IASS STUDY

Institute for Advanced Sustainability Studies (IASS)

Marine Conservation in Greenland

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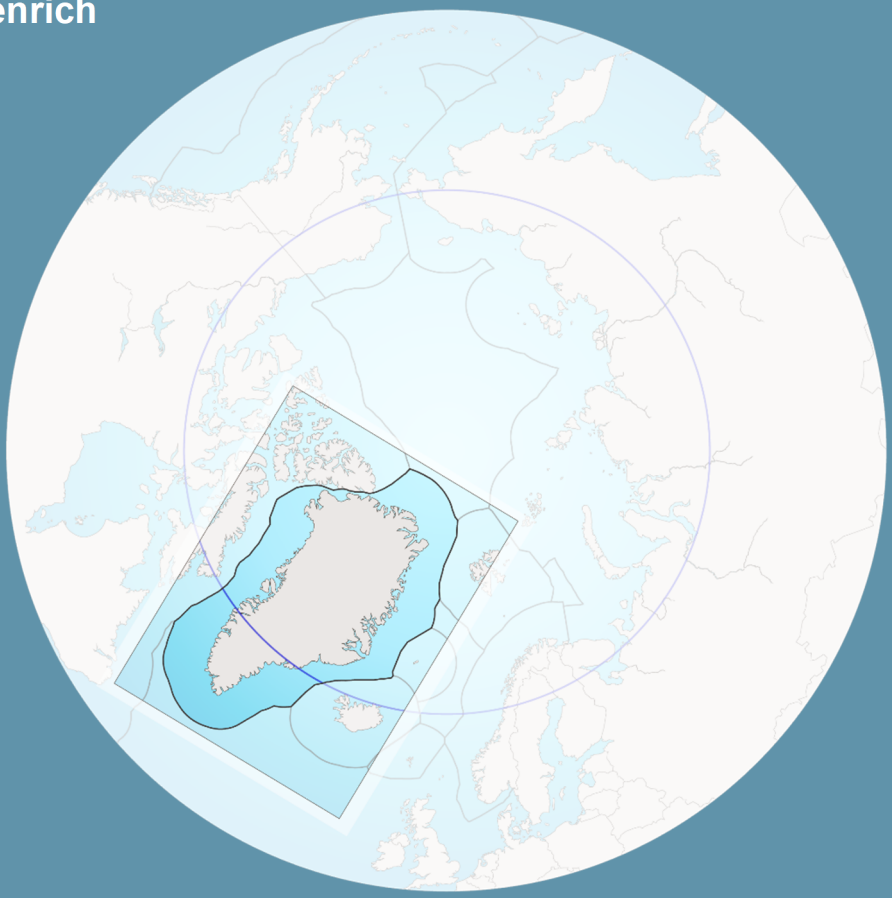
Nicole Wienrich



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Cover Graphic

The exclusive economic zone of Greenland (highlighted) and other coastal states on the map of the Arctic region. The blue line indicates the Arctic circle. IASS visualisation based on Flanders Marine Institute (2019), GRID-Arendal (2019).

Author

Nicole Wienrich, Institute for Advanced Sustainability Studies (IASS)

Data Collection and Analysis

Nicole Wienrich (IASS), Olga Lukyanova (IASS)

Visualisations

Olga Lukyanova (IASS)

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Note on Covid-19

This report was mainly prepared and written in 2020 and 2021 when the Covid-19 pandemic was spreading across the world, also affecting Arctic communities and economies.

Covid-19 affected the Arctic blue economy in several ways. The pandemic initially limited shipping, and with it imports of fuel, food, and equipment as well as exports of oil, natural gas, minerals, and fish (Arctic Council, 2020). After this initial phase, the cargo transportation corridors continued operations and shipments through the Northern Sea Route actually saw an increase of 2.9% in the first 10 months of 2020 compared to the same period in 2019 (Staalesen, 2020a). However, tourist vessels and especially cruise ships were mainly absent from Arctic waters in 2020, and it is expected to take several years for the tourism and gastronomic industries in the Arctic to return to 2019 levels (Arctic Council, 2020). In a similar manner, most marine research expeditions were either cancelled or reduced in 2020. While remote data collection could continue, pandemic-related cancellations of polar research expeditions have interfered with research typically being carried out during the summer Arctic surveys (Alaska Fisheries Science, 2020).

In the fisheries sector, labour shortages as well as Covid-19-related safety measures on board fishing vessels created new challenges and costs. At the same time, the role of hunting and fishing activities has increased in some areas and engagement in subsistence expanded because of the pandemic (Arctic Council, 2020). Finally, the downturn in oil prices led to a reduction of oil and natural gas production in the Arctic. In Norway for example, the government decided to lower Norwegian oil production through June to December 2020 (Norwegian Ministry of Petroleum and Energy, 2020).

While some of the impacts can now be detected, much uncertainty remains regarding how extensive the economic downturn due to Covid-19 will be and how fast the different sectors will recover. What is becoming clear already is that the decreases in vessel traffic led to a significant decrease in shipping noise during the first half of 2020. In addition, pandemic-related safety concerns and economic slowdowns also decreased a multitude of other activities that generate ocean noise and other impacts, including fishing, aquaculture, seismic exploration, oil drilling, military exercises, offshore construction, and dredging activity for at least some portion of the pandemic (Carr, 2021).

Zusammenfassung

Die Arktis erwärmt sich substanziell schneller als der globale Durchschnitt. Der rasche Temperaturanstieg verändert die Arktis bereits tiefgreifend - und wird dies auch weiterhin tun - mit noch unbekannten Folgen für die Region und die ganze Welt. Gleichzeitig mit dem Rückgang des Meereises und der sich verändernden Verteilung der lebenden Meeresressourcen hat eine Zunahme des wirtschaftlichen Interesses an der Region zu Bedenken hinsichtlich der Nachhaltigkeit der wirtschaftlichen Aktivitäten in der Arktis geführt.

Um Wege zu finden, wie der Schutz und die nachhaltige Nutzung der arktischen Meeresumwelt gewährleistet werden können, ist ein umfassendes Verständnis der Meeresumwelt, der sie beeinflussenden Belastungen und der relevanten Regulierungen und Managementmaßnahmen erforderlich. Das Ecologic Institut und das Institute for Advanced Sustainability Studies haben sich zum Ziel gesetzt, durch eine Reihe von Berichten zum Meeresschutz in der Arktis einen Überblick über die relevanten Informationen zu geben. Die Berichte konzentrieren sich auf die fünf arktischen Anrainerstaaten: Kanada, Dänemark (durch Grönland), Norwegen, die Russische Föderation und die Vereinigten Staaten. Darüber hinaus gibt ein regionaler Bericht einen umfassenden Überblick und fasst die einschlägigen internationalen und regionalen Vorschriften zusammen.

Der vorliegende Bericht behandelt die für den Meeresschutz in Grönland relevanten Informationen. Der Bericht deckt vier Hauptthemen ab: Er beginnt mit der Beschreibung der wichtigsten Merkmale der grönländischen Meeresumwelt. Anschließend werden wesentlichen Belastungen untersucht, die sich auf die marine Biodiversität in der Region auswirken, gefolgt von einer Untersuchung der soziokulturellen und wirtschaftlichen Rolle sowie der Umweltauswirkungen der wichtigsten meeresbezogenen menschlichen Aktivitäten in Grönland. Der letzte Teil des Berichts gibt einen Überblick über die relevanten nationalen Institutionen sowie über Regulierungen, Vorschriften und Instrumente, die zum Schutz der grönländischen Meeresbiodiversität und zur Gewährleistung ihrer nachhaltigen Nutzung eingesetzt werden oder eingesetzt werden könnten.

Hinweis: Die in diesem Bericht präsentierten Informationen wurden hauptsächlich während der weltweiten Covid-19-Pandemie und vor dem russischen Einmarsch in die Ukraine im Jahr 2022 zusammengetragen. Die (weiteren) politischen und wirtschaftlichen Auswirkungen dieser Ereignisse und die sich daraus ergebenden Veränderungen in der Arktis-Governance sind zum jetzigen Zeitpunkt nicht absehbar, und es ist zu erwarten, dass sich einige der in diesem Bericht dargestellten Entwicklungen und Trends erheblich ändern werden.

Die Kernbotschaften des Berichts finden sich unter der folgenden englischen Zusammenfassung.

Summary

The Arctic is warming three times faster than the global average. These rapidly increasing temperatures are already profoundly changing the Arctic – and will continue to do so – with yet unknown consequences for the region as well as worldwide. The diminishing sea ice extent and the changing distribution of marine living resources have led to an increase in economic interest in the region as well as concerns about the sustainability of economic activities in the Arctic.

In order to identify ways in which conservation and sustainable use of the Arctic marine environment can be ensured, a broad understanding of the marine environment, the pressures affecting it, and the relevant regulations is needed. Ecologic Institute and the Institute for Advanced Sustainability Studies aim to provide an overview of relevant information through a series of reports on marine conservation in the Arctic. The reports focus on the five Arctic coastal states: Canada, Denmark (by virtue of Greenland), Norway, the Russian Federation, and the United States. In addition, a regional report is providing a broader overview and summarises relevant international and regional regulations.

This current report presents an overview of information relevant to marine conservation in Greenland. The report covers four main issues: it starts with the description of the key characteristics of the Greenlandic marine environment. Then it examines significant pressures impacting marine biodiversity in the region, followed by exploring the socio-cultural and economic role as well as the environmental impact of the main sea-based human activities in Greenland. The last part of the report describes the Greenlandic ocean governance system and provides an overview of relevant national institutions as well as rules, regulations and tools which are, or could be, employed to protect the Greenlandic marine biodiversity and ensure its sustainable use.

NB: The information presented in this report was mainly collated during the global Covid-19 pandemic and prior to the 2022 Russian invasion of Ukraine. The (further) political and economic impacts of these events and resulting changes in Arctic governance cannot be foreseen at this point in time and it can be expected that some of the developments and trends presented in this report may change substantially.

The following key messages are derived from the assessment:

The Greenlandic Marine Environment

- The Greenlandic marine areas offer a variety of habitats for marine flora and fauna, ranging from ridges to shallow fjords and deep-sea plains, with depths of more than 4,000 metres.
- Ocean currents, seasonal ice cover, and stark fluctuations in temperature and light strongly affect the marine environment in Greenland.
- The melting of sea ice in spring and summer is typically accompanied by a sudden increase in light and plant growth in the ocean. This ‘ice edge bloom’ supports large populations of fish, marine mammals and birds.
- High primary productivity can furthermore be observed in areas of open seawater surrounded by ice, so-called ‘polynyas’.

- The North Water Polynya (Pikialasorsuaq) between Greenland and Canada is the largest polynya in the Arctic and belongs to the most productive marine environments in the Arctic Ocean.
- The diversity and abundance of fish species is highest in Greenlandic waters in the south-west and the south-east, and greater in the west as compared to east.
- Polar cod, Atlantic herring, capelin, Greenland halibut, and Atlantic halibut are both ecologically and economically important pelagic fish species in Greenlandic waters.
- Northern shrimp and snow crab are common shellfish in Greenlandic waters.
- It is expected that certain species' reproduction and survival capacities will decline in the future due to the decline of sea ice, while the conditions for species that are currently limited in their distribution by the cold water off Greenland are expected to improve.
- The Greenlandic marine areas provide important habitats and foraging areas for an estimated 28 species of marine mammals.
- Narwhals and polar bears are believed to be the marine mammals most affected by climate change impacts, followed by hooded seals, bowhead whales, and white whales.
- Greenland provides many important areas for seabirds along its coast as well as offshore, including areas for large breeding colonies.
- Many seabird populations have experienced a strong decline in the past years.
- A highly diverse benthic macrofauna exists in the northeast and northwest of Greenland. In South Greenland, the composition of benthic communities remains largely unknown.

Climate Change and Pollution: Key Pressures Affecting the Norwegian Arctic Marine Environment

- The Greenlandic marine environment is strongly influenced by climate change.
- Especially changes in sea ice cover have a significant impact on ecosystems and wildlife dependent on the ice.
- The levels of certain heavy metals and persistent organic pollutants are high in the Greenlandic marine environment, primarily as a result of long-range transboundary pollution.
- Several of the heavy metals and persistent organic pollutants bio-accumulate and bio-magnify along the food chain, potentially leading to negative health impacts and impairments of biota at the top of the food chain, such as whales, seals and polar bears.
- Marine litter in the Greenlandic marine environment is mainly of local origin and poses another threat to marine life.

Sea-based Human Activities in Greenland

- Greenland is overwhelmingly an Inuit society and its socio-economic activities have traditionally been and continue to be very sea-oriented.
- The fisheries industry is the primary industry in Greenland. Northern prawn and Greenland halibut have traditionally been the main target species for offshore fisheries.
- Fishing and hunting of marine mammals and seabirds are important subsistence activities and essential for Inuit culture and identity.
- Shipping is vital for transportation of goods and people in Greenland.
- In comparison to European coastal areas, Greenlandic waters are characterised by a low traffic density.
- Shipping and cruise tourism activities have increased until 2019, partly due to decreasing sea ice coverage.
- Changes in sea ice extent are expected to make additional areas of the Greenlandic waters accessible to socio-economic activities in the future.

- There was political interest in the development of an offshore oil and gas industry, however no commercially viable deposits of oil have been found to date and exploration activities declined both offshore and onshore.
- In 2021, the Greenlandic government decided to stop the issuing of licences for new oil and gas exploration in Greenland.
- Attempts to establish aquaculture projects in Greenland have not been successful to date.

Governance of the Greenlandic Marine Environment

- The responsibility for conserving Greenland's marine environment is shared between Greenland and Denmark, with Greenland being in charge of the area up to three nautical miles from the coastline and Denmark being responsible for the area from three nautical miles until the outer limits of Greenland's exclusive economic zone.
- The Ministry of Environment and Nature (now Ministry for Agriculture, Self-Supply, Energy and Environment) has the overall responsibility for nature conservation in Greenland.
- The Ministry of Fisheries, Hunting and Agriculture (now Ministry of Fisheries and Hunting) is in charge of the management of shellfish, fish, mammals and birds.
- The Greenland Institute of Natural Resources and Århus University have key roles with regards to biodiversity monitoring as well as the development of indicators and assessments.
- In the past years, much work has been undertaken in Greenland to identify important marine species habitats, migratory pathways, and the population sizes of sensitive species, as well as marine areas and coastlines vulnerable to oil spills.
- Several conservation measures are employed by the Greenlandic government to protect marine species and ecosystems. In addition to designated marine protected areas, areas have been designated as seabird breeding sanctuaries and Wetlands of International Importance under the Ramsar Convention.

Contents

List of Abbreviations

AECO	Arctic Expedition Cruise Operators
CAFF	Conservation of Arctic Flora and Fauna (Arctic Council Working Group)
EEA	European Economic Area
EU	European Union
GFLK	Greenland Fisheries and License Control
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JCNB	Canada-Greenland Joint Commission on the Conservation and Management of Narwhal and Belug
MARPOL	International Convention for the Prevention of Pollution from Ships
MPA	Marine Protected Area
NAMMCO	North Atlantic Marine Mammal Commission
NASCO	North Atlantic Salmon Conservation Organization
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic
Polar Code	International Code for Ships Operating in Polar Waters
SOLAS	International Convention for the Safety of Life at Sea
TAC	Total Allowable Catch

1 Introduction

Global interest and activity in the Arctic have increased greatly in recent decades. The Arctic is warming three times faster than the global average. These rapidly increasing temperatures are already profoundly changing – and will continue to change – the Arctic with yet unknown consequences for the people, environment, and economy in the region as well as worldwide (SDWG, 2021).

The diminishing sea ice extent and the changing distribution of marine living resources have led to an increase in economic interest in the region as well as concerns about the sustainability of economic activities in the Arctic (Raspotnik et al., 2021). The challenge now is to identify development pathways that can ensure the sustainable use and conservation of the Arctic marine environment (SDWG, 2021).

In order to identify ways in which conservation and sustainable use of the Arctic marine environment can be ensured, a broad understanding of the marine environment, the pressures affecting it, and the relevant regulations is needed.

Ecologic Institute and the Institute for Advanced Sustainability Studies aim to provide an overview of relevant information through a series of reports on marine conservation in the Arctic. The reports focus on the five Arctic coastal states: Canada, Denmark (by virtue of Greenland), Norway, the Russian Federation, and the United States. In addition, a regional report is providing a broader overview and summarises relevant international and regional regulations. The reports were published in 2022 and are available for download on the websites of the Ecologic Institute and the Institute for Advanced Sustainability Studies.

This current report presents an overview of information relevant to marine conservation in Greenland. Greenland (Kalaallit Nunaat) is a self-governing country within the Kingdom of Denmark and shares certain legal rights and responsibilities related to the sustainable use and conservation of the Greenlandic marine environment with Denmark (Government of Greenland, 2020a; Statistics Greenland, 2020). Prior to the adoption of the Self-Government Act in 2009, Greenland was governed under the Home Rule Act (1979).

More than two thirds of the waters surrounding Greenland lie above the polar circle, including parts of the Greenland Sea and Baffin Bay (Avannaata Imaa) (Figure 1). As it is challenging to access, compile and summarise data specifically for this area, this report presents data for all of Greenland and its surrounding waters.

The report covers four main issues: it starts with the description of the key characteristics of the Greenlandic marine environment. Then it examines significant pressures impacting marine biodiversity in the region, followed by exploring the socio-cultural and economic role as well as the environmental impact of the main sea-based human activities in Greenland. The last part of the report describes the Greenlandic ocean governance system and provides an overview of relevant national institutions as well as rules, regulations and tools which are, or could be, employed to protect the Greenlandic marine biodiversity and ensure its sustainable use. An overview of relevant international and regional agreements and frameworks is provided in the regional report that forms part of this series of reports.

The content of this report is entirely based on publicly available data, articles, and reports. substantially. The information presented in this report was mainly collated during the global Covid-19 pandemic and prior to the 2022 Russian invasion of Ukraine. The (further) political and economic impacts of these events and resulting changes in Arctic governance cannot be foreseen at this point in time and it can be expected that some of the developments and trends presented in this report may change substantially.

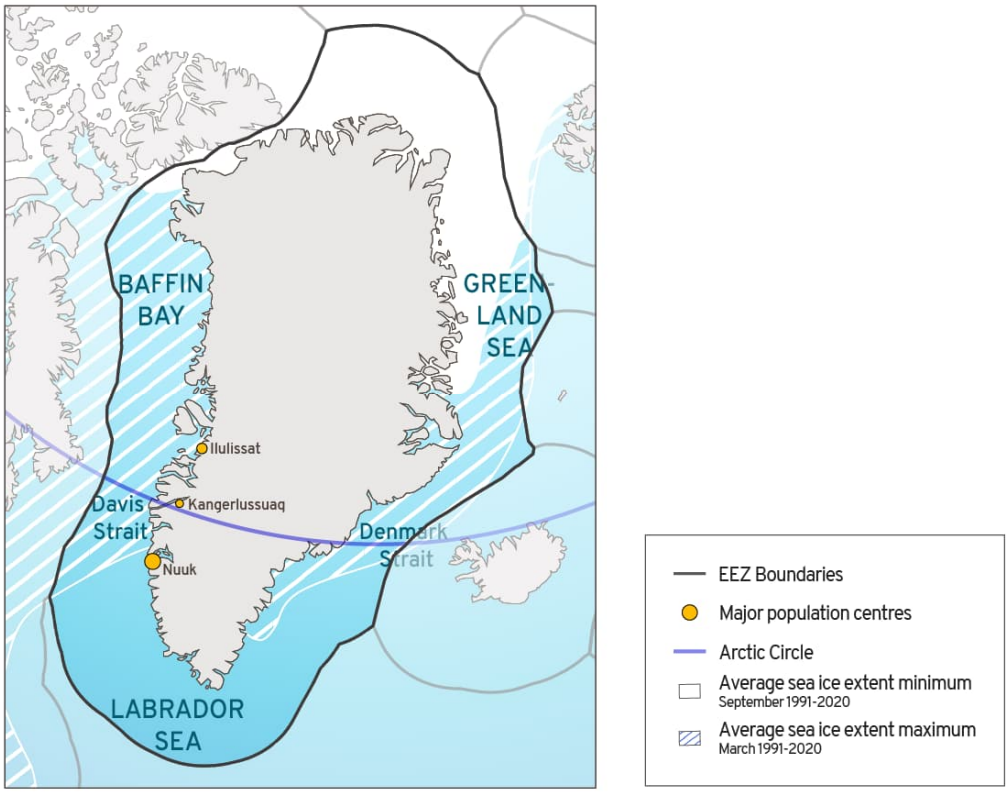

Figure 1: The exclusive economic zone of Greenland. The blue line indicates the polar circle. IASS visualisation based on Flanders Marine Institute (2019), GRID-Arendal (2019).

2 The Greenlandic Marine Environment

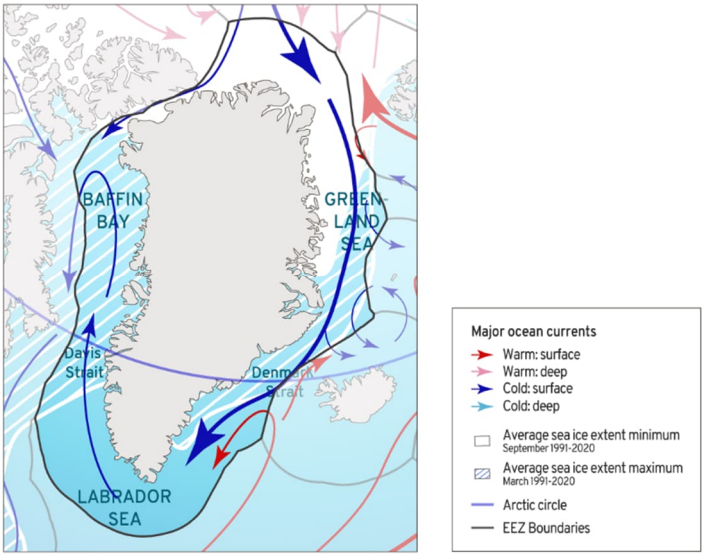

Figure 2: Main oceanic currents and Arctic Sea ice extent with a focus on the Greenlandic exclusive economic zone. IASS visualisation based on: Copernicus Climate Change Service/ECMWF (2021a, 2021b), Flanders Marine Institute (2019), GEBCO Compilation Group (2021), GRID-Arendal (2019), Hunt et al. (2016).

Greenland is the largest island in the world. Its rocky coastline is about 40,000 kilometres long and features numerous large and small islands and fjords (Government of Greenland, 2010).

The Greenlandic marine areas offer a variety of habitats for marine flora and fauna, ranging from ridges to shallow fjords and deep-sea plains, with depths of more than 4,000 metres. The northern Baffin Bay (*Avannaata Imaa*) and the Greenland Sea are separated from the warmer, southern Labrador and Irminger Seas by rather shallow submarine sills in the Davis Strait and the Denmark Strait (*Ikerasak*) (600–800 metres deep) (Moller et al., 2010).

The bodies of water surrounding Greenland are characterised by different levels of salinity and temperatures. The East Greenland Current conveys cold, low salinity surface water and polar pack ice from the north southward along the east coast of Greenland. South of the Denmark Strait (*Ikerasak*), a branch of the warmer, more saline North Atlantic Current (the Irminger Current) turns to Greenland and continues to flow parallel to the East Greenland Current around Cape Farewell (*Nunap Isua*) and further north-westwards along the coast of Greenland. The balance between the cold East Greenland Current and the warmer Irminger Current strongly affects the conditions in the waters off southwest

Greenland, as the mixing of both currents influences the West Greenland Current. The currents affect the distribution of marine species in Greenlandic waters and partly determine which species of fish and marine mammals can be found in Greenlandic waters (Frederiksen et al., 2012; Figure 2).

Apart from the currents, the marine environment surrounding Greenland is strongly influenced by seasonal ice cover and stark fluctuations in temperature and light. The melting of sea ice in spring and summer is typically accompanied by a sudden increase in light and plant growth in the ocean. This 'ice edge bloom' supports large populations of fish, marine mammals and birds (Government of Greenland, 2010).

High primary productivity can also be observed in areas of open seawater surrounded by ice, so-called 'polynyas' (Figure 3). In winter, large polynyas provide important habitats for many seabirds and ice-associated marine mammals, including polar bears, narwhals, beluga whales, seals, and walruses. In spring, these areas support widespread phytoplankton blooms, which in turn form the basis of biological productivity needed for migrating birds and marine mammals. The North Water Polynya (*Pikialsorsuaq*), located between Greenland and Canada in the northern Baffin Bay (*Avannaata Imaa*), is the largest polynya in the Arctic and belongs to the most productive marine environments in the Arctic Ocean (Speer et al., 2017). Another large polynya in Greenlandic waters is the Northeast Water Polynya off the northeastern coast of Greenland.

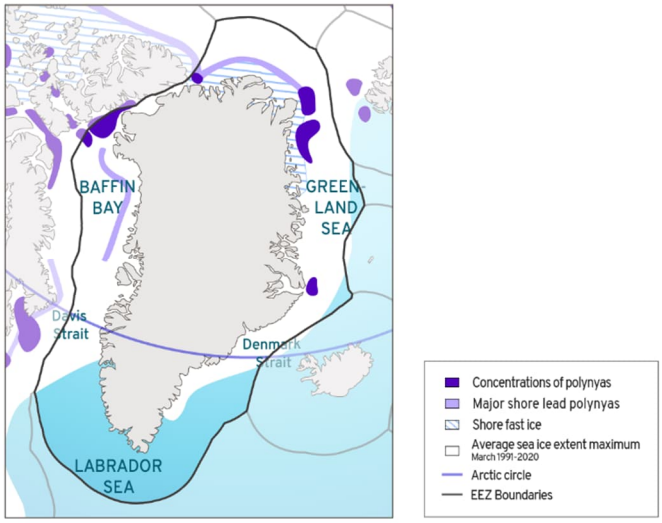

Figure 3: Known polynyas and ice conditions around Greenland. IASS visualisation based on: Copernicus Climate Change Service/ECMWF (2021b), Flanders Marine Institute (2019), GRID-Arendal (2019), Meltofte (2013).

Other areas of high primary productivity can be found along the coast and in areas where upwellings or hydrographic fronts transport nutrient-rich water to the surface, for instance alongside the shelf break and where currents meet (Frederiksen et al., 2012).

Fish Species

The number of fish species identified in the marine waters of Greenland increased markedly in the past years as a result of increased fishing and survey efforts as well as the immigration of several warm water species into the south Greenlandic waters. Areas deeper than 1,500 metres remain mostly unstudied and it is expected that more species will be discovered there in the future (Moller et al., 2010). The diversity and abundance of fish species is highest in Greenlandic waters in the south-west and the south-east, and greater in the west than the east (Boertmann et al., 2020). These differences are most likely due to higher water temperatures as well as northward flowing sea currents along the west coast of Greenland. In addition, the ridges between Canada and Greenland and Greenland and Iceland act as barriers, which prevent especially deep water species from crossing further north (Moller et al., 2010).

Polar cod, Atlantic herring, capelin, Greenland halibut, and Atlantic halibut are both ecologically and economically important pelagic fish species which can mainly be found in the waters off west Greenland (PAME, 2012). Polar cod abundance is highest on the shelf break and ice cover is essential for the spawning of polar cod as their eggs accumulate under the ice (Boertmann et al., 2020). Capelin spawns in the shallow water along numerous coastal areas of Greenland, with the main areas located in waters in the southeast and along the northern coast (Aastrup et al., 2016). The main spawning ground of Greenland halibut is located in the Davis Strait off Nuuk. It is assumed that currents carry the eggs and larvae further north along the west coast of Greenland to nursery areas in Baffin Bay (*Avannaata Imaa*) and that the Greenland halibut gradually migrate back to their spawning areas as they mature (Boertmann & Mosbech, 2017).

Arctic char is another common species in Greenland and can be found in many areas, including the most northern areas. Some populations of Arctic char reside entirely in lakes and rivers, while anadromous populations migrate to the sea during summer to feed, remaining mainly in the coastal waters around the river they derived from (Boertmann et al., 2020). Northern shrimp and snow crab are common shellfish in Greenlandic waters. They are widely distributed in the south of Greenland (Frederiksen et al., 2012). Other important fish species in Greenland include lumpsuckers, sand eels, roundnose grenadier, Greenland sharks, Atlantic cods and redfish (Frederiksen et al., 2012; PAME, 2012).

Generally speaking, most fish populations in Greenlandic waters are in good condition. One exception is the Greenland halibut stock in the Disko Bay (*Qeqertarsuup Tunua*) area, which has shown signs of overfishing. In addition, cases of overfishing of Atlantic cod and northern prawn were documented in the past (Government of Greenland, 2020a; FAO, 2022a; Booth & Knip, 2014). Also, it is expected that certain species' reproduction and survival capacities will decline in the future due to climate change impacts (Boertmann et al., 2020).

On the other hand, a rise in sea temperature as a consequence of climate change may lead to the immigration of new fish species to Greenland (FAO, 2022a). Since slope habitat corridors connect the south of Greenland with the Atlantic, much of the Atlantic fish fauna could theoretically move to Greenlandic waters as a result of climate change induced warming (Moller et al., 2010).

Marine Mammals

According to the International Union for Conservation of Nature (IUCN) Red List, 27 species of marine mammals exist in Greenlandic waters, 14 of which are present in the Arctic Sea area of the Greenlandic waters. Eight of the marine mammals present in Greenlandic waters are globally recognised as

vulnerable, endangered, or critically endangered[1] (IUCN 2022, Annex 1, Table 3).

Important areas for sea mammals exist in many areas of the Greenlandic waters (Figure 4). Harped seals and hooded seals, for example, have whelping areas on the drift ice off Greenland and scatter throughout the north Atlantic after the whelping season (Boertmann et al., 2020). Walrus colonies are related to the moving pack ice along the Greenlandic coast (PAME, 2012). The Northeast Water Polynya provides an especially important habitat for them and most calves of the northeast Greenland stock are born and raised in the area (AMAP/CAFF/SDWG, 2013). When the ice melts in summer and fall, the walrus haul out onto low, rocky shores with easy access to the water (PAME, 2012). Ringed seals and polar bears can be found in the Greenland Sea area year round (Boertmann et al., 2020). They utilise both the coast and offshore ice-covered areas, including the Northeast Water Polynya where denning areas of polar bears were identified (AMAP/CAFF/SDWG, 2013).

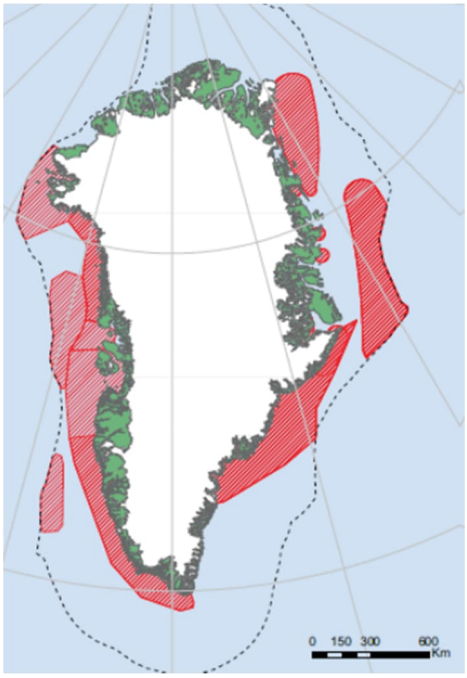

Figure 4: Important areas for sea mammals. Source: Christensen et al. (2012).

Greenlandic waters also provide important habitats for narwhals, killer whales, beluga whales and bowhead whales. Narwhals occur along the west coast of Greenland all through the year and have important summer habitats in Dove Bay and Jokel Bay on the east coast (Boertmann et al., 2020). They typically winter in areas of heavy pack ice along the southern Baffin Bay (*Avannaata Imaa*) and the northern Davis Strait. Beluga whales are known to winter in the rather loose pack ice south of Disko Island (*Qeqertarsuaq*) and have distributed wider as a result of the decline in sea ice. Bowhead whales can be encountered in the Baffin Bay (*Avannaata Imaa*) and Davis Strait region as well as in the Greenland Sea (PAME, 2012).

In spring and summer, migratory humpback whales, minke whales, fin whales, sperm whales and other toothed whales come from further south to feed in the productive waters above the shelf break to the south and east of Greenland (Boertmann et al., 2020). In a similar manner, Atlantic right whales feed

[1] The IUCN Red List threat category relates to the species as a whole, not necessarily to the population(s) in Greenland.

in the waters off southern Greenland in summer (AMAP/CAFF/SDWG, 2013).

Several of the marine mammals present in Greenlandic waters are affected by climate change impacts. This concerns especially ice-dependent species such as polar bears, narwhals, beluga whales, walruses and some species of seals (see chapter on climate change for more information) (Government of Greenland, 2010; PAME, 2012.). Apart from climate change impacts, harvesting levels may pose a threat to marine mammals The walrus population, for instance, decreased strongly due to industrial-scale hunting by commercial European and North American hunters, and to a much smaller extent, Indigenous communities, from the sixteenth to the twentieth century (Keighley et al., 2019). The harvesting of polar bear populations in the Baffin Bay (*Avannaata Imaa*) and Kane Basin shared by Canada and Greenland was deemed to be non-sustainable in the early 2000s (Government of Greenland, 2010; PAME, 2012.).

Atlantic right whales are also considered to be at risk due to their low numbers and their slow swimming, which makes them especially vulnerable to ship strikes (Annex 1; AMAP/CAFF/SDWG, 2013).

Seabirds

Greenland provides many important areas for seabirds along its coast as well as offshore (Figure 5). Most of the seabird colonies are bound to the sea and feed on crustaceans and small fish like capelin (Government of Greenland, 2010). Each year during summer, many seabird colonies gather in the Greenland Sea. Large breeding colonies of little auks, thick-billed murres, northeastern fulmars, ivory gulls, kittiwakes, and common eiders are found particularly around Scoresby Sound (*Kangertittivaq*), the Northeast Water Polynya and the Sirius Water Polynya (Boertmann et al., 2020).

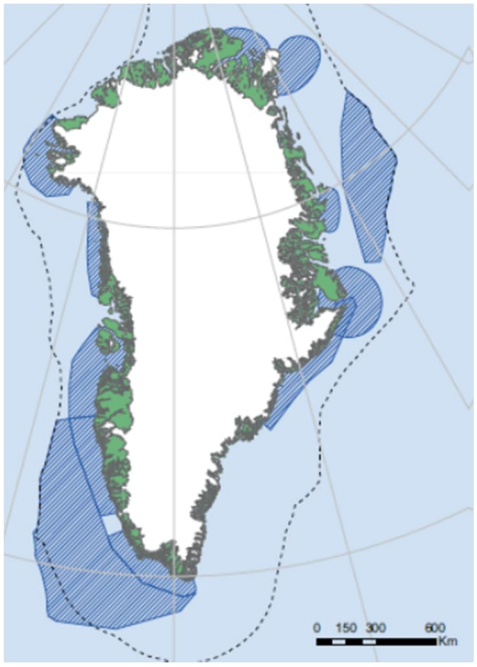

Figure 5. Important areas for seabirds. Source: Christensen et al. (2012).

In the south of Greenland, important populations of common murre and razorbill can be found around the island Outer Kitsissut. In addition, the coastal areas are significant for moulting harlequin ducks and as wintering areas of common eiders. The offshore areas are used by migrating and wintering populations of thick-billed murres, black-legged kittiwakes, Atlantic puffins, and ivory gulls. Non-breeding great shearwaters also frequent the area in large numbers during summer (Frederiksen et al., 2012). Along the coast of northwest Greenland, important breeding colonies of little auks and thick-billed murres exist. Arctic terns, Sabines gulls, and common eiders breed on Sabine Island (Clausen et al., 2016).

Greenland has identified 24 key sites recommended for the monitoring of seabird populations under the working group on Conservation of Arctic Flora and Fauna (CAFF) of the Arctic Council. Population trends and productivity studies are being implemented for eider and little auk colonies and a monitoring programme for thick-billed murre and black-legged kittiwake has been implemented. The oldest colony surveys in Greenland go back to the early twentieth century, but historical survey activity has generally been limited and non-systematic. Since the mid-2000s, ships conducting seismic surveys in Greenlandic waters need to have seabird and marine mammal observers onboard, leading to survey efforts being concentrated in areas where oil exploration activities took place, such as Disko Bay (*Qeqertarsuup Tunua*), eastern Baffin Bay (*Avannaata Imaa*), Davis Strait, and the Greenland Sea (CAFF, 2017).

Many seabird populations experienced a strong decline in the past years and it is expected that the reproduction and survival capacities of species that have their primary habitat on sea ice, such as the ivory gull, will be negatively affected by the decline of sea ice (Boertmann et al., 2020).

Benthic Species

A highly diverse benthic macrofauna exists in the marine areas northeast and northwest of Greenland, providing an important source of food for demersal fish, marine mammals, and sea ducks in the area (Frederiksen et al., 2012). Identified species include several species of worms, crabs, sea spiders, and molluscs. In addition, populations of giant sea pens, sponges, and cold-water corals were detected. The comparison of samples suggests that both the biomass and the species abundance is significantly higher on the west Greenland shelf than on the northeast Greenland shelf (Hansen et al., 2019).

In South Greenland, few studies of benthic fauna were conducted to date and the location and composition of benthic communities in the area is largely unknown. An exceptional form of calcium carbonate columns, called ‘ikaite’, were identified in the Ikka Fjord. Apart from being globally unique geological structures, the ikaite columns provide a habitat for a diverse and highly specialised set of species of bacteria, algae, and fauna (Frederiksen et al., 2012).

3 Climate Change and Pollution: Key Pressures Affecting the Greenlandic Marine Environment

3.1 Climate Change

Status

The Greenlandic marine environment is strongly influenced by climate change. Studies have documented rapid loss of Greenland's inland ice sheet (Sermersuaq) and increased glacial meltwater runoff. With the meltwater, dissolved organic carbon is entering the Greenland Sea and the Labrador Sea. The meltwater affects the water temperature and circulation patterns as well as the formation, thickness and break-up of sea ice. It leads to sea ice generally forming later in the winter and breaking up earlier in spring. In addition, the sea ice is oftentimes not as thick, extensive, and fast as in the past (Nuttall, 2019).

Polynyas have also become increasingly instable over the last two decades. The ice arch of the North Water Polynya (Pikialasorsuaq), for instance, is breaking up earlier, leading to increased ice drift from the Arctic Ocean into the Baffin Bay (Avannaata Imaa) as well as increased melting in the North Water region (Ribeiro et al., 2021).

Related Impacts

Climate change related changes in water temperature, sea ice cover, and circulation patterns influence the occurrence and distribution of marine biodiversity in Greenlandic waters. Especially changes in sea ice cover are significant, as they provoke noticeable changes among marine species which are associated with the sea ice and/or ice edges and polynyas, including ivory gulls, thick-billed murres, polar bears, narwhals, and some species of seals (Boertmann & Mosbech, 2017; Nuttall, 2020). Narwhals, for example, were observed to have expanded their use of glacial fronts in Melville Bay, probably as a result of reduced summer fast ice and a delayed formation of ice in autumn, and seals have been moving further away from coastal waters with the shifting pack ice. In addition, Greenland's glacial fjords become increasingly vital habitats for ice-dependent species as the sea ice disappears (Nuttall, 2020).

Changing ice conditions and warming waters have furthermore led to changing migration routes of fish, such as halibut and cod, as well as marine mammals (Nuttall, 2020) and have led to adaptations in the ranges of some seabirds (Nuttall, 2020; Boertmann & Mosbech, 2017). Common eiders, for instance, have expanded their breeding range several hundreds of kilometres northwards in recent years (Boertmann & Mosbech, 2017).

All of these changes also have profound implications for local livelihoods. Hunters and fishers in Greenland, for instance, report that changes in how the sea ice forms, thickens, and persists over winter mean that it is becoming increasingly challenging and risky to access hunting and fishing sites (Nuttall, 2019). While it was formerly possible to travel by dog sled on firm sea ice, on average, for five months a year in the coastal areas of northwest Greenland, it is now possible for only around three months. This is a significant reduction in the time during which hunting and fishing activities can be carried out with dog sled transportation (Nuttall, 2020).

Trends

Climate change is predicted to lead to further sea ice thinning and loss, with negative effects for future polynya formation (Ribeiro et al., 2021). In addition, glaciers are predicted to retreat to shallow water and eventually switch to land-terminating glaciers (Nuttall, 2020).

Large-scale oceanographic changes may include geographic shifts in the locations of the frontal and upwelling areas. These changes will in turn lead to changes in the distribution of migratory species. Baffin Bay (Avannaata Imaa), for example, may become increasingly important for large whales as the ice edge retreats further north (Boertmann & Mosbech, 2017). For fish stocks, a variety of changes in distributions and productivity are expected as a result of climate change but these are very difficult to predict over a longer period (Government of Greenland, 2020a).

Last but not least, increasing water temperatures will increase the risk of alien and invasive species becoming established in Greenlandic waters (Boertmann & Mosbech, 2017).

3.2 Pollution

Status

Hazardous substances found in Greenlandic marine areas include heavy metals and persistent organic pollutants. Persistent organic pollutants comprise various pesticides and industrial chemicals as well as their by-products, which are listed under the Stockholm Convention due to characteristics such as environmental persistence, bioaccumulation, long-range transport, and toxicity (AMAP, 2021a). In addition, marine litter increasingly contributes to the pollution of the Greenlandic marine environment.

Heavy metals, such as mercury, cadmium, and lead are released into the environment from both anthropogenic sources such as coal burning and mining, as well as from natural sources such as the weathering of rocks. In addition, the use of leaded gasoline was formerly a major source of atmospheric lead before it was banned in many countries during the 1970s and 1980s (Aastrup et al., 2016).

Most heavy metals found in the Greenlandic environment are transported to the Arctic via winds and ocean currents. Small-scale local pollution sources include mining and the use of lead shot for bird hunting, although the latter was banned in 2012 (Aastrup et al., 2016). Baseline data on mercury, cadmium, lead, and selenium levels in marine organisms in west Greenland indicated that lead levels were low, whereas cadmium, mercury and selenium levels were high, and in some cases exceeded Danish food standard limits. Data also suggested that marine mammal populations from northwest Greenland are among those with the highest concentrations of cadmium and mercury in the whole Arctic (Boertmann & Mosbech, 2017).

Persistent organic pollutants remain in the environment for a long time and can therefore be transported over long distances. Most persistent organic pollutants in the Arctic environment stem from industrialised regions further south and were transported to the Arctic via wind and ocean currents. As a result

of internationally agreed bans and use restrictions, the concentrations of several persistent organic pollutants in Arctic biota are declining (Aastrup et al., 2016). However, new persistent organic pollutants, such as brominated flame retardants and perflouronated chemicals, are being used now (Boertmann & Mosbech, 2017). In Greenland, concentrations of persistent organic pollutants are generally lower among marine biota in west Greenland than in east Greenland. Levels of petroleum compounds in Greenlandic water are relatively low with the exception of polluted areas such as harbours, where levels are higher (Boertmann & Mosbech, 2017).

Marine litter, and especially plastic pollution, is another challenge for the Greenlandic marine environment. According to research results, around 80% of the litter that washes ashore in Greenland is plastic and of largely local origin (Government of Greenland, 2020a). Much of the litter is household waste, which is likely to have escaped from dump sites (Government of Greenland, 2020a; Kirkfeld, 2016). In addition, litter related to fishing and hunting activities was frequently found during marine litter surveys at beaches in Greenland (Strietman et al., 2019). As no wastewater treatment plants exist in Greenland, the input of untreated wastewater to the sea is another source of marine litter, including microplastics (Kirkfeld, 2016). It should be kept in mind though, that the production of waste water is limited, since Greenland has only around 56,000 inhabitants (Statistics Greenland, 2020).

Related Impacts

Relatively high levels of certain heavy metals and persistent organic pollutants have been detected in a number of marine mammals living in Greenlandic waters (Government of Greenland, 2014a; CAFF, 2017). These substances are known to bio-accumulate and bio-magnify along the food chain, meaning that species at the top of the food chain, such as whales, seals and polar bears, exhibit the highest concentrations (Aastrup et al., 2016). Little is known about the biological impacts of high contaminant loads, but negative health effects and impairments are likely consequences (Aastrup et al., 2016; Boertmann & Mosbech, 2017). In addition, in Arctic communities where these species are integral to the diet, their consumption may lead to adverse health effects, including neurological and cardiovascular impairments (AMAP, 2021b). Blood mercury levels which exceed thresholds set out in blood guidelines as well as unusually high concentrations of certain persistent organic pollutants were, for example, detected among Inuit in the eastern parts of the Canadian Arctic and in Greenland (Boertmann & Mosbech, 2017). In recent years, mercury levels and concentrations of certain persistent organic pollutants appear to be decreasing, probably as a result of international regulations as well as a reduction in the consumption of traditional food (AMAP, 2021a; AMAP, 2021b).

Marine litter and especially plastics pose an additional threat to marine life in Greenland. Pieces of litter can, for example, be ingested, lead to entanglement, or may damage benthic habitats and communities. In addition, bioaccumulation and biomagnification of toxics which are being released from plastic may occur. Floating pieces of litter may also carry species from faraway places which may disrupt the local food web (Strietman et al., 2019).

Trends

Generally, it is anticipated that concentrations of many persistent organic pollutants will further decrease as a result of national and international regulations. Currently, it cannot be predicted how concentrations of persistent organic pollutants in marine biota will develop, as this depends on the species, ecosystem, and area. In addition, expanding human activities in the Arctic as well as climate-related environmental changes may lead to increased local releases of contaminants to local and coastal waterways (AMAP, 2021a).

With regards to mercury concentration, predictions are hard to make, as future mercury concentrations will depend on changes in levels of pollution as well as the Arctic climate and environment. The

thawing of permafrost, for example, may lead to the release of vast amounts of mercury, though it remains unclear how, when, and if this will occur (AMAP, 2021b).

In general terms, the amount of marine litter is expected to rise further as a result of increasing activities in the Arctic as well as increased waste generation (Kirkfeld, 2016). Contrary to this general trend, local sources of waste in Greenland might be reduced, as currently two large combustion plants with sufficient capacity to handle all household waste generated in Greenland are in planning (Government of Greenland, 2020a).

4 Sea-based Human Activities in Greenland

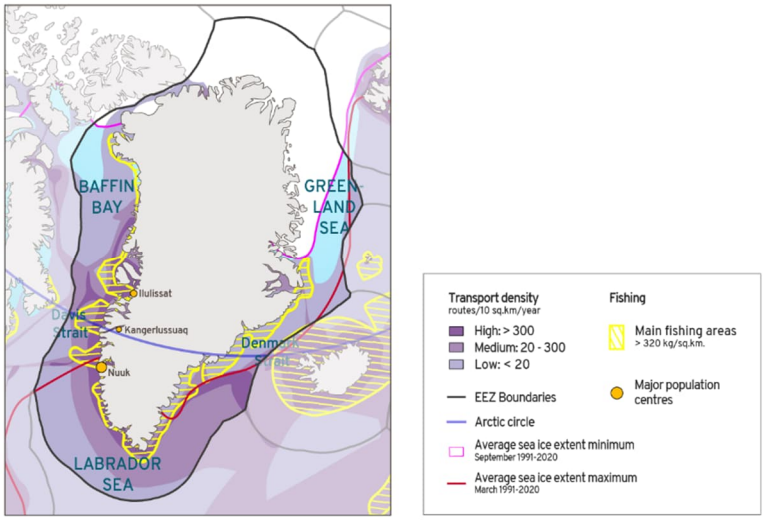

Figure 6: Overview of the major sea-based human activities in the Greenlandic exclusive economic zone (except tourism). IASS visualisation based on: Copernicus Climate Change Service/ECMWF (2021a, 2021b), Flanders Marine Institute (2019), GRID-Arendal (2019), MarineTraffic (2021), Pauly et al. (2020).

Greenland is overwhelmingly an Inuit society and its socio-economic activities and culture have traditionally been and continue to be very sea-oriented, with fishing forming the primary industry (FAO, 2022a). Greenland has about 56,000 inhabitants, which live exclusively along the coastline. Most of the population lives on the southern west coast in the five largest towns of Nuuk (the capital of Greenland), Sisimiut, Ilulissat, Aasiaat and Qaqortoq. As there are no roads connecting towns and settlements, ships and aircrafts are the main means of transporting goods and passengers (Statistics Greenland, 2020).

Based on value added and employment, fisheries-related industries and trade are by far the largest marine based industry in Greenlandic waters, followed by shipping (Figure 7; Statistics Greenland 2020). Tourism and oil and gas activities were for many years regarded as important sectors for efforts to achieve greater economic diversification and reduce Greenland's heavy reliance on fishing. In the past years, tourism activities have increased, while plans for future offshore oil and gas exploration and exploitation were halted by the Greenlandic government in 2021 (The Associated Press, 2021; Government of Greenland, 2021).

Apart from economic considerations, subsistence activities such as hunting and fishing are essential to cultural identity in Greenland (Government of Greenland, 2010).

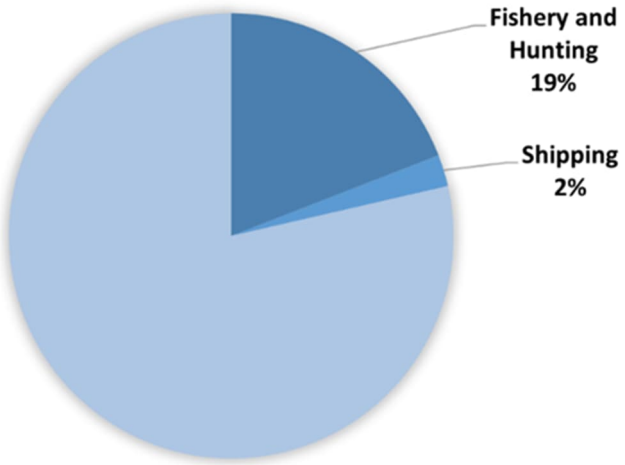

Figure 7: Contribution of selected marine related sectoral activities to the 2018 Greenlandic gross domestic product (GDP). IASS visualisation based on: StatBank Greenland (2022a).

4.1 Fishing and Hunting

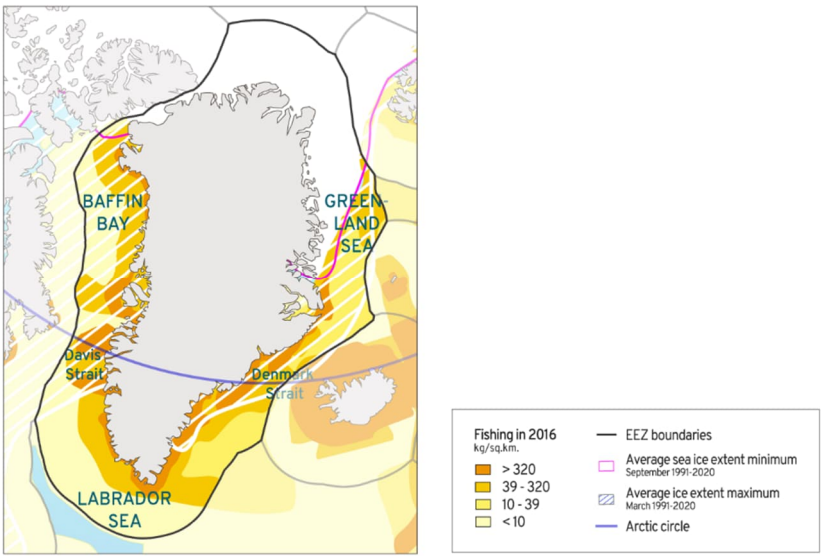

Figure 8: Fishing effort in Greenlandic waters. IASS visualisation based on: Copernicus Climate Change Service/ECMWF (2021a, 2021b), Flanders Marine Institute (2019), GRID-Arendal (2019), Pauly et al. (2020).

Quick Facts on Fishing in Greenland

- Capture in tonnes (2019): 265,179[2]
- Main areas: Denmark Strait (Ikerasak), Disko Bay (Qeqertarsuup Tunua), and Davis Strait
- Summary & Trend: Moderate activity likely to remain stable; main target species estimated to be fully utilised or overharvested; aquaculture receives increasing interest

Socio-cultural and Economic Relevance

The fishery industry is the primary industry in Greenland. More than one fifth of the Greenlandic workforce are employed in fisheries and related industries and around 90% of all export is derived from fisheries, with the main products being shrimp, halibut, cod, and crab (FAO, 2022a).

In all of Greenland's towns and settlements, subsistence and/or recreational fishing takes place, supporting local economies and contributing to social and cultural cohesion and food security. Small-scale fishing principally takes place close to settlements and towns and supplies land-based seafood buyers, such as the government-owned company Royal Greenland, and the privately-owned company Polar Seafood (Statistics Greenland, 2020). The annual fish consumption in Greenland is one of the

[2] Source: FAO (2022b); amount describes to overall capture by Greenland, not necessarily in the Greenlandic EEZ.

highest globally and was assessed at around 87 kilograms per capita in 2013 (FAO, 2022a).

In offshore fisheries, northern prawn and Greenland halibut have been the main target species in the past years (Figure 9). Northern prawn are harvested mainly by larger offshore fishing vessels with on-board production facilities along the west coast of Greenland (FAO, 2022a; Statistics Greenland, 2020). Greenland halibut are harvested by both large- and small-scale fishing vessels, the latter of which are concentrated in the areas of Disko Bay (Qeqertarsuup Tunua) and Nuuk Fjord (Nuup Kangerlua). In the past years, the northern prawn population has seen a decline, resulting in the decrease of the northern prawn quota by 25% between 2012 and 2013 (FAO, 2022a).

Other target species are capelin, Atlantic mackerel, Atlantic cod, Atlantic halibut, blue whiting, haddock, saithe, roundnose grenadier, Greenland cod, polar cod, ling, lumpfish, redfish, wolffish, queen crab, Atlantic herring, Atlantic salmon, Arctic char, and Iceland scallop. Target species have not changed much over the last decades, apart from the Atlantic mackerel, which was not targeted until 2011, when Atlantic mackerel stocks moved northward to Greenland due to rising ocean temperatures. Mackerel capture has since risen and constituted the second largest fishery in 2016 (FAO, 2022a).

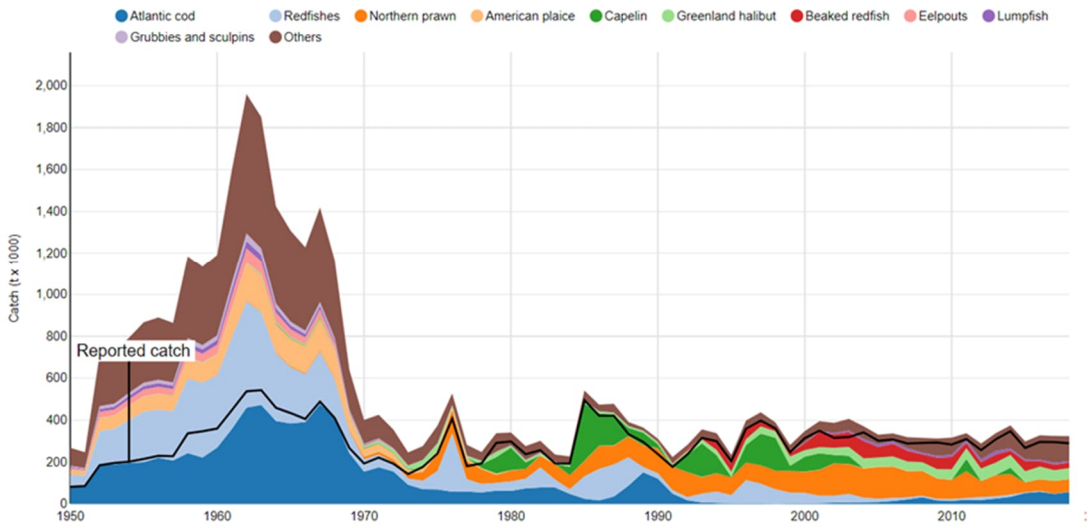

Figure 9: Catch reconstruction from 1950 to 2018 for the Greenlandic EEZ. Sources: Chu et al. (2020), Pauly et al. (2020).

Hunting can be very important locally but does not contribute greatly to the national economy. Estimates of the formal and informal value attribute less than 4% of the Greenlandic gross domestic product (GDP) to hunting. There are around 2,000 professional hunting licence holders in Greenland (Figure 10), most of which supplement their income with seasonal employment in other sectors, such as tourism, administration, construction, mining, recreational hunting and fishing (Government of Greenland, 2010). In general, the input to the formal economy from hunting has decreased over the years though it still remains a valuable contribution to the economy of many households (Government of Greenland, 2014a).

Apart from economic considerations, hunting is regarded as the traditional way of life and is essential to cultural identity in Greenland (Government of Greenland, 2010). The hunting and harvesting of marine mammals and the preparation and sharing of food contributes to the perception of family and

community and reinforces the relationship between Arctic Indigenous Peoples and the environment (PAME, 2021a). As such, subsistence activities are central to nature-based livelihoods of Arctic residents and taking this into account is vital when developing legal regulations, land-use planning, and wildlife management (Glomsrød et al., 2021).

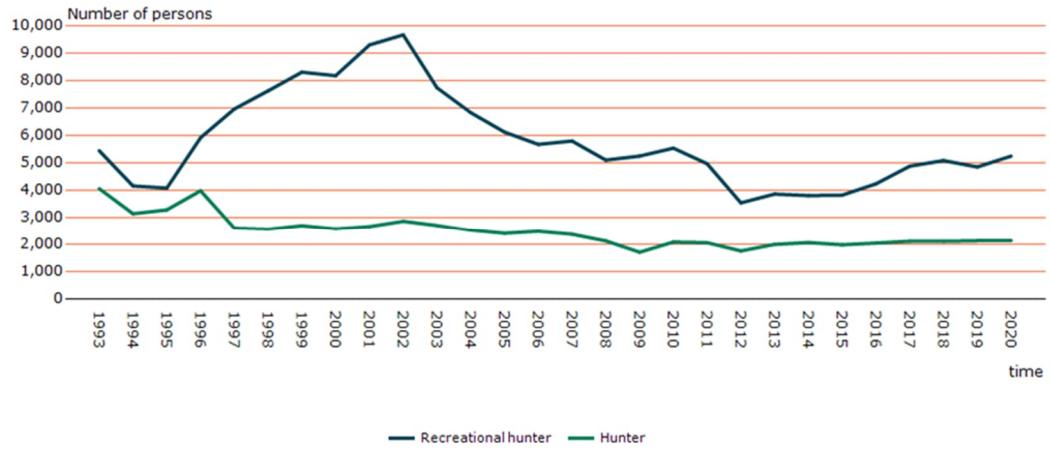

Figure 10: Hunting licenses for recreational and professional hunters in Greenland, 1993 to 2019. Source: StatBank Greenland (2022b).

The most important marine mammals targeted by hunters are ringed seal, harp seal, harbour porpoise, hooded seal, bearded seal and narwhal (Annex 2, Table 4). The seal meat is consumed and fed to dogs in sledge dog areas while the skin is typically traded. Whale meat and skin are also consumed in Greenland (Statistics Greenland, 2020).

Seabird hunting is a traditional activity in Greenland, dating back thousands of years. Seabirds are still important today in subsistence hunting and harvesting of some species has increased due to improved guns and boats (Government of Greenland, 2014a). Hunting is permitted for around 20 species, the most important being little auk, eider, ptarmigan, guillemot, theist, black-legged kittiwake, and king eider (Annex 2, Table 5).

Main Areas

The main fishing areas are the Denmark Strait (Ikerasak), Disko Bay (Qeqertarsuup Tunua), and Davis Strait as well as a few coastal areas close to larger settlements and towns (Elgsaas & Offerdal, 2018; Figure 8).

Related Impacts

The most direct impact of fishing and hunting is the mortality of the target species (CAFF, 2017). While habitats in Greenland are largely considered to be intact, the (over)exploitation of species through fishing and hunting is one of the main threats to Greenland's natural resources (Government of Greenland, 2010). In the past, cases of overfishing of Atlantic cod, northern prawn and Greenland halibut were documented and, in some cases, led to stricter regulations (Government of Greenland, 2020a; FAO, 2022a; Booth & Knip, 2014). Marine mammal species which have been overexploited in the past include walruses and polar bears. The walrus population in Greenland decreased strongly due to industrial-scale hunting by commercial European and North American hunters, and to a much

smaller extent, Indigenous communities, from the sixteenth to the twentieth century (Keighley et al., 2019). Also, harvesting levels of polar bear populations in the Baffin Bay (Avannaata Imaa) and Kane Basin shared by Canada and Greenland were estimated to be non-sustainable in the early 2000s (Government of Greenland, 2010; PAME, 2012). Other marine mammal populations which have been declining and are subject to hunting include hooded seals in the Greenland Sea as well as fin whales, humpback whales, and white-beaked dolphins in west Greenland. In addition, some poorly studied populations are subject to direct and indirect takes, such as bearded seals and killer whales in west and east Greenland (NAMMCO, 2019a).

Apart from the overexploitation of some target species, certain fishing and hunting techniques put pressure on the marine environment and non-target species. Scallop scraping, for example, causes large-scale unevenness on the sea floor as it lifts large pebbles from the sediment and presumably damages the epifauna (Government of Greenland, 2010). In a similar manner, fisheries for deepwater prawns, offshore halibut, and cod employ deep-sea trawls. This technique harms or even destroys seabed fauna, presenting a particular threat to fixed and long-lived organisms (Clare, 2018). Furthermore, unintentional bycatch might affect some populations of seabirds. Gillnet fishing for north Atlantic lumpsucker in southwest Greenland, for example, is recognised as posing a threat to eider populations (Merkel, 2011).

Apart from these impacts, fishing vessels, like all ships, contribute to underwater noise and may contribute to overall pollution through loss of gear, emissions, and discharges (see chapter on shipping impacts for more details).

Trends

The fishery sector is expected to remain dominant in the foreseeable future. Future changes in target species populations are uncertain for most species, as warming water temperatures may lead to the immigration of new fish species to Greenland while the abundance of other, pre-existing target species may diminish as they move further north into colder waters (FAO, 2022a). In this respect, it is,for instance, expected that the abundance of northern prawns in Greenlandic waters will further decline due to climate change effects (Government of Greenland, 2014a).

Greenland has numerous unexploited living marine resources which may be exploited in the future. Red, brown, and green seaweeds, sea cucumber, and sea urchin are abundant in Greenlandic marine areas and export markets exist for these species. Research on seaweed farming is carried out by the Greenland Institute of Natural Resources and supply-chain development is underway for sea urchin fishery (FAO, 2022a).

4.2 Shipping

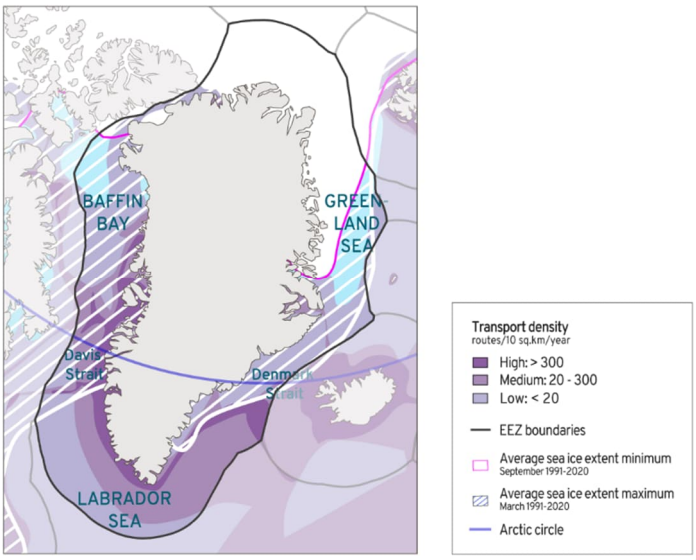

Figure 11: Transport density in Greenlandic exclusive economic zone. IASS visualisation based on: Copernicus Climate Change Service/ECMWF (2021a, 2021b), Flanders Marine Institute (2019), GRID-Arendal (2019), Marine Traffic (2021).

Quick Facts on Shipping in Greenland

- Main areas: Majority of activities in Davis Strait, Disko Bay (Qeqertarsuup Tunua), along the southwest coast, and in Denmark Strait (Ikerasak)
- Summary & Trend: Shipping activity likely to increase as a result of diminishing sea ice coverage and expected increase in leisure activity (including cruise ships)

Socio-cultural and Economic Relevance

Shipping is a vital infrastructure in Greenland. Due to the natural setting and low population density, road systems in Greenland only exist in towns and settlements but not between towns, making ships and aircraft the main means of transporting goods and passengers (Elgsaas & Offerdal, 2018).

The transport sector in Greenland is publicly subsidised, creating a near-monopoly condition. Royal Arctic Line conducts the intercontinental traffic and the supply of goods within Greenland. The company is owned by the Government of Greenland and employs around 700 workers in around 13 harbours in Greenland as well as in the harbour in Aalborg, Denmark (Borch et al., 2016).

In 2014, most vessel traffic in Greenlandic waters was associated with small-scale fishing activities, followed by cargo vessels and passenger transport. Vessel traffic related to oil and gas exploration peaked in the period 2012-2014, but declined again thereafter (Borch et al., 2016; see section on oil and gas for more information).

Main Areas

In comparison to European coastal areas, Greenlandic waters are characterised by a low traffic density. The low amounts of maritime traffic are due to the small population, comparatively few export activities, the lack of international transit routes, and climatic conditions. While parts of the south-western coastal areas of Greenland are now ice-free during the whole year, waters along the northern coast and most of the eastern coast are covered by (pack) ice during parts of the year or the entire year, necessitating ships with ice class hulls or icebreaker assistance (Borch et al., 2016). Most vessel traffic can be observed in the Davis Strait region, the Disko Bay (Qeqertarsuup Tunua) area, along the southwest coast, and in the Denmark Strait (Ikerasak) (Figure 6). Indeed, much of the shipping activity takes place between towns on the west coast (Borch et al., 2016).

Related Impacts

Oil spills are the main threat related to shipping in the Arctic. The slow rate of degradation, very limited evaporation, and limited dispersion into the water column mean that an oil spill in the Arctic could have very serious impacts on the marine environment and marine life and could endanger the food security and livelihoods of local Arctic communities (PAME, 2020).

In Greenland, as elsewhere, increased maritime traffic will result in an increased probability of accidents (Borch et al., 2016). The ability to implement emergency operations in response to large-scale incidents is a cause for concern, as large parts of the Greenlandic waters are extremely remote, infrastructure is scarce, and emergency preparedness capabilities are limited (Elgsaas & Offerdal, 2018; Borch et al., 2016).

An analysis conducted regarding the management of maritime traffic in the Disko Bay (Qeqertarsuup Tunua) and Big Hellefiskebanke areas found that ecosystems in the area are very sensitive to the environmental impacts that shipping may cause. However, the assessment of possible impacts of maritime traffic in the area concluded that there is no immediate need for additional regulations. Further investigation into the environmental impacts from heavy fuel oil in Greenland was recommended (Christensen et al., 2015).

In addition to the threat posed by oil spills, potential environmental impacts common to all shipping activities include toxic emissions, chemical discharges, habitat damage, collisions with marine mammals, introduction of invasive species, and underwater noise (CAFF, 2017; Chircop et al., 2020; PAME, 2021c).

With regards to the impacts of underwater noise in the Arctic, there are concerns that excessive noise may cause increased stress in marine mammal populations and may present challenges for communication, navigation, feeding, and calf protection. A recent report by PAME indicated that excessive noise levels were measured in three Arctic regions characterised by high densities of marine mammals, amongst them the Baffin Bay (Avannaata Imaa)/Davis Strait region off the west coast of Greenland (PAME, 2021c).

Trends

Climate change impacts already influence vessel traffic in Greenland and will continue to do so. As sailing seasons lengthen, more traffic of all types will be able to access the waters. Maritime activities related to fisheries, maritime tourism, as well as research are anticipated to increase in the coming years. For coastal passenger and goods transportation, the level of activity is expected to remain constant. Overall, growth is not expected to be significant though, as maritime traffic primarily continues to serve a small population and small industry (Borch et al., 2016).

4.3 Tourism

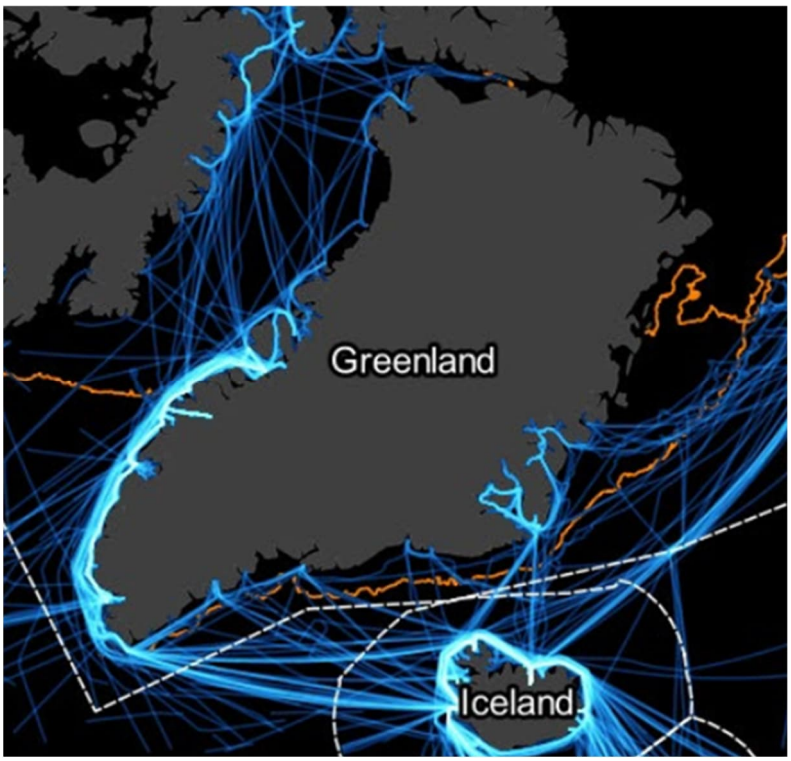

Figure 12: Tracks of all tourism vessels in Greenladic waters in 2019. Source: PAME (2021b).

Quick Facts on Tourism in Greenland

- Number of cruise passengers (2019): 46,633[3]
- Main areas: Along the southwest coast
- Summary & Trend: While Greenland attracts comparatively few tourists, the growth seen in the years preceding the Covid-19 pandemic is generally expected to continue

Socio-cultural and Economic Relevance

Greenland has attempted to diversify its economy in order to become less dependent on the fisheries industry. Much importance has been given to the tourist industry as one of the pillars around which to develop the economy (FAO, 2022a).

Indeed, the number of tourists and related overnight stays increased steadily in the years preceding the Covid-19 pandemic, which resulted in the imposition of severe travel restrictions (Figure 13). In 2019, most tourists in Greenland were resident visitors, followed by tourists from Denmark, Germany, and the United States (StatBank Greenland, 2022c).

[3] Source: StatBank Greenland (2022d)

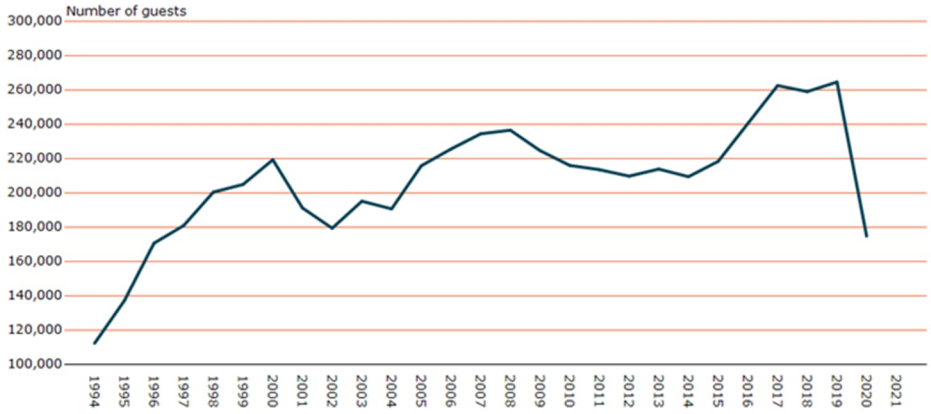

Figure 13: Overnight stays in Greenland from 1994-2020. Source: StatBank Greenland (2022c).

Cruise tourism is popular in Greenland, with strong growth through to 2019. In 2020 and 2021, this trend was discontinued as all calls in the ports of Greenland were cancelled due to the Covid-19 pandemic (StatBank Greenland, 2022d; Figure 14).

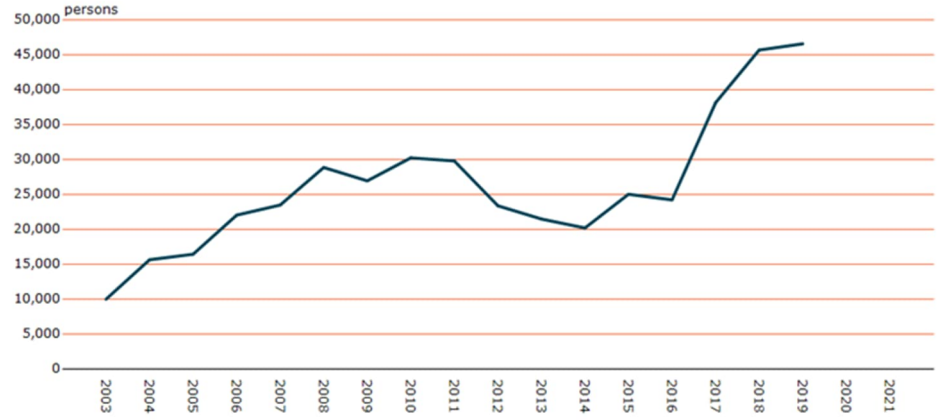

Figure 14: Number of cruise passengers in Greenland from 2003-2021. Source: StatBank Greenland (2022d).

No international passenger ship routes are operated by Greenland, but passenger ships from the United States, Canada, and Europe journey to Greenland. The Arctic Umiaq Line serves passenger routes along the west coast throughout most of the year. In addition, numerous minor passenger routes exist, such as the Disko Line, which is in charge of passenger transport in the Disko Bay (Qeqertarsuup Tunua) and Ilulissat area, and Royal Arctic Line, which offers passenger transport to and from settlements linked to the supply of goods. Ice conditions in the northern part of the west coast and along the east coast prevent regular service (Borch et al., 2016).

Main Areas

The cruise season runs from spring to fall, with activities concentrated in the Disko Bay (Qeqertarsuup Tunua) area as well as further south near Nuuk, and Qaqortoq (Figure 12) (Statistics Greenland, 2020).

Related Impacts

Pressures related to tourism relate mainly to increased shipping traffic and the resulting disturbance of wildlife and spread of invasive species (Government of Greenland, 2010). In this way, tourism presents many of the same environmental pressures such as shipping, including local pollution, greenhouse gas emissions and noise pollution to sea and air.

Trends

Tourism experienced rapid growth in Greenland through to 2019 and is generally expected to increase further. This applies to cruise tourism especially. New transatlantic airports in Ilulissat, Nuuk and Qaqortoq are projected to be operational by the end of 2023 and are expected to lead to a substantial increase in tourism (Ministry of Tourism, 2020). Uncertainties in these forecasts are related to the effects of the Covid-19 pandemic and related restrictions and implications for international travel.

4.4 Emerging Activities

4.4.1 Offshore Oil & Gas Exploration and Exploitation

The first extensive assessment of Arctic oil and gas resources conducted by the United States Geological Survey (USGS) in 2008 estimated the presence of important oil and gas resources in the East Greenland Rift Basins and off west Greenland between Canada and Greenland (Bird et al., 2008; Table 1). The estimates attracted interest among investors and operators and raised hopes in Greenland that offshore oil and gas exploitation could contribute to economic independence from Denmark (Poppel, 2018).

Table 1: Summary of results of the Circum-Arctic Resource Appraisal. Adapted from Bird et al. (2008).

Province	Oil (in million barrels)	Gas (in billion cubic feet)	Natural gas liquids (in million barrels)
East Greenland Rift Basins (EGR)	8,902.13	86,180.06	8,121.57
West Greenland-East Canada (WGEC)	7,274.40	51,818.16	1,152.59
North Greenland Sheared Margin (NGS)	1,349.80	10,207.24	273.09

Until recently, the development of the mineral resources sector into a primary industry enjoyed broad backing in Greenland (Ministry of Mineral Resources, 2020; Poppel, 2018). Indeed, the National Oil and Minerals Strategy 2014-2018 included precise objectives regarding the establishment of offshore oil and gas projects in the strategy period, stating that that "one to two offshore drilling projects may be established every second year" (Government of Greenland, 2014b:8). In 2018, a resource assessment project was initiated by the Geological Survey of Denmark and Greenland, the Greenland National Oil Company NUNAOIL and the then Ministry of Foreign Affairs and Energy, aiming at identifying those areas of Greenland with the highest exploration potential. Under the project, assessments for the areas Davis Strait and Labrador Sea, Baffin Bay (Avannaata Imaa), Nuussuaq Basin and Disko West were finalised, and assessments for central east Greenland, southeast Greenland, and north Greenland are expected to be released in 2022 (GEUS et al., 2022).

While political interest in developing the industry was high, no oil deposits of commercial relevance were found (Poppel, 2018). Besides, the climate conditions, a lack of adequate infrastructure and high environmental risks create challenges for implementing oil and gas exploration and production in Greenland (Kay & Thorup, 2014). As a result, most companies renounced their existing licences. Currently, four oil and gas exploration and exploitation licences in Greenland are active, three onshore Jameson Land (Operator Greenland Gas and Oil) and one offshore west of Nuuk (Operator Pan- oceanic Energy Limited) (Nunaoil, 2022; Figure 15).

In 2020, Greenland's Mineral Strategy 2020-2024 was published. Unlike the National Oil and Minerals Strategy 2014-2018, the current strategy does not include specific targets regarding offshore oil and gas developments but rather focuses on improving and establishing the necessary framework for exploration and exploitation activities (Ministry of Mineral Resources, 2020).

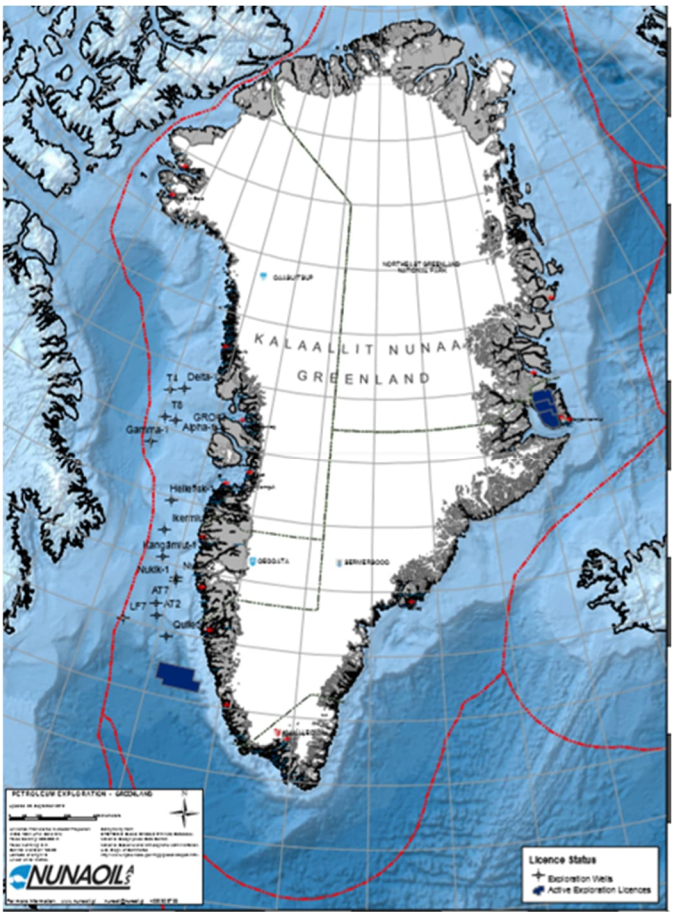

Figure 15: Map indicating exploration wells and active licences in Greenlandic waters. Source: Nunaoil (2020).

When the new government took office in 2021, it announced that it would not issue any further licences for oil and gas exploration in Greenland, due to economic calculations as well as the potential impact on climate and the environment (Government of Greenland, 2021). The four exploration licences which are still active will be maintained as long as the licensees are actively exploring (The Associated Press, 2021).

Related Impacts

There is significant public concern that petroleum exploration and exploitation activities could cause environmental catastrophes and disturbances to the marine environment in Greenland. Offshore exploration drillings in west Greenland in the 1970s were met with environmental concerns. These grew when the US Navy tanker Potomac hit an iceberg in 1977, resulting in the leakage of about 380 tons of heavy fuel into Melville Bay. Local hunters testified that the accident led to diminished seal catches and the soiling of marine animals with oil. They sued the Potomac but did not receive any compensation. Also, seismic surveys carried out in Baffin Bay (Avannaata Imaa) in 2012-2014 are believed to have negatively influenced the narwhal hunt in the area. Up to now, concerns are greatest where there is a risk that explorative activities could affect marine mammals and/or fish and thus negatively impact hunting and fishing activities (Poppel, 2018).

Regulations

As part of the Self-Government Act of 2009, Greenland gained the rights to its subsurface resources (Poppel, 2018). The Mineral Resources Act and its amendments provide the legal basis for all activities related to the exploration and exploitation of mineral and hydrocarbon resources in Greenland, including offshore (Government of Greenland, 2020a).

The main bodies responsible for licences and environmental oversights are the Mineral Licence and Safety Authority and the Environment Agency for Mineral Resources Activities. The Mineral Licence and Safety Authority operates under the auspices of the Ministry of Mineral Resources (now Ministry of Mineral Resources and Justice) and is responsible for issuing licences and for establishing the legal and political framework needed for the safe exploration and exploitation of mineral resources in Greenland. The Environment Agency for Mineral Resources Activities belongs to the former Ministry of Environment and Nature (now Ministry for Agriculture, Self-Supply, Energy and Environment), and cooperates closely with the Danish Center for Environment and Energy and the Greenland Institute of Natural Resources in providing scientific guidance regarding environmental protection in mineral resources activities (Ministry of Mineral Resources, 2020; Government of Greenland, 2020a).

To obtain exploration and exploitation licences for oil and gas, licence holders need to provide an environmental impact assessment and a social impact assessment detailing the environmental and societal impacts of the planned exploration/exploitation activities and how these will be addressed (based also on public participation process). Before construction and exploitation activities are initiated, an exploitation and closure plan must be developed and approved by the Government of Greenland, detailing inter alia financial security and assurance for clean-up obligations (Ministry of Mineral Resources, 2020).

Oil spill response responsibilities are divided among Denmark and Greenland, with Greenland being in charge of oil spill response within three nautical miles and Denmark in the remaining Greenlandic waters. In Greenland, the municipal fire brigade is responsible for oil spill response activities and the Joint Arctic Command acts on behalf of the Government of Denmark (Elgsaas & Offerdal, 2018).

Trends

Any future exploration and exploitation activities in Greenland will depend greatly on economic viability, making them difficult if not impossible to predict. The extreme climate conditions, lack of adequate infrastructure for the industry, and high environmental risks all create challenges for oil and gas exploration and production in Greenland, meaning that operations would only be economically viable when oil or gas prices are constantly high and several billions of barrels are discovered (Kay & Thorup, 2014).

4.4.2 Aquaculture

Aquaculture production currently does not take place in Greenland, partly because much of the land and surrounding water bodies are frozen or covered by ice during (parts of) the year. The government-owned seafood company Royal Greenland A/S conducted experiments with Atlantic cod and the Greenland Institute of Natural Resources started to explore options for seaweed production. In addition, there have been efforts to farm char and blue mussels, but production proved unprofitable. While attempts to establish aquaculture projects in Greenland have not been successful until now, aquaculture project may be established once this becomes profitable in Greenlandic waters (FAO, 2022a).

5 Governance of the Greenlandic Marine Environment

A range of institutions and agreements were developed internationally, regionally, and nationally to regulate human activities and ensure the conservation and sustainable use of marine biodiversity. The institutions and agreements in place either holistically aim to contribute to the sustainable use and conservation of marine biodiversity, address specific sectors/pressures, or focus on specific marine species.

In this chapter, an overview of relevant national rules, regulations and procedures governing sea-based human activities as well as the establishment of conservation tools, including marine protected areas (MPAs), in Greenland will be provided.

Apart from these 'official' regulations, Indigenous management practices contribute to conservation outcomes. Arctic Indigenous People have been stewarding the land and sea for thousands of years, which has resulted in sustained biodiversity conservation (Indigenous Circle of Experts, 2018). The contribution of such efforts to area-based conservation is oftentimes not considered, though, as governments may not recognise the efforts as formally designating protected areas, the areas may not meet national or international definitions; and/or those managing the area may not want it to be designated as a protected area (PAME, 2017).

The main international and regional agreements and frameworks with implications for the conservation and sustainable use of marine biodiversity in Greenlandic waters, while highly relevant, are only briefly mentioned in this report, and are explained in further detail in the regional overview report which is published as part of this report series.

Main International and Regional Agreements and Frameworks

The conservation and sustainable use of marine biodiversity in Greenlandic waters is based on the 1982 United Nations Convention on the Law of the Sea (UNCLOS), which is complemented by other instruments, frameworks and agreements, such as those established under the Convention on Biological Diversity (CBD), the Food and Agriculture Organization of the United Nations (FAO), the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP), the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), the UNESCO World Heritage Convention, and the International Whaling Commission (IWC). In addition, regional mechanisms and agreements, such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), the European Union (EU), the Arctic Council, and several regional fisheries bodies affect the conservation and sustainable use of marine biodiversity in Greenlandic waters.

The Arctic Council is the only Arctic-specific forum for cooperation between the governments of the eight Arctic states (Canada, Denmark (by virtue of Greenland), Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States) and representatives of Arctic Indigenous Peoples. The Arctic Council promotes sustainable development and environmental protection in the Arctic by providing assessments and recommendations. At the time of writing this report, work within the Arctic

Council was suspended indefinitely by the Arctic countries due to the Russian invasion of Ukraine, leading to uncertainties about the future of circumpolar cooperation (Dickie & Gardner, 2022).

OSPAR covers the waters to the east of Greenland within its 'Region I' (OSPAR, 2022). As an OSPAR contracting party, Denmark is bound to a set of mandatory rules as well as recommendations aimed at protecting the marine environment of the North-East Atlantic when carrying out activities in the convention area. These obligations extend to Greenland. The OSPAR Commission, inter alia, addresses marine pollution from the offshore industry and land-based sources of pollution, as well as non-polluting human activities that can adversely affect the sea.

Together with Denmark, Greenland was a member of what was then the European Economic Community from 1973 onwards, but left the community in 1985 following a referendum, which largely focused on regaining control of Greenlandic fisheries areas. Greenland subsequently acquired the status of an 'Associated Overseas Territory' associated with the community, now the EU, a status which is primarily meant to promote the economic, social and cultural development of the associated states or territories (Tomala, 2017). Under the current Overseas Countries and Territories-Greenland Decision, EU funds are mainly allocated to support the education sector, with a smaller portion of 10% meant to support 'Green Growth' areas, including biodiversity conservation, hydrogen production, and research (Government of Greenland, 2022a). The current provisions with regards to fisheries are set out in the 2021 Sustainable Fisheries Partnership Agreement and are further elaborated upon in the chapter of fishing and hunting regulations (Government of Greenland, 2022b).

Main National Rules, Regulations and Procedures

Greenland is part of the Kingdom of Denmark. As part of its status as a self-governing sub-national territory, Greenland has far-reaching autonomy, but cannot take home foreign affairs, defence and security related policy under the Act on Greenland Self-Government (Borch et al., 2016; Statistics Greenland, 2020).

When it comes to conserving Greenland's marine environment, responsibilities are shared between Greenland and Denmark. Greenland is in charge of the area up to three nautical miles from the coast and Denmark is responsible for the area from three nautical miles until the outer limits of Greenland's EEZ (Government of Greenland, 2020a). The Ministry of Environment and Nature (now Ministry for Agriculture, Self-Supply, Energy and Environment) has the overall responsibility for managing nature conservation in Greenland (Government of Greenland, 2014a). The Ministry of Fisheries, Hunting and Agriculture (now Ministry of Fisheries and Hunting) is in charge of the management of shellfish, fish, mammals and birds (Government of Greenland, 2020a).

The Greenland Institute of Natural Resources and Århus University have key roles with regards to biodiversity monitoring as well as the development of indicators and assessments. Both institutions have been co-leading the Circumpolar Biodiversity Monitoring Programme in the CAFF working group of the Arctic Council on behalf of Denmark since 2013. The Greenland Ecosystem Monitoring programme was set up by Greenlandic and Danish research institutions in order to measure climate change and its impact on Arctic ecosystems. The data obtained through the various monitoring programmes has, inter alia, been used to provide the Greenlandic government with guidance regarding the sustainable use and conservation of living resources and fed into strategic environmental impact assessments for hydrocarbon exploration and exploitation in South Greenland (2012), Disko Island (Qeqertarsuaq) and Nuusuaq Peninsla (2016), Baffin Bay (Avannaata Imaa) (2017), and the Greenland Sea (2020) (Government of Greenland, 2020a).

While Indigenous and local knowledge related to biodiversity and biological resources is not subject to specific national legislation, the Greenland Institute of Natural Resources frequently arranges public

meetings and includes local and Indigenous knowledge in its scientific research. A local observations database called PISUNA-net was developed to collect, archive, and share Indigenous and local knowledge and expertise on natural resources and their use. As part of the programme, local communities interpret the observations they make and provide suggestions for changes in the management of the natural resources if required (Government of Greenland, 2020a).

In 2021, Greenland adopted its first National Biodiversity Strategy up to 2030 (Anguniakkavut, 2021).

5.1 Marine Protected Areas and Other Effective Area-based Conservation Measures

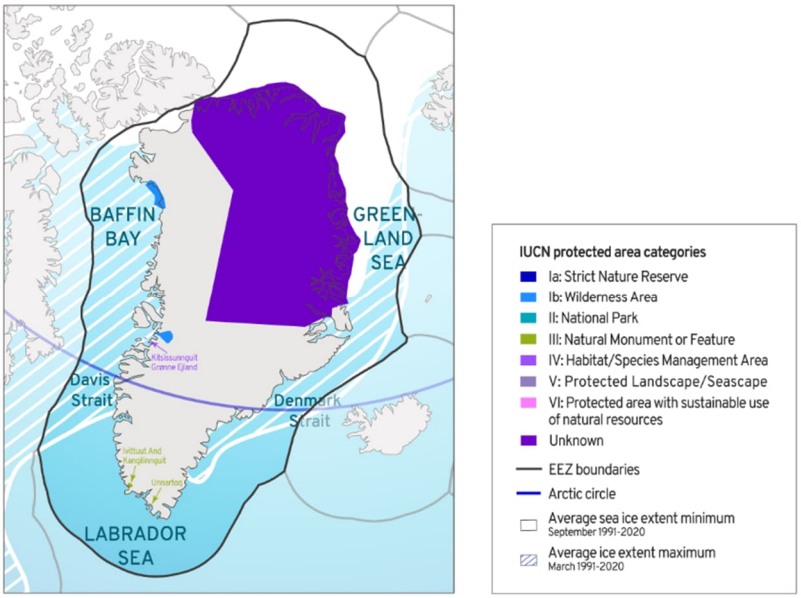

Figure 16: Marine protected areas in Greenland. IASS visualisation based on Copernicus Climate Change Service/ECMWF (2021a, 2021b), Flanders Marine Institute (2019), GRID-Arendal (2019), UNEP-WCMC and IUCN (2022).

Quick Facts on Marine Protected Areas in Greenland[4]

- Percentage of marine area designated as MPAs: 4.2%
- Protected area in km²: 95,875 km²
- Amount of MPAs: 6
- Proposed MPAs: 0

The Nature Protection Act from 2003 provides the basis for the designation of protected areas in Greenland. Under the act, several executive orders were developed, providing for the protection of specific sites and regulating the protection of individual species (Government of Greenland, 2020a).

The Ministry of Environment and Nature (now Ministry for Agriculture, Self-Supply, Energy and Environment) is the main authority responsible for the conservation of habitats and management of protected areas in Greenland as well as for implementation of relevant international agreements and conventions regarding biodiversity (Government of Greenland, 2014a).

According to the Marine Protection Atlas, nearly 100,000 km² of Greenland's marine area are protected by a total of six MPAs (Marine Conservation Institute, 2022a; Figure 16, Table 2). All of the protected areas are located within three nautical miles from the coastline and allow for multiple use.

[4] Source: Marine Conservation Institute (2022a)

Their management authority lies with the Ministry of Environment and Nature (now Ministry for Agriculture, Self-Supply, Energy and Environment) (PAME, 2015).

Table 2: Overview of Marine Protected Areas in Greenland. Sources: PAME (2015), Marine Conservation Institute (2022b).

Name of MPA	Designation	Reported area in km²	Marine area in km²	Primary conservation focus
Melville Bay	Nature reserve	10,500	8,412	Protection of narwhals and polar bears in the area.
Ilulissat Icefjord	World heritage site	4,024	399	Protection of the natural beauty of the Icefjord, as well as the area's natural and cultural history, and other natural values.
Green Ejland (*Kitsissunnguit*)	Ramsar site	69	61	Protection of the ecosystem and the rich biodiversity of the area with special focus on breeding Arctic terns.
Ikka Fjord and adjacent land area (*Ivittuut og Kangilinnguit*)	Nature reserve	573	106	Protection of the inner part of Ikka Fjord which hosts a unique ecosystem.
National Park in North- and East Greenland	UNESCO Biosphere reserve	972,000	87,911	Protection of flora, fauna, and other cultural relics of the past.
Unnartoq	Nature reserve	6	0.1	No information available

Apart from the designation of MPAs, Greenland employs several additional conservation measures to protect its marine species and ecosystems. Specific areas have, for instance, been designated as seabird breeding sanctuaries. In 2017, Greenland had a total of 40 seabird breeding sanctuaries in place. In addition, area-based conservation measures have been introduced in relation to fisheries, such as the prohibition of bottom trawling in certain areas, with the aim of protecting seafloor /benthic habitats (Government of Greenland, 2020a). Also, Greenland designated 12 Wetlands of International Importance under the Ramsar Convention (Ramsar, 2022).

Greenland has also initiated national projects to identify important habitats for marine species, migratory pathways, and the population sizes of sensitive species, as well as vulnerable marine areas (Government of Greenland, 2020a). In 2012, a report identifying ecologically valuable and sensitive marine areas in relation to intensified shipping in Greenlandic waters was published. The report builds on the strategic environmental impact assessments conducted for hydrocarbon exploration and exploitation activities and identifies 12 areas of heightened ecological significance in Greenlandic waters which have been classified according to their priority (Christensen et al., 2012; Figure 17). Among these areas, the North Water Polynya (Pikialasorsuaq), and Disko Bay (Qeqertarsuup Tunua) with Store Hellefiskebanke were given the highest priority, and two additional assessments were conducted in 2015 and 2017 based on requests from the Greenlandic Government and the Danish Ministry of Environment in order to determine especially important biological and sensitive sections within those two areas at a finer scale (Government of Greenland, 2020a).

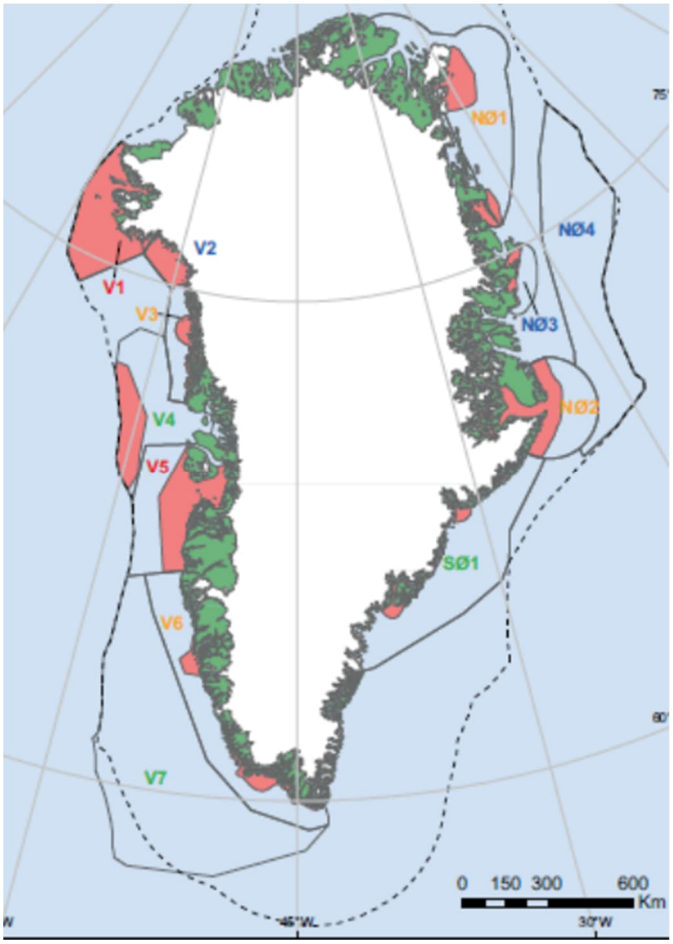

Figure 17: Proposed designation of vulnerable sea areas. The 12 areas are prioritised in four categories: Priority 1: red, Priority 2: orange, Priority 3: blue, Priority 4: green. Especially important 'core areas' are marked by red toning. Source: Christensen et al. (2012).

With regards to the North Water Polynya (Pikialasorsuaq), the Inuit Circumpolar Council (ICC) initiated the Inuit-led Pikialasorsuaq Commission to conduct consultations among communities in both Canada and Greenland in order to provide Inuit who have lived in the region and managed its resources for generations the opportunity to voice their vision for the polynya and its adjacent waters. As a result of the consultations, the Pikialasorsuaq Commission outlined three recommendations. Inter alia, it was recommended to establish an Inuit-led management regime for the area, which would include a protected area comprised of the polynya itself as well as a larger management zone. In addition, the creation of a free travel zone for Inuit across the region was recommended (Pikialasorsuaq Commission, 2017). At the time of writing of this report, negotiations are still ongoing, and no management regime has been put into place for the North Water Polynya (Pikialasorsuaq)

5.2 Sector-based Regulations

5.2.1 Fishing and Hunting

Regulations Pertaining to Fishing

The Fishery Act of 1996 constitutes Greenland's legal framework for fisheries management. The Ministry of Fisheries, Hunting and Agriculture (now Ministry of Fisheries and Hunting) is the central government authority in charge of managing commercial fisheries, as well as hunting of marine mammals and birds (Government of Greenland, 2020a).

The assignment of Total Allowable Catch (TAC) quotas is the basis of Greenland's fisheries management system. The TACs for both small-scale and large-scale fisheries are based on advice provided by the Greenland Institute of Natural Resources and assigned by the Ministry of Fisheries, Hunting and Agriculture (now Ministry of Fisheries and Hunting) after consultations with the Hunting Council, the Fishery Council, the Association of Hunters and Fishers of Greenland (Kalaallit Nunaanni Aalisartut Piniartullu Kattuffiat; KNAPK in short), and the Greenland Business Association. Proposals for setting TACs are also subject to a public hearing process (Government of Greenland, 2020a). In 2020, 11 species were regulated through TACs in the offshore sector: Northern prawn, Greenland halibut, cod, redfish, capelin, blue whiting, herring, mackerel, grenadier, halibut, and scallops. In the coastal fishery, TAC limitations applied to Greenland halibut, cod and snow crabs (Government of Greenland, 2020b).

Vessel size is the main factor distinguishing offshore and coastal fishing fleets. Vessels above 120 gross tonnage are not allowed within the three nautical mile limit (FAO, 2022a). Exceptions exist for shrimp trawlers, which may operate within the three nautical mile limit, as well as small vessels engaging in cod fishery which may operate beyond three nautical miles (Government of Greenland, 2020b).

The Greenland Fisheries and License Control (GFLK) is in charge of surveillance and enforcing existing regulations for inshore and offshore fisheries. In the coastal waters off west Greenland, GFLK operates small patrol vessels in order to monitor fishing activities. The GFLK operates a human observer programme for the offshore fisheries, which places GFLK employees on fishing vessels to guarantee the usage of approved gear and improve the quality of log book catch data (FAO, 2022a). In 2015, GFLK introduced a supplementary reporting system for the reporting of bycatch (Christensen-Dalsgaard et al., 2019). Additionally, the navy of Denmark patrols the waters off Greenland to prevent illegal, unreported, and unregulated fishing activities (FAO, 2022a).

Recreational fishing activities are mostly carried out with small dinghies and play an important role for subsistence in Greenland. No licence or permit is needed for recreational fishing and no restrictions exist regarding target fish species, except for salmon, for which a licence is required. GFLK monitors the salmon fishery (FAO, 2022a).

Apart from national rules and regulations, several international agreements on fisheries cooperation affect fisheries management in Greenlandic waters. Greenland has fishing agreements with the Faroe Islands, Norway, the Russian Federation, and Iceland, for example. The agreements are reciprocal, providing Greenland with the right to fish in the waters of other states while these are allowed to fish in Greenlandic waters. No fishing agreements exist between Greenland and Canada or the United States (FAO, 2022a).

Since 2021, a new Sustainable Fisheries Partnership Agreement and protocol is in force between the

EU and Greenland, replacing the previous agreement and protocol, which had been in place since 2007. The agreement matches the granting of fishing quotas in the Greenlandic EEZ with an annual economic contribution, parts of which are a direct payment for access to the EEZ while a smaller portion is reserved for the development of the Greenlandic fishing sector (Government of Greenland, 2022b).

In addition, the management of wild salmon stocks in Greenland is based on the management principles adopted by the North Atlantic Salmon Conservation Organization (NASCO). NASCO aims to conserve, restore, and manage wild Atlantic salmon. Under NASCO, targeted fisheries for Atlantic salmon are prohibited in most areas of the North Atlantic beyond 12 nautical miles from the coast, thus creating a large area which is free of directed salmon fisheries (NASCO, 2021).

Regulations Pertaining to Hunting

Hunting of marine mammals and seabirds in Greenland is regulated through the Act on Fishing and Hunting, the Home Rule Act of 1999 on Hunting with later amendments, as well as executive orders, which regulate the protection and hunting of individual species and matters such as hunting permits and reporting of catches (Government of Greenland, 2010).

As with fishing, a system of licences and quota was put into place to ensure sustainable harvest levels (NAMMCO, 2019a). Hunters are often in disagreement with biologists over scientific population estimates and the quota which are set based on scientific advice, and argue for community-based monitoring of key marine mammals and fish (Nuttall, 2020).

A hunting licence is required for professional and recreational hunting alike. Marine mammals for which quota were set, such as polar bears, walruses, minke whales, fin whales, humpback whales and bowhead whales, can only be hunted by professional hunters. An exception applies to narwhals and beluga whales, of which up to 10% of the quota are allowed to be hunted by recreational hunters (NAMMCO, 2019a). For seabirds, hunting seasons are established and for some species these are combined with a bag quota (Government of Greenland, 2020a).

For a number of species, harvesting levels are not regulated by quota. For these species, validation of reported catches is especially challenging, given the relative isolation of some hunting communities. Greenland is aiming to address this issue by introducing an online catch reporting tool for non-quota species (NAMMCO, 2019a).

Greenland is a member of the North Atlantic Marine Mammal Commission (NAMMCO) which provides advice on the effective conservation and management measures in relation to whales, dolphins, porpoises, seals and walruses in the north Atlantic. In addition, Greenland receives management advice by the Canada-Greenland Joint Commission on the Conservation and Management of Narwhal and Beluga (JCNB), the International Council for the Exploration of the Sea (ICES) and the IWC (NAMMCO, 2019b).

Conservation and management actions, such as quotas, helped alleviate the pressure of overharvesting associated with hunting. Improved stocks of walruses, beluga whales and narwhals, for example, are highlighted by NAMMCO as examples of the successful establishment of scientifically recommended quotas and sustainable hunting. While the quotas implemented by Greenland for beluga whales and narwhals were in some years above the quotas recommended by NAMMCO and/or JCNB, they are nevertheless regarded by NAMMCO as a significant step towards the sustainable management of those species (NAMMCO, 2019a).

Wildlife officers form part of regular national controls and are responsible for supervising large whale

hunts, as well as beluga whale, narwhal, seal, and walrus hunts. These officers cooperate closely with municipal authorities, the police, and the Arctic Command. Inspectors review hunting permits and check catches as they are landed at the harbour or being sold. Inspections at sea are carried out on a random basis, with more inspections taking place during hunting and migrations seasons (NAMMCO, 2019a).

With regards to polar bears, Denmark, now represented by the Government of Greenland, signed the 1973 Agreement on the Conservation of Polar Bears (Range States Agreement) and thus agreed to undertake coordinated action to manage polar bears throughout their circumpolar range. The collaboration of the range states (Canada, Denmark, represented by the Government of Greenland, Norway, the Russian Federation, and the United States) has been regarded as mostly successful in eliminating overharvesting and has assisted in the signing of bilateral cooperative arrangements for the management of most of the shared populations (Range States Agreement, 2022). The bilateral agreements included a Memorandum of Understanding between the Government of Canada, the Government of Nunavut and the Government of Greenland for the Conservation and Management of Polar Bear Populations. This Memorandum of Understanding was signed in 2009 and expired in 2014, but collaborative work is ongoing regarding the harvest of shared polar bear populations in Baffin Bay (Avannaata Imaa) and Kane Basin (Government of Canada, 2022). In 2019, the government published a national management plan for polar bears in Greenland (Government of Greenland, 2019).

5.2.2 Shipping

The governance of shipping activities in Greenlandic waters is shared among Greenlandic and Danish authorities, with Greenland having authority for shipping in the sea area up to the three nautical miles from the coastline and Denmark having authority concerning shipping from the three nautical miles limit to the outer limit of the EEZ of Greenland. An exception to this arrangement are shipping activities related to oil and gas exploration and exploitation for which Greenland has authority both within the three nautical miles zone as well as the EEZ (Borch et al., 2016).

The Greenlandic police is in charge of search and rescue activities within the three nautical miles zone and the Joint Arctic Command, which forms part of the Danish Defence, is responsible for search and rescue activities outside the three nautical miles to the limit of the Danish/Greenlandic Search and Rescue Region. At present, most search and rescue operations occur in and nearby inhabited areas in Greenland with satisfactory results (Elgsaas & Offerdal, 2018). To improve the safety of shipping in Arctic waters, Denmark enhanced port state controls of cruise ships sailing to Greenland. In addition, the common Danish/Greenlandic Preparedness Service Commission established the so-called ‘Operative Contact Group Arctic’ to further improve implementation of search and rescue activities and strengthen cooperation between the numerous involved authorities (Elgsaas & Offerdal, 2018).

International treaties and instruments with relevance to shipping activities in Greenlandic waters were principally established under the IMO. The IMO is responsible for developing international standards for ship safety and security and for the protection of the marine environment and the atmosphere from harmful shipping impacts. To fulfil this mandate, the IMO has adopted several international agreements and a wide range of measures to prevent and control pollution by ships and to mitigate the possible effects of maritime operations and accidents (IMO, 2021a).

Two key conventions adopted under the IMO are the International Convention for the Safety of Life at Sea (SOLAS), which lays down rules on navigation and safety, and the International Convention for the Prevention of Pollution from Ships (MARPOL), which establishes regulations to prevent pollution by oil and other hazardous substances resulting both from accidental pollution and routine operations (IMO, 2021b; IMO, 2021c). The International Code for Ships Operating in Polar Waters

(Polar Code) is mandatory under both SOLAS and MARPOL and pertains to passenger and cargo ships of 500 gross tonnes or more operating in polar areas. The Polar Code includes mandatory as well as recommended measures regarding safety and pollution prevention, including the recommendation not to use or carry heavy fuel oil in the Arctic (IMO, 2021d).

On that point, an amendment to MARPOL Annex I was approved in 2021, introducing prohibition of the use and carriage of heavy fuel oil for use as fuel in Arctic waters starting 1 July 2024. Exemptions were established, inter alia, for vessels engaged in securing the safety of ships, search and rescue operations, and oil spill preparedness and response activities. In addition, MARPOL parties with a coastline bordering Arctic waters can exempt their vessels when operating in their waters until 1 July 2029 (IMO, 2021e).

Regionally, guidelines and assessments with regard to shipping were, for instance, developed under the Arctic Council. In addition, the legally binding regional governance instruments on Aeronautical and Maritime Search and Rescue (2011) and Marine Oil Pollution Preparedness and Response (2013) are also relevant to shipping in the Arctic (Elgsaas & Offerdal, 2018).

5.2.3 Tourism

Vessel-based tourism in Greenland is largely subject to the same regulations as shipping.

The Ministry of Industry, Labour, Trade and Energy (now Ministry for Industry, Trade, Foreign Affairs and Climate) is the main body responsible for regulating the tourism industry. The then Ministry of Industry, Labour, Trade and Energy developed a tourism policy for 2016-2020, entitled 'Tourism development in Greenland: What does it take?'. The strategy aims to reduce taxes and fees applicable to international flights and cruise ships and focuses on improving transportation infrastructure in Nuuk, Ilulissat and elsewhere as this is seen as vital for tourism increase. Additionally, the policy stresses the importance of drafting local tourism development plans in several communities and promotes marketing efforts targeting Iceland, Germany, North America, and Asia (Petridou et al., 2019).

Visit Greenland A/S is Greenland's National Tourist Board and is responsible for the development and promotion of the tourism industry and tourism activities in Greenland. Visit Greenland published its 2020-2023 strategy in 2020, in which it outlines its vision and mission: "We help create economic growth, jobs and the sustainable development of our community by making Greenland an internationally known and sought after adventure destination with a focus on quality, safety and sustainability."(Visit Greenland, 2020:5). The strategy identifies four core tasks for the immediate future: 1) to increase demand from adventure tourists; 2) to achieve year-round tourism in all of Greenland; 3) to increase knowledge sharing and upgrade competence; and 4) to promote favourable framework conditions (Visit Greenland, 2020).

With regards to cruise tourism, it should be mentioned that Greenland is one of the core areas of the Association of Arctic Expedition Cruise Operators (AECO). AECO is an international association for expedition cruise operators operating in the Arctic and is committed to promoting responsible, environmentally friendly, and safe tourism in the Arctic by setting the highest possible operating standards (Pashkevich et al., 2015).

6 Annex 1

Table 3. Marine mammal species present in Greenlandic waters and their IUCN Red List categories. Source: IUCN, 2022.

Common Name	Scientific Name	Red List Category	Assessment Date	Arctic Sea
North Atlantic Right Whale	Eubalaena glacialis	Critically Endangered	2020-01-01	
Sei Whale	Balaenoptera borealis	Endangered	2018-06-25	
Blue Whale	Balaenoptera musculus	Endangered	2018-03-16	Present
Fin Whale	Balaenoptera physalus	Vulnerable	2018-02-04	Present
Hooded Seal	Cystophora cristata	Vulnerable	2015-06-07	
Walrus	Odobenus rosmarus	Vulnerable	2016-02-05	Present
Sperm Whale	Physeter macrocephalus	Vulnerable	2008-06-30	
Polar Bear	Ursus maritimus	Vulnerable	2015-08-27	Present
Northern Bottlenose Whale	Hyperoodon ampullatus	Near Threatened	2020-10-20	
Bowhead Whale	Balaena mysticetus	Least Concern	2018-01-01	Present
Common Minke Whale	Balaenoptera acutorostrata	Least Concern	2018-03-16	Present
Beluga Whale	Delphinapterus leucas	Least Concern	2017-06-22	Present
Common Dolphin	Delphinus delphis	Least Concern	2020-10-20	
Bearded Seal	Erignathus barbatus	Least Concern	2016-02-17	Present
Long-finned Pilot Whale	Globicephala melas	Least Concern	2018-06-18	
Grey Seal	Halichoerus grypus	Least Concern	2016-03-01	
Atlantic White-sided Dolphin	Lagenorhynchus acutus	Least Concern	2019-04-01	
White-beaked Dolphins	Lagenorhynchus albirostris	Least Concern	2018-03-18	
Humpback Whale	Megaptera novaeangliae	Least Concern	2018-03-24	Present
Sowerby's Beaked Whale	Mesoplodon bidens	Least Concern	2020-08-23	
Narwhal	Monodon monoceros	Least Concern	2017-07-03	Present
Harp Seal	Pagophilus groenlandicus	Least Concern	2015-06-06	Present
Harbour Seal	Phoca vitulina	Least Concern	2016-01-04	
Harbour Porpoise	Phocoena phocoena	Least Concern	2020-05-19	Present

Ringed Seal	Pusa hispida	Least Concern	2016-01-16	Present
Striped Dolphin	Stenella coeruleoalba	Least Concern	2018-04-19	
Killer Whale	Orcinus orca	Data Deficient	2017-06-20	Present

Retrieved from IUCN using the following search query:

- Type: Species
- Taxonomy: Animalia -> Chordata -> Mammalia
- Land Regions: Europe -> Greenland
- Habitats: 10. Marine Oceanic
- *Marine Regions: Arctic Sea (only for the data in the last column 'Arctic Sea')

Source: IUCN. (2022). IUCN red list of threatened species. www.iucnredlist.org (Accessed: 13.07.2022)

7 Annex 2

Table 4. Catch of marine mammals in Greenland by species from 2009 to 2019. Source: StatBank Greenland (2021).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ringed seal	65701	61635	62199	60509	64805	64626	57584	48219	40948	47959	32051
Harp seal	73406	90909	74358	55633	66521	63968	62847	56910	48619	48629	29885
Hooded seal	1986	2144	2069	1707	1515	1849	1949	1516	1526	1023	1416
Bearded seal	1259	1406	1302	1100	1116	1358	1355	1332	1143	1071	728
Harbour seal	33	26	79	0	10	20	3	4	0	0	0
Walrus	127	107	97	114	120	127	131	135	111	98	114
Beluga whale	231	226	151	211	305	271	127	203	198	213	265
Narwhal	377	268	296	361	350	415	312	401	426	511	541
Killer whale	14	15	39	44	38	16	23	14	18	21	16
Harbour porpoise	2029	2093	2828	2385	2646	2558	2009	2375	2385	2890	2778
Pilot whale	238	338	274	432	316	433	283	195	384	399	305
Atlantic white-sided dolphin	92	261	237	180	146	137	96	123	98	137	225
Minke whale	168	196	189	152	181	157	139	163	143	118	171
Bowhead whale	3	3	1	0	0	0	1	0	0	0	0
Humpback whale	0	9	8	10	8	7	6	5	2	6	4
Fin whale	10	6	5	5	9	12	12	9	8	7	8
Polar bear	124	100	131	138	127	143	142	120	142	149	140
Total	**145798**	**159742**	**144263**	**122981**	**138213**	**136097**	**127019**	**111724**	**96151**	**103231**	**68647**

Table 5. Catch of seabirds in Greenland by species from 2009 to 2019. Source: StatBank Greenland (2021).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Guillemot	62847	64468	68276	66226	67524	53841	45792	41914	30931	23397	22783
Eider	26443	27492	30835	31522	26097	25185	22588	21891	17827	14721	13895
King eider	4437	6369	4362	4103	4510	4405	2958	2731	2827	3726	3968
Squaw	479	821	654	472	351	340	383	428	233	268	259
Mallard	281	191	331	257	297	203	146	116	96	68	104
Fulmar	751	593	135	784	562	526	918	371	342	257	331
Theist	13221	16361	16492	14713	13954	11332	10049	10290	9965	8677	8564
Little auk	22093	28984	26474	12739	14787	16677	22516	18471	27215	20591	17337
Black-legged Kittiwake	7689	8117	7656	7785	7726	5430	4756	5819	3075	2626	3285
Canada goose	385	434	456	461	614	530	288	461	247	284	259
Barnacle goose	66	87	98	101	118	114	132	87	61	74	44
Short nest goose	86	109	298	215	210	257	142	204	120	132	96
Ptarmigan	22026	19247	17257	13798	11742	10584	10375	8889	9975	6537	6171
Total	**160804**	**173273**	**173324**	**153176**	**148492**	**129424**	**121043**	**111672**	**102914**	**81358**	**77096**

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About the authors

Nicole Wienrich

Nicole Wienrich has been with the IASS since 2017. She was a project manager for the IKI STRONG High Seas project at the IASS in 2017/18. Since 2018, her work as research associate at the IASS focuses on topics related to regional ocean governance processes, global and regional governance of marine plastic litter, and marine conservation in the Arctic. She forms part of the research groups on Ocean Governance and Arctic Governance.

Previous to joining the IASS, Nicole Wienrich worked as a freelance consultant on sustainable agriculture and tourism with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and was a programme assistant with the Forum Ziviler Friedensdienst e.V. in Davao City, Philippines. She holds a Master's in Sustainable Development from the universities of Utrecht und Leipzig and a BA in Social Science and Communication Studies from the University of Erfurt.

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Contact:
Nicole.Wienrich@iass-potsdam.de

Address:
Berliner Strasse 130
14467 Potsdam
Tel: +49 (0) 331-28822-340
Fax: +49 (0) 331-28822-310
Email: media@iass-potsdam.de
www.iass-potsdam.de

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