WWF

FACTSHEET

DK

Photo: Crystal Cruises

CRUISE SHIP TOURISM IN GREENLAND
MODELING A POTENTIAL OIL SPILL ACCIDENT

The Arctic has become a favoured tourist destination. Every year both the number of tourists and the miles navigated by cruise ships increase. The rising tourist industry bring potential benefits for Arctic communities, but navigating the Arctic is not easy: extreme weather, difficult ice conditions, incomplete charting and limited search and rescue capabilities challenge the safety of passengers and the sensitive marine ecosystems. To better understand the risks WWF have modelled a cruise ship oil spill accident happening at one of Greenland's most popular cruise ship destinations.

The ocean is the cornerstone of life in the Arctic. Many Arctic communities rely on the marine ecosystem for food and subsistence, and the Arctic nations rely on fisheries for jobs and export.

As the Arctic warms and the sea ice retreats new areas open up to ship traffic and the cruise season is longer. The increased ship activity brings potential for progress and development for the Arctic communities, but it also poses a potential threat to the environment. The Arctic Council has in the Arctic Marine Shipping Assessment (2009) identified oil spills as the most serious threat to the Arctic environment.

One of the most popular cruise destinations in Greenland is Disko Bay, where ships visit Ilulissat, Aasiaat and Disko Island.

Disko Bay and Store Hellefiskebanke off the coast of West Greenland are very important places for ocean life and for local fisheries and tourism. This has led WWF to consider what would happen if a large cruise ship grounded off Disko Island, causing a major oil spill accident.

Oil spill modelling

Modelling can be a powerful tool for visualizing the potential impacts of accidental oil spills. These scenarios can effectively be used to evaluate the risk, take the proper precautions and inform planning decisions about how the marine environmental preparedness should be structured and dimensioned. This is important in the Arctic where clean-up is particularly difficult due to the harsh and isolated conditions.

Thus WWF has commissioned research into the potential trajectory of a variety of oil spills that might occur in the Arctic.

This fact sheet focuses on oil spill from a cruise ship and is part of a series of five different oil spill scenarios in the waters between Greenland and Canada including: The North Water Polynya, Disko Island, Baffin Bay, Lancaster Sound and Eclipse Sound. Find the full report on wwf.dk

The modelling was done in cooperation with Shoal's Edge Consulting, an environmental consulting firm that provides specialized services in oil spill risk and impact assessment.

The location

The location for the hypothetical oil spill is south of Disko Island/Qeqertarsuaq in Disko Bay, West Greenland. This location was chosen as it is one of the most popular cruise ship destinations. Disko Island and the city of Qeqertarsuaq receive approximately 15-20 cruise ships per week during the cruise season of July to September, or approximately 240 cruise ships a year.

Navigation around Disko Island is difficult, and the presence of rocks near the shipping lane makes this area a very likely location for a grounding accident. In fact, the chosen spill site location is only 15 km south of the location of the MS Quest grounding in June 2007.

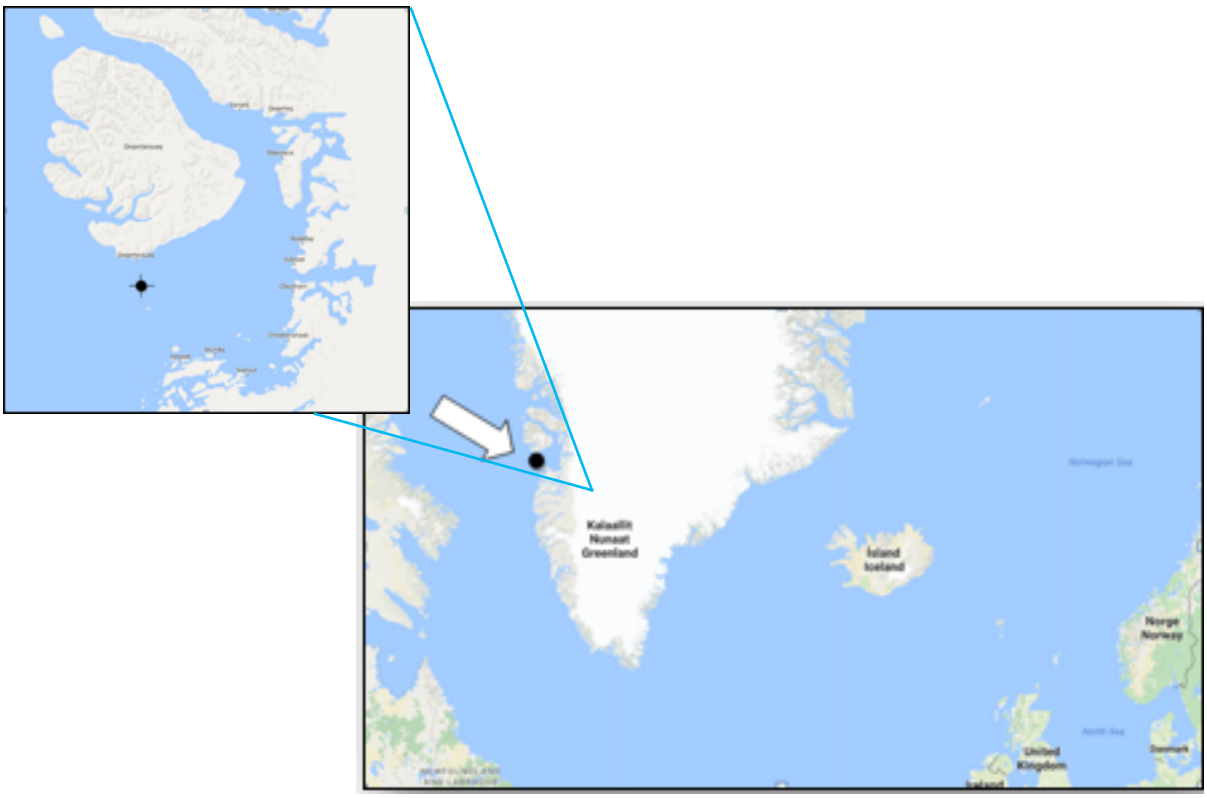

Figure 1 The location of the hypothetical cruise ship grounding

The area around Disko Island has a very high biological spring productivity, making it a favourable foraging and birthing area for many marine mammals and sea birds. The spill location is within the Particular Sensitive Sea Area recognized by DCE (Danish Centre for Environment and Energy), University of Aarhus and Greenland Institute of Natural Resources (2012). The region has been identified as a potential SUPER-EBSA, meaning that it is a particularly Ecologically or Biologically Significant Marine Area by the IUCN (International Union for Conservation of Nature). Several species depend on the resources in this area – especially the high numbers of capelin (*Mallotus villosus*), sandeel (*Ammodytes sp.*) and copepods (*Calanus sp.*) attract many marine mammals and sea birds.

In addition, the marine resources of Disko Bay is of socio-economic significance for the entire region. Fishery is the dominant industry in the region and targeted species include Greenland halibut (*Reinhardtius hippoglossoides*) and shrimp (*Pandalus borealis*), but also cod (*Gadus morhua*), lumpfish (*Cyclopterus lumpus*) and snow crab (*Chionoecetes opilio*). Pristine nature with calving glaciers and migrating whales makes Disko Bay a hotspot for eco-tourism as well.

The scenario

The modelling was done using a worst-case accident, in other words using the largest ship to transit the waters of Disko Bay and the largest bunker fuel volume. The spill volume is therefore based on a 68,000 GT (gross tonnage) cruise ship, with a bunker fuel volume of 2,800 m^3 (1,761 barrels) such as the Crystal Serenity, which has regularly-scheduled cruises to Ilulissat during August and September. The oil type selected for modelling was an intermediate fuel oil (IFO 180), which is typical for a larger cruise ship.

Intermediate heavy fuel oils pose greater health and environmental consequences and would be a greater challenge for clean-up response operations than lighter fuels such as diesel.

The modelled spill scenario assumed a spill volume of 280 m^3 corresponding to 10 % of the bunker fuel. This volume would generally be considered a "maximum most-probable" discharge for a vessel of this size and type. It was assumed that the oil leakage would continue over the course of 12 hours.

Coastline on Disko Island. Photo: Simone Gress Hansen

The way it was done

The possible effects of an oil spill is presented in two different ways. One way, using a stochastic model (SIMAP™ stochastic 3-dimensional) to show average impacts given a wide range of environmental conditions. The other, using a deterministic model (RPS ASA's OILMAP Deep™) to show a single selected worst-case spill event.

The models predict the course of the oil through the water, focusing on potential impacts on the shoreline and water surface.

This was done by using site-specific information affecting how oil moves through water including: ocean currents, ice cover, wind speed, wind direction, water temperature, salinity and density.

Of course, it is important to acknowledge that there are big limitations on any attempt to accurately predict the impacts of a major spill in a complex environment. But the modelling does help to provide a good general idea of how a particular spill event is likely to unfold.

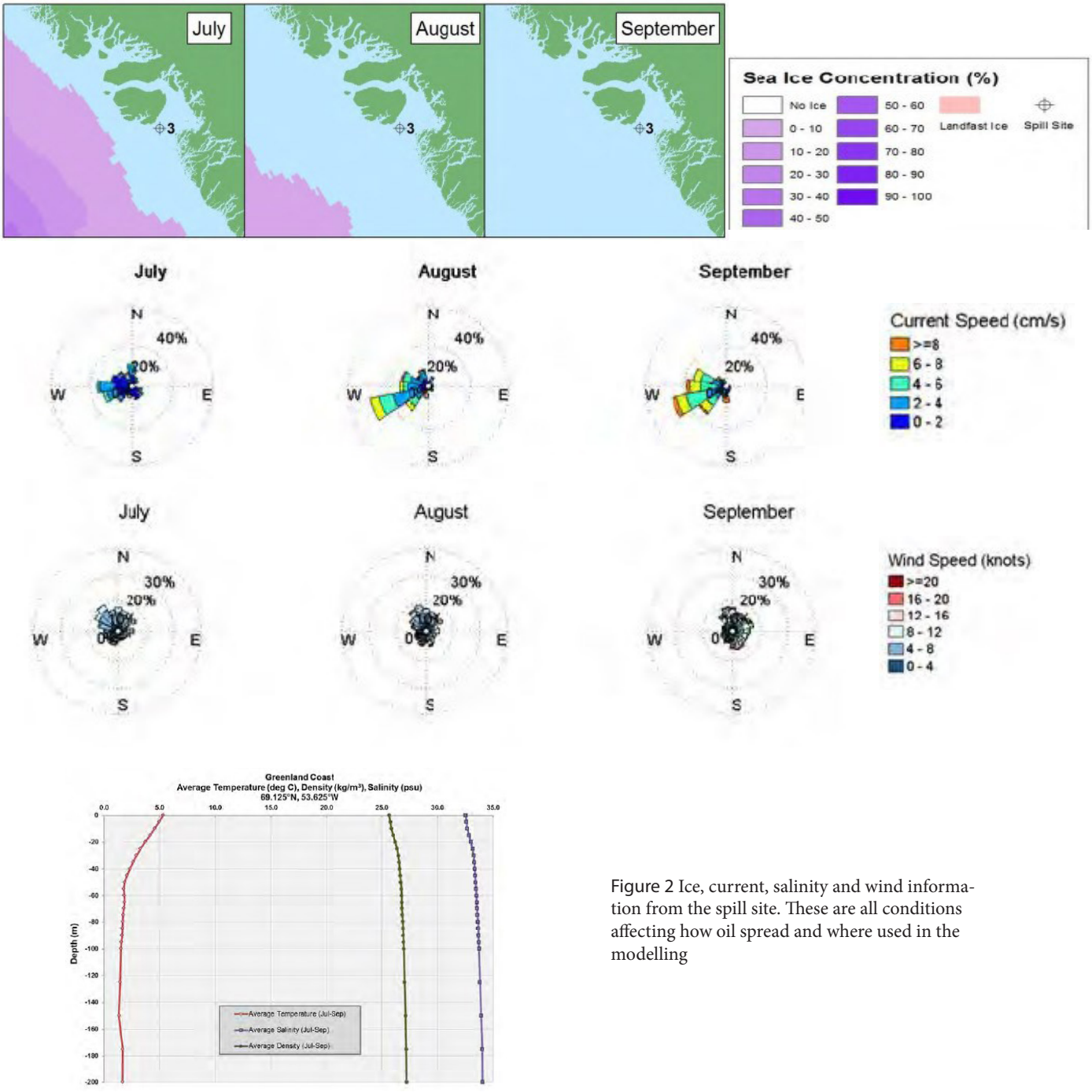

Figure 2 Ice, current, salinity and wind information from the spill site. These are all conditions affecting how oil spread and where used in the modelling

Results

The oil movement can be shown in three maps, showing where oil might spread out on the surface and on the shoreline. The light and dark green areas show where the probability of oil spreading is less than 50%, while the much smaller yellow/red region shows areas where the probability is higher than 50%.

The three maps represent different concentrations of oil pollution (0,01 g/m^2, 10 g/m^2 and 100 g/m^2) explained below.

Surface oil 0.01 g/m^2 "The socioeconomic threshold"

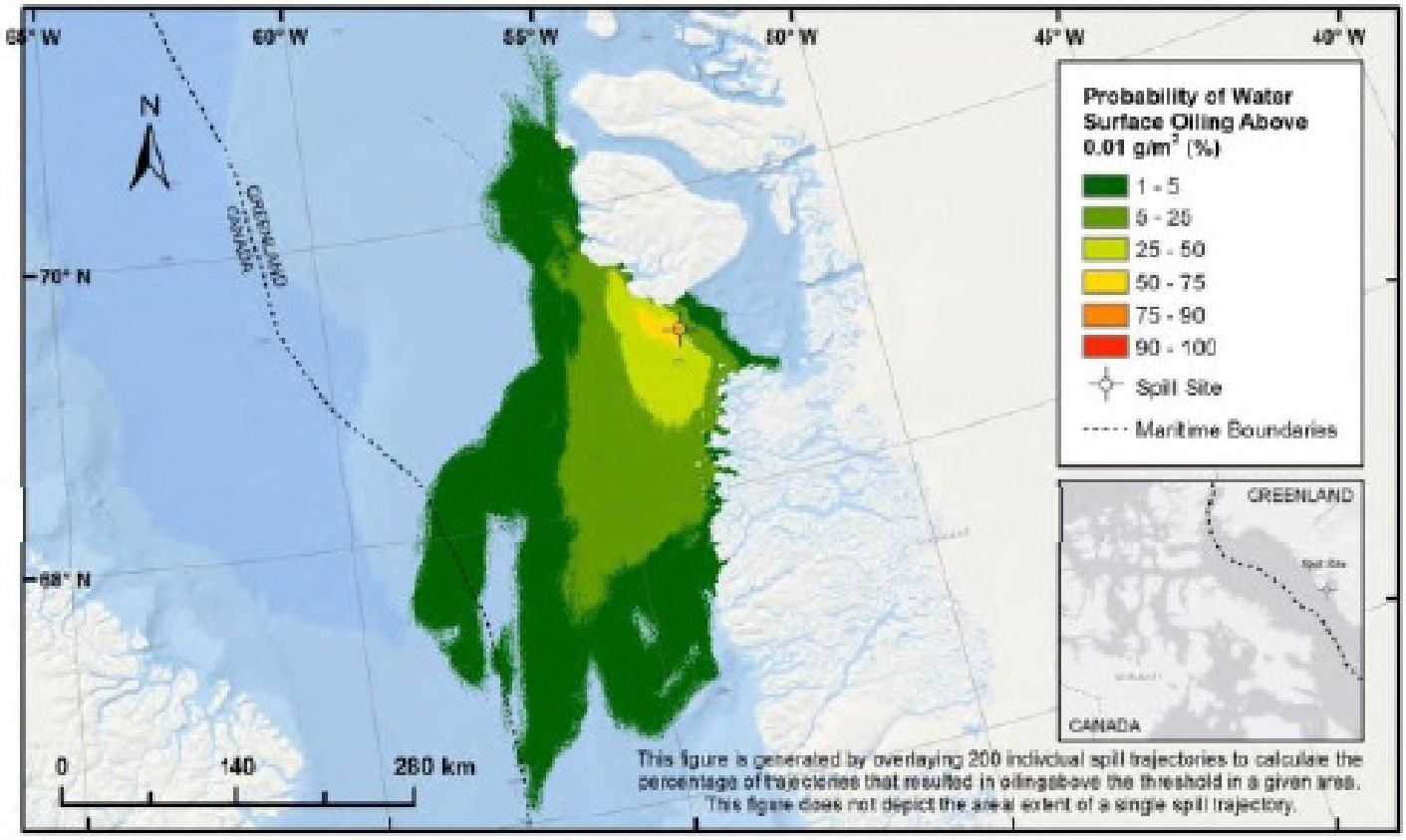

Figure 3 the result of modelling surface oil 0.01 g/m^2

Even at low concentrations like 0.01 g/m^2 (a hundredth of a gram per square metre) oil can have significant impacts. The model shows that oil in the surface water will vary in direction, but the zone of highest probabilities is oriented to the northwest of the spill site towards Disko Island. There is a low to moderate probability of water surface oiling to the south of the spill site, and a very low (less than 5%) probability of oiling in Canadian territorial waters.

Oil in a concentration of 0.01 g/m^2 would be visible as a silver sheen on the water surface, the oil would mean that fish would be contaminated as they are brought to the surface and therefore fishing in the area would be prohibited.

An oil spill would have severe socio-economic consequences since in this area, shrimp, crab and Greenland halibut fisheries are important to the Greenland economy. The concentration of 0.01 g/m^2 is thus called "the socio-economic threshold".

This region is within the Particular Sensitive Sea Area recognized by DCE, and an oil spill here will have important environmental impacts on marine mammals and seabirds. The area is important wintering ground for several seabirds such as: king eider *(Somateria spectabilis*), ivory gull (*Pagophila eburnean*), common eider (*Somateria mollissima*) and thick-billed murre (*Uria lomvia*).

More than half a million king eiders use Store Hellefiskebanke as resting and wintering ground making this area critical for the population. From July to September the area is used as moulting ground. During this period the birds are particularly sensitive to disturbances and cannot fly.

During winter, narwhals stay in the deep ice-covered waters of Baffin Bay here they depend on cracks and openings in the ice for breathing. Pollution of the marine environment with oil can have severe consequences for the species. The narwhal is listed as critically endangered on the 2006 Greenland red list and near threatened on the 2012 IUCN global red list. The narwhal is challenged by loss of sea ice due to climate change, but also disturbances from oil and gas development, shipping and unsustainable harvest.

Surface oil 10 g/m^2

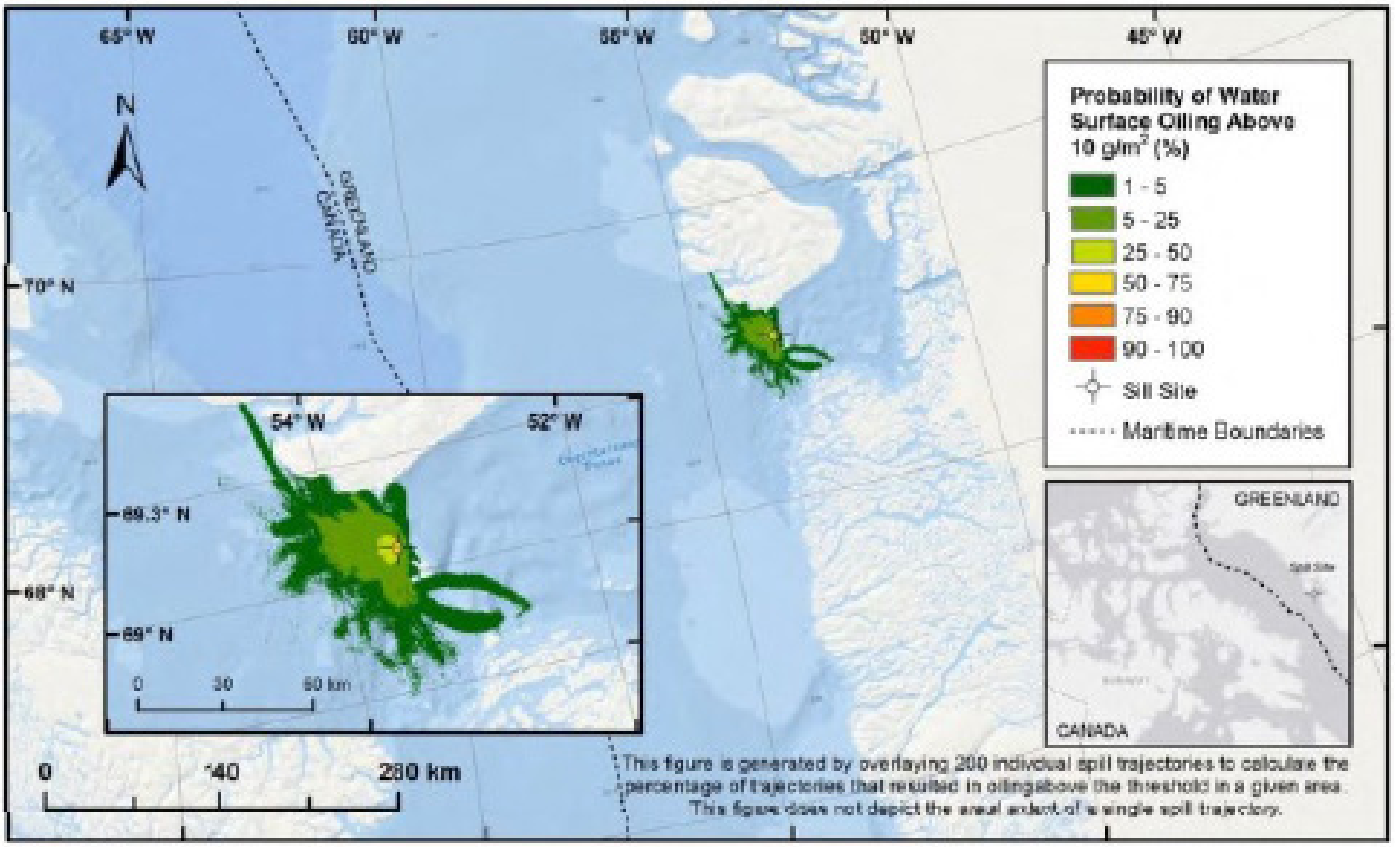

Figure 4 the result of surface oil 10 g/m^2

Oil in a concentration of 10 g/m^2 (one thousand times higher than the socioeconomic threshold) could kill birds and other wildlife on the surface of the water. The model shows that around 12 km^2 of the water surface would likely be covered with oil in higher concentrations than 10 g/m^2. Areas of moderate or high probability are limited to within a few kilometres of the spill site, and he footprint is restricted to Greenlandic waters at the mouth of Disko Bay.

The peak volume of oil that is mixed deeper into the water column is only about 0.1% of the total volume spilled. Heavy fuel does not easily mix into the water.

This region is a hotspot for seabirds living off the zooplankton and fish in the area. Most Sea birds die from cold if they come in to contact with oil, since the oil destroys the isolating capacity of their feathers.

The islands of Grønne Ejland/Kitsissunnguit are protected by law because of their status as an important site for Arctic tern *(Sterna paradisaea)*. Several other bird colonies are found in this region, giving Disko Bay a high diversity of sea birds. Furthermore, the area is summer forage grounds for seals and whales such as humpback whale *(Megaptera novaeangliae)*, minke whale *(Balaenoptera acutorostrata)*, fin whale *(Balaenoptera physalus)* and especially bowhead whales *(Balaena mysticetus)* where pregnant females use the area south of Disko Island as key spring feeding grounds.

Shoreline oil 100 g/m^2 "The ecological threshold"

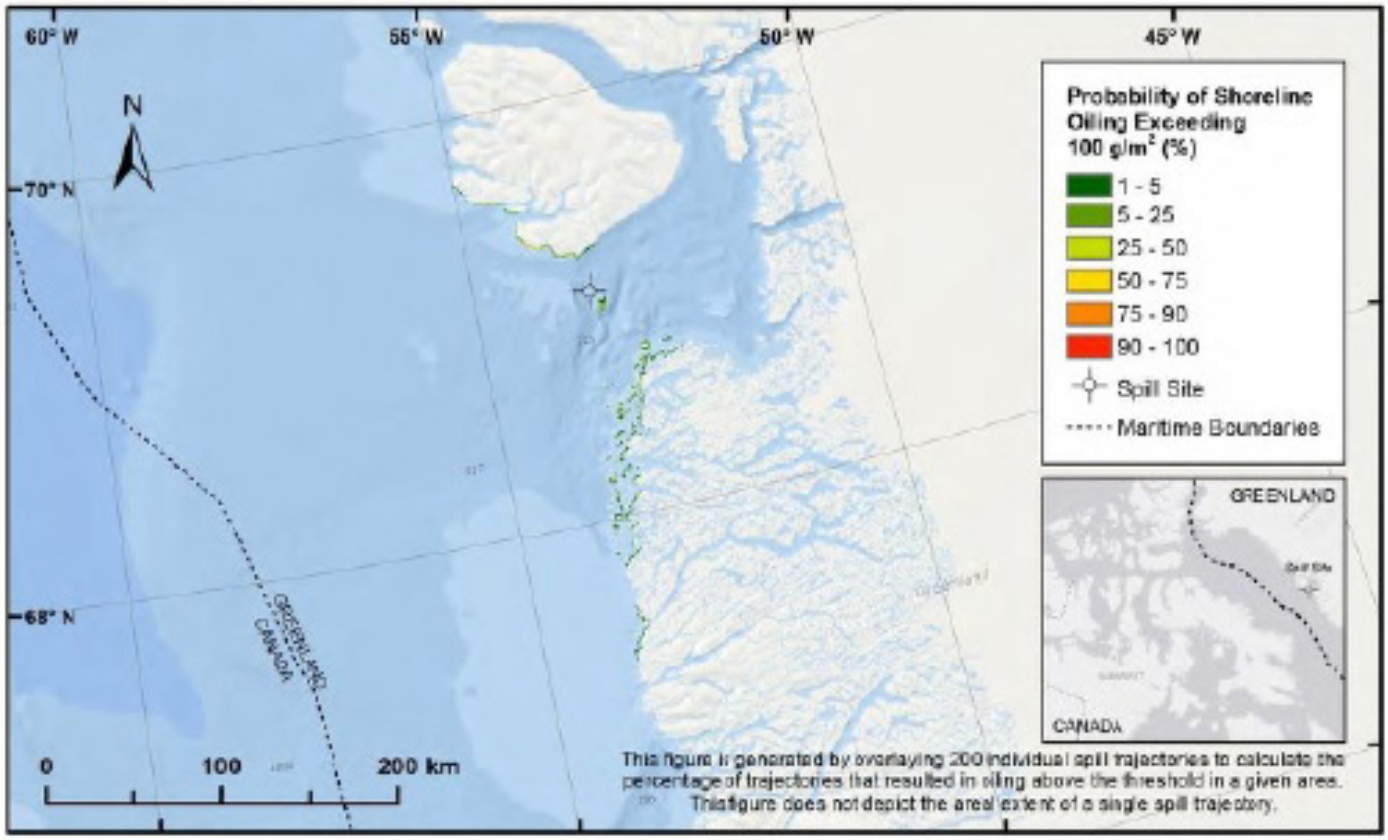

Figure 5 The result of shoreline oil in a concentration of 100 g/m

This map shows how large an area of the shoreline can be expected to be oiled at higher concentrations than 100 g/m^2. There is a very high (95%) risk of some oil reaching the shoreline in concentrations higher than 100 g/m^2. However, because of the variable effects of winds and currents it is only possible to say that the probability of oil (exceeding 100 g/m^2) reaching any particular location is less than 50% (31%), therefore the area is marked with light green/ yellow on the map. In other words, it is virtually certain that oil will reach the shoreline, but very difficult to predict exactly where.

Due to the persistent nature of heavy fuel, about two thirds of the total volume spilled will reach shore, resulting in a relatively large impacted shoreline area. The average length of shoreline oiled is 49 km, with an average total volume of 186 m^3 reaching shore. The highest probability of oiling is for shorelines to the northwest of the spill site on Disko Island (west of Qeqertarsuaq). There is a low probability of shoreline oiling along the coastline from Aasiaat and south towards Attu.

The minimum time for oil to first reach shore is 12 hours, which could make for a challenging response effort. Shoreline oiling can have the most visible and long-lasting impacts, this concentration is called the ecological threshold since it can affect many animals connected to the shore, such as arctic char (*Salvelinus alpinus*) and capelin, which are important fish for the local communities, and is used for selling and subsistence. Capelin lay their eggs in high numbers in the tidal zone on shore, and arctic char is found in many of the fresh-water streams opening out to the sea along the shore. Capelin is a key forage species for the whales feeding in the area during summer.

During winter the coastal areas serve as key wintering grounds for several species. Belugas and bowhead whales are found on the shallow banks along the coast during winter, where they feed and benefit from the high marine production in the area. There is also a high risk that the benthic organisms such as mussels will be polluted during an oil spill. This will especially affect walrus and king eiders that are found in very high numbers around Store Hellefiskebanke feeding on the rich benthic flora.

Humpback whales feeding on capelin off the coast of Disko Island. Photo: Jean-Claude Kresse

An individual spill

So far we have looked at the spreading of oil using an average of 200 different climatic conditions. This is useful information when planning emergency and clean up preparedness, but WWF also wanted to illustrate what an individual worst-case spill scenario might look like.

This was done by selecting two model runs; out of the 200 used in the previous approach, one of which produced the largest area of surface oiling, and the other produced the highest shoreline impacts.

Surface oiling

The orange and red colors show places where oil concentrations exceed 10 g/m^2, while the green and yellow areas show areas that exceed the socio-economic threshold of 0.01 g/m^2.

The whole area between northwest of Disko Island to Aasiaat will be polluted by the oil.

The highest concentrations will be restricted to the area around the spill site and spreading southwards towards Aasiaat. Oil in concentrations higher than the socio-economic threshold

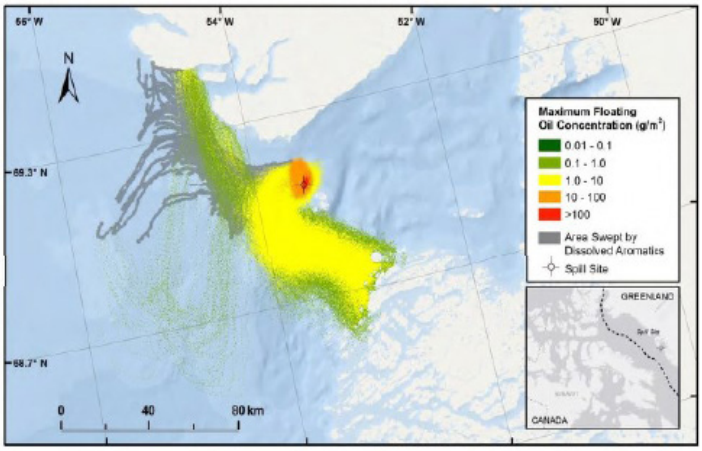

Figure 6 Individual worst-case surface oiling scenario

Shoreline oiling

The dark blue and purple colors show where the shoreline oil exceeds the ecological threshold of 100 g/m^2.

The oil reaches both the coast of Disko Island north of the spill site and the Islands to the southeast. Finally the oil spreads west reaching the shoreline around Aasiaat.

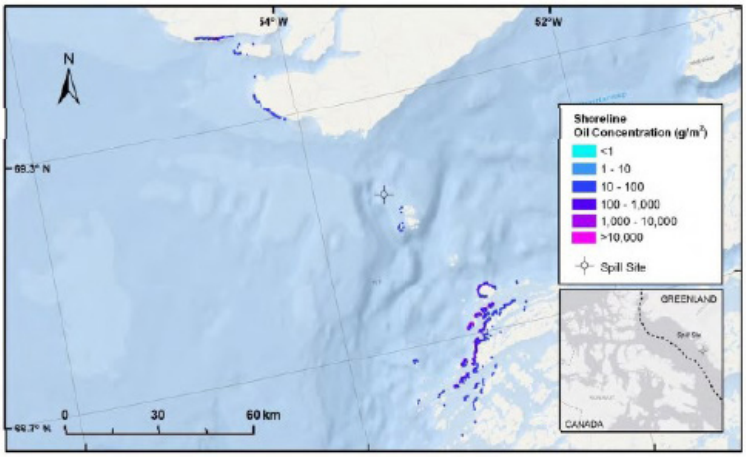

Figure 7 Individual worst-case shoreline oiling scenario

Icebergs in Disco Bay with Disco Island in the back. Photo: Simone Gress Hansen

Impacts of an oil spill

The Arctic environment contains unique habitats and wildlife that are particularly sensitive to disturbances and environmental catastrophes.

The area around Disko Bay and Store Hellefiskebanke is important to marine mammals and seabirds throughout the year. Several species congregate in the area for spring/summer and wintering ground. Short seasons and great seasonal variation mean that very high concentrations of the wildlife populations will be gathered within a limited area. Any interference can have serious consequences, and here even a small local disturbance would have big impacts on the population.

DCE have in their report "Disko West: A strategic environmental impact assessment of hydrocarbon activities" concluded that many marine mammals, on an annual basis use the waters around West Greenland as main forage ground, therefore effects from oil spills may have disproportionably high impacts here.

Belugas, narwhals, bowhead whales and walruses are especially sensitive because they all have small or declining populations. Sea birds are highly vulnerable, since this area contains several bird cliffs and moulting areas.

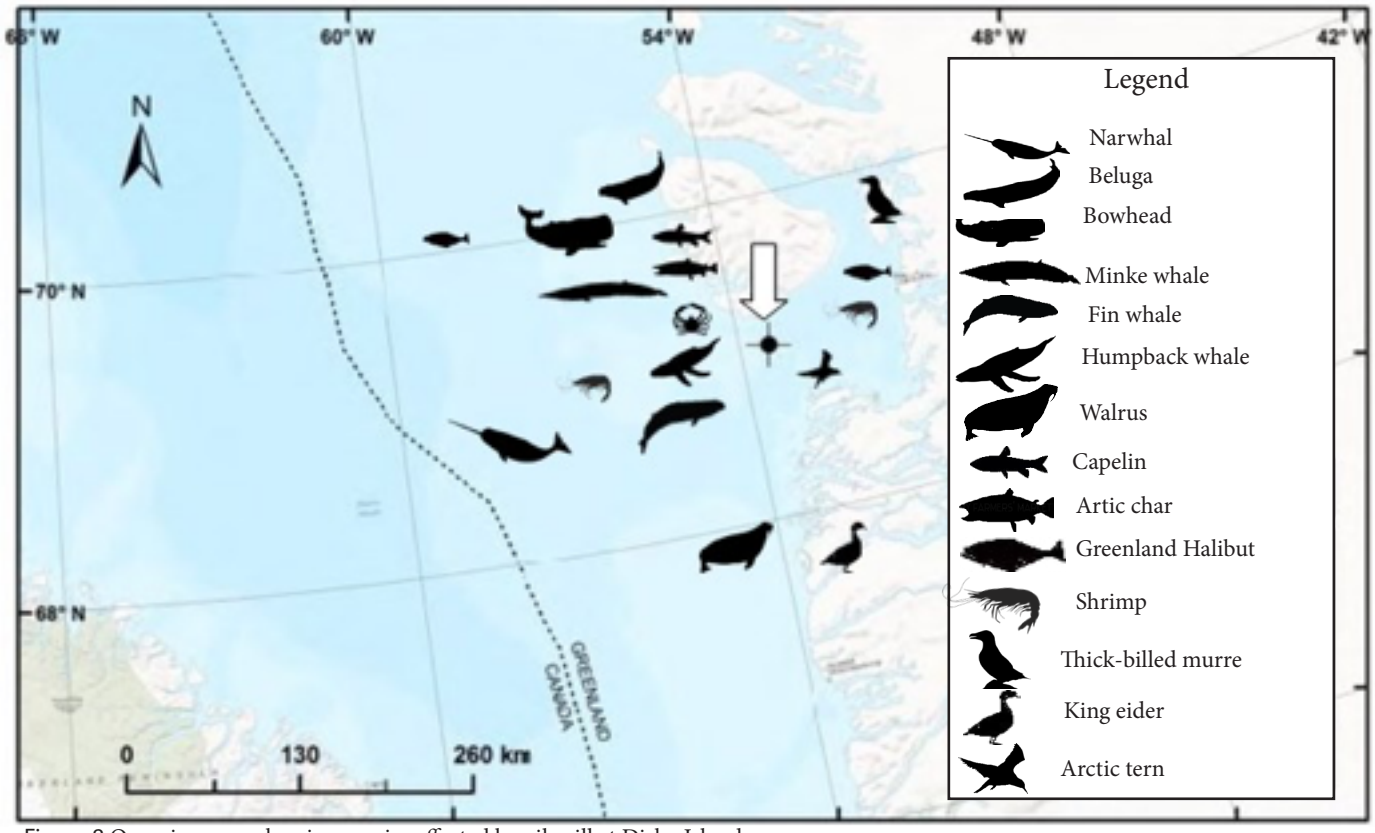

Figure 8 Overview map showing species affected by oil spill at Disko Island

Tourism - potentially great potentially risky

Standing on deck surrounded by icebergs, while watching whales under the midnight sun. It is no wonder cruise tourists love the Arctic. In 2016 a total of 66.876 tourists visited Greenland; of these 24.244 were cruise ship tourists. Today tourism makes up 2-5 % of the Greenlandic economy making it the third biggest economic sector in Greenland. The Government of Greenland plan to double cruise ship tourism by 2040. Tourism has a great potential for creating economic development, employment and a stable and improved economy in Greenland.

But it is necessary to take the proper precautions when increasing the ship traffic. The unspoiled natural environment is what attracts most tourists. It would be unfortunate if tourism caused harm to this same environment. A healthy and productive marine ecosystem is crucial to Greenland. This is for example demonstrated by exports from fish and sea food accounting for more than 90 % of the total export value. The fishery sector is one of the biggest employers of both men and women.

Hunting and fishing is fundamental for life and culture in Greenland, many communities maintain a subsistence lifestyle where the majority of the food comes from the sea. Closure of the fishing and hunting areas in Disko region due to an oil spill - even only temporary would have severe economic and societal consequences.

Besides risk of oil spill, there are several environmental impacts related to cruise ship traffic in the Arctic:

- Ships generate noise over and under water drowning out the sounds whales use to communicate, find food and avoid predators
- Collisions between ships and marine mammals
- Disturbances of seabirds
- Ice destruction - Ice is an important habitat for several Arctic species
- Cultural consequences such as strains on small communities without capacity to receive a high number of tourists
- Introduction of invasive species in the ship's ballast water
- Discharge of sewage, grey water, oily bilge water and trash, these substances can create both immediate and long-term environmental damage

WWF is working to persuade governments to agree to ban the use of heavy fuel oil in Arctic waters and to promote responsible shipping practices to reduce the risk to Arctic wildlife and peoples.

For more information please contact:

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To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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This fact sheet focuses on oil spill from cruise ships and is part of a series of five different oil spill scenarios in the waters between Greenland and Canada including: The North Water Polynya/Pikialasorsuaq, Disko Island, Baffin Bay, Lancaster Sound and Eclipse Sound. Find the full report on http://www.wwf.dk/wwfs_arbejde/gronland_og_arktis/sadan_arbejder_vi/scenarier_for_oliespild_i_gronland/

Read more about WWF's international work in the Arctic http://wwf.panda.org/what_we_do/where_we_work/arctic/last_ice_area/polynya/

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