskeriaktiviteten i området Lofoten-Barentshavet. Delrapport til konsekvensutredning for fiskeri, havbruk og skipstrafikk. p. 27

[127] Nærings- og fiskeridepartementet (2015). Meld. St. 10(2015–2016): En konkurransekraftig sjømatindustri, p. 25. Retrieved 21 July 2019 from https://www.regjeringen.no/no/dokumenter/meld.-st.-10-20152016/id2461010/

[128] Havforskningsinstituttet (2019). Tilrår rekefangstar på inntil 70.000 tonn. 4 July 2019. Retrieved 1 February 2020 from https://www.hi.no/hi/nyheter/2018/november/tilrar-rekefangstar-pa-inntil-70.000-tonn

[129] Norges Fiskarlag 2021-11-03 Sjømateksporten https://www.fiskarlaget.no/nyheter/details/5/2658-ny-sterk-maned

Aquaculture

While it was rapidly growing in the Southern parts of Norway, aquaculture was seen as mostly inapplicable to the climatic conditions in the then three northernmost counties, due to the low sea water temperature. However, North Norway has turned out to benefit exactly from these circumstances, as they limit the development of salmon lice and other diseases, and stands currently for between 40% and 50 % of the farmed fish produced on a national level.[130] With farmed salmon constituting traditionally more than 90% of the production, followed by trout and other species, aquaculture in North Norway is projected to have the highest potential for growth, compared to the rest of the production regions in the country.[131]

During 2019 the then three northernmost counties produced together 606,463 tons (550,173 metric tons) of farmed fish, whereas salmon accounted for the largest part of the production – 600,058 tons (544,363 metric tons).[132] Nordland stands for more than half of the production in the region while Troms and Finnmark produced 29% and 20%, respectively during 2019, maintaining an overall stable production compared to 2018. Nordland has been the leading producer on a national level with around 21% of the total produced amount.

The landed value of the production from Finnmark, Troms and Nordland during 2018 was 28 billion NOK ($3 billion), reflecting a rapid increase for the last 10 years. The region's contribution to the national value creation from aquaculture is estimated to have grown from 28% and 1,1 billion NOK ($120 million) during 2008, and despite significant variations, it grew up to 42% during 2016 and additional created values were estimated to be 13,2 billion NOK ($1,4 billion) during 2016.[133] With regards to the economic significance, it has to be pointed out that although the seafood with aquaculture origin represents around 1/3 of the seafood produced in North Norway, the sector has been responsible for the greatest part of the value created in the seafood industry as a whole, and estimated almost three fourths of the export value.[134] Most of the production is exported fresh, with markets such as the U.S. and

[130] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[131] DNV GL (2019). Sustainable Blue Economy in the Norwegian Arctic, Part 1: Status, p. 86. Retrieved 1 April 2020 from https://www.havarktis.no/en/projects/sustainable-blue-economy-in-the-norwegian-arctic

[132] Statistics Norway. Aquaculture (discontinued). Sales of slaughtered fish for food. Quantity, by fish species and county. Retrieved 23 October 2020 from https://www.ssb.no/en/jord-skog-jakt-og-fiskeri/statistikker/fiskeoppdrett/aar-forelopige

[133] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, pp. 12-14. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[134] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 46. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

Japan, and reaching overall 140 countries. The biggest market remains the EU, with its proximity and land-based transport infrastructure.

One of the most important factors for the growing value of Norwegian farmed seafood has been the safety of production and the reputation both locally and internationally,[135] not least because of the cooperation of the businesses with research institutions for increased fish welfare and quality as food. Reduced use of medication, vaccine development and stricter monitoring have been in the focus of aquaculture research and innovation.

In addition, according to the "Traffic light system" management strategy of the government, six of the seven production regions (numbers 7-13) designated in North Norway, have been granted "Green light" for increase of production, and "Yellow" in one, for maintaining the same production capacity. According to the strategy, based on scientific recommendations, the coast is divided in 13 production regions, in which environmental indicators will regulate the production capacity. The current environmental factor is the impact of salmon lice on wild salmon and trout population and it determines if a production increase may be granted.[136]

For a detailed analysis on the governance aspects of fisheries and aquaculture/ mariculture in Alaska and North Norway, see the **Blue Governance Report**

Not least, Norwegian salmon has been established as a highly valued sushi product and through the work of the Norwegian Seafood Council, has been reaching and maintaining new markets.[137]

[135] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 54. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[136] Nærings- og fiskeridepartementet (2019). Havbruk til havs: Ny teknologi –nye områder, p. 32. Retrieved 1 December 2020 from https://www.regjeringen.no/no/dokumenter/havbruk-til-havs/id2625352/

[137] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 49. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

Socioeconomic Dimensions and Societal Impact

Gergana Stoeva, Apostolos Tsiouvalas and Malte Humpert

Alaska

EMPLOYMENT

As of 2018, the Alaskan seafood industry is the single largest private-sector employer in the State, providing jobs and income for 58,700 people (about 30% of the State's private sector jobs), and creating an additional 10,000 secondary jobs.[138] The seafood industry is particularly important in rural areas of Alaska, where employment opportunities are rather limited. The commerce associated with harvesting and processing contributes to local utility and commodity usage (fuel, electricity, potable water, etc.), as well as marine transportation infrastructure associated with moving supplies in and finished product out.[139] In 2015, Alaska's seafood industry generated $1,6 billion in annual labor income and contributed $5,9 billion to the State's economy.[140]

[138] Resource Development Council (2018). Alaska's Fishing Industry. Retrieved 25 November 2020 from https://www.akrdc.org/fisheries. This figure includes fishermen as well as workers in on-shore and off-shore fish processing industry.

[139] Alaska Seafood Marketing Institute (ASMI) (2010). Generations of Fishing Brochure, p. 5. Retrieved 25 November 2020 from https://www.alaskaseafood.org/wp-content/uploads/2017/05/Final-FamCom_nfr.pdf

[140] Alaska Seafood Marketing Institute (ASMI) (2015). The Economic Value of Alaska's Seafood Industry, December 2015. Retrieved 3 January 2019 from https://ebooks.alaskaseafood.org/ASMI_Seafood_Impacts_Dec2015/pubData/source/ASMI%20Alaska%20Seafood%20Impacts%20Final%20Dec2015%20-%20low%20res.pdf

TABLE 5: Seafood Industry Impact on Alaska's Economy, 2015 numbers[141]

DIRECT IMPACTS	NUMBER OF WORKERS	LABOR INCOME	TOTAL IMPACTS	
COMMERCIAL FISHING	31,580	$920 million	Full-time Equivalent Job	41,200
PROCESSING	25,055	$460 million	Labor Income	$1,6 billion
MANAGEMENT/ HATCHERIES/OTHERS	2,904	$204 million	Economic Output	$5,9 billion
TOTAL	59,539	$1,6 million		

The majority of fishing traffic is located well south of the Arctic. Out of 6,609 registered fishing vessels[142] less than a third, or 1926, are registered in western and northern Alaska, and less than 15%, or 725, are registered in Arctic Alaska.[143]

Undoubtedly, in addition to their economic value, Alaskan fisheries significantly contribute to the region's social wellbeing. Many fishing operations in Alaska remain family based and, in many cases, have been harvesting fish for generations in the same area and in some instances using the same artisanal techniques.[144] Local participation by families supports rural community's economies and significantly contributes to the sustainable diet and food security to many people around the world.[145] In these terms, both commercial fishing and subsistence fishing are important for the maintenance of economic and social viability in each community. The participation of local residents in any fishery of the State provides an individual not only with access to food, but is a collaborative activity that contributes to the maintenance of strong relationships with their families and communities.[146]

[141] Alaska Seafood Marketing Institute (ASMI) (2015). The Economic Value of Alaska's Seafood Industry, December 2015. Retrieved 3 January 2019 from https://ebooks.alaskaseafood.org/ASMI_Seafood_Impacts_Dec2015/pubData/source/ASMI%20Alaska%20Seafood%20Impacts%20Final%20Dec2015%20-%20low%20res.pdf

[142] Commercial and recreational resident-owned fishing vessels.

[143] Alaska Seafood Marketing Institute (ASMI) (2015). The Economic Value of Alaska's Seafood Industry, December 2015. Retrieved 3 January 2019 from https://ebooks.alaskaseafood.org/ASMI_Seafood_Impacts_Dec2015/pubData/source/ASMI%20Alaska%20Seafood%20Impacts%20Final%20Dec2015%20-%20low%20res.pdf

[144] Alaska Seafood Marketing Institute (ASMI) (2020) Alaska Seafood: The model for Sustainability. Retrieved 5 August 2021 from https://uploads.alaskaseafood.org/2021/03/Sustainability-White-Paper-final-rev2.pdf

[145] Alaska Seafood Marketing Institute (ASMI): Sustainability. Retrieved 1 December 2020 from https://www.alaskaseafood.org/sustainability/

[146] Holen, D. (2014). Fishing for community and culture: the value of fisheries in rural Alaska. Polar Record, 50(4), pp. 403-413.

Local participation is an important indicator of sustainability and blue economy of Alaskan fisheries and is materialized in many ways. The Western Alaska Community Development Quota (CDQ) Program has been developed, aiming at providing eligible villages the opportunity to participate and invest in fisheries; supporting economic development; alleviating poverty and providing economic and social benefits for residents; and achieving sustainable and diversified local economies.[147] To non-profit CDQ groups are allocated 10% of the annual quotas for Alaska Pollock, groundfish, crab and halibut fisheries of the Bering Sea and Aleutian Islands, in order to fund docks, seafood processing facilities and other projects.[148] 65 communities are associated with the CDQ program, 80% of whose are Alaskan Natives.[149] Revenues achieved through the CDQ program totals in the hundreds of millions annually distributed among the eligible communities.[150] Indigenous participation is an important domain of the State's societal development, with prominent example the Tamgas Creek Hatchery, exclusively organized by Native communities.

RESEARCH AND INSTITUTIONS

The primary body responsible for developing management strategies, policies and regulations related to Alaska federal fisheries outside 3 nm is the North Pacific Fishery Management Council (NPFMC).[151] Regulations adopted by NPFMC are implemented by the NOAA Alaska Fisheries Science Center (AFSC), which has been monitoring the health and sustainability of fish, marine mammals, and their habitats across nearly 1.5 million square miles of water surrounding the State.[152] AFSC has further initiated the Economic and Social Sciences Research Program (ESSPR) which provides economic and sociocultural information that assist the National Marine Fisheries Service (NMFS) in meeting its stewardship responsibilities.[153]

Activities in support of this mission include: collecting economic and sociocultural data relevant for the conservation and management of living marine resources, developing models to use that data both to monitor changes in economic and

[147] Alaska Seafood Marketing Institute (ASMI): Sustainability. Retrieved 1 December 2020 from https://www.alaskaseafood.org/sustainability/

[148] Alaska Seafood Marketing Institute (ASMI): Sustainability. Retrieved 1 December 2020 from https://www.alaskaseafood.org/sustainability/

[149] Alaska Seafood Marketing Institute (ASMI): Sustainability. Retrieved 1 December 2020 from https://www.alaskaseafood.org/sustainability/

[150] Alaska Seafood Marketing Institute (ASMI) (2020) Alaska Seafood: The model for Sustainability. Retrieved 5 August 2021 from https://uploads.alaskaseafood.org/2021/03/Sustainability-White-Paper-final-rev2.pdf

[151] North Pacific Fisheries Management Council: https://www.npfmc.org/

[152] Alaska Fisheries Science Center: https://www.fisheries.noaa.gov/about/alaska-fisheries-science-center

[153] NOAA Fisheries (2021). Economic and Social Sciences Research Program. Retrieved 29 March 2019 from https://www.fisheries.noaa.gov/contact/economic-and-social-sciences-research-program

sociocultural indicators and to estimate the economic and sociocultural impacts of alternative management measures, preparing reports and publications, participating on NPFMC, NMFS, and inter-agency working groups, preparing and reviewing research proposals and programs, preparing analyses of proposed management measures, assisting Alaska Regional Office and NPFMC staff in preparing regulatory analyses, providing data summaries.[154]

To the present, the ESSPR has profiled a total of 196 communities.[155] The profiles include new information to better contextualize communities' reliance on fishing. Introductory materials discuss purpose and methods and provide an overview of the profiled communities in the larger context of the State of Alaska and North Pacific fisheries. As provided by NOAA Fisheries, community profiles provide additional information on: annual population fluctuation, fisheries-related infrastructure, community finances, natural resources, educational opportunities, fisheries revenue, shore-based processing plant narratives, landings and permits by species, subsistence and recreational fishing participation, information collected from communities in the Alaska Community Survey and the Processor Profiles Survey.[156] Similarly, significant research programs have been fostering the North Pacific Research Board (NPRB) which was created in 1997 to recommend marine research activities to the U.S. Secretary of Commerce.[157] Through science planning, prioritization of pressing fishery management and ecosystem information needs, coordination and cooperation among research programs, competitive selection of research projects, enhanced information availability, and public involvement, NPRB aims at developing a comprehensive science program for the North Pacific, Bering Sea, and Arctic Ocean ecosystems and their fisheries.[158]

EDUCATION AND INNOVATION

The contribution of educational institutions to research and public engagement in relation to the States' fisheries has also been tremendous. Throughout the year, the AFSC participates in various events from Newport, Oregon to St. Paul Island, Alaska. At these events the public has the opportunity to ask questions, participate in hands-on activities, or pick up information about the science that AFSC conducts.

[154] Economic and Social Sciences Research Program (ESSPR): https://www.afsc.noaa.gov/REFM/Socioeconomics/Default.php

[155] Himes-Cornell, A., K. et al. (2013). Community profiles for North Pacific fisheries - Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-259, Volume 1, 70 p. Retrieved 6 September 2019 from https://archive.fisheries.noaa.gov/afsc/REFM/Socioeconomics/Projects/communityprofiles/Introduction_Methods_Overview.pdf

[156] Alaska Fisheries Science Center. Fishing Communities of Alaska. Retrieved 1 March 2019 from https://archive.fisheries.noaa.gov/afsc/REFM/Socioeconomics/Projects/communities/profiles.php

[157] North Pacific Research Board: https://www.nprb.org/

[158] North Pacific Research Board: https://www.nprb.org/nprb/about-us/

In addition, the University of Alaska Fairbanks College of Fisheries and Ocean Sciences offers undergraduate and graduate programs in fisheries science, while the University of Alaska Southeast is focusing on training fisheries technicians. Their joint program B.S. Fisheries and Ocean Sciences is also available, while degrees such as Marine Biology, Salmon Enhancement, Fisheries Technology, and others can be completed in the different campuses of the State.

Alaska's commitment to sustainable fishing extends beyond education and is grounded on the combination of tough regulation, strict enforcement, close monitoring and innovative technologies. In that regard, AFSC, the Alaska Regional Office, academia, and the commercial fishing industry have now been long working with NOAA's Fisheries Information System Program to develop innovative technologies for the effective and cost-efficient management and monitoring of U.S. commercial fisheries. 2018 was a milestone in the Alaskan fisheries sector when for the first time electronic monitoring was used successfully in catch estimation.[159] In addition, AFSC, together with the State's universities and commercial fishermen have been working together to develop innovative monitoring tools to identify and measure fish from digital images.[160] By transitioning a paper-based fish ticket system to an electronic reporting form, fisheries agencies have gradually managed to improve the accuracy and timeliness of commercial landings data for several species in the United States.[161]

Innovative technologies have not only been adopted by State authorities, but also from private fishing corporations. For instance, the Alaskan Leader Seafood uses vessels that are among the most modern and cleanest in the longline U.S fleet, and fly the Maltese Falcon Cross, the symbol of inspection excellence from the American Bureau of Shipping.[162] Similarly, the Westward Seafoods use innovative technology methods in order to reduce energy costs, meet strict environmental legislation and create value from waste. Aiming at minimizing its eco-footprint, Westward Seafoods, by separating the fish oil from the stick water, manages to clean the water and get valuable fish oil to use for omega-3 supplements as well as an alternative to diesel.[163]

[159] NOAA Fisheries (2019). 2018 Alaska Fisheries Science Center Year in Review, 28 February 2019. Retrieved 29 March 2019 from https://www.fisheries.noaa.gov/feature-story/2018-alaska-fisheries-science-center-year-review

[160] NOAA Fisheries (2019). 2018 Alaska Fisheries Science Center Year in Review, 28 February 2019. Retrieved 29 March 2019 from https://www.fisheries.noaa.gov/feature-story/2018-alaska-fisheries-science-center-year-review

[161] Bradley, D. et al. (2019). Opportunities to improve fisheries management through innovative technology and advanced data systems. Fish and Fisheries, 20(3), pp. 564-583.

[162] Alaskan Leader: https://alaskanleader.com/

[163] Westward Seafoods: https://www.westwardseafoods.com/

North Norway

EMPLOYMENT IN THE FISHERIES SECTOR

Securing stable settlement and employment in the coastal communities, as well as profitable and sustainable harvesting and exploitation of marine living resources and genetic material are principles incorporated in the Norwegian Marine Resources Act, intended to characterize the socio-economic aspects of the sector.

After structural and regulatory changes undergoing in the organization of capture fisheries, the number of fishing vessels and full-time fishermen has decreased significantly since the 1980s,[164] while the efficiency and profitability have been increased, with catches distributed on fewer vessels.[165]

The fishing fleet in North Norway consisted of 3,292 registered vessels during 2018, most of which are shorter vessels with length of up to 15 meters, equipped for small scale fishing in inshore and coastal areas. In many local communities, such as Lofoten and Senja, they offer most employment opportunities, and have been especially significant for the cod fishery.[166]

More recently, with Finnmark as an exception, the figures show only a limited decrease in the overall number of vessels and fishermen in the then three northernmost counties. It is important to point out that the distribution on a national level has remained stable with around 55% of the vessel registrations in North Norway, and with almost 50% of the fishermen resident in the region.[167]

The Register of Norwegian Fishermen includes people engaged directly in seawater fisheries and hunting for marine mammals, as well as the related crews on fishing vessels, facilitating the fishing operations. For 2019, the number of people listed in the Register with a main occupation as a fisherman was 4,315 for the counties, working on 2,843 registered vessels for Nordland, Troms and Finnmark. The Register

[164] DNV GL (2019). Sustainable Blue Economy in the Norwegian Arctic, Part 1: Status, p. 61. Retrieved 1 April 2020 from https://www.havarktis.no/en/projects/sustainable-blue-economy-in-the-norwegian-arctic

[165] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 53. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[166] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 53. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[167] Fiskeridirektoratet (2019). Årsrapport 2018: Fiskeridirektoratet, p. 20. Retrieved 28 October 2020 from https://www.fiskeridir.no/Om-oss/AArsrapport

includes in addition 880 people registered with a secondary occupation in the sector.[168] Yet, these numbers may be subject to under-reporting, due to statistics held during the third quarter, while the season with highest occupational rates is during the first quarter. In 2015, for example, it has been calculated that the overall number of people occupied in the sector would be around 7,000 people.[169]

With regards to distribution of employment, the municipalities with proximity to the marine resources naturally account for higher numbers of employed in the fisheries sector. In some of the island communities with immediate access to the fisheries resources, such as Træna, Røst, Værøy and Moskenes, more than 40% of the workforce has been employed in the sector.[170]

HEALTH, SAFETY AND ENVIRONMENT IN THE FISHERIES SECTOR

The working conditions within the small-scale fisheries, in which most North Norwegian fishermen are engaged, have been often pointed out as dangerous and exposing workers to higher risk for injuries and fatalities, compared to professionals in other fields. However, studies of the working environment and health in Norwegian fisheries have shown, that fishermen are mostly satisfied with their occupation and wellbeing, not least because of the companionship and experienced independence and meaningful work, but also with the purely physical circumstances of the climate and the type of labor, as well as the competitive income. In addition, it has been observed that Norwegian fishermen rate their own overall health as good or very good more often than control groups resident in the same counties.[171]

EMPLOYMENT IN THE AQUACULTURE SECTOR

The number of employed people in the aquaculture sector has been growing rapidly on national basis and has increased from approximately 4,500 employees in 2008 to 8,200 during 2019. By 2019, in all counties 3,113 people were employed in the sector within food production and hatcheries, a number that has been relatively stable, and representing over 35% of the employment in the sector on a national basis.[172]

[168] Fiskeridirektoratet (2020). Fiskefartøy og fiskarar, konsesjonar og årlege deltakaradgangar 2019/Norwegian fishing vessels, fiskermen and licenses 2019. Retrieved 30 June 2020 from https://www.fiskeridir.no/English/Fisheries/Statistics/Fishermen-fishing-vessels-and-licenses

[169] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 46. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[170] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 53. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[171] SINTEF (2018) (by Thorvaldsen, T. et al.). Arbeidsmiljø og helse i fiskeflåten - utfordringer og helsefremmende faktorer. Retrieved 21 July 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1575150

[172] Fiskeridirektoratet (2019). Nøkkeltall fra norsk havbruksnæring 2019, p. 10. Retrieved 28 October 2020 from https://www.fiskeridir.no/Akvakultur/Tall-og-analyse/Statistiske-publikasjoner/Noekkeltall-for-norsk-havbruksnaering

The aquaculture sector offers important employment opportunities on a district level and in some municipalities, it accounts for more than 10% of the workplaces. On national level it offers just 0,3% of the employment, but the value creation per full-time employee is estimated to be four times higher than the average in Norway. In addition, FAO has estimated that the average productivity of a Norwegian employee in the aquaculture sector is 77 times higher than the world average.[173]

COMPANIES AND LICENSES

The Norwegian aquaculture industry has been characterized by a gradual expansion from more local ownership and funding to becoming a part of the national and international financial markets. Currently, the industry consists of around 100 companies on a national level, owned by 80 companies, with the 5 biggest actors owning around 50% of the licenses.[174] Both bigger and medium sized companies are operating in the North, representing around half of the companies on national level, with only a limited part of the management located in the North. These include the three biggest companies on a national level – Marine Harvest, Lerøy and SalMar.[175]

With regards to the licenses for production of salmon and trout for food, out of the 1,051 licenses on a national basis during 2018, 398 are in North Norway. Nordland has been holding the largest number licenses out of all counties in Norway.[176]

In addition to the production of consumption goods, the aquaculture sector plays an important role for the development of the related value chain, which includes equipment supply, fish feed production, hatcheries, processing and further transportation and export. This contributes further to the development and exchange of technology and best practices for the aquaculture sector, benefitting the region, producers and the quality of the seafood.[177] With nationally 15,000 employees, around 5,500 people in North Norway are full-time engaged in the supplier industries. It is therefore estimated, that the aquaculture sector "creates" additional two workplaces for each employee in the main industry.[178]

[173] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 46. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[174] Nærings- og fiskeridepartementet (2019). Havbruk til havs: Ny teknologi –nye områder, p.15. Retrieved 1 December 2020 from https://www.regjeringen.no/no/dokumenter/havbruk-til-havs/id2625352/

[175] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 49. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[176] Number of licenses per 31 December from 1994 to 2019, see Directorate of Fisheries (2020). Atlantic salmon and rainbow trout. Retrieved 1 January 2021 from https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout

[177] Nærings- og fiskeridepartementet (2019). Havbruk til havs: Ny teknologi –nye områder, p. 15. Retrieved 1 December 2020 from https://www.regjeringen.no/no/dokumenter/havbruk-til-havs/id2625352/

[178] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

The processing industry, associated traditionally with the fisheries, has been growing with the development of aquaculture in the North, but is still being characterized by smaller and medium sized companies. Including reception of wild caught fish, it receives, processes and refines the production originating in the aquaculture industry.[179]

With regards to hatcheries, 42 production licenses, or just under a quarter of the total on a land basis have been granted in North Norway during 2016, producing most of the smolt used for farms within the region, and a value amounting to 39% of the total value on a national level.[180]

[179] Norwegian Ministry of Trade, Industry and Fisheries (2017). New Growth, Proud History: The Norwegian Government's Ocean Strategy, p. 20. Retrieved 1 December 2019 from https://www.regjeringen.no/en/dokumenter/the-norwegian-governments-ocean-strategy/id2552610/

[180] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 13. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

Current and Future Challenges to Economic Development

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Our oceans will play an increasingly important role in the future of food production worldwide. Although major commercial fish stocks have been fully utilized or depleted, improved management and sustainable utilization might increase the volume of wild capture globally. Meanwhile, the highest potential for – global – growth in the seafood industry is expected within marine aquaculture, driven by factors such as higher demand for protein from sustainable sources as population grows, including expanding middle class with increased purchase power, as well as technological advances, climate change impacts and mitigation measures, pressure on wild fish stocks etc. In addition, food produced in the ocean does not directly impact land areas and importantly stands for significantly less greenhouse gas emissions compared to terrestrial production, being a keystone for the blue economy.[181]

In order to keep developing their ocean-based industries in the future, countries will have to combine economic development and ocean health, through sound protection of the marine environment and responsible management of the marine resources – factors, characterizing the blue economy both on global and local scale. Accordingly, the same considerations will drive the future of fisheries and aqua-/mariculture in Alaska and North Norway.

Alaska

For Alaska, it is very difficult for the existing fishing and mariculture industry, government and consumers to find new ground, especially when Alaskan fisheries continue to perform well. Looking for new ground accounts for much more than assessing how well the fisheries and mariculture sectors are doing. This idea supports

[181] Costello, C. et al. (2019). The Future of Food from the Sea. Washington, DC: World Resources Institute, p. 3. Retrieved 1 January 2021 from www.oceanpanel.org/future-food-sea

good conservation, reducing waste, while finding new markets and products to sell from the waste stream.

FISHERIES

Yet, the Alaskan fisheries sector is confronted with several challenges and limitations. There is a push by U.S. presidential administration(s) to improve ocean-based economic development, but the lack of lack of consistent State/federal funding remains an issue. It is generally observed that not much money has been provided to Alaskans for mariculture or fisheries research & development as of yet. In addition to the lack of investments, capacity limitations, economies of scale, lower production and investment priority for specialty products and low value species, production and market development costs are afflicting the sector.[182]

Although Alaska's fisheries include a variety of harvested species and management schemes, a number of species and sea products remain underdeveloped in the region. A generally undeveloped industry is this of Arrowtooth flounder (*Atheresthes stomas*). Arrowtooth flounder shares similarities with Pacific halibut and lives in similar habitats, yet it contains an enzyme that results in very soft, unpalatable fillets.[183] Consequently, Arrowtooth flounder remains one of Alaska's lowest priced commercial species, whereas halibut is one of the most valuable.[184] Arrowtooth and halibut compete for habitat and food and the imbalance in their populations have shifted dramatically over the past 20 years. In 1996, there was 3,1 metric tons (2,8 tons) of Arrowtooth/Kamchatka flounder for each metric ton of exploitable Alaska halibut biomass which increased nearly 250% by 2017.[185] McDowell Group suggests to the Alaska Seafood Marketing Institute that a concerted effort to significantly increase Arrowtooth harvests, while minimizing halibut mortality due to bycatch, may increase the value of Arrowtooth and provide better growth potentials for halibut populations.[186]

[182] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[183] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2 and 78. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[184] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2 and 78. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[185] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2 and 78. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[186] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

Similarly, the spiny dogfish (*Squalus suckle)* industry is also undeveloped in the region for several reasons. In general, dogfish require advanced handling and retention methods in order to preserve its quality, fact that is time-consuming.[187] Furthermore, the fish may contain toxins, while the industry is also confronted with the growing public perception against cruel shark fin harvesting methods, which, in turn, has led to the reduction of demand for all types of sharks.[188] Alaskan fishermen typically catch 3 to 5 million pounds of dogfish per year, but as of 2017 only a small amount is retained.[189] If properly handled, the spiny dogfish could produce both quality fillets and cartilage-based products. However, its utilization has not yet been certified as sustainable. As a result, there is no directed dogfish fishery up to date, leading to inconsistent supply.[190]

Not least, skates remain an underdeveloped, yet promising fishery. Due to its unique physiology, skates have nutraceutical benefits that are the subject of increasing research, while its 'wings' are used for their meat.[191] However, the value of the species suffers due to relatively low production of skate wings (in comparison to fish fillets), more costly retention and processing procedures to ensure quality as well as limited demand from retail or high-volume food service operators.[192] Confronted to competition against fillets produced from other species is also the Alaska herring (*Clupea pallasii*) fishery.

MARICULTURE

While market demand for mariculture products is blossoming in Alaska, the industry is confronted with several challenges too. Of prominent concern to Alaska's mariculture industry are Harmful Algal Blooms (HABs).[193] Mariculture (specifically

[187] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[188] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[189] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[190] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[191] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[192] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 3. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[193] NCOOS Research Project (2011). Harmful Algal Blooms Event Response: Responding to Paralytic Shellfish Poisoning Outbreaks in Alaska. Retrieved 1 December 2020 from https://coastalscience.noaa.gov/project/harmful-algal-blooms-event-response-paralytic-shellfish-poisoning-alaska/

shellfish) is being threatened by HABs, their associated toxins, and, not least, the cost of product testing for harmful compounds. In addition, costs associated with the transportation of test samples and product shipping are high, while Alaska's permitting process for any aquaculture operation takes about two years. High barriers to entry and increasing costs discourage new operations from emerging.

The most significant problem caused by HABs in Alaska is paralytic shellfish poisoning (PSP), which is caused when human ingest "shellfish that have bioaccumulated a suite of toxins collectively known as paralytic shellfish toxins".[194] PSP poses risks to public health in Alaska and costs the State (including commercial shellfish fisheries, recreational harvesters, and the aquaculture industry) more than $10 million annually.[195] When shellfish feed on toxic algae, paralytic shellfish poisoning toxins (called saxitoxins) accumulate in their flesh and viscera and may cause consumers a variety of symptoms and even led to death.[196]

Yet, Alaska has successfully developed different methods for monitoring HABs, including a citizen science program that tracks toxins found in harvestable shellfish.[197] In Alaska, commercial shellfish populations are regulated by the State and are regularly monitored and tested. However, systematic testing may not always be available for coastal areas that support recreational, traditional, and even subsistence shellfish harvests.[198] Given the lack of an algae bloom early warning system, commercial shellfish fisheries may lose money if they do not harvest before the bloom strikes and the fishery may even close. Since 2011, the National Centers for Coastal Ocean Science research project has initiated a process of monitoring the shellfish industry in collaboration with State authorities and NOAA's weather service and provided the shellfish industry, as well as community leaders with funding, training and direct access to HAB experts.[199]

[194] Trainer V. L, et al. (2014). Enhancing Shellfish Safety in Alaska through Monitoring of Harmful Algae and Their Toxins. Journal of Shellfish Research, 33(2), 581.

[195] NCOOS Research Project (2011). Harmful Algal Blooms Event Response: Responding to Paralytic Shellfish Poisoning Outbreaks in Alaska. Retrieved 1 December 2020 from https://coastalscience.noaa.gov/project/harmful-algal-blooms-event-response-paralytic-shellfish-poisoning-alaska/

[196] NCOOS Research Project (2011). Harmful Algal Blooms Event Response: Responding to Paralytic Shellfish Poisoning Outbreaks in Alaska. Retrieved 1 December 2020 from https://coastalscience.noaa.gov/project/harmful-algal-blooms-event-response-paralytic-shellfish-poisoning-alaska/

[197] Trainer V. L, et al. (2014). Enhancing Shellfish Safety in Alaska through Monitoring of Harmful Algae and Their Toxins. Journal of Shellfish Research, 33(2), 581.

[198] NCOOS Research Project (2011). Harmful Algal Blooms Event Response: Responding to Paralytic Shellfish Poisoning Outbreaks in Alaska. Retrieved 1 December 2020 from https://coastalscience.noaa.gov/project/harmful-algal-blooms-event-response-paralytic-shellfish-poisoning-alaska/

[199] NCOOS Research Project (2011). Harmful Algal Blooms Event Response: Responding to Paralytic Shellfish Poisoning Outbreaks in Alaska. Retrieved 1 December 2020 from https://coastalscience.noaa.gov/project/harmful-algal-blooms-event-response-paralytic-shellfish-poisoning-alaska/

North Norway

For Norway, models of the future of the seafood industry predict a further development, estimating five- or six-fold growth of revenue within 2050, with highest increase in production and value within the aquaculture, or amounts of up to 5 million tons (4,5 million metric tons).[200] This is in line with expected pre-Covid 19 developments on a global scale, predicting that by 2030, two thirds of the seafood will be farmed within the marine environment,[201] and further out at sea. In addition, the increased conscience for a holistic approach to resource use has created the basis for complete utilization of farmed or caught fish. This, in combination with nutritional and pharmaceutical research, is expected to raise the value of rest biomass from fisheries and aquaculture. North Norway is set to become one of the most productive and sustainably managed regions in the country, and advance the region's value creation, based on the access to resources.[202]

FISHERIES

With regards to capture volume, mainly biological fluctuations and changing migration patterns will be the factors causing variations. This has been observed for example in North-East Atlantic cod and NSS-herring stock. This has resulted in some changes in the typical geographical positions of fishing fields and more complex predictability of future fishing activities.[203] The need for further knowledge is identified, not least to clarify potential impacts of ice melting and changing sea water temperature on lower trophic levels and further up to commercially important species.[204]

The most important fish stocks in the Barents Sea are in a stable condition and size, not least because of effective management. The effects of climate change have been subject to uncertainty, but are manifested through ocean acidification, differences in sea water temperatures and changing patterns and effects of ocean currents.[205]

[200] Olafsen, T. et al. (2012). Value created from productive oceans in 2050. A report prepared by a working group appointed by the Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA). Retrieved 28 October 2019 from https://www.sintef.no/en/latest-news/value-created-from-productive-oceans-in-2050/

[201] World Bank; United Nations Department of Economic and Social Affairs (2017). The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries, p. 12. Retrieved 28 October 2019 from https://openknowledge.worldbank.org/handle/10986/26843

[202] Nærings- og fiskeridepartementet (2019). Havbruk til havs: Ny teknologi –nye områder, p. 13. Retrieved 1 December 2020 from https://www.regjeringen.no/no/dokumenter/havbruk-til-havs/id2625352/

[203] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[204] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 22. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[205] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

These factors may have implications for fishermen and in the negotiations and allocation of shared stocks.

Other potential challenges for traditional fisheries include reduced prices, unstable supply of cod from year to year and uncertainty of market access. Technological advances, such as the live storage of fish for stabilized supply, as well as marketing measures such as promoting as an "Arctic product" may be solutions for maintaining the appeal of and increasing the demand for North Norwegian fish.[206] This type of "local branding" is also recognized as an important trend within the development of a sustainable bioeconomy. It is proven to have a positive impact on the whole supply chain, not least by increasing the value of the product, guaranteeing transparency of origin, and through allowing the consumer to support a certain community. The so-called REKO-ring, a Scandinavian business model for distribution of local products, including producers in North Norway, is a prime example of this approach on a local level.[207]

With regard to employment, most of the (pre-Covid 19) studies building on models with the current rates of the blue economy within the region predict stable or somewhat decreased employment in fisheries, while increase in value creation. With regards to the socioeconomic dimensions of fisheries, the trend of a stable number or gradual reduction of vessels and increased efficiency is predicted to continue, resulting in better profitability.[208] Some studies project an increase in employment opportunities in case of larger volumes of landed catch.[209]

AQUACULTURE

North Norway may offer optimal conditions for growth in the aquaculture sector. Yet it remains debatable whether the conditions will be maintained optimal in the long run, with existing challenges within disease control, escapes, marine spatial planning, market access and a somewhat strained reputation of the farmed products.[210] However, taking into account the current state of aquaculture, it has been predicted

[206] NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 48 and 55. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

[207] Nordic Council of Ministers (2020). Ten trends for the sustainable bioeconomy in Nordic Arctic and Baltic Sea Region. Retrieved 1 January 2021 from https://www.norden.org/en/publication/ten-trends-sustainable-bioeconomy-nordic-arctic-and-baltic-sea-region

[208] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 55. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/

[209] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 23. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[210] Klima og miljødepartementet (2011). Meld. St. 10 (2010–2011): Oppdatering av forvaltningsplanen for det marine miljø i Barentshavet og havområdene utenfor Lofoten, p. 55. Retrieved 11 November 2019 from https://www.regjeringen.no/no/dokumenter/meld-st-10-2010-2011/id635591/ and NOFIMA (2018) (by Elde, S. et al.). The Arctic as a Food Producing Region Phase 1: Current status in five Arctic countries. Issue 10/2018, p. 48. Retrieved 5 May 2020 from https://nofima.no/en/publication/1581246/

that the sector will continue to grow both in employment opportunities, as well as in value creation and demand for farmed seafood.

It is estimated that the sea water temperature along the Norwegian coast has increased on average 1° since the 1980s, and this tendency is expected to continue, with optimal farming conditions moving northwards.[211] Potential negative implications on salmon aquaculture may occur throughout the Norwegian coast, in a varying scale, causing farms to experience a greater number of days with sea water temperature above the optimal for the fish welfare in terms of growth and feed intake.

The dominating challenges for the aquaculture sector in North Norway are closely aligned with the occurring problems on a national basis. The most pressing issues currently constitute salmon lice and other parasites' impact on wild salmon populations, medication discharges and other pollution, and escapes. Between 2001 and 2018, around 6,9 million salmon and rainbow trout have been reported as escaped from aquaculture localities on a national level. Relevant institutions have also noted that in recent years escapes may be subject to underreporting. This is considered to potentially create the greatest environmental impact of aquaculture, causing genetic contamination on wild salmon population and aggravating impacts of parasites.[212]

The seriousness of another pressing issue for the aquaculture sector became too apparent during the spring of 2019, when a massive algal bloom in the counties of Nordland and Troms caused the death of more than 9 million salmon in farms, with corresponding economic loss and social effects. It has been estimated that the lost amount represented around 2% of the national production and more than 6% of the local production in the two counties. It was estimated that the loss costed between 2,3 and 2,8 billion NOK ($260 and $320 million) in profit, including the direct effects on the employment in slaughterhouses, fish feed production and other related parts of the supply chain.[213] Among other effects, it further became apparent that the processing of the resulting biomass was too slow, causing challenges for its utilization as rest raw material. This major incident prompted businesses to seek improved monitoring and contingency.

[211] Olafsen, T. et al. (2012). Value created from productive oceans in 2050. A report prepared by a working group appointed by the Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA), p. 30. Retrieved 28 October 2019 from https://www.sintef.no/en/latest-news/value-created-from-productive-oceans-in-2050/

[212] SINTEF (2018) (by Breimo, G. et al.). Havnæringene i nord - næringsutvikling og verdiskaping frem mot 2040, p. 16. Retrieved 11 November 2020 from https://www.sintef.no/publikasjoner/publikasjon/?pubid=CRIStin+1704201

[213] Kontali (2020). Økonomiske og samfunnsmessige konsekvenser av algeoppblomstringen i havbruksnæringen i Nord-Norge, p. 3. Retrieved 28 October 2020 from https://www.kontali.no/uploads/6VY1FKI6/Sluttrapport_901574-Konsekvenser_av_algesituasjonen_i_nord.pdf

OFFSHORE AQUACULTURE

Enclosing and moving the production further out at sea may be one of the most promising strategies for overcoming the main challenges within aquaculture, which will limit the impact of diseases, create presumably less spatial competition with other uses of the sea. It is considered to offer more optimized farming conditions, and increased animal welfare. Offshore aquaculture or ocean-based fish farming is a concept for farms located outside of coastal areas, moored to the seabed, or navigating independently. The Norwegian government issued trial licenses for development of such installations in the period 2015-2017, stimulating the innovation technologies within aquaculture. The first operating offshore farm in the world is Ocean Farm 1, owned by SalMar and located outside the coast of Trøndelag. Currently, it is unlikely that offshore aquaculture will substitute the traditional forms of aquaculture, and it is considered initially rather as an addition to it.[214]

Aquaculture companies have commenced development of offshore farming facilities for operation also in the North. Among the companies developing offshore aquaculture farms is Nordlaks, based in Nordland.[215] The company is currently operating two "Havfarm" concepts – a self-propelled one, and a moored one stationed outside of Hadseløya in Nordland county, which has already commenced salmon production.[216] The self-propelled farm is still under development and is expected to be launched in the municipality of Hamarøy, Nordland. Other companies include Norway Royal Salmon, with their concept "Arctic Offshore Farming",[217] as well as AkvaDesign[218] based in Nordland, with their concept for semi-closed farms.

Expanding Industries

It has been recognized that the commercial fish species in sea areas outside the Norwegian coast have been almost fully utilized. However, opportunities for harvesting of new resources have been identified, with target species developed lower in the marine ecosystem. Species on lower trophic levels, such as krill, copepods, mollusks and other crustaceans, as well as micro- and macroalgae, have the potential to gain importance as seafood, as well as within the bio-marine industry, as a global demand for health and dietary supplements is rising. Meanwhile, the rest raw materials have a significant potential to be fully utilized as a resource,

[214] Nærings- og fiskeridepartementet (2019). Havbruk til havs: Ny teknologi –nye områder, p. 6. Retrieved 1 December 2020 from https://www.regjeringen.no/no/dokumenter/havbruk-til-havs/id2625352/

[215] Nordlaks: https://www.nordlaks.no/havfarm/om-havfarm-prosjektet

[216] Fiskeridirektoratet (2021). Kunnskap fra utviklingsprosjektene. Retrieved 28 Juni 2021 from https://www.fiskeridir.no/Akvakultur/Tildeling-og-tillatelser/Saertillatelser/Utviklingstillatelser/Kunnskap-fra-utviklingsprosjektene

[217] Norway Royal Salmon – Arctic Offshore Farming: https://www.arcticoffshorefarming.no/

[218] Miljølaks: https://www.akvafuture.com/no/

while waste from the seafood sector will be reduced and put value into. The expected value of industries such as marine biotechnologies, marine ingredients industry and production of marine algae is expected to reach 120 billion NOK ($13 billion) combined.[219]

DEVELOPMENT OF RESOURCES LOWER IN THE FOOD CHAIN

The development of new and untraditional marine species for harvesting or farming will further promote and strengthen the blue economy on a global scale, and provide important diversification within the fisheries and aquaculture industries. North Norway has recently started to explore the opportunities within the sector in close collaboration with research institutions, and is yet to develop them into products for commercial exploitation.

HARVESTING OF COPEPODS (*CALANUS FINMARCHICUS*)

The copepod, a large zooplankton species, providing an important source of nutrition throughout the marine food chain, is one of the largest resources measured in biomass in the North-East Atlantic, and is present in the sea areas outside the coast of North Norway. Harvesting copepods has been carried out in the sea areas adjacent to the region since 2003 on exploratory means, with the goal to gain knowledge about the stock and potential for development of sustainable industry. Commercial harvesting has commenced only recently and is carried out North of 62°, with projected high potential for growth. During 2019, overall, 35 companies have applied for a commercial license. Containing high levels of proteins and fats, the copepods can be a main resource within a broad spectrum of products for nutrition, cosmetics and fish feed ingredients. Technology and practices for harvesting and processing have been initially developed during the last more than a decade by Calanus, a company based in Troms and operating in North Norway, and engaged primarily in the development of value chains for copepods.

It is currently uncertain what the potential impacts of copepod harvesting might have higher in the food chain. Concerns about effects on commercially important fish species have been expressed within the fisheries sector, with potential for decreased access to food for juvenile fish, and risk of bycatch, identified as the main challenge before a large-scale commercial harvesting can commence.

MARINE ALGAE

On a world scale, macroalgae farming constitutes the largest part of aquaculture production, measured in volume. Versatile in their application, algae have been used

[219] Paulsen, V. et al. (2019). Nord-Norge kan bli best i verden på verdiskaping fra marin biomasse. Fiskeribladet, 8 April 2019. Retrieved 8 April 2020 from https://www.fiskeribladet.no/meninger/-nord-norge-kan-bli-best-i-verden-pa-verdiskaping-fra-marin-biomasse/8-1-66266

as food, within the production of fish feed, and hold the potential for increased application within nutrition, cosmetics, pharmaceuticals and fertilizers, as well as in the production of bioenergy. Recognized as an important emerging trend facilitating the further strengthening of a sustainable bioeconomy also in the Nordic region, wild seaweed harvesting and cultivation gain importance in the Arctic as well, expected to gradually create conditions for employment, and not least opportunities for positive environmental impact.[220] In Norway, macroalgae production is a growing industry, with harvesting and farming licenses granted only recently, since 2014. The North Norwegian contribution has been showing significant growth within farming, with Nordland hosting most of the licenses – currently 25% of the national production areas. The macroalgae with largest production volume in North Norway are currently sugar and winged kelps.

Standing out as a best practice from North Norway is the small company Lofoten Seaweed, creating food, nutritional and cosmetic products, using solely wild and responsibly harvested seaweed, taking into consideration the capacity of the ecosystem to regrow and reproduce.[221] The company has been awarded numerous certifications and honors, and is employing women in the local community.

In addition, trials within the production of microalgae have been carried out, not least in relation to CO2 capture and reduction, and fish feed, with the potential for impact on a range of industries. An example for that is the cooperation project between Finnfjord Smelteverk and UiT The Arctic University of Norway, which reduces CO2 emissions from factory smoke through the production of microalgae. The algae are further used as a more sustainable raw material for the production of fish feed, compared to the traditional soya or fisheries-based ones.[222] It has also been estimated that with increased demand within human consumption and biofuels, paired with the necessary policy steps,[223] the marine algae sector will experience significant growth.

FISH WASTE

Millions of tons of fish waste are produced globally each year. Because demand for fish will likely exceed 70% by 2050, this is an unsustainable and potentially disastrous practice. But, in order to get to sustainable food production teamwork between Arctic fishing regions, including Alaska and North Norway incorporating

[220] Nordic Council of Ministers (2020). Ten trends for the sustainable bioeconomy in Nordic Arctic and Baltic Sea Region, pp. 45-47. Retrieved 1 January 2021 from https://www.norden.org/en/publication/ten-trends-sustainable-bioeconomy-nordic-arctic-and-baltic-sea-region

[221] Lofoten Seaweed: https://lofotenseaweed.no

[222] Eriksen, T. et al. (2017). Disse algene renser fabrikkrøyk. Forsking.no, 21 June 2017. Retrieved 1 January 2021 from https://forskning.no/biologi-forurensning-klima/disse-algene-renser-fabrikkroyk/339234

[223] Nordic Council of Ministers (2020). Ten trends for the sustainable bioeconomy in Nordic Arctic and Baltic Sea Region, pp. 45-47. Retrieved 1 January 2021 from https://www.norden.org/en/publication/ten-trends-sustainable-bioeconomy-nordic-arctic-and-baltic-sea-region

researchers and the industry will be essential. More and more it will be critical to improve and increase byproduct processing such as using enzymatic hydrolysis to produce valuable proteins, amino acids and fish oils. New technologies have been developed and adapted for use in fish processing plants and at sea processors. The rationale and intelligent use of industrial, food, cosmetic, and pharmaceutical byproducts from fishery processing and plant biomass towards the production of durable components, easy to reuse, remanufacture, or recycle is becoming a must for our society to save the integrity and biodiversity of our planet.

Alaska

There is a significant amount of waste generated in the Alaskan seafood industry, primarily from fish heads, that represents enormous potential for both buyers and suppliers. In addition to fish heads there are other market opportunities including oils, collagen, food additives, peptides/nutraceuticals, fertilizers, and animal food hydrolysates. Other opportunities for expanding these markets are currently being evaluated in Alaska including frozen and dried fish heads, cod and pollock tongues, internal organs, stomachs, enzymes and milt in addition to finding value in underutilized species. The key takeaways are that Alaskan fisheries have the capacity to produce significantly more fish oil and meal and meeting other market demands for pet food and treats. But these are at the lower end of the revenue spectrum. Alaska would be much better situated by looking at higher value-added products and markets including supplements, oils, biofuel additives, chitin and chitosan extracts and collagen.[224]

BEST PRACTICES

Silver Bay Seafood is a different type of processing company in Alaska in the sense that it is owned by fishermen who represent over 80% of its committed fishing effort. It began in 2007 as a single salmon processing facility in Sitka, Alaska. Today, Silver Bay is one of the largest seafood companies in Alaska, operating five processing facilities throughout Alaska, including Naknek in Bristol Bay. Silver Bay Seafood seems to be unique in its cooperative business model that is fisherman-owned. Its new facilities provide automated processing lines. It has a vision of social sustainability through its "silver bay experience" according to which all employees are valued and contribute to the fate of the company. The wages are slightly higher than other processing wages and are transparently shown on the website. Silver Bay appears to give better social sustainability to its employees and, in turn, this would mean a stable workforce for local processing. A stable workforce was an identified barrier in the previous section for byproduct utilization that Silver Bay may have a competitive advantage and hence its strong growth in processing facilities.

[224] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 2. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

North Norway

In line with the increased ethical and environmental conscience, as well as potential economic yields, the rest raw materials utilization has been gaining significant importance in association with aquaculture and traditional fisheries in Norway, and specifically North Norway. The production of nutritional supplements, fish feed or biochemicals with broad application are the main uses of such materials and create the basis for the marine ingredients industry. It is estimated that the rest biomass from the fisheries in North Norway amounted to 121,000 tons (110,000 metric tons) during 2017, while on a national basis it has been estimated that around 25% of the rest materials are not utilized. It has to be noted that the aquaculture sector stands out with an estimated over 90% utilization rate of its rest raw materials, while most underutilized material originates from the white fish sector.[225] Most of the used material is currently processed into oils for human consumption or flour for use in fish feed.

The processing of rest raw materials, or the biomass left after the processing of the fish for consumption, is naturally situated in proximity to the resource, and is also dependent on the seasonality of the resource.[226] As a result, around 1/3 of the Norwegian companies engaged in the industry are located in North Norway.[227] Biotech North, a cluster based in Tromsø, consists of companies engaged in the marine biotechnology, research and development, with the goal to create awareness and business opportunities within the complete utilization of biological resources deriving from fisheries and aquaculture.[228] Creating value in the residual biomass and cooperation with research institutions engaged in its utilization will further become an incentive for fishermen to bring back to land what was once solely regarded as waste, while promoting the business interests.[229] This, in combination with technological solutions, will ultimately solve the recognized as a number one challenge for trawlers to effectively utilize the rest materials from fish – namely profitability.[230]

[225] SINTEF (2020). Analyse marint restråstoff 2019: Tilgjengelighet og anvendelse av marint restråstoff i fra norsk fiskeri- og havbruksnæring, p. 25. Retrieved 28 October 2020 from https://www.sintef.no/contentassets/6b30fa1babed4d6eba0e243e08192d08/analyse-marint-restrastoff-2019_endelig.pdf

[226] SINTEF (2020). Analyse marint restråstoff 2019: Tilgjengelighet og anvendelse av marint restråstoff i fra norsk fiskeri- og havbruksnæring, p. 25. Retrieved 28 October 2020 from https://www.sintef.no/contentassets/6b30fa1babed4d6eba0e243e08192d08/analyse-marint-restrastoff-2019_endelig.pdf

[227] Nofima (2019). «Alt skal med» – en analyse av nordnorsk marin ingrediensindustri. 1 March 2019. Retrieved 21 July 2019 from https://www.kbnn.no/artikkel/alt-skal-med-en-analyse-av-nordnorsk-marin-ingrediensindustri

[228] Biotech North: https://www.biotechnorth.no/about-biotech-north/

[229] Nofima (2019). «Alt skal med» – en analyse av nordnorsk marin ingrediensindustri. 1 March 2019. Retrieved 21 July 2019 from https://www.kbnn.no/artikkel/alt-skal-med-en-analyse-av-nordnorsk-marin-ingrediensindustri

[230] Arctic Council (2021). Blue Bioeconomy in the Arctic Region. Project Report 2021, p. 45. Retrieved 30 June 2021 from https://oaarchive.arctic-council.org/handle/11374/2613

On a national level too, it has been recognized that a great potential lies in the development of this sector. The Norwegian government recently presented a strategy exclusively addressing the increase of value creation from marine rest raw materials.[231]

BEST PRACTICES

Hordafor AS was established in 1983 with the intent to utilize the resulting byproducts from production of capelin roe and pelagic fish, and has gradually expanded its operation along the Norwegian coast up to its northernmost municipalities.[232] It is Norway's largest seafood byproduct company, with North-Norwegian daughter companies such as Akva Ren AS,[233] located in Furuflaten and North Capelin Honningsvåg.[234] According to their strategic location and proximity to resources and rest materials, the companies specialize in ensilage of fish farming byproducts, transportation and further processing from both healthy and diseased fish, in close cooperation with the fisheries and aquaculture sector in North Norway. Finished products include mainly fish feed and fish oil, which are further traded within the sector or to other industries. Hordafor AS and its daughter companies throughout Norway have helped transform the management of marine byproducts and have contributed to their nearly 100% utilization.

BIO-MARINE INDUSTRIES

With a growing market for pharmaceutical and health products, there is a rising interest in discovering biological materials holding a potential for development of the bio-marine industry through bioprospecting and biotechnologies. A number of specialized laboratories and facilities have already been established in affiliation to scientific and academic institutions based in Tromsø, not least because of the recognized resource advantages of North Norway and established interdisciplinary cooperation. Examples include Marbank – a national biorepository for marine resources from the Arctic as part of the Institute of Marine Research,[235] BioTep – a national facility for marine bioprocessing,[236] and Marbio – an analytical platform for screening, isolation and identification of bioactive substances, based at UiT The Arctic University of Norway.[237]

[231] Norwegian Ministry of Foreign Affairs (2020). Meld. St. 9 (2020-2021) Mennesker, muligheter og norske interesser i Nord, p. 89. Retrieved 30 June 2021 from https://www.regjeringen.no/no/dokumenter/meld.-st.-9-20202021/id2787429/

[232] Hordafor: http://www.hordafor.no/

[233] Akva Ren: https://akvaren.no/

[234] Pelagia: https://pelagia.com/facilities/north-capelin-honningsvag/

[235] Marbank: https://www.hi.no/hi/forskning/forskningsgrupper/marbank

[236] Nofima BioTep: https://nofima.no/en/research-facilities/biotep/

[237] UiT – The Arctic University of Norway, Marbio: https://en.uit.no/forskning/forskningsgrupper/gruppe?p_document_id=380005

The bioeconomy provides room for new business opportunities in the North. Blue synergies between sectors will be created and strengthened, as industries utilize each-others remaining materials, fully in line with the circular economy, also recognized as a major trend within the bioeconomy.[238] As an important step on the path from research and development to market establishment is the products' commercialization, and not least their realization by local entrepreneurs for an uplift of the local economy. An example for such an approach within the marine biotechnology in North Norway is the MABIT program,[239] which not only supports the development of new applications for rest materials from the fisheries and aquaculture, and cross-cooperation between sectors, but also promotes the products' market value. This is done through collaborative work with businesses in order to create demand, which has consecutive positive effects on this whole new value chain.

Circular Economy and the Full-Utilization of Byproducts

A collaborated effort between Alaska and North Norway that operates with circular economy business models will realize transparency, sharing data, and encouraging innovation and entrepreneurship is an answer to speed up transition. This strategy is closely aligned with the UN's Sustainable Development Goals (SDGs), all of which support each-others realization – in a shared pursuit of a global prosperity, started locally.

CIRCULAR ECONOMY is an industrial system that is restorative by intention and design, where products are designed for ease of recycling, reuse, disassembly, and remanufacturing.[240] It is an economy with closed material loops.[241] It is the alternative to the traditional linear model of growth that operates by 'take, make & dispose' mentality that has dominated the global economy so far.

Figure 5 below shows the circular linkage of full utilization and local processing centered on the blue economy, as emphasized in SDG 14 of life below water. The first step would be if Alaska and North Norway have a vision of seeing their resource as this connected loop of local processing and full utilization. They could then align

[238] Nordic Council of Ministers (2020). Ten trends for the sustainable bioeconomy in Nordic Arctic and Baltic Sea Region. Retrieved 1 January 2021 from https://www.norden.org/en/publication/ten-trends-sustainable-bioeconomy-nordic-arctic-and-baltic-sea-region

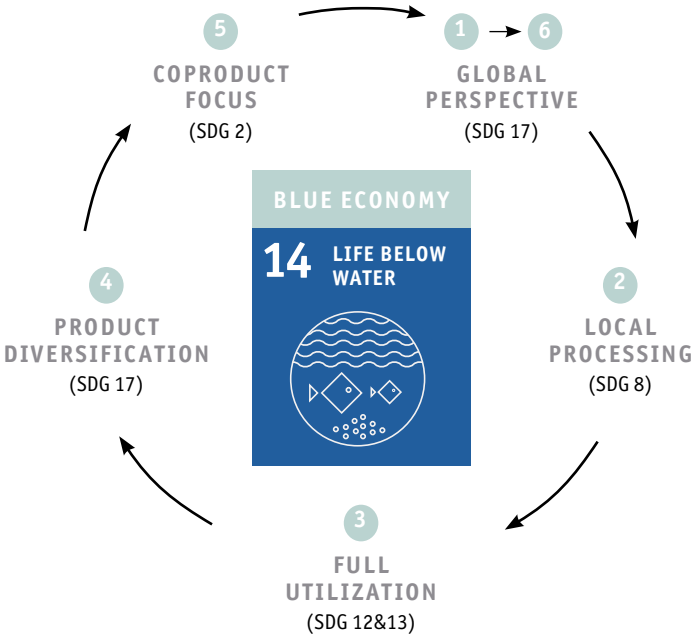
[239] MABIT: http://www.mabit.no/

[240] Wijkman, A. & Skånberg, K. (2016). The Circular Economy and Benefits for Society. Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency. The Club of Rome. Retrieved 1 January 2019 from https://clubofrome.org/wp-content/uploads/2020/03/The-Circular-Economy-and-Benefits-for-Society.pdf

[241] Wautelet, T. (2018). The Concept of Circular Economy: its Origins and its Evolution. https://doi.org/10.13140/RG.2.2.17021.87523

their future strategies to move in the direction of full utilization of byproducts and thereby contributing to the objectives of a blue- and circular economy. This will set both areas as having global perspective via SDG 17. SDG 8 is decent work and economic growth and with a valuable resource as salmon, this can be used to provide healthy, local workplaces. The economic growth arises by at least two ways. First, the local connection of engaging in end products allows for local adaptions to ensure market stability; thus, product innovation and entrepreneurship is a possible result that causes economic growth. Second, by not exporting the fish for further processing allows for the ability to engage in high valued secondary products found in pharmaceuticals and medical applications. With not having access to the lost byproducts, it is difficult to adapt the secondary product to other uses of possibly higher value.

FIGURE 5: Circular diagram showing the connection of local processing and full utilization in terms of seven of the UN SDGs



By processing the salmon in as many end-products at a local level as possible, then one knows that the salmon is being fully utilized in environmentally friendly ways. This is the case for Alaska and North Norway that have certifications schemes and institutional standards of responsible harvesting and presumably the case for their processing practices. This represents SDG 12 of responsible consumption and

production and SDG 13 of climate change. By sending the salmon to a country of lower operation costs to do the processing and then further sending the salmon to the final market, one disengages in the treatment of byproducts and countries with lower operating costs may also have lower environmental standards for disposal and or utilization. As for climate change, there is an additional transportation step. For Arctic countries that are often far from the consumer market, the transportation is often long distances, such as Alaska sending its fish to China for processing to sell in the U.S. or Norway sending its fish to Eastern countries to sell to the EU.[242]

SDG 17 helps product diversification in Alaska and North Norway by building a collaborative partnership. As sustainable harvesters of the salmon, both regions can coordinate and collaborate with their product diversification. A strong partnership between these fishing regions can assure to maximize the potential of their renewable resource, so they do not flood markets and can focus on building niche markets for byproducts. By focusing the byproduct to coproduct status, the industry further supports SDG 2 of ending hunger, and minimizing food waste.

[242] Nystoyl, R. (2018). Global Salmon Production. Trends in Production and Market Development.

AlaskaNor–Areas for Cooperation

Garrett Evridge, Gergana Stoeva, Apostolos Tsiouvalas, Merrick Hartness Mordal and Andreas Raspotnik

Although Alaska and North Norway are two competing regions in global markets, they both share one major common characteristic: a high dependency on the ocean and its resources. Subsequently, transnational and multi-sectoral approaches in (fisheries) management, science, policy, industry and business connecting across disciplines are imperative for the future of both regions. Interfacing fisheries and aqua-/mariculture in the two regions through the AlaskaNor Project has paved the way for future AlaskaNor-collaboration in many sectors: policy development, application of improved/appropriate technologies, improving handling, services, infrastructure, regulatory evaluation, and market/consumer analysis/ best practices. Against this background, both regions would benefit from an exchange of information, best practices, and technological improvements.*

*Part of the recommendations and conclusions in this chapter concern Norway in its entirety and are equally applicable and relevant to North Norway.

Climate Change

Changing ocean conditions are impacting fisheries in Alaska and North Norway. Two primary areas of research are needed to inform stakeholders about anticipated changes to the fisheries in both regions:

- The first is to understand how species will be affected by the impacts of climate change, including diminishing Arctic sea ice, ocean acidification, and higher sea surface temperatures. Will survivability increase or decrease? Can species population ranges move to follow favorable ocean conditions? Will new predators impact populations or will food sources diminish? The answers to these and other questions are needed to inform the best response to climate change.
- The second is the need to increase the quantity and quality of information available to fisheries managers in order to set annual harvest levels. Instead of a periodic survey of fishing stocks, real-time data collection will improve the decision-making process.

Bycatch

Alaska and North Norway desire to reduce incidental harvest of species taken when targeting other species. Novel technologies, harvest methods, and regulatory changes are tools that have been successfully used in both regions. An exchange of these practices offers the potential to further reduce bycatch.

Examples from Alaska include a robust exchange of information between vessels. If a captain notices increased bycatch, other vessels are alerted to avoid the location. On-deck sorting has also limited the impact of incidental catch, particularly for halibut. Once a halibut has been identified among other targeted species, a quick return to the ocean increases its chance for survival.

Commerce

Beyond current estimates for mineral development, Alaska and (North) Norway are on the verge of massive expansion of their seafood production industries and increasing the current fishing fleet value through value-added research & development focused on waste stream reduction and wealth creation. Current estimates place fisheries waste at between 35-50% of each fish harvested. There are several examples, e.g., the Iceland Ocean Cluster's "Fish Value Machine", of successful efforts to bring significantly more value, without additional harvesting, to Alaska and (North) Norway's fisheries.

Maritime companies in both regions should look for opportunities to sell goods and services to one another. Technological advancements in Norway's aquaculture sector could be applicable to Alaska's hatcheries. Improvements in seafood processing, packing, and distribution should be actively marketed in the state. And Norway's modern naval architect designs and operating processes are relevant to the thousands of vessels in the Alaska fleet.

A variety of early-stage companies in Alaska and the United States offer technologies that could be relevant to Norway. Blue Ocean Gear, Inc., a California-based company, makes GPS-equipped smart buoys that can track the location of fixed gear (pots and longline) while gathering temperature, depth, and other parameters. The buoy offers fuel and time saving for operators while reducing the likelihood of losing fishing gear. PolArctic LLC is a company specialized in remote sensing and advanced statistical analysis with the capability to forecast the ice edge in the Arctic.[243]

[243] Both companies are partners of the Alaska Ocean Cluster.

Governance

Alaskan fisheries management is characterized by close cooperation between federal and state authorities, while in Norway there is no management level below the national. On one hand, this is perhaps not so surprising given that the U.S. is a federal state, while Norway is not. On the other hand, management can be delegated to the regional level also in non-federal states, and in Norway fisheries play a big role both economically and culturally in the northern and western parts of the country, but less in the more heavily populated eastern parts. There have been regular calls for decentralization and regionalization of Norwegian fisheries management over the years, but national authorities have persistently opposed this. The devolution of the governance from federal to state level, prioritizing the domestic needs of the state could, however, be an example for Norway, since several issues pertinent to the Norwegian fisheries policy derive from the centralization of fisheries governance around Oslo.

For more, see again the **Blue Governance Report**

Salmon Fisheries Management

Both Alaska and Norway are global players in the salmon industry. Salmon production is an extremely profitable source of income and employment for both regions. Keeping in mind that the salmon industries in Alaska and (North) Norway are carried out in a fundamentally different manner, there is great potential for them to learn from each other's practices, with Alaska's successful development of hatcheries and sustainable management of salmon stocks, and North Norway's highly profitable aquaculture. With half of Norway's aquaculture companies operating in North Norway, the region can offer practical experience and technical solutions for the development of the industry in Arctic conditions, as well as successful marketing strategies for maintaining markets. The two sectors need to interact and exchange best practices, improving and maintaining their status in future.

Increased Domestic Processing

Currently, a significant portion of Alaska and (North) Norway seafood production is processed in other countries. Key reasons for this dynamic are the relatively high labor, energy, and regulatory costs present in both regions. In many cases it is more cost-effective to ship seafood to low-cost manufacturing centers such as China, Thailand, or Vietnam instead of processing in-region. There is a desire in Alaska and

(North) Norway to process more seafood domestically. Benefits include reduced risk associated with geopolitical tension, increased local economic impact of fisheries, and preventing emissions associated with transporting seafood thousands of miles. In some cases, the cost differential between high and low-cost regions can be moderated through adoption of technological solutions. These solutions include automation of processing activity, transportation optimization, and regulatory changes to allow innovation. Increasing domestic processing centers could contribute to the creation of new jobs for the sector, sustainably revitalize small arctic and subarctic settlements and promote further community engagement.

MISSING OUT ON COMPLETE VALUE CHAIN

At the moment, both Alaska and (North) Norway use other countries for further processing than the end-product consumer countries. Averaging over the years 2013-2016, Alaska exported approximately 70% of their 375,000-ton salmon harvest for further processing with Norway exporting 81% of its farmed salmon for further processing of their approximately 1-million-ton harvest. By not engaging in local processing to export salmon directly to the consumer markets, Alaska loses 108,000 tons (98,000 metric tons) of the estimated 210,000 potential tons (190,000 metric tons). Norway again loses 575,000 tons (522,000 metric tons) of the estimated 953,000 potential tons (865,000 metric tons). Alaska's volumes do not reflect bycatch or unsold salmon. Norway's volume includes their second most important available byproduct fraction of dead/diseased fish, which are not allowed for human consumption. Alaska utilizes an estimated 65% of their available byproducts and Norway utilizes 90%; however, the volume utilized represents only 1/3 of the estimated potential byproducts.

Alaska and (North) Norway are operating as production-oriented regions for primary products and not secondary products and missing out on the complete value chain. Focusing on harvesting and production, instead of the complete value chain from harvest to consumer, has been economical for both Alaska and (North) Norway. However, this production-oriented mind-set does not satisfy the so-called triple bottom line growth, which entails taking consideration of both profit, people and the planet.

Being production-oriented yields to a limited volume of available byproducts. In today's fish value chain, production oriented refers to harvest, the first processing form, and post-harvest handling. In Alaska, the fisherman catches the fish and sells it to a processor, and byproducts associated with this can be discarded fish, undervalued wastewater from slaughtering/cleaning the fish, and in the worst

scenario unsold fish that becomes perishable. The first processing form is the wholesale product, which is gutted and the primary export product of Alaska (head-off) and Norway (head-on). Thus, with a focus mainly on harvest and a wholesale that required further processing, byproducts volumes are not optimized, and neither are the value-added potential that lies within them.

For Norway, its near 100% utilization of its farmed salmon is not as impressive when looking at the potential volume of byproducts. Averaging 2013-2016 processing volumes, the edible farmed fish sent for export represented 81% of the total harvest volume, signifying a large portion is being sent for further processing abroad. Unimpressively, Norway utilizes only 36% of the total byproducts, where the dead/diseased fish represent half of the byproducts.

COST OF PRODUCTION

The cost of production in Alaska is higher than in other countries or the continental U.S. due to the operating costs associated with labor, energy, and the remote nature of Alaska ports.[244] In Norway, labor costs were attributed as a major cost. When the processing lines are not automated, fish processing jobs require intense, manual labor and demanding schedules with uneven harvest supplies. For Alaska, local processing has been deemed not manageable with the limited space, time, and employees associated to the harvest seasons. For Norway, the current system is already profitable and there has been little environmental and social incentives to increase local processing.[245]

The limitations of growth in the current and future levels of local processing and utilization vary between Alaska and (North) Norway. Alaska struggles with high rural energy costs; disjointed entities between the fishermen, tenders, and processors; lack of qualified workforce; lack of environmental regulations to promote less discharge; unstable funding to educate, certify the workforce; and lack of coordination within the state's industry. (North) Norway struggles with lack of incentives with the super-profit making it lucrative business for farm permit holders; difficulties in increasing harvest due to salmon diseases, high labor costs, which are twice that of Alaska production employees; and the higher tariff on processed seafood to their main market of the EU.

[244] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, p. 93. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

[245] A perception survey was carried out Merrick Hartness Mordal in 2018, which included 56 stakeholders from the following fisheries: 7 Alaskan white fish, 13 Alaskan wild salmon, 7 Norwegian farmed salmon, 15 Alaskan fisheries and 10 Norwegian fisheries. The last two categories reflected stakeholders that worked with all fisheries from the entire state/country.

UTILIZATION OF BYPRODUCTS AND THE CIRCULAR BLUE ECONOMY

More coordination, collaboration and adaptation are necessary to transition to circular economy business models. Operating in economy of scope, one receives stable production because one is focused on the full utilization of the harvest. As long as the harvest is available, there is a secure resource of products to create several processing lines. The stable production in marine capture with its natural cycles means to guarantee products to consumer markets and thus, secondary products play a crucial role, and undervalued and unsold fish are not existent. As seen with Norway's farmed fish, the large and stable volume has led to the growing internal industry of processing fresh fish byproducts for extraction of fresh salmon oil and protein hydrolysate. Both Alaska and (North) Norway have the benefit of having the harvests, so secondary products can be processed fresh. Norwegian fresh products are now of similar volume as the traditional fish meal and oil, which is around 140.000 tons, making up around 20%.[246] Processing fresh materials requires large capital investment for facility and logistics for instantaneous processing after slaughter, but produces higher value products.[247] This can be done by altering the production line or in the case of a seasonal fishery, innovative ideas such as the Norwegian cod hotels that are currently not perceived as a success.[248]

Seeing that Alaska and North Norway should focus on different markets due to their geographic locations; they can collaborate on coproduct/byproduct ideas that diversify their products and increases their utilization. The versatility of fish products creates also a versatile consumer market. What one county or culture considers waste; another considers a delicacy. In general, diversifying products to full utilization represents cascading production when done in harmony with local environment and thus shows environmental stewardship. In terms of sustainable harvesting, Alaska and North Norway can be seen that it is a must to close some of the production loops. Both fishing states realize and are working hard to prevent not overfeeding the sea with nutrients in the form of byproduct discharge. The valorization of abundant and available biowastes with high potential to manufacture value-added products is the first step to close the loop between waste and consumption in line with the main goal of the circular economy.[249]

[246] Richardsen, R., Nystøyl, R., Strandheim, G. & Marthinussen, A. (2017). Analyse marint restråstoff, 2016, p. 3. Retrieved 10 November 2020 from https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/2446152/Analyse%2bmarint%2brestr%25C3%25A5stoff%2b%2b2016%2bsluttrapport%2bsignert.pdf?sequence=2&isAllowed=y

[247] PwC (2018). Økt foredling av sjømat og restråstoff i Norge – en analyse av muligheter, barrierer og lønnsomhet. Retrieved 10 November 2020 from https://www.innovasjonnorge.no/globalassets/0-ryddemappe--arkiv/converted-pages-shared-root/502443/sluttrapport---okt-foredling-av-sjomat-og-restrastoff-i-norge.pdf

[248] Norway Exports (2014). Building cod hotels along the coast. 12 September 2014. Retrieved 1 January 2019 from https://www.norwayexports.no/news/building-cod-hotels-along-the-coast/

[249] de la Caba, K., Guerrero, P., Trung, T. S., Cruz-Romero, M., Kerry, J. P., Fluhr, J., ... Newton, R. (2019). From seafood waste to active seafood packaging: An emerging opportunity of the circular economy. Journal of Cleaner Production, 208, pp. 86–98.

Alaska Pollock fish meal/oil production is an example of how Alaskan/Norwegian partnerships to reduce rural energy costs will create symbiotic effects. The byproducts of Pollock represent the bulk of Alaska's fish meal/oil production with 81% of meal and 95% of oil by volume in 2015. Due to the high rural energy costs, approximately 75% of fish oil produced in Alaska is blended with diesel fuel and burned in diesel generators powering shore-side plants and large fishing/processing vessels, thus not sold.[250] This type of utilization is not going towards human consumption and thus not working towards the vision of using byproducts towards coproducts when possible. However, the energy costs are of a serious issue and burning the fish oil has an important function to allow for the local processing. Innovation that allows for lowering rural energy costs will in turn free up this byproduct resource.

While Alaska and (North) Norway move towards automating their processing lines, there will be an increased number of technical skills needed for the workforce. Collaboration in terms of certification schemes to ensure skilled workers is of great importance for social sustainability. Having a successful marketing scheme that focuses on the full value chain is essential for transitioning from production to market-oriented. Alaska includes full utilization in its marketing schemes, while Norway focuses more on the sustainability harvesting.

Community Support and Local Engagement

Social development in the Arctic is characterized by generally growing, often highly innovative Arctic cities, and thinning-out rural areas that face demographic and resource challenges. However, both regions have maintained management models and practices in order to promote local socioeconomic growth, that can be worth exchanging. Alaska's community-based fisheries, such as the Tamgas Creek Hatchery, and initiatives such as the CDQ or the Local Fish Fund program of the Alaska Sustainable Fisheries Trust, aiming to protect and support local fishing businesses and revitalize fishing communities, could inspire similar approaches in (North) Norway. On the other hand, the established management regime of the red king crab in Finnmark could serve as an example for the maintenance of a small-scale fishery for the benefit of the local communities while preventing ecological impacts on the native ecosystem, with reported increased appeal and value of the end-product.

[250] McDowell Group (2017). Analyses of Specialty Alaska Seafood Products (Prepared for: Alaska Seafood Marketing Institute), November 2017, pp. 19-22. Retrieved 28 August 2019 from https://www.alaskaseafood.org/wp-content/uploads/2017/11/ASMI-Specialty-Products-Analysis-Final.pdf

The seafood industry in both Alaska and North Norway needs to reduce operating costs to compete in the global market. But a difficult tension arises between this need and the need to preserve economic benefits for local communities. While a company might benefit from reducing labor costs, those labor costs are an individual's income. A reduction in energy consumption can increase profitability, but it may reduce tax revenue.

Both Alaska and North Norway should consider ways to moderate the disruptive elements of technological changes while preserving its benefits. This is an opportunity for leaders to articulate a clear message about the benefits and challenges associated with technological change. Support of retraining programs can allow individuals to shift towards sectors that are growing. Availability of capital can allow companies to reorient in a changing economy. And local communities should actively plan for changes which are anticipated to avoid surprise.

Monitoring, Innovation and Technology

Alaska's mariculture industry (specifically shellfish) is being threatened by HABs, their associated toxins, and the cost of testing their products for harmful compounds. Yet, Alaska has developed different methods for successfully monitoring HABs, including a citizen science program that tracks toxins found in harvestable shellfish. Norway has felt the consequences of HABs through the salmon industry. Salmon farming could distill insights about better monitoring HABs by looking at Alaskan best practices.

Research Collaboration

Research partnerships have contributed significantly to academic and scientific progress related to fisheries and should dominate both states' scientific agendas for the near future. Further collaboration between academic organizations focusing on fisheries research such as the University of Fairbanks, UiT The Arctic University of Norway, or the High North Research Centre for Climate and the Environment (Fram Centre) should be fostered, stimulating new interdisciplinary fields, and increasing opportunities for meaningful impact on policy making, as well as finding solutions to common challenges.