ENVIRONMENTAL OIL SPILL SENSITIVITY ATLAS FOR THE NORTHWEST GREENLAND (75°-77° N) COASTAL ZONE

Scientific Report from DCE – Danish Centre for Environment and Energy No. 196 2016

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Data sheet

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Abstract: This oil spill sensitivity atlas covers the shoreline and the offshore areas of West Greenland between 75° N and 77° N. The coastal zone is divided into 53 shoreline segments, and the offshore zone into 4 areas. A sensitivity index value is calculated for each segment/area, and each segment/area is subsequently ranked according to four degrees of sensitivity. Besides this general ranking, a number of smaller areas are especially selected, as they are of particular significance. They are especially vulnerable to oil spills and they have a size making oil spill response possible. The shoreline sensitivity rankings are shown on 15 maps (in scale 1:250,000), which also show the different elements included in the analysis and the selected areas. Coast types, logistics and proposed response methods along the coasts are shown on another 15 maps. The sensitivities of the offshore zones are depicted on four maps, one for each season. Based on all the information, appropriate oil spill response methods have been assessed for each area.

Keywords:	Northwest Greenland, oil spill sensitivity mapping, shoreline oil spill sensitivity, offshore oil spill sensitivity, coastal zone environmental mapping, meteorology, oceanography, ice conditions, coastal morphology, human use, archaeology, local knowledge, marine mammals, seabirds, fish, logistics, oil spill response.
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Contents

Preface

This Atlas was produced as a part of the preparations for exploratory oil/gas drilling offshore Greenland. It is a continuation of the atlases covering the regions 58° N to 62° N, 62° N to 68° N, 68° N to 72° N and 72° N to 75° N, produced in respectively 2004, 2000, 2012 and 2011.

The atlas is based the available information. However, this is by no means complete and as further information becomes available, it will be relevant to update the atlas.

The atlas is primarily produced as an oil spill response tool, but will be useful for other management purposes as well.

The study team

DCE - Danish Centre for Environment and Energy, headed and performed the main part of the study.

DCE has prepared the coastal morphology interpretation, provided and processed the biological information in the Atlas and prepared the shoreline and offshore sensitivity maps. DCE also developed versions on CD and to the internet.

SL Ross Environmental Research Ltd. developed the sections on countermeasures, access and safe havens on the Physical Environment and Logistics maps.

Greenland National Museum & Archives (NKA) compiled and reviewed the archaeological information.

The Greenland Institute of Natural Resources (GINR) contributed with information regarding living resources (fish, marine mammals) and their use. As a part of the project, a study of local knowledge was carried out by GINR (Appendix C, Chapter 12).

The software application used to generate shoreline and offshore sensitivity scores was originally developed for the first atlas (Mosbech et al. 2000) in co-operation with AXYS Environmental Consulting Ltd. The map layout applied was originally developed in collaboration with The Geological Survey of Denmark and Greenland (GEUS).

1 Summary

This atlas is produced as a part of the preparations for exploratory drilling offshore Greenland. The objective of the project is to give an overview of resources vulnerable to oil spills, for example biological resources (fish, birds etc.), which again will be implemented as a tool for oil spill response. The project covers the region between 75° N and 77° N in West Greenland, including the offshore waters to the Canadian border.

The following elements are included in the project

- coast types,
- oceanography, ice and climate,
- biological resources (fish, birds etc.),
- fishing and hunting,
- tourism,
- protected areas,
- archaeological sites,
- logistics and oil spill response methods.

As the oil spill sensitive resources are very different in character (e.g. seabird breeding colonies, important fishing areas and archaeological sites), it has been common practice to calculate an index value of the sensitivity of a specific area in order to compare areas with different characteristics. The index calculations are based on a Canadian system, which has been used in Lancaster Sound. An overview of the methods used in the atlas is given in Chapter 5.

The coastline is divided into areas (coastlines and groups of islands) approx. 50 km long. Each area has been ranked in one of four degrees of sensitivity based on the index calculation that includes abundance and sensitivity of a number of environmental or community elements (e.g. different birds and marine mammals, hunting areas and archaeological sites).

Besides the general classification of coastal sensitivity, the mapsheets of the atlas also show smaller selected areas. They have been selected as being of particular significance, particularly vulnerable to oil spills and as being of a size, where an effective oil spill response can be performed.

As a part of the project, classification of the coastline morphology has been conducted from satellite photography, e.g. the occurrence of rocky shores and beaches, and geological and topographical maps. An index value of the self-cleaning ability of the coast after an oil spill has been calculated based on this classification in combination with shoreline exposure to waves and ice. For example, oil on a rocky coast exposed to wave action will be cleaned faster than oil on a beach in a protected lagoon.

Based on all the information, appropriate methods to respond to oil spills in the different areas have been assessed.

Chapter 7 in the atlas contains offshore and overview information, primarily in 1:2.5 million scale maps, and Chapter 8 contains detailed coastal information in 1: 250,000 scale maps. Chapter 5 is a user's guide common to Chapter 7 and 8.

Chapter 7 contains maps showing the sensitivity of the offshore areas and with indication of the elements used in the classification (fishing areas, fish, birds and marine mammals). A number of maps show ice conditions and the most important biological resources and their use, e.g. deep sea shrimp and Greenland halibut.

Chapter 8 contains 15 maps in the scale 1: 250,000 showing index values for coastal sensitivity and symbols for the elements of the classification (hunting and fishing areas, fish, birds, marine mammals and archaeological sites). The maps also show the selected areas. Each map has a description of biological resources and human use of the area.

Chapter 8 also contains 15 maps showing coast types, logistics and proposed methods to oil spill response for each area.

The Environment Agency for the Mineral Resources Activities of the Government of Greenland (EAMRA) financed the preparation of the atlas.

This atlas was prepared by DCE - Danish Centre for Environment and Energy/ Aarhus University, The Greenland Institute of Natural Resources, The Greenland National Museum and Archives and Canadian SL Ross Environmental Research Ltd.

2 Eqikkaaneq

Ukioq 2000 uuliamik ujaasisoq Statoil, Nuuk eqqaani ´fyllas banke´uuliamik gassimillu qilleripput. 1977-miilli siullermik kalaallit Nunaami immami qillerisoqarpoq. Taamanili firmaat Cain Energy katillugit arfineq pingasunik misiliutinik qillerillutik, taakkunanilu Davids stræde, Diskollu imaani aasaanerani ukiuni 2010-11 pillutik. Tassungalu arfineq malunnik kisermaassinissamik akuersissummik pisimallutik, taakkunanili akuersissutit pingasut utertissimallugit. Kingulliit tallimat Baffin bugt avannaani siesmiskimik misissuillutik.

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Takussutissami pineqatut ukuupput:

- sinerissat assigiinngitsut nassuiarneqarnerat,
- immamut, sikunut silallu pissusiinut tunngasut,
- uumasut isumalluutit (timmissat, aalisakkat il.il.),
- aalisarneq piniarnerlu,
- sumiiffiit immikkut illersorneqartut (assersuutigalugu timmissat ineqarfii),
- qangarsuarnitsat eriagisassat,
- Takornariartitsineq
- Logistiskimik pissutsit periarsinnaanermik piareersarneq uuliamik kuuttoqariasaarsinnaaneranik piareersimaniarlutik.

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atorlugit, qanoq pinngortitap inuiaallu eqqugaasinnaaffii (timmissat assigiinngitsut, miluumasut, piniartafiit, aalisartarfiit, itsarnisallu il.il). Tamakku nalilersorneqartarput qanoq uuliamik aniasoqarnissaanut malussarissusaat, taavalu kisitsitigut/ pingaarutikkullu takkutikulassusiallu agguataarnerni nalilertarlugit.

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Atlas takussutissaq immikkoortortaqarpoq sinerissap avataani ujarlerfinnut tunngatillugu takussutissanik nunap assilianillu (kapitel 7) pingaartumik angissutsinut uuttuutit 1:1,25 million. Immikkoortup allaap imarai sinerissap qanittuanut tunngatillugu paasissutissat (kapitel 8) nunap assingi angissutsinut uuttuut 1:250.000 atorlugu. Kapitel 5-ip nunap assingisa kapitel 7 aamma 8-miittut atornissaannut ilitsersuutit imarai.

Kapitel 7 nunap assinginik avataasiorluni ujarlerfiit misikkarissusiannut pineqartunut ilisarnaatit qanoq inissisimanerinut takussutissanik imaqarpoq (aalisarfiit, aalisakkat, timmissat miluumasulluimarmiut).

Kapitel 8 nunap assinginik 15-inik angissutsinut uuttuut 1:250.000 atorlugu sanaanik imaqarpoq.

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Suliaq Aatsitassanik suliassaqarfinnut Avatangiisinut Aqutsisoqarfik (Miljøstyrelsen for Råstofområdet) aningaasalerneqarpoq, DCE - Nationalt Center for Energi og miljø/Aahus Universit-mik, Pinngortitaleriffik, Nunatta katersugaasivia allagaateqarfialu, minnerunngitsumillu Canadami siunnersuisut S.L Ross environmental Ltd.

3 Sammenfatning

I sommeren 2000 udførte olieselskabet Statoil en boring efter olie/gas på havet vest for Fyllas Banke ud for Nuuk. Det var den første boring til havs i Grønland siden 1977. Siden foretog det skotske firma Cairn Energy i alt otte efterforskningsboringer i Davis Stræde og i farvandet vest for Disko i somrene 2010 og -11. Dertil er der givet 7 eneretstilladelser til efterforskning og udnyttelse i Baffin Bugt, hvoraf de tre dog siden er leveret tilbage. De resterende fem tilladelser ligger i den nordlige del af Baffin Bugt, og her er der ind til videre kun foretaget seismiske undersøgelser.

Som led i forberedelserne til Statoils boring i 2000 iværksatte de danske og grønlandske myndigheder en kortlægning af kyststrækninger, som er sårbare overfor eventuelle oliespild fra det sted, der blev boret. Der indgik tillige en vurdering af de åbne havområders sårbarhed. Hensigten med denne kortlægning var at få et samlet overblik over de ressourcer, der er følsomme over for olieforurening. Det drejer sig bl.a. om de biologiske ressourcer (forekomst af fisk, fugle m.v.), arkæologiske forekomster og om fiskeri- og fangstinteresser.

Det resulterende atlas bidrog til oliespildsberedskabet og indgik i prioriteringen og planlægningen af en eventuel indsats.

Det oprindelige atlas er efterfølgende blevet udvidet ad flere omgange. Først blev der i 2004 produceret et atlas dækkende fra 68° N til 72° N, samtidig blev atlasset også udvidet mod syd, så hele kyststrækningen til og med Kap Farvel nu var dækket. I 2011 blev atlasset yderligere udvidet fra 72° N til 75° N (udgivet særskilt). I 2012 blev atlasset over området mellem 68° N og 72° N opdateret med den nyeste tilgængelige viden. Med nærværende atlas er Grønlands vestkyst dækket fra havområderne syd for Kap Farvel (62° N) i Sydgrønland til Kap Perry ved Thule (77° N) i nord.

I projektet indgår følgende elementer:

- kysttypebeskrivelser,
- oceanografi, is og klima,
- biologiske ressourcer (fugle, fisk osv.),
- fiskeri og jagt,
- turisme,
- særligt beskyttede områder (f.eks. fuglefjelde),
- fortidsminder,
- logistiske forhold og metoder til at bekæmpe oliespild.

Da elementerne har meget forskellig karakter (f.eks. fuglekolonier, vigtige fiskeriområder og fortidsminder), er det almindeligt, at udregne index-værdier som udtryk for et områdes følsomhed, så forskellige områder kan sammenlignes og prioriteres. Der er udviklet en række forskellige index-systemer til dette formål. Det grønlandske atlas tager udgangspunkt i et canadisk system, der bl.a. er brugt i Lancaster Sound i det nordøstlige, arktiske Canada.

Kysten er inddelt i segmenter (områder) af ca. 50 km's længde, der er blevet klassificeret i fire grader af følsomhed. Klassifikationen er sket ved hjælp af en index-beregning, hvor der indgår et antal miljø- og samfundselementer (forskellige fugle og havpattedyrgrupper, jagtområder, fiskeriområder, fortidsminder m.v.). Disse elementer er givet dels en værdi for følsomhed overfor

oliespild, dels en værdi for, hvor talrig/vigtig forekomsten er i hvert segment. De biologiske elementers følsomhed over for oliespild beregnes ud fra, hvor sandsynligt det er, at den pågældende art kommer i kontakt med olie under et oliespild, samt hvor følsom arten er overfor olie. De biologiske elementer og deres udnyttelse indgår med den største vægt ved beregningen af segmenternes samlede følsomhed.

Udover den generelle klassificering af hele kystens følsomhed er der på kortene udpeget en række mindre områder. Disse områder er udvalgt, fordi de er særligt værdifulde, særligt følsomme overfor oliespild samt fordi de har en størrelse, der generelt gør det praktisk muligt at gennemføre en effektiv oliespildsbekæmpelse.

Som en del af projektet er der ud fra satellitfotografier og geologiske kort foretaget en morfologisk kortlægning af kysterne (deres opbygning og materialesammensætning, f.eks. om de består af klippeflader eller sand). Ud fra denne viden, og hvor udsatte de er overfor påvirkning fra bølger og is, er der udregnet et mål (index) for deres selvrensende evne efter en eventuel olieforurening. For eksempel vil en klippekyst, der er meget udsat for bølgeslag, hurtigere blive "vasket ren" for olie end en strand i en beskyttet lagune.

På baggrund af det samlede materiale er der foretaget en vurdering af egnede metoder til bekæmpelse af oliespild i de forskellige områder.

Atlasset indeholder en sektion med oversigtsinformation og kortlægning af offshore-områderne (kapitel 7), der hovedsageligt er angivet på kort i målestoksforholdet 1: 2,5 million, og en sektion med detaljeret information om de kystnære områder (kapitel 8) på kortblade i målestoksforholdet 1: 250.000. Kapitel 5 indeholder en fælles brugervejledning til kortene i kapitel 7 og 8.

Kapitel 7 indeholder kort, der viser offshore-områdernes følsomhed med symboler for elementerne i klassifikationen (fisk, fugle og havpattedyr). Desuden er der en række kort over de vigtigste områder for en række biologiske ressourcer og deres udnyttelse, bl.a. for narhval.

Kapitel 8 indeholder 15 kortblade i målestoksforholdet 1: 250.000 med angivelse af index-værdier for kysternes følsomhed og symboler for elementerne i klassifikationen (jagt- og fiskeriområder, fisk, fugle og havpattedyr samt fortidsminder). Kortene viser også de særligt udvalgte områder. Til hvert kortblad er der udarbejdet en beskrivelse med oplysninger om områdets udnyttelse og biologiske forekomster.

I kapitel 8 findes desuden 15 kortblade med angivelse af kysttyper og logistiske forhold samt forslag til metoder til bekæmpelse af oliespild for hvert område.

Projektets resultater er blevet præsenteret for og diskuteret med berørte kommuner og interesseorganisationer i en høringsfase undervejs.

Projektet er finansieret af Miljøstyrelsen for Råstofområdet. Det er udført af DCE – Nationalt Center for Energi og miljø/ Aarhus Universitet, Grønlands Naturinstitut, Grønlands Nationalmuseum og Arkiv, samt det canadiske konsulentfirma S.L. Ross Environmental Research Ltd.

4 Introduction

4.1 Objectives

This Environmental Oil Spill Sensitivity Atlas has been prepared to provide oil spill response planners and responders with tools to identify resources at risk, establish protection priorities and identify appropriate response and clean-up strategies.

The atlas is designed for planning and implementing year-round oil spill countermeasures in both coastal and offshore areas in Northwest Greenland between 75° N and 77° N latitude. An important component of the atlas is a sensitivity ranking system, which is used to calculate an index value describing the relative sensitivity of coastal and offshore areas. The sensitivity index value is calculated based on information on resource use (human use), biological occurrences and physical environment. The sensitivity ranking system is based on a Canadian system used in Lancaster Sound (Dickins et al. 1990) and modified to meet the specific requirements of the Greenland study area (see Chapter 5.3). As a supplement to the Canadian ranking system, a number of smaller areas have been selected for priority in case of an oil spill (see Chapter 6.4). The selection of these areas is based on the principles from a Norwegian system (Anker-Nilssen 1994), which gives priority to oil spill sensitive areas for oil spill contingency planning, combined with expert judgement.

Northwest Greenland between 75° N and 77° N covers the Qaanaaq (Thule) area. The area is very sparsely populated with one small settlement, Savissivik with approx. 60 inhabitants. Furthermore Thule Air Base (TAB) is situated within the area, and approx. 700 people live here. Hunting and fishing are the main ways of living in the settlement.

The area also includes the eastern part of the very important (in an ecological sense) North Water Polynya, which is a critical habitat to many seabirds and marine mammals.

This atlas is an extension of a similar atlas prepared for the central part of Northwest Greenland between 72° N and 75° N in 2011 (Mosbech et al. 2011). Combined with other previously released sensitivity atlases, the whole West Greenland coast from 60° N north to 77° N has now been mapped.

4.2 Contents and organisation

This atlas is produced as a pdf-document available as download on the DCE website. In addition to the report, the shoreline sensitivity maps and physical environment and logistics maps are also available in a GIS application, which makes it possible to produce seamless maps at various scales.

The information in the atlas is organised by map scale moving, from summary information (Chapter 6) in a scale of approx. 1: 2.5 million to operational information (Chapter 8) in a scale of 1: 250,000 (G/250 Vector copyright Danish Survey & Cadastre 1998).

Chapter 5 contains a user guide to the maps, which supplements the legend.

Chapter 6 is a summary of the information and data used in the atlas.

Chapter 7 contains the offshore and summary maps, which include:

- bathymetry,
- sea surface currents,
- overall distribution of important species,
- overview of extreme and highly sensitive areas,
- offshore sensitivity (winter, spring, summer and autumn),
- ice conditions.

Chapter 8 contains the coastline operational maps, which include Shoreline Sensitivity Maps with:

- shoreline species,
- resource use (human use),
- archaeological sites,
- sensitivity rankings,
- selected areas,

and Physical Environment and Logistics Maps with:

- shoreline geomorphology,
- anchorages and safe havens,
- access by boat or aircraft,
- descriptions of potential countermeasures.

Detailed accounts of methodology and data documentation, including a summary of the data used as well as the limitations, are given in Appendix C, Chapter 12.

4.3 Sensitivity index system

An environmental sensitivity ranking system is used in the atlas to determine and illustrate the relative sensitivity of shoreline and offshore areas of Northwest Greenland (75°-77° N) to the effects of an oil spill. This pre-spill ranking allows spill responders and on-scene planners to make a quick evaluation of which areas and environmental components are most susceptible to an oil spill and, thus, provides the information to consensus regarding protection priorities during a spill event.

Through the use of the sensitivity ranking system, each shoreline and offshore area receives a single numeric value, which represents the relative sensitivity of that area to a marine oil spill. This numeric value is ranked as extreme, high, moderate or low and is illustrated on the summary, regional and operational maps by the use of a colour code.

This ranking system is based on the scheme developed for the Canadian atlases (e.g. Lancaster Sound, Dickens et al. 1990), with some modifications to account for the different biological and physical features of the region. The sensitivity ranking system incorporates the biophysical and social elements of the region that are important from an oil spill perspective. These elements are

assigned to and ranked on a relative scale within three major categories: (1) resource (human) use; (2) species occurrence; and (3) oil residence. The latter category considers the oil residence periods associated with various coastal types and the differences in ice and open water zones for the shoreline and offshore areas of West Greenland, respectively. Each of the categories is assigned a weighting factor, which is based on their relative importance within the region. The elements within each of the categories are ranked based on their relative sensitivity to potential effects of oil spills. These assigned values are then multiplied by the weighting factor to produce a single numeric value the PI (priority index). It is the sum of the priority indices that determines the overall sensitivity of a specific shoreline or offshore area.

PI = AV x WF

and

S = sum of PI

where:

AV = assigned value of the element
WF = weighting factor of the category
PI = priority index
S = relative sensitivity of an area: the **sensitivity value**

Criteria for ranking the relative sensitivity of the human use elements are based on their importance to local residents from a cultural/historic and economic perspective and the replaceability of the resource.

Biological elements (species or species group) selected for the sensitivity index are listed in Table 4.1. They are selected based on their sensitivity to oil spills, their ecological importance and their importance to biodiversity and the local human population.

The following formula is used to calculate the AV (assigned value) for each biological element (species or species group):

AV = (RS x RA x TM x ORI) / C

Where:

RS = relative sensitivity of the species
RA = relative abundance of the species
TM = temporal modifier
ORI = oil residence index
C = constant used to reduce the maximum possible score.

The relative sensitivity (RS) for the species relies on available information regarding the vulnerability, recovery potential and the potential for lethal and sublethal effects, which are summarised in Table 4.1. The relative sensitivity for the selected species ranges from 7 to 25. The relative abundance and timing of occurrence of the selected species (biological elements) is extracted from available knowledge and encoded for each shoreline and offshore area.

Table 4.1. The relative sensitivity. The relative sensitivity (RS) and characteristics of the selected species or species groups in relation to oil spills. Note that there is not a complete correspondence between the species groups used in the shoreline and the offshore sensitivity calculation.

Species/ group name	Habitat	Vulnerability to oil spills	Mortality potential from oil spill	Sublethal potential from oil spills	Population recovery period	Relative sensitivity
Fish						
Greenland halibut	Offshore	Very low	Very low	Low	Short	7
Arctic char	Shoreline	Moderate	Low/short	Moderate	Moderate	14
Seabirds						
Alcids	Shoreline & offshore	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Gulls	Shoreline & offshore	Moderate	High/long	Very High/ No recovery	Low/Short	17
Little auks	Shoreline & offshore	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Seaducks	Offshore	Very high	High	Very high	Long	23
Seaducks breeding	Shoreline	Very high/ No recovery	High/long	Very High/ No recovery	High/long	23
Seaducks moulting	Shoreline	Very high/ No recovery	High/long	Very high/ No recovery	High/long	23
Surface feeders	Shoreline & offshore	High/long	High/long	High/long	Low/short	18
Non alcid pursuit divers*	Offshore	High/long	High/long	High/long	Moderate	19
Marine mammals						
Baleen whales	Offshore	Low/short	Very low/ Very short	Very low/ Very short	Moderate	9
Narwhal	Offshore	Low/short	Low/short	Low/short	Very high/ No recovery	13
Polar bear	Offshore & shoreline	High/long	High/long	High/long	Very high/ No recovery	21
Seals	Offshore & shoreline	Low/short	Low/short	High/long	Low/short	12
Walrus	Offshore & shoreline	High/long	Moderate	Low/short	Very high/ No recovery	18
White whale	Offshore	Low/short	Low/short	Low/short	Very high/ No recovery	13

*The species group non-alcid pursuit divers includes great cormorant, red-throated diver, and great northern diver. The species group surface feeders includes northern fulmar, black-legged kittiwake, arctic tern, and the large gull species. For a detailed description, see chapter 12 in the appendix.

The biological resource constant, "C", refers to a value that is used to limit the maximum possible biological resource score and, thus, to balance the importance of the biological components with the other components.

The oil residence index (ORI) provides a relative estimate of the potential residence period of oil stranded within the shore zone under normal conditions. The index is only an approximation, because many aspects of a spill are unknown until the time of the spill incident (e.g. the volume of spill, oil type, degree of weathering). The oil residence is ranked from 1 to 5, mainly based on the shoreline exposure class and the shoreline substrate. Table 4.2 shows the basic relation. A few minor modifications to the basic classification of the ORI value are made to account for slope (where steep shorelines are less vul-

nerable) and to account for a few geomorphologic coast types considered to have longer residence times (archipelagos, pocket beach, barrier beach and delta). Offshore ORI is determined by the length and extension of ice cover.

Table 4.2. Basic Oil Residence Index (ORI). Basic Oil Residence Index (ORI) ranking based on a combination of shoreline substrate and exposure class.

Substrate/ Exposure class	Protected	Semi-protected	Semi-exposed	Exposed
Coarse sediment	4	3	1	1
Fine sediment	4	3	1	1
Ice	1	1	1	1
Not classified	4	3	2	1
Rock	4	3	1	1
Rock and coarse sediment	5	4	2	1
Rock and fine sediment	5	4	2	1

4.4 Selected areas

In particular, a total of 6 areas along the coast and within fjords have been selected for priority in an oil spill situation. These areas are identified by a red polygon border and a number with the prefix, 'S'. The basis for their selection is that they are, relative to the shoreline in general: i) of high value either environmentally or for resource use; ii) sensitive to oil spills; and iii) of a size and form that may allow effective protection in an oil spill situation with a manageable amount of manpower and equipment. The selection of these areas is based on the principles from a Norwegian system (Anker-Nilssen 1994), combined with expert judgement.

4.5 Countermeasure overview

Oil spill countermeasure considerations are described for each of the 15 operational maps in Chapter 8. The following is an overview of their basis and content.

The low level of industrial and marine activity in the waters of West Greenland has until now given rise to a limited risk of marine oil spills. The main sources are related to fuel supply to the communities and to fuel carried by fishing vessels and other ships. A new, small but finite, risk is added with exploration drilling. Furthermore, global warming and the resulting decline in sea ice concentration may, in the near future, facilitate and increase in marine traffic through the area.

If a significant spill were to occur, there would be severe limitations to the response, particularly during the critical initial stages of the incident. The remoteness of the region, the distance of existing response bases, and, most importantly, the low level of marine activity practically eliminate the possibility of an effective initial marine-based response unless dedicated response plans and equipment are available. The main countermeasure activities that could be carried out are described in general terms below, with specific local notes on where they would be applicable on each of the operational maps. These countermeasures could include surveillance and tracking, *in situ* burning of spills in ice, dispersant-use in offshore areas, and the protection and clean-up of important coastal entities, such as the "selected areas", site specific resources (such as sea bird breeding colonies) and extremely sensitive shore lines (see Chapter 4.4).

Surveillance and tracking activities will be critical in determining the location and extent of spilled oil. This will be particularly important in establishing clean-up priorities and adjusting strategies when a long-term and geographically widespread response is required. Aircraft-based remote sensing and surveillance overflights could be mounted from the airports at Thule Air Base, Qaanaaq and Upernavik. A program to track oiled ice would be required for spills that occur among pack ice or for open water spills that reach the pack ice edge or persist through freeze-up in protected inshore waters.

Conventional containment and recovery techniques will be severely limited by the lack of vessels with which to deploy and operate equipment, unless vessels and equipment are available on standby in the area as part of a contingency plan. Spills that are not contained within the first few days of a response will likely be too thin and widespread to allow effective recovery.

In situ burning may be applicable as an initial response measure for spills in ice conditions. Pack ice concentration of 6 tenths or greater will limit the spread of an oil spill and may allow the opportunity for burning until some time after an incident. For inshore areas and fjords that freeze over during winter, oil that persists through the freezing season may be available for burning the following melt season when released into leads and melt pools. This would require a tracking and monitoring program through the winter to delineate oiled areas and to prepare for the likely release period.

Dispersing an oil spill by applying dispersants is another effective way of removing oil from the surface in the early phases of an oil spill. This method and the chemicals used require approval from the Greenland authorities (which includes a Net Environmental Benefit Analysis NEBA). The method is not allowed in shallow areas (see below), but it should be considered in offshore areas to prevent or reduce surface oil from contaminating more sensitive inshore areas. Dispersants should receive particular consideration in situations where containment and recovery countermeasures may not be fully effective due to the size of the spill, the limited logistical support for a large-scale clean-up, the prevailing weather and sea conditions, or a combination of the three. The use of dispersants is not allowed within a zone ranging from the coast line and to 10 km off the Greenland baseline and in some particularly sensitive and relatively shallow offshore areas.

Shoreline protection countermeasures will also be limited by a lack of logistical support. In case of an oil spill threat, countermeasure priority should be given to the selected areas, the site specific resources and the extremely sensitive shore lines, considering the time of the year (e.g. no birds are present at breeding colonies in the winter). Particular priority should be given to the selected areas, which are vulnerable to oiling, and can generally be protected with a relatively modest effort and, in some cases, could be difficult to clean if heavily oiled.

In many cases, deflection rather than containment booming will be preferred because the tidal currents exceed 1 knot. While deflection booming may not offer complete protection, it will be valuable in limiting the extent and degree of contamination and may contribute to faster and more complete post-spill recovery. Deflection booming strategies will require monitoring and perhaps repositioning periodically to account for changes in current strength and direction.

A more significant limitation for shoreline protection countermeasures is dictated by the currents and topography of the shores. Information on currents in the area is limited; the few data available indicate that tidal currents are strong in most areas – as high as 4 knots. This coupled with steep, rocky shorelines and bottom contours may preclude effective booming. As noted above, for areas that cannot be boomed, the most effective strategy may be to use deflection booming to limit the extent of shoreline oiling.

It should be noted that there are many areas, including some of the "selected areas", for which effective containment operations are not likely to be possible. In many areas, offshore countermeasures present the only realistic option for effective protection. For spills that may affect such areas, consideration should be given to dispersant-use and *in situ* burning.

Much of the coastline in the region covered by this atlas consists of a steep rocky shoreline that is moderately or highly exposed to prevailing weather and sea conditions as well as some ice action. In many areas, fjords, bays and other inshore areas may also be somewhat protected from extensive contamination by the flushing action of tidal currents and by the natural outflow of streams and rivers. As a result, much of the shoreline may not require a widespread active cleaning effort unless it is heavily contaminated. Where active shoreline clean-up is required, priorities for restoration can be established based on both the environmental sensitivity and oil persistence factors. Preference should be given to *in situ* cleaning techniques such as in-place washing of rocky shores, use of shoreline cleaning agents, *in situ* burning and bio-remediation. Use of these techniques will minimise the amount of oily material collected and subsequent hauling requirements. Disposal site selection was beyond the scope of this study and would require extensive study involving technical, logistical, environmental, and political factors. An alternative to land disposal within the region would be the trans-shipment of collected oily materials from temporary stockpiles to disposal sites and/or incineration elsewhere.

Marine access for shoreline clean-up may be limited in some areas by shoaling and off lying rocks and islets. In some areas, locally forming ice and the encroachment of seasonal pack ice may also limit access. The steep shorelines in many areas will rule out the use of land based staging areas and may necessitate ship- or barge-based clean-up operations.

One potential safe haven has been proposed near Kap Walker (Map no. 7551). This is a site where unloading and/or stabilisation operations could be carried out on a stricken vessel with limited risk of fouling extensive and sensitive shorelines. It is indicated on the map sheet. There are, moreover, a number of other locations that could be considered for use as safe havens, but insufficient information (usually limited or no soundings) reduce their suitability and they cannot be fully recommended. In these instances, reconnaissance at the time of the spill would be required to determine their acceptability. These locations are identified in the text, but not on the map sheets.

5 Users guide

The region covered by this atlas is the northern part of West Greenland. It covers the region between 75° N and 77° N and is included in the Qaasuitsup Kommunia in the part which formerly was the municipality Avanersuaq. The offshore waters to the Canadian border are also included. The entire region in this atlas is generally referred to as 'the study region/area', 'the region covered by this atlas' or 'the sensitivity mapping region'.

Offshore sensitivity information is given in Chapter 7. This information, covering the entire study area, is presented on one-page maps with an approximate scale of 1: 2.5 million.

Detailed shoreline information is given in Chapter 8 on maps with a smaller scale. The entire study area is covered by a total of 15 separate maps with a scale of 1: 250,000 (A4 size). The name of each map reflects the northern latitude (degrees N) of the area covered, and the position of the area from west to east, where numbering starts from west. For example, the western-most map (map number 1) that covers the area at 75° N is named Map 7501, and the next to the east is named Map 7502. Note that there are two rows for each latitudinal degree, thus, the map to the north of Map 7501 is at 68.5° N and is named Map 7551.

In Chapter 8, there are two series of detailed maps: **Shoreline Sensitivity Maps** and **Physical Environment and Logistics Maps**. The Shoreline Sensitivity Maps are on the left-hand side, and Physical Environment and Logistics Maps are on the right. Descriptive text appears on the pages between these maps.

5.1 Shoreline and Offshore Sensitivity Maps

5.1.1 Sensitivity index and icons (animal and other symbols)

The shoreline zone in the study area has been divided into 53 shoreline areas, each consisting of approximately 50 km of shoreline or in archipelagos: a group of islands and skerries having roughly 50 km shoreline. The 53 shoreline areas are numbered from south to north, and the numbers are given on the map with the nearest latitudinal degree south of it given as prefix, e.g. 75_5.

The offshore zone in the study area has been divided into 4 offshore areas. The boundaries of the offshore areas are based on oceanographic, bathymetric and climatic features.

An oil spill sensitivity index value has been calculated for each of the 53 shoreline and 4 offshore areas based on:

1) abundance and sensitivity of selected species (or species groups),
2) resource use (human use), mainly fishing and hunting,
3) potential oil residency on the shoreline (Oil Residency Index) based mainly on wave exposure, substrate and slope of coast,
4) presence of towns, settlements and archaeological sites (for shorelines).

The sensitivity index value for each of the 53 shoreline areas and 4 offshore areas is given on the opposite page to the corresponding map. All areas are

ranked as extreme, high, moderate or low sensitivity areas and a corresponding colour code has been used. Detailed index value calculations for each shoreline and offshore area are given in Appendix A and Appendix B, respectively. These can be accessed by links on the opposite pages in the pdf-document.

The importance of resource use and the abundance of a number of biological occurrences in each of the 53 shoreline and 4 offshore areas have been rated on a scale from 0 to 5 (see legend or Chapter 4.3 for a list of species and species groups included in the index). If resource use and abundance of a particular species in an area is significant (rated 5, 4 or 3), it is indicated on the map with a **black icon** (and a letter code) after the shoreline area number. Please note that although some icons are similar in the offshore and the shoreline sensitivity maps, they don't necessarily represent the same species group. (See chapter 4.3, chapter 12.4 and the map legends.)

Blue icons (animal symbols) indicate a site-specific significant habitat. For example, such sites include important bird breeding colonies.

Species and resource occurrences. For each Shoreline Sensitivity Map is given a figure showing (by a horisontal pale blue bar) the temporal occurrence of each of the species and resources shown on the map.

5.1.2 Selected areas

To supplement the rather general mapping of shoreline sensitivity using the 50 km long shoreline areas, a number of small sensitive localities have been selected. A total of 13 areas along the coast and within fjords have been selected as priority areas in case of an oil spill situation. These areas are identified by a red polygon border and a number with the prefix, 'S', for selected. The basis for their selection is that, compared to the coastline in general, they are:

1) of high value either environmentally or for resource use,
2) sensitive to oil spill, and
3) of a size and form that may allow effective protection in an oil spill situation with a manageable amount of manpower and equipment.

5.1.3 Season information

Offshore sensitivity is presented on seasonal maps reflecting the changes in sensitivity during winter (January - March), spring (April - May), summer (June – August) and autumn (September - December).

Seasonal occurrence of species and resource use in the shoreline areas is presented on species and resource occurrence graphs, corresponding to each of the shoreline sensitivity maps.

5.1.4 Resource use data

Information on resource use, mainly Greenland halibut fishing and hunting of seabirds (mainly eiders) polar bears and whales, were collected by the Greenland Institute of Natural Resources (GINR), by interviewing local hunters and fishermen. Data on resource use was also extracted from unpublished material collected by Petersen (1993a, b).

5.1.5 Species distribution and abundance data

Information on species distribution and abundance is mainly derived from a number of DCE (former NERI) reports reviewing data on biological resources in the area. See the strategic environmental impact assessment of oil activities in the Baffin Bay compiled by DCE in 2011 (Boertmann & Mosbech 2011).

5.1.6 Archaeological and historical sites included

All known prehistoric and historic sites are included in the background database to the present atlas. However, only sites likely to be threatened by a marine oil spill are included on the maps (as purple squares). In order to protect the sites from illegal excavation, only the most basic information is given.

Further information on the archaeological sites is available from either the Greenland National Museum and Archives or the Greenland Secretariat at the Danish National Museum, if needed e.g. in an oil spill situation.

All man made relics more than 100 years old are protected according to *"Landstingslov nr. 5/1980 af 16. oktober 1980 om fredning af jordfaste fortidsminder og bygninger"* (The Conservation Act). The Greenland National Museum & Archives manages the legislation and is responsible for recording the sites concerned.

5.2 Physical environment and logistics maps

5.2.1 Coastal types description

The shores in the study area are classified into eleven different shoretypes on the Operational Maps of Physical Environment and Logistics. Shoretype definitions are given in Table 5.1 and photos of shore types in Figures 5.1-5.15. See also Appendix D section 12.3.

5.2.2 Access

For each operational map, access information is provided to cover the following issues:

Marine access: navigational information, prevailing currents, tides, local ice conditions, shoal hazards, identified anchorages, beach landing sites.

Air access: size, surface and seasonality of airstrips within the area. Details of size, surface and seasonality of airstrips can be found at:
http://aim.naviair.dk.

Marine information is taken from the nautical charts for the area and from the corresponding descriptions in the Arctic Pilot, Volume III published by the British Admiralty.

Table 5.1. Shoreline classification. Classification of shore types in West Greenland between 75° N and 77° N.

Shore type	Characteristics
Shores developed in solid rock	
Rocky coast	Coast developed in bedrock of varying morphology, elevation and gradient (narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur. The occurrence of abraded inter-tidal platforms is indicated by the gradient).
Archipelago	Several smaller islands, usually of solid rock (rocky coasts and pocket beaches might occur, but have only been classified individually if the perimeter of the island exceeds 6 kilometres).
Shores developed in sediments of glacial, alluvial or colluvial origin	
Moraine	Shore developed in unconsolidated glacial sediments (narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur. he occurrence of abraded intertidal platforms is indicated by the gradient).
Alluvial fan	Shore developed in alluvial fan (narrow beach with sediment consisting of boulders, cobbles, pebbles, gravel and sand might occur. The occurrence of intertidal platforms is indicated by the gradient).
Talus	Shore developed in talus (colluvial fan) of varying gradient (narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur).
Shores developed in marine sediments	
Beach	Long, linear depositional beaches of well-sorted sand, gravel, pebbles, cobbles or boulders (beach ridge plains often occur landwards the beach).
Barrier beach	Coastal environment consisting of coastal barriers and lagoons with beaches, dunes, salt marsh and tidal flats. (spits often occur near tidal inlets; washover fans might occur on barriers). Beaches consisting of well-sorted sand, gravel, pebbles or cobbles.
Salt marsh and/or tidal flat	Wide salt marshes and/or wide intertidal flats (consisting of relatively fine sediments: mud, sand, silt and clay).
Pocket beach	Beach developed in the inner part of an embayment in otherwise solid rock. No larger rivers run into the embayment. Beaches normally consist of well-sorted sediments consisting of sand, gravel, pebble or cobbles.
Shores developed in deltaic sediments	
Delta	Low gradient intertidal platform developed by fluvial sediments in front of a river valley. Braided river channels often occur within the inter-tidal zone. Sediment normally fine grained ranging from clay to fine sand.
Others	
Glacier coast	Glacier reach/cross the intertidal zone.
Not classified	The shore has not been classified due to lack of air photo information (cloud cover, shadow, etc.)

Figure 5.1. Steep rocky coasts are found here and there in the region. Melville Monument in Melville Bay.

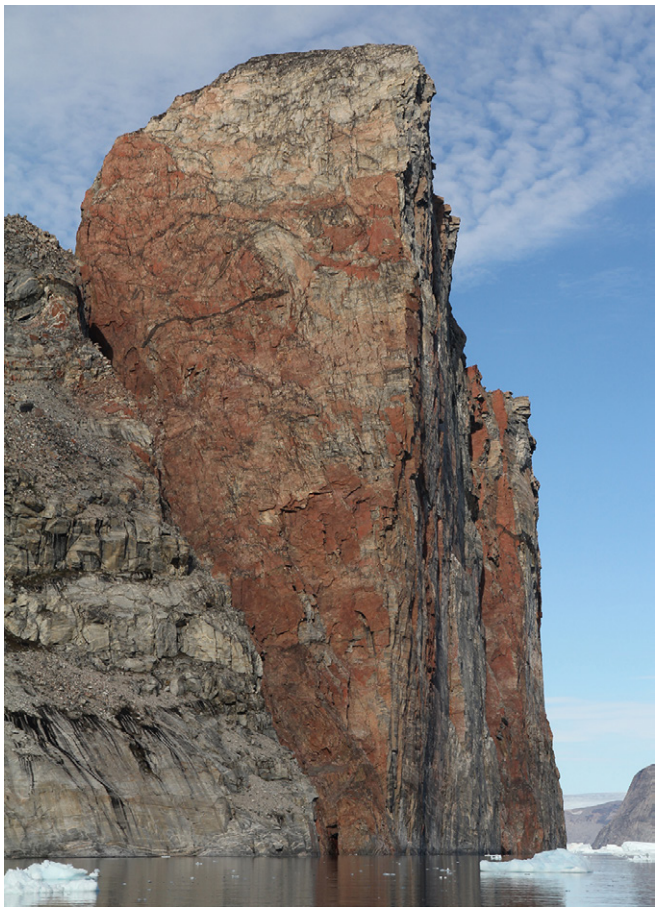


Figure 5.2. Low rocky coasts are widespread in the region. Red Head in Melville Bay.

Figure 5.3. Low islands with rocky coasts. Sabine Islands in Melville Bay.

Figure 5.4. Low coasts with sediment beach - here mainly sand - are not common in the region. Note the house ruin in the front. Sabine Islands in Melville Bay.

Figure 5.5. Glaciers reach the coast over long stretches in the Melville Bay.

Figure 5.6. Coast with loose blocks Balgoni Island in Melville Bay.

Figure 5.7. Barrier beach in Melville Bay.

Figure 5.8. Steep talus, just north of Savissivik. Nesting site for hundreds of little auks.

Figure 5.9. Layered sedimentary rocks (sandstone) with narrow beaches. Saunders Island. Nesting site for thousands of thick-billed murres.

Figure 5.10. Steep cliffs of Appat Appai. Breeding site for thousands of thick-billed murres and other seabirds.

Figure 5.11. Lagoon with narrow boulder beaches and rocky outcrops.

Figure 5.12. Archipelago in Melville Bay. Low rocky coasts.

Figure 5.13. Pocket beach with coarse gravel, Saunders Island.

Figure 5.14. Moraine and low boulder beach in sheltered bay, Melville Bay.

Figure 5.15. The settlement Savissivik.

Figure 5.16. Exopsed beach with coarse gravel. Paakitsoq north of Pituffik Glacier.

5.2.3 Potential safe havens

A safe haven is a site where unloading and/or stabilisation operations can be carried out on a stricken vessel with limited impact on the environment. Small bays and inlets, which can be exclusion boomed and which are situated in areas with low sensitive coasts, qualify for such areas. One potential safe haven, which generally qualifies and where the navigation information is apparently good, is indicated on the map sheets. However, the general knowledge on the navigability and water depth on other potential safe haven sites within the mapped region is very limited, and such sites should be investigated for their suitability. Therefore, in the text we have also included a number of sites that might possibly be used as safe havens after a reconnaissance or by involving local knowledge. It will be more feasible to investigate the use of such a nearby potential safe haven at the time of an incident, rather than searching for safe havens within the entire region. If only those areas that unreservedly can be recommended for use as a safe haven were to be identified, very few would be left.

5.2.4 Countermeasures

Countermeasure information is given for each map. Potential sites for booming and inshore containment lengths are indicated on the maps.

5.2.5 Topographic maps and nautical charts

The study region is covered by 4 topographic maps at a scale of 1:250,000. The maps are named 75 V.1, 76 V.1, 76 V.2 and 76 V.3. The region is also partly covered by nautical charts No. 3200 in 1: 400,000 and charts of the main harbour in Thule Air Base in 1:40,000 (No. 3130). The maps are available from Weilbach (http://www.weilbach.dk).

5.2.6 Climate, oceanography and ice conditions

Information regarding the climate, oceanography and ice conditions in the region covered by this atlas can be found in the recent strategic environmental impact assessment of oil activities in the Baffin Bay region (Boertmann & Mosbech 2011).

6 Summary information

6.1 Study area information

6.1.1 The offshore area

The offshore part of the region (75°-77° N) covers the northeastern Baffin Bay, where Melville Bay and the North Water Polynya (NOW) constitute significant parts. The North Water is a polynya (that is an open water area – even in winter – surrounded by ice). It is one of the largest (~80,000 km$^{2)}$ and biologically most productive polynyas in the Arctic and is exceptionally important for seabirds, marine mammals and humans.

The shelf (depths less than 200 m) is generally rather narrow, usually less than 50 km, but further off the Melville Bay there is a shallow (< 200 m) bank. In the southwestern part of the region, depths are more than 2000 m.

6.1.2 Oceanography

Two major currents influence the oceanography in the region. The West Greenland Current brings relatively warm and saline water in from the south and it can be traced all the way to Qaanaaq (Figure 6.1).

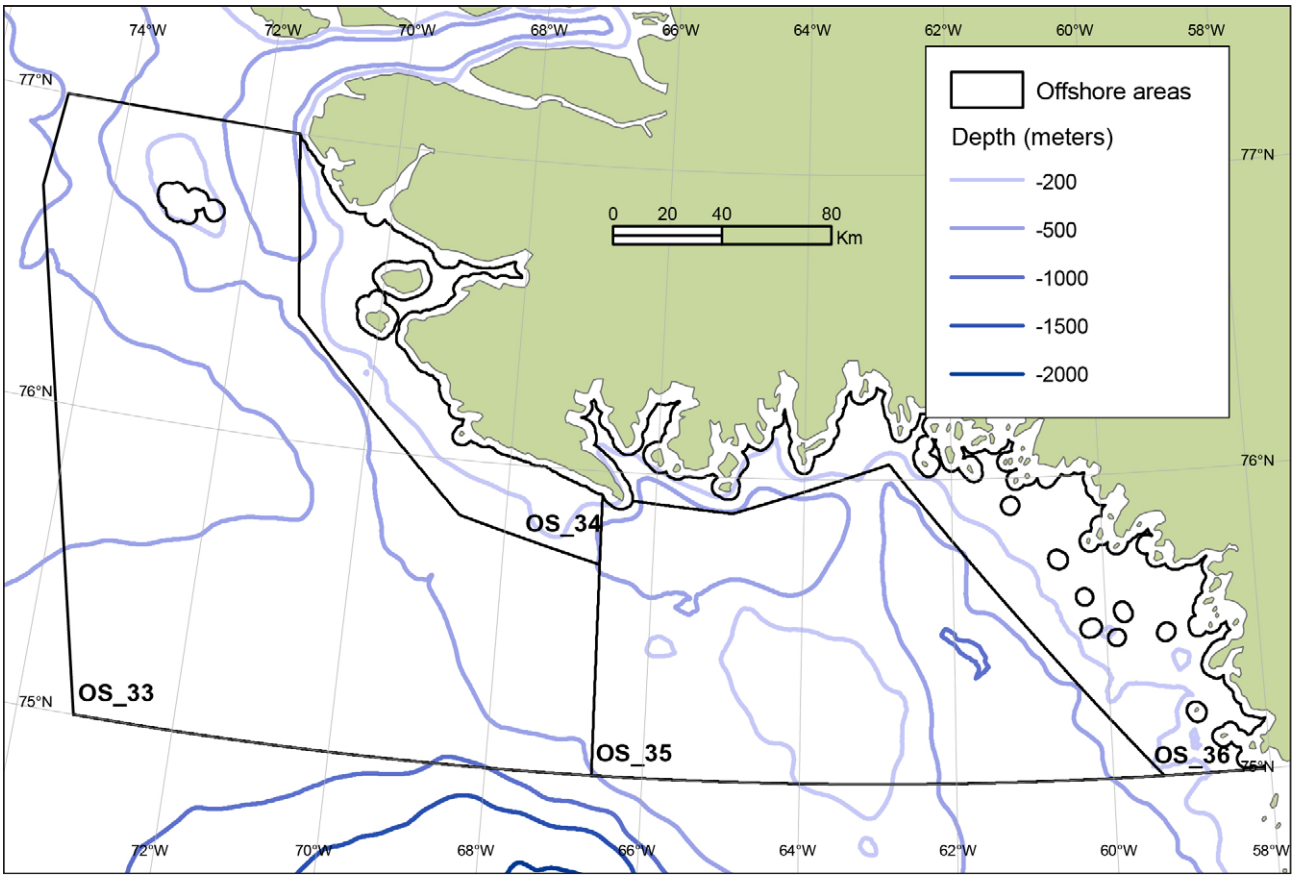


Figure 6.1. Bathymetry of the region covered by this atlas.

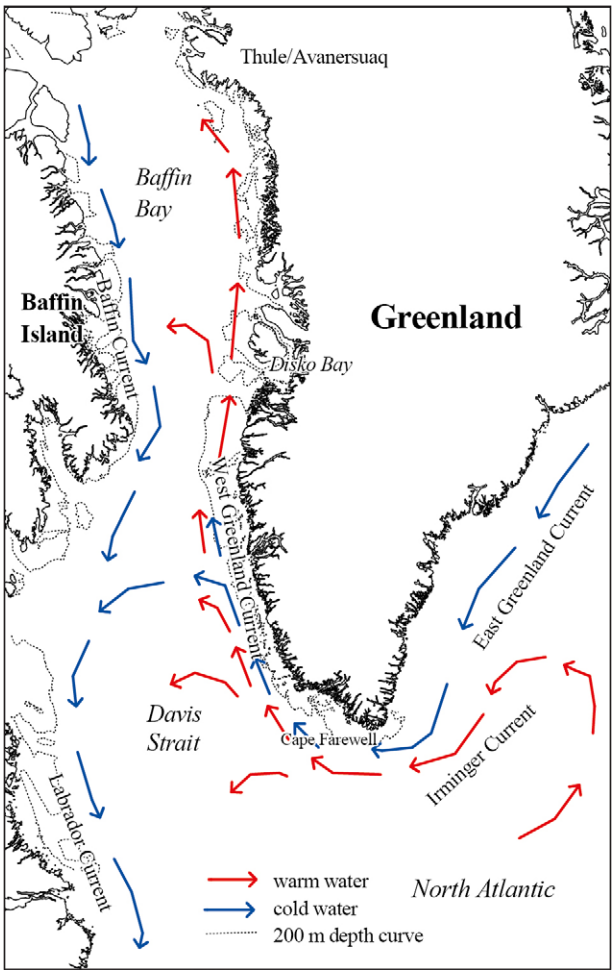


Figure 6.2. Surface current patterns in the waters off West Greenland.

From the north, a strong southward flow brings cold polar water and ice from the Arctic Ocean to the region (Figure 6.1). This polar water inflow through the narrow Nares Strait north of the assessment area is strongest during spring and early summer (May- July), while the inflow of Atlantic water masses from the south is strongest during autumn and winter. A significant feature is upwelling of relatively warm water in the eastern part of the North Water Polynya.

6.1.3 Ice

Sea ice in the form of drift ice is normally present throughout the offshore areas from November to June, while fast ice forms in fjords and in Melville Bay from mid-October and stays on often through July. However, in the North Water, open water is present as early as April and locally also throughout the winter.

Icebergs originating from numerous glaciers occur in the entire region. The density is very high in Melville Bay. However, the drift patterns and distribution of this ice have not been investigated systematically and are therefore only known roughly. Many large icebergs are often grounded on the offshore bank in Melville Bay.

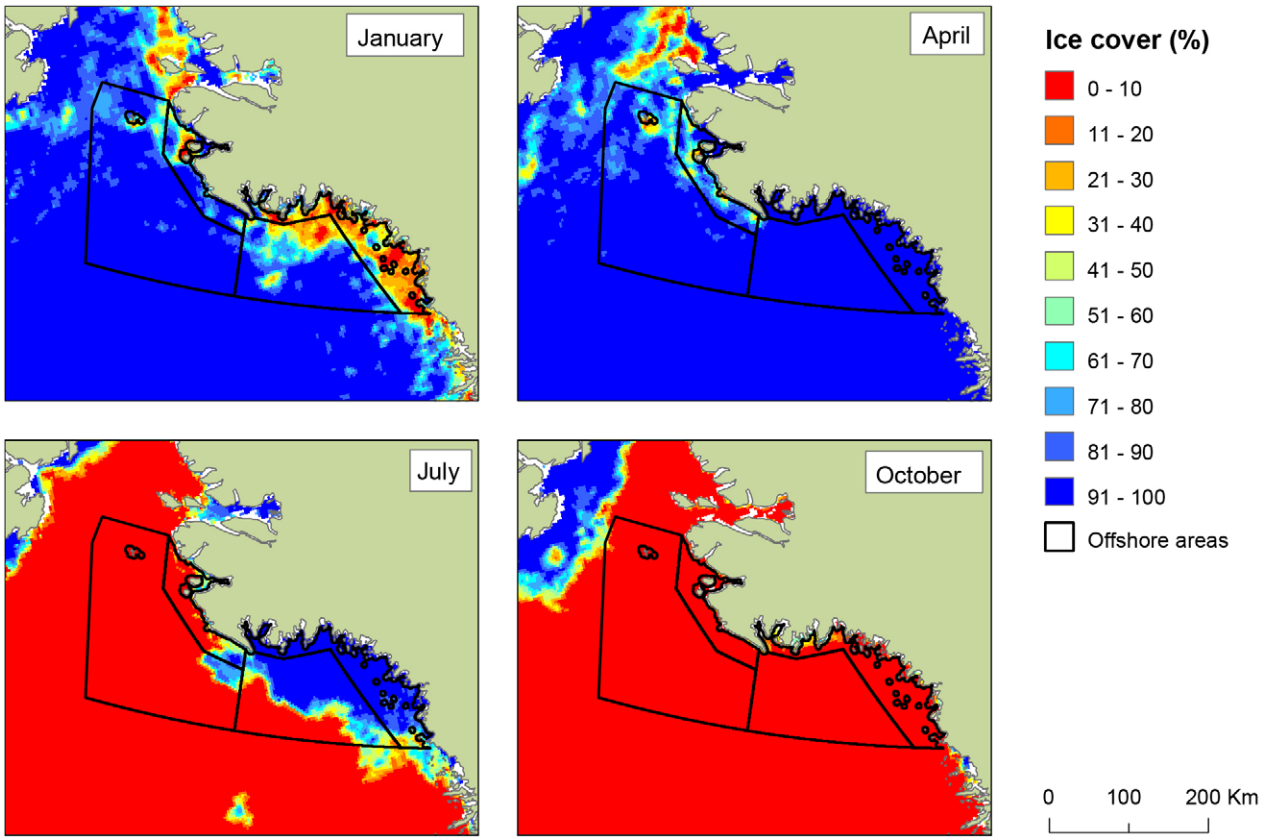


Figure 6.3. Seaice concentrations in Melville bay 2013. (Data: http://www.iup.physik.uni-bremen.de:8084/ssmis/ (see Spreen *et al.* 2008).

6.1.4 Coastal zone geomorphology

The coasts of the region are generally rocky with small and few, low sedimentary coasts, especially inside fjords and bays. The dominant geology in the region is various gneissic rock types. In the northern part, including Saunders Island and Wolstenholme Island, the rocks are characterized by various sandstone types. The inner Melville Bay is dominated by numerous and very wide glaciers, which reach and calve into the sea, and long stretches of the coast are covered by glacier ice. In total, app. 450 km of the coastline is glacier coast.

The division of the shoreline into shore type segments is based on the geomorphology of the coast. As the classification has been performed on the basis of topographical and geological maps and satellite imagery, some shore types with short extent (< 2 km) might be underrepresented in the classification. Short segments have been included, where a clear indication of type could be found. The input data have not allowed for the identification of small pocket beaches. The total number of segments identified is 739, which covers a total of 2355 km. Of these, 562 segments (1621 km) are on the mainland coast, 174 segments (734 km) are on islands.

The distribution of segments on shore type and exposure categories, respectively, is given in Tables 6.1-6.2. In terms of shoreline length, the 'Rocky coast' is the dominant shore type (61.6 %) and 'Exposed' is the dominant exposure type (49.1%).

Table 6.1. Shoreline statistics. Shoretype statistics in the atlas area.

Shoretype	No. of stretches	Km	%
Rocky coast	351	1,450	61.5
Archipelago	88	186	7.9
Glacier coast	201	452	19.2
Moraine	18	45	1.9
Alluvial fan	8	19	0.8
Talus	70	198	8.4
Beach	3	6	0.3
Total	665	2,355	100

Table 6.2. Exposure statistics. Shoreline exposure statistics in the atlas area.

Exposure type	Km	%
1 - Protected	83	3.5
2 - Semi-protected	361	15.3
3 - Semi-exposed	755	32
4 - Exposed	1,156	49.1
Total	2,355	100

6.1.5 Ecology of the area

The most important feature for the ecology of the region covered by this atlas is the North Water Polynya (see Figure 6.4). The ice free water allows the primary production to start much earlier in the spring than in the surrounding ice covered areas. This production is, moreover, enhanced by the ocenanographic conditions (upwelling) and attracts huge amounts of large zooplank-

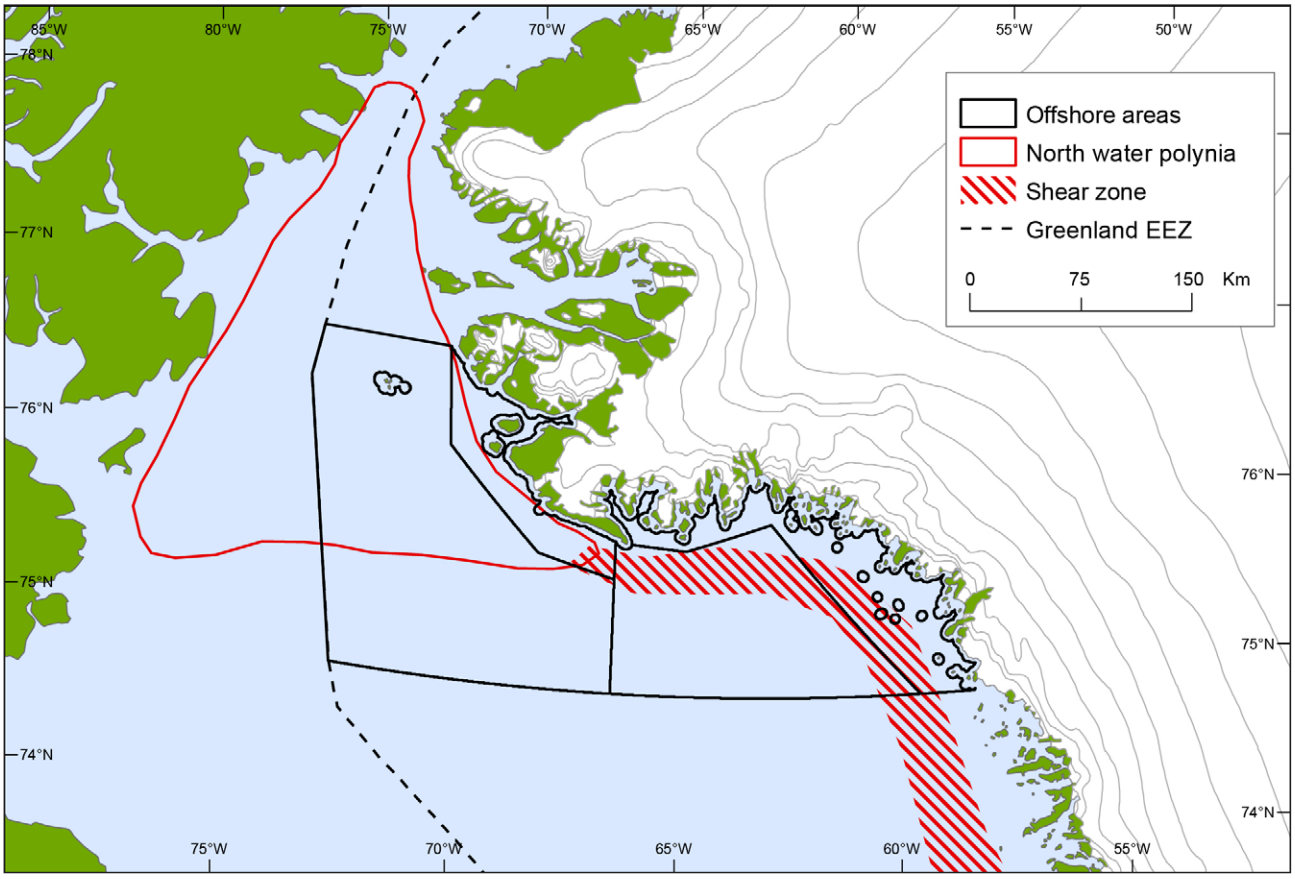


Figure 6.4. Approximate delineation of the North Water Polynia (NOW) and the shear zone.

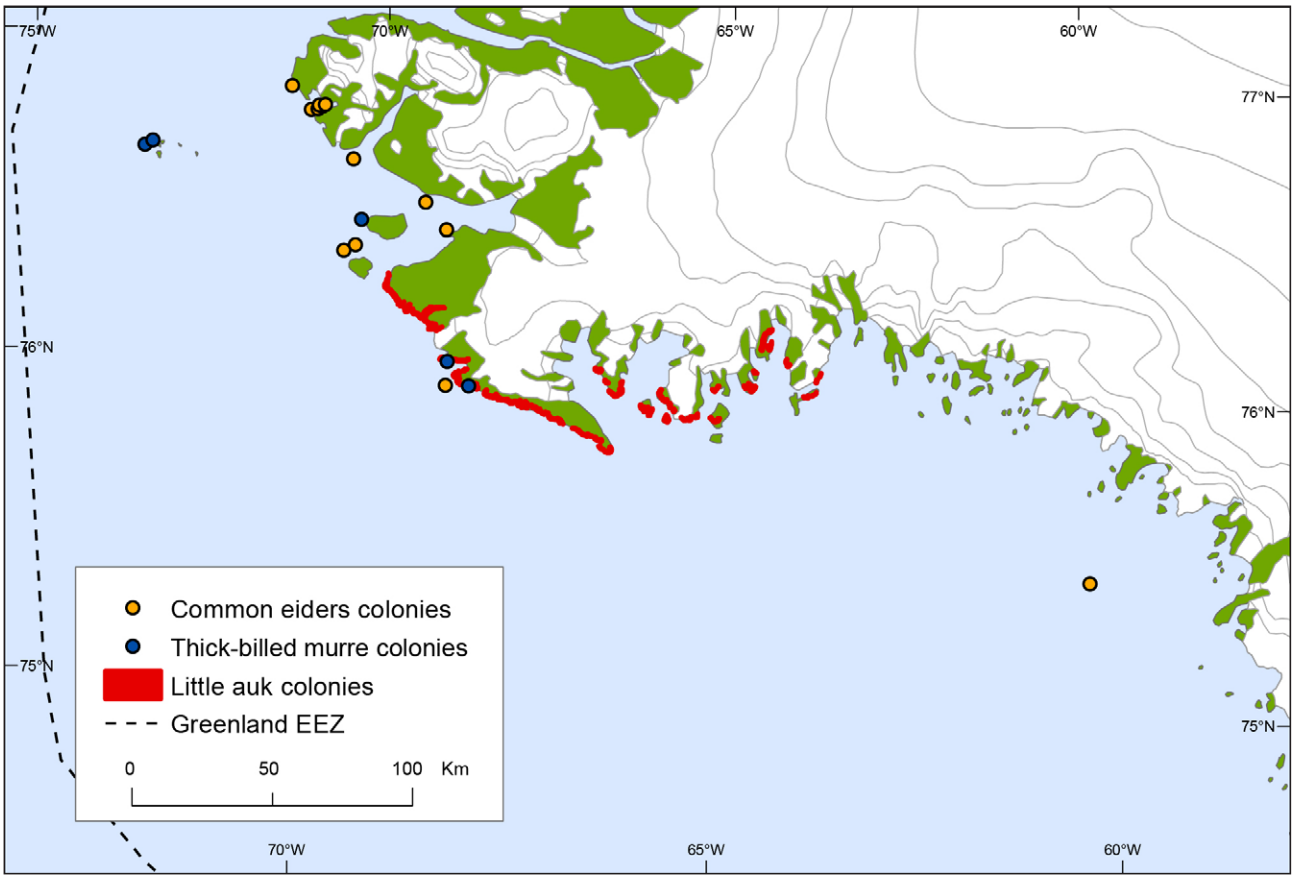


Figure 6.5. Breeding colonies of selected seabird species in the atlas area.

ton, mainly the copepod *Calanus hyperboreus*. This copepod is a key species in the food web, as it constitutes the main food resource for the very abundant seabird – the little auk. The breeding population of this seabird is estimated at 35 mill. pairs along the coasts of NW Greenland, with the major part breeding on the coasts of the mapped region. Also, the bowhead whale utilizes these copepods.

Another key species is the polar cod, a small gadoid fish living in the water column and spawning in the late winter under the sea ice. Eggs and larvae accumulate under the ice. This fish is an important food item for the numerous thick-billed murres (See figure 6.5) breeding in three large colonies within the mapped region.

The high production of the North Water is in contrast to the Melville Bay, where the winter ice may last until late July and production is low. Very few seabirds manage to breed here. The most important site in the bay is the group of small islands, Sabine Island, which are situated in the shear zone between the fast ice and the drift ice. Large numbers of Artic terns, Sabines gulls and common eiders breed here. A complete list of seabird species included in this atlas can be found in table 6.3. Despite the low production, a discrete and very important stock of narwhals spends the summer here. Other important marine mammals occurring in the region covered by this atlas include walrus and polar bear. A complete list can be found in table 6.4.

For further details on the ecology of the region, see the strategic environmental impact assessment of hydrocarbon activities in the Eastern Baffin Bay produced by DCE in 2011 (Boertmann & Mosbech 2011).

Table 6.3. Seabird occurrence in the atlas area (75º -77ºN)

Species	Occurence		Distribution	National red list status
Fulmar	b/s	April-October	c & o	Least concern (LC)
Red-throated diver	s	September	c	Least concern (LC)
Common eider	b/s/m	April-October	c	Vulnerable (VU)
King eider	m	July -September	c	Least concern (LC)
Long-tailed duck	b/m	May-October	c	Least concern (LC)
Kittiwake	b/s	May-October	c & o	Vulnerable (VU)
Glaucous gull	b/s	April-December	c & o	Least concern (LC)
Iceland gull	b/s	April-December	c & o	Least concern (LC)
Ivory gull	s	April-November	c & o	Vulnerable (VU)
Arctic tern	b	May-September	c	Near threatened (NT)
Thick-billed murre	b/	May-September	c & o	Vulnerable (VU)
Puffin	b	May-September	c & o	Near threatened (NT)
Black guillemot	b	May -September	c	Least concern (LC)
Little auk	b	May-October	c & o	Least concern (LC)

Categories of occurrence: b: breeding, s: summering, m: moulting, mv: migrant visitor, w: wintering.
Categories of distribution: c: coastal, o: offshore.

Table 6.4. Overview of marine mammals in the study area

Species	Period	Main habitat	Stock size in the area/occurence	Protection / exploitation	National red list status
Bowhead whale	May-June	Drift ice/ice edge	unknown	Annuals quota of two	Near threatened (NT)
Minke whale	April-October	whole area	rare in region	Hunting regulated	Least concern (LC)
Narwhal	May-October	Pack ice/deep waterIglacier fjords	~3100 (2014)	Annual quota	Critical endangered (CR)
White whale	October-June	Shore lead and polynya	Some thousands	Annual quata	Critical endangered (CR)
Harp seal	May-November	Whole area	Common	Hunting unregulated	Least concern (LC)
Hooded seal	March-October	Whole area	Rather common in Melville Bay	Hunting unregulated	Least concern (LC)
Ringed seal	Whole year	Whole area, mainly fjords with ice	Common	Hunting unregulated	Least concern (LC)
Bearded seal	Whole year	Coastal waters and drift ice	Common	Hunting unregulated	Least concern (LC)
Walrus	Winter and spring	Ice edges, shallow areas	~2400 (April 2014)	Annual quota	Critical endangered (CR)
Polar bear	Whole year	Drift ice	Widespread in low numbers	Annual quota	Vulnerable (VU)

6.1.6 Archaeological and historic sites

Based on our present knowledge, Greenland seems to have been inhabited almost continuously since 4500 BC. Evidence of the various prehistoric cultures and settlements and use of resources are found almost everywhere along the Greenland coasts. Between 75° and 77° N, some 86 archaeological sites are registered in the central database of the Greenland National Museum & Archives (NKA), and they are therefore subject to the terms of the Conservation Act (see chapter 12.5). The main part of the 86 sites is coastal and is included in this atlas.

The sensitivity of the items of archaeological interest is expressed on an ascending scale from 1 to 3:

1) Sites considered not likely to be impacted by marine oil spill.
2) Sites considered likely to be directly impacted by marine oil spill.
3) Sites of special importance, which require special consideration in the event of an oil spill or other activities in connection with raw material exploration and extraction.

6.2 Areas of extreme and high sensitivity

Figure 6.6 shows an overview of the shoreline areas of extreme (red) and high (yellow) sensitivity to marine oil spill. In total, there are 14 areas of extreme sensitivity and 15 of high sensitivity. In addition, six smaller areas have been selected because of their significant biological importance in the atlas area. This selection of areas is based on expert judgement.

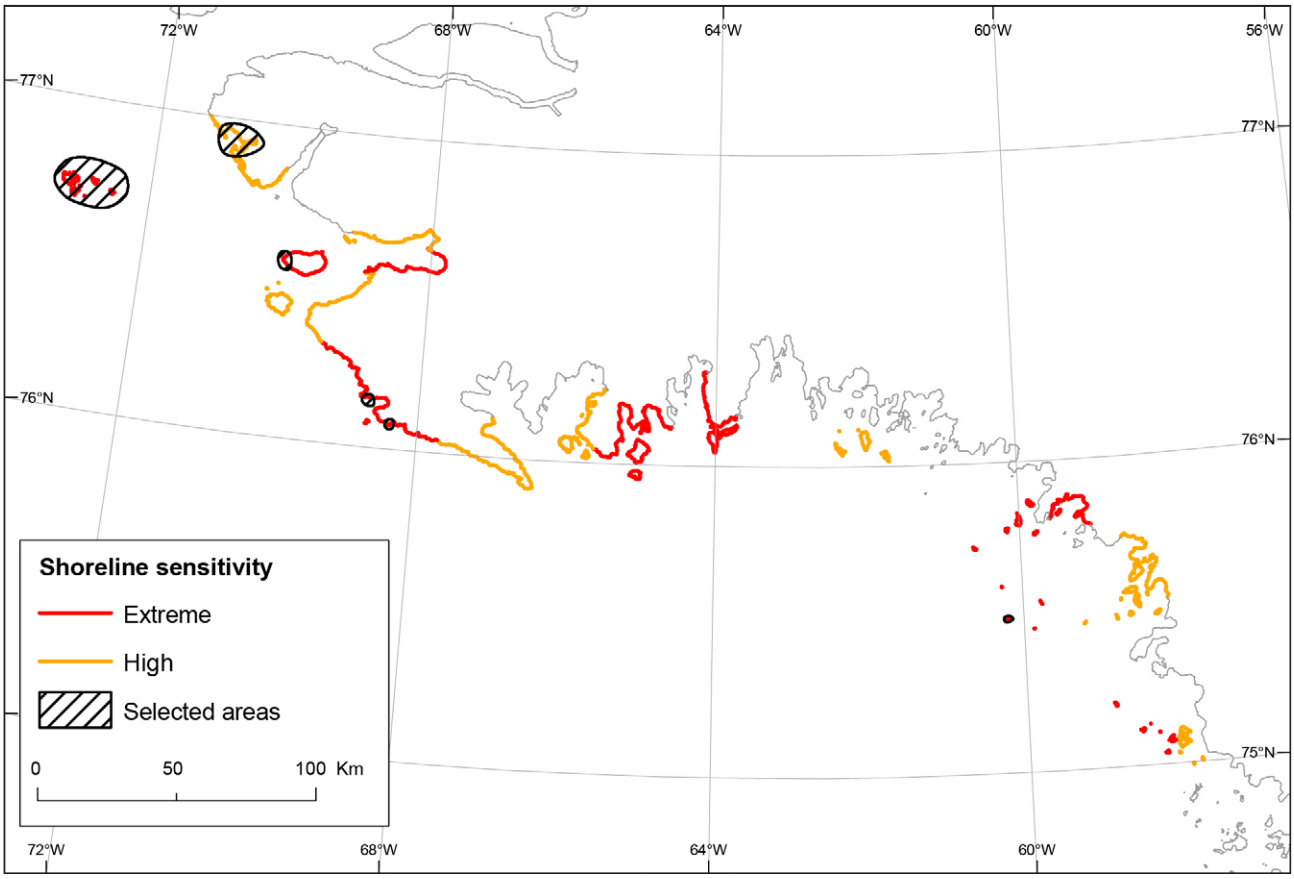


Figure 6.6. Areas of extreme and high sensitivity and selected areas.

7 Offshore sensitivity

This chapter presents four maps showing the relative sensitivity of the four offshore areas between 75° and 77° N for each of the seasons, winter, spring, summer and autumn. When interpreting the maps, it is important to keep in mind that the ranking of each offshore area into the categories extreme, high, moderate and low is based on a neighbourhood analysis of offshore areas around the given area within the season in question (see Appendix C for details). A comparison of the sensitivity scores of each season indicates that spring is the most sensitive time of the year (Table 7.1. and table 7.2). Along with each map, a short environmental description, including values for species occurrence and human resource use, is provided for each offshore area. For a more detailed listing of elements used in the sensitivity calculation, see Appendix B.

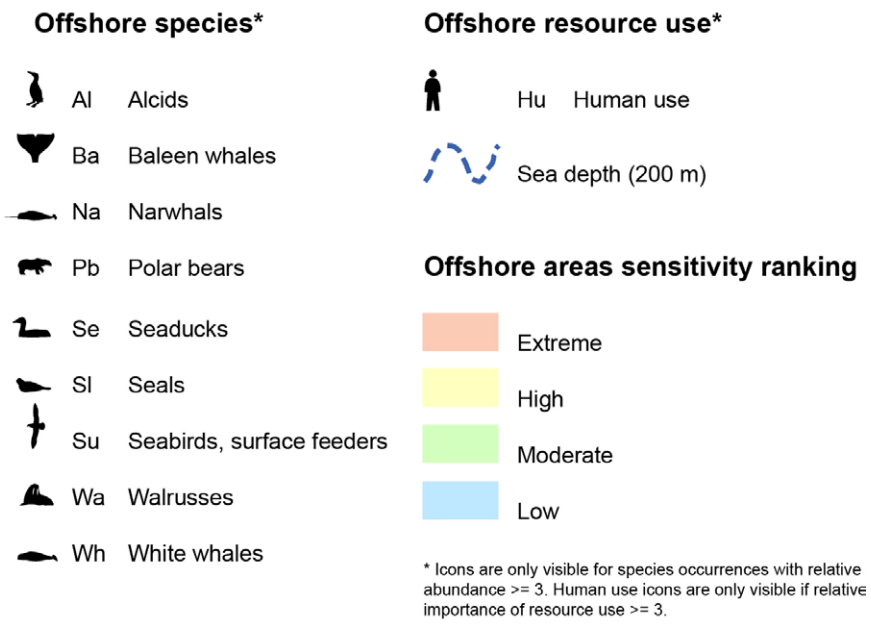
Table 7.1. Seasonal offshore sensitivity.

Season	Average sensitivity per offshore area
Spring	81
Summer	56
Winter	46
Autumn	41

Within the four individual offshore areas between 75° and 77° N, the sensitivity also varies seasonally. The following table lists the most sensitive season for each area:

Table 7.2. Most sensitive season in the offshore areas.

Area	Most sensitive season	Sensitivity value in most sensitive season	Average sensitivity across seasons
OS_33	Spring	82	59
OS_34	Spring	87	61
OS_35	Spring	78	49
OS_36	Spring	76	53


Offshore species*
Al Alcids
Ba Baleen whales
Na Narwhals
Pb Polar bears
Se Seaducks
Sl Seals
Su Seabirds, surface feeders
Wa Walrusses
Wh White whales
Offshore resource use*
Hu Human use
Sea depth (200 m)
Offshore areas sensitivity ranking
Extreme
High
Moderate
Low
* Icons are only visible for species occurrences with relative abundance >= 3. Human use icons are only visible if relative importance of resource use >= 3.

7.1 Offshore sensitivity, winter (January-March)

Environmental description (Figure 7.1)

Offshore area 33 (OS_33): *Resource use* (1): Hunting area, primarily for polar bear. *Species occurrence*: Pb (5): Important habitat for polar bears. Wa (5): Important wintering areas for walrus in northern part. Sl (4): The North Water Polynya is an important habitat for seals (ringed and bearded). Ba (3): Bowhead whales winter in the North Water Polynya. Wh (3): White whales winter in the North Water Polynya. Gh (1): Greenland halibut occur on the shelf break along the southern border.

Offshore area 34 (OS_34): *Resource use* (5): Important hunting area for inhabitants of Qaanaaq and Savissivik, main quarry is walrus, polar bear, ringed seal and bearded seal. *Species occurrence*: Wa (5): Important wintering areas for walrus in northern part. Sl (4): The North Water Polynya is an important habitat for seals (ringed and bearded). Pb (3): Polar bears in winter. Wh (3): White whales winter in the Northeast Water Polynya.

Offshore area 35 (OS_35): *Resource use* (5): Important hunting area for the inhabitants of Savissivik. Main quarry is polar bear, ringed seal and bearded seal. *Species occurrence*: Pb (5): Important area for polar bears. Sl (3): The shore lead is an important seal habitat (ringed and bearded seals).

Offshore area 36 (OS_36): *Resource use* (5): Important hunting area for the inhabitants of Savissivik, main quarry is polar bear, ringed seal and bearded seal. *Species occurrence*: Pb (5): Important area for polar bears. Sl (5): The shore lead is an important seal habitat (ringed and bearded seals).

Table 7.3. Offshore sensitivity, winter.

Area	Sensitivity value	Ranking
OS_33	54	Extreme
OS_34	51	Extreme
OS_35	37	Moderate
OS_36	41	High

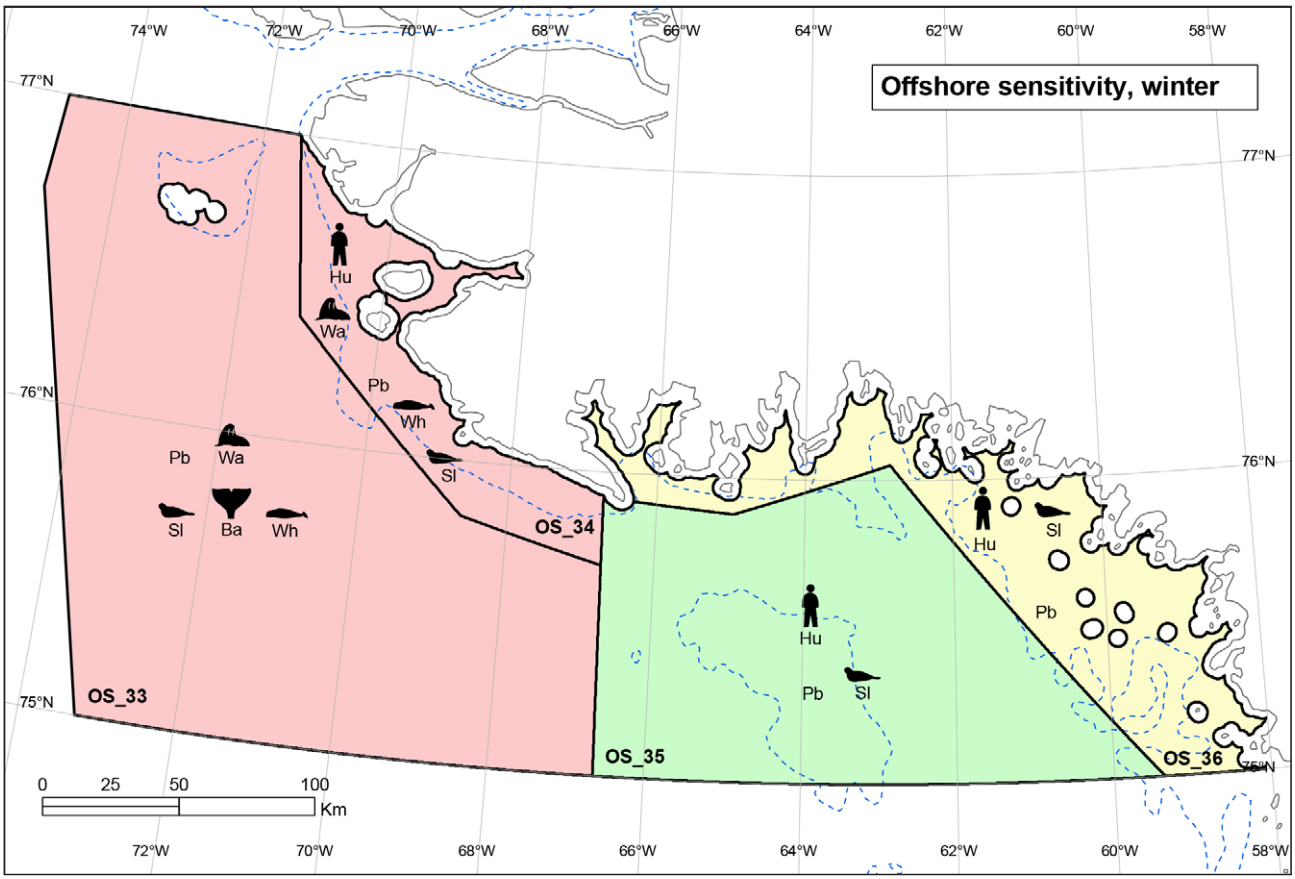


Figure 7.1.

7.2 Offshore sensitivity, spring (April – May)

Environmental description (Figure 7.2)

Offshore area 33 (OS_33): *Resource use* (1): Hunting area, primarily for polar bear. *Species occurrence*: Al (5): Breeding thick-billed murres and little auks arrive in huge numbers in May. Wa (5): Walruses present in open water and areas with thin ice. Pb (4): Polar bears widespread, but especially at the lead zone. Ba (3): Bowhead whales on spring migration. Na (3): Narwhals migrate through in spring. Sl (3): North Water Polynya is an important seal habitat (bearded and ringed seals). Wh (3): Spring migrating white whales. Iv (2): Spring migration of ivory gulls. Su (2): Northern fulmars, gulls and black-legged kittiwakes assemble in open water areas of the polynya. Gh (1): Greenland halibut grounds on the on shelf break along the southern border.

Offshore area 34 (OS_34): *Resource use* (5): Important hunting area for inhabitants of Qaanaaq and Savissivik, main quarry is walrus, narwhal, white whale, polar bear, ringed seal and bearded seal. *Species occurrence*: Al (5): Breeding thick-billed murres and little auks arrive in huge numbers in May. Se (5): Eiders and long-tailed ducks assemble in open water areas. Wa (5): Walruses present in open water and areas with thin ice. Pb (3): Polar bears widespread. Sl (3): North Water Polynya is an important seal habitat (bearded and ringed seals). Su (2): Northern fulmars, gulls and black-legged kittiwakes assemble in open water areas of the polynya. Ba (1): Bowhead whales on spring migration. No (1): Red-throated divers in shore leads.

Offshore area 35 (OS_35): *Resource use* (5): Important hunting area for the inhabitants of Savissivik. Main quarry is narwhal, polar bear, ringed seal and bearded seal. *Species occurrence*: Al (5): Breeding thick-billed murres and little auks arrive in huge numbers in May. Na (5): Narwhals migrate through area and stage until coastal waters become icefree. Pb (4): Polar bears widespread, but especially at the lead zone. Ba (3): Bowhead whales on spring migration. Sl (3): The shore lead is an important seal habitat (bearded and ringed seal). Wh (3): Spring migration of white whales through area. Su (2): Northern fulmars, black-legged kittiwakes and gulls assemble in open water areas in the shear zone. Wa (1): Walruses present in open water and areas with thin ice.

Offshore area 36 (OS_36): *Resource use* (5): Important hunting area for the inhabitants of Savissivik, main quarry is polar bear, narwhal, ringed seal and bearded seal. *Species occurrence*: Al (5): Breeding thick-billed murres and little auks arrive in huge numbers in May. Pb (5): Polar bears widespread, but especially at the lead zone. Se (5): Eiders and long-tailed ducks assemble in open water areas. Sl (3): Bearded seals and ringed seals are common. No (1): Red-throated divers in shore leads. Su (1): Northern fulmars, black-legged kittiwakes and gulls assemble in open water areas in the shear zone.

Table 7.4. Offshore sensitivity, spring.

Area	Sensitivity value	Ranking
OS_33	82	High
OS_34	87	Extreme
OS_35	78	High
OS_36	76	Moderate

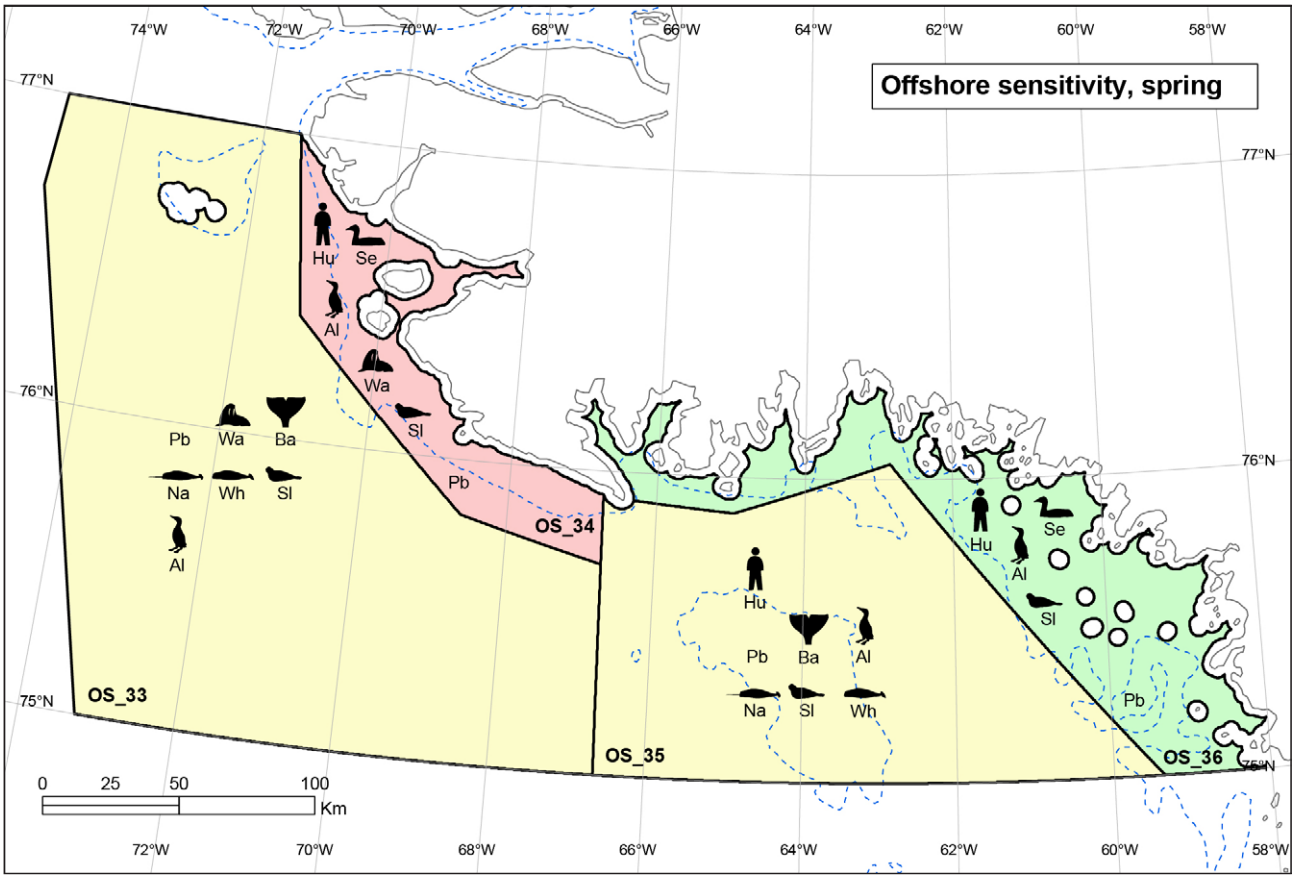


Figure 7.2.

7.3 Offshore sensitivity, summer (June – August)

Environmental description (Figure 7.3)

Offshore area 33 (OS_33): *Resource use* (1): Commercial fishery for Greenland halibut has been tried in the southern part. *Species occurrence*: Al (5): Thick-billed murres and little auks from huge breeding colonies on the nearby coasts. Ba (4): Bowhead whales and a few minke whales. Se (4): Breeding common eiders and moulting king eiders. Iv (2): Ivory gulls in summer. Pb (2): Polar bears in low numbers. Su (2): Kittiwakes and fulmars from breeding colonies on the adjacent coasts. Gh (1): Greenland halibut grounds on the on shelf break along the southern border. Na (1): Narwhals occur in low numbers in summer. No (1): A few red-throated divers forage near the coasts. Sl (1): Seals are, ring, harp and bearded throughout the summer, hooded in late summer.

Offshore area 34 (OS_34): *Resource use* (5): Important hunting area for inhabitants of Qaanaaq and Savissivik, main quarry are seals and little auk. *Species occurrence*: Al (5): Thick-billed murres and little auks from huge breeding colonies on the adjacent coasts. Se (4): Breeding common eiders and moulting king eiders. Su (3): Kittiwakes, gulls and fulmars from breeding colonies on the adjacent coasts. Ba (2): A few minke whales. Na (1): Narwhals occur in low numbers in summer. No (1): A few red-throated divers forage near the coasts. Pb (1): Polar bears in low numbers. Sl (1): Seals are widespread, ring, harp and bearded throughout the summer, hooded in late summer.

Offshore area 35 (OS_35): *Resource use* (5): Important hunting area for the inhabitants of Savissivik. Main quarry is narwhal, polar bear, ringed seal, harp seal, hooded seal and bearded seal. *Species occurrence*: Al (5): Little auks from huge breeding colonies on the adjacent coasts. Na (4): Narwhals are numerous in eastern part. Ba (3): A few minke whales. Pb (2): Polar bears in low numbers. Su (2): Kittiwakes, gulls and fulmars from breeding colonies on the adjacent coasts. Sl (1): Seals are widespread, ring, harp and bearded throughout the summer, hooded in late summer.

Offshore area 36 (OS_36): *Resource use* (5): Important hunting area for the inhabitants of Savissivik, main quarry is polar bear, narwhal, ringed seal, harp seal bearded seal and little auk, and there is small scale fishery for Greenland halibut. *Species occurrence*: Al (5): Little auks from breeding colonies on coasts of northern part. Na (5): Very important narwhal habitat. Pb (4): Polar bears in low numbers. Se (2): Breeding common eiders. Sl (2): Seals are widespread, ring, harp and bearded throughout the summer, hooded in late summer. No (1): A few red-throated divers forage near the coasts. Su (1): Gulls from colonies on the coast.

Table 7.5. Offshore sensitivity, summer.

Area	Sensitivity value	Ranking
OS_33	57	High
OS_34	58	Extreme
OS_35	49	High
OS_36	59	Extreme

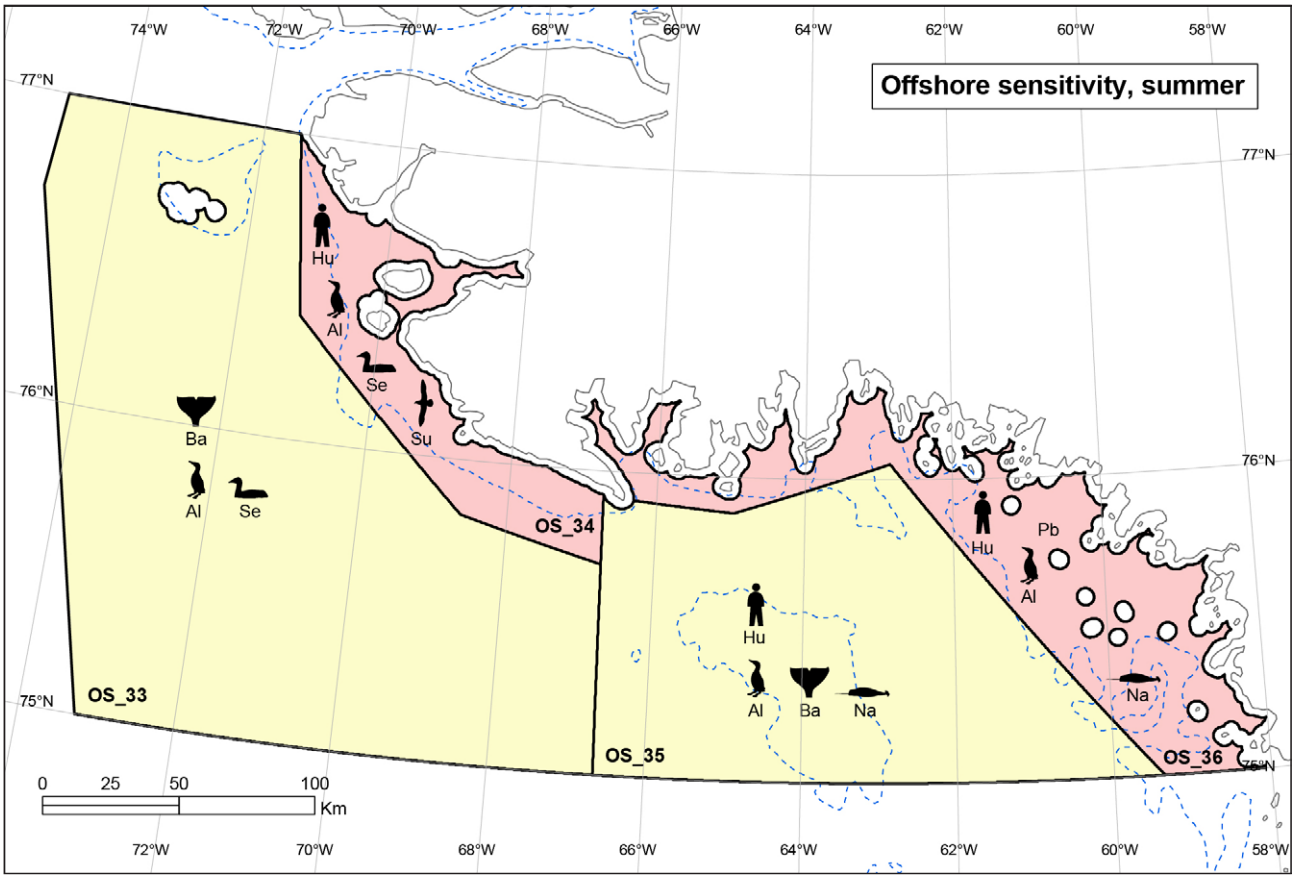


Figure 7.3.

7.4 Offshore sensitivity, autumn (September – December)

Environmental description (Figure 7.4)

Offshore area 33 (OS_33): *Resource use* (1): Hunting area, primarily for polar bear. Commercial fishery for Greenland halibut has been tried in southern part. *Species occurrence*: Wa (5): Walruses arrive to wintering areas in October. Al (3): Migrating thick-billed murres and little auks early in the period. Na (3): Narwhals occur on autumn migration. Wh (3): Migrating (from September) white whales. Pb (2): Polar bears in low numbers. Gh (1): Greenland halibut grounds on the shelf break along the southern border. Sl (1): Ring and bearded seals throughout the period, hooded and harp seals as long as open water is present. Su (1): Mainly fulmars.

Offshore area 34 (OS_34): *Resource use* (5): Important hunting area for inhabitants of Qaanaaq and Savissivik, main quarry is walrus, narwhal, white whale, polar bear, ringed seal and bearded seal. *Species occurrence*: Se (5): Staging eiders and long-tailed ducks near coasts. Wa (5): Walruses arrive to wintering areas in October. Wh (4): Migrating (from September) white whales. Pb (1): Polar bears in low numbers. Sl (1): Ring and bearded seals throughout the period, hooded and harp seals as long as open water is present. Su (1): Mainly large gulls.

Offshore area 35 (OS_35): *Resource use* (5): Important hunting area for the inhabitants of Savissivik. Main quarry is narwhal, polar bear, ringed seal, harp seal, hooded seal and bearded seal. *Species occurrence*: Na (3): Narwhals occur on autumn migration. Wh (3): Migrating (from September) white whales. Pb (2): Polar bears in low numbers. Sl (1): Ring and bearded seals throughout the period, hooded and harp seals as long as open water is present. Su (1): Mainly large gulls.

Offshore area 36 (OS_36): *Resource use* (5): Important hunting area for the inhabitants of Savissivik, main quarry is polar bear, narwhal, ringed seal, harp seal and bearded seal, and there is small scale fishery for Greenland halibut. *Species occurrence*: Na (5): Important habitat for narwhals until mid-October. Pb (3): Polar bears in low numbers. Wh (3): Migrating (from October) white whales. Sl (1): Mainly ringed seals. Su (1): Mainly large gulls.

Table 7.6. Offshore sensitivity, autumn.

Area	Sensitivity value	Ranking
OS_33	44	High
OS_34	50	Extreme
OS_35	33	Moderate
OS_36	38	High

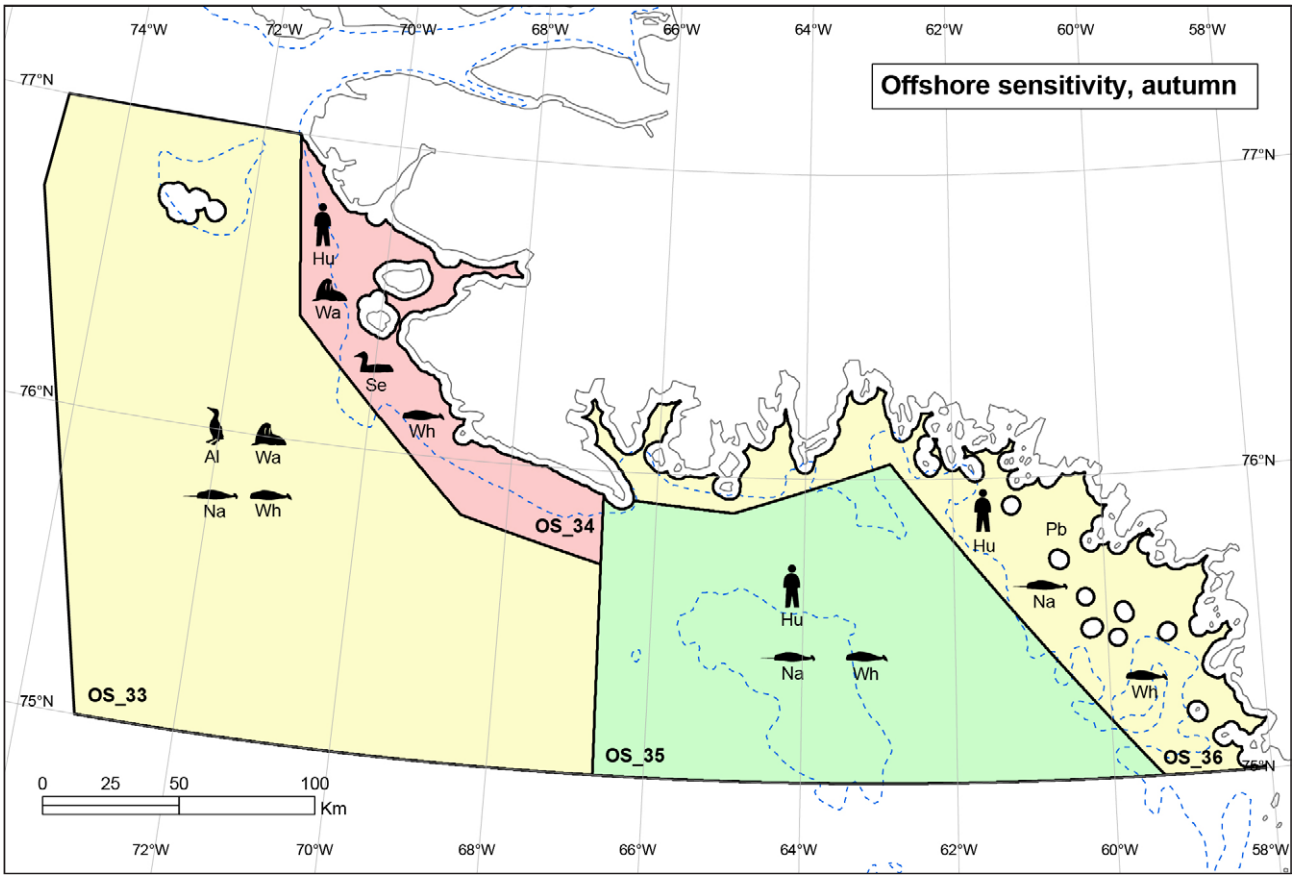
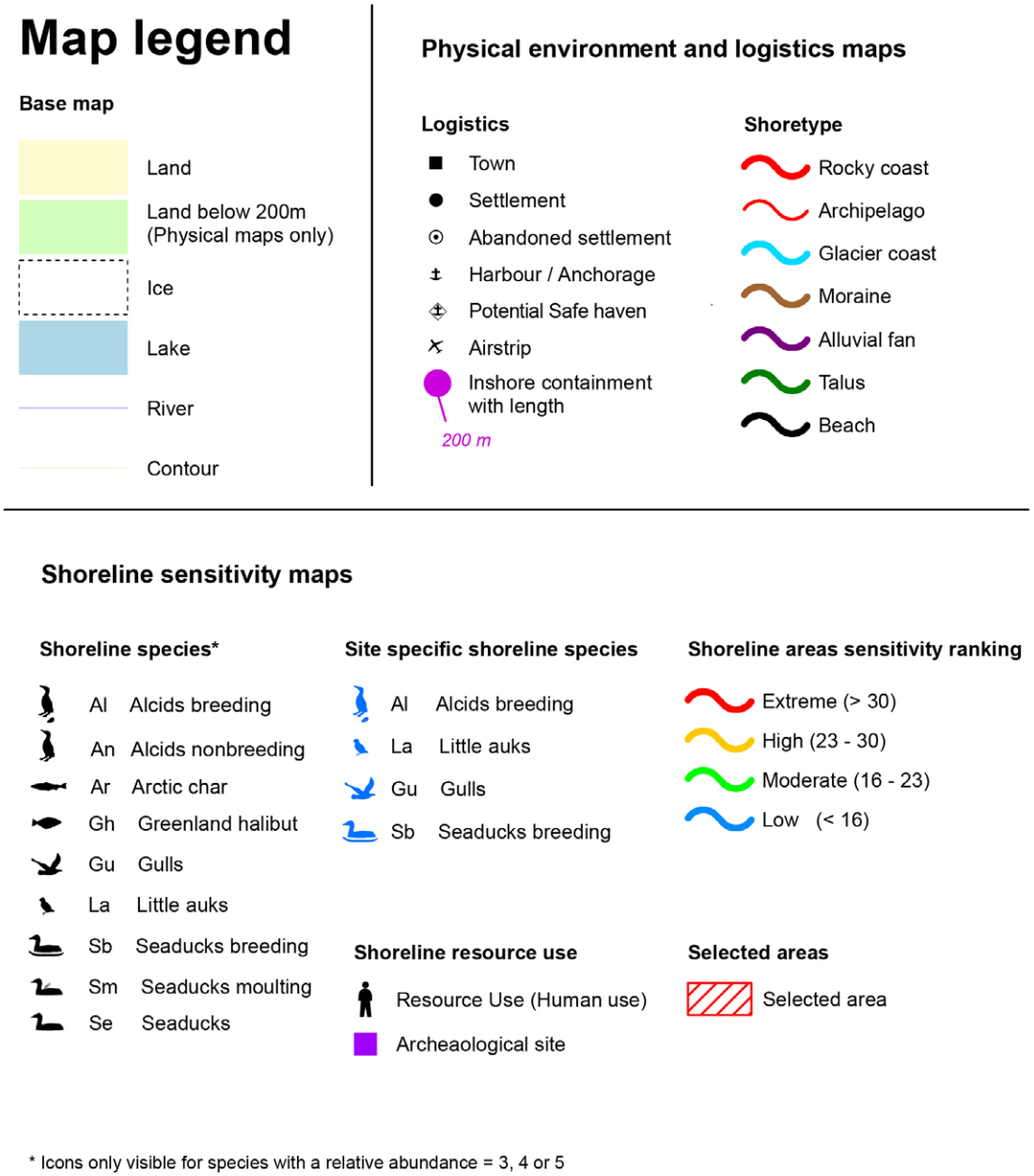


Figure 7.4.

8 Shoreline sensitivity

This chapter contains two series of 15 detailed maps covering the area: Shoreline sensitivity maps and Physical environment and logistics maps. The Shoreline sensitivity maps are on left-hand side, and Physical environment and logistics maps are on the right. Descriptive text appears on the pages in between. There is a common legend to the maps to be unfolded on the page facing this. Please refer to the official topographical maps and nautical charts for any site names missing on the maps and to the Greenland Pilot (Grønlands Lods) and the nautical charts for detailed information on anchorages and sailing routes.

See Chapter 5, Users guide, for further information on map interpretation.



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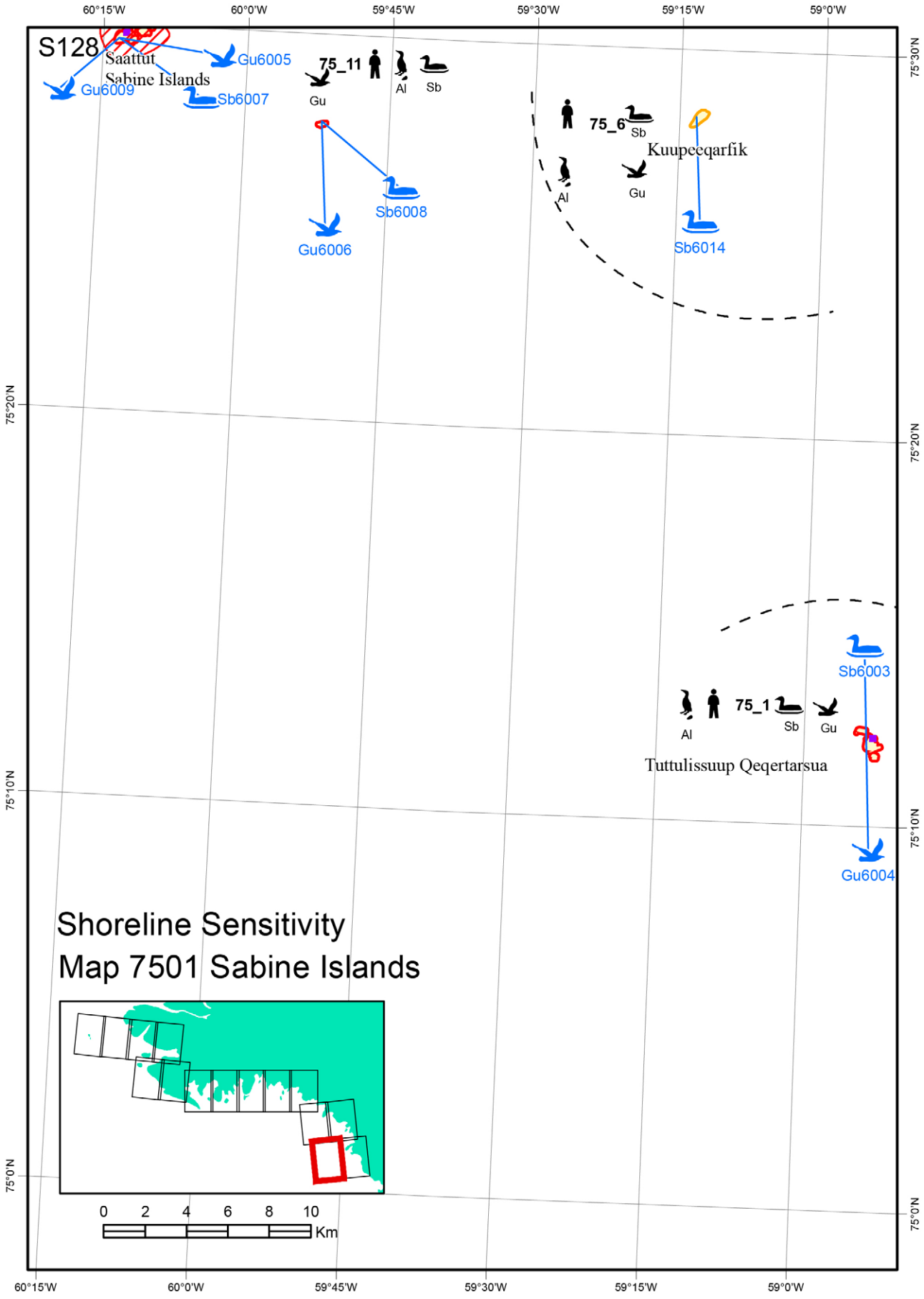


Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84

8.1 Shoreline sensitivity, Map 7501 – Sabine Islands

Environmental Description

Resource use
Resource use is not significant on this map sheet. However, hunting for seabirds and marine mammals takes place on occasional basis.

Species occurrence

Al75011	1 colony with breeding black guillemots.
Gu75011	3 colonies with breeding Arctic terns, Sabine's gulls and glau cous gulls.
Sb75011	2 colonies with breeding common eiders.

Site specific species occurrence (seabird breeding colonies); blue icons

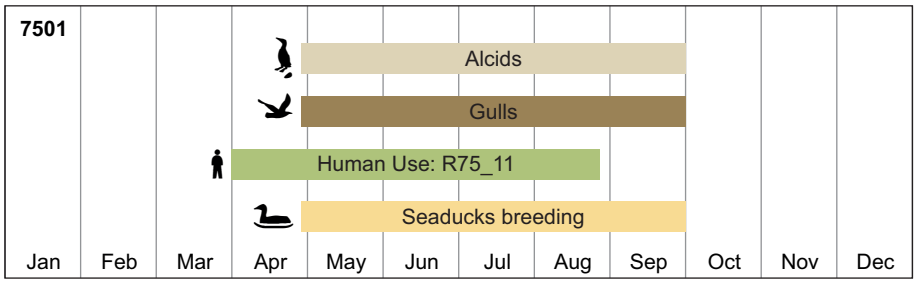
Gu6004	Breeding gulls.
Gu6005, Gu6006	Breeding Sabine's gulls (**S128**).
Gu6009	Breeding Arctic terns (**S128**).
Sb6003	Breeding common eiders.
Sb6007	Breeding common eiders (**S128**).
Sb6008	Breeding common eiders.
Sb6014	Breeding common eiders.

Selected area

S128	The Sabine Islands (Saattut), due to a high diversity of breeding seabirds.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
75_1	21	Extreme
75_6	16	Moderate
75_11	28	Extreme



Map 7501.
Species and Resource Occurrence.

8.1.1 Physical environment and logistics. Map 7501- Kuupeeqarfik

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to June. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the spring months and the coast is generally ice-free by mid-July. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, allowing little opportunity for marine access.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 375 km to the northwest (Map 7654) and at Upernavik (only STOL) 300 km to the south.

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas.

The waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

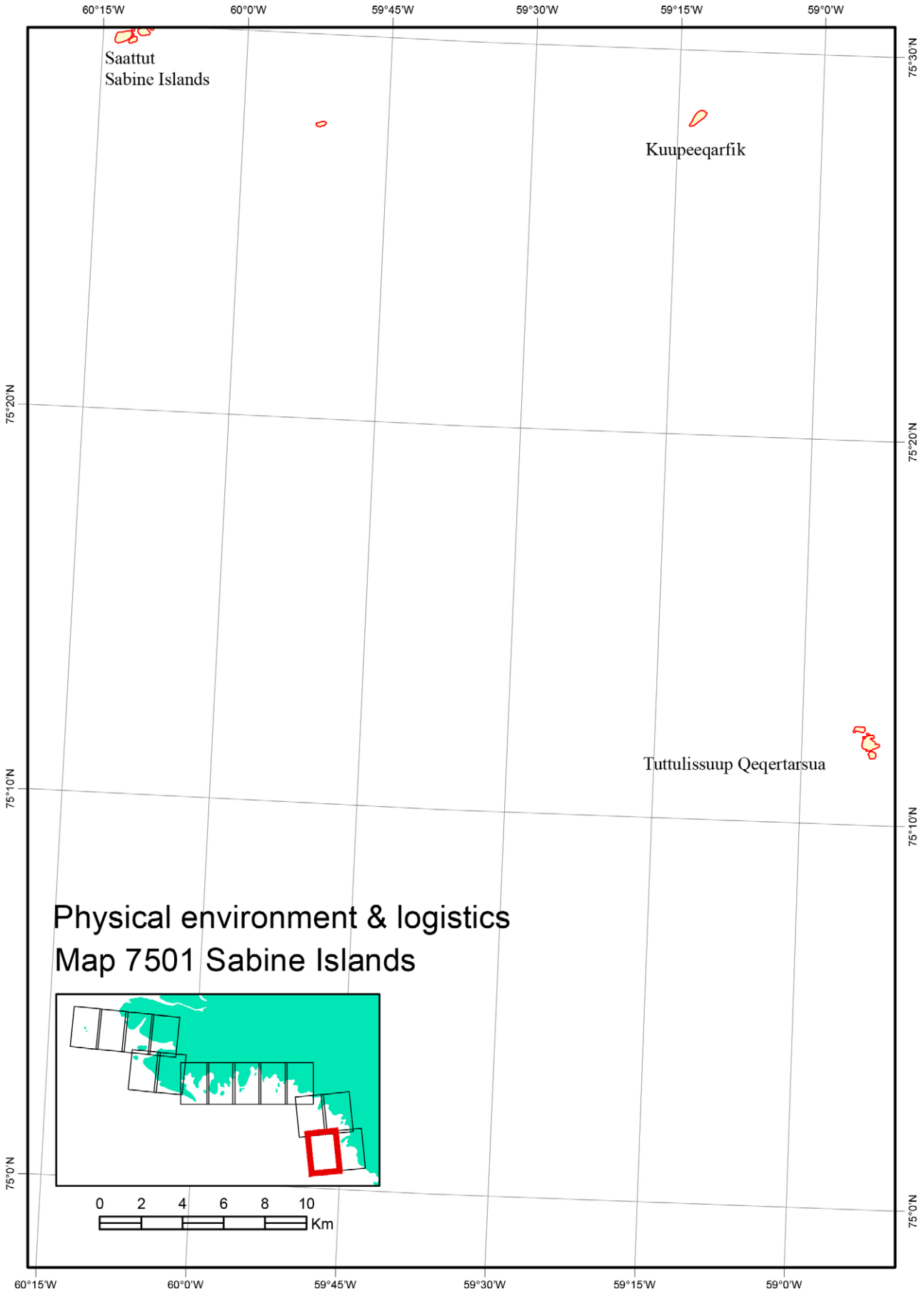
There are no opportunities for nearshore or exclusion booming among the islands described on this map.

Shorelines shown on this map are almost exclusively exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. There are some small sedimentary beaches on the islands to the north (Figure 7.3).

Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

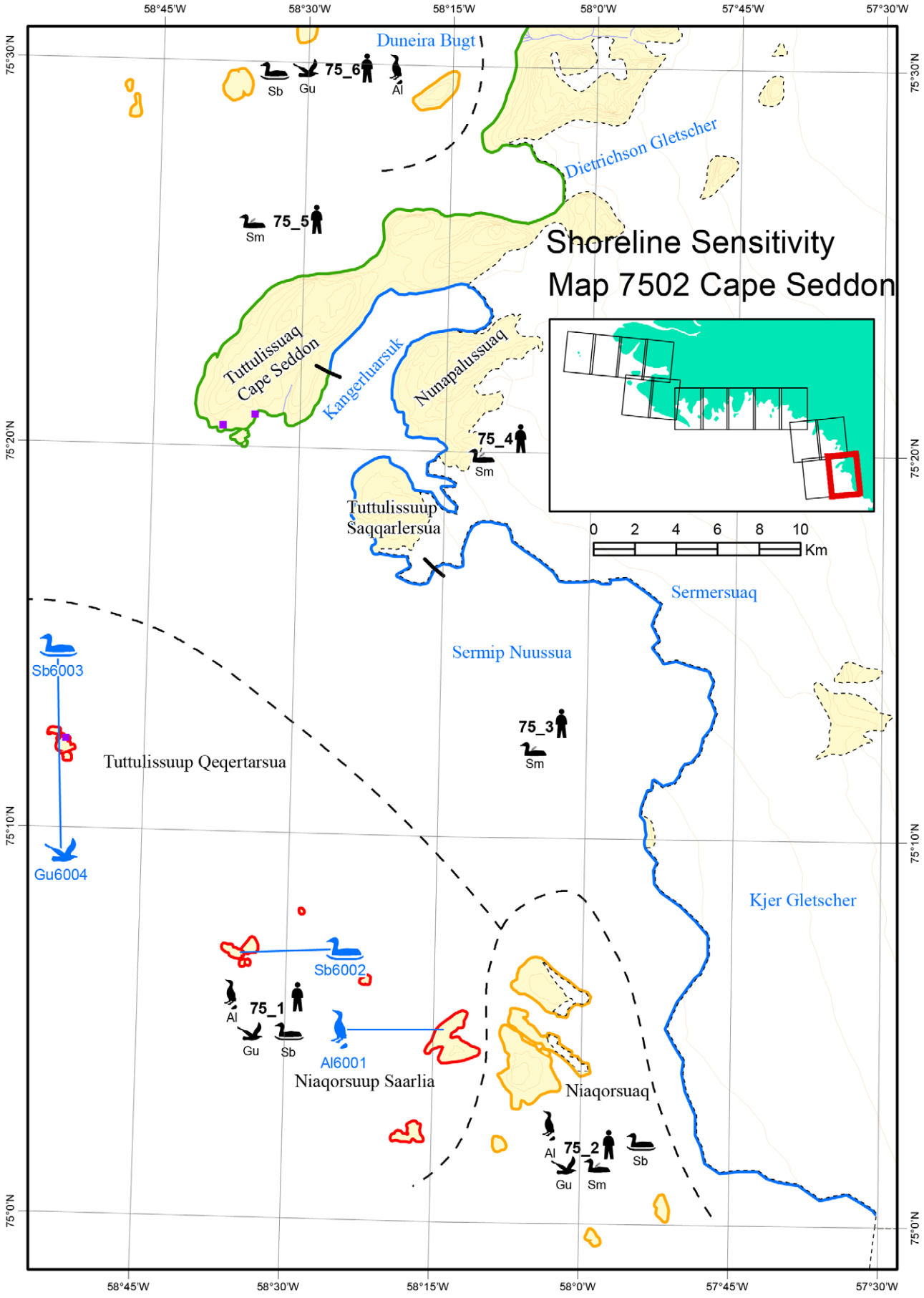
Safe Havens
There are no potential safe havens identified on this map.

Maps
Danish Survey & Cadastre (KMS) topographical map: 75 V.1. Nautical charts: 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84

8.2 Shoreline sensitivity, Map 7502 – Cape Seddon

Environmental Description

Resource use

R75_1-R75_3	Hunting for polar bear, narwhal and white whale.

Species occurence

Al75001	1 colony with breeding black guillemots.
Gu75001	2 colonies with breeding Arctic terns and glaucous gulls.
Gu75002	4 colonies with breeding Arctic terns, Iceland gulls and black-legged kittiwakes.
Sm75002, Sm75004	Moulting area for common eiders and king eiders.

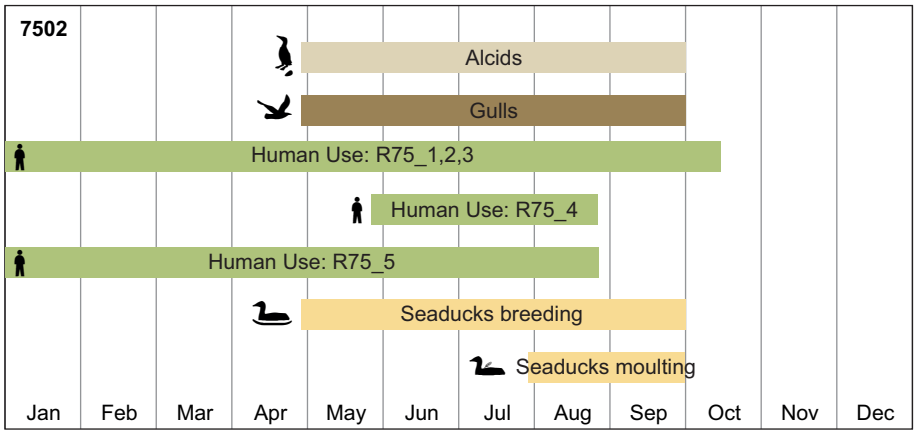
Site specific species occurrence (seabird breeding colonies); blue icons

Al6001	Breeding black guillemots.
Gu6004	Breeding Arctic terns.
Sb6002, Sb6003	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
75_1	21	Extreme
75_2	18	High
75_3	8	Low
75_4	9	Low
75_5	12	Moderate
75_6	16	Moderate

Map 7502.
Species and Resource Occurrence.



8.2.1 Physical environment and logistics. Map 7502 – Cape Seddon

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July, although glacier ice may block the coasts for periods throughout the summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

About 30 km west of Tuttulissuaq (Cape Seddon), there is a rock that dries to 0.6 m. Several foul areas have been reported 10 km ESE of this rock.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. Landings may be possible near the beach and alluvial shorelines within the fjords, but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 400 km to the northwest (Map 7654) and at Upernavik (only STOL) 300 km to the south.

Countermeasures

In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for nearshore booming along the shoreline described on this map.

Alternatively, diversion booming could be attempted to protect the islands noted as high and extremely sensitivity, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters. Moreover, glacier ice will contribute to the difficulties.

Shorelines shown on this map are predominantly exposed rock, talus, and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

Consideration should be given to flushing operations in the protected waters within the fjords east of Tuttulissuaq. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

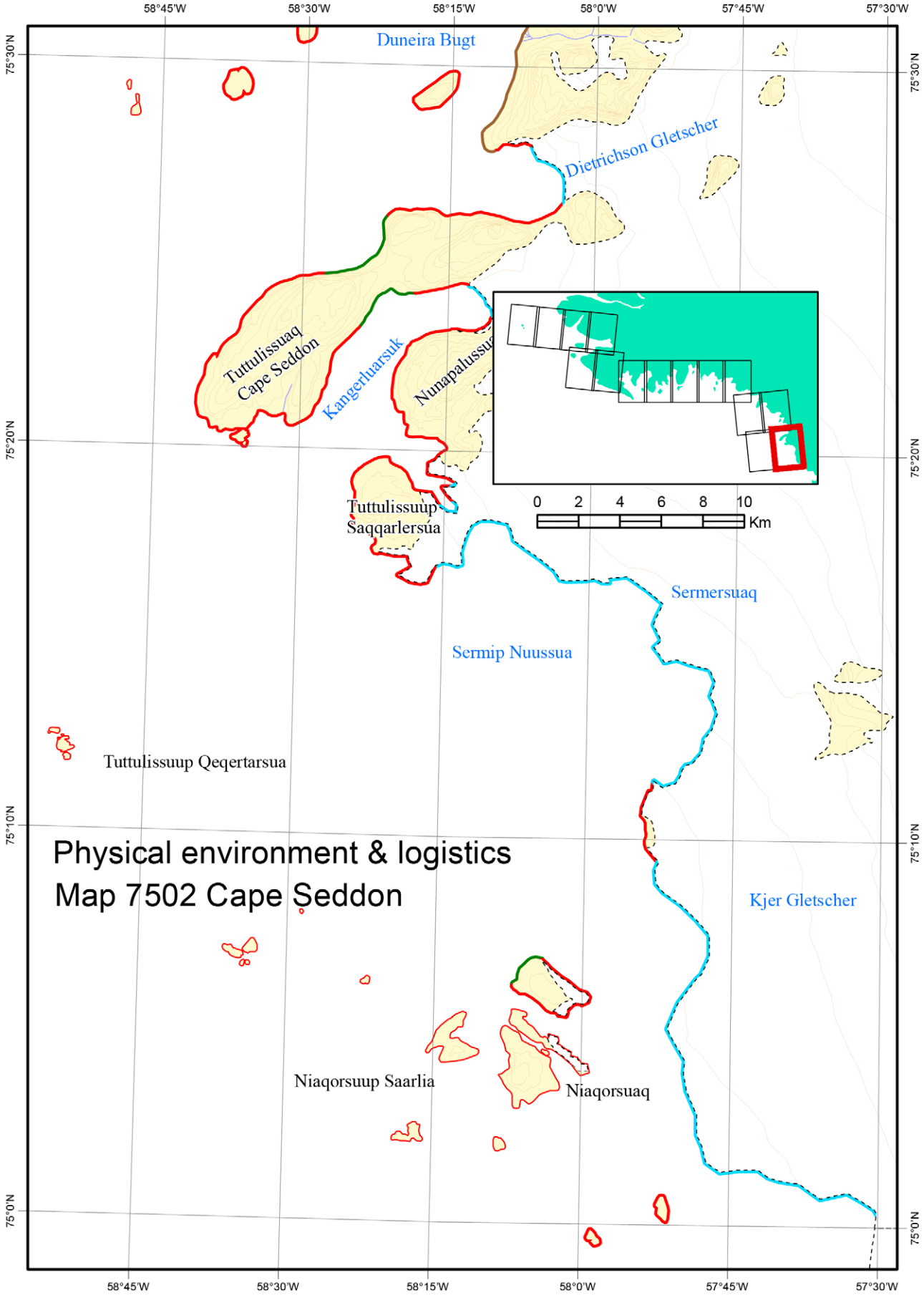
Safe Havens

There are no potential safe havens identified on this map.

The fjords east of Tuttulissuaq could be considered as potential safe havens given their moderate sensitivity rating. Exclusion booming would be impractical due to the width of the channel; however, the shape of the channel may afford natural containment, depending on wind direction and tidal streams. As they are uncharted, soundings should be taken to confirm their depth prior to use.

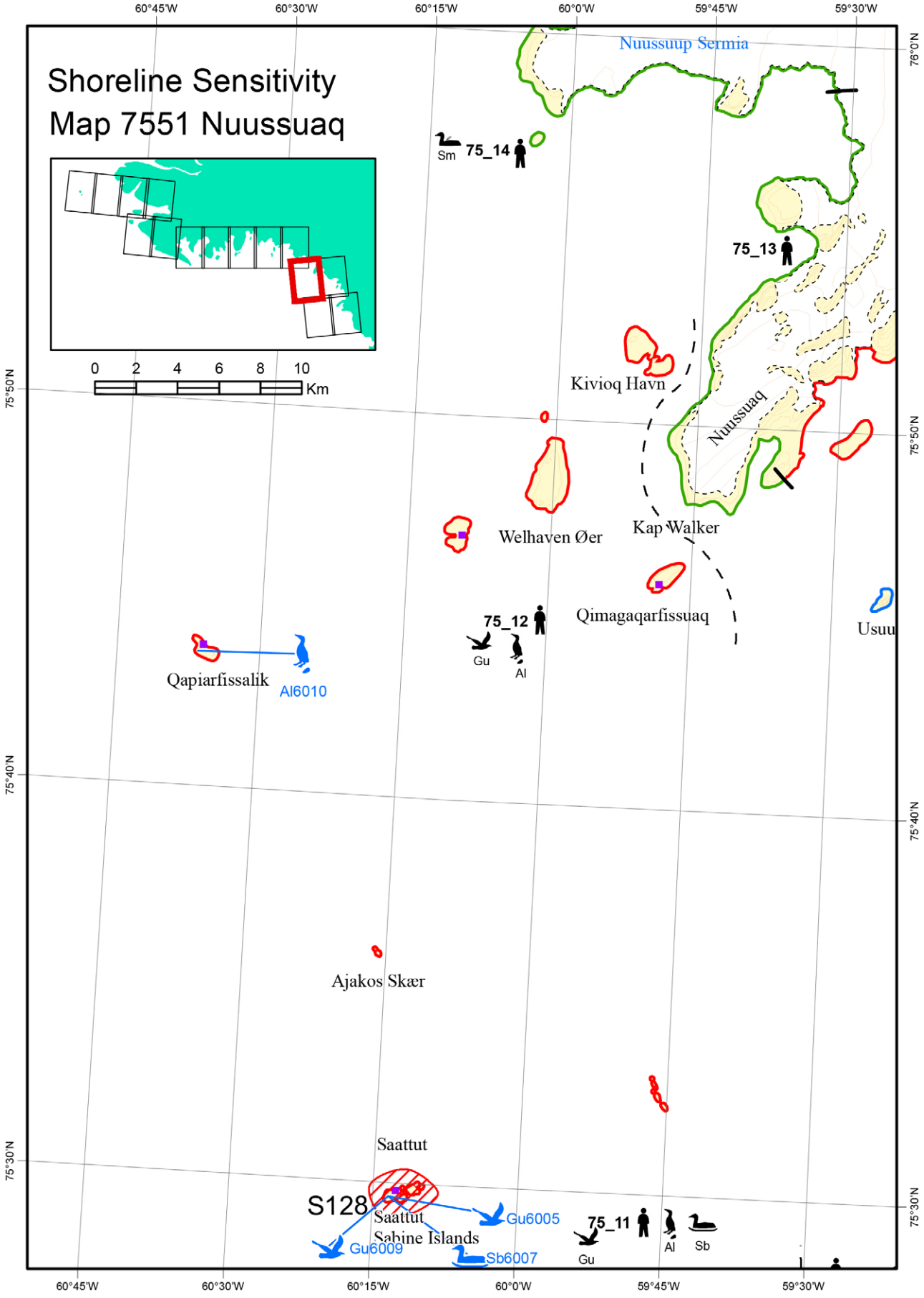
Maps

Danish Survey & Cadastre (KMS) topographical map: 75 V.1. Nautical charts: 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84

8.3 Shoreline sensitivity, Map 7551 – Nuussuaq

Environmental Description

Resource use
Narwhals are hunted along the glaciers and coasts, and occasional hunting for seabirds and other marine mammals takes place.

Species occurrence

Al75012	2 colonies with breeding black guillemots and one with Atlantic puffins.

Site specific species occurrence (seabird breeding colonies); blue icons

Gu6005	Breeding Sabine´s gulls (S128).
Gu6009	Breeding Arctic terns (S128).
Sb6007	Breedning common eiders (S128).
Al6010	Breeding Atlantic puffins.

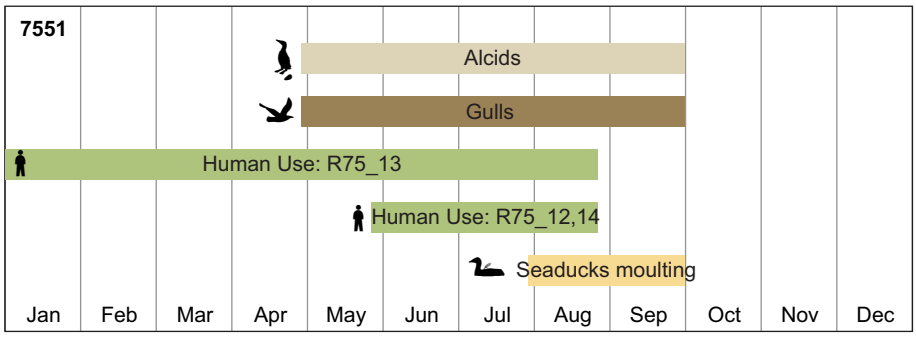
Selected area

S128	The islands of Sabine (Saattut) due to a high diversity of breeding seabirds.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
75_11	28	Extreme
75_12	21	Extreme
75_13	13	Moderate
75_14	12	Moderate

Map 7551.
Species and Resource Occurrence.



8.3.1 Physical and logistics, Map 7551 – Nuussuaq

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. Glacier ice may for periods block the coast during summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. Landings may be possible near the beach and alluvial shorelines within the fjords, but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 350 km to the northwest (Map 7654) and at Upernavik (only STOL) 350 km to the south.

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

Alternatively, diversion booming could be attempted to protect the inshore areas, but this will be complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

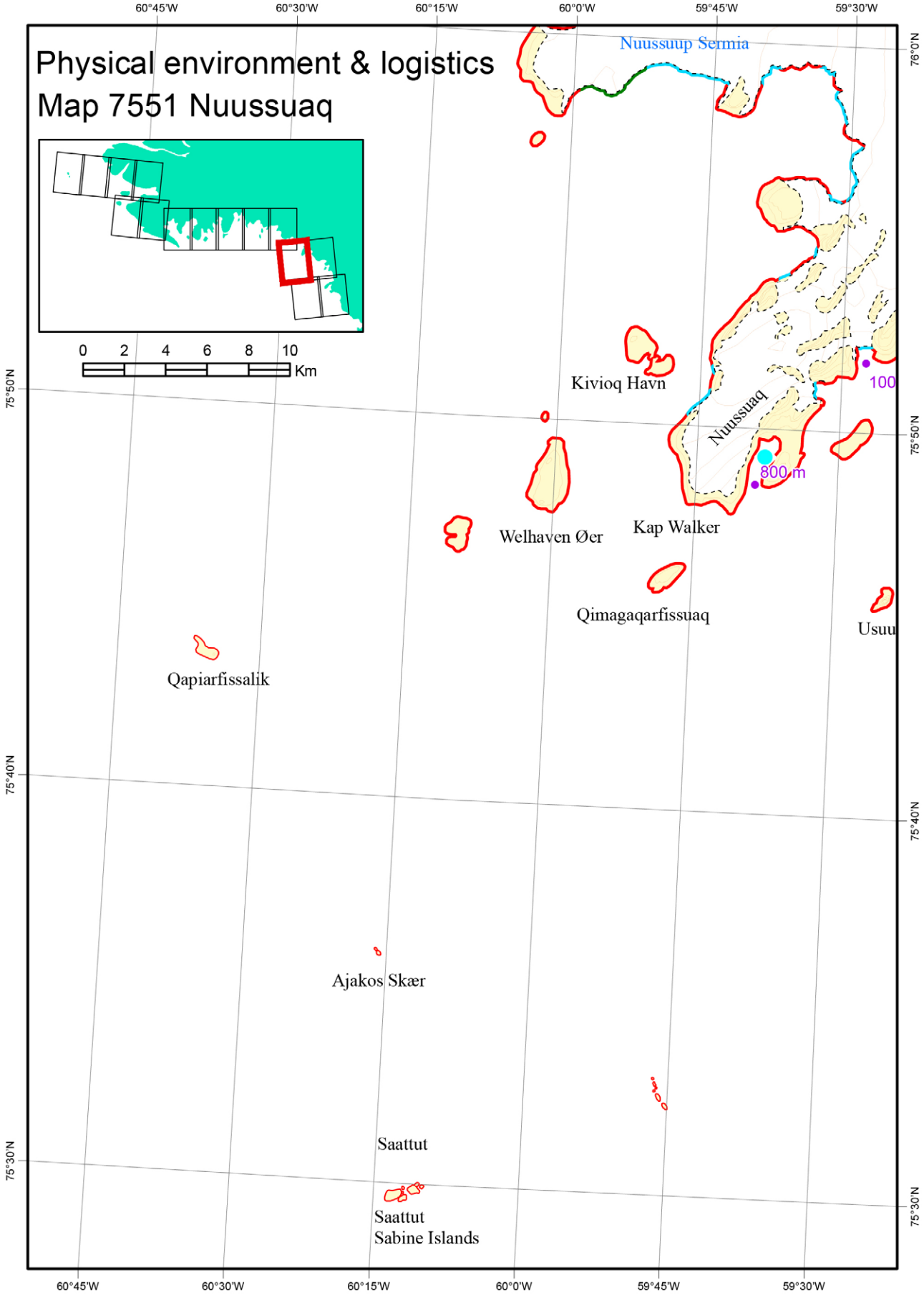
Exclusion booming could be used to prevent oil from entering the inlets close east and NE of Kap Walker, where the inlet widths are 800 and 1000 m. Depths are unknown and would require reconnaissance at the time of a spill.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

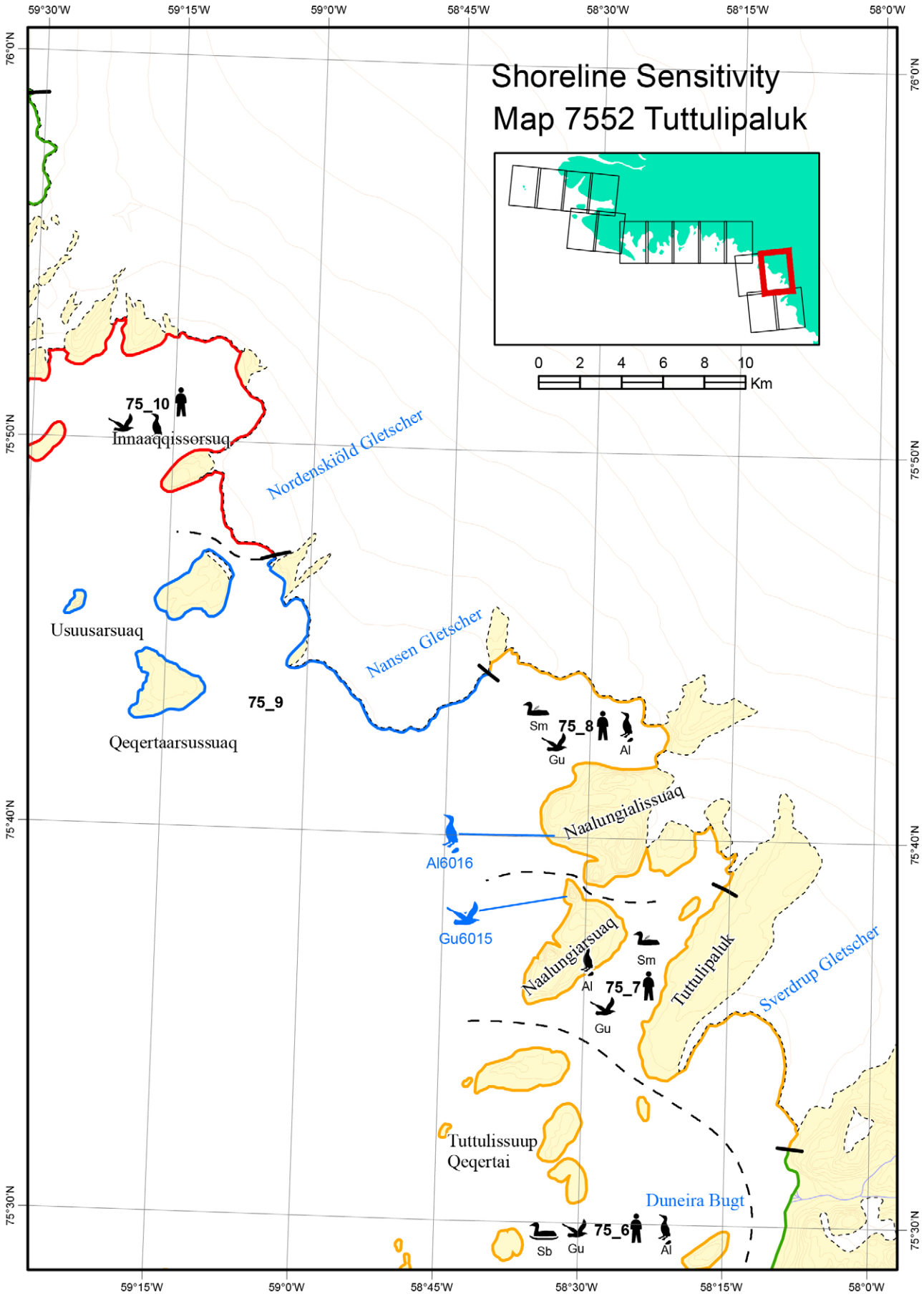
Safe Havens
A potential safe haven exists in the inlet close east of Kap Walker, where the inlet width is 800 m. Exclusion booming could be used to contain any further release of oil. Depths are unknown and would require reconnaissance at the time of a spill.

Maps
Danish Survey & Cadastre (KMS) topographical map: 75 V.1. Nautical charts: 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84

8.4 Shoreline sensitivity, Map 7552 – Tuttulipaluk

Environmental Description

Resource use
Narwhals are hunted along the glaciers and coasts, and occasional hunting for seabirds and other marine mammals takes place.

Species occurrence

Al75008	1 colony with breeding black guillemots.
Gu75007	3 colonies with breeding black-legged kittiwakes, iceland gulls and glaucous gulls.
Gu75010	3 colonies with breeding Thayer's gulls and glaucous gulls.
Sm75007	Moulting common eiders and king eiders.

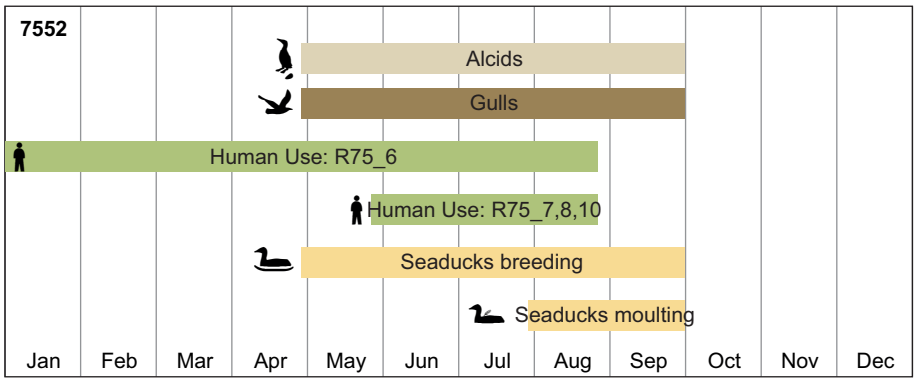
Site specific species occurrence (seabird breeding colonies); blue icons

Al6016	Breeding black guillemots.
Gu6015	Breeding black-legged kittiwakes.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
75_6	16	Moderate
75_7	17	High
75_8	17	High
75_9	9	Low
75_10	19	Extreme

Map 7552.
Species and Resource Occurrence.



8.4.1 Physical and logistics, Map 7552 – Tuttulipaluk

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current. Glacier ice may prevent access to to the coasts in summer.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. Landings may be possible near the beach and alluvial shorelines within the fjords, but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 375 km to the northwest (Map 7654) and at Upernavik (only STOL) 400 km to the south.

Countermeasures

In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

Alternatively, diversion booming could be attempted to protect the selected area, but is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Exclusion booming could be used to prevent oil from entering the inlet NW of Innaaqqissorsuq, where the inlet width is 900 m. Depths are unknown and would require reconnaissance at the time of a spill. Similarly, exclusion booming to limit the extent of alongshore contamination could be employed in the channels between Naalungialisuaq, and the islands south and west of Tuttulipaluk and the mainland, with inlet widths of 600, 500, 900, and 300 m, respectively. In each location, water currents and depths are unknown, necessitating site surveys at the time of a spill.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

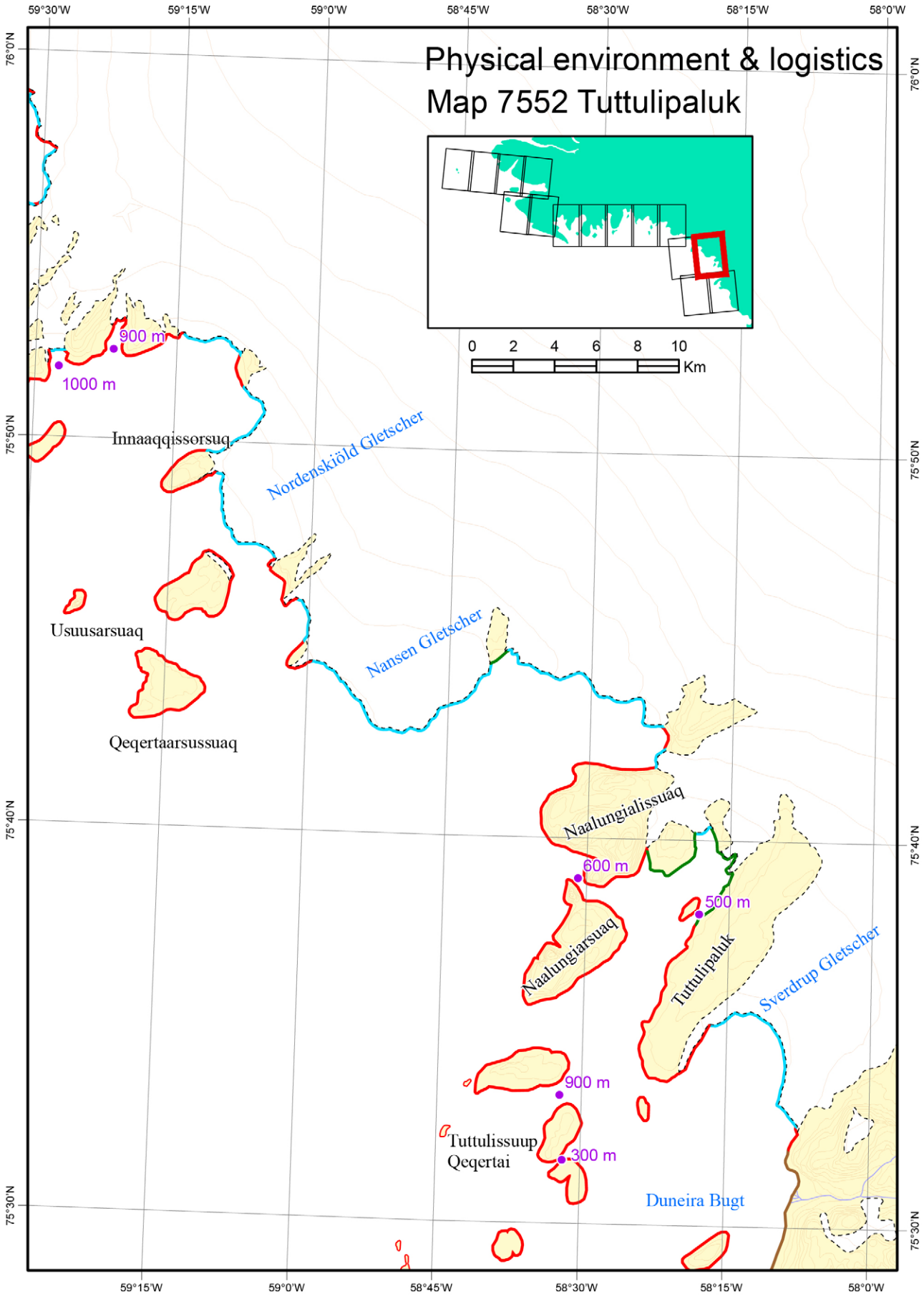
Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens

There are no potential safe havens identified on this map.

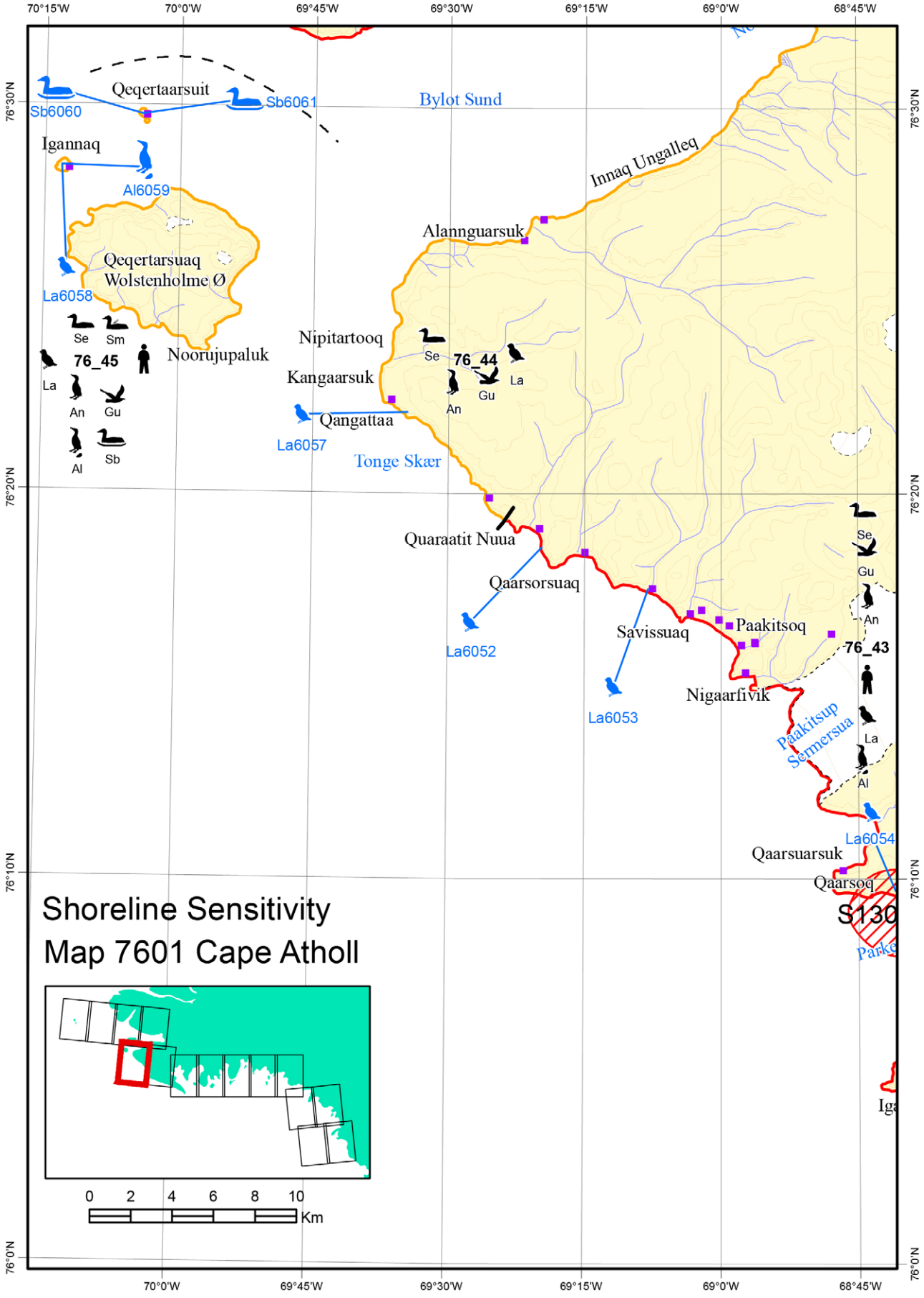
Maps

Danish Survey & Cadastre (KMS) topographical map: 76 V.2. Nautical charts: 3200,10.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 21N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.5 Shoreline sensitivity, Map 7601 – Cape Atholl

Environmental Description

Resource use
Resource use is not significant on this map sheet. However, hunting for sea-birds and marine mammals takes place on occasional basis.

Species occurrence

Al76043	3 colonies with breeding black guillemots, and one with thick-billed murres (S130).
Al76045	3 colonies with breeding black guillemots, razorbills and Atlantic puffins.
Gu76043	2 colonies with breeding black-legged kittiwakes and glaucous gulls.
La76043	Large breeding colonies of little auks.
Se76043	Spring concentrations of long-tailed ducks and common eiders.
Se76045	Spring concentrations of long-tailed ducks, king eiders and common eiders.
Sb76045	3 colonies with breeding common eider.

Site specific species occurrence (seabird breeding colonies); blue icons

Al6059	Breeding Atlantic puffins.
La6052, La6053	Breeding little auks.
La6054	Breeding little auks (S130).
La6057, La6058	Breeding little auks.
Sb6060, Sb6061	Breeding common eiders.

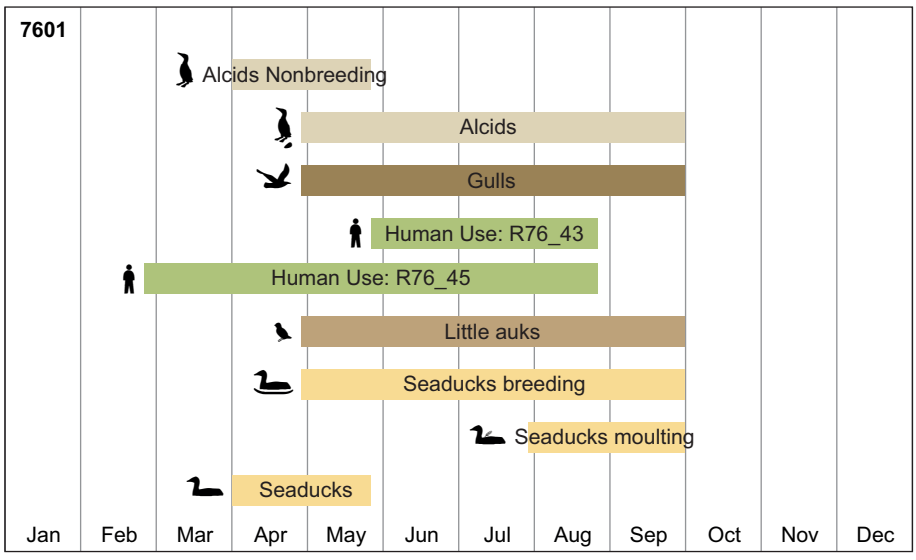
Selected area

S130	The cliff Parker Snow Bay and adjacent waters, due to a huge seabird breeding colony.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_43	25	Extreme
76_44	17	High
76_45	18	High

Map 7601.
Species and Resource Occurrence.



8.5.1 Physical and logistics map, 7601 – Cape Atholl

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. But glacier ice and old drift ice may block the coasts for periods during the summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

Good anchorage can be obtained off the N side of the face of Paakitsup Sermersua in depths of 42 m to 46 m.

Close N of Paakitsup Sermersua is a cave, about 6 m high and wide, in the solid rock just above the high water mark. It is a favourite resting place and cache for hunters travelling along this coast.

Tonge Skær, a low, tabular rock about100 m long and barely awash, lies parallel to the coast 4 km SE of Nipitartooq (Cape Atholl). A dark patch on a mountain side in the vicinity of this danger is prominent from a considerable distance.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access.

There is an airport is on the adjoining map at Thule Air Base (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for nearshore or exclusion booming along the shorelines described on this map.

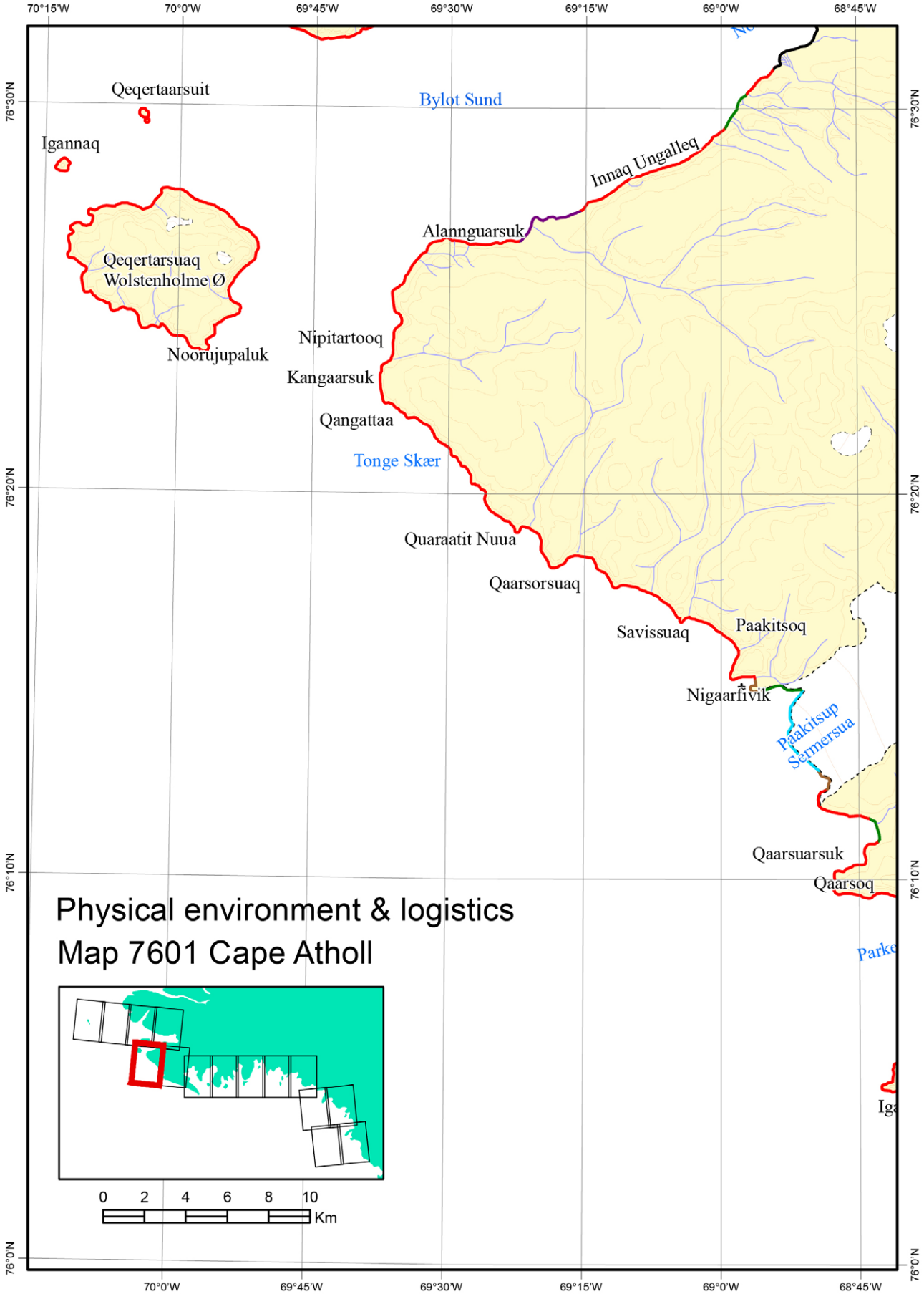
Alternatively, diversion booming could be attempted to protect the selected area, but this will be complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils. But there also beaches with boulders and coarse gravel (Figure 5.16) where oil may be buried and preserved. Consideration should be given to flushing operations of rocky coasts in the more protected waters and highly sensitive shorelines within Qaarsuarsuk and south of Qaarsoq. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based, given the likely nature of the shoreline.

Flushing may also be considered on the several sections of shoreline northeast of Nipitartooq (Cape Atholl) that are designated as moraine, although these have somewhat exposed coastal exposure. Marine access and beach trafficability are unknown, necessitating site surveys at the time of the clean-up.

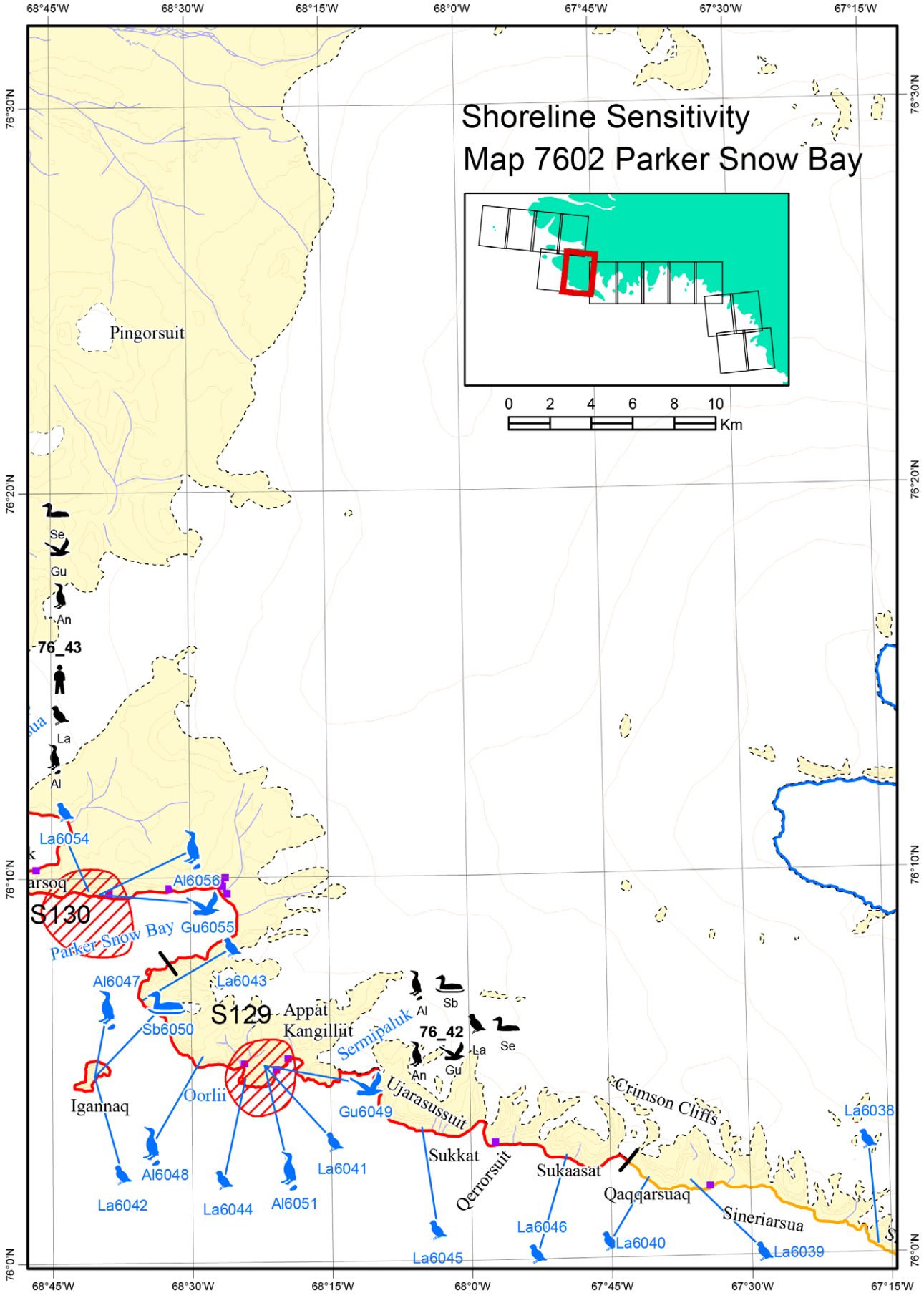
Safe Havens
There are no potential safe havens identified on this map.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.1. Nautical charts: 3130, 3200,1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.6 Shoreline sensitivity, Map 7602 – Parker Snow Bay

Environmental Description

Resource use
Resource use is not significant on this map sheet. However, hunting for sea-birds and marine mammals takes place on occasional basis.

Species occurrence

Al76042	3 colonies with breeding black guillemots, and one large with thick-billed murres (S129).
An76042	Spring concentrations of black-legged kittiwakes and thick-billed murres.
Gu76042	2 colonies with breeding black-legged kittiwakes and glaucous gulls.
La76042	Huge breeding colonies with little auks.
Se76042	Spring concentrations of long-tailed ducks and common eiders.
Sb76042	2 colonies with breeding common eiders.

Site specific species occurrence (seabird breeding colonies); blue icons

Al6051	Large colony of breeding thick-billed murres (S129).
Al6056	Large colony of breeding thick-billed murres (S130).
Gu6049	Breeding black-legged kittiwakes (S129, S130).
La6038- La6046	Huge colonies with breeding little auks.
Sb6050	Breeding common eiders.

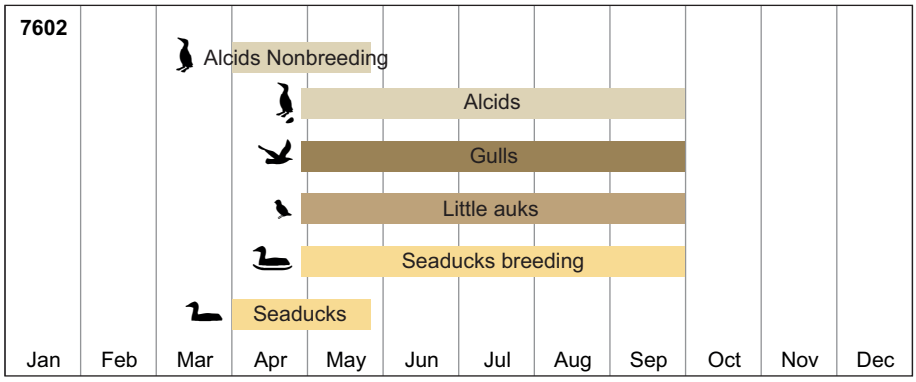
Selected areas

S129	The cliff Appa Appai and adjacent waters, due to a huge seabird breeding colony.
S130	The cliff Parker Snow Bay and adjacent waters, due to a huge seabird breeding colony.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_42	21	Extreme
76_43	25	Extreme

Map 7602.
Species and Resource Occurrence.



8.6.1 Physical and logistics, Map 7602 – Parker Snow Bay

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and many apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-August. Icebergs are present throughout the year, discharged from the numerous glaciers to the south of the area.

Excellent anchorage can be found in the innermost part of Issuvissuup Paava (Paker Snow Bay), approximately 350 m offshore at a depth of 20 m (clay).

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. The bay's beaches and alluvial shorelines provide places where landings may be possible, but would require reconnaissance to confirm.

There is an airport is on the adjoining map at Thule Air Base (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are few opportunities for nearshore booming along the short section of shoreline described on this map.

Alternatively, diversion booming could be attempted to protect the selected area, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Exclusion booming could be used to reduce the extent of inshore oiling at Appat Kangilliit and Sukkat, where the inlet widths are less than 1000 m and the tidal stream is reported to be weak. Tidal steams and depths are unknown and would require reconnaissance at the time of a spill.

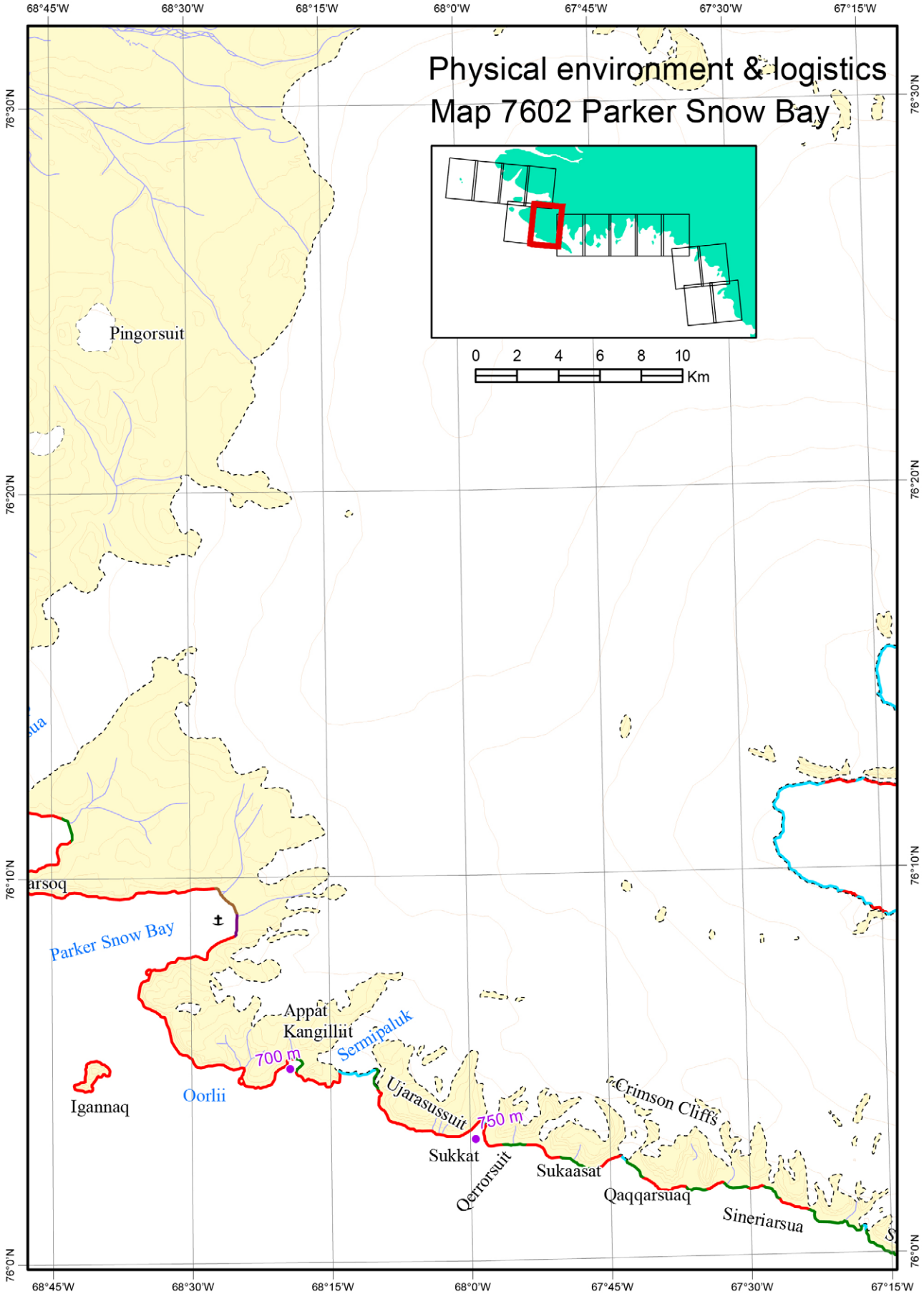
Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

Consideration should be given to flushing operations in the protected waters within the few inlets (Appat Kangilliit and Sukkat) and in Issuvissuup Paava (Parker Snow Bay).

Safe Havens
There are no potential safe havens identified on this map.

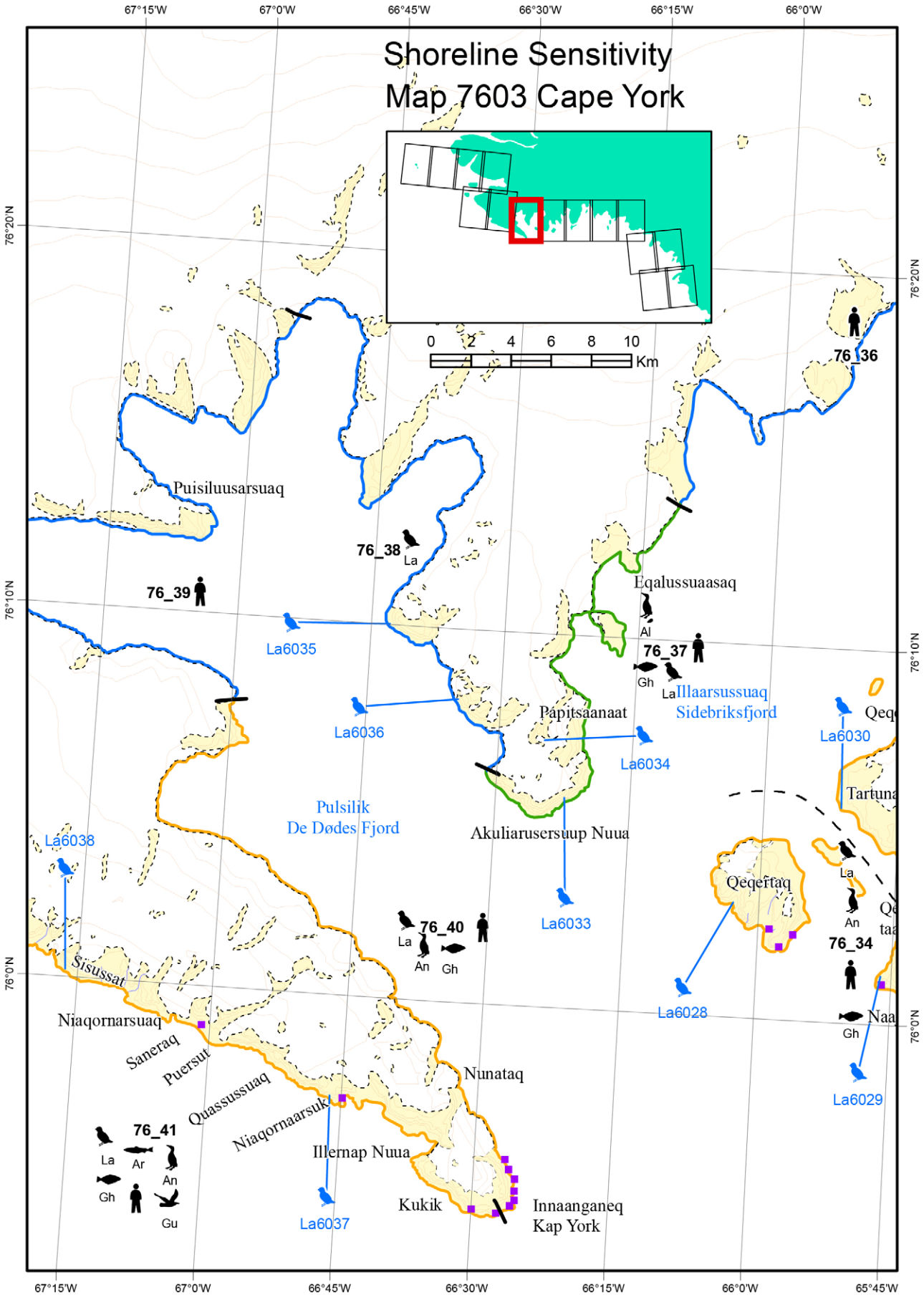
The small bays at Appat Kangilliit and Sukkat could be considered as potential safe havens, but both inlets have a high sensitivity rating. Both areas offer some shelter, and exclusion booming may be possible to contain any further release of oil.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.1. Nautical charts: 3200,1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84

8.7 Shoreline sensitivity, Map 7603 – Cape York

Environmental Description

Resource use

R 76_34	Hunting for narwhal and white whale. Fishery for Greenland halibut.
R 76_37	Hunting for polar bear and white whale. Fishery for Greenland halibut.

Species occurrence

Ar76041	Important area for Arctic char along the coastline.
Gh76034	Fishery for Greenland halibut.
La76034, La76037	Huge breeding colonies with little auks.
La76038, La76041	Huge breeding colonies with little auks.

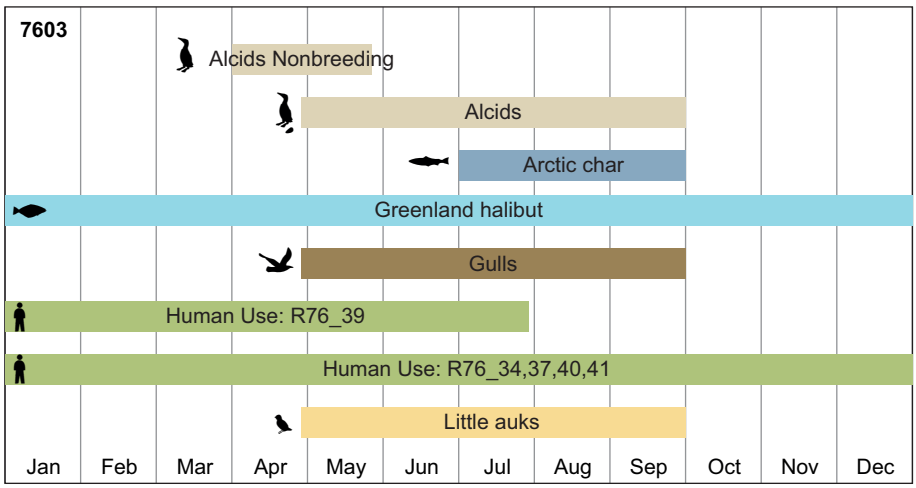
Site specific species occurrence (seabird breeding colonies); blue icons

La6028- La6030	Huge breeding colonies with little auks.
La6033- La6038	Huge breeding colonies with little auks.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_34	18	High
76_36	6	Low
76_37	15	Moderate
76_38	5	Low
76_39	5	Low
76_40	16	High
76_41	17	High

Map 7603.
Species and Resource Occurrence.



8.7.1 Physical and logistics, Map 7603 – Cape York

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and some islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from November to mid-July, although the fjords of De Dødes Fjord and Sidebriksfjord usually do not become ice free. Icebergs and glacier ice are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock and glacier allowing little opportunity for marine access. Landings may be possible near the beach and alluvial shorelines, but would require reconnaissance to confirm.

Kap York is reported to be a good radar target and an excellent mark for fixing position visibly, particularly from S or SW, having been seen from 50 km.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 125 km to the northwest (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

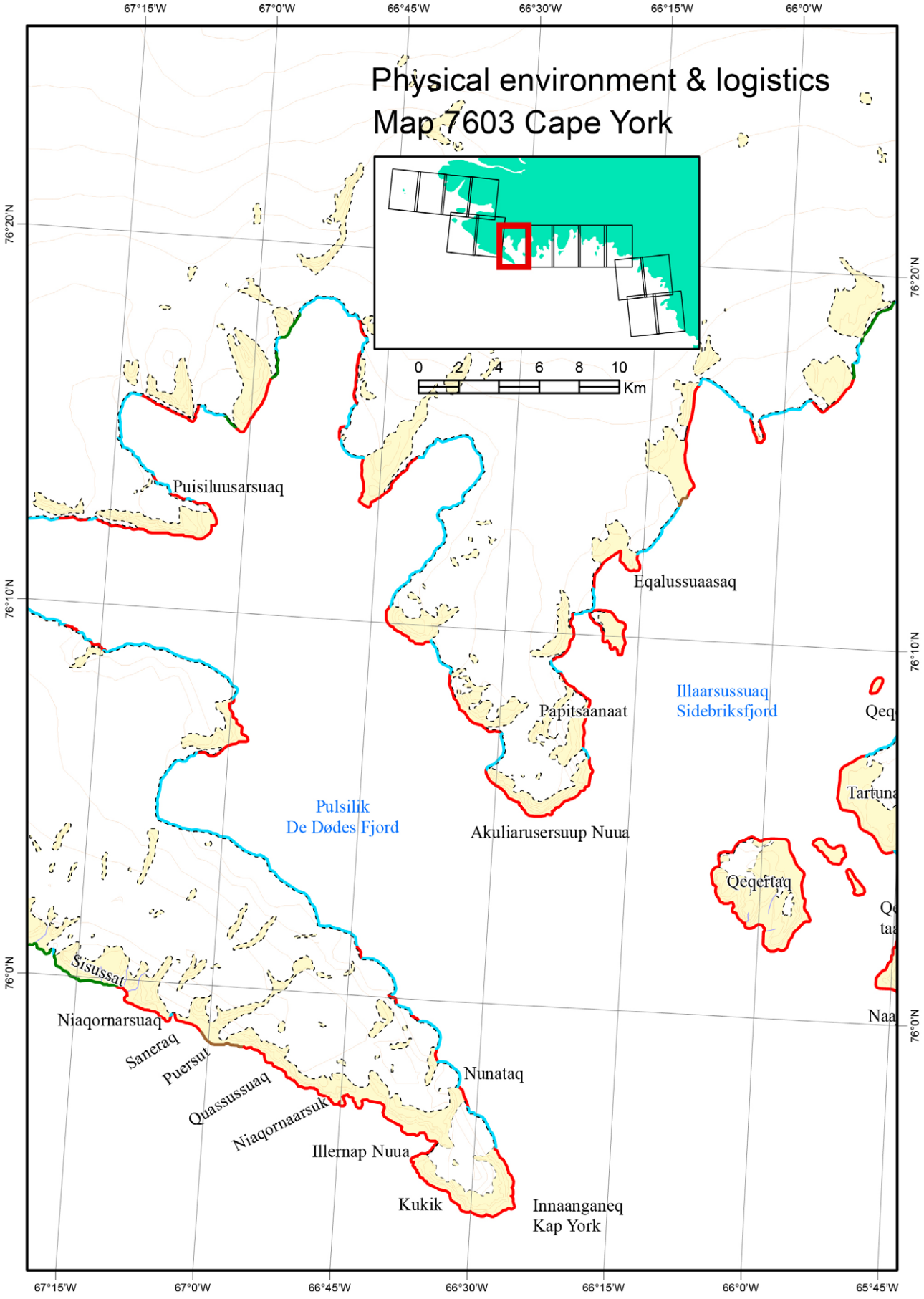
Offshore countermeasures represent the only practical method of protecting most shoreline areas.

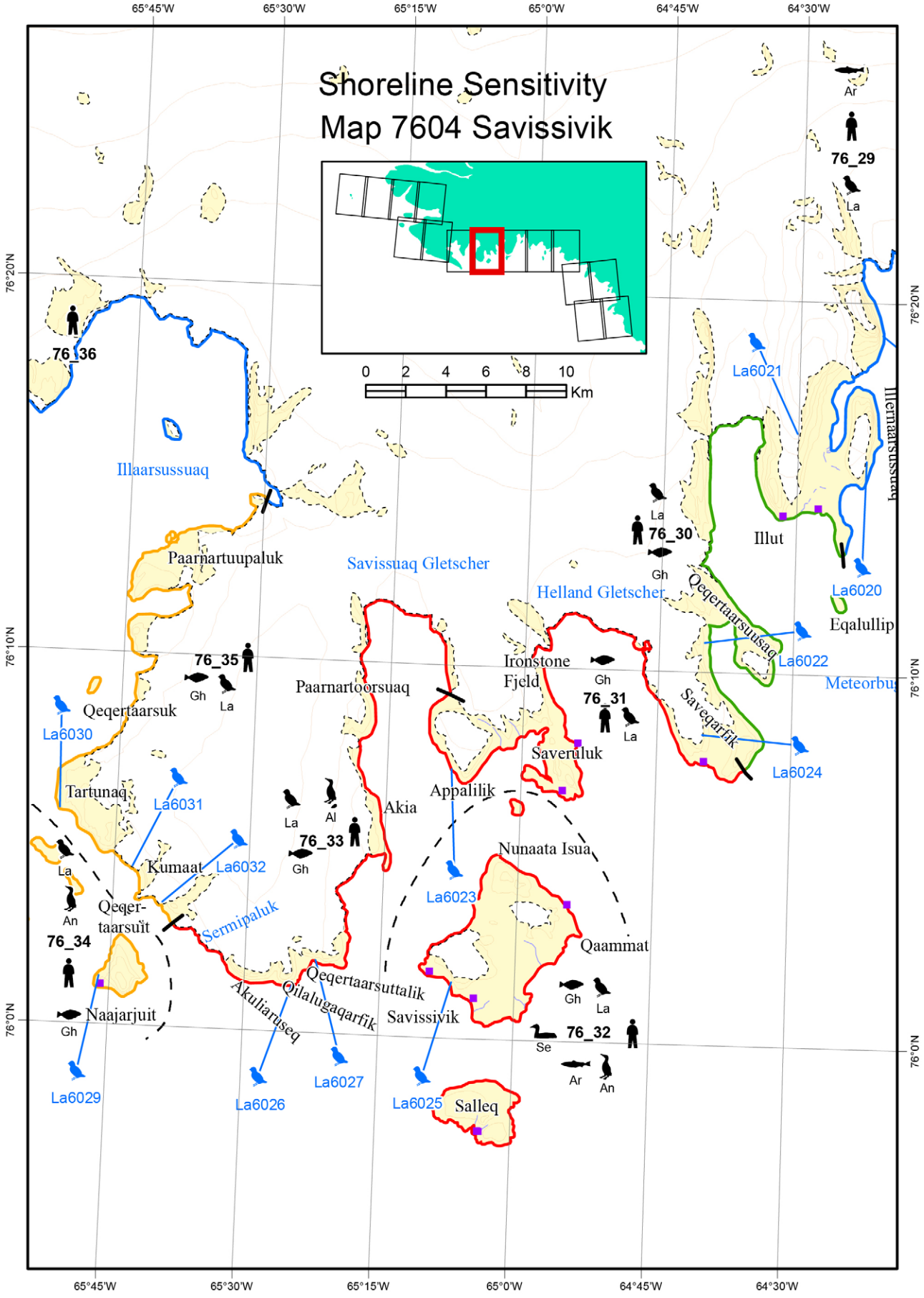
There are no opportunities for nearshore or exclusion booming along the shorelines described on this map. Alternatively, diversion booming could be attempted to protect the selected area, but this will be complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Shorelines shown on this map are predominantly semi-exposed rock and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords. Consideration should be given to flushing operations in the more protected waters. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens
There are no potential safe havens identified on this map.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.2. Nautical charts: 3200,1000.


Physical environment & logistics
Map 7603 Cape York
67°15'W
67°0'W
66°45'W
66°30'W
66°15'W
66°0'W
65°45'W
76°20'N
76°10'N
76°0'N
0 2 4 6 8 10
Km
Puisiluusarsuaq
Eqalussuaasaq
Illaarsussuaq
Sidebriksfjord
Papitsaanaat
Pulsilik
De Dødes Fjord
Akuliarusersuup Nuua
Qeqertaq
Tartuna
Qeq
Naa
Sisussat
Niaqornarsuaq
Saneraq
Puersut
Quassussuaq
Niaqornaarsuk
Nunataq
Illernap Nuua
Kukik
Innaanganeq
Kap York
Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)
Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84


Shoreline Sensitivity
Map 7604 Savissivik
65°45'W
65°30'W
65°15'W
65°0'W
64°45'W
64°30'W
76°20'N
76°10'N
76°0'N
0 2 4 6 8 10 Km
76_36
76_29
La
Ar
La6021
Illernaarsussuaq
Illaarsussuaq
Paarnartuupaluk
Savissuaq Gletscher
Helland Gletscher
La
76_30
Gh
Illut
La6020
Eqalullip
Qeqertaarsuusaq
La6022
Meteorbu
76_35
Gh
La
Paarnartoorsuaq
Ironstone
Fjeld
Gh
76_31
La
Qeqertaarsuk
La6030
Saveruluk
Savegarfik
La6024
Tartunaq
La6031
La
Al
Akia
Appalilik
76_33
Gh
Nunaata Isua
La
Kumaat
La6032
La6023
An
Qeqer-
taarsuit
Sermipaluk
76_34
Qaammat
Qeqertaarsuttalik
Akuliaruseq
Qilalugaqarfik
Savissivik
Gh
La
Naajarjuit
Gh
76_32
Se
Ar
An
La6029
La6026
La6027
La6025
Salleq
Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)
Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84

8.8 Shoreline sensitivity, Map 7604 – Savissivik

Environmental Description

Resource use

R 76_30, R 76_31	Hunting for polar bear, narwhal and white whale. Fishery for Greenland halibut.
R 76_32, R 76_33	Hunting for polar bear, narwhal and white whale. Fishery for Greenland halibut.
R 76_35	Hunting for polar bear, narwhal and white whale. Fishery for Greenland halibut.

Species occurrence

Ar76032	Important area for Arctic char along the coastline.
Gh76030-Gh76035	Fishery for Greenland halibut along the coastline.
La76032-La76035	Huge breeding colonies with little auks.

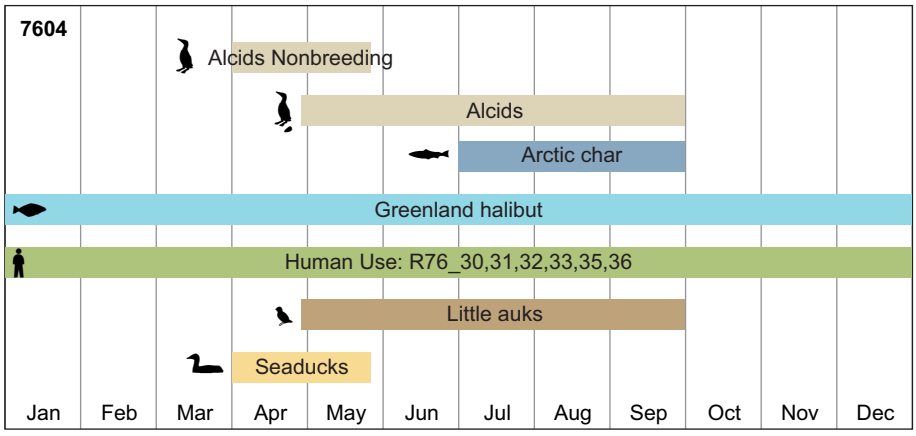
Site specific species occurrence (seabird breeding colonies); blue icons

La6020-La6027	Huge breeding colonies with little auks.
La6029-La6032	Huge breeding colonies with little auks.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_29	12	Low
76_30	15	Moderate
76_31	24	Extreme
76_32	41	Extreme
76_33	27	Extreme
76_35	15	High
76_36	6	Low

Map 7604.
Species and Resource Occurrence.



8.8.1 Physical and logistics, Map 7604 – Savissivik

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from October to mid-July. Glacier ice may block coasts for periods during the summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area.

Anchorage can be obtained about 200 m SE of Savissivik, a settlement with about 70 inhabitants, at a depth of 16 m. Vessels of 70 m length and 4.5 m draught have anchored off Savissivik. The tide attains a maximum height of about 3.4 m. It is approached from W of Bushnan Ø, keeping well clear of a rock with a depth of 4.9 m over it, which lies about 800 m NW of Bushnan Ø; care is necessary as the area has not been completely surveyed.

There is no appreciable tidal stream in the anchorage.

Ice forms locally in mid-September and there is normally heavy ice in the vicinity of Savissivik until the end of July.

Shorelines within this area are predominantly rock, talus and glacier, allowing little opportunity for marine access.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 175 km to the northwest (Map 7654).

Countermeasures

In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for nearshore booming along the short section of shoreline described on this map.

Alternatively, diversion booming could be attempted to protect the inshore areas, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Exclusion booming could be used to prevent oil from entering the inlet at Saveruluk, however, the inlet width of 1200 m may be excessive. Depths are unknown and would require reconnaissance at the time of a spill.

Exclusion booming to reduce inshore contamination could be considered for the inlet on the west side of Illernaarsussuaq with an inlet width of 450 m. Water currents and depths are unknown, necessitating site surveys at the time of a spill.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

Consideration should be given to flushing operations in the protected waters within the fjords, Illaarsussuaq, Paarnartoorsuaq, Ironstone Fjord, and Illut. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

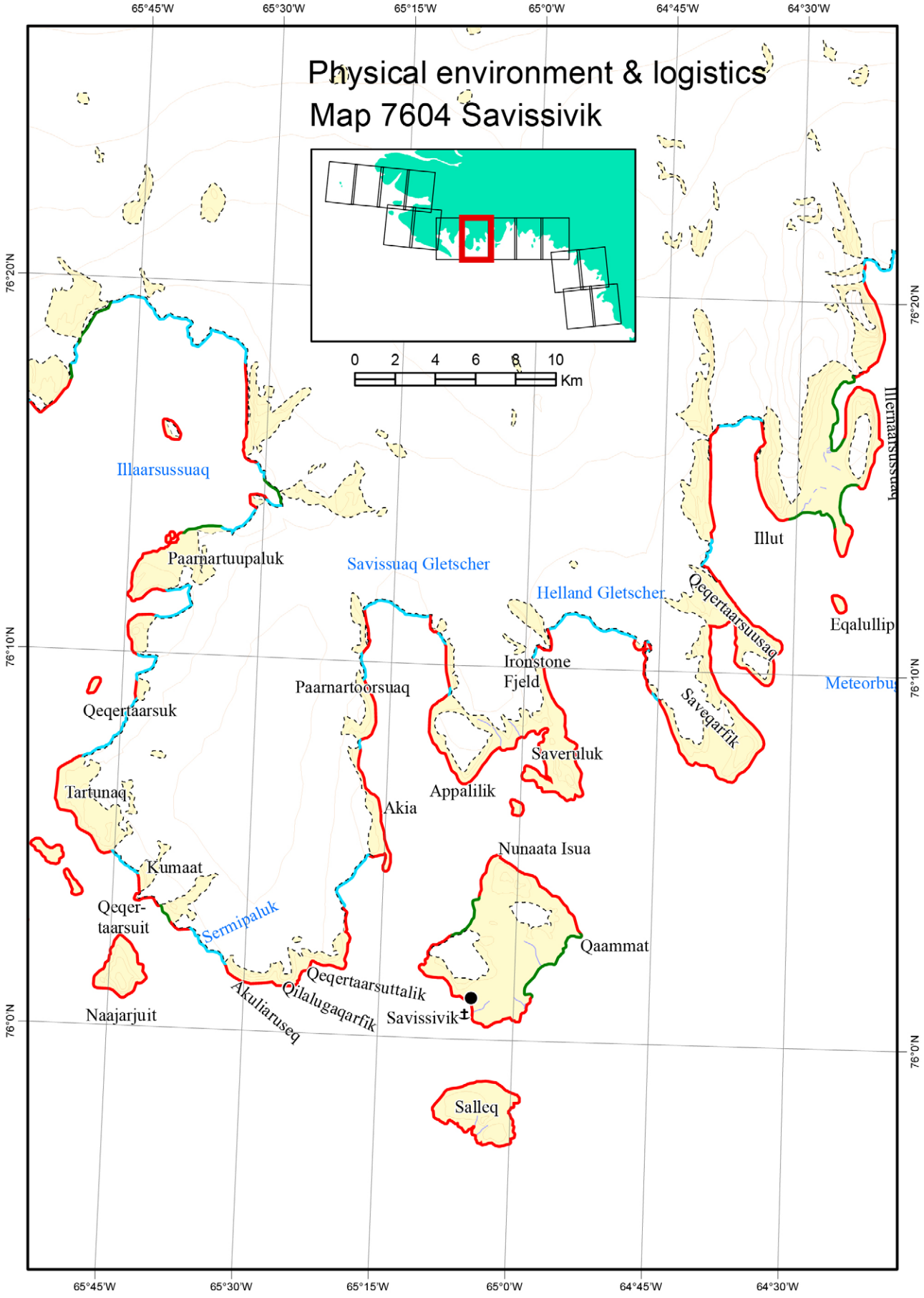
Safe Havens

There are no potential safe havens identified on this map.

The waters in the vicinity of Illut could be considered as a potential safe haven given its low sensitivity rating. Exclusion booming would be impractical due to the width of the channel; however, the shape of the channel may afford natural containment depending on wind direction and tidal streams.

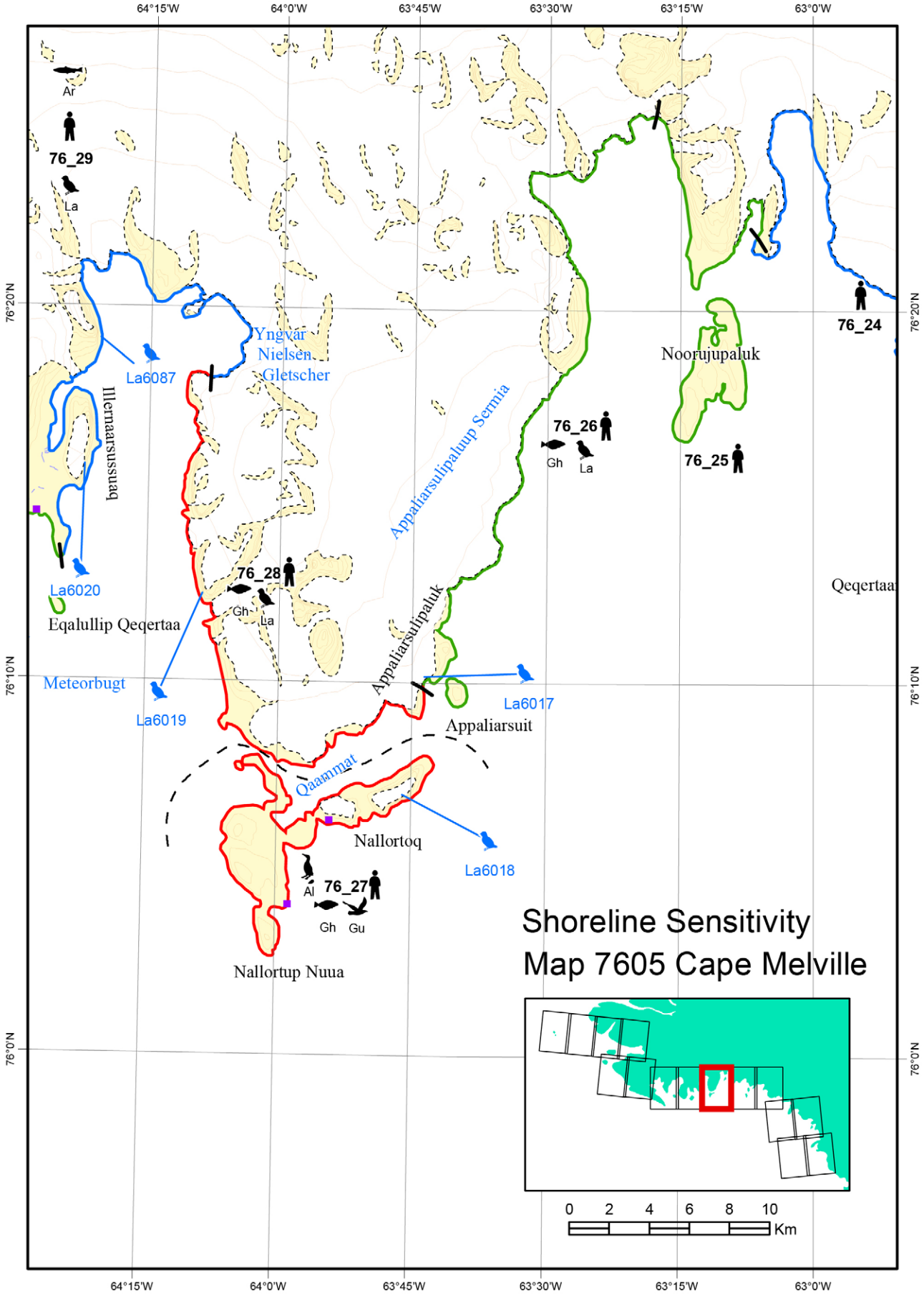
Maps

Danish Survey & Cadastre (KMS) topographical map: 76 V.2. Nautical charts: 3200,1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84

8.9 Shoreline sensitivity, Map 7605 – Cape Melville

Environmental Description

Resource use

R 76_27	Hunting for polar bear and narwhal. Fishery for Greenland halibut.
R 76_28	Hunting for narwhal and polar bear. Fishery for Greenland halibut.

Species occurrence

Ar76029	Important area for Arctic char along the coastline.
Gh76027, Gh76028	Fishery for Greenland halibut along the coastline.
La76029-La76029	Breeding little auks.

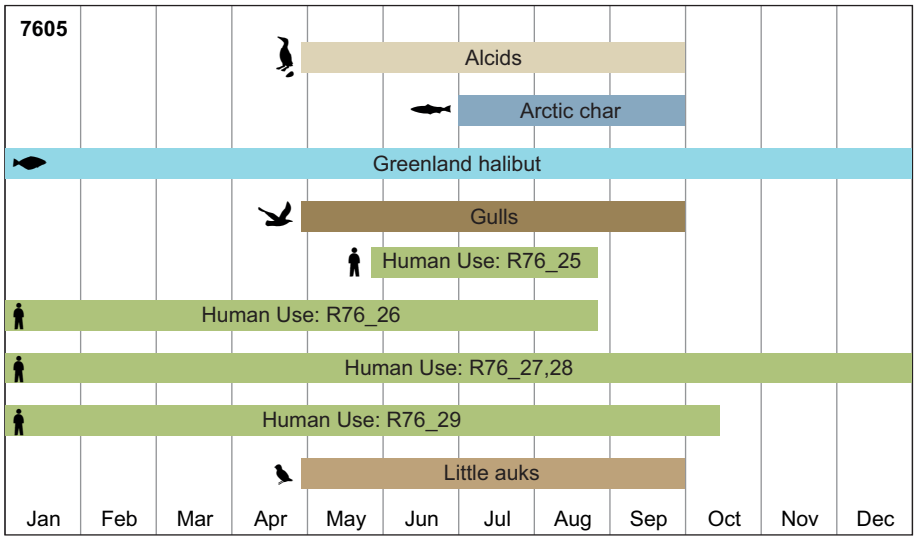
Site specific species occurrence (seabird breeding colonies); blue icons

Al6017-Al6020	Breeding little auks
La6089	Breeding little auks.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_24	11	Low
76_25	13	Moderate
76_26	15	Moderate
76_27	20	High
76_28	20	High
76_29	12	Low

Map 7605.
Species and Resource Occurrence.



8.9.1 Physical and logistics, Map 7605 – Cape Melville

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from November to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. Glacier ice may block the coasts for periods during the summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. Landings may be possible near beach and alluvial shorelines within the fjords, but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 200 km to the northwest (Map 7654).

Countermeasures

In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for nearshore booming along the shorelines described on this map.

Alternatively, diversion booming could be attempted to protect the areas of high sensitivity, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Exclusion booming to reduce inshore contamination could be considered for the inlet at the head of Illernaarsussuaq, with an inlet width of 900 m, and the inlet north of Noorujupaluk, with an inlet width of 1000 m. However, glacier ice can prevent navigation, especially to the latter site. Exclusion booming to limit the extent of alongshore contamination could be employed at the NW channel between Nallortoq and the mainland, with an inlet width of 500 m, and the channel between Appaliarsuit and the mainland, with an inlet width of 400 m. In each location, water currents and depths are unknown, necessitating site surveys at the time of a spill.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

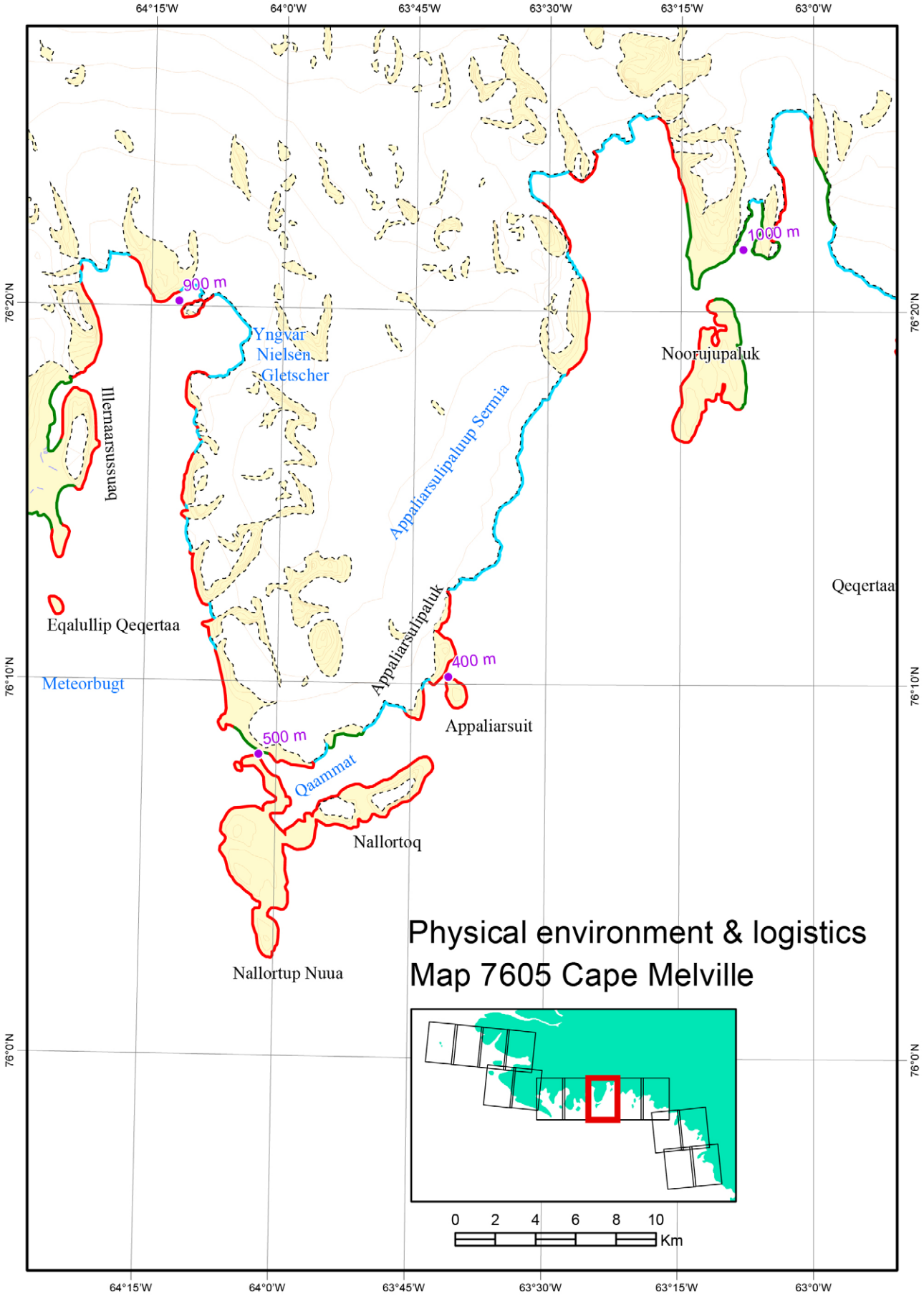
Consideration should be given to flushing operations in the protected waters within the fjords, and in the channel between Nallortoq and the mainland, noted as high sensitivity. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens

There are no potential safe havens identified on this map.

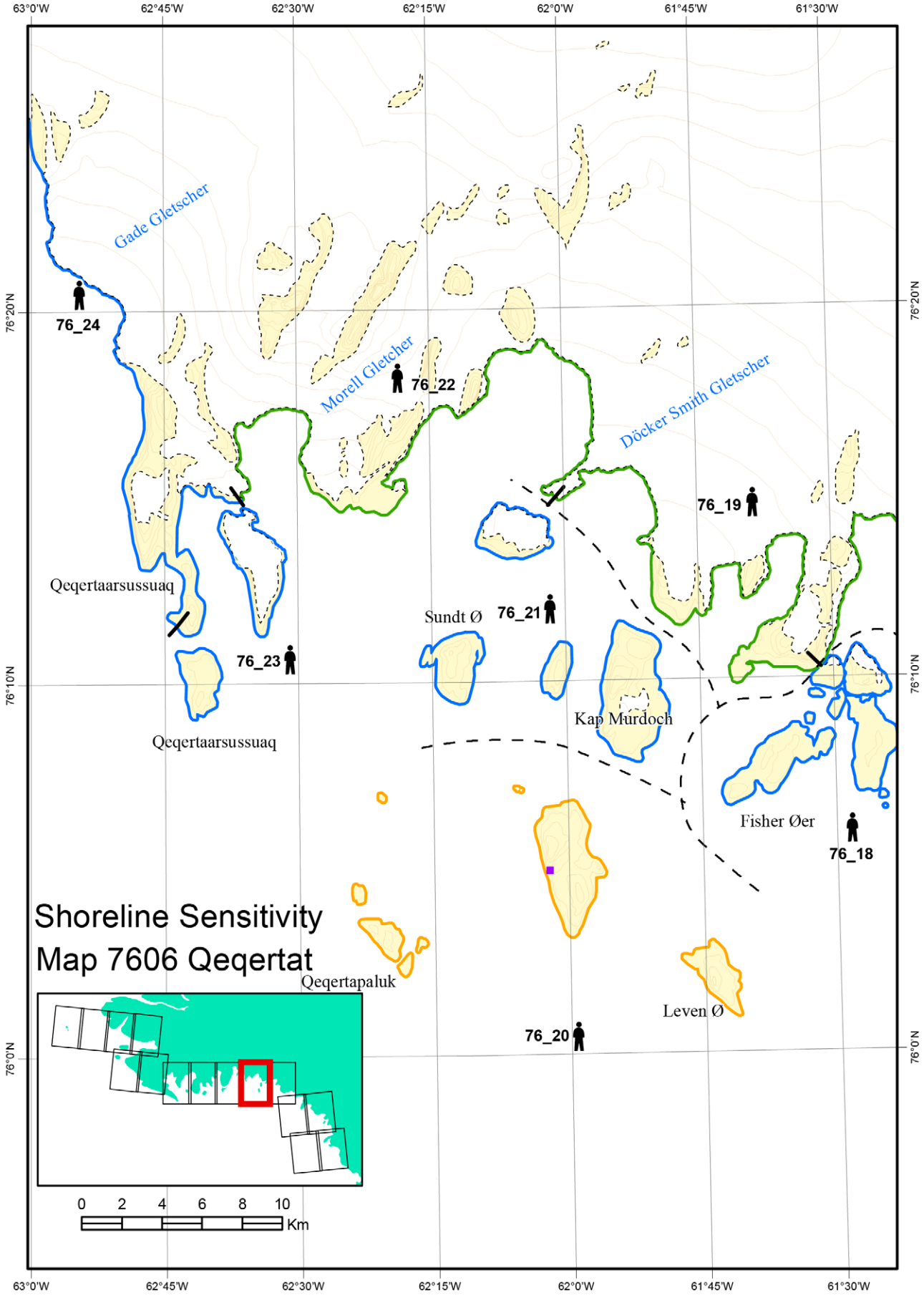
Maps

Danish Survey & Cadastre (KMS) topographical map: 76 V.2. Nautical charts: 3200,1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84

8.10 Shoreline sensitivity, Map 7606 – Qeqertat

Environmental Description

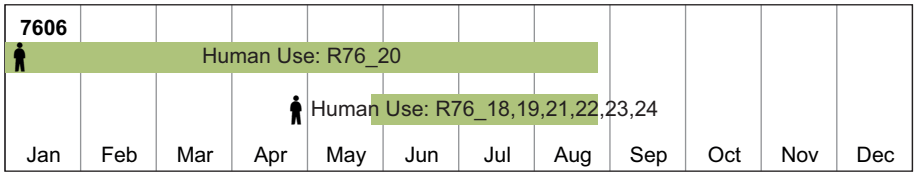
Resource use
Narwhal hunting is important in summer and hunting for seabirds and other marine mammals takes place on occasional basis.

Species occurrence
No significant occurences

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_18	12	Low
76_19	14	Moderate
76_20	16	High
76_21	12	Low
76_22	12	Moderate
76_23	12	Low
76_24	11	Low

Map 7606.
Species and Resource Occurrence.



8.10.1 Physical and logistics, Map 7606 – Qeqertat

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from November to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. Large drifts of glacier ice occur in the area and prevent navigation for periods during summer. Icebergs are present throughout the year, discharged from the numerous glaciers in the area.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock, talus and glacier, allowing little opportunity for marine access. Landings may be possible near the beach and alluvial shorelines within the fjords, but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 300 km to the northwest (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

Diversion booming could be attempted to protect the nearshore areas, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

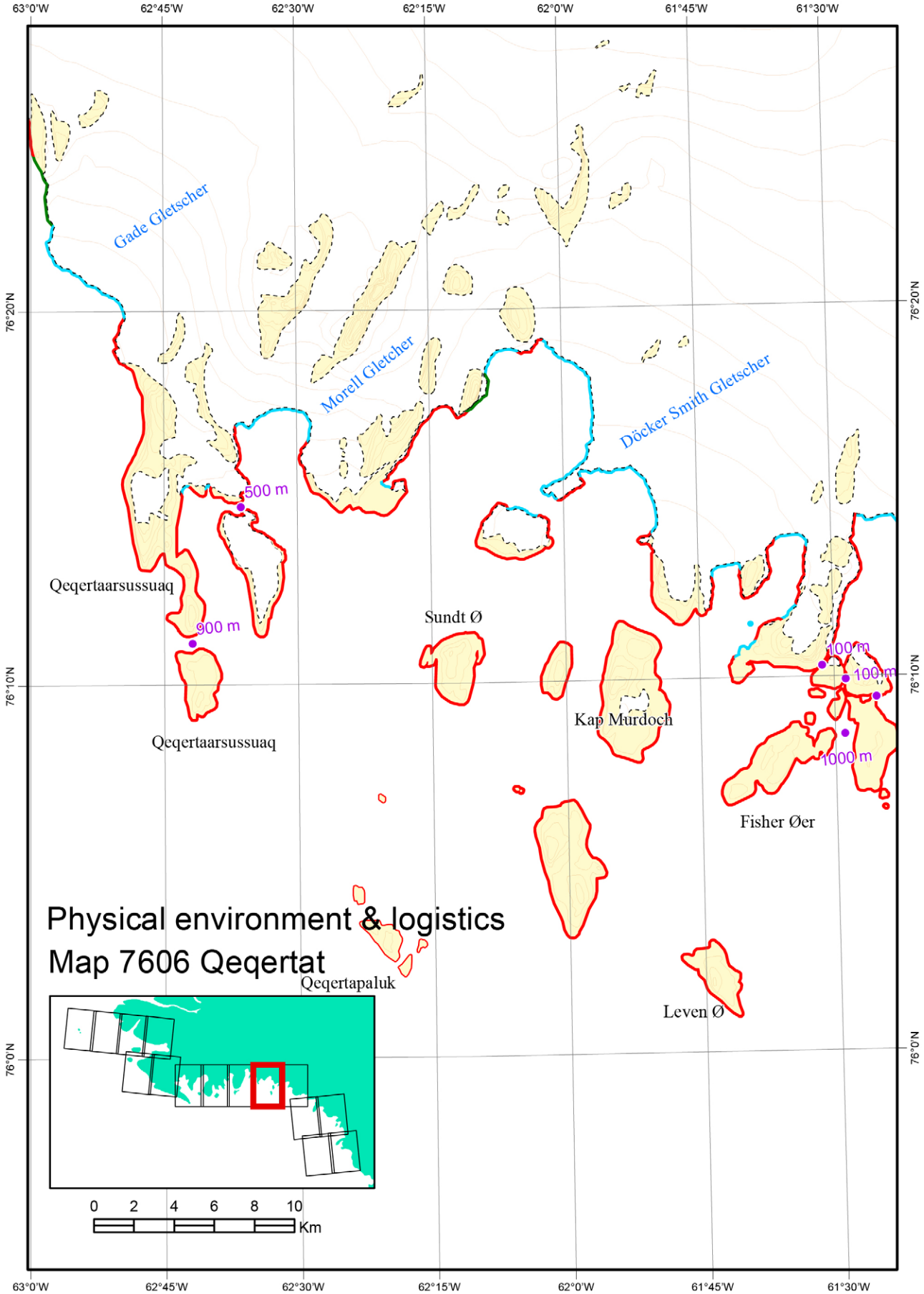
Exclusion booming to reduce inshore contamination could be considered for the channels between the islands NNE of Fisher Øer, with inlet widths of 100 m in three locations. Similarly, exclusion booming to limit the extent of alongshore contamination could be employed at several channels between islands and islands and mainland (locations noted on the map), with channel widths ranging from 600 to 1000 m. In each location, water currents and depths are unknown, necessitating site surveys at the time of a spill. However, glacier ice will often prevent the use of booms.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

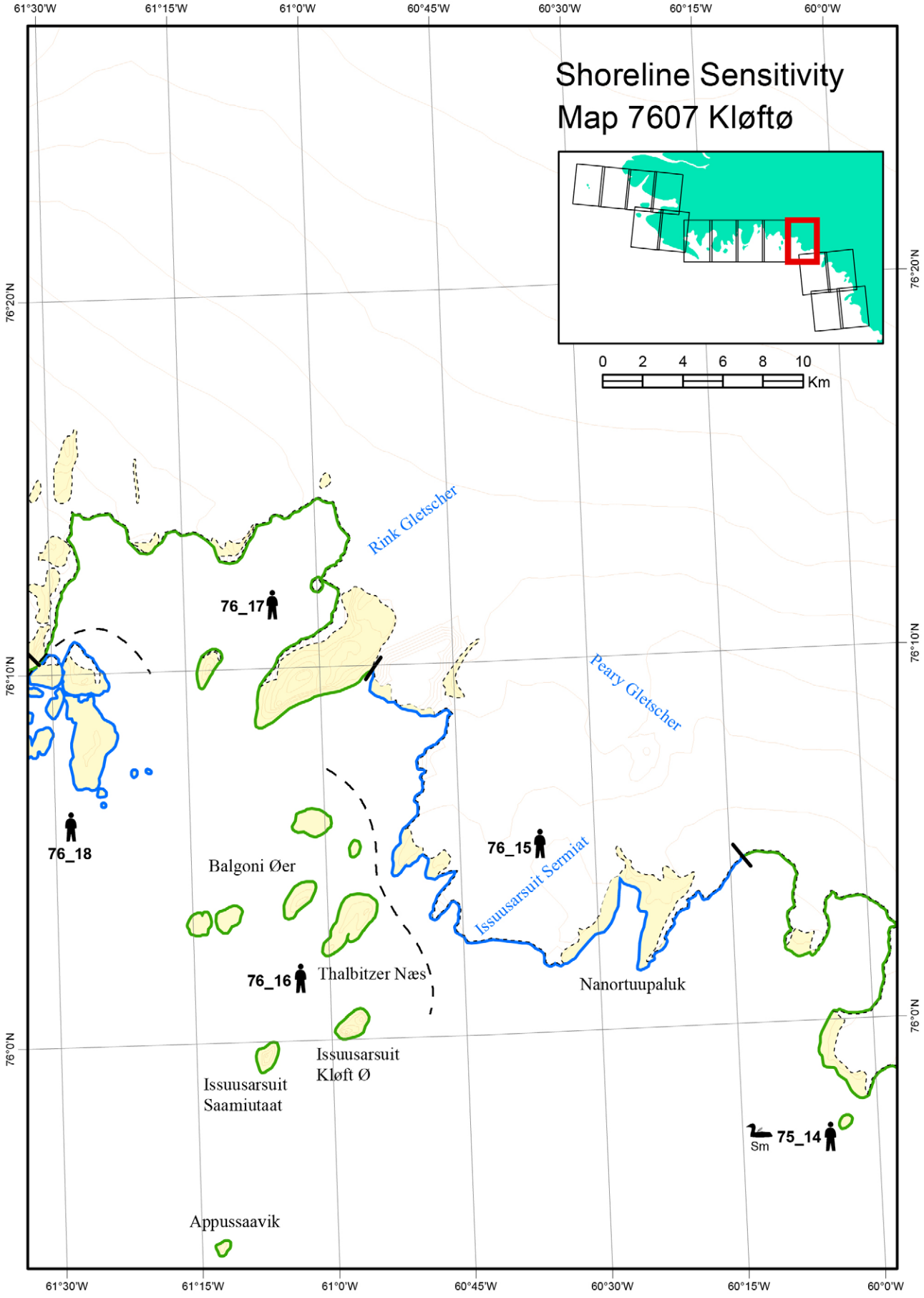
Safe Havens
There are no potential safe havens identified on this map.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.2. Nautical charts: 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84

8.11 Shoreline sensitivity, Map 7607 – Kløftø

Environmental Description

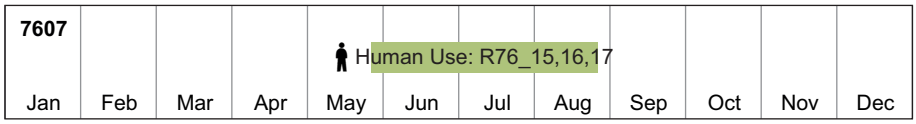
Resource use
Narwhal hunting takes place and, hunting for seabirds and other marine mammals takes place on occasional basis.

Species occurrence
No significant occurrences.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_14	13	Moderate
76_15	11	Low
76_16	13	Moderate
76_17	13	Moderate
76_18	12	Low

Map 7607.
Species and Resource Occurrence.



8.11.1 Physical and logistics, Map 7607 – Kløftø

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from November to mid-July. Breakup begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens through the summer months and the coast is generally ice-free by mid-July. Glacier ice often blocks the coasts in summer and prevents navigation. Icebergs are present throughout the year, discharged from the numerous glaciers in the area and carried into the area from the south by the West Greenland Current.

Shorelines within this area are predominantly rock, talus and glacier, allowing little opportunity for marine access.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 300 km to the northwest (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas.

Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

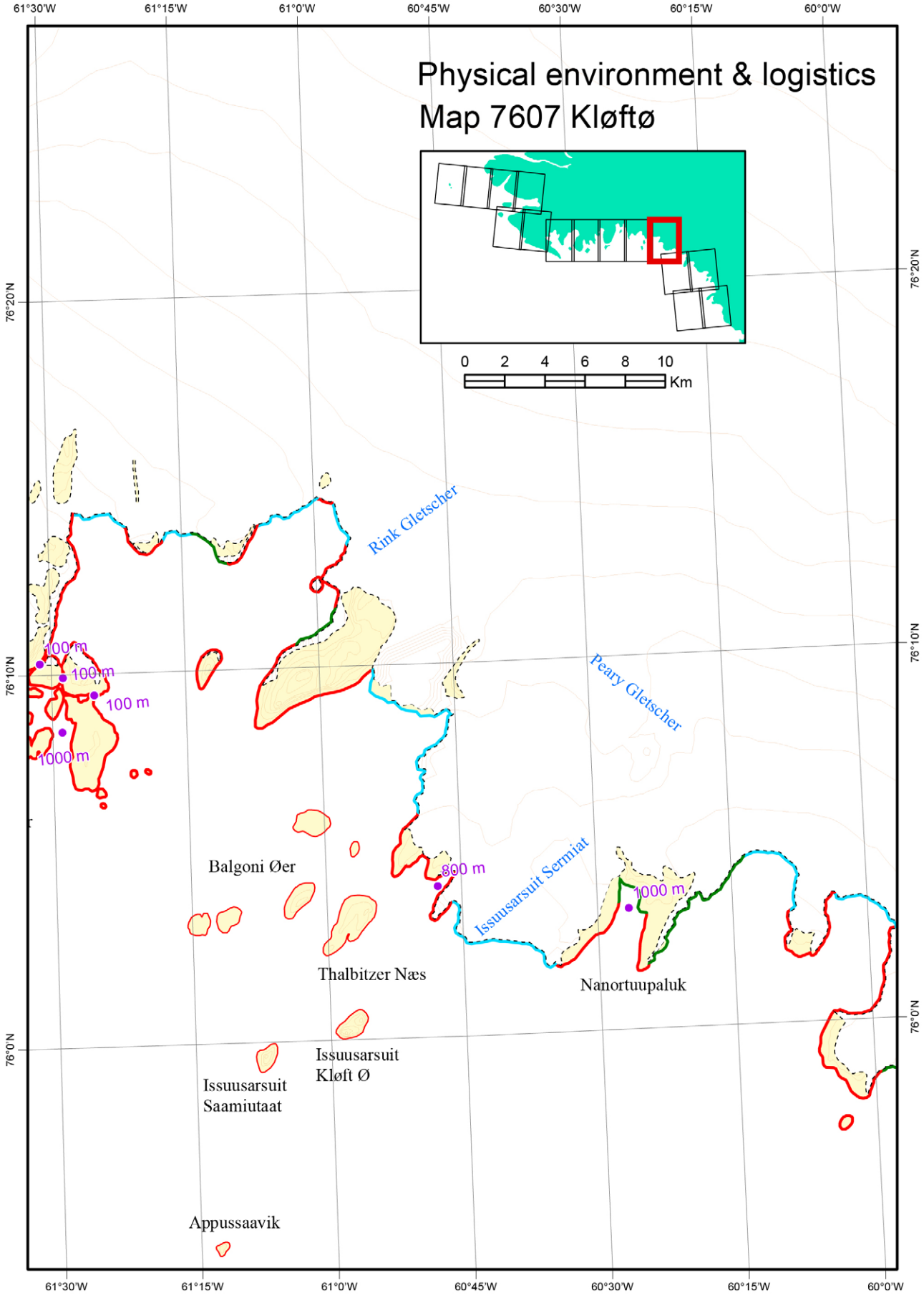
Exclusion booming to reduce inshore contamination could be considered for the inlet NW of Nanortuupaluk, with an inlet width of 1000 m, and the inlet NE of Thalbitzer Næs, with an inlet width of 800 m. Similarly, exclusion booming to limit the extent of alongshore contamination could be employed at the channel between Thalbitzer Næs and the mainland, with an inlet width of 1600 m. In each location, water currents and depths are unknown, necessitating site surveys at the time of a spill. However, booming will be impeded by glacer ice.

Shorelines shown on this map are predominantly exposed rock, talus and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords.

Consideration should be given to flushing operations in the protected waters within the several inlets. Access and trafficability of these areas are unknown, and at least glacier ice will often prevent access to coasts in summer. Any clean-up operations would most likely be marine-based given the likely nature of the shoreline.

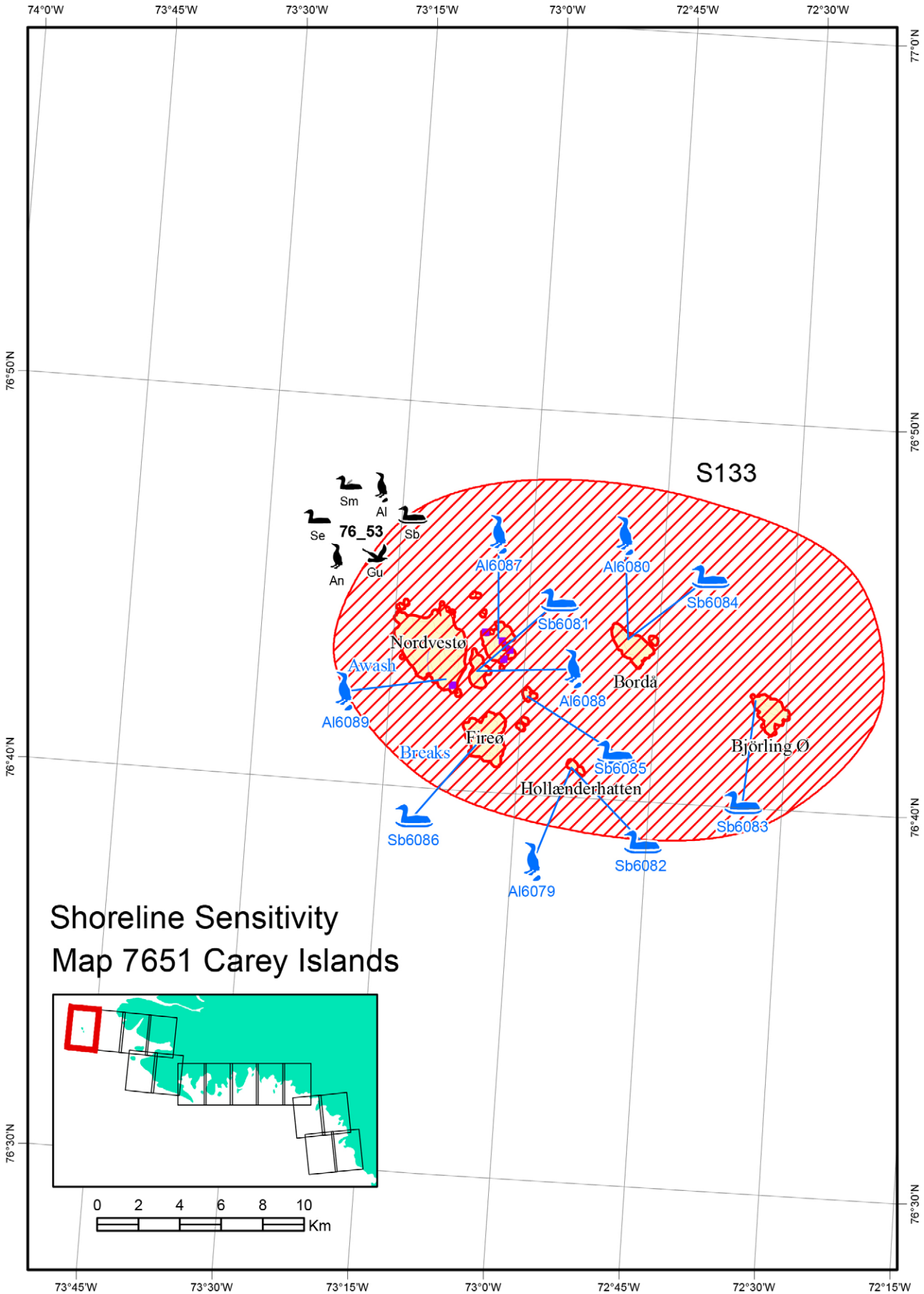
Safe Havens
There are no potential safe havens identified on this map.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.3. Nautical charts: 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 20N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.12 Shoreline sensitivity, Map 7651 – Carey Islands

Environmental Description

Resource use
Resource use is not significant on this map sheet.

Species occurrence

Al76053	4 colonies with breeding black guillemots, razorbills, Atlantic puffins and thick-billed murres.
An76053	Spring concentrations of black-legged kittiwakes and thick-billed murres.
Se76053	Spring concentrations of common eiders and king eiders.
Sb76053	5 colonies with breeding common eiders.
Sm76053	Moulting common eiders and long-tailed ducks.

Site specific species occurrence (seabird breeding colonies); blue icons

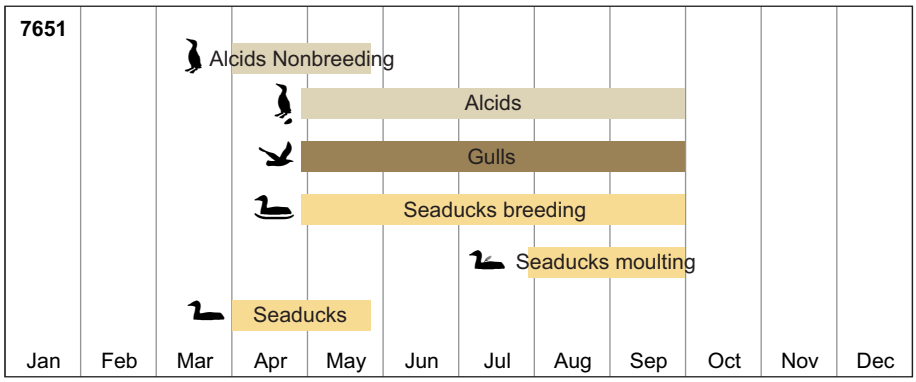
Al6079, Al6080	Breeding Atlantic puffins.
Al6087-Al6089	Breeding thick-billed murres.
Sb6081-Sb6086	Breeding common eiders.

Selected area

S133	The entire archipelago due to a high diversity and high numbers of breeding seabirds.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_53	31	Extreme



Map 7651.
Species and Resource Occurrence.

8.12.1 Physical and logistics, Map 7651 – Carey Islands

Access
The nearshore waters in and around the islands in this map area are uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands appear to be deep, however, uncharted dangers may exist. Rocks, awash and below-water, are charted off the SW side of the group of islands. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to June. Icebergs are present throughout the year, discharged from the numerous glaciers to the south of the area.

Although only accessible between August and mid-September, the waters around the islands are never completely frozen over and drifts of sea ice may occur throughout the summer.

Shorelines within this area are predominantly rock, allowing little opportunity for marine access.

Isbjørn Harbour is formed in the SE end of the channel that separates Isbjørneø from Mellemø; breakers have been observed in the NW part. The harbour affords almost landlocked anchorage and is said to be sheltered in all weathers in depths of from 16 to 22 m. Tidal streams are reported to be weak.

Anchorage is also reported in a bay at the SE end of Mellemø.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 150 km to the east (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

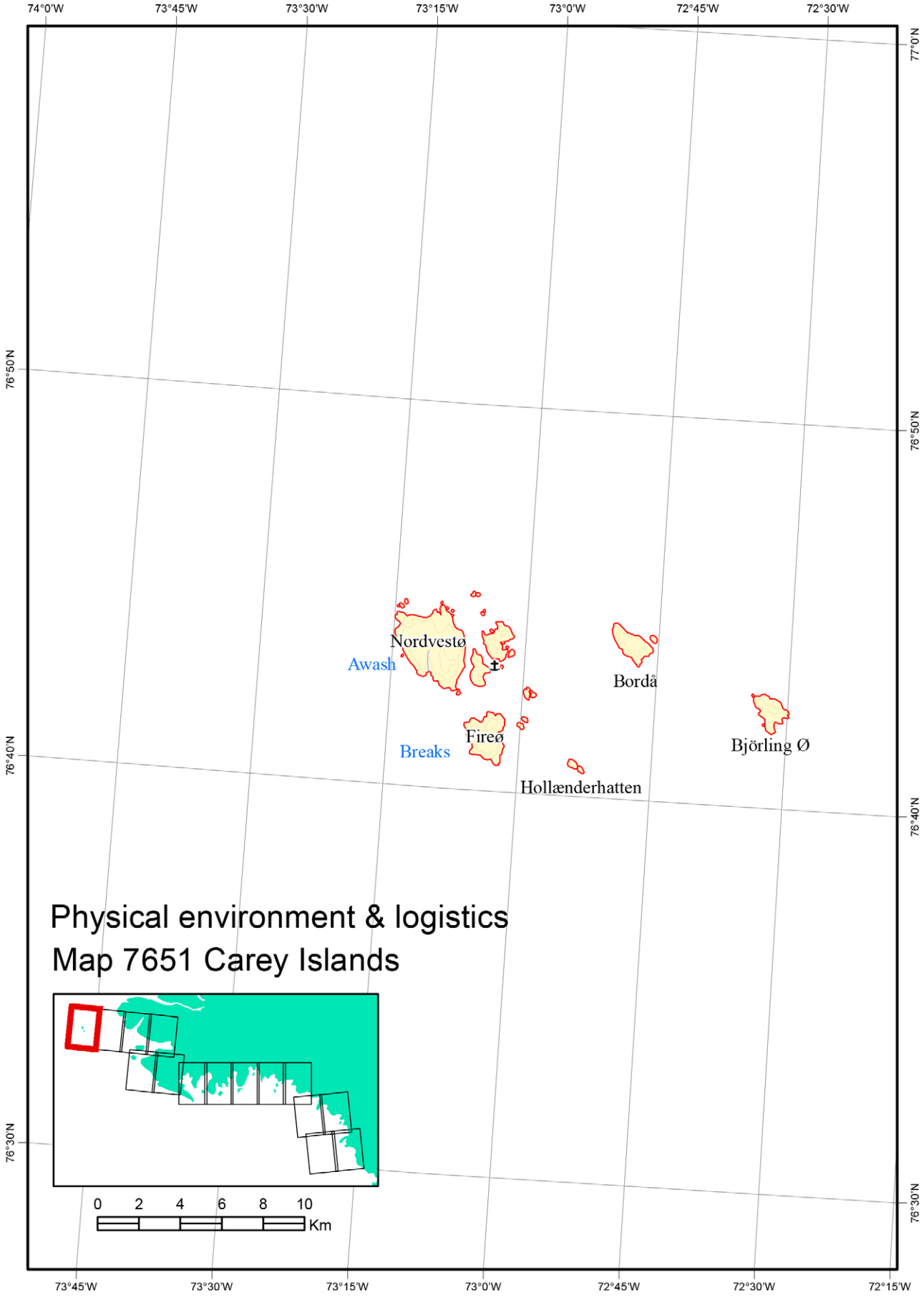
There are no opportunities for nearshore booming among the island shorelines described on this map.

Shorelines shown on this map are predominantly rocky coast, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the islands. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens
There are no potential safe havens identified on this map.

The anchorage within Isbjørn Harbour could be considered as a potential safe haven given its good shelter, but it is within a selected area with extreme sensitivity.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.1. Nautical charts: 3200, 1000.

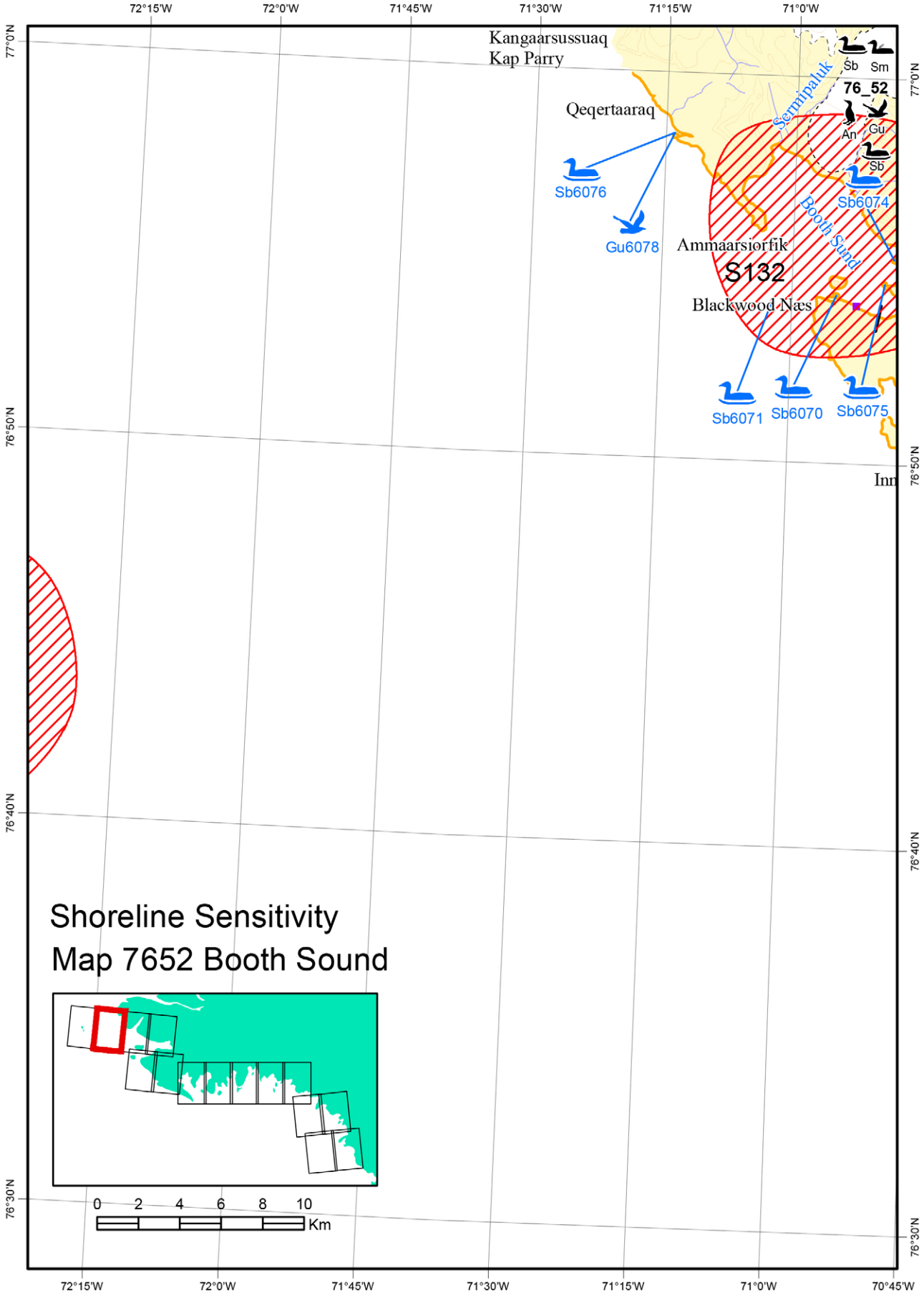


Physical environment & logistics

Map 7651 Carey Islands

Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.13 Shoreline sensitivity, Map 7652 – Booth Sound

Environmental Description

Resource use
Resource use is not significant on this map sheet. However, hunting for sea-birds and marine mammals takes place on occasional basis.

Species occurrence

An76052	Spring concentrations of black-legged kittiwakes and thick-billed murres.
Gu76052	2 colonies with breeding Arctic terns and glaucous gulls.
Se76052	Spring concentrations of long-tailed ducks, king eiders and common eiders.
Sb76052	6 colonies with breeding common eiders.
Sm76052	Moulting long-tailed ducks, king eiders and common eiders.

Site specific species occurrence (seabird breeding colonies); blue icons

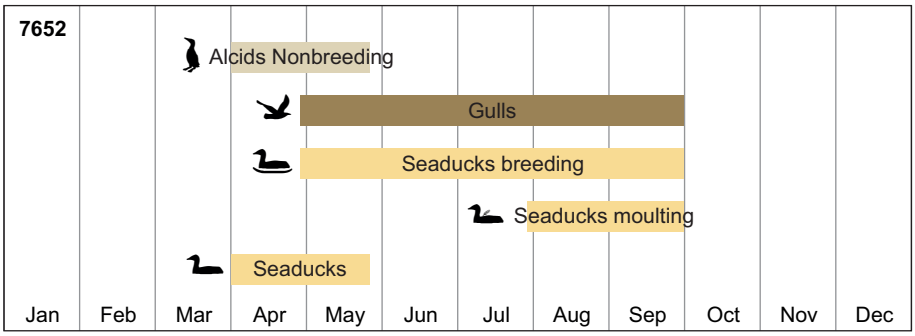
Gu6078	Breeding Arctic terns.
Sb6070, Sb6071	Breeding common eider (**S132**).
Sb6074, Sb6075	Breeding common eider (**S132**).
Sb6076	Breeding common eider.

Selected area

S132	Booth Sound due to several seabird breeding colonies.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_52	18	High



Map 7652.
Species and Resource Occurrence.

8.13.1 Physical and logistics, Map 7652 – Booth Sound

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore and nearshore appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and many islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to mid-July.

A sandbar, barely awash, extends across the entrance to Booth Sund, and icebergs ground in shoal water off Blackwood Næs, the SE entrance point.

Shorelines within this area are predominantly rock, allowing little opportunity for marine access. Inside the sound, low sedimentary shores are found.

No anchorages are reported for this map area.

There are no airports on this or adjoining maps. The closest airport is at Thule Air Base, 100 km to the east (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for exclusion booming in the area shown on this map due to the width of the inlets and the deep nearshore waters.

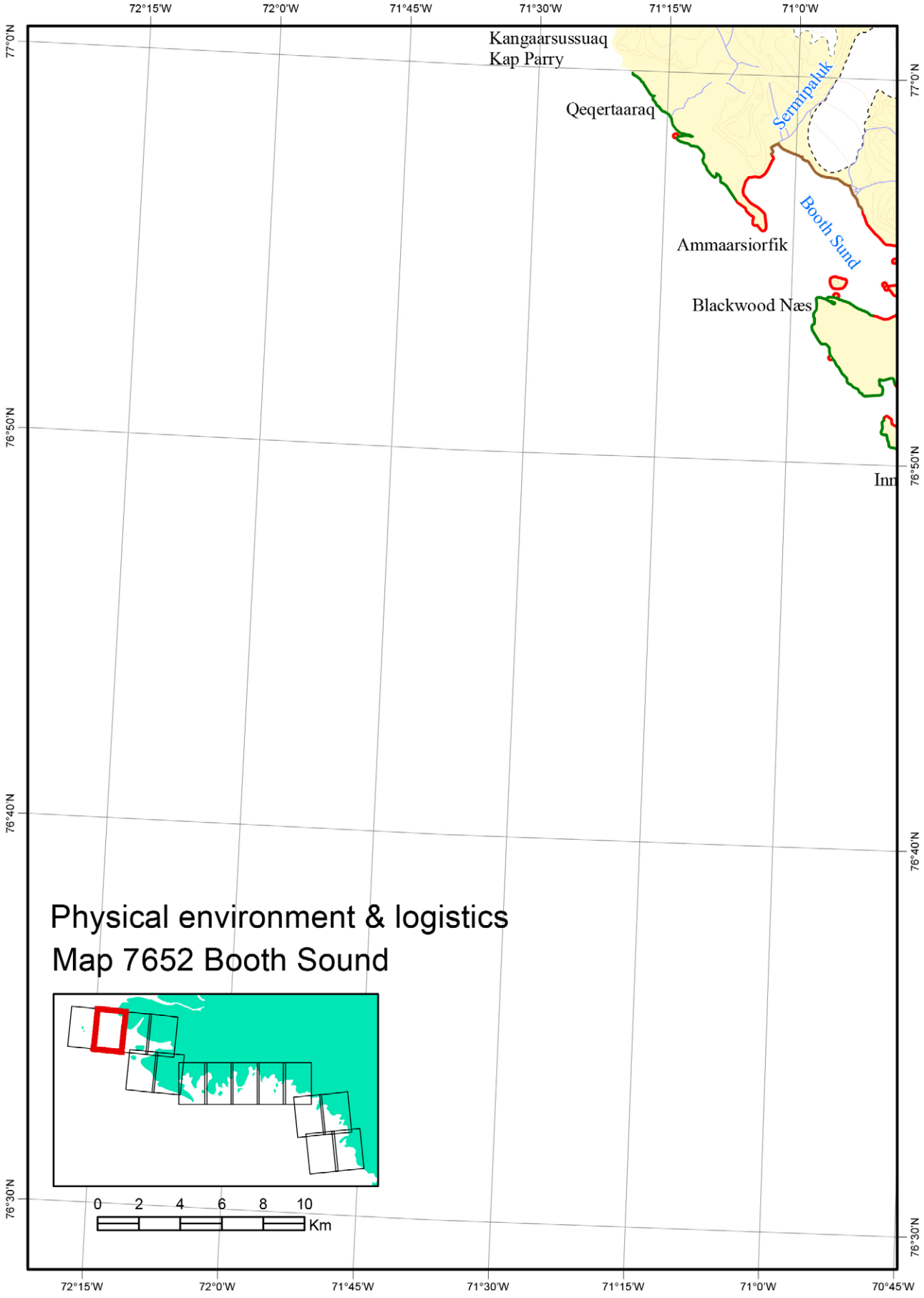
Alternatively, diversion booming could be attempted to protect the selected area, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

Shorelines shown on this map are predominantly exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within Booth Sound. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens
There are no potential safe havens identified on this map.

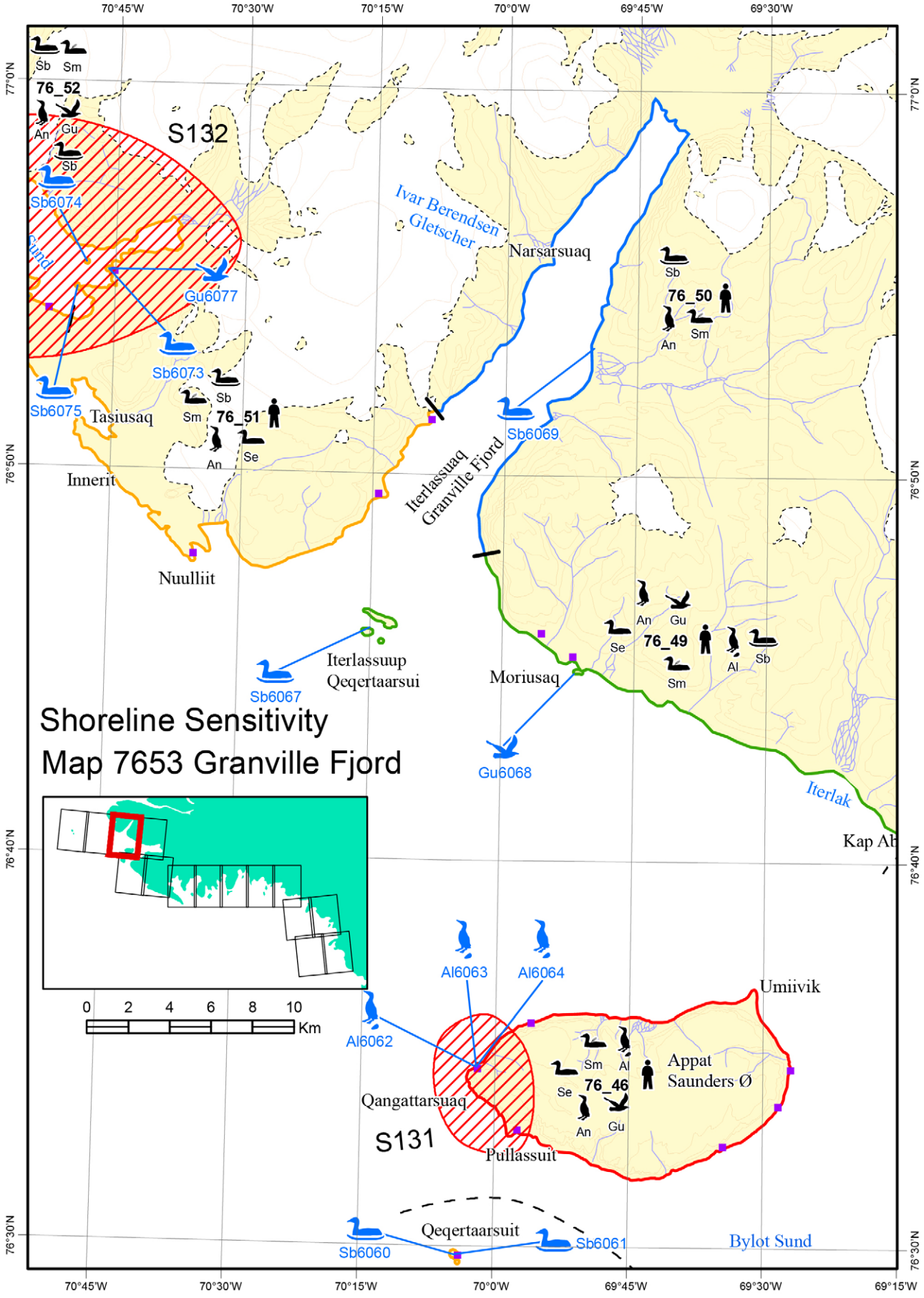
The waters within Booth Sound could be considered as a potential safe haven, but the area has a high sensitivity rating. Anchorage is unknown, and exclusion booming of the Sound is not feasible.

Maps
Danish Survey & Cadastre (KMS) topographical map: 76 V.1. Nautical charts: 3200, 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.14 Shoreline sensitivity, Map 7653 – Granville Fiord

Environmental Description

Resource use
Hunting for walrus takes place in winter Hunting for seabirds and other marine mammals takes place on occasional basis.

Species occurrence

Al76046	3 colonies with breeding black guillemots, Atlantic puffins and thick-billed murres.
An76046, An76049, An76051	Spring concentrations of black-legged kittiwakes and thick-billed murres.
Gu76049	2 colonies with breeding Arctic terns and glaucous gulls.
Se76046	Spring concentrations of common eiders and king eiders.
Se76051	Spring concentrations of long-tailed ducks, king eiders and common eiders.
Sb76049, Sb76051	2 colonies with breeding common eiders.
Sm76046, Sm76050	Moulting common eiders and long-tailed ducks.
Sm76051	Moulting long-tailed ducks.

Site specific species occurrence (seabird breeding colonies); blue icons

Al6062	Breeding black guillemots.
Al6063	Breeding Atlantic puffins.
Al6064	Breeding thick-billed murres.
Gu6068	Breeding Arctic terns.
Sb6067,	Breeding common eiders.
Sb6069-Sb6071	Breeding common eiders.
Gu6077	Breeding Arctic terns (**S132**).
Sb6073-Sb6073	Breeding commen eiders (**S132**).

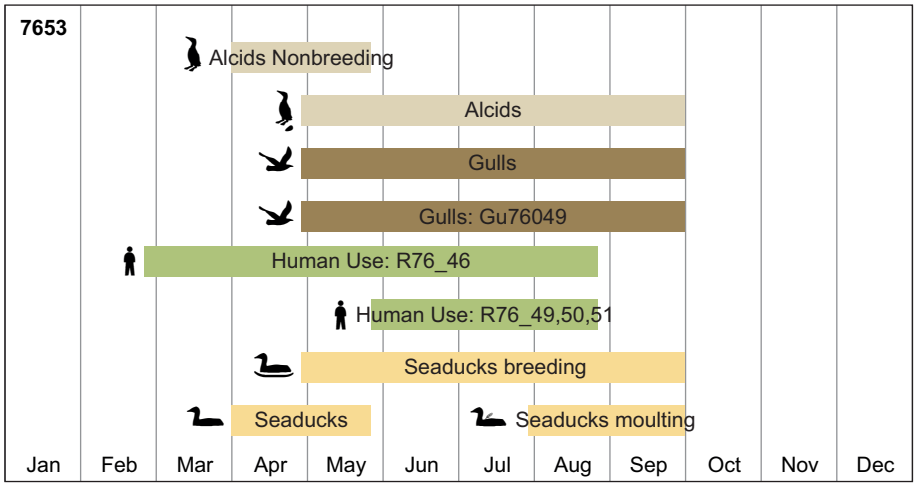
Selected area

S131	Saunders Island, due to huge seabird breeding colony
S132	Booth Sound due to several seabird breeding colonies.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_46	31	Extreme
76_49	14	Moderate
76_50	11	Low
76_51	16	High
76_52	18	High

Map 7653.
Species and Resource Occurrence.



8.14.1 Physical and logistics, Map 7653 – Granville Fiord

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings and numerous islets and apparent hazards. Local knowledge is essential for navigation.

This area is ice-bound in the average year from December to late June.

Anchorage is available off Moriusaq, 15 km NW of Kap Abernathy, 200 m offshore in a depth of 33m.

There is an overland sledge route between the head of Granville Fjord and the entrance to Olrik Fjord, 21 km NNE (outside the map).

Shorelines within this area are predominantly rock and talus, and there are some large alluvial fans at river outlets, allowing little opportunity for marine access.

There is an airport is on the adjoining map at Thule Air Base (Map 7654).

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords on this map: the waters appear to be deep, but as they are uncharted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are few opportunities for nearshore booming along the short section of shoreline described on this map.

Alternatively, diversion booming could be attempted to protect the selected area on Saunders Island, but this is complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

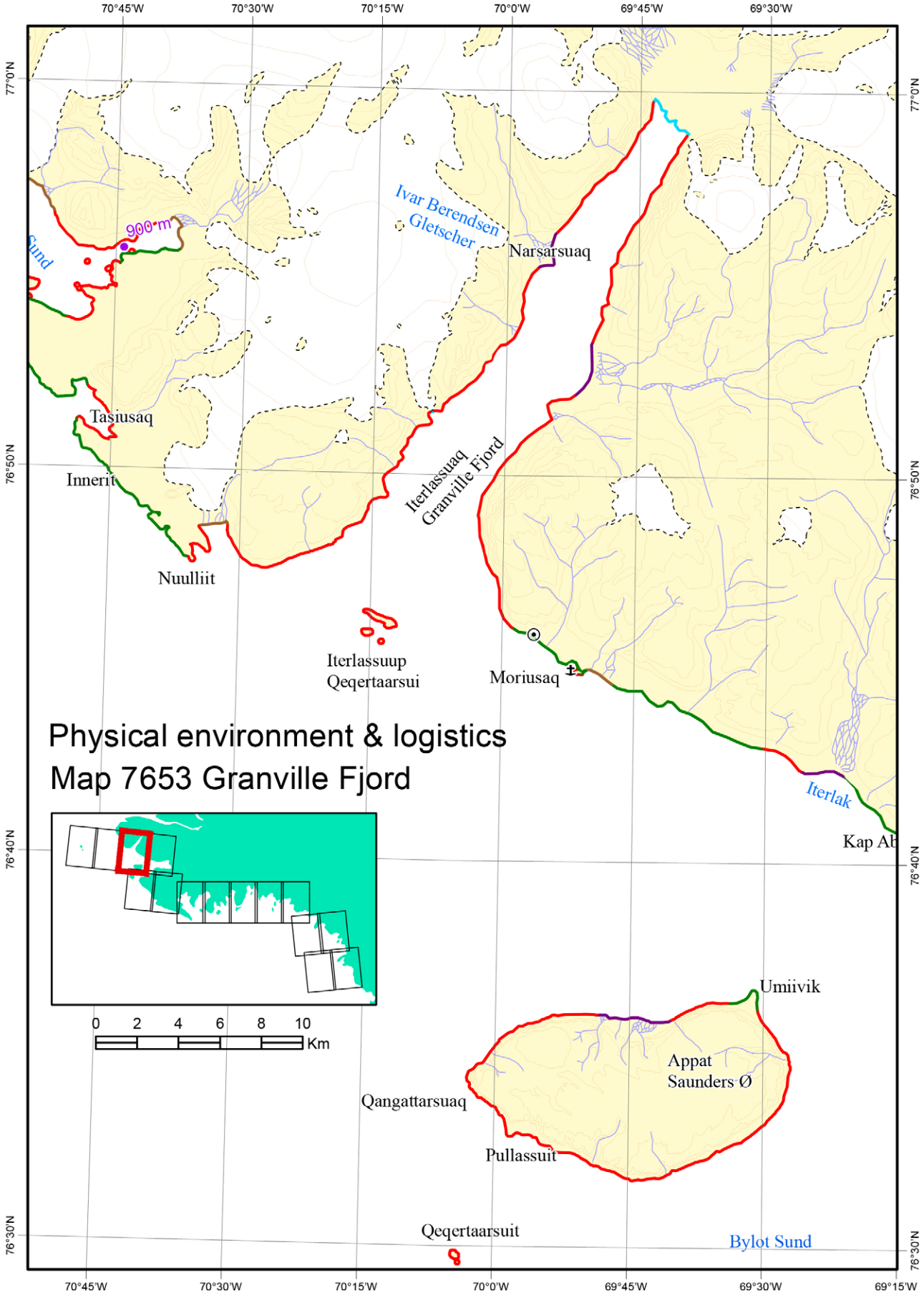
Exclusion booming could be used to prevent oil from entering the NE extremity of Booth Sund, where the inlet width is 900 m. Depths are unknown and would require reconnaissance at the time of a spill.

Shorelines shown on this map are predominantly exposed rock and talus, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within Booth Sound , Tasiusaq, Nuuliit, and Iterlassuaq. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

Safe Havens
There are no potential safe havens identified on this map.

The waters within Iterlassuaq could be considered as a potential safe haven given their low sensitivity rating, but the waters are not charted and exclusion booming would be impractical; however, the shape of the channel may afford natural containment, depending on wind direction and tidal streams.

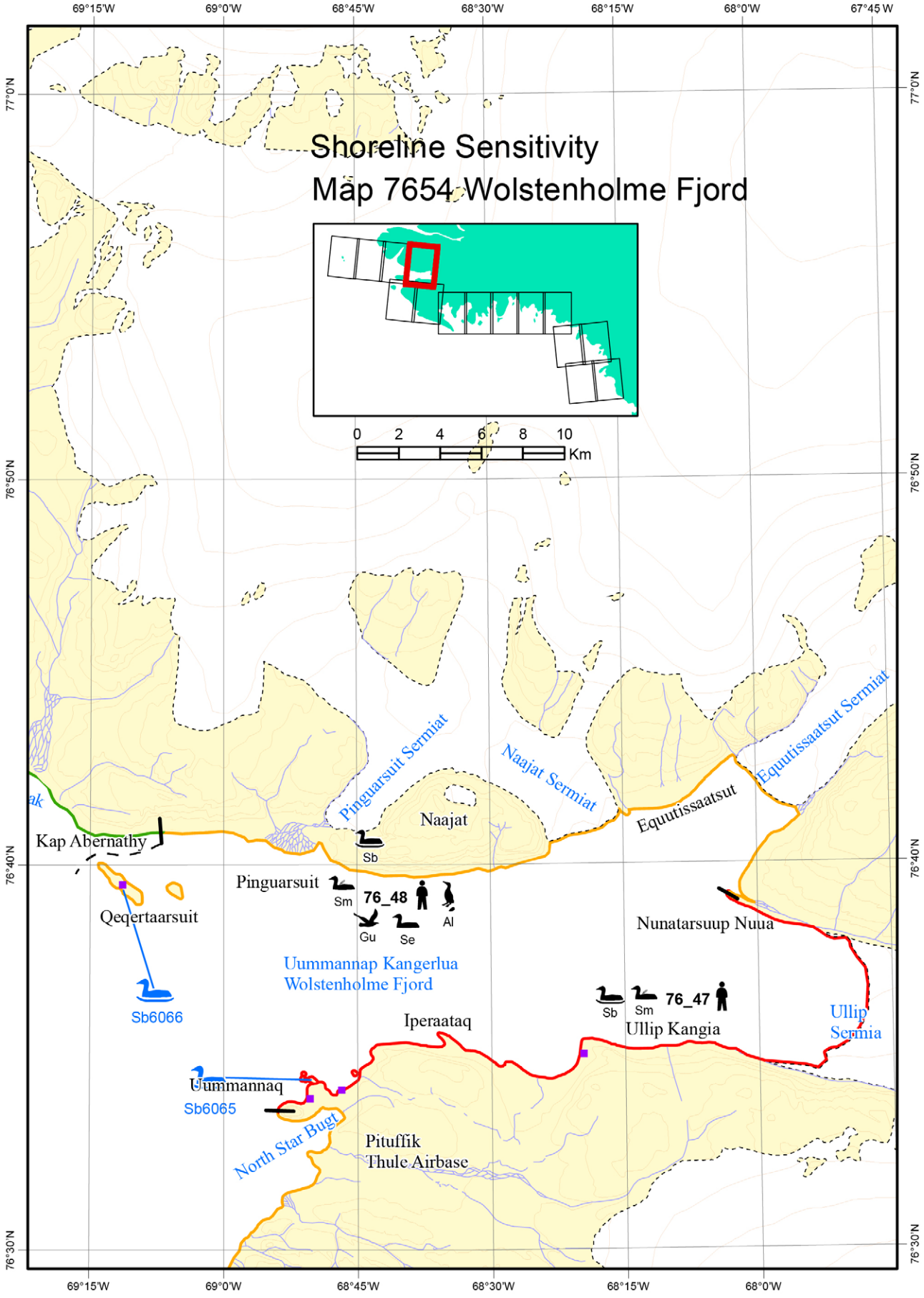
Maps
Danish Survey & Cadastre (KMS) topographical Map: 76 V.1. Nautical charts: 3130, 3200, 1000.



Physical environment & logistics
Map 7653 Granville Fjord

Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

8.15 Shoreline sensitivity, Map 7654 – Wolstenholme Fjord

Environmental Description

Resource use
Resource use is not significant on this map sheet. However, hunting for sea-birds and marine mammals takes place on occasional basis.

Species occurrence

Al76048	1 colony with breeding black guillemots.
Sb76048	2 colonies with breeding common eiders.

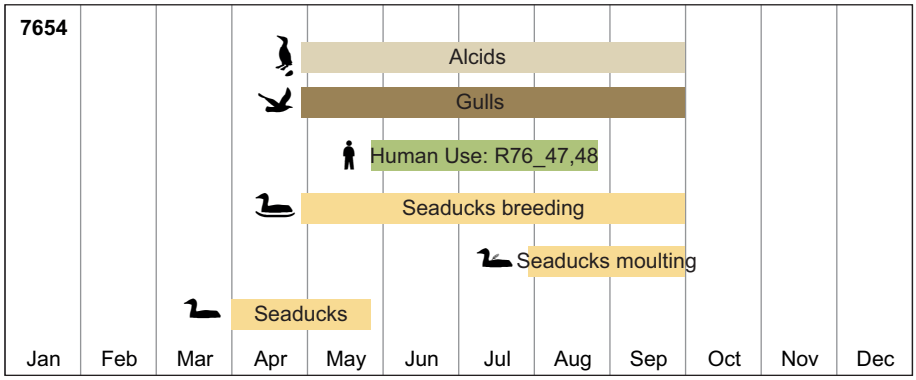
Site specific species occurrence (seabird breeding colonies); blue icons

Sb6065, Sb6066	Breeding common eider.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
76_47	27	Extreme
76_48	19	High

Map 7654.
Species and Resource Occurrence.



8.15.1 Physical and logistics, Map 7654 – Wolstenholme Fiord

Access
The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters offshore, nearshore, and within the islands and fjords appear to be deep, however, uncharted dangers may exist. The entire coastline in this area appears to be foul, with few soundings. Local knowledge is essential for navigation.

This area is ice-bound in the average year from November to mid-July.

There are a number of good anchorages in Uummannap Kangerlua (Wolstenholme Fjord) the best of which is North Star Bugt at Thule Air Base, situated 3 km within the SE entrance point. The E part of the fjord is a prohibited area, as indicated on the chart. The ice around Saunders Island breaks up early, but the islands tend to hold back the ice in the fjord itself, which does not normally clear until early July. The bay forms a harbour, which is part of a U.S. Defence Area; on its S side there are port facilities for supply of the U.S. Air Force Base at Thule. Vessels of 130 m length and 7 m draught have berthed alongside in North Star Bugt and there is anchorage off the bay for large vessels.

Tidal streams in North Star Bugt are weak. The winter ice is normally about 1.8 m thick. During the navigation season, ice conditions in North Star Bugt may suddenly become dangerous and vessels must be ready to move at instant notice

Shorelines within this area are predominantly rock and glacier allowing little opportunity for marine access. There are also som large alluvial fans at river outlets.

An airport is located at Thule Air Base.

Countermeasures
In ice concentrations down to six tenths, *in situ* burning of oil in conjunction with tracking oiled ice is recommended. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect wildlife and to prevent oil from entering inshore areas.

Offshore countermeasures represent the only practical method of protecting most shoreline areas.

There are no opportunities for exclusion booming in the area shown on this map due to the width of the inlets and the deep nearshore waters.

Shorelines shown on this map are predominantly exposed rock and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils.

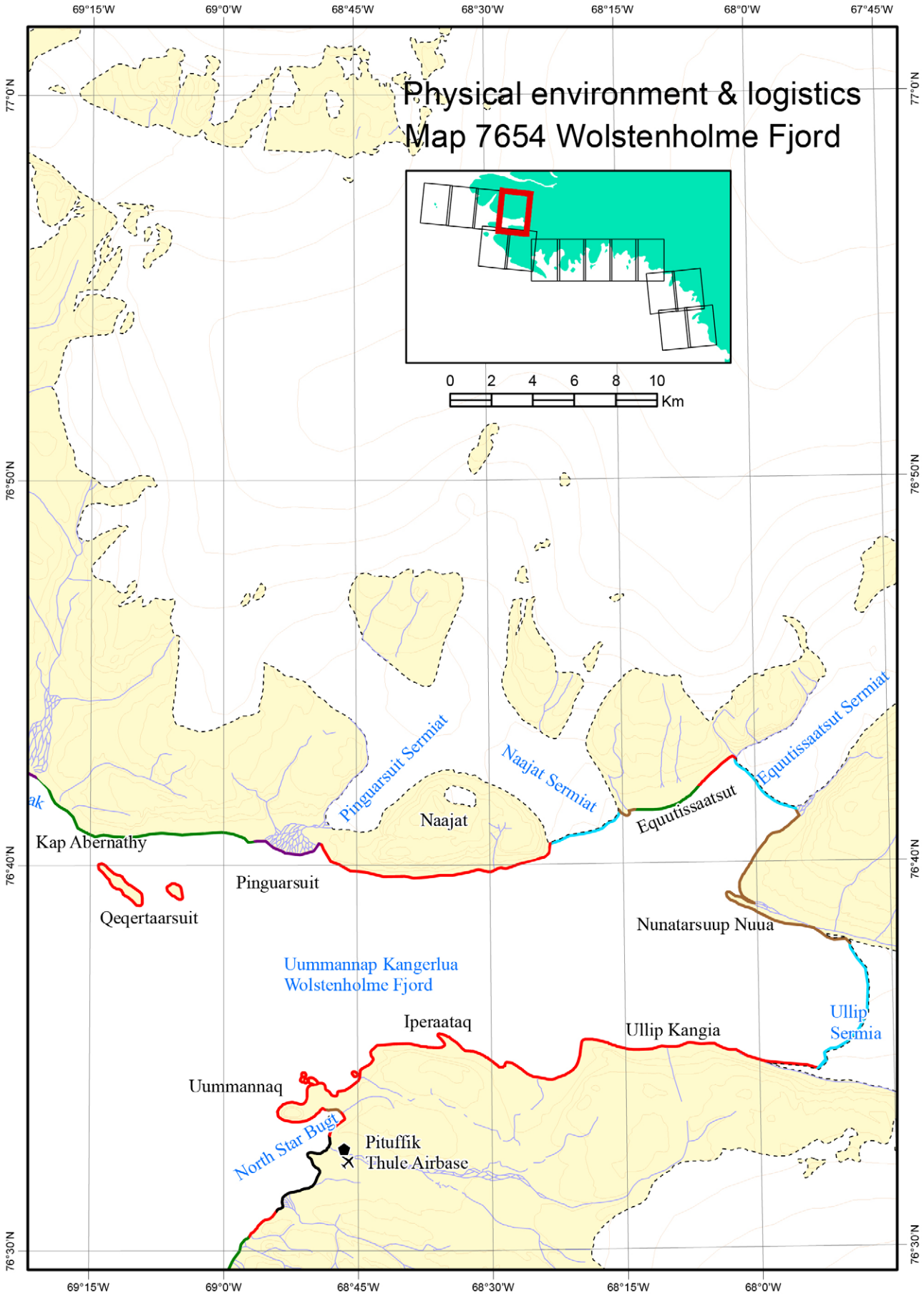
Consideration should be given to flushing operations in the protected waters within North Star Bugt. Access and trafficability of these areas are unknown, but it is probable that any clean-up operations would be marine-based given the likely nature of the shoreline.

One small section of the shoreline near Pingarsuit is designated as glacial moraine and has semi-protected coastal exposure; if oiled, this area may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. Marine access and beach trafficability are unknown, necessitating site surveys at the time of the clean-up.

Safe Havens
There are no potential safe havens identified on this map.

The anchorage within North Star Bugt could be considered as a potential safe haven, however, it has a high sensitivity rating; the anchorage offers some shelter, but exclusion booming would be impractical.

Maps
Danish Survey & Cadastre (KMS) topographical Map: 76 V.1. Nautical charts: 3130, 3200, 1000.



Environmental Oilspill Sensitivity Atlas for the NW Greenland zone (75°-77°N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen 1998
Projection: UTM zone 19N, WGS84

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10 Appendix A. Shoreline ranking details

Explanation to calculations used in the table

Assigned value x Weighting factor = Priority index

Sensitivity value = sum of Priority Indices

For biological elements:

(**Relative sensitivity x Relative abundance x Temporal modifier** x Oil residence index)/ Constant = **Assigned value**

Formula for calculation of the sensitivity value of shoreline areas. Bold abbreviations indicate factors which appear in the column headlines for the Shoreline Sensitivity ranking table. The Oil Residence Value (ORI) is a row heading. For further explanation see Chapter 6.3 and Appendix C, Chapter 12.

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_1	7502	Human Use				3	6		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2	3		
		Alcids	25	4	0.5	3.32	5.81		
		Gulls	17	3	0.5	1.69	2.97		
		Seaducks breeding	23	1	0.5	0.76	1.34		
								21	Extreme
75_2	7502	Human Use				3	6		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.68	2.52		
		Alcids	25	2	0.5	1.39	2.44		
		Gulls	17	5	0.5	2.37	4.14		
		Seaducks breeding	23	1	0.5	0.64	1.12		
		Seaducks moulting	23	3	0.25	0.96	1.68		
								18	High
75_3	7502	Human Use				3	6		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1	1.5		
		Seaducks moulting	23	1	0.25	0.19	0.33		
								8	Low
75_4	7502	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.22	3.32		
		Seaducks moulting	23	5	0.25	2.12	3.7		
								9	Low

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_5	7502	Human Use				2	4		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.32	1.98		
		Seaducks moulting	23	1	0.25	0.25	0.44		
								12	Moderate
75_6	7552	Human Use				2	4		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.22	1.84		
		Alcids	25	1	0.5	0.51	0.89		
		Gulls	17	1	0.5	0.35	0.61		
		Seaducks breeding	23	1	0.5	0.47	0.82		
								16	High
75_7	7552	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.18	1.77		
		Alcids	25	2	0.5	0.98	1.72		
		Gulls	17	4	0.5	1.33	2.33		
		Seaducks moulting	23	3	0.25	0.68	1.18		
								17	High
75_8	7552	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.44	2.16		
		Alcids	25	3	0.5	1.79	3.14		
		Gulls	17	2	0.5	0.81	1.42		
		Seaducks moulting	23	1	0.25	0.28	0.48		
								17	High
75_9	7552	Human Use				0	0		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.28	1.92		
								9	Low
75_10	7552	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2.09	3.13		
		Alcids	25	2	0.5	1.73	3.03		
		Gulls	17	3	0.5	1.77	3.1		
								19	Extreme

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_11	7552	Human Use				1	2		
		Archaeological Sites				1	2		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2	3		
		Alcids	25	3	0.5	2.49	4.36		
		Gulls	17	5	0.5	2.82	4.94		
		Seaducks breeding	23	3	0.5	2.29	4.01		
								28	Extreme
75_12	7552	Human Use				1	2		
		Archaeological Sites				3	6		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.24	1.86		
		Alcids	25	3	0.5	1.55	2.7		
		Gulls	17	1	0.5	0.35	0.61		
								21	Extreme
75_13	7551	Human Use				2	4		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.31	1.97		
								13	Moderate
75_14	7551	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.38	2.07		
		Seaducks moulting	23	1	0.25	0.26	0.46		
								12	Moderate
75_15	7607	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.03	1.55		
								11	Low
75_16	7607	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2	3		
								13	Moderate
75_17	7607	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2.07	3.11		
								13	Moderate

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_18	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.36	2.05		
								12	Low
75_19	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2.8	4.2		
								14	Moderate
75_20	7606	Human Use				2	4		
		Archaeological Sites				1	2		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.36	2.03		
								16	High
75_21	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.67	2.51		
								12	Low
75_22	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.91	2.86		
								12	Moderate
75_23	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.6	2.39		
								12	Low
75_24	7606	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.14	1.71		
								11	Low
75_25	7605	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				2.11	3.17		
								13	Moderate

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_26	7605	Human Use				2	4		
		Archaeological Sites				0	0		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.29	1.94		
		Greenland halibut	7	1	1	0.3	0.53		
		Little auks	25	1	0.5	0.54	0.94		
								13	Moderate
75_27	7605	Human Use				3	6		
		Archaeological Sites				1	2		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.02	1.53		
		Alcids	25	1	0.5	0.42	0.74		
		Greenland halibut	7	15	1	1.18	2.07		
		Gulls	17	1	0.5	0.29	0.5		
								20	Extreme
75_28	7605	Human Use				3	6		
		Archaeological Sites				1	2		
		Special Status Areas				5	7.5		
		Communities				0	0		
		Oil Residency Index				1.75	2.62		
		Greenland halibut	7	3	1	1.22	2.14		
		Little auks	25	1	0.5	0.73	1.27		
								20	Extreme
75_29	7605	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.02	3.04		
		Arctic char	14	3	0.25	0.71	1.24		
		Little auks	25	4	0.5	3.36	5.88		
								12	Low
75_30	7604	Human Use				3	6		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.23	3.35		
		Greenland halibut	7	2	1	1.04	1.82		
		Little auks	25	1	0.5	0.93	1.62		
								15	Moderate
75_31	7604	Human Use				3	6		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				2.57	5.15		
		Oil Residency Index				1.74	2.61		
		Greenland halibut	7	4	1	1.62	2.83		
		Little auks	25	1	0.5	0.72	1.26		
								24	Extreme

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_32	7604	Human Use				4	8		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				9.96	19.92		
		Oil Residency Index				1	1.5		
		Alcid Nonbreeding	21	2	0.25	0.35	0.61		
		Arctic char	14	3	0.25	0.35	0.61		
		Greenland halibut	7	5	1	1.16	2.03		
		Little auks	25	3	0.5	1.25	2.18		
		Seaducks	23	1	0.25	0.19	0.33		
								41	Extreme
75_33	7604	Human Use				4	8		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				5.18	10.36		
		Oil Residency Index				1.86	2.79		
		Alcid	25	1	0.5	0.77	1.35		
		Greenland halibut	7	4	1	1.73	3.03		
		Little auks	25	1	0.5	0.77	1.35		
								27	Extreme
75_34	7603	Human Use				3	6		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.53	2.3		
		Alcid Nonbreeding	21	1	0.25	0.27	0.47		
		Greenland halibut	7	5	1	1.78	3.12		
		Little auks	25	4	0.5	2.55	4.46		
								18	High
75_35	7604	Human Use				3	6		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.23	3.35		
		Greenland halibut	7	3	1	1.56	2.72		
		Little auks	25	2	0.5	1.85	3.24		
								15	High
75_36	7604	Human Use				2	4		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.57	2.35		
								6	Low
75_37	7603	Human Use				3	6		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.24	3.35		
		Alcids	25	1	0.5	0.93	1.62		
		Greenland halibut	7	1	1	0.52	0.91		
		Little auks	25	2	0.5	1.86	3.25		
								15	Moderate

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_38	7603	Human Use				0	0		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.67	2.5		
		Little auks	25	2	0.5	0.39	2.42		
								5	Low
75_39	7603	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.28	3.42		
								5	Low
75_40	7603	Human Use				2	4		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.71	2.56		
		Alcids Nonbreeding	21	2	0.25	0.6	1.04		
		Greenland halibut	7	2	1	0.79	1.39		
		Little auks	25	1	0.5	0.71	1.24		
								16	High
75_41	7603	Human Use				2	4		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1	1.5		
		Alcids Nonbreeding	21	1	0.25	0.17	0.31		
		Arctic char	14	3	0.25	0.35	0.61		
		Greenland halibut	7	1	1	0.23	0.41		
		Gulls	17	1	0.5	0.28	0.49		
		Little auks	25	5	0.5	2.08	3.63		
								17	High
75_42	7602	Human Use				0	0		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1	1.5		
		Alcids	25	5	0.5	2.08	3.63		
		Alcids Nonbreeding	21	3	0.25	0.52	0.92		
		Gulls	17	5	0.5	1.41	2.47		
		Little auks	25	5	0.5	2.08	3.63		
		Seaducks	23	4	0.25	0.76	1.34		
		Seaducks breeding	23	3	0.5	1.15	2.01		
								21	Extreme

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_43	7601	Human Use				1	2		
		Archaeological Sites				5	10		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.08	1.61		
		Alcids	25	5	0.5	2.23	3.91		
		Alcids Nonbreeding	21	1	0.25	0.19	0.33		
		Gulls	17	5	0.5	1.52	2.66		
		Little auks	25	4	0.5	1.79	3.13		
		Seaducks	23	5	0.25	1.03	1.8		
								25	Extreme
75_44	7601	Human Use				0	0		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				3.96	7.92		
		Oil Residency Index				1.84	2.76		
		Alcids Nonbreeding	21	2	0.25	0.64	1.12		
		Gulls	17	1	0.5	0.52	0.91		
		Little auks	25	1	0.5	0.75	1.34		
		Seaducks	23	1	0.25	0.35	0.61		
								17	High
75_45	7601	Human Use				2	4		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1	1.5		
		Alcids	25	5	0.5	2.08	3.63		
		Alcids Nonbreeding	21	2	0.25	0.35	0.61		
		Gulls	17	1	0.5	0.28	0.49		
		Seaducks	23	5	0.25	0.96	1.67		
		Seaducks breeding	23	5	0.5	1.91	3.34		
		Seaducks moulting	23	1	0.25	0.19	0.33		
								18	High
75_46	7653	Human Use				2	4		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.07	3.1		
		Alcids	25	5	0.5	4.3	7.52		
		Alcids Nonbreeding	21	5	0.25	1.8	3.16		
		Gulls	17	1	0.5	0.58	1.02		
		Seaducks	23	5	0.25	1.98	3.46		
		Seaducks moulting	23	4	0.25	1.58	2.77		
								31	Extreme
75_47	7654	Human Use				1	2		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				4.56	9.12		
		Oil Residency Index				3.08	4.61		
		Seaducks breeding	23	2	0.5	2.35	4.11		
		Seaducks moulting	23	1	0.25	0.59	1.03		
								27	Extreme

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_48	7654	Human Use				1	2		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				1.18	2.35		
		Oil Residency Index				1.38	2.07		
		Alcids	25	3	0.5	1.72	3.01		
		Gulls	17	2	0.5	0.78	1.37		
		Seaducks	23	1	0.25	0.26	0.46		
		Seaducks breeding	23	5	0.5	2.64	4.62		
		Seaducks moulting	23	2	0.25	0.53	0.92		
								19	High
75_49	7653	Human Use				1	2		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.06	1.59		
		Alcids	25	1	0.5	0.44	0.77		
		Alcids Nonbreeding	21	5	0.25	0.92	1.61		
		Gulls	17	3	0.5	0.9	1.57		
		Seaducks	23	1	0.25	0.2	0.35		
		Seaducks breeding	23	5	0.5	2.02	3.54		
		Seaducks moulting	23	2	0.25	0.4	0.71		
								14	Moderate
75_50	7653	Human Use				1	2		
		Archaeological Sites				0	0		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2.43	3.65		
		Alcids Nonbreeding	21	1	0.25	0.42	0.74		
		Seaducks breeding	23	1	0.5	0.93	1.62		
		Seaducks moulting	23	4	0.25	1.86	3.25		
								11	Low
75_51	7653	Human Use				1	2		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1	1.5		
		Alcids Nonbreeding	21	3	0.25	0.52	0.92		
		Seaducks	23	5	0.25	0.96	0.67		
		Seaducks breeding	23	4	0.5	1.53	2.67		
		Seaducks moulting	23	4	0.25	0.76	1.34		
								16	High
75_52	7652	Human Use				2	0		
		Archaeological Sites				1	2		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				1.55	2.33		
		Alcids Nonbreeding	21	3	0.25	0.81	1.42		
		Gulls	17	3	0.5	1.31	2.3		
		Seaducks	23	5	0.25	1.48	2.59		
		Seaducks breeding	23	5	0.5	2.96	5.19		
		Seaducks moulting	23	5	0.25	1.48	2.59		
								18	High

Area	Map no.	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
75_53	7651	Human Use				0	0		
		Archaeological Sites				3	6		
		Special Status Areas				0	0		
		Communities				0	0		
		Oil Residency Index				2	3		
		Alcids	25	5	0.5	4.15	7.27		
		Alcids Nonbreeding	21	3	0.25	1.05	1.83		
		Gulls	17	2	0.5	1.13	1.98		
		Seaducks	23	5	0.25	1.91	3.34		
		Seaducks breeding	23	4	0.5	3.06	5.35		
		Seaducks moulting	23	4	0.25	1.53	2.67		
								31	Extreme

11 Appendix B. Offshore sensitivity ranking

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
Scenario, Winter								
OS_33	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				1	2		
	Baleen whales	9	3	1	2.16	3.78		
	Greenland halibut	7	1	1	0.56	0.98		
	Polar bear	21	5	1	8.40	14.70		
	Seals	12	4	1	3.84	6.72		
	Walrus	18	5	1	7.20	12.60		
	White whale	13	3	1	3.12	5.46		
							54	Extreme
OS_34	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Polar bear	21	5	1	5.04	8.82		
	Seals	12	4	1	3.84	6.72		
	Walrus	18	5	1	7.20	12.60		
	White whale	13	3	1	3.12	5.46		
							51	Extreme
OS_35	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Polar bear	21	5	1	8.40	14.70		
	Seals	12	3	1	2.88	5.04		
							51	Extreme
OS_36	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Polar bear	21	5	1	8.40	14.70		
	Seals	12	5	1	4.80	8.40		
							41	High

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
Scenario, Spring								
OS_33	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				1	2		
	Alcids	25	5	1	10.00	17.50		
	Baleen whales	9	3	1	2.16	3.78		
	Greenland halibut	7	1	1	0.56	0.98		
	Ivory gull	18	2	1	2.88	5.04		
	Narwhal	13	3	1	3.12	5.46		
	Polar bear	21	4	1	6.72	11.76		
	Seals	12	3	1	2.88	5.04		
	Surface feeders	18	2	1	2.88	5.04		
	Walrus	18	5	1	7.20	12.60		
	White whale	13	3	1	3.12	5.46		
							82	High
			5	1	5.04	8.82		
OS_34	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Alcids	25	5	1	10.00	17.50		
	Baleen whales	9	1	1	0.72	1.26		
	Non-alcid persuit divers	19	1	1	1.52	2.66		
	Polar bear	21	3	1	5.04	8.82		
	Seaducks	23	5	1	9.20	16.10		
	Seals	12	4	1	2.88	5.04		
	Surface feeders	18	3	1	2.88	5.04		
	Walrus	18	5	1	7.20	12.60		
							87	Extreme
OS_35	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Alcids	25	5	1	10.00	17.50		
	Baleen whales	9	3	1	2.16	3.78		
	Narwhal	13	5	1	5.20	9.10		
	Polar bear	21	4	1	6.72	11.76		
	Seals	12	3	1	2.88	5.04		
	Surface feeders	18	2	1	2.88	5.04		
	Walrus	18	1	1	1.44	2.52		
	White whale	13	3	1	3.12	5.46		
							78	High
OS_36	Marine Oil Residency Index				5	7.5		
	Special Status Areas				0	0		
	Human Use				5	10		
	Alcids	25	5	1	10.00	17.50		
	Non-alcid pursuit divers	19	1	1	1.52	2.66		
	Polar bear	21	5	1	8.40	14.70		
	Seaducks	23	5	1	9.20	16.10		
	Seals	12	3	1	2.88	5.04		
	Surface feeders	18	1	1	1.44	2.52		
							78	High

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
Scenario, Summer								
OS_33	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				1	2		
	Alcids	25	5	1	8.00	14.00		
	Baleen whales	9	4	1	2.30	4.03		
	Greenland halibut	7	1	1	0.45	0.78		
	Ivory gull	18	2	1	2.30	4.03		
	Narwhal	13	1	1	0.83	1.46		
	Non-alcid pursuit divers	19	1	1	1.22	2.13		
	Polar bear	21	2	1	2.69	4.70		
	Seaducks	23	4	1	5.89	10.30		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	2	1	2.30	4.03		
	Walrus	18	1	1	1.15	2.02		
							57	High
					5	7.5		
OS_34	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				1	2		
	Alcids	25	5	1	8.00	14.00		
	Baleen whales	9	2	1	1.15	2.02		
	Narwhal	13	1	1	0.83	1.46		
	Non-alcid pursuit divers	19	1	1	1.22	2.13		
	Polar bear	21	1	1	1.34	2.35		
	Seaducks	23	4	1	5.89	10.30		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	3	1	3.46	6.05		
	Walrus	18	1	1	1.15	2.02		
							58	Extreme
OS_35	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				5	10		
	Alcids	25	5	1	8.00	14.00		
	Baleen whales	9	3	1	1.73	3.02		
	Narwhal	13	4	1	3.33	5.82		
	Polar bear	21	2	1	2.69	4.70		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	2	1	2.30	4.03		
							49	High
OS_36	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				5	10		
	Alcids	25	5	1	8.00	14.00		
	Narwhal	13	5	1	4.16	7.28		
	Non-alcid pursuit divers	19	1	1	1.22	2.13		
	Polar bear	21	4	1	5.38	9.41		
	Seaducks	23	2	1	2.94	5.15		
	Seals	12	2	1	1.54	2.69		
	Surface feeders	18	1	1	1.15	2.02		
							59	Extreme

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
Scenario, Autumn								
OS_33	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				1	2		
	Alcids	25	3	1	4.80	8.40		
	Greenland halibut	7	1	1	0.45	0.78		
	Narwhal	13	3	1	2.50	4.37		
	Polar bear	21	2	1	2.69	4.70		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	1	1	1.15	2.02		
	Walrus	18	5	1	5.76	10.08		
	White whale	13	3	1	2.50	4.37		
							44	High
	Surface feeders	18	2	1	2.30	4.03		
				1	1.15	2.02		
OS_34	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				5	10		
	Polar bear	21	1	1	1.34	2.35		
	Seaducks	23	5	1	7.36	12.88		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	1	1	1.15	2.02		
	Walrus	18	5	1	5.76	10.08		
	White whale	13	4	1	3.33	5.82		
							50	Extreme
OS_35	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				5	10		
	Narwhale	13	3	1	2.50	4.37		
	Polar bear	21	2	1	2.69	4.70		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	1	1	1.15	2.02		
	White whale	13	3	1	2.50	4.37		
							33	Moderate
OS_36	Marine Oil Residency Index				4	6		
	Special Status Areas				0	0		
	Human Use				5	10		
	Narwhale	13	5	1	4.16	7.28		
	Polar bear	21	3	1	4.03	7.06		
	Seals	12	1	1	0.77	1.34		
	Surface feeders	18	1	1	1.15	2.02		
	White whale	13	3	1	2.50	4.37		
							38	High

12 Appendix C. Methods and documentation

12.1 Introduction

In the Chapters 4, 5 and 6, the methods and data used in the present atlas project have been described. However, some technical details and data documentation was not included in these chapters and are presented here. Appendix C should, thus, be seen as supplementary to the descriptions in Chapters 4, 5 and 6.

This chapter contains the detailed settings used for calculating the sensitivity index values with the Greenland oil spill sensitivity application (Chapter 12.2):

- a description of the data and methods used in the geomorphological coast classification (Chapter 12.3),
- a description of the data and methods used to assess abundance values for the biological occurrences for each area (Chapter 12.4),
- a description of the data and method used to assess assigned values for the archaeological sites for each shoreline area (Chapter 12.5),
- an account of the selected areas (Chapter 12.6).

12.2 The parameters of the Greenland oil spill sensitivity application

Below is a list of the parameter settings in the Greenland oil spill sensitivity application for the index calculations in this atlas.

Assigned Values to shoreline and offshore areas:

Score per community	1-4*
Special status area score	5
Resource (human) use, range**	0-4
Archaeological sites, range	0-5
Animal relative abundance, range	0-5

*Calculated in GIS using a 10 km and a 15 km buffer zone around each community. The initial weights being 2 in the 0 to 10 km zone and 1 in the zone from 10 to 15 km, and the index value is proportional to the length of shoreline segments included within this buffer zone.

*Range from 0 (no importance) to 4 (extreme importance).

Shoreline exposure class modifier for shoreline ice cover:
No modifiers for short open water periods have been applied.

Shoreline ORI modifiers
A single modifier to the basic classification of the ORI value (see Chapter 6) is made to account for the expected longer residence times in the geomorphologic shore type "Archipelagos". The maximum the maximum ORI value is limited to 5.

Weighing factors	
Resource (human) use	2
Species occurrences	1.75
Special status areas (Ramsar sites)	1.5
Oil residence index	1.5
Application constants	
Biological resource constant (shoreline)	30.1
Biological resource constant (offshore)	35
Maximum ORI value	5

The final classification into the four shoreline sensitivity classes "low", "moderate", "high" and "extreme" was based on a rolling window analysis, comparing each shoreline segment PI-score to all segments in a 200 km radius. For this reason, the Low and Moderate PI value domain has a slight overlap. For a detailed description of the procedure see section 12.5 in this chapter.

Table 12.1. Sensitivity class distribution.

Sensitivity class	PI value domain	No. of segments	Length (km)
Low	4.93 – 12.16	13	626
Moderate	12.03 – 15.14	12	531
High	15.31 – 18.81	14	617
Extreme	18.81 – 41.19	14	581

With these settings, the average contributions (PI-values) to the final sensitivity values for the shoreline areas are: biological occurrences 30 %, resource (human) use 19 %, oil residence index 15 %, archaeological sites 11%, communities 4 % and special status areas (Melville Bay reserve) 20 %. However, this is a simplification, since the oil residence index value is a factor in the calculation of the PI-value for biological occurrences and, thus, has a higher relative contribution to the final sensitivity value. The special status area contributes to a large part of the sensitivity score, since the Melville Bay reserve covers a large extent of the atlas area and, thus, a large part of the shoreline.

12.3 Geomorphological information

The geomorphology of the Northwest Greenland coast between c. 75° N and 77° N has been classified according to shore type, sediment type and exposure. The classification covers the coastline from the west coast of 8 km north of Tuuttulikassaak/Lille Renland to Cape Peary north of WolstenholmeIsland and Thule Airbase, including the Carey Islands. The total shore-line length is c. 2355 km.

12.3.1 Methods

The classification is based on a mixture of information from topographic maps (1:250,000), geological maps in 1: 500,000 and 1:2,500,000 and Landsat 7 imagery from 2010 and 2009.

Overall, the geology is divided into four geological provinces. Three of them are located in Melville Bay and are called Melville Bay Orthogneiss Complex, Cape York Meta-igneous Complex and Thule Mixed-gneiss Complex. They extend from the southern most part of the atlas to Cape Atholl in Bylot Sound. The dominant geology in this part of the area is various gneissic rock types.

The remaining part of the atlas, including Saunders Island and Wolstenholme Island, is characterized by various sandstone types. As sandstone is a relatively soft rock type, a large part of the moraine, alluvial and delta coast types is located in this part of the atlas.

To allow the calculation of oil spill sensitivity indexes, the coastal classification is mainly based on the methods outlined in the proposal 'West Greenland Coastal Atlas for Environmental Protection. A Proposal to the Danish Energy Agency' produced by AXYS in July 1999 (Mosbech et al. 2000). For definition of shore types, the classification has been changed a bit to suit Greenland coasts better. The classification scheme has been simplified in comparison to the previous shoreline sensitivity atlases for the Greenland west coast to accommodate a faster production without aerial photography interpretation.

The overall process consisted of the following processes:

1) A revision of the coastline from the topographic maps for the changes in extent of the Greenland Icecap. This mapping also identified all shore of type "glacier coasts" Landsat 7 composite from August – September 2009 was used for this.
2) An identification and delineation of primarily the loose deposits as mapped in the geological maps. Secondarily, the bedrock type was identified.
3) The areas of "undifferentiated deposits" were interpreted into the sedimentary shore types using topographic information, and satellite imagery, where the geological maps not already provided a classification.
4) The remaining hard rock areas were classified into "rocky coast", "archipelago" and "talus" from the complexity of the coastline and presence of of small islands, as interpreted in the Landsat satellite imagery.

The division of the shoreline into shore type segments is based on the geomorphology of the coast. A shore type is a repeatable category of coastal geomorphology, which indirectly indicates the coastal sediment type. Seventeen different shore types have been used for the classification (Table 12.1). However, in the atlas the seventeen shore types have been reduced to twelve shore types for simplicity (Table 5.1). This has been done by lumping shore types with erosional cliffs together with the corresponding shore types without erosional cliffs.

No specific lower segment length was applied, but the sedimentary shore types have been included to the extent they have been mapped in the geological maps. In practical terms this has led to a lower segment limit of c. 200 meters. Inside the hard rock areas, the often short formations of intrusive rockhave not been delineated separately. For the sake of consistency throughout the entire atlas series, all of the Gneissic rocktypes have been classified as "Granite" in this atlas.

For each segment, the shore type (Table 12.1) and the exposure (Table 12.4) were classified. The segments were marked and classified directly on a corresponding digital shoreline. The shore type "Talus" includes shorelines, which consist of larger landslide areas.

Table 12.2. Classification of shore types in Northwest Greenland between 75° and 77° N.

	Shore-type no.	Shoretype	Characteristics
Shores developed in solid rock	1	Rocky coast	Coast developed in bedrock of varying morphology, elevation and gradient. Narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur.
	3	Archipelago	Several smaller islands normally developed in solid rock. Rocky coasts on larger islands are included if interpreted to be a part of same landscape of very uneven coastline as the islands.
Glacier coast	4	Glacier coast	Occurrence of a glacier ice in the intertidal zone.
Shores developed in sediments of glacial alluvial or colluvial origin	5	Moraine	Shore developed in unconsolidated glacial sediments. Narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur.
	7	Alluvial fan	Shore developed in alluvial fan. Narrow beach with sediment consisting of boulders, cobbles, pebbles, gravel and sand might occur.
	9	Talus	Shore developed in talus (colluvial fan) of varying gradient. Narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur.
Shores developed in marine sediments	11	Beach	Long, linear depositional beaches of well-sorted sand, gravel, pebbles, cobbles or boulders. Beach ridge plains often occur landwards the beach.
	14	Salt marsh and/or tidal flat	Wide salt marshes with or without salt marsh cliff and/or wide intertidal flats. Consisting of relatively fine sediments (mud, sand, silt and clay).
Others	17	Not classified	The shore has not been classified due to lack of satellite imagery information (cloudcover, shadow, etc.).

To accommodate the shoreline sensitivity calculation using the AXYS application, the shore types have been reclassified into coastal sediment types.

Table 12.3. Reclassification of sediment types.

Shore type	Sediment type / substrate
Moraine (5)	Fine sediment (6)
Alluvial fan (7)	Fine sediment (6)
Talus (9)	Coarse sediment (5)
Beach (11)	Fine sediment (6)
Archipelago (3)	Rock (2)
Rocky coast (1)	Rock and coarse sediment (3)
Glacier coast (4)	Ice (1)

Classification of exposure:
The classification of exposure was performed as a grid analysis with a cell size of 250 meters and UTM zone 19, 20 and 21 as the orthogonal coordinate systems. The basis for the classification was the distance to coast in the 8 main directions (N, NE, E, SE, S, SW, W and NW). The distance threshold was set to 50 km. As the coast itself was not oriented in a entirely north-south direction, the classification procedure was repeated three times, based on which UTM zone the segments was located in. (See fig 12.1) This corresponded very well with the orientation of the coastline and was, thus, used to determine the main fetch directions:

Utm zone	Main fetch directions
19	W, SW, S
20	SW, S, NW
21	NW, W, SW

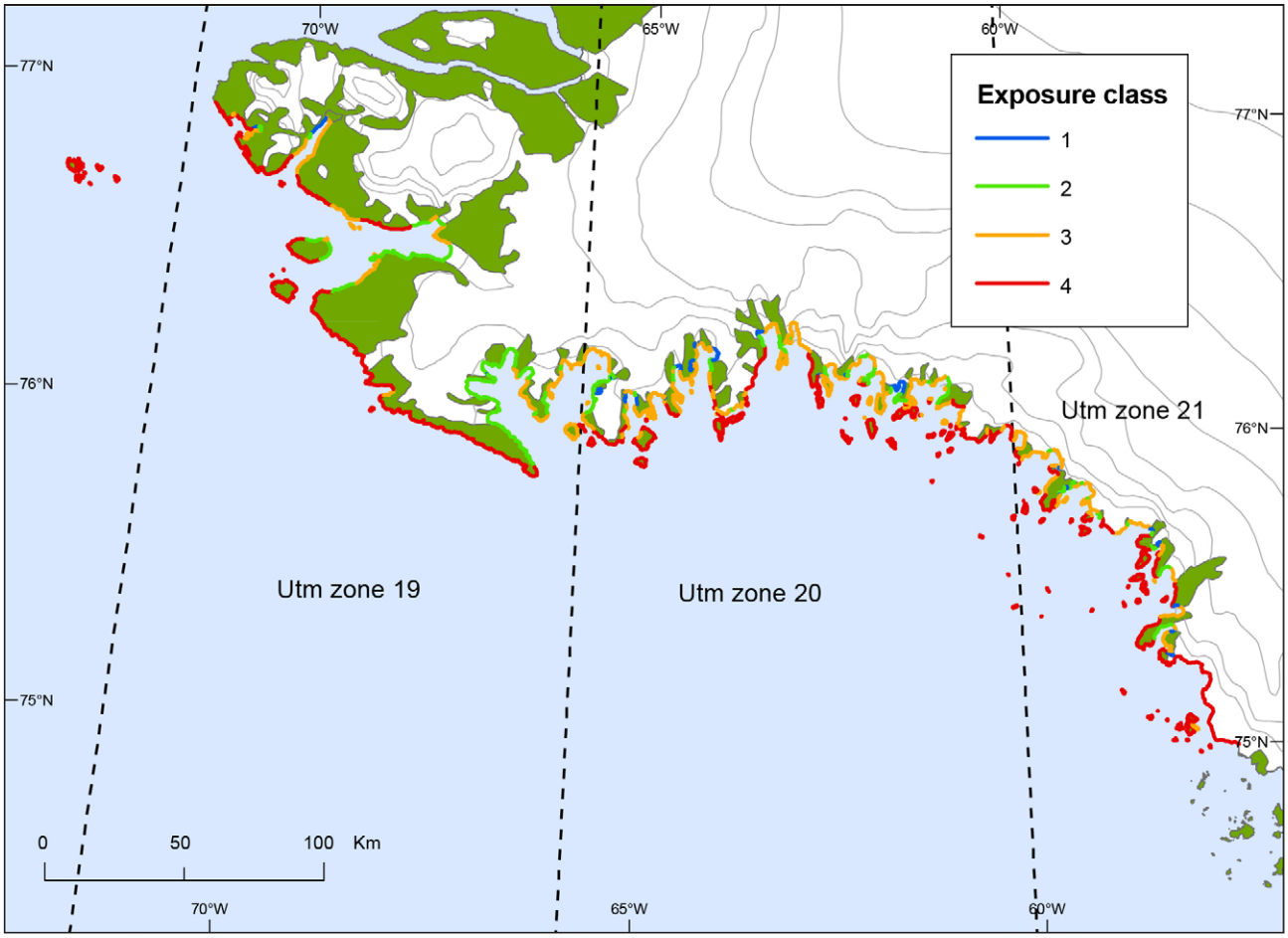

Figure 12.1. Shoreline exposure to wind and wave forces, in the atlas area.

Exposure classes have been defined as:

Class 4 (Exposed):
Distances min 50 km from at least 2 of the main fetch directions

Class 3 (Semi-exposed):
Distance of min. 50 km from one of the main fetch directions
OR
Mean distance of all main fetch directions greater than 10 km.

Class 1 (Protected):
Maximum distance in any direction 4 km
AND
The mean distance of all directions less than 2 km

Class 2 (semi-protected):
Remaining shorelines

Compared to the previous atlases, a very large proportion of the coastline is classified as Exposed. The reason for this is that there are few islands and archipelagoes off the coast to shield the mainland, thus exposing a large proportion to wave action and wind forces. However, sea ice and glacier ice may in some ways protect shorelines.

Oil Residence Index classification:

Table 12.4. Basic Oil Residence Index (ORI) ranking based on a combination of shore type and exposure for the Thule area.

Shore type / Exposure class	Protected	Semi-protected	Semi-exposed	Exposed
Moraine (5)	4	3	1	1
Alluvial fan (7)	4	3	1	1
Talus (9)	5	4	1	1
Beach (11)	4	3	1	1
Archipelago (3)	5	4	2	2
Rocky coast (1)	5	4	2	1
Glacier coast (4)	1	1	1	1

The ORI index entering the calculations is a length proportional average value of the individual segments.

12.3.2 Statistics

The total length of the coastline is approximately 2355 km, of which ~735 km is the length of the coastlines of islands amd ~1620 km is the length of mainland coast.

The distribution of segments on shore type and exposure categories, respectively, is given in Tables 12.6-12.7. In terms of shoreline length, the 'Rocky coast' is the dominant shore type (61.5 %) and 'Exposed' is the dominant exposure type (49.1 %). Together the 'Glacier coast' and 'Rocky coast' shore types by length constitute 80.7 % of the total investigated shoreline.

Table 12.5. Shoretype statistics.

Shore type	No. of stretches	Km	%
1	351	1450	61.5
3	88	186	7.9
4	201	452	19.2
5	18	45	1.9
7	8	19	0.8
9	70	198	8.4
11	3	6	0.3
Total	665	2355	100

Table 12.6. Exposure statistics.

Exposure type	Km	%
1 - Protected	83	3.5
2 - Semi-protected	361	15.3
3 - Semi-exposed	755	32
4 - Exposed	1,156	49.1
Total	2,355	100

12.4 Biological and resource use information

12.4.1 Introduction

This section describes the different species/species groups included in the biological part of the atlas, and it gives an overview of the different sources of the biological information. Moreover, a description of the rationale behind the selection of seabird breeding colonies and behind the calculation of the relative abundance of seabirds in each shoreline area is given. Many more species of birds, marine mammals and fish/shellfish occur in the region. These are, however, of insignificant importance as hunting/fishing objects, they occur widespread without any concentration areas or they are not particularly exposed to oil in case of a spill in the region. Following acronyms are used: DCE= Danish Centre for Environment and Energy GINR = Greenland Institute of Natural Resources.

12.4.2 Marine mammals

Seals
The true seals are represented by four species: Bearded seals can be found in all parts of the atlas area and they are seen throughout the year. During winter, ice cover limits the available habitats in the assessment area to feeding grounds in the NOW Polynya and in the dynamic shear zone. Ringed seals are numerous throughout the region and especially frequent in ice covered waters, both in fjords with fast ice and in the drift ice. They occur year-round and whelp in liars on the ice. Harp seals are numerous visitors in the open water season, both in the fjords and offshore. Hooded seals also occur in the open water season, but in much lower numbers than the harp seals. For details, see the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann & Mosbech 2011).

Walrus
Walruses winter near the eastern parts of NOW, including areas around Wolstenholme Island and Saunders Island. During spring, they migrate across to the eastern shores of Canada, and only occasional stragglers are seen in the summer time. The presented information is retrieved from the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann & Mosbech 2011).

Polar bears
The Melville Bay area is an important polar bear habitat throughout the year and denning occurs in the area. The recurrent shear zone system south of Kap York and the edges of the North Water Polynya are importnat bear habitats (Boertmann & Mosbech 2011).

Baleen whales
This group comprises three species: fin whale, minke whale and bowhead whale. Fin whale and minke whale are occasional summer visitors to the area, and both are hunted under regulation by the International Whaling Commission. The presented data on these two species are from the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann et al. 2011). The third species is the bowhead whale, which is a winter and spring visitor to the area. The presented information is retrieved from the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann & Mosbech 2011). A few more species occur in the area: Humpback whale, which is an increasing summer visitor, and blue whale, which is a rare summer visitor.

White whale (Beluga)
The white whale is a migrant visitor to the region both in spring (April and May) and autumn (late October and November). The NOW is also wintering grounds to white whales, but mainly in the Canadian part. The information is summarised in the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann & Mosbech. 2011).

Narwhal
Melville bay is an important summer ground for Narwhals. During autumn, they migrate south, and they return when the ice breaks up, during spring. See also the Strategic Environmental Impact Assessment of the Baffin Bay East area (Boertmann & Mosbech 2011).

12.4.3 Seabirds

The seabird species have been assembled in some seabird groups:

- Alcids, comprising breeding thick-billed murre, razorbill, black guillemot and Atlantic puffin.
- Alcids nonbreeding, comprising autumn concentrations of breeding little auks, thick-billed murre, razorbill, black guillemot and Atlantic puffin.
- Little auks. In previous atlases, little auk was treated as part of the Alcid group, however, since the Thule-area is home to approximately 80% of the world population of little auks, little auk is treated as a separate species in this context (Boertmann & Mosbech. 2011).
- Seaducks breeding, comprising breeding common eider.
- Seaducks spring, comprising spring concentrations of common eider, king eider and long-tailed duck.
- Seaducks moulting, comprising autumn (and late summer) concentrations of usually moulting common eider, king eider and long-tailed duck.
- Gulls, comprising Iceland gull, glaucous gull, Sabines gull, kittiwake and Arctic tern.
- The species group non-alcid pursuit divers include great cormorant, red-throated diver, and great northern diver. This group division is only used in the offshore analysis.

The species group surface feeders include northern fulmar, black-legged kittiwake, arctic tern, and the large gull species. This group division is only used in the offshore analysis.

Breeding seabirds at shorelines
The selection of seabird breeding colonies included in this atlas derives from the database of seabird breeding colonies covering entire Greenland (see Boertmann et al. 1996). The selection is based upon the geographical range

between 72° N and 75° N and on the best available surveys, as many colonies have been surveyed several times. However, the most recent surveys are not necessarily the best, as for example aircraft based surveys are inferior to boat based surveys.

All numbers of birds are expressed in individuals, as many species can only be monitored as such. Numbers expressed in pairs or nests are transformed to individuals (No. of pairs/nests x 2).

Species criteria for selection
The criteria for inclusion of colonies are listed in Table 12.7.

Table 12.7. Criteria for inclusion of seabird colonies.

Species	Criteria	No. of colonies meeting the criterion	No. of colonies because other species meet the criterion (Mixed colonies)
Common eider	colonies with ≥ 5 indvs.	29	-
Iceland gull	colonies with ≥ 500 indvs.	0	4
Glaucous gull	colonies with ≥ 500 indvs.	0	32
Sabine gulls	all colonies	1	-
Black-legged kittiwake	colonies with ≥ 50 indvs.	5	1
Arctic tern	colonies with ≥ 30 indvs.	6	5
Thick-billed murre	all colonies	4	-
Razorbill	colonies with ≥ 5 indvs.	0	3
Black guillemot	colonies with ≥ 250 indvs.	3	31
Little auk (dovekie)*	all colonies	35	-
Atlantic puffin	all colonies	7	-

*Since the little auk colonies are very large, the delineation of each colony can be difficult. This is an approximate number based on the DCE Seabird colony database.

Comments to the criteria
The criteria take into account the sensitivity of the bird species to oil spills, both on an individual level and on a population level. These sensitivities are dependent on the behaviour and ecology of the birds, but also on the distance to neighbouring colonies, which is a measure of the ability to re-colonise a colony. Moreover, they take into account the status of the breeding population within the region, whether they are decreasing, increasing or stable and, finally, their international conservation status.

The breeding population of common eider in West Greenland decreased throughout most of the 20th century, but a significant increase has been observed in the recent decade caused by a much stronger regulation of the hunting pressure (Merkel 2002). Due to the decrease, the West Greenland population was assessed as vulnerable (VU) on the national Greenland Redlist (Boertmann 2007).

Iceland gull, glaucous gull (incl. unsp. Iceland/glaucous gull) are widespread breeders in West Greenland. As gulls are only moderately sensitive to oil spills, only the largest colonies are included.

Black-legged kittiwakes breed exclusively in colonies usually on the lower part of steep cliff faces, and the species is widespread in entire West Greenland. Colony sizes range from very few to tens of thousands. Colonies less than 50 pairs are excluded, as they tend to be less stable over time. The population is gener-

ally decreasing in West Greenland (Labansen et al. 2010) and was assessed as vulnerable (VU) on the national Greenland Redlist (Boertmann 2007).

Arctic terns usually breed in dense colonies on low islands. The population in West Greenland has been decreasing, although it may have stabilised now. Due to the decrease, the Arctic terns were assessed as near threatened (NT) on the national Greenland Redlist (Boertmann 2007). A characteristic feature is that colonies in large areas are in certain years (with adverse weather in spring) abandoned. Small colonies consisting of less than 30 pairs are excluded. Terns are moderately sensitive to oil spills, but colonies situated on low islands are very sensitive to disturbance, e.g. from oil spill response activities.

All members of the family auks (alcids), that is thick-billed murre, razorbill, black guillemot, little auk and Atlantic puffin, are very sensitive to oil spills. This is caused by their behaviour and also by their very low population turnover. Protection of their breeding sites, therefore, has high priority. Moreover, the breeding population of thick-billed murres is seriously decreasing in West Greenland as a whole, probably due to disturbance and hunting. The species is assessed as vulnerable (VU) on the national Greenland Redlist (Boertmann 2007).

Razorbill breeds in small colonies (rarely more than a 100 pairs) are scattered throughout the region (and entire West Greenland). The colonies are difficult to monitor because the nests are concealed, and the presence of a few birds at a site may sometimes only be prospecting birds not breeding there. Sites with less than 5 birds are therefore excluded.

The little auk is the most widespread species in the region, and it is estimated that more than 80% of the world's population breeds in NW Greenland, and perhaps half of that in the area covered by the present atlas. The colonies are often very large and difficult to delimit. In the atlas the colonies are depicted as points, but in reality they extend over large areas.

The population of Atlantic puffin is small in West Greenland, the largest colonies holding a few hundred pairs. Moreover, the population was decreasing until hunting and egging was prohibited in 1960. It stabilised then and furthermore increased, but recently it has shown signs of a decrease again, which is why it is assessed as near threatened (NT) on the Greenland Redlist (Boertmann 2007). All colonies are included.

In each shoreline segment, the numbers of breeding seabirds for each of the species groups are added to calculate the input (relative abundance) to the sensitivity calculation:

Alcids

Black guillemot	1-100	1
	101-200	2
	201-500	3
	501-1,000	4
	> 1,001	5
Razorbill	1-20	1
	21-50	2
	51-100	3
	101-200	4
	> 201	5

Puffin	1-5	1
	6-10	2
	11-20	3
	21-50	4
	> 51	5
Thick-billed murre	1-10	1
	11-50	2
	51-100	3
	101-200	4
	> 201	5
Little auk	1-10	1
	11-50	2
	51-100	3
	101-200	4
	>201	5

A colony/shoreline area, which otherwise only will reach a relative abundance of 3 or less, is added one point if three or more alcid species are present.

Seaducks

Common eider	1-50	1
	51-100	2
	101-200	3
	201-500	4
	> 501	5

Gulls

Iceland Gull	1-200	1
Glaucous Gull	201-400	2
Great	401-1,000	3
black-backed	1,001-2,000	4
Sabine gull	> 2,001	5
Kittiwake	1-100	1
	101-1,000	2
	1,001-2,000	3
	2,001-10,000	4
	> 10,001	5
Arctic tern	1-50	1
	51-200	2
	201-1,000	3
	1,001-2,000	4
	> 2,001	5

Included are seaducks (separated in spring and autumn occurrence), and non-breeding alcids in winter and spring. The data originates from arial surveys conducted by DCE between 1995 and 1998 (Boertmann & Mosbech 2001a).

The index values for non-breeding shoreline seabirds are:

Seaducks			
	Common eider	1-200	1
		201-500	2
		501-2,000	3
		2,001-5,000	4
		> 5,000	5
	Long-tailed duck	300-500	3
		501-1,000	4
		> 1,000	5
Alcids			
	Thick-billed murre	1-500	1
		500-1,000	2
		1,001-5,000	3
		5,001-20,000	4
		> 20,001	5
	Black-legged kittiwake	1-100	1
		101-500	2
		501-1,000	3
		1,001-2,000	4
		> 2,001	5

Offshore seabirds
The information regarding offshore occurrence of seabirds has been retrieved from the many surveys carried out by DCE and GINR, both by ship and aircraft.

12.4.4 Fish and fisheries

Greenland halibut
Greenland halibut is the most important fish species in the region. It was until recently not commercially landed, but used as dog food in all settlements. But now they are landed on commercial basis. The information on Greenland halibut in the area is sparse. Greenland halibut is caught on longlines in waters more than 500 meters deep. The annual catch is mainly determined by the assigned quotas and the possibility to ship the catch out of the area. There is no survey data to assess the fish stocks in the area. During the interview survey in 2011, local fishermen and hunters were asked to delineate the areas where Greenland halibut are caught. Abundance values are based on the proportion of the shoreline segment neighbouring the fishing grounds.

- 0-20%, abundance value =1
- 20-40%, abundance value =2
- 40-60%, abundance value =3
- 60-80%, abundance value =4
- 80-100%, abundance value =5

In total, 12 shoreline segments have been assigned a Greenland Halibut abundance value and also registered as human resource exploited. See figure 12.2. The value is used both as the relative species abundance and as a factor in the human resource value.

12.4.5 Other fish species

Polar cod
Polar cod is present throughout the region and is typically caught at low depth. Polar cod is exclusively used as fishing bait for Greenland halibut and is as such very important. Both large and small polar cod are caught.

Arctic char
Rivers with Arctic char are found primarily in the central part of the region. It is not commercially landed and is primarily of recreational importance. All arctic char localities are given species abundances of 3 and above and are not mapped on the Shoreline Sensitivity Map.

12.4.6 Hunting and human use

Hunting is a very important activity in the region covered by this atlas, and it forms the basis for the income of many families. It is, however, difficult to map areas important for the hunting, as this takes place throughout the region and the hunting sites vary in location with season, weather and ice conditions.

In December, 2011, GINR conducted a telephone interview with local hunters in the region. The aim was to delineate the fishing and hunting grounds for Greenland halibut, Walrus, White whale and Narwhal in the atlas area. Together with reported catches of polar bears, this information is the basis for the human resource use included in the atlas.

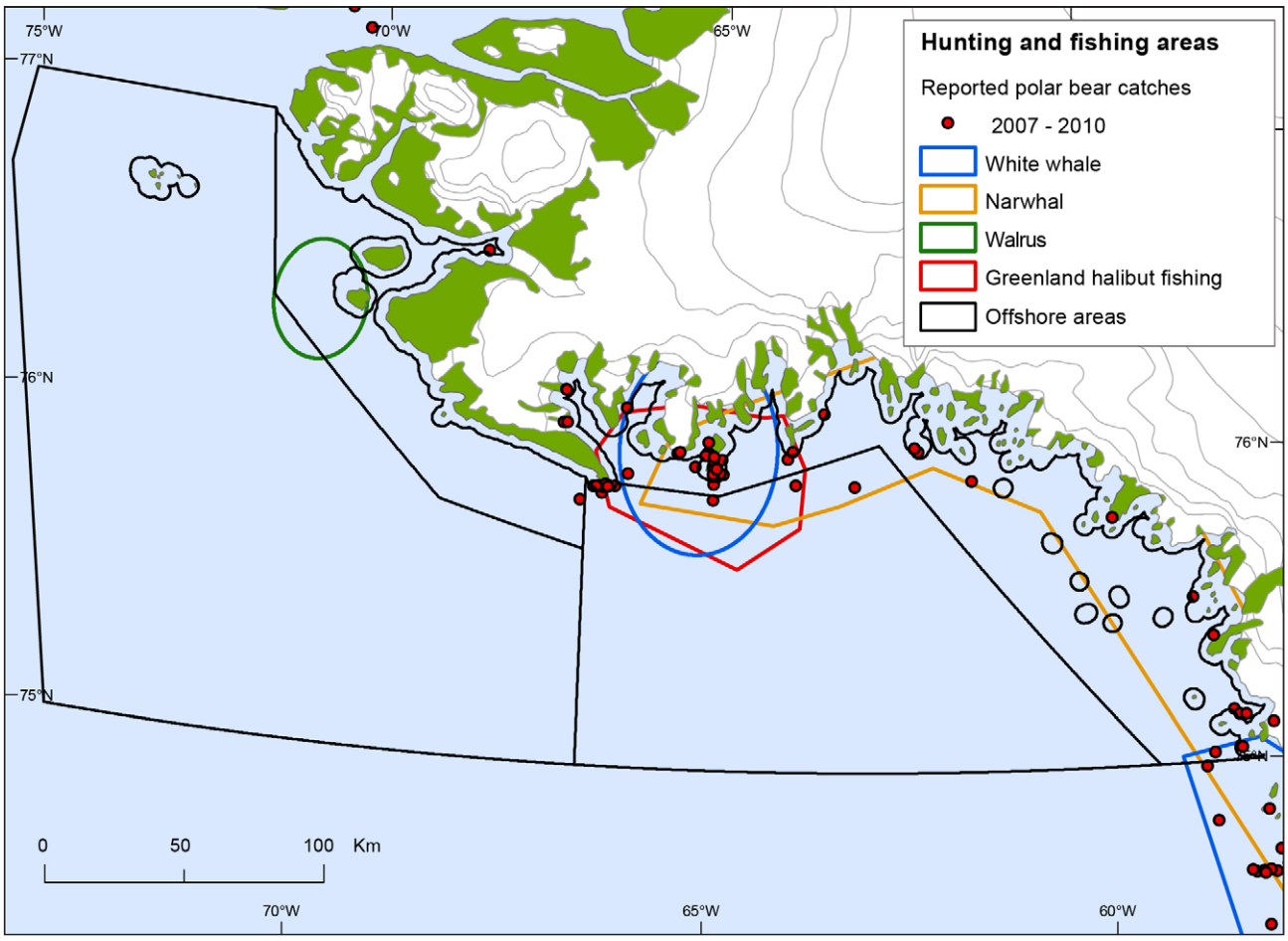

Figure 12.2. Hunting and fishing in the atlas area. Data provided by GINR.

White whales are taken in autumn, when they migrate southwards along the outer coast, and are often killed along the ice edge in spring. The main hunting grounds are the area near Savissivik.

Narwhals are hunted between July and September. The hunting area for narwhals is the inner part of Melville Bay from Cape York to the southern border of the Atlas.

Polar bears are hunted throughout the area covered by the Atlas. The hunt usually takes place during winter time. A large amount of the bears are caught near Savissivik and Cape York. Between 2007 and 2010, a total of 74 bears were caught.

Walrus is mainly hunted in the area around Saunders Island and Wolstenholme Island. This takes place during spring and late summer/autumn time.

Tourism
Resource use also includes the use of the coast as tourist attraction and activity areas. In the area, there is no organised tourism, but an increasing amount of cruise ships travel through the area. However, the personnel at Thule Air Base regularly take smaller trips to various locations near the base during the summer.

Resource use
The relative human use figures for each segment are based on the number of exploited resources, including Greenland halibut fishery and sites used as recreational excursion sites by Thule Air Base personnel. The maximum number of exploited resources on a shoreline segment is 4. See table 12.8.

Table 12.8. Human resource use.

No. of resources exploited	No. of segments	Human use figure
4	2	4
3	10	3
2	10	2
1	25	1

12.5 Sensitivity ranking procedures

The shoreline and the offshore sensitivity calculations result in a numeric sensitivity value (S) for each shore line segment and offshore area, respectively. To ease the interpretation of the maps in chapter 9 and 10, the sensitivity of the shore line segments and offshore areas are ranked into the classes extreme, high, moderate and low, based on these calculated values. In this section, the applied ranking procedures are described.

In the previous atlases, the shoreline segments are divided into four classes (extreme, high, moderate and low), with approximately equal number of segments in each group. Class division is based on the final sensitivity score (see chapter 4.3). This is, however, not compatible with a universal ranking across multiple atlas areas, since the ranking is only based on the sensitivity score of shoreline segments within each region. This means that spatially close shoreline segments in different bordering atlas areas are not ranked with the same class division (sensitivity score) and they are, therefore, not directly comparable, based only on the ranking. To overcome this border issue, the sensitivity

ranking procedure has been adjusted in this atlas and has adopted a rolling window ranking system.

Each shoreline segment is ranked, based on the sensitivity score of all the shoreline segments in a variable 200 km radius, which effectively is approximately 400 km of coastline. The rank is determined according to the specific distribution of sensitivity scores of the selected segments, so that each class (extreme, high, moderate and low) approximately equals the number of segments in each group. The shoreline segment is then ranked accordingly, and the procedure is repeated with the next segment, and so forth. In this way, an analysis window traverses the study area and ranks the entire atlas area by also taking into account the sensitivity score of shoreline segments south of 75°, located in the Upernavik atlas area (72° - 75° N) (Stjernholm et al. 2011).

The 200km radius has been chosen because 400 km corresponds approximately with the extent of one atlas area. But since the most northern segments in the study area will be ranked based on the sensitivity score of effectively a 200 km window and, thus, fewer shoreline segments, the window varies in size. In order to ensure that the ranking is based on a comparable amount of shoreline segments, the radius of the analysis window is:

- 200 km, if the distance to the nearest end segment is greater than 200 km
- 400 km minus the distance to the nearest end segment, if the distance to the nearest end segment is less than 200 km.

12.5.1 Offshore sensitivity ranking

The ranking of each offshore area into the sensitivity categories extreme, high, moderate and low is based on a neighbourhood analysis of offshore areas around the given area within the season in question. Thus, the ranking always highlights the most sensitive areas locally at a particular time of the year (space-time relative ranking).

The fact that the ranking of an offshore area is based on neighbourhood analysis of offshore areas around it means that offshore areas, which are actually not covered by the current atlas, are included in the ranking calculations. This is particularly the case for the offshore areas close to the border of the atlas area. The ranking procedure could only be applied because the update of the offshore part of the current atlas was done in conjunction with a general update of all offshore areas from all sensitivity atlases, between 56° N and 77° N in West Greenland.

In the ranking procedure, *the neighbourhood of an offshore area was defined as all offshore areas that intersect a buffer of 250 km around the offshore area in question*. In the following table 12.9, the neighbourhood of each offshore area covered by the atlas is listed (see Fig. 12.3 for the location of the offshore areas listed in the table):

Table 12.9. Offshore analysis area.

Offshore area	Offshore areas included in ranking neighbourhood	No of areas
OS_33	27, 28, 30, 31, 32, 33, 34, 35, 36	9
OS_34	30, 31, 32, 33, 34, 35, 36	7
OS_35	27, 28, 29, 30, 31, 32, 33, 34, 35, 36	10
OS_36	27, 28, 29, 30, 31, 32, 33, 34, 35, 36	10

Once the neighbourhood of each offshore area was established, the 15th, 45th and 75th percentiles of the sensitivity values of the neighbourhood in the given season were calculated. Finally, the sensitivity value (S) for each offshore area and season was ranked according to the following scheme.

Table 12.10. Offshore ranking.

S of area > neighbourhood percentile	S of area ≤ neighbourhood percentile	Rank	Percentile range of rank
0	15	Low	15
15	45	Moderate	30
45	75	High	30
75	100	Extreme	25

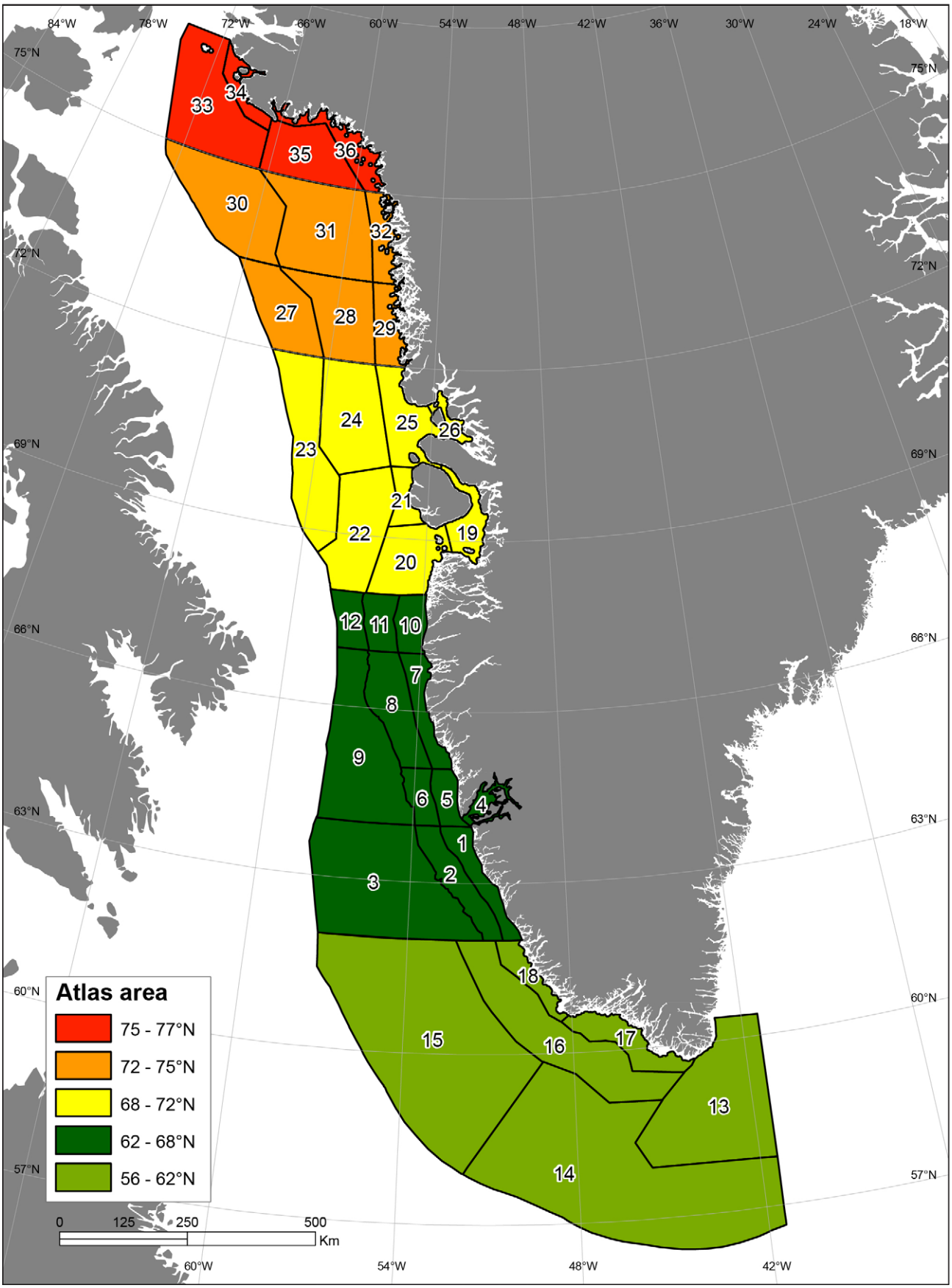

Figure 12.3. Offshore areas in West Greenland. Only offshore areas in 72º - 77º N are included in this analysis.

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12.6 Considerations on Cultural History and Archaeology

12.6.1 Settlement in Greenland

Greenland has been populated for two long periods, which together span *c.* 4,400 years. The oldest period is *c.* 2400 BC - 200 AD; the later period is *c.* 1000 AD until the present day.

The settlement strategy of the various cultures, the visibility of the features, and the utilisation of the resources of the country have left their mark on the landscape. The area in question covers the west coast from 75° N to 77° N.

As the crow flies, this is *c.* 425 km, but in reality the distance is much greater because of fjords, islands and sounds. In this area, there are e.g. some 87 archaeological sites, i.e. localities containing man-made structures, which are registered in the central database of the Greenland National Museum & Archives (NKA) and which are, therefore, subject to the terms of the Conservation Act (see below). Of the 87 known sites, the vast majority are positioned immediately by the coast.

The natural conditions within the mapped coastal stretch vary greatly from north to south and from the outer coast to the inner fjords. Islands, peninsulas and narrow strips of land between the inland ice sheet and the sea consist of alpine, sterile rock with good vegetation areas in the more low-lying parts. Such areas, with subsistence potential for caribou, have also attracted Inuit through the ages.

In the summer, the open water is typified by drifting ice floes and icebergs. In the winter, the sea is frozen over. These conditions provide very different possibilities for settlement, for transport and for access to resources, depending on the traditions and cultural preconditions that form the starting-point.

All Inuit immigrations to northern west Greenland came through the Avanersuaq (Thule) region.

Around the year 1000 AD, Icelandic farmers ("the Norse Greenlanders") settled in south Greenland, and with Hans Egede's establishment of the mission station "Håbets Koloni" ("Hope Colony") in 1721, the foundation was laid for the Colonial Period and the later development of modern Greenland.

In north-west Greenland, the oldest part of the Palaeoinuit period in Greenland comprised the cultural periods *Saqqaq* and *Early Dorset*, i.e. *c.* 2400 BC - 200 AD. Settlements and finds from these periods are known in large numbers from islands and the mainland coast in the Disko Bay area. At some of these settlement sites, the finds also include implements of organic material, something otherwise extremely rare in the Palaeoinuit context.

In the northern Upernavik and the southern Avanersuaq region, there are very few reports of Palaeoinuit settlement sites. This must be due to among other things:

- lack of awareness in former times of the Palaeoinuit period
- inadequate reconnaissance in more recent times
- land subsidence/the rising of the sea level, which have left older low-lying sites under water or eroded them down to the beach level.

At the Norse farms in South West Greenland, the presence of a few Late Dorset implements suggests that the Norsemen met these people and exchanged tools and/or raw materials with them. This presumably happened during the Norsemen's journeys north to the Avanersuaq area. Although the Norsemen travelled the Disko Bay, which they called "Nordsæteren", there are no safely identified Norse ruins. There are many Norse objects in the ruins of the Thule culture, but often these are from the period after the disappearance of the Norse Greenlanders. From the Norse period (985 - 1450 AD) comes a small stone with an unusually long narrative runic inscription from the island of Kingittorsuaq just north of Upernavik.

In the course of the thirteenth century, the last great Inuit wave came from Alaska. Via Canada, the people of the Thule culture came over Smith Sound to the Avanersuaq area. From there, they quickly spread all over the country. The Thule people were whalers and sealers. The *umiaq* ('women's boat'), kayak and dog-sledges gave them great mobility and the potential for incorporating whaling.

Around 1500 AD, the Norse Greenlanders had gone and the Thule people had settled along the entirety of the Greenland coasts. In the following centuries, there were great migrations of people along the coasts and an incipient concentration of the population in particular regions and large settlements. Sermermiut near Ilulissat was e.g. in the view of the population one of the largest settlements at the beginning of the eighteenth century.

The Palaeoinuit period is richly represented with many settlement sites and important finds in Disko Bay, but it is very poorly represented further north - despite the fact that this was the immigration route. The very scant evidence of Palaeoinuit presence in the area in question, therefore, in a risk assessment context will induce an elevated value designation.

12.6.2 Which items of archaeological and historical interest are included?

All known coastal archaeological and historical find-spots (minus colonial trading posts, villages and the like) are included in this atlas, but with view to the protection of the antiquities, only the basic site information is included.

If, in connection with an acute situation or for other reasons, it emerges that there is a need to establish a higher state of preparedness, detailed information about the individual sites can be obtained from the Greenland National

Museum & Archives, Box 145, DK-3900 Nuuk, which can be contacted by telephone at (+299) 32 26 11 or e-mail: nka@natmus.gl

12.6.3 The Conservation Act

If a man-made feature predates the year 1900, it is protected by the terms of *"Inatsisartutlov nr. 11 af 19. maj 2010 om fredning og anden kulturarvsbeskyttelse af kulturminder"* ("The Conservation Act"). The Greenland National Museum & Archives administers this act and is responsible for the registration of antiquities.

12.6.4 Description of the data

History
For more than 200 years, information has been gathered about archaeological sites in Greenland. The oldest reports are from the beginning of the eighteenth century, when Denmark initiated the colonisation of Greenland and the Christian mission was established. The first missionaries were preoccupied with the fate of the Norse Greenlanders and visited the ruins of their settlements. Thus, throughout the 1800s a large body of material was gathered to shed light on the history of Norse settlement; but it was only after 1900 that serious interest in the indigenous population of the country arose. It was not before the beginning of the 1930s that an actual archaeological investigation of the prehistory of the Inuit began.

In the 1950s, the first systematic archaeological investigations were conducted at Sermermiut near Ilulissat. There, for the first time, stratigraphic deposits were found from the three great Inuit periods: the *Saqqaq* culture, the *Dorset* culture and the *Thule* culture. Today, Sermermiut is part of an area designated as a World Heritage area under the auspices of UNESCO.

With the transfer of the conservation and museum acts to the Greenland Home Rule Government in 1981, the collected knowledge of antiquities in Greenland was systematised in the form of card indices, overview maps, conservation numbers etc. This knowledge has been regularly developed and updated by surveys and other ways of gathering information about the antiquities. This material has since been entered into a database, which is subject to on-going expansion and quality assurance.

The data
Information concerning the individual sites is a mixture of experts' inspections in older and more recent times and various pieces of information from past and present. It is a mixture of good site information and less good and poor information. The latter categories may also include information that has not yet been verified by specialists. Information that sounds credible and which can be localised has been used in this atlas. The settlement type has typically been inferred from the feature types. Place-names have been used to shed light on the activities in the area in question.

Data quality
Much of the information comes from secondary sources, and in the present context the information is usually inadequate. We may lack information on which and how many features are covered by the registration; on how old they are believed to be; how close to the present sea level they are; their state of preservation etc. This information is important today for the assessment of their sensitivity in the event of an oil spill.

For most of the coastal sites, we have no information on their position in terms of elevation above sea level. In some cases, this has been estimated on the basis of other available information and/or personal experience. All coastal sites with no information on elevation above sea level are treated in this atlas as being in the risk zone for oil spills, i.e. Group 2, until proven otherwise.

The more recent surveys in the area have given rise to two typical comments in the database:

1) the site could no longer be found
2) the site no longer exists.

The first of these indicates that the site is not at the position indicated, but that it may exist somewhere else nearby, or that it may have eroded away. Sites with such information have been retained as fully valid items in this atlas, since the littoral zone may have unverified remains, or there may be features/ remains close by that have not yet been registered.

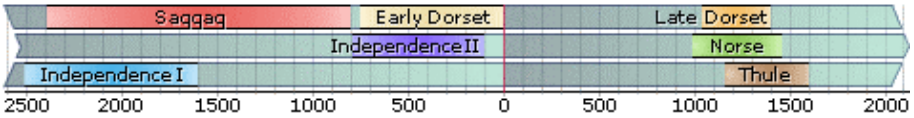
The second comment means that we have positive knowledge that there was once a feature or features at the site, but that they have now disappeared. This may have happened e.g. as a result of coastal erosion or construction activities. Sites listed with such information have been retained as fully valid items in this atlas, since the beach zone may still have remains or traces of the features originally observed.

In a number of cases, there is uncertainty about the precise geographical position of the site. On the original physical maps of the antiquities, each 'antiquity circle' covers an area with a diameter of 500 metres. The transfer of 'points' from physical maps to a digital map has only increased the precision if more recent GPS coordinates have been obtained.

In the section "Sensitivity assessment", there is an account of the principles underlying the assessment of the individual sites.

Table 12.11. Explanations of the classification and terms.

Identification	
Fmnr.	Each archaeological site entered in the Greenland Archive of Antiquities (GFA) has a *frednings-nummer* ('conservation number'). All man-made remains predating the year 1900 are subject to the Conservation Act. When a report on a new find is received, the site is assigned a conservation number and entered in the GFA.
Datings	
Periods of cultural history	For each site in GFA, there is an account of when or in what periods the individual features were used – that is, which periods of cultural history are represented. Distinctions are made between Inuit, Norse and European origin. If we only know that there are ruins on the location with no dating, we use the overall category "Unknown".
Inuit	The table shows the Inuit cultural periods that are known in Greenland and their chronological placing. If no accurate dating has been possible, one must refer to the next level above. The Independence cultures are found in North East Greenland.



The Palaeoinuit period is considered as lasting until the end of "Late Dorset". With "Thule" begins the Neoinuit period, which lasts until 1800 AD.

Norse	The period from the *landnam* (pioneering settlement) of Eric the Red until the collapse of the Norse society, i.e. *c.* 985 - 1450 AD.
Whaling	European cultural traces dated within the period *c.* 1450 - 1721 AD, the latter being the year when the Danish colonisation of Greenland began.
Colonial	The period from 1721 until 1900 AD.
Recent	All cultural remains more recent than 1900 AD. If there are recent features at an archaeological site, this is noted in GFA, even if they are not subject to the protection of the Conservation Act. No distinction is made here between Inuit and European features.
Site type	The general terms for site types given below are used in GFA. More detailed information on the feature types and other signs of activity at the individual sites have been entered in the database if they are available. Settlement Summer Winter Other season Assembling camp Camp for capelin-fishery Sea-hunting camp Musk ox hunting camp Base camp Overnight camp Caribou hunting camp Camp for catching arctic char Gravesite or graveyard Hunting system Cache Mineral utilization – pit or exposed mineral – mine Cairn Town Village Expedition base camp Hunting station Fishery station Sheep farm Trading post Churchyard Missionary station Wintering camp Fox farm Recent camp site Train-oil production Norse farm Isolated norse building Isolated norse structure Other Indeterminable structure

12.6.5 Sensitivity assessment

General assessment
Most of the coastal Inuit settlements were established close to the sea and just above the present-day high water line. Most of the Norse structures lie inland, but there are also many along the coast, where they have been subject to the same erosive forces as many of the Inuit remains.

Because of the sinking of the land and/or the rising of the sea, many sites today may lie very close to – or even below - the current high water line. These will, therefore, be particularly sensitive in the event of an oil spill:

- directly, because contamination in several ways will mean a deterioration of the scientific documentation value of the cultural deposits:
    - the preservation conditions for organic material will become considerably poorer
    - the possibility of conducting analyses and scientific dating will be rendered impossible.
- indirectly, because emergency measures or land based actions would be difficult to implement without causing substantial physical damage to the coastal ruins and culture layers.

Many of the registered cultural remains are very difficult to recognize in the terrain, even for the trained eye. The sensitivity assessment of the archaeological sites must therefore only be regarded as providing guidelines. It is assumed that in the event of a spill, archaeological expertise will be involved in the planning of the emergency measures and in the practical implementation of the plan.

The assessment of sensitivity is based both on factual knowledge of the relevant local cultural history of the region and on qualified opinion.

Since the atlas covers all the known coastal sites, in principle they are all, without exception, at risk in the event of coastal land based activities in connection with an oil spill.

Criteria for the assessment
The criteria applied are in principle the same as were used for the sensitivity assessment of the antiquities between 62° N and 68° N in the *Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone* (2000). The differences lie on the one hand in a more rigorous linguistic approach to the criteria and on the other in the transfer of all "coastal sites on which there is at present no more detailed information" from Group 1 to Group 2, until we have evidence that suggest a site should be in one of the other groups. The sensitivity of the items of archaeological interest is expressed on an ascending scale from 1 to 3:

1) Sites considered not likely to be affected by pollution.
2) Sites considered likely to be directly affected by pollution.
3) Sites of special importance ,which require special status in the event of an oil spill or other activities in connection with raw material exploration and extraction.

Group 1 comprises sites situated more than 20 metres above sea level, or remains of features considered to be of very little importance as historical documentation because they are very poorly preserved.

In principle, the features in this group could be threatened by land based activities, for example in connection with oil spills.

Group 2 comprises a) all coastal archaeological sites deemed to represent historical source value, b) sites considered to have recreational value or sightseeing value, and c) sites which can be localised, but about which there is at present no further information.

In principle, the features in this group could be threatened by land based activities, for example in connection with oil spills.

Group 3 meets the criteria for Group 2, items a) and b), but these sites also contain additional information, especially in scientific respects. The basis of this evaluation may be the result of archaeological investigations, historical source material or the like.

The sightseeing value or the local population's use of the locality in question may also be included as criteria.

In principle, the features in this group could be threatened by land based activities, for example in connection with oil spills.

13 Appendix D. Place names

This is an index of all the place names used on the maps in Chapter 8 and 10. Some place names also have a name in Danish, which is listed too. Some place names only have a name in Danish and are listed at the end of the index. The positions listed are the positions of the names on the maps.

Table 13.1. Place names.

Greenlandic	Danish	Map sheet	Latitiude	Longitude
Ajukus Skær		7551	75°36’	60°16’
Akia		7604	76°06’	65°18’
Akuliaruseq		7604	76°02’	65°25’
Akuliarusersuup Nuua		7603	76°05’	66°26’
Alannguarsuk		7601	76°26’	69°31’
Ammaarsiorfik	Hoppner Næs	7652	76°56’	71°05’
Appaliarsuit		7605	76°10’	63°40’
Appaliarsulipaluk		7605	76°11’	63°43’
Appaliarsulipaluup Sermia	Mohn Gletscher	7605	76°16’	63°48’
Appat	Saunders Ø	7653	76°34’	69°45’
Appat Appai		7602	76°05’	68°24’
Appat Kangilliit		7602	76°05’	68°22’
Appussaavik		7607	75°55’	61°14’
Eqalullip Qeqertaa		7604	76°12’	64°25’
Eqalussuaasaq		7603	76°12’	66°11’
Equutissaatsut		7654	76°42’	68°09’
Equutissaatsut Sermiat	Knud Rasmussen Gletscher	7654	76°45’	67°50’
Igannaq	Conical Rock	7601	76°05’	68°43’
Igannaq	Dalrymple Rock	7601	76°28’	70°14’
Illernap Nuua		7603	75°56’	66°37’
Illernaarsussuaq		7604	76°16’	64°22’
Illut		7654	76°34’	68°52’
Illut		7604	76°14’	64°33’
Illaarsussuaq	Sidebriksfjord	7603	76°10’	66°05’
Innaq Ungalleq		7601	76°28’	69°08’
Innerit		7653	76°50’	70°47’
Innaanganeq	Kap York	7603	75°55’	66°28’
Innaaqqissorsuaq		7606	76°14’	62°49’
Innaaqqissorsuq		7552	75°49’	59°15’
Iperaataq		7654	76°36’	68°36’
Issuusarsuit	Kløftø	7607	76°00’	60°58’
Issuusarsuit Sermiat		7607	76°04’	60°38’
Issuusarsuit Saamiutaat		7607	75°59’	61°08’
Issuvissuup Paava	Parker Snow Bugt	7602	76°09’	68°35’
Iterlak		7653	76°42’	69°25’
Iterlassuaq		7653	76°52’	70°10’
Iterlassuup Qeqertaarsui	Three Sister Bees	7653	76°46’	70°16’
Kangerluarsuk		7502	75°22’	58°24’
Kangaarsuk	Kap Atholl	7601	76°23’	69°38’
Kangaarsussuaq	Kap Parry	7652	77°01’	71°23’

Greenlandic	Danish	Map sheet	Latitiude	Longitude
Kivioq Havn		7551	75°52’	59°52’
Kukik		7603	75°55’	66°33’
Kumaat		7604	76°04’	65°40’
Kuupeeqarfik		7501	75°28’	59°14’
Moriusaq	Kraulshavn	7653	76°45’	69°52’
Nallortup Nuua	Kap Melville	7605	76°03’	64°01’
Nanortuupaluk		7607	76°03’	60°28’
Narsarsuaq		7653	76°56’	69°58’
Niaqornaarsuk		7603	75°57’	66°48’
Niaqorsuaq	Red Head	7502	75°04’	58°05’
Niaqorsuup Saarlia		7502	75°05’	58°18’
Nigaarfivik		7601	76°15’	68°59’
Nipitartooq		7601	76°24’	69°36’
Noorujupaluk		7605	76°19’	63°10’
Nunapalussuaq		7502	75°22’	58°16’
Nunataq		7603	75°58’	66°33’
Nunatarsuup Nuua		7654	76°39’	68°3’
Nunaata Isua		7604	76°05’	65°02’
Nuulliit	Blackwood Næs	7653	76°48’	70°36’
Nuussuup Sermia	Kong Oscar Gletscher	7551	75°58’	59°49’
Naajarjuit		7604	76°01’	65°44’
Naajat		7654	76°41’	68°36’
Naajat Sermiat	Chamberlin Gletscher	7654	76°44’	68°31’
Naalungialissuaq	Astrup Kystland	7552	75°41’	58°29’
Naalungiarsuaq		7552	75°37’	58°33’
Oorlii		7602	76°05’	68°28’
Papitsaanaat		7603	76°08’	66°23’
Pinguarsuit		7654	76°40’	68°49’
Pinguarsuit Sermiat	Salisbury Gletscher	7654	76°44’	68°45’
Pituffik		7601	76°32’	68°52’
Puersut		7603	75°59’	66°58’
Puisiluusarsuaq		7603	76°13’	67°10’
Pullassuit		7653	76°33’	69°56’
Pulsilik	De Dødes Fjord	7603	76°09’	66°55’
Paakitsoq		7601	76°16’	68°59’
Paakitsup Sermersua	Pituffik Gletscher	7602	76°16’	68°35’
Paarnartoorsuaq		7604	76°09’	65°19’
Paarnartuupaluk		7604	76°13’	65°43’
Qangattarsuaq		7653	76°34’	70°04’
Qangattaa		7601	76°22’	69°37’
Qapiarfissalik	Thom Ø	7551	75°44’	60°38’
Qaqqarsuaq		7602	76°02’	67°40’
Qeqertapaluk		7606	76°03’	62°23’
Qeqertaq	Salve Ø	7603	76°03’	66°00’
Qeqertarsuaq	Wolstenholme Ø	7601	76°26’	70°03’
Qeqertaaraq		7652	76°59’	71°18’
Qeqertaarsuit		7603	76°04’	65°53’
Qeqertaarsuit	Edderfugleøer	7601	76°30’	70°05’
Qeqertaarsuk		7603	76°09’	65°50’
Qeqertaarsussuaq		7606	76°10’	62°41’

Greenlandic	Danish	Map sheet	Latitiude	Longitude
Qeqertaarsussuaq	Stenersen Ø	7552	75°44’	59°14’
Qeqertaarsuttalik		7604	76°02’	65°20’
Qeqertaarsuusaq		7604	76°10’	64°35’
Qerrorsuit		7602	76°03’	67°59’
Qilalugaqarfik		7604	76°01’	65°25’
Qimagaqarfissuaq	Marie Ø	7551	75°46’	59°49’
Qimmiliviup Nuua		7601	76°27’	70°14’
Quaraatit Nuua		7601	76°19’	69°23’
Quassussuaq		7603	75°58’	66°51’
Qaammat		7604	76°03’	64°55’
Qaarsoq		7601	76°10’	68°48’
Qaarsorsuaq		7601	76°18’	69°19’
Qaarsuarsuk		7601	76°11’	68°46’
Salleq	Bushnan Ø	7604	75°58’	65°05’
Saneraq		7603	75°59’	67°02’
Saveqarfik		7604	76°08’	64°40’
Saveruluk		7604	76°07’	64°57’
Savissivik	Meteoritø	7604	76°02’	65°02’
Savissuaq		7601	76°17’	69°05’
Savissuaq Gletscher		7604	76°15’	65°12’
Sermersuaq	Steenstrup Gletscher	7502	75°17’	57°53’
Sermip Nuussua		7502	75°11’	58°10’
Sermipaluk		7604	76°03’	65°35’
Sineriarsua		7602	76°00’	67°30’
Sisussat		7603	76°00’	67°13’
Sukkat		7602	76°03’	67°59’
Sukaasat		7602	76°03’	67°49’
Saattut	Sabine Øer	7551	75°30’	60°14’
Tartunaq	Pattefjeldene	7603	76°7’	65°51’
Tasiusap Nuua		7652	76°52’	70°51’
Tuttulipaluk		7552	75°37’	58°18’
Tuttulissuaq		7502	75°23’	58°33’
Tuttulissuaq	Kap Seddon	7502	75°21’	58°40’
Tuttulissuup Qeqertai		7552	75°31’	58°43’
Tuttulissuup Qeqertarsua	N.E. Balle Ø	7501	75°12’	58°53’
Tuttulissuup Saqqarlersua		7502	75°18’	58°23’
Ujarasussuit		7602	76°04’	68°05’
Ullip Kangia		7654	76°35’	68°10’
Umiivik		7653	76°37’	69°32’
Usuusarsuaq	Melville Monument	7551	75°46’	59°25’
Uummannap Kangerlua	Wolstenholme Fjord	7654	76°38’	68°50’
Uummannaq	Dundas Fjeld	7654	76°33’	68°54’
	Awash	7651	76°43’	73°16’
	Björling Ø	7651	76°43’	72°33’
	Blackwood Næs	7652	76°54’	70°58’
	Booth Sund	7652	76°56’	70°56’
	Bordø	7651	76°44’	72°48’
	Breaks	7651	76°41’	73°10’
	Bylot Sund	7601	76°30’	69°30’
	Crimson Cliffs	7602	76°05’	67°45’

Greenlandic	Danish	Map sheet	Latitiude	Longitude
	Dietrichson Gletscher	7502	75°27’	58°00’
	Duneira Bugt	7502	75°27’	58°32’
	Döcker Smith Gletscher	7606	76°18’	61°46’
	Fireø	7651	76°42’	73°05’
	Fisher Øer	7606	76°08’	61°30’
	Helland Gletscher	7604	76°16’	64°54’
	Hollænderhatten	7651	76°41’	72°54’
	Ironstone Fjeld	7604	76°10’	65°04’
	Kap Abernathy	7653	76°41’	69°16’
	Kap Murdoch	7606	76°08’	61°54’
	Kjer Gletscher	7502	75°06’	57°34’
	Leven Ø	7606	76°02’	61°44’
	Meteorbugt	7604	76°06’	64°30’
	Morell Gletcher	7606	76°19’	62°30’
	Nansen Gletscher	7552	75°45’	58°51’
	Nordenskiöld Gletscher	7552	75°50’	58°54’
	Nordvestø	7651	76°44’	73°11’
	North Star Bugt	7654	76°33’	68°54’
	Peary Gletscher	7607	76°07’	60°24’
	Rink Gletscher	7607	76°13’	61°00’
	Sverdrup Gletscher	7552	75°36’	58°03’
	Tange Skær	7601	76°21’	69°34’
	Thalbitzer Næs	7607	76°02’	61°00’
	Yngvar Nielsen Gletscher	7605	76°20’	64°05’

14 Appendix E. Animal names

Scientific name **Videnskabeligt navn** ***Ilisimatuussutsikkut taaguutaat***	**English name** **Engelsk navn** **Tuluttut taaguutaat**	**Danish name** **Dansk navn** **Qallunaatut taaguutaat**	**Greenlandic name** **Grønlandsk navn** **Kalaallisut taaguutaat**
Pisces, Mollusca, Crustacea	***Fish and shellfish***	***Fisk m.m.***	***Aalisakkat il. il.***
Hippoglossoides platessoides	American plaice	Håising	Oquutaq
Salvelinus alpinus	Arctic char	Fjeldørred	Eqaluk
Arctogadus glacialis	Arctic cod	Istorsk	
Gadus morhua	Atlantic cod	Torsk	Saarullik
Hippoglossus hippoglossus	Atlantic halibut	Helleflynder	Nataarnaq
Salmo salar	Atlantic salmon	Laks	Kapisilik
Anarichas lupus	Atlantic wolffish	Havkat	Qeeraaraq
Sebastes mentella	Beaked redfish	Dybhavrødfisk	Suluppaagaq itisoormiu
Mytilus edulis	Blue mussel	Blåmusling	Uiloq
Pholis gunnellus	Butterfish	Tangspræl	Pilaatalik
Mallotus villosus	Capelin	Lodde	Ammassak
Salmo clarki	Cutthroat trout	Cutthroat ørred	-
Pandalus borealis	Deep sea shrimp	Dybvandsreje	Kinguppak
Sebastes marinus	Golden redfish	Stor rødfisk	Suluppaagaq
Gadus ogac	Greenland cod	Uvak	Uugaq
Reinhardtius hippoglossoides	Greenland halibut	Hellefisk	Qaleralik
Hippoglossoides platessiodes	Long rough dab	Håsing	Oquutaq
Cyclopterus lumpus	Lumpsucker	Stenbider	Nipisa
Boreogadus saida	Polar cod	Polartorsk	Eqalugaq
Sebastes spp.	Redfish	Rødfisk	Suluppaagaq
Ammodytes sp.	Sand eel	Tobis	-
Chlamys islandica	Scallop	Kammusling	Uiluiq
Myoxocephalus scorpius.	Shorthorn sculpin	Almindelig ulk	Kanajoq
Anarhicas minor	Spottet wolffish	Plettet havkat	Qeeraq milattooq
Chionoecetes opilio	Snow crab	Krabbe	Saattuaq
Raja radiata	Starry skate	Tærbe	Allernaq
Gasterosteus aculeatus	Three-spined stickleback	Trepigget hundestejle	Kakilisak pingasunik kapinartulik
Anarhicas sp.	Wolffish	Havkat	
Aves	**Birds**	**Fugle**	**Timmisat**
Stercorarius parasiticus	Arctic skua	Almindelig kjove	Isunngaq
Sterna paradisaea	Arctic tern	Havterne	Imeqqutaalaq
Fratercula arctica	Atlantic puffin	Lunde	Qilanngaq
Cepphus grylle	Black guillemot	Tejst	Serfaq
Rissa tridactyla	Black-legged kittiwake	Ride	Taateraaq
Somateria mollissima	Common eider	Ederfugl	Miteq siorartooq
Uria aalge	Common murre (common guillemot)	Almindelig lomvie	Appa sigguttooq
Phalacrocorax sp.	Cormorant	Skarv	Oqaatsoq
Larus hyperboreus	Glaucous gull	Gråmåge	Naajarujussuaq
Larus marinus	Great black-backed gull	Svartbag	Naajarluk
Phalacrocorax carbo	Great cormorant	Storskarv	Oqaatsoq

Scientific name **Videnskabeligt navn** ***Ilisimatuussutsikkut taaguutaat***	**English name** **Engelsk navn** **Tuluttut taaguutaat**	**Danish name** **Dansk navn** **Qallunaatut taaguutaat**	**Greenlandic name** **Grønlandsk navn** **Kalaallisut taaguutaat**
Gavia immer	Great northern diver	Islom	Tuullik
Puffinus gravis	Great shearwater	Storskråpe	Qaqullunnaq
Stercorarius skua	Great skua	Storkjove	-
Phalaropus fulicarius	Grey phalarope	Thorshane	Kajuaraq
Histrionicus histrionicus	Harlequin duck	Strømand	Toornarviarsuk
Larus glaucoides	Iceland gull	Hvidvinget måge	Naajarnaq
Pagophila eburnea	Ivory gull	Ismåge	Naajavaarsuk
Somateria spectabilis	King eider	Kongeederfugl	Miteq siorakitsoq
Alle alle	Little auk (dovekie)	Søkonge	Appaliarsuk
Clangula hyemalis	Long-tailed duck	Havlit	Alleq
Stercorarius longicaudus	Longtailed skua	Lille kjove	Papikkaaq
Anas platyrhynchos	Mallard	Gråand	Qeerlutooq
Fulmarus glacialis	Northern fulmar	Mallemuk	Qaqulluk
Stercocarius pomarinus	Pomarine skua	Mellemkjove	Isunngarsuaq
Calidris maritima	Purple sandpiper	Sortgrå ryle	Saarfaarsuk
Corvus corax	Raven	Ravn	Tulugaq
Alca torda	Razorbill	Alk	Apparluk
Mergus serrator	Red-breasted merganser	Toppet skallesluger	Paaq
Phalaropus lobatus	Red-necked phalarope	Odinshane	Naluumasortoq
Gavia stellata	Red-throated diver	Rødstrubet lom	Qarsaaq
Larus sabini	Sabine's gull	Sabinemåge	Taateraarnaq
Uria lomvia	Thick-billed murre (Brünnich's guillemot)	Polarlomvie	Appa
Haliaeetus albicilla	White-tailed eagle	Havørn	Nattoralik
Mammalia	**Mammals**	**Pattedyr**	**Uumasut miluumasut**
Erignathus barbatus	Bearded seal	Remmesæl	Ussuk
Phoca groenlandica	Bedlamer	Grønlandssæl (blåside)	Allattooq
Balaenoptera musculus	Blue whale	Blåhval	Tunnulik
Hyperoodon ampullatus	Bottlenose whale	Døgling	Anarnak
Balaena mysticetus	Bowhead whale	Grønlandshval	Arfivik
Balaenoptera physalis	Fin whale	Finhval	Tikaagulliusaaq
Phocoena phocoena	Harbour porpoise	Marsvin	Niisa
Phoca vitulina	Harbour seal	Spættet (spraglet) sæl	Qasigiaq
Phoca groenlandica	Harp seal	Grønlandssæl (sortside)	Aataaq
Cystophora cristata	Hooded seal	Klapmyds	Natsersuaq
Megaptera novaeangliae	Humpback whale	Pukkelhval	Qipoqqaq
Orcinus orca	Killer whale	Spækhugger	Aarluk
Balaenoptera acutorostrata	Minke whale	Vågehval (sildepisker)	Tikaagullik
Monodon monoceros	Narwhal	Narhval	Qilalugaq qernertaq
Ursus maritimus	Polar bear	Isbjørn	Nanoq
Phoca hispida	Ringed seal	Ringsæl (netside)	Natseq
Balaenoptera borealis	Sei whale	Sejhval	Tunnullit ilaat
Physeter macrocephalus	Sperm whale	Kaskelot	Kigutilissuaq
Odobenus rosmarus	Walrus	Hvalros	Aaveq
Delphinapterus leucas	White whale (beluga)	Hvidhval (hvidfisk)	Qilalugaq qaqortaq

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ENVIRONMENTAL OIL SPILL SENSITIVITY ATLAS FOR THE NORTHWEST GREENLAND (75°-77° N) COASTAL ZONE

This oil spill sensitivity atlas covers the shoreline and the offshore areas of West Greenland between 75° N and 77° N. The coastal zone is divided into 53 shoreline segments, and the offshore zone into 4 areas. A sensitivity index value is calculated for each segment/area, and each segment/area is subsequently ranked according to four degrees of sensitivity. Besides this general ranking, a number of smaller areas are especially selected, as they are of particular significance. They are especially vulnerable to oil spills and they have a size making oil spill response possible. The shoreline sensitivity rankings are shown on 15 maps (in scale 1:250,000), which also show the different elements included in the analysis and the selected areas. Coast types, logistics and proposed response methods along the coasts are shown on another 15 maps. The sensitivities of the offshore zones are depicted on four maps, one for each season. Based on all the information, appropriate oil spill response methods have been assessed for each area.

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