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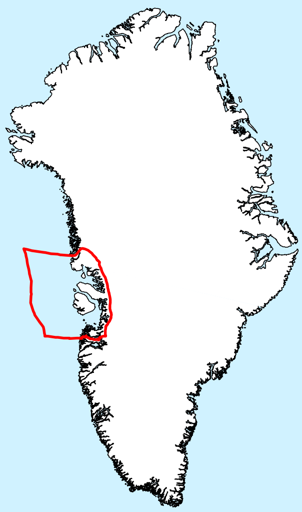
Environmental Oil Spill Sensitivity Atlas for the West Greenland (68°-72° N) Coastal Zone

NERI Technical Report, No. 494



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2004

A. Mosbech, D. Boertmann, B.Ø. Olsen, S. Olsvig,
F. von Platen, E. Buch, K.Q. Hansen, M. Rasch, N. Nielsen,
H.S. Møller, S.Potter, C. Andreasen, J. Berglund, M. Myrup
National Environmental Research Institute
Geological Survey of Denmark and Greenland
Danish Meteorological Institute
Institute of Geography University of Copenhagen
SL Ross Environmental Research Ltd
Greenland National Museum and Archives,
Greenland Institute of Natural Resources

Produced for:
Bureau of Minerals and Petroleum, Greenland Home Rule
and
Danish Environmental Protection Agency
as part of the environmental support program DANCEA

Data sheet

Title: Environmental Oil Spill Sensitivity Atlas for the West Greenland (68°-72° N) Coastal Zone.

Authors: A.Mosbech[1], D.Boertmann[1], B.Ø. Olsen[1], S. Olsvig[1], F. von Platen[2], E. Buch[3], K.Q. Hansen[3], M. Rasch[4], N. Nielsen[4], H.S. Møller[4], S. Potter[5], C. Andreasen[6], J. Berglund[6] & M.Myrup[6]

Institutions: [1)]National Environmental Research Institute, [2)]Geological Survey of Denmark and Greenland, [3)]Danish Meteorological Institute, [4)]Institute of Geography University of Copenhagen, [5)]SL Ross Environmental Research Ltd, and [6)]Greenland National Museum and Archives, Greenland Institute of Natural Resources.

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Abstract: This oil spill sensitivity atlas covers the shoreline and the offshore areas of West Greenland between 68° N and 72° N. The coastal zone is divided into nearly 200 areas and the offshore zone into 8 areas. A sensitivity index value is calculated for each area, and each area is subsequently ranked according to four degrees of sensitivity. Besides this general ranking a number of smaller areas are especially selected because they are of particular significance, they are particularly vulnerable to oil spill and, an effective oil spill response can be performed. The shoreline sensitivity ranking is shown on 37 maps (in scale 1:250,000), which also show the different elements included. These maps also show the selected areas. Coast types, logistics and proposed response methods along the coasts are shown on another 38 maps. The sensitivities of the offshore zones are depicted on 4 maps, one for each season. Based on all the information, appropriate oil spill response methods have been assessed for each area.

Keywords: West 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.

Referees: Kjeld Frank Jørgensen (Danish Environmental Protection Agency), Andreas Vedel (Ministry of Environment and Nature, Greenland), Nils Westergaard (Greenland Command).

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DK-2400 Copenhagen NV
Denmark
Tel.: + 45 70 12 02 11
frontlinien@frontlinien.dk

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Additional figures available:

Seabird breeding colonies (32 photos): Linked from blue icons on shoreline sensitivity maps.

Archaeological sites (13 photos): Linked from text in 14.5 Achaeological and historic information,page 14-25.

Air photos (in total 225): Linked from each shoreline sensitivity map and from a keymap.

Additional living resource maps: Linked from relevant sites in the text and tables of chapter 8.1 and 14.4.

- Distribution of scallop catches
- Distribution of snow crab catches
- Distribution of arctic char rivers and fishing areas
- Distribution of capelin spawning and fishing areas
- Distribution of lumpsucker spawning and fishing areas
- Distribution of seabirds in spring
- King eider concentration areas in winter
- Distribution of large baleen whales
- Distribution of bowhead whales in winter and spring
- Distribution of white whales in winter
- Distribution of narwhals in winter
- Walrus concentrations areas in winter
- Bearded seal concentrations areas in winter

2 Preface

This Atlas was produced as a part of the preparations for exploratory oil/gas drilling offshore Greenland. And it is a continuation of the atlas covering the region 62º N to 68º N, produced in 2000.

This atlas was produced using the best available information. Draft maps with environmental information was presented to local communities for quality assurance and gathering of supplemental information on resources and resource use. Further a draft of the complete Atlas was sent to relevant Greenlandic and Danish institutions for comments. However, the available information was by no means complete and as further information becomes available, it will be relevant to update the atlas. The atlas was produced in a dynamic GIS (Geographical Information System) where atlas updates can be produced easily, when input data is updated. It is our hope that this atlas with all its integrated information and suggestions will be a valuable tool for Greenlandic authorities, oil companies and others.

The study team

The National Environmental Research Institute, Department of Arctic Environment (NERI-AE) headed the study team.

NERI further provided the biological information in the Atlas and prepared the shoreline and offshore sensitivity maps. NERI also developed a CD presentation solution and an Internet version of the Atlas.

The Geological Survey of Denmark and Greenland (GEUS) prepared the coastal morphology maps and the basic map layout.

The Institute of Geography, University of Copenhagen, was responsible for shoreline morphology classification based on air photo interpretation.

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

The Danish Meteorological Institute (DMI) reviewed and compiled data regarding ice, oceanography and climate, mainly the chapters 8.1 (part), 8.4, 8.5, 8.6, 8.7 and Appendix C.

The Greenland National Museum and Archives (GNMA) compiled and reviewed the archaeological information.

The Greenland Institute of Natural Resources (GINR) contributed with information regarding living resources (fish, shellfish, birds and whales) and their use in Greenland. The Greenland Ministry of Environment and Nature supplied various information and commented on an early draft of the Atlas.

The software application used to generate shoreline and offshore sensitivity scores was originally developed for the first atlas in co-operation with AXYS Environmental Consulting Ltd.

As a part of the project, a study of local knowledge, was carried out by NERI and GINR (Olsvig & Mosbech 2003).

A draft version of the Atlas was presented at community consultations in June 2003 in Aasiaat, Kitsissuarsuit, Akunnaq, Ikamiut, Qasigiannguit, Ilimanaq, Ilulissat, Oqaatsut, Saqqaq, Qeqertarsuaq, Kangerluk, Niaqornat, Qaarsut, Uummannaq, Ikerasak, Saattut, Ukkusissat, Illorsuit, Nuugaatsiaq, Upernavik Kujalleq, Kangersuatsiaq and Upernavik. We thank the residents and representatives for the local hunters and fishermens organisations for constructive participation. The community consultations were carried out by Sara Olsvig and Josephine Nymand (both NERI).

Team members

Anders Mosbech (NERI) headed the study team producing the Atlas,
and the team consisted of (in alphabetic order):
Claus Andreasen (GNMA),
Joel Berglund (GNMA),
David Boertmann (NERI),
Erik Buch (DMI),
Keld Q. Hansen (DMI),
Niels Nielsen, (Institute of Geography, University of Copenhagen),
Josephine Nymand (NERI),
Mikkel Nyrup (GNMA),
Bent Østergaard Olsen (NERI),
Sara Olsvig (NERI),
Frants von Platen (GEUS),
Steve Potter (SL Ross Environmental Research Ltd.),
Morten Rasch (Institute of Geography, University of Copenhagen),
Henrik S. Møller (Institute of Geography, University of Copenhagen).

Contributions from the Greenland Institute of Natural Resources were delivered by Helle Siegstad, Ole Jørgensen, Lars Witting, AnnDorte Burmeister, Lars Heilmann, Jesper Boje, Claus Simonsen and Flemming Merkel.

Peter Mikkelsen (NERI), Frank Riget (NERI) and Mikkel Tamstorf (NERI) contributed to the preparation of the offshore data analysis, and Mette Jensen (NERI) contributed to the design of the local knowledge studies. Greenland Command in Grønnedal commented on the proposed potential safe havens.

The present project has been funded by the Bureau of Minerals and Petroleum, Greenland Home Rule and by the Danish Ministry of the Environment as part of the environmental support program Dancea – Danish Cooperation for Environment in the Arctic. The authors are solely responsible for all results and conclusions presented in the report, and do not necessary reflect the position of the Danish Ministry of the Environment.

3 Summary

Environmental Oil Spill Sensitivity Atlas for the West Greenland (68º-72º N) Coastal Zone

This atlas is produced as a part of the preparations for exploratory drilling offshore Greenland. The objective of the project is to produce an overview of resources vulnerable to oil spills, for example biological resources (fish, birds etc.), and a tool to respond to an oil spill. The project covers the region between 68° N and 72° 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 6.

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 maps of the atlas also show smaller selected areas. They have been selected as being of particular significance, particular 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 aerial photographs, e.g. the occurrence of rocky shores and beaches. 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 8 in the atlas contains offshore and overview information, primarily in 1: 3.5 million scale maps, and Chapter 9 contains detailed coastal information in 1: 250,000 scale maps. Chapter 7 is a users guide common to Chapter 8 and 9.

Chapter 8 contains maps showing the sensitivity of the offshore areas and with each 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 9 contains 37 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 9 also contains 37 maps showing coast types, logistics and proposed methods to oil spill response for each area.

A community consultation phase was carried out during the project. A draft version of the atlas was presented and discussed with local communities and user organisations in June 2003, and new information was incorporated.

The Danish Environmental Protection Agency as part of the environmental support program, Dancea (Danish Cooperation for Environment in the Arctic) and the Bureau of Minerals and Petroleum (Greenland Home Rule) financed the preparation of the atlas.

The project was carried out by the National Environmental Research Institute, the Geological Survey of Denmark and Greenland, the Greenland Institute of Natural Resources, the University of Copenhagen (Institute of Geography), the Greenland National Museum and Archives, Danish Meteorological Institute and SL Ross Environmental Research Ltd.

4 Eqikkaaneq

Kitaata avannaata imartai kangerluilu – Uuliaarluernermi piffiit immikkut sunnertiasut pillugit atlassi

Ukioq 2000-ip aasaanerani uuliasioqatigiiffik Statoil Nuup avataani Fyllap imartaata kitaani uuliamik/gassimik ujarlerluni qillerivoq. 1977-mili Kalaallit Nunaanni imaani qillerinerit siullersaraat. Tamatuma kingorna canadamiut uuliasioqatigiiffiat Encana aamma Kitaata imartaani uuliasiornermut akuersissummik tunineqarsimavoq, kitaanilu imarnersat allat sisamat piffissami aggersumi uuliasiornissamut neqeroorutigineqartussaapput. Taamaattumik uuliasiornerit Kitaata imartaani annertusisussaapput. Uuliasiornermi avatangiisinut sunniuteqarlussinnaasut annersaraat qillerisoqartillugu uuliarluerujussuarneq, tamatumalu kingorna uulia aqunneqarsinnaanngitsumik imaanut siaruaappat. Taamatulli pisoqarsinnaanerata ilimanassusaa annikitsuararsuuvoq, assersuutigalugulu Statoil-ip 2000-mi qillerinera avatangiisinut akornutaanani ingerlanneqarpoq.

Statoil-ip qillerinerinissaanut pilersaarusiornermut atatillugu qallunaat kalaallillu pisortaasa atlassiliorneq aallartissimavaat. Suliap siunertaraa uuliaarluernermi pinngortitami sunnertiasut tamakkerlugit suunerisa nalunaarsorneqarnissaat. Tamakku ilagaat uumasut (aalisakkat, timmissat il.il.) kiisalu aalisarnermut piniarnermullu soqutigisaqaqatigiinnut attuumassuteqartut. Uuliaarluertoqartillugu suut siulliullugit illersortariaqarnersut aalajangiisoqartariaqalernissaa pisariaqalissappat uuliasioqatigiiffik pisortallu ilisimasat nalunaarsorneqarsimasut tunngavigalugit siumut naliliisinnaalersimapput. Suliaq taamani Kitaani allorniusat sanimukartut 62° N aamma 68° N akornanni ingerlanneqarsimavoq.

Maannakkut atlassi siulleq kitaata avannaatungaani Kangaatsiamit (68° N) Upernaviup kujataatungaa tikillugu (72° N) ilaneqarpoq tamatumalu imartaa tamaat ilanngullugu. Kiisalu atlassi kujammut ilaneqarpoq, taamaalilluni Nunap Isuata Upernaviullu kujataata akornani sineriak tamakkerneqassalluni (immikkut saqqummersinneqassaaq).

Suliami immikkoortut maku ilaapput:

- sinerissap iluasaanik allaaserisat,
- imaq, siku silalu,
- uumasut pisuussutit (timmissat, aalisakkat il.il.),
- aalisarneq piniarnerlu,
- piffiit immikkut illersorneqartut (soorlu timmissat inaat),
- itsarnitsat eriagisariaqartut,
- angalanermut tunngasut uuliaarluernermilu akiueriaatsit.

Immikkoortut assigiinngeqisunik pisuussuteqarmata (soorlu timmissat ineqarfii, aalisarfiit pingaartut itsarnitsallu eriagisariaqartut), nunani allani nalinginnaavoq piffiup ataatsip qanoq sunnertiatiginera kisitsisinngorlugu nalilersuisarneq, taamaalilluni piffiit assigiinngitsut imminnut assersuunneqarsinnaanngorlugit pingaarnerutitallu tulleriiaarneqarsinnaanngorlugit. Tamanna siunertaralugu nalilersueriaatsit assigiinngitsut inerisarneqarsimapput. Suliami uani canadamiut nalilersueriaasiat aallaaviuvoq, taannalu Canadap kangiata avannaani Lancaster Sound-imi aamma atorneqarsimavoq.

Sineriak immikkoortunut 50 km-rit missiliorlugit isorartutigisunut agguarneqarsimavoq malussarissutsinullu immikkoortunut sisamanut agguarneqarsimasunut. Immikkoortiterneranullu atatillugu qanoq sunnertiatiginerisa nalilersorneranni avatangiisinut inuiaqatigiinnullu tunngassuteqartut ilanngunneqarsimapput (timmissat imaanilu uumasut miluumasut eqimattat assigiinngitsut, piniarfiit, aalisarfiit, itsarnitsanik eriagisariaqartut il.il.). Tamakku ataasiakkaat uuliaarluernermut qanoq sunnertiatiginerat, kiisalu immikkoortut ataasiakkaat qanoq amerlatiginerat/pingartiginerallu nalilerneqarsimalluni. Uumaasut immikkuutaartut uuliaarluernermut malussarissusaat taakku uuliaarluertoqartillugu uuliamik sunnerneqarsinnaanerata ilimanassusaa uuliamullu malussaritsiginerat tunngavigalugu nalilerneqarsimavoq. Uumasut immikkoortut taakkulu atorneqarnerat immikkoortut ataatsimut katillugit malussaritsiginerata naatsorsorneqarnerani pingaartinneqarnerpaasimavoq.

Sineriak tamakkerlugu malussaritsiginerata nalinginnaq nalilersorneqarnerata saniatigut nunap assingini piffiit minnerusut immikkut toqqarneqarsimasut nalunaarsorneqarsimapput. Piffiit tamakku immikkut naleqassusaat, uuliaarluernermut immikkut malussarissusaat kiisalu annertussusaat naapertorlugu uuliaarluertoqartillugu pitsaasumik siaruatsaaliorsinnaanerat tunngavigalu immikkoortinneqarsimapput.

Suliamut atatillugu timmisartumit assilisat tunngavigalugit sinerissat nalunaarsorneqarsimapput (ilusaat sunillu sananeqaateqarnerat, soorlu qaarsoqarfiunersut sioraqarfiunersulluunniit). Ilisimasaq taanna aallaavigalugu aammalu mallinut sikunullu qanoq sunnerneqartigisarnerat tunngavigalugu uuliaarluernermi imminut salissinnaassusaat kisitsisinngorlugu nalilerneqarsimavoq. Soorlu sineriak qaarsorissoq mallinit sunnerneqartuartoq sissamut kangerliumanermi oqquartamiittumut naleqqiullugu uuliamik sukkanerusumik akuiarneqartarpoq. Paasisat katersorneqarsimasut tunngavigalugit piffinni assigiinngitsuni uuliaarluernermik siaruatsaalioriaatsit naleqquttut nalilersorneqarsimapput.

Atlassi aamma nassuiaatinik immikkoortortaqarpoq (kapitali 8), nunap assinganut uuttuut 1:3.5 million tunngavigalugu nalunaarsorneqarsimasunik kiisalu sukumiinerusumik nassuiaatitalimmik immikkoortortaqarpoq (kapitali 9) nunap assinganut uuttuut 1:250.000 tunngavigalugu nalunaarsorneqarsimasunik. Kapitali 7 kapitalit 8-mi 9-milu nunap assingisa atornissaannut ataatsimut ilitsersuummik imaqarpoq.

Kapitali 8 nunap assinginik imaani piffiit sunnertiatigineri tunngavigalugit immikkoortut ataasiakkaat ilisarnaataannik nalunaaqutserneqarsimasunik (aalisartarfiit, aalisakkat, timmissat imarmiullu miluumasut) imaqarpoq. Taassuma saniatigut piffiup sikusarneranut tunngasunik nunap asseqarpoq kiisalu uumasut pisuussutit arlallit sumiissusaat taakkulu atorneqarneri nalunaarsorneqarsimallutik, soorlu kinguppaat qalerallillu.

Kapitali 9 nunap assinginik uuttut 1:250.000 tunngavigalugu sananeqarsimasunik 37-nik imaqarpoq taakkunanilu sinerissat sunnertiatiginerat nalilerneqarsimavoq sumullu atorneqartarnera ilisarnaaserneqarsimalluni (piniarfiit aalisarfiillu, aalisakkat, timmissat imaanilu uumasut miluumasut itsarnitsallu eriagisariaqartut). Nunap assingi piffiit immikkut pingaaruteqartut ilanngunneqarsimapput. Nunap assinginut ataasiakkaanut piffiup sumut atorneqartarneranut kiisalu sunik uumasoqarneranik paasissutissat allaaserineqarsimapput.

Kapitali 9 nunap assingi 37-it saniatigut aamma nunap assinginik sinerissap qanoq ilusaanik, periarfigitsigineranik kiisalu piffinni ataasiakkaani uuliaarluernerup qanoq akiorneqarsinnaaneranik siunnersuutinik imaqarpoq.

Paasissutissat pissarsiarineqarsimasut suliap ingerlanerani kommuninut soqutigisaqaqatigiin-nuullu ataasiakkaanut saqqummiunneqarsimapput oqallisigineqarsimallutillu.

Suliaq Namminersornerullutik Oqartussat Aatsitassanut Ikummatissanullu Pisortaqarfiannit Avatangiisinillu aqutsisoqarfimmit aningaasaliiffigineqarsimavoq (avatangiisinik misissuinermik tapiissuteqartartoq Dancea aqqutigalugu – Danish Cooperation for Environment in the Arctic). Suliffeqarfiillu makku ingerlatsisuusimapput: Qallunaat Nunaanni Avatangiisinut Misissuisoqar-fik (DMU), Pinngortitaleriffik (Grønlands Naturinstitut), Qallunaat Nunaanni Kalaallit Nunaan-nilu Ujarassiuut Misissuisoqarfiat (GEUS), Københavnip Universititiani Geografisk Institut, Nu-natta Katersugaasivia Allagaateqarfialu, Qallunaat Nunaanni Silasiornermut Misissuisoqarfik (DMI) kiisalu canadamiut siunnersuisoqatigiiffiat S.L. Ross Environmental Research Ltd.

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5 Sammenfatning

Vestgrønlandske (68°-72° N) havområder og fjorde – atlas over områder der er særligt følsomme for oliespild

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 har det canadiske selskab Encana fået tildelt en efterforskningstilladelse også ud for Vestgrønland, og fire nye vestgrønlandske havområder forventes udbudt i den kommende tid. Aktiviteterne omkring olieefterforskning vil derfor intensiveres på havet ud for Vestgrønland. Den alvorligste miljømæssige påvirkning fra sådanne aktiviteter vil opstå, hvis der sker et stort oliespild fra en boring, og olien efterfølgende spredes ukontrolleret i havet. Sandsynligheden for et stort oliespild er dog lille.

Som led i forberedelserne til Statoils boring iværksatte de danske og grønlandske myndigheder et atlas projekt. Hensigten med dette projekt var at få et samlet overblik over de ressourcer, der er følsomme over for et oliespild. Det drejer sig bl.a. om de biologiske ressourcer (forekomst af fisk, fugle m.v.) og om fiskeri- og fangstinteresser. Med en kortlægning af denne viden fik såvel selskabet som myndighederne mulighed for på forhånd at vurdere, hvor de særligt følsomme områder findes med henblik på planlægning og prioritering af en indsat i tilfælde af et oliespild. Projektet, der afsluttedes i 2000, omfattede områderne mellem 62° N og 68° N ved Vestgrønland.

Nu udvides det oprindelige atlas med regionen fra Kangaatsiaq (68° N) til det sydlige Upernavik (72° N) og hele havområdet ud herfor. Samtidigt udvides atlasset mod syd (udgives særskilt), så hele kyststrækningen mellem Kap Farvel og det sydlige Upernavik nu bliver dækket.

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 i andre lande 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. I dette projekt tages 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 overfor 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 luftfotografier 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 lavet 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 8), der hovedsageligt er angivet på kort i målestoksforholdet 1: 3,5 million, og en sektion med detaljeret information om de kystnære områder (kapitel 9) på kortblade i målestoksforholdet 1: 250.000. Kapitel 7 indeholder en fælles brugervejledning til kortene i kapitel 8 og 9.

Kapitel 8 indeholder kort, der viser offshore-områdernes følsomhed med symboler for elementerne i klassifikationen (fiskeriområder, fisk, fugle og havpattedyr). Desuden er der en række kort over isforholdende i området samt kort over de vigtigste områder for en række biologiske ressourcer og deres udnyttelse, bl.a. for rejer og hellefisk.

Kapitel 9 indeholder 37 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.

Derudover indeholder kapitel 9 andre 37 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 finansieres af den danske Miljøstyrelse (via miljøstøtteprogrammet Dancea - Danish Cooperation for Environment in the Arctic) og Grønlands Hjemmestyres Råstofdirektorat. Det er udført af Danmarks Miljøundersøgelser (DMU), Grønlands Naturinstitut, Danmarks og Grønlands Geologiske Undersøgelse (GEUS), Geografisk Institut v. Københavns Universitet, Grønlands Nationalmuseum og Arkiv, Danmarks Meteorologiske Institut (DMI) samt det canadiske konsulentfirma S.L. Ross Environmental Research Ltd.

6 Introduction

6.1 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 West Greenland between 68° N and 72° 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 6.3). 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.

West Greenland between 68º and 72º N has in the Disko Bay area a relatively dense population (in a Greenland context), while further north the human population is sparse and scattered among several small settlements and a few towns. Hunting and fishing are the main ways of living in the region. The region is also ecologically highly important for a number of seabird and marine mammal species. It is therefore essential that all possible measures are taken to minimise the environmental risk of oil activities in the area. The objective of this atlas is to contribute to that effort.

This atlas is an extension of a similar atlas prepared for the central part of West Greenland between 62° N and 68° N in 2000 (Mosbech et al. 2000). As an atlas covering the South Greenland region is prepared along side the present atlas, the whole West Greenland coast from 60° N north to 72° N is now mapped.

6.2 Contents and organisation

The study area covers the northern part of the west coast of Greenland, between 68° N and 72° N including offshore areas as far west as the Canadian border.

The information in the atlas is organised by map scale moving from summary information (Chapter 8) in a scale of approx. 1: 3.5 million to operational information (Chapter 9) in a scale of 1: 250,000 (G/250 Vector copyright Danish Survey & Cadastre 1998).

Chapter 7 contains a user guide to the maps, which supplements the legend.

Chapter 8 contains the offshore and summary maps, which include:
- bathymetry,
- sea surface currents,
- overall distribution of important species,
- overview of extreme and high sensitive areas and special status areas,
- offshore sensitivity (winter, spring, summer and autumn),
- ice conditions.

Chapter 9 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,
- anchorage's and safe havens,
- access by boat or aircraft,
- descriptions of potential countermeasures.

Further information on the physical environment is given in Appendix C: Climatic data for logistics. Detailed accounts of methodology and data documentation and limitations are given in Appendix D.

6.3 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 West Greenland (68º-72º N) to the effects of an oil spill. This pre-spill ranking allows spill responders and on-scene planners to do a quick evaluation of which areas and environmental components that 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 receive a single numeric value, which represents the relative sensitivity of that area to a marine oil spill. This numeric value is ranked as extremely high, 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 are 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 6.1. 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 rely on available information regarding the vulnerability, recovery potential and the potential for lethal and sublethal effects which are summarised in Table 6.1. 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 6.1. The relative sensitivity (RS) and characteristics of the selected species or species groups in relation to oil spills.

Species name	Vulnerability	Mortality potential	Sublethal potential	Recovery period	Relative sensitivity
Alcids	Very high	Very high	Very high	Very long	25
Arctic char	Moderate	Low/Short	Moderate	Moderate	14
Baleen whales	Low	Very low	Very low	Moderate	9
Bearded seal	Low	Very low	Low	Short	9
Capelin	Very high	High	High	Moderate	21
Cormorants	High	High	High	Moderate	19
Deep sea shrimp	Very low	Very low	Low	Short	7
Greenland halibut	Very low	Very low	Low	Short	7
Gulls	Moderate	High	Very high	Short	17
Harbour seal	Moderate	Moderate	High	No recovery	18
Hooded seal	Moderate	Moderate	Moderate	Moderate	15
Lumpsucker	Moderate	Moderate	High	Short	15
Narwhal	Low	Low	Low	No recovery	13
Scallop	High	Low	High	Long	18
Seaducks	Very high	High	Very high	Long	23
Seaducks breeding	Very high	High	Very high	Long	23
Snow crab	Very low	Low	Moderate	Short	9
Tubenoses offshore	Moderate	High	High	Moderate	17
Tubenoses shoreline	Moderate	High	High	Long	18
Walrus	High	Moderate	Low	No recovery	18
White whale	Low	Low	Low	No recovery	13

The biological resource constant, "C", refers to a value which 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 6.2 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 vulnerable) and to account for a few geomorphologic coast types considered to have longer residence times (archipelagos, pocket beach, barrier beach and delta).

See also Appendix A (page 11-1), where the RS, RA, TM, AV, PI and S values are listed for each segment.

Table 6.2. 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

6.4 Selected areas

In particular, a total of 16 areas along the coast and within fjords have been selected for priority in an oil spill situation. These areas are identified by a black 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. A summary of the selected areas is given in Appendix D (14.6). The selection has been supported by a grid-based GIS analysis described in Appendix D (14.6).

6.5 Countermeasure overview

Oil spill countermeasure considerations are described for each of the 37 operational maps in Chapter 9. The following is an overview of their basis and content.

The low level of industrial and marine activity in the waters of West Greenland leads to a very limited number of spill possibilities, both currently and in the foreseeable future. The main possibilities at present are those related to fuel re-supply to the communities, and fuel carried by fishing vessels and other ships. A small but finite risk will be added with the advent of exploration drilling for crude oil, which is anticipated on the offshore area to the south of the present region in the coming years.

If a significant spill occurs, there would be severe limits 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 as is the case for offshore exploration drilling. The main countermeasure activities that could be carried out are described in general terms below, with specific local notes where 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 6.4).

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 airports at Kangerlussuaq, Aasiaat, Ilulissat, Qaarsut 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 response plan for specific activities such as offshore drilling. 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 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.

Dispersants could be considered for use 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.

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, 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 of the "selected area" it will be valuable in limiting the extent and degree of contamination and lead 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 will be that dictated by the water currents and topography. Little water current information is available for the area; the few data available indicates 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 can be boomed, the most effective strategy may be to use deflection booming to limit the extent of shoreline oiling and thereby hasten recovery.

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 of spills in ice conditions).

Much of the coastline in the region covered by this atlas consists of a high-relief 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 remote staging areas and may necessitate ship- or barge-based clean-up operations.

One potential safe haven has been proposed. 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 sheets. There are a number of other locations that could be considered for use as safe havens, but have insufficient information (usually limited or no soundings) to fully recommend them. 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.

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7 Users Guide

The region covered by this atlas is the northern part of West Greenland. It covers the region between 68º N and 72º N and includes the municipalities Kangaatsiaq (north of 68º N), Aasiaat, Qasigiannguit, Ilulissat, Qeqertarsuaq, Uummannaq and Upernavik (south of 72º N). The offshore waters to the Canadian border are also included. The entire region is generally refereed to as 'the study region/area', 'the region covered by this atlas' or 'the sensitivity mapping region'.

Offshore sensitivity information is given in Chapter 8. This information covering the entire study area is presented on one-page maps with an approximate scale of 1: 3.5 million.

Detailed shoreline information is given in Chapter 9 on maps with a smaller scale. The entire study area is covered by a total of 37 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 to east. For example, the western-most map (map number 1) that covers the area at 68° N, is named Map 6801, and the next to the east is named Map 6802. Note that there are two rows for each latitudinal degree, thus the map to the north of Map 6801 is at 68.5° N and is named Map 6851
In Chapter 9 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.

7.1 Shoreline and Offshore Sensitivity Maps

7.1.1 Sensitivity index and icons (animal and other symbols)

The shoreline zone in the study area has been divided into 199 shoreline areas, each consisting of approximately 50 km of shoreline or in the archipelagos: a group of islands and skerries having roughly 50 km shoreline. The 199 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. 69-98.

The offshore zone in the study area has been divided into 8 offshore areas (including 2 major fjords/bays). 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 199 shoreline and 8 offshore areas based on:

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

The sensitivity index value for each of the 199 shoreline areas and 8 offshore areas is given on the opposite page to the corresponding map. All areas are ranked as extreme, high, moderate and 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. For segments cut by map edges (where there is a considerable overlap with adjacent map sheet), 'Environmental description' notes shall be found at the map sheet depicting the largest part of the segment.

The importance of resource use and the abundance of a number of biological occurrences in each of the 199 shoreline and 8 offshore areas has been rated on a scale from 0 to 5 (see legend or Chapter 6.3 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. However, all resource use and species are shown on the offshore maps.

Blue icons (animal symbols) indicate a site-specific significant habitat. For example, such sites include important bird breeding colonies and terrestrial haul-outs for harbour seals. Photos of the coastal setting for about 20 bird colonies have been included in the pdf-document and can be accessed from links on the opposite page to the shoreline sensitivity map.

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. These figures are based on all the segments irrespective of there sensitivity rating.

7.1.2 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 the case of an oil spill situation. These areas are identified by a black 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:

i) of high value either environmentally or for resource use,
ii) sensitive to oil spill, 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.

7.1.3 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. These graphs are based on all the segments irrespective of there sensitivity rating.

7.1.4 Resource use data

Data on resource use was extracted from NERI's interview survey regarding fishery for capelin, lumpsucker and Arctic char (Olsvig & Mosbech 2003) as well as from unpublished material collected by Petersen (1993a, b, c, d, e, f & g). Additional information of resource use (especially shrimp, Greenland halibut, snow crab and scallop fisheries) and hunting of seabirds (mainly guillemots and eiders) seals and whales were derived from Greenland Institute of Natural Resources (GINR). Finally, unpublished data from NERI have been included. Tourist activities in coastal sites are also included in the resource use.

A preliminary atlas with all the data available on human use was presented to hunters and fishermen in settlements and towns between Aasiaat and Upernavik during summer 2003. New and supplementary information was gathered during these sessions and were afterwards included in the present atlas.

7.1.5 Species distribution and abundance data

Information on species distribution and abundance is mainly derived from a number of NERI reports reviewing data on biological resources and resource use in the area (Boertmann et al. 1996, Boertmann et al. 1999, Mosbech et al. 1996, Mosbech et al. 1998). In these reports relevant aspects of the species status and ecology are further described.

7.1.6 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.

To illustrate what archaeological sites in the coastal zone look like, some photos are presented in the pdf-document.

Further informations on the archaeological sites are 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 from before 1900 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.

7.2 Physical environment and logistics maps

7.2.1 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 7.1 and photos of shore types in Figures 7.1-7.15. See also Appendix D section 14.3.

7.2.2 Access

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

- **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.

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 7.1. *Classification of shore types in West Greenland between 68° N and 72° N.*

Shores developed in solid rock

Shore type	**Characteristics**
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, normally developed in solid rock. - Rocky coasts and pocket beaches might occur, but have only been classified individually if the perimeter of the island exceeds 6 kilometres.
Glacier coast	- Occurrence of a glacier in the intertidal zone.

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. - The occurrence of abraded intertidal platforms are 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 with or without salt marsh cliff 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 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

Not classified	- The shore has not been classified due to lack of air photo information (cloud cover, shadow, etc.)

Figure 7.1. Rocky coast east of Godhavn/Qeqertarsuaq.

Figure 7.2. Rocky coast, Skalø, in Upernavik municipality.


Figure 7.3. The archipelago Hunde Ejland/Kitsissuarsuit in Disko Bay.


Figure 7.4. The archipelago Schades Øer /Qeqertat in Karrat Fjord.


Figure 7.5. Glacier coast.


Figure 7.6. Moraine coast.

Figure 7.7. Alluvial fan in Umiiarfik.

Figure 7.8. Talus.

Figure 7.9. Talus with erosional cliff.

Figure 7.10. Barrier beach in Aqajarua/Mudderbugten on the east coast of Disko.

Figure 7.11. Barrier beach.

Figure 7.12. Pocket beach surrounded by rocky coast.

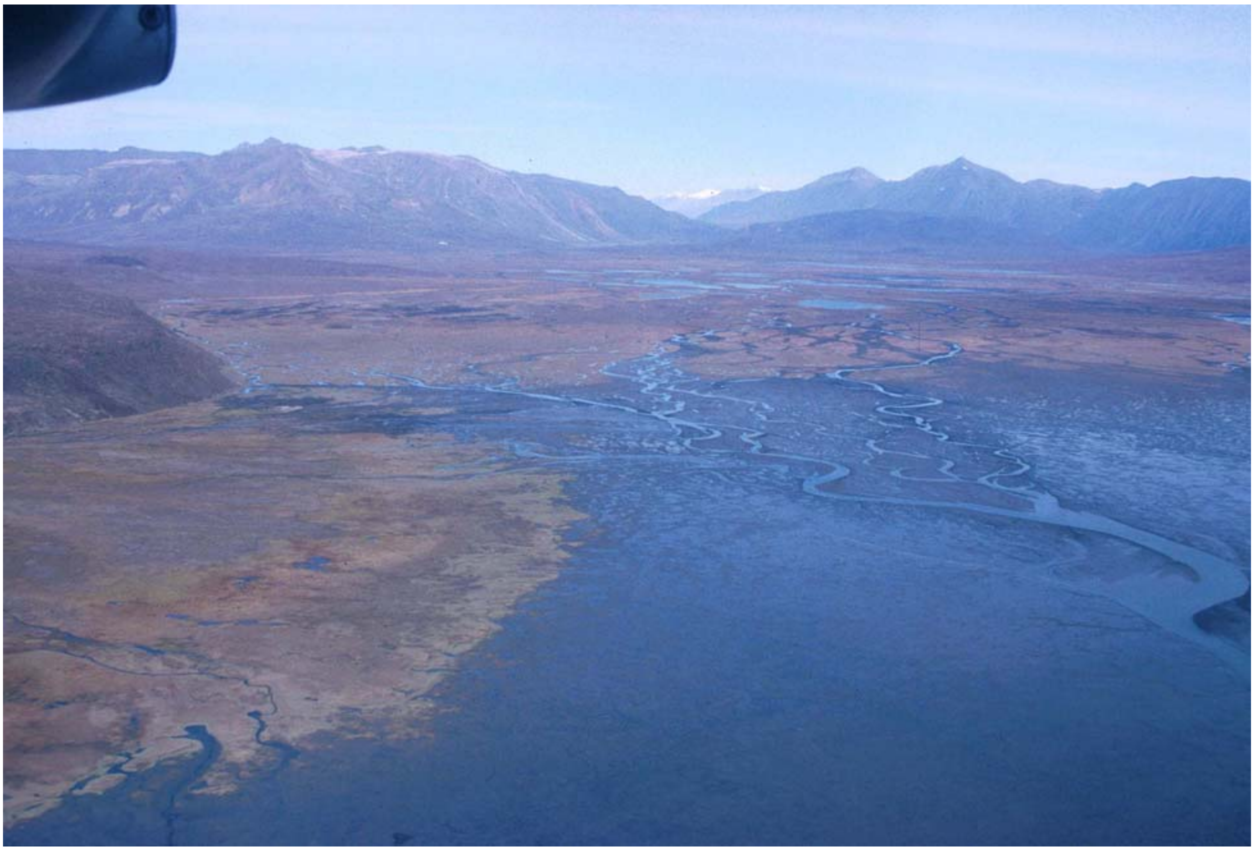


Figure 7.13. Delta with tidal flat, east coast of Svartenhuk Peninsula/Sigguup Nunaa.

Figure 7.14. Beach with well-sorted sand and gravel.

Figure 7.15. South coast of Nuussuaq, a mixture of rocky coasts, moraine coasts and beaches.
Note that sea ice still is attached to the coast (the ice foot) in mid-May.

7.2.3 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. A few potential safe havens which generally qualify and where the navigation information apparently is good are 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 which possibly might be used as safe havens after a reconnaissance or by involving local knowledge. It will be more feasible, at the time of an incident, to investigate the use of such a nearby potential safe haven, 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.

7.2.4 Countermeasures

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

7.2.5 Topographic maps and nautical charts

Topographic map no. (at a scale of 1: 250,000) and nautical chart no. (at a scale of 1: 80,000) are given for each map. Topographic maps and nautical charts were available from The Danish National Survey and Cadastre until 2002. When writing this, it is not known were to obtain these maps except at local marine stores and shops.

8 Offshore and summary information

8.1 Study area introduction

8.11 The offshore area

The offshore parts of the study region (68º-72º N) are the eastern Davis Strait and southern Baffin Bay. The shelf is the rather shallow (less than 200 m) waters between the coast and the steep break to the deep sea. This shelf includes several large shoals or banks, which typically ranges between 20 and 200 m in depth (Figure 8.1). In the southern part of the study area the shelf is up to 120 km wide, while it in the northern part is wider and less well defined towards the deep sea. The shelf is traversed by deep troughs, which separate the fishing banks. There is deep water down to 2,500 m to the west of the shelf.

In winter the waters normally are covered with ice: Fast ice occur near the shore and in fjords and bays while in the offshore areas highly dynamic drift ice occur.

The banks off the southern part of the study region and the Disko Bay waters have a high biological production. This high production is the basis for high densities of small schooling fish and large plankton organisms, which again are important food for large numbers of marine mammals and seabirds as well as for larger fish species, which all (including the deep sea shrimp) constitute important resources to the Greenland human population through hunting and fishing. In contrast, the productivity of the waters in the central and western Davis Strait and in Baffin Bay is lower.

8.1.2 Currents

Along West Greenland flows the West Greenland current with two principal components. Closest to the shore the East Greenland Current brings component water of polar origin northward along the West Greenland coast. On its way, this water is diluted by run-off water from the various fjord systems. The East Greenland Current component looses its momentum on the way northward and at the latitude of Fylla Bank (64º N) it turns westward towards Canada where it joins the Labrador Current. West for and below the Polar water of the East Greenland Current, another water component is found, originating from the Irminger Sea and the North Atlantic Current. This relatively warm and salty water can be traced all the way along West Greenland from Cape Farewell to Thule (Avanersuaq). See Figure 8.2.

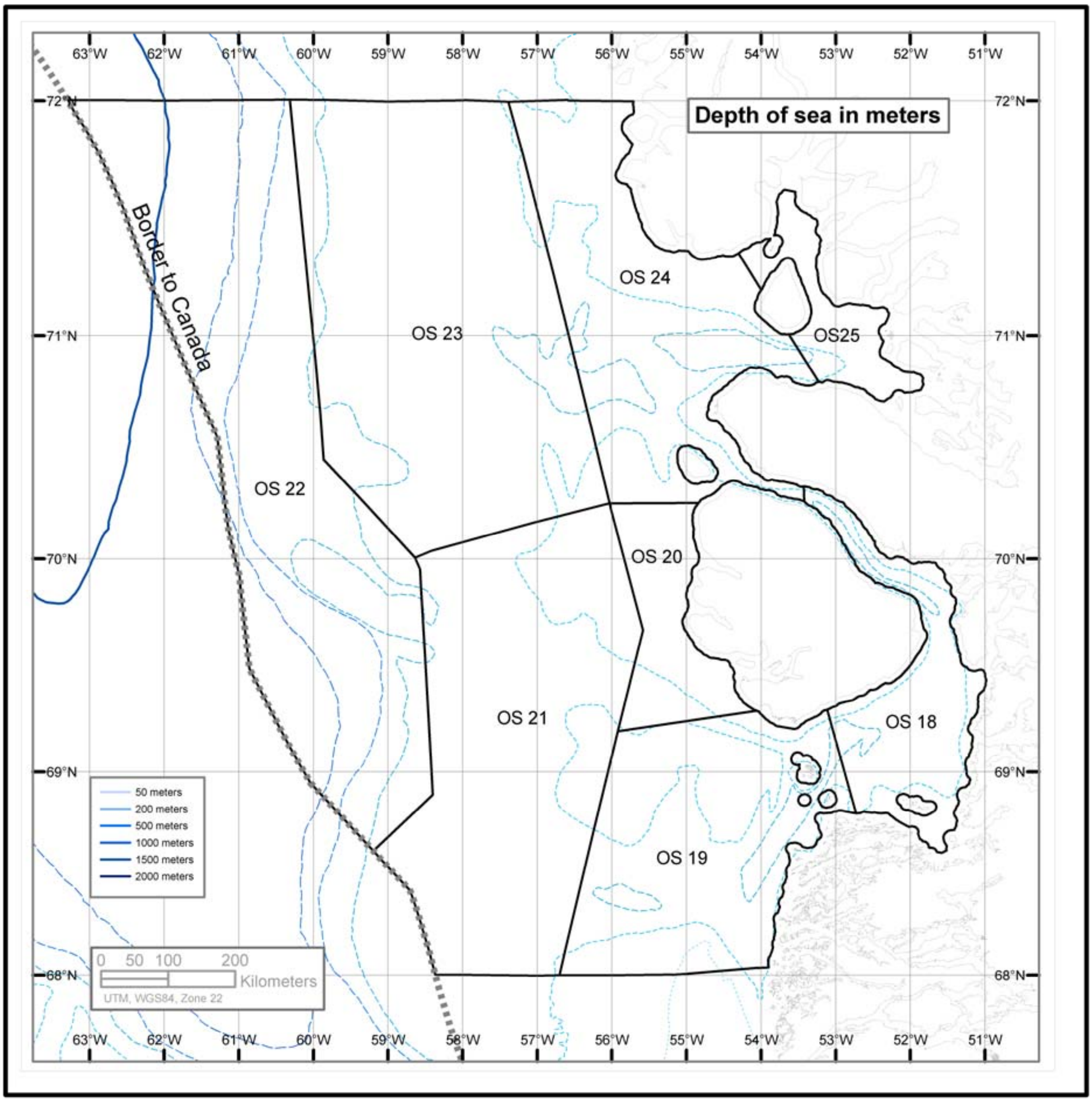


Figure 8.1. Bathymetry of the West Greenland (68º-72º N) offshore waters. The offshore areas shown.

The Polar Water inflow is strongest during spring and early summer (May - July), and since the East Greenland Current carry large amounts of Polar Ice with it, the distribution of Polar Ice along the coasts of West Greenland will attain its maximum during the same period. The inflow of Atlantic water masses is strongest during autumn and winter explaining why the waters between 62° and 67° N normally are ice free during wintertime.

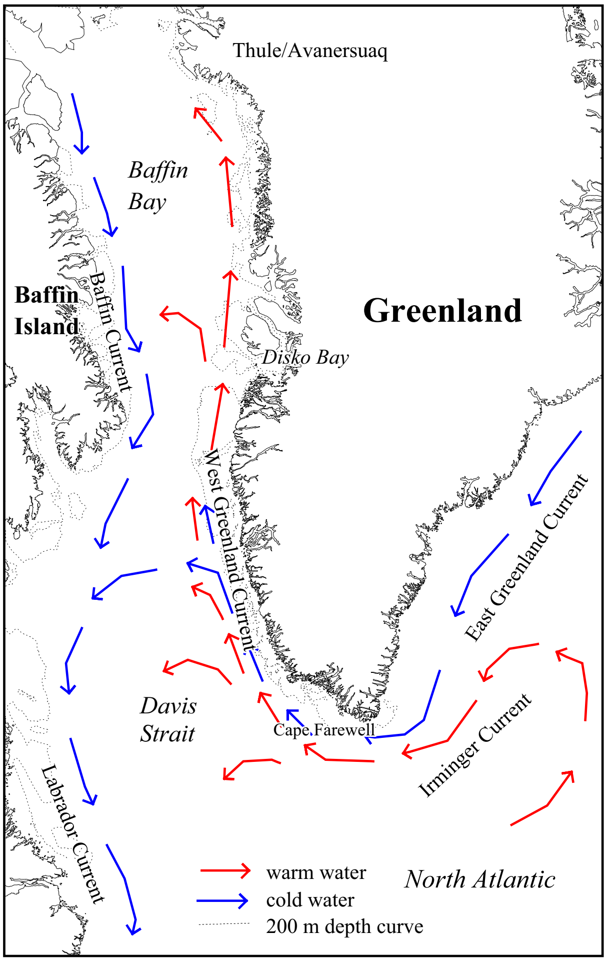


Figure 8.2. Surface current patterns in the waters off West Greenland.

A fifty year long time-series of temperature and salinity measurements from West Greenland oceanographic observation points reveal strong inter-annual variability in the oceanographic conditions off West Greenland. Moreover are some distinct climatic events obvious, of which three cold periods within the recent thirty years are the most dominant. The inter-annual variability is caused by changes in the atmospheric circulation or by variation in the strength of the ocean currents transporting water to the West Greenland area, and both seem to be related to the North Atlantic Oscillation Index (NAO-index) reflecting the difference in mean sea level air pressure between the Icelandic Low and the Azores High.

8.1.3 Ice and weather

Sea ice is normally present throughout the region from January to May. Inside fjords fast ice may form from October (depending on latitude), and generally the ice cover peak in March.
Icebergs and growlers originating from glaciers occur in the entire region. The density is high in Disko Bay and Uummannaq Fjord, where large and very productive glaciers are located. However, the drift and distribution of glacial ice at sea have never been investigated systematically and is therefore only known roughly.
The meteorological conditions in the area are influenced by the North American continent and the North Atlantic Ocean, but also the Greenland Inland Ice and the steep coasts of Greenland have a

southern tip of Greenland and cause frequently very strong winds off West Greenland. Also small-scale phenomena such as fog or polar lows are common features near the West Greenland shores. The probability of strong winds increases close to the Greenland coast and towards the Atlantic Ocean. See also Appendix 13.

8.1.4 Coastal zone geomorphology

South of Disko Bay in the study area (68º-72º N) the coastal zone is dominated by bedrock shorelines with many skerries and archipelagos. Small bays with sand or gravel are found between the rocks in sheltered areas. In western Disko Bay and further north the coasts are more straight and often made up from sediments like sand or gravel. The tidal amplitude is 3-4 m and a rich subtidal flora and fauna exists on the bedrock shorelines.
The geomorphology of the West Greenland coast has been classified according to shore type, sediment type, slope and exposure. The classification covers the coastline from about 40 km south of Kangaatsiaq to northern Sigguup Nunaa (Svartenhuk). The total shoreline length is c. 10,106 km.

The division of the shoreline into shore type segments is based on the geomorphology of the coast. A lower shore type segment length of c. 2 km has been applied. Therefore, shore types with an extend less than c. 2 km are not categorised separately, but have been included in the neighbouring shore type. Therefore, shore types with an extent of less than 2 km, are underrepresented in the classification. For example are the widespread pocket beaches typically less than 2 km, and such has been classified as their surrounding shore type, rocky coast or archipelago.
The total number of segments identified is 3,819. Of these 1,267 segments (4,952 km) are on the mainland coast, 964 segments (3,679 km) are on bigger islands (perimeter > 6 km) and 1,588 segments (1,474 km) are on smaller islands (perimeter < 6 km).

The distribution of segments on shore type, sediment type, slope and exposure categories respectively are given in Tables 8.1-8.4. In terms of shoreline length, the 'Rocky coast' is the dominant shore type (60.8 %). 'Rock' is the dominant substrate (71.4 %). 'Inclined' is the dominant slope (58.0 %) and 'Semi-protected' is the dominant exposure type (60.1 %). The majority of the coasts within the 'Archipelago' shore type are rocky coasts. Together the 'Archipelago' and 'Rocky coast' shore types by length constitute 72.2 % of the total investigated shoreline.

Table 8.1. Shore type statistics.

Shore type	No. of segments	km	%
Rocky coast	1,639	6,140	60.8
Rocky coast with erosional cliff	27	85	0.8
Archipelago	1,288	1,148	11.4
Glacier coast	49	131	1.3
Moraine	214	637	6.3
Moraine with erosional cliff	11	28	0.3
Alluvial fan	82	231	2.3
Alluvial fan with erosional cliff	0	00	0.0
Talus	236	863	8.5
Talus with erosional cliff	19	59	0.6
Beach	32	78	0.8
Beach ridge plain with erosional cliff	89	248	2.5
Barrier beach	33	94	0.9
Salt marsh and/or tidal flat	0	00	0.0
Pocket beach	0	00	0.0
Delta	69	187	1.9
Not classified	31	177	1.8
Total	**3,819**	**10,106**	**100.0**

Table 8.2. Sediment type statistics.

Sediment type	No. of segments	km	%
Ice	50	132	1.3
Rock	2,902	7,217	71.4
Rock and coarse sediment	11	35	0.3
Rock and fine sediment	41	123	1.2
Coarse sediment	533	1,841	18.2
Fine sediment	282	758	7.5

Table 8.3. Slope statistics.

Slope type	No. of segments	km	%
Steep	972	3,896	38.6
Inclined	2,713	5,865	58.0
Flat	134	344	3.4

Table 8.4. Exposure statistics.

Exposure type	No. of segments	km	%
Protected	364	1,061	10.5
Semi-protected	1,974	6,074	60.1
Semi-exposed	778	1,685	16.7
Exposed	703	1,285	12.7

8.1.5 Marine fish and invertebrates

Table 8.5. Important fish and large invertebrate species in the area (68 °-72 ° N).

Species	Main habitat	Spawning area	Spawning period	Exploitation
Blue mussel	Subtidal, rocky coast			s
Scallop	Inshore and on the banks, in area with high current velocity, 20-60 m depth		July-August	c & s
Deep sea shrimp	Mainly offshore, 100-600 m depth	Larvae released at relatively shallow depth (100-200 m), larvae in middle water-column	(July -September) larvae released March to May	Important c
Snow crab	Coastal and fjords, 180-400 m depth		Larvae released April-May	c
Atlantic cod	Fjords and bays	Pelagic eggs and larvae in upper water column	April-May	See text
Greenland cod	Inshore/fjords	Inshore/fjords, demersal eggs	February-March	c & s
Arctic cod	Pelagic	Mainly north of 68° N, probably planktonic eggs	Winter	No
Sand eel	On the banks and in Disko Bay at depths between 10 and 80 m	On the banks, demersal eggs, larvae in the water column	July-August	No, important prey item
Wolffish	Inshore and offshore	Hard bottom, demersal eggs	Peaks in September	c & s
Atlantic salmon	Offshore and coastal	Freshwater	-	c & s
Arctic char	Coastal waters, fjords	Freshwater	-	c & s
Capelin	Coastal waters	Beaches, demersal eggs	April-June	c & s, important prey item
Atlantic halibut	Offshore and inshore, deep water	Offshore, south of 68° N, pelagic eggs and larvae, deep water	Spring	c & s
Greenland halibut	Offshore and inshore, deep water	Offshore south of 66° N, deep water, pelagic eggs and larvae	Winter	Important c & s
Redfish	Offshore and in fjords, 150-600 m depth	Main spawning south-west of Iceland, larvae drifts to West Greenland banks and fjords		
Lumpsucker	Pelagic coastal, demersal eggs	Shallow water near coast	May-June	c & s

Exploitation of the species are categorised in c: commercial and s: subsistence fishery.

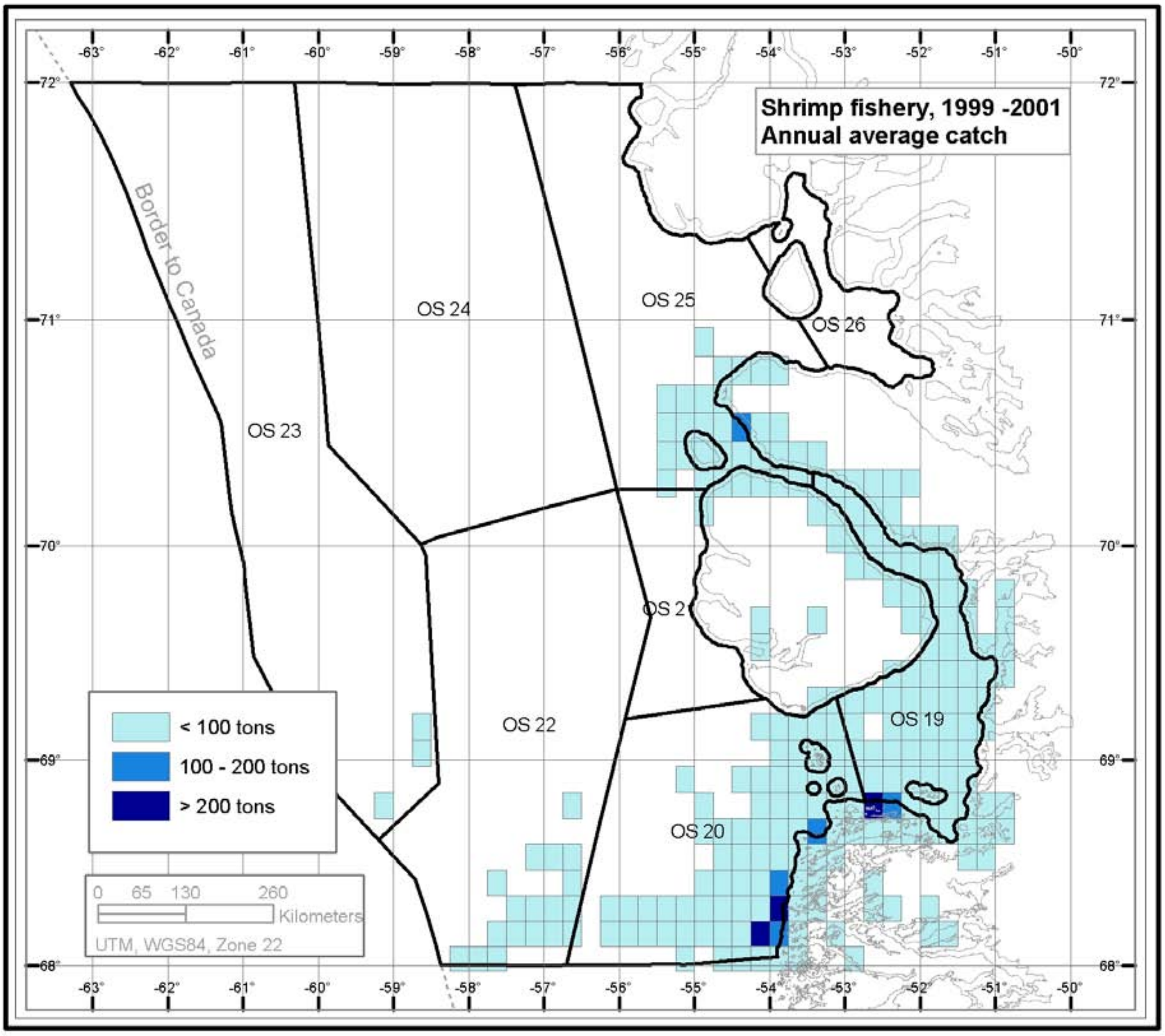


Figure 8.3. Distribution of deep sea shrimp catches in West Greenland (68º-72º N) waters. Annual arverage over 1999 to 2001 Based on data from GINR.

Bottom fish dominates the offshore fish assemblage in the area. The most important fish and invertebrate species in the study area are listed in Table 8.5. There are important fisheries for deep sea shrimp (Figure 8.3) and Greenland halibut (Figure 8.4) in the area.

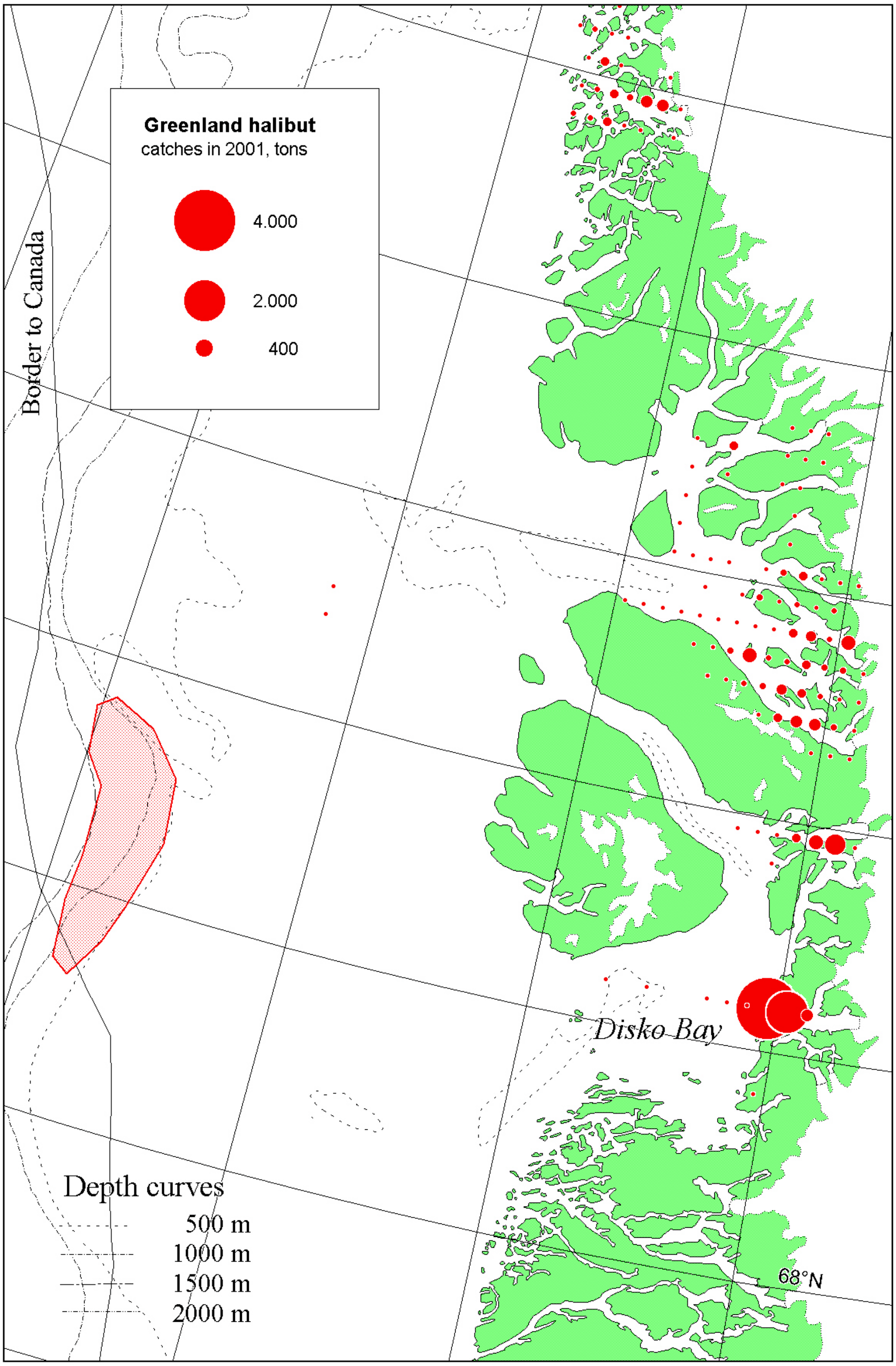


Figure 8.4. The offshore trawl areas for Greenland halibut in 2001 (dotted red area), where about 650 tons were taken in 2001. And inshore catches of Greenland halibut (red dots). Based on data from GINR.

Lumpsucker and capelin are coastal spawners, and capelin are found inshore during most of the year. During summer, Arctic char also feed in coastal waters.
In recent years new recourses have been exploited, and the most successful are scallop and snow crab, which both are utilised in several areas now.

8.1.6 Seabirds

The study area (68°-72° N) is rich in seabirds with many species adapted to different ecological niches.
Some species feed predominately on fish, such as the Brünnich's guillemot (during summer, outer coast and offshore) and cormorants (coastal and fjords), some are surface plankton feeders like the kittiwakes and some are bottom feeders like eiders (hard bottom) and king eiders (soft bottom).
The largest seabird populations are present in the area during summer, as the winter ice force the bird populations southwards to open waters. However, recurrent open waters in winter are of extreme importance to seabirds, and such are for example located in the fjord mouths near Kangaatsiaq.

Spring
From April through to June, when the ice starts to break up, large numbers of birds which winter in the open water area south of the study region move into and through the study area. King eiders head for breeding areas mainly in the western Canadian Arctic, common eiders to breeding areas along the Canadian and Greenland coasts, little auks to the huge colonies in Thule (Avanersuaq) and Brünnich's guillemots to the large colonies in Upernavik and Avanersuaq (and one in Disko Bay).
Large numbers of kittiwakes and fulmars, which winter south of Greenland, also move into or pass through the region on their way to breeding grounds in the region or further north.

Summer
There are 14 species of colony breeding seabirds in the study area (Figure 8.5). The most important breeding colonies is the Brünnich's guillemot colony in interior Disko Bay, large colonies of fulmar at western Disko and in Uummannaq Fjord, some large colonies with kittiwakes in northwestern Disko Bay, several large colonies of Arctic terns in Disko Bay and a number of puffin colonies in outer Disko Bay. There are moreover many small colonies of black guillemot, great cormorant, razorbill and common eiders.
In July/August, post-breeders of several duck species gather in the coastal zone for moulting and feeding. Moulting birds loose the ability to fly for 3-4 weeks and are particular sensitive to disturbance and oil spills. The post breeding ducks are common eider (mainly scattered along the coasts and archipelagos for example at Disko and Nuussuaq; Harlequin ducks (moult in small numbers along the exposed rocky shores from Disko and southwards and the most significant, the king eider (they arrive in high number from Canadian breeding areas from late July, and moult in remote fjords and bays).

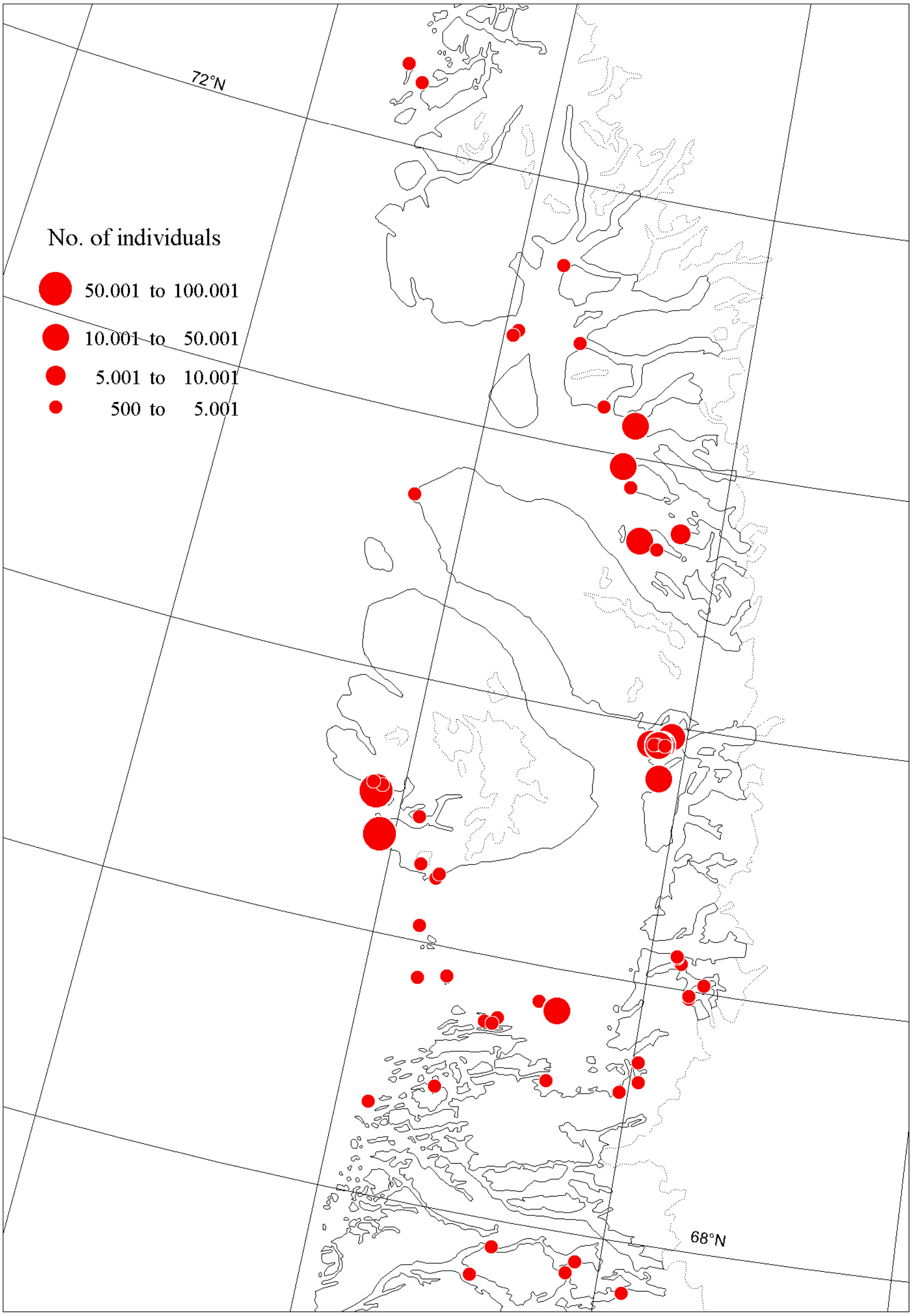


Figure 8.5. Distribution and size of seabird breeding colonies in West Greenland (68° - 72° N). Only colonies with more than 500 individuals included.

During summer the offshore density of seabirds generally is low compared to the autumn and spring period. The most common and widespread specie in summer is the northern fulmar, and most of them are probably non-breeding immature birds. Breeding birds from the coastal colonies of gulls, fulmars and alcids may also occur, although they usually stay closer to the coast

Autumn and winter

During autumn concentrations of different seabird species build up on the banks of the study area. Brünnich's guillemots arrive from the colonies further north and little auks from the colonies in Thule (Avanersuaq).

Table 8.6. Seabird occurrence and activity in the coastal zone and offshore areas between 68° and 72° N.

Specie	Occurrence		Distribution
Fulmar	b/s	April-December	c & o
Cormorant	b/s/w	May-November, entire year in open waters south of Disko Bay	c
Common eider	b/s/m/w	Year-round (in winter only southernmost part)	c
King eider	m w	August-September October-May	c c & o in south
Long-tailed duck	b/m/w	Year-round (only southernmost part in winter)	c
Red-breasted merganser	b/m	May-December	c
Harlequin duck	m	August-September	c (exposed rocky shores)
Kittiwake	b/s	May-November	c & o foraging
Glaucous gull	b/s/w	Year-round	c & o
Iceland gull	b/s/w	Year-round	c & o
Great black-backed gull	b/s/w	Year-round	c & o
Arctic tern	b	May-September	c
Brünnich's guillemot	b/s/w	Year-round (only southernmost part in winter)	c & o
Razorbill	b	May-October	c & o
Puffin	b	May-October	c & o
Black guillemot	b/w	Summer Winter	c c & o
Little auk	b w	May-August September-November	c & o o

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

Increasing ice cover in December-January force the seabirds southward to wintering sites in the southernmost part of the study region or further south along the West Greenland coast and Newfoundland.

8.1.7 Marine mammals

The study area (68°-72° N) is important to many marine mammal species. Table 8.7 gives an overview of the species. Bowhead whales, narwhals, white whales and walrusses are winter visitors occurring in and along the drift ice in Davis Strait and Baffin Bay. Bearded seals concentrate during winter in some parts of the banks. As the ice starts to break up, these winter visitors move north. In May-June minke, humpback, fin and blue whales arrive to the area from the south. Ringed seals occur throughout the year but usually associated with ice. Harp and hooded seals start their migration along the West Greenland coasts in May-June and stay until November/December. These patterns are summarised in Table 8.7.

Table 8.7. Overview of marine mammals present in the study area (68°-72°N).

Specie	Period	Main habitat	Stock size in the area/ occurrence	Protection / exploitation	Species status (IUCN 1996 categories)
Bowhead whale	December-June	Drift ice/ice edge	c. 250	Protected (1940)	Vulnerable*
Minke whale	April-November	whole area	Rather common	Hunting regulated	Lower risk
Humpback whale	July-November	Banks and coastal waters in south	Rather common in south	Protected (1986)	Vulnerable
Fin whale	June-October	Banks and coastal waters	Commons	Hunting regulated	Endangered
Blue whale	June-October	Banks and coastal waters	Few	Protected (1966)	Vulnerable*
Harbour porpoise	June-December	Whole area	Common	Hunting unregulated	Vulnerable
Narwhal	December-April	Pack ice/deep water	Thousands	Hunting unregulated	Unknown
White whale	November-May	Drift ice on banks	Some thousands	Hunting regulated	Vulnerable
Killer whale	Whole year	Whole area	Rare	Hunting unregulated	Lower risk
Sperm whale	May-November	Deep water	Few	Protected (1985)	Vulnerable
Harp seal	May-November	Whole area	Common	Hunting unregulated	Lower risk
Hooded seal	March-October	Whole area	Rather common	Hunting unregulated	Lower risk
Ringed seal	Whole year	Whole area, mainly fjords with ice	Common	Hunting unregulated	Lower risk
Harbour seal	Whole year	Coastal waters	Rare	Hunting regulated	Lower risk**
Bearded seal	Mainly winter	Drift ice	Common	Hunting unregulated	Lower risk
Walrus	February-May	Drift ice on banks	<500	Hunting regulated	Lower risk
Polar bear	February-May	Drift ice	Rare	Hunting regulated	Lower risk

* apply to the Northwest Atlantic stock, ** local population vulnerable

Some of the marine mammals, such as walrus and bearded seal feed on the bottom fauna. Ringed seal, harp seal and harbour seal feed on a broad range of pelagic prey items, whereas hooded seal mainly feed close to the bottom at great depths. Baleen whale feed on krill and smaller schooling fish species, which often are present in the productive upwelling areas of the banks at depths less than 200 m. Toothed whales cover a broader depth range. Harbour porpoise feed on fish in the upper water layers whereas other species e.g. sperm whale and narwhal often dive as deep as 1,000 m to feed.
The only seal, which hauls out on land in the study area, is the harbour seal. Harbour seal occur in archipelagos, on remote skerries and also on the sand banks in the head of undisturbed fjords during summer time. The harbour seal is however rare today.

8.1.8 Archaeological and historic sites

Based on our present knowledge, Greenland seems to have been inhabited almost continuously since 4500 BP. Evidence of the various prehistoric cultures and settlements and use of resources are found almost everywhere along the Greenland coasts. Between 68º and 72º N there are for example some 720 archaeological sites 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 Appendix D). The main part of the 720 sites is coastal and 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 considerations in the event of an oil spill or other activities in connection with raw material exploration and extraction.

8.2 Areas of extreme and high sensitivity

Figure 8.6 shows an overview of the shoreline areas of extreme (red) and high (yellow) sensitivity to marine oil spill. In total there are 41 areas of extreme sensitivity and 53 of high sensitivity.

Included on the map are also the special status areas, which can be affected by a marine oil spill. These comprise the so called Ramsar-areas, wetlands of international importance especially as waterfowl habitats designated according to the Ramsar convention (Boertmann & Egevang 2001) and Ilulissat Isfjord, which is nominated as a UNESCO World Heritage Site (Mikkelsen & Ingerslev 2002).

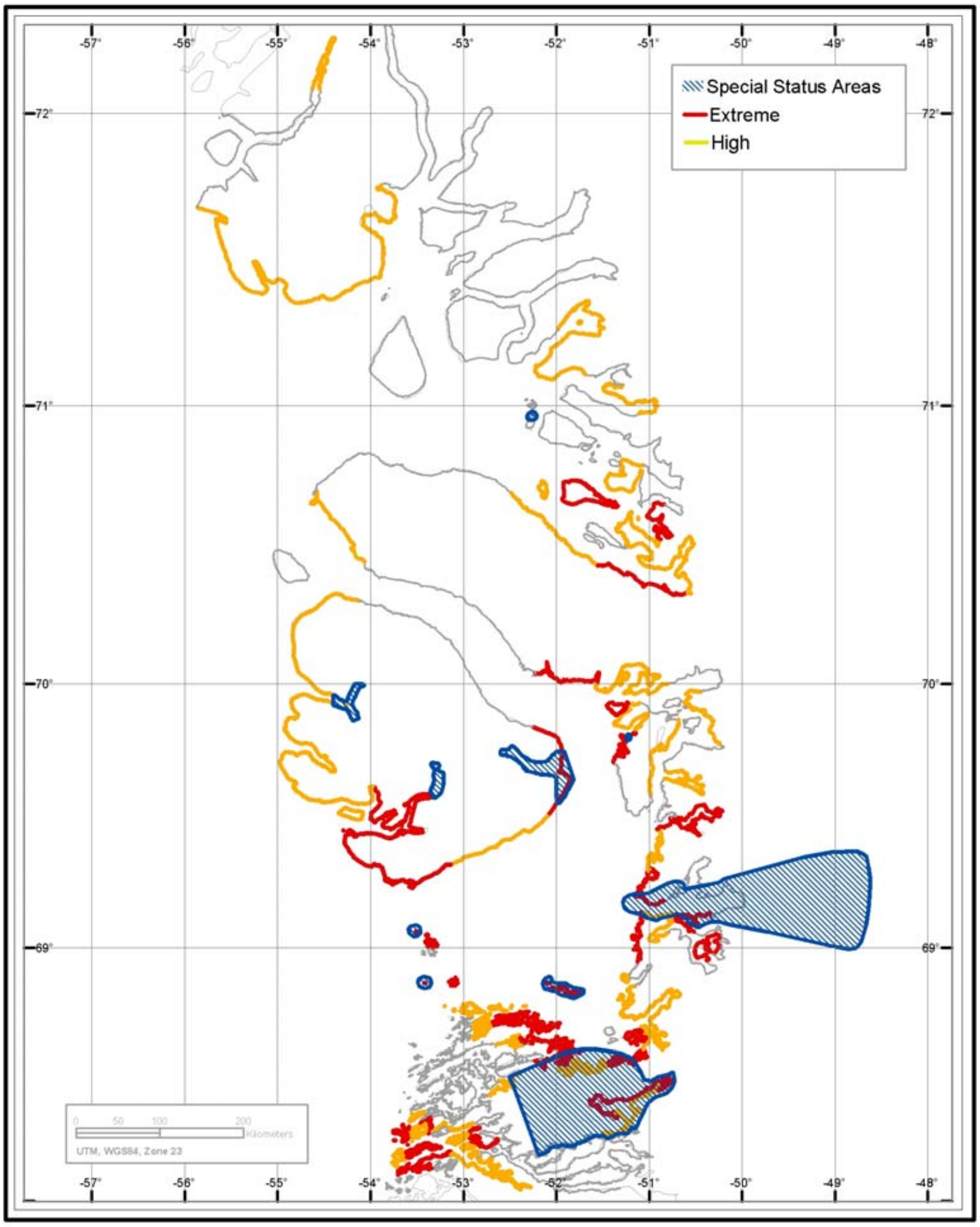


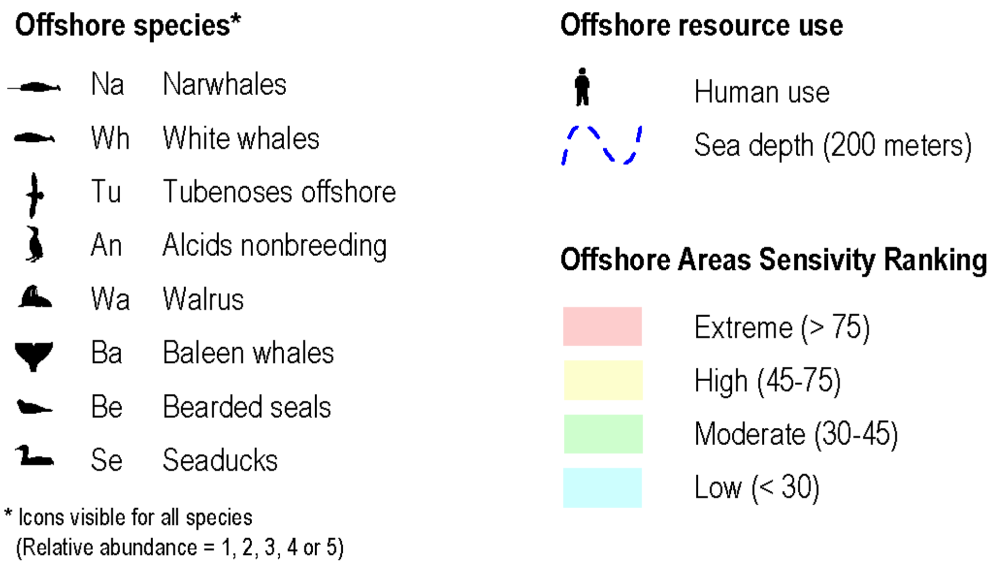
Figure 8.6. Areas of extreme and high sensitivity and special status areas (Ramsar areas and proposed World Heritage Site).

8.3 Offshore sensitivity

This chapter presents the four maps showing the sensitivity of the offshore areas between 68° and 72° N for each of the seasons, winter, spring, summer and autumn.

See Chapter 7 Users Guide for further information on map interpretation.

Legend to the offshore maps (Figures 8.7-8.10):



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Environmental description (Figure 8.7)

Offshore area 19 (OS 19): *Resource use* (**R OS 19**): Fishery (mainly in ice free periods) for deep sea shrimp (very important) and Greenland halibut. Hunting for narwhal, white whale and seals. *Species occurrence*: Wintering white whales (Wh OS 19) and narwhal (Na OS 19).

Offshore area 20 (OS 20): *Resource use* (**R OS 20**): Fishery (in ice free periods) for deep sea shrimp (very important). Hunting for narwhal, white whales and walrus. *Species occurrence*: Wintering white whales (Wh OS 20), narwhal (Na OS 20) and walrus (from February) (Wa OS 20); wintering bearded seal in southern part (Be OS 20); wintering king eider in southern part (Se OS 20) and wintering Brünnich's guillemot and little auk (An OS 20).

Offshore area 21 (OS 21): *Resource use* (**R OS 21**): Hunting for narwhal, white whale and walrus. *Species occurrence*: Wintering white whale (Wh OS 21), narwhal (NA OS 21) and walrus from February (Wa OS 21) wintering bearded seal (Be OS 21).

Offshore area 22 (OS 22): *Resource use* (**R OS 22**): Fishery (in ice free periods) for deep sea shrimp in southern part. Hunting for walrus from February. *Species occurrence*: Wintering white whales (Wh OS 23) and narwhal (Na OS 22).

Offshore area 23 (OS 23): *Resource use* (**R OS 23**): Fishery (in ice free periods) for deep sea shrimp in southern part. *Species occurrence*: Important wintering area for narwhal (NA OS 23).

Offshore area 24 (OS 24): *Resource use* (**R OS 24**): No fisheries or hunting activities are reported from this area. *Species occurrence*: Wintering narwhal (NA OS 24).

Offshore area 25 (OS 25): *Resource use* (**R OS 25**): Fishery (in ice free periods) for deep sea shrimp (mainly in Vaigat mouth). Hunting for narwhal, white whales, seals and walrus. *Species occurrence*: Wintering narwhal (Na OS 25) and walrus (Wa OS 25).

Offshore area 26 (OS 26): *Resource use* (**R OS 26**): Fishery for Greenland halibut. Hunting for narwhal and seals. *Species occurrence*: Wintering narwhal (Na OS 26).

Offshore sensitivity summary, winter

Area	Sensitivity value	Ranking
OS 19	34	moderate
OS 20	140	extreme
OS 21	59	high
OS 22	25	low
OS 23	24	low
OS 24	14	low
OS 25	46	high
OS 26	19	low

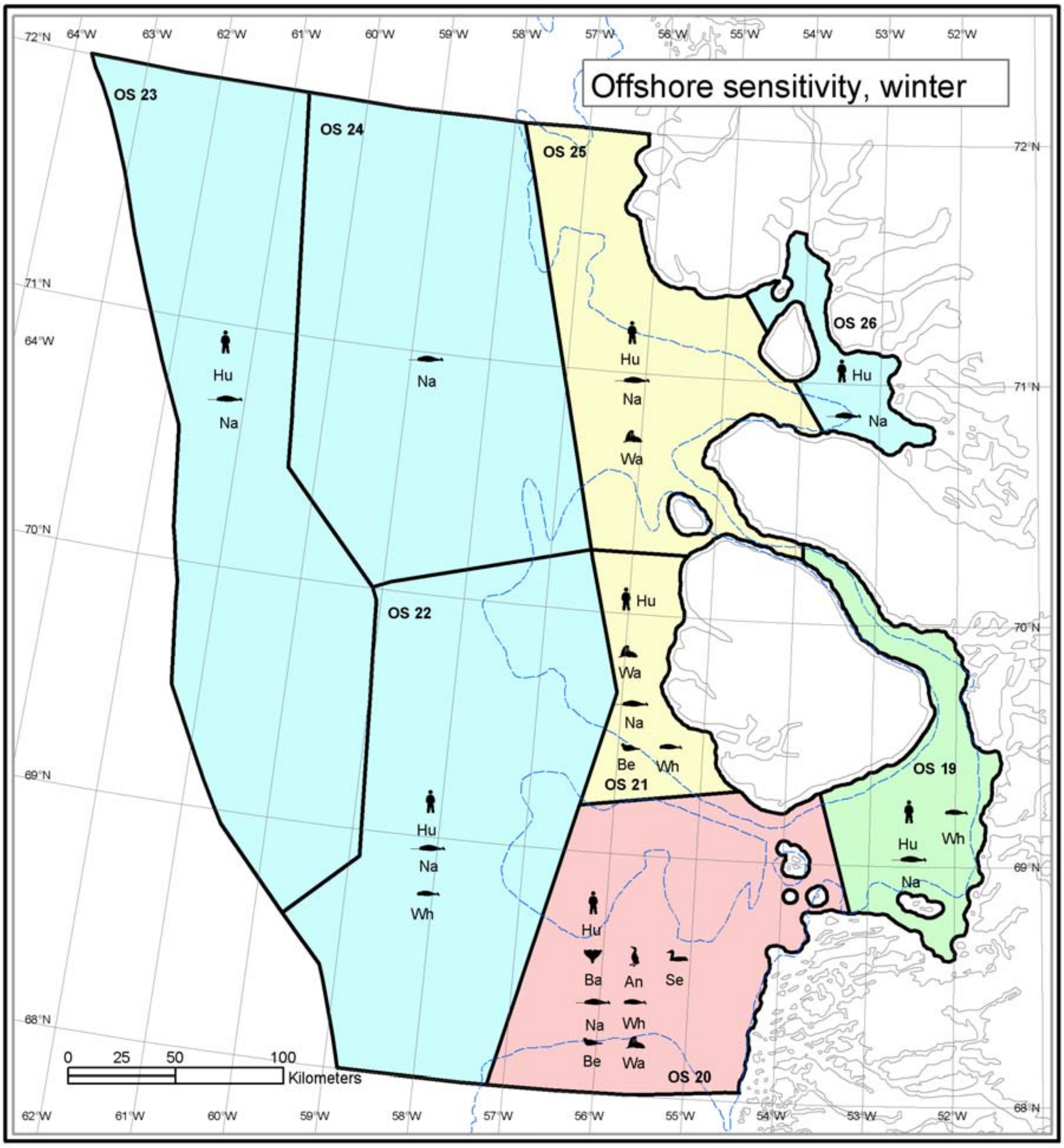


Figure 8.7. Offshore sensitivity in winter. Legend to map on page 8-15.

Environmental description (Figure 8.8)

Offshore area 19 (OS 19): *Resource use* (**R OS 19**): Fishery (mainly in ice free periods) for deep sea shrimp (very important) and Greenland halibut. Hunting for narwhal, white whales and seals. *Species occurrence*: Wintering and spring migrating white whales (Wh OS 19) and narwhal (Na OS 19); spring migrating bowhead whale (Ba OS 19); spring migrating Brünnich's guillemot (AN OS 19) and spring migrating and breeding fulmar (Tu OS 19).

Offshore area 20 (OS 20): *Resource use* (**R OS 20**): Fishery (in ice free periods) for deep sea shrimp (very important). Hunting for narwhal, white whales and walrus. *Species occurrence*: Wintering walrus (Wa OS 20) in southern part; wintering and spring migrating white whales (Wh OS 20) and narwhal (Na OS 20); spring migrating bowhead whale (Ba OS 20); wintering bearded seal (Be OS 20) in southern part; wintering and spring migrating king eider (Se OS 20) in southern part and spring migrating Brünnich's guillemot (An OS 20) and fulmar (TU OS 20).

Offshore area 21 (OS 21): *Resource use* (**R OS 21**): Hunting for narwhal, white whales and walrus. *Species occurrence*: Wintering walrus (Wa OS 21); wintering and spring migrating narwhal (Na OS 21) and white whales (Wh OS 21); spring migrating bowhead whale (Ba OS 21); wintering bearded seal (Be OS 21); spring migrating Brünnich's guillemot (AN OS 21) and breeding fulmar (Tu OS 21).

Offshore area 22 (OS 22): *Resource use* (**R OS 22**): Fishery (in ice free periods) for deep sea shrimp in southern part. Hunting for walrus. *Species occurrence*: Wintering and spring migrating white whales (Wh OS 22) and narwhal (Na OS 22); wintering and spring migrating bowhead whale (Ba OS 22), wintering walrus (Wa OS 22) and spring migrating Brünnich's guillemot (An OS 22) and fulmar (Tu OS 22).

Offshore area 23(OS 23): *Resource use* (**R OS 23**): Fishery (in ice free periods) for deep sea shrimp in southern part. *Species occurrence*: Wintering and spring migrating narwhal (Na OS 23) and spring migrating bowhead whale (Ba OS 23).

Offshore area 24 (OS 24): *Resource use* (**R OS 24**): No fisheries or hunting activities are reported from this area. *Species occurrence*: Spring migrating white whales (Wh OS 24), narwhal (NA OS 24) and bowhead whale (Ba OS 24) and spring migrating Brünnich's guillemot (An OS 24).

Offshore area 25 (OS 25): *Resource use* (**R OS 25**): Fishery (in ice free periods) for deep sea shrimp (mainly in Vaigat mouth). Hunting for narwhal, white whales, seals and walrus. *Species occurrence*: Wintering walrus off Svartenhuk and Nuussuaq (Wa OS 25); spring migrating white whales (Wh OS 25) and bowhead whale (Ba OS 25); wintering and spring migrating narwhal (Na OS 25); spring migrating Brünnich's guillemot (An OS 25) and breeding and spring migrating fulmar (Tu OS 25).

Offshore area 26 (OS 26): *Resource use* (**R OS 26**): Fishery for Greenland halibut. Hunting for narwhal, white whales and seals. *Species occurrence*: Spring migrating white whales (Wh OS 26) and breeding fulmar (Tu OS 26).

Offshore sensitivity summary, spring

Area	Sensitivity value	Ranking
OS 19	69	high
OS 20	161	extreme
OS 21	120	extreme
OS 22	72	high
OS 23	31	moderate
OS 24	43	moderate
OS 25	94	extreme
OS 26	47	high

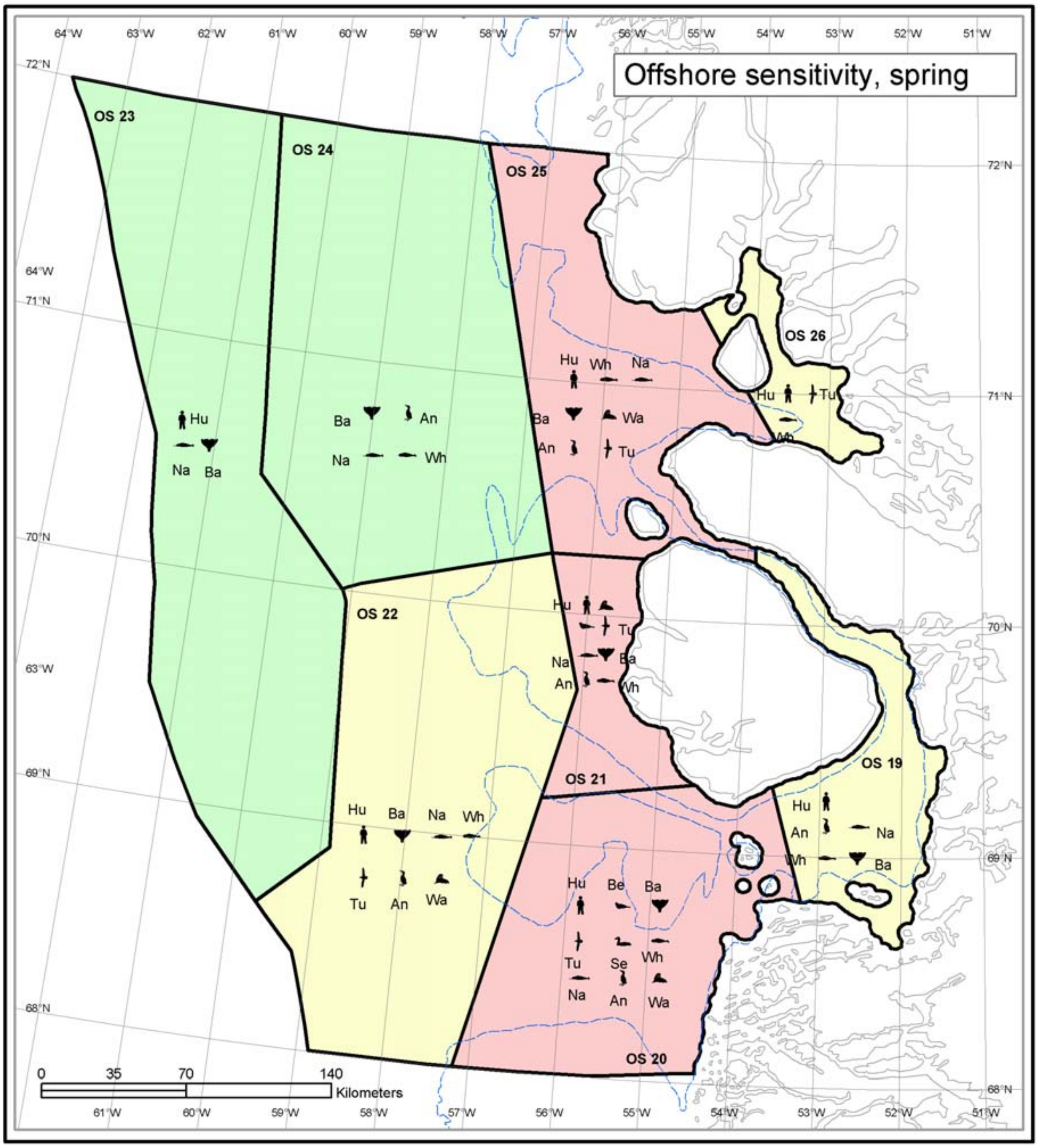


Figure 8.8. Offshore sensitivity in spring. Legend to map on page 8-15.

Environmental description (Figure 8.9)

Offshore area 19 (OS 19): *Resource use* (**R OS 19**): Fishery for deep sea shrimp (very important), Greenland halibut scallop (off east Disko) and snow crab. Hunting for minke whale, fin whale and seals. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 19) and breeding and non-breeding fulmar (Tu OS 19).

Offshore area 20 (OS 20): *Resource use* (**R OS 20**): Fishery for deep sea shrimp (very important), scallop (small amounts near the Disko coast) and snow crab (important). Hunting for minke whale, fin whale and seals. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 20) and breeding and non-breeding fulmar (Tu OS 20).

Offshore area 21 (OS 21): *Resource use* (**R OS 21**): Fishery for scallop (near the Disko coast) and snow crab; hunting for minke and fin whales. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 21) and breeding and non-breeding fulmar (Tu OS 21).

Offshore area 22 (OS 22): *Resource use* (**R OS 22**): Fishery for deep sea shrimp and snow crab in southern part. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 22) and breeding and non-breeding fulmar (Tu OS 22).

Offshore area 23 (OS 23): *Resource use* (**R OS 23**): Fishery for deep sea shrimp in southern part and for Greenland halibut in central part. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 23), breeding and non-breeding fulmars (Tu OS 23) and summering little auk (An OS 23).

Offshore area 24 (OS 24): *Resource use* (**R OS 24**): No fisheries or hunting activities are reported from this area. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 24) and breeding and non-breeding fulmar (Tu OS 24).

Offshore area 25 (OS 25): *Resource use* (**R OS 25**): Fishery for deep sea shrimp and snow crab (mainly in Vaigat mouth). Hunting for minke whale, fin whale and seals. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 25) and breeding and non-breeding fulmar (Tu OS 25).

Offshore area 26 (OS 26): *Resource use* (**R OS 26**): Fishery for Greenland halibut and snow crab. Hunting for minke whale, fin whale and seals. *Species occurrence*: Summering minke, fin and humpback whales (Ba OS 26) and breeding fulmar (Tu OS 26).

Offshore sensitivity summary, summer

Area	Sensitivity value	Ranking
OS 19	46	high
OS 20	30	moderate
OS 21	39	moderate
OS 22	25	low
OS 23	31	moderate
OS 24	18	low
OS 25	25	low
OS 26	29	low

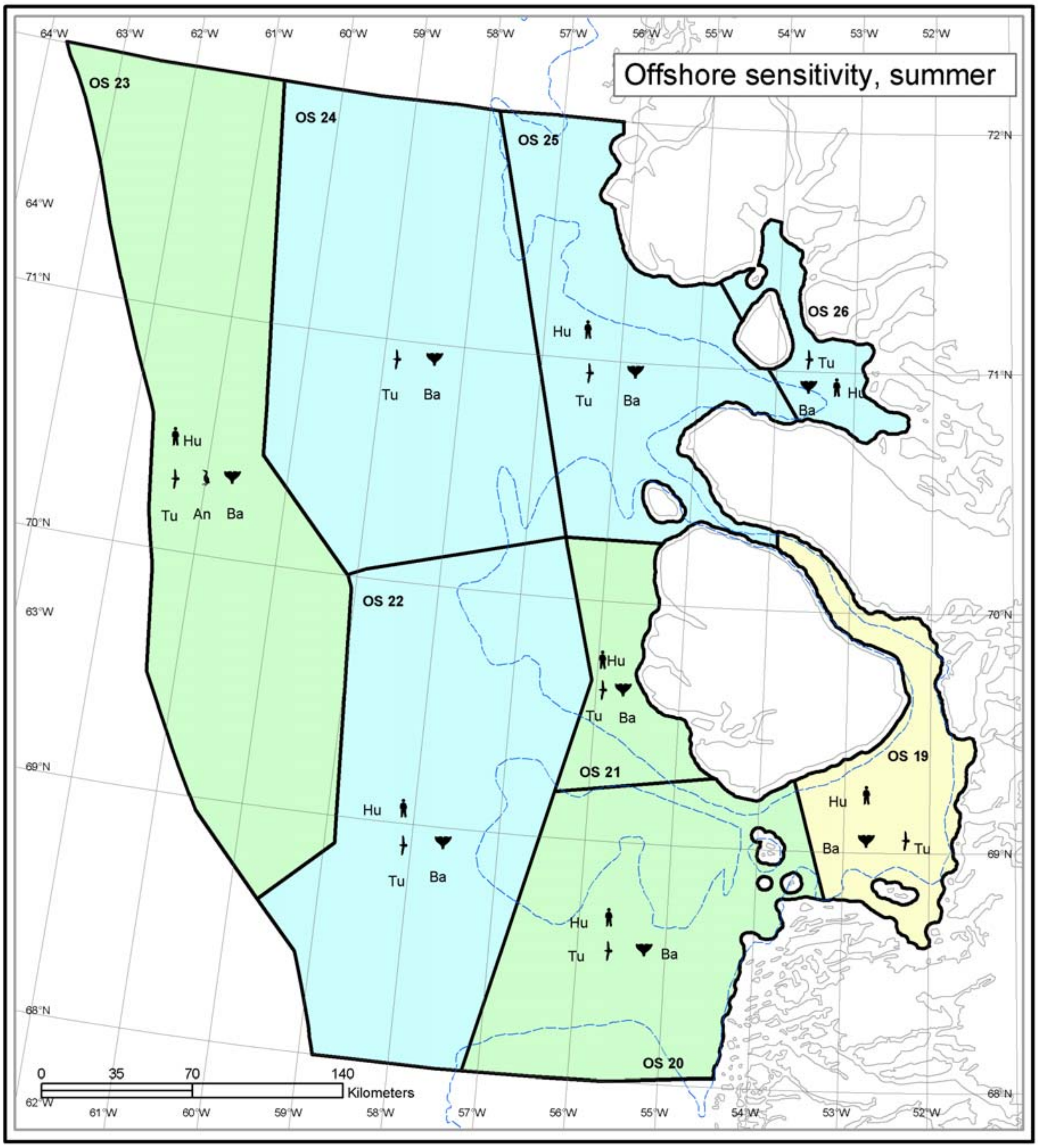


Figure 8.9. Offshore sensitivity in summer. Legend to map on page 8-15

Environmental description (Figure 8.10)

Offshore area 19 (OS 19): *Resource use* (**R OS 19**): Fishery for deep sea shrimp (very important), Greenland halibut, scallop (off east Disko) and snow crab. Hunting for seabirds, narwhal and white whales, minke whale, fin whale and seals. *Species occurrence*: Autumn migrating (from November) and wintering white whales (Wh OS 19) and narwhal (Na OS 19); summering minke, fin and humpback whales until October (Ba OS 19); autumn migrating Brünnich's guillemot (An OS 19) and fulmar (Tu OS 19).

Offshore area 20 (OS 20): *Resource use* (**R OS 20**): Fishery for deep sea shrimp (very important), scallop (small amounts near the Disko coast) and snow crab (important). Hunting for narwhal and white whales, for minke whale, fin whale and seabirds. *Species occurrence*: Autumn migrating and wintering narwhal (from November) (Na OS 20) and white whales (from November) (Wh OS 20); summering minke, fin and humpback whales until October (Ba OS 20); wintering bearded seal in southern part from November (Be OS 20); wintering (from October) king eider in southern part (Se OS 20) and autumn migrating and wintering Brünnich's guillemot, little auk (An OS 20) and fulmar (Tu OS 20).

Offshore area 21 (OS 21): *Resource use* (**R OS 21**): Fishery for scallop (near the Disko coast) and snow crab. Hunting for narwhal and white whales, for minke and fin whales and seabirds. *Species occurrence*: Autumn (from November) migrating and wintering white whales (Wh OS 21) and narwhal (Na OS 21); summering minke, fin and humpback whales until October (Ba OS 21); wintering bearded seal from November and autumn migrating Brünnich's guillemot, little auk (An OS 21) and fulmar (Tu OS 21).

Offshore area 22 (OS 22): *Resource use* (**R OS 22**): Fishery for deep sea shrimp in southern part. *Species occurrence*: Autumn (from November) migrating white whales (Wh OS 22) and narwhal (Na OS 22); summering minke, fin and humpback whales until October (Ba OS 22); autumn migrating Brünnich's guillemot, little auk (An OS 22) and fulmar (Tu OS 22).

Offshore area 23 (OS 23): *Resource use* (**R OS 23**): Fishery for deep sea shrimp in southern part and for Greenland halibut in central part. *Species occurrence*: Autumn (from November) migrating and wintering narwhal (Na OS 23); autumn migrating Brünnich’s guillemot, little auk (An OS 23) and fulmar (Tu OS 23).

Offshore area 24 (OS 24): *Resource use* (**R OS 24**): No fisheries or hunting activities are reported from this area. *Species occurrence*: Autumn (from November) migrating white whales (Wh OS 24) and narwhal (Na OS 24); autumn migrating Brünnich's guillemot, little auk (An OS 24) and fulmar (Tu OS 24).

Offshore area 25 (OS 25): *Resource use* (**R OS 25**): Fishery for snow crab and deep sea shrimp (mainly in Vaigat mouth). Hunting for narwhal and white whales, seals, and seabirds. *Species occurrence*: Autumn (from November) migrating white whales (Wh OS 25); autumn (from October) migrating and wintering narwhal (Na OS 25) and autumn migrating Brünnich's guillemot, little auk (An OS 25) and fulmar (Tu OS 25).

Offshore area 26 (OS 26): *Resource use* (**R OS 26**): Fishery for Greenland halibut and snow crab. Hunting for narwhal and white whale, seals and seabirds. *Species occurrence*: Autumn (from November) migrating white whales (Wh OS 26) and narwhal (Na OS 26) and autumn migrating Brünnich's guillemot, little auk (An OS 26) and fulmar (Tu OS 26).

Offshore sensitivity summary, autumn

Area	Sensitivity value	Ranking
OS 19	87	extreme
OS 20	84	extreme
OS 21	91	extreme
OS 22	65	high
OS 23	45	moderate
OS 24	45	moderate
OS 25	51	high
OS 26	36	moderate

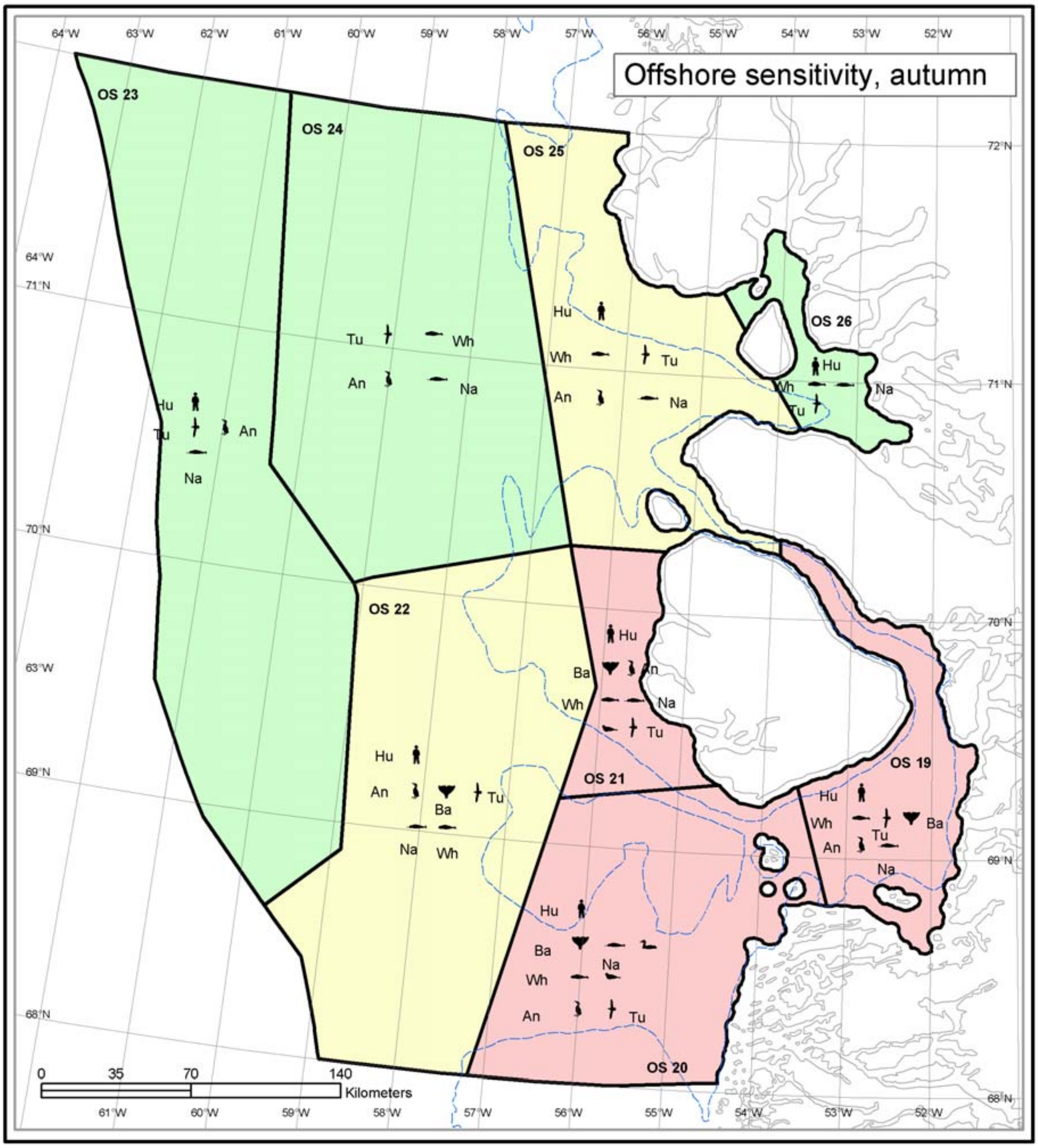


Figure 8.10. Offshore sensitivity in autumn. Legend to map on page 8-15.

8.4 Offshore ice zones and ice edges in Davis Strait and West Greenland waters (60°-72° N)

8.4.1 Definitions and terminology

This chapter (8.4) apply to entire West Greenland from Cape Farewell in the south (app. 60° N) to southern Upernavik municipality at 72° N.

The following description of the sea ice environment contains a number of terms describing the sea ice thickness or stage of development, as defined by World Meteorological Organisation.

Ice types:	Thickness	WMO-code (Egg-code)
New ice-frazil, grease, slush, shuga	0-10 cm	1
Nilas, ice rind	0-10 cm	1-2
Young ice	10-30 cm	3
Grey ice	10-15 cm	4
Grey-white	15-30 cm	5
First year ice	30-200 cm	6
Thin first year ice	30-70 cm	7
Medium first year ice	70-120 cm	1•
Thick first year ice	120-200 cm	4•
Multi year ice	>2 m	7•

8.4.2 The "West Ice"

The ice conditions between 60° N and 72° N are primarily determined by the relatively warm north or northwest flowing West Greenland Current (WGC) and the cold south flowing Baffin Current (BIC). The WGC delays the time of ice formation in eastern Davis Strait and results in an earlier break up than in the western parts of the Davis Strait (Figure 8.11). The BIC conveys large amounts of sea ice from Baffin Bay to the Davis Strait and the Labrador Sea for most of the year, especially during winter and early spring. During this period sea ice normally covers most of the Davis Strait north of 65° N, except areas close to the Greenland coast, where a flaw lead (open water or thin ice) of varying width often appears between the shore or the fast ice and the drift ice offshore as far north as latitude 67° N**.** South of 65-67° N sea ice free areas dominate throughout the year. The sea ice edge (the boundary between the drift ice and the ice-free water) is normally oriented southwest towards Hudson Strait or the Labrador Coast. In the beginning of the melt season a wide lead or polynya-like feature often forms west of Disko Island in front of Disko Bay. The eastern part of Davis Strait, south of Disko Island, is free of sea ice during this period (Figure 8.14), whereas drifting ice is dominating to the west and north. In Greenland this ice regime is recognised as the 'The West Ice' (Figure 8.12a & b).

The predominant sea ice type in the Davis Strait and the southern Baffin Bay is first-year ice. Small amounts of multi year ice of Arctic Ocean origin drift to the western parts of the area from Lancaster Sound or Nares Strait, however, the multi year ice from these waters does not usually reach the West Greenland shores. At the end of the freeze up season first year ice in the thin and medium categories dominate in eastern parts (up to about 100 km from the Greenland coast). The western and central parts of Davis Strait and southern Baffin Bay are dominated by medium and thick first year ice mixed locally with small amounts (1-3 tenths) of multi year ice.

The dominant size of ice floes range from large floes of about 1 kilometre wide to vast floes larger than 10 km. Near the ice edge in Davis Strait the size of the common floes are reduced to less than 100 meters as a result of melting and break up by waves. These floes are often very consolidated.

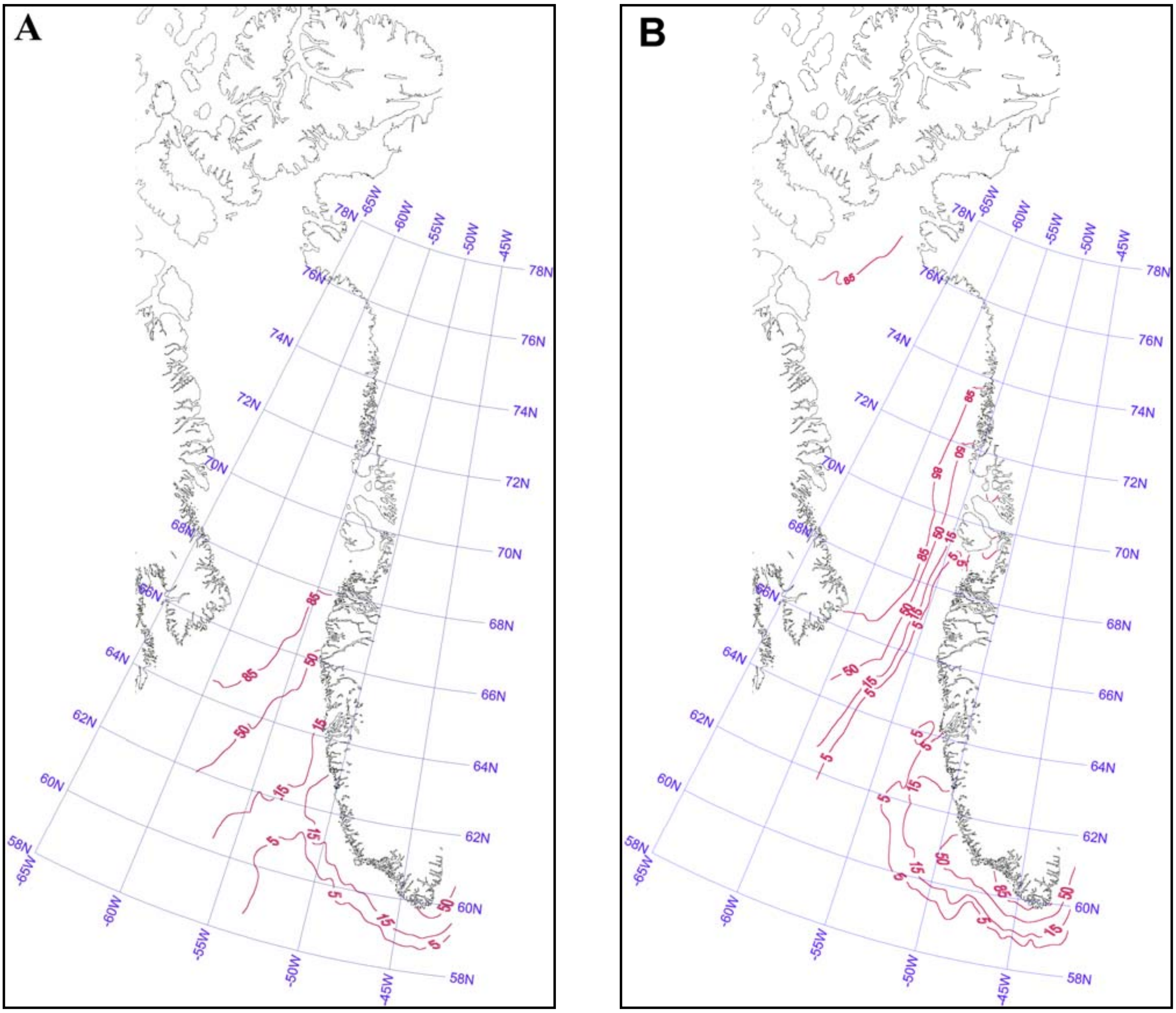
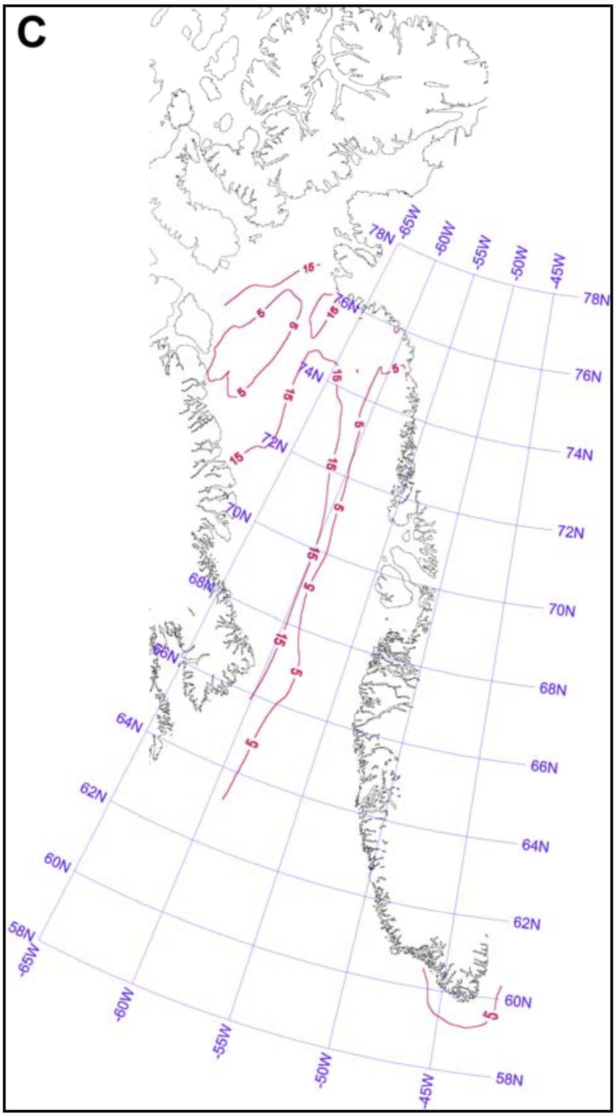


Figure 8.11. Probability of sea ice in West Greenland waters based on data from the period 1960-96. (A) March 1st, (B) June 4th, (C) September 3rd and (D) December 3rd (Data sources: Danish Meteorological Institute and Canadian Ice Service).



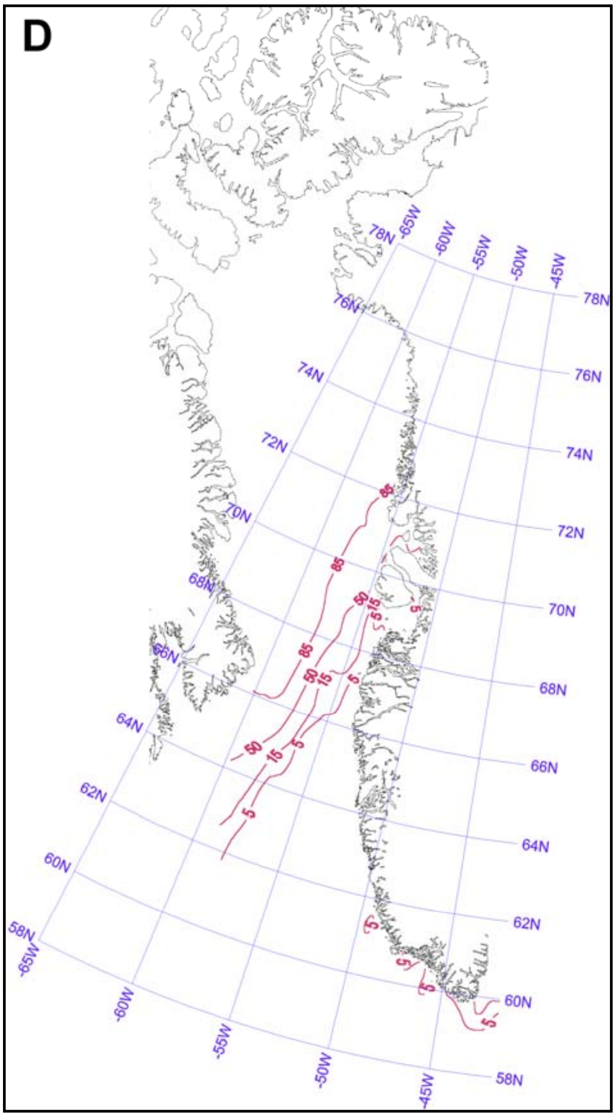


Figure 8.11 (cont.). Probability of sea ice in West Greenland waters based on data from the period 1960-96. (A) March 1st, (B) June 4th, (C) September 3rd and (D) December 3rd (Data sources: Danish Meteorological Institute and Canadian Ice Service).

Figure 8.12a. Typical winter phenomenon in eastern Davis Strait, February 26th 1999 at a position near (66° N, 55° W). Convection clouds develop rapidly near the sea ice edge when cold air masses meet the warm sea surface (Photo: Keld Q. Hansen).

Figure 8.12b. The 'West Ice', eastern Davis Strait, February 26th 1999 at a position near (66° N, 57° W), normally consists of large floes of a variety of ice types ranging from young (grey) ice to thin/medium first-year ice. Cracks and leads indicate that the ice is drifting (Photo: Keld Q.Hansen).

8.4.3 Multi year sea ice ("Storis" from the Greenland east coast)

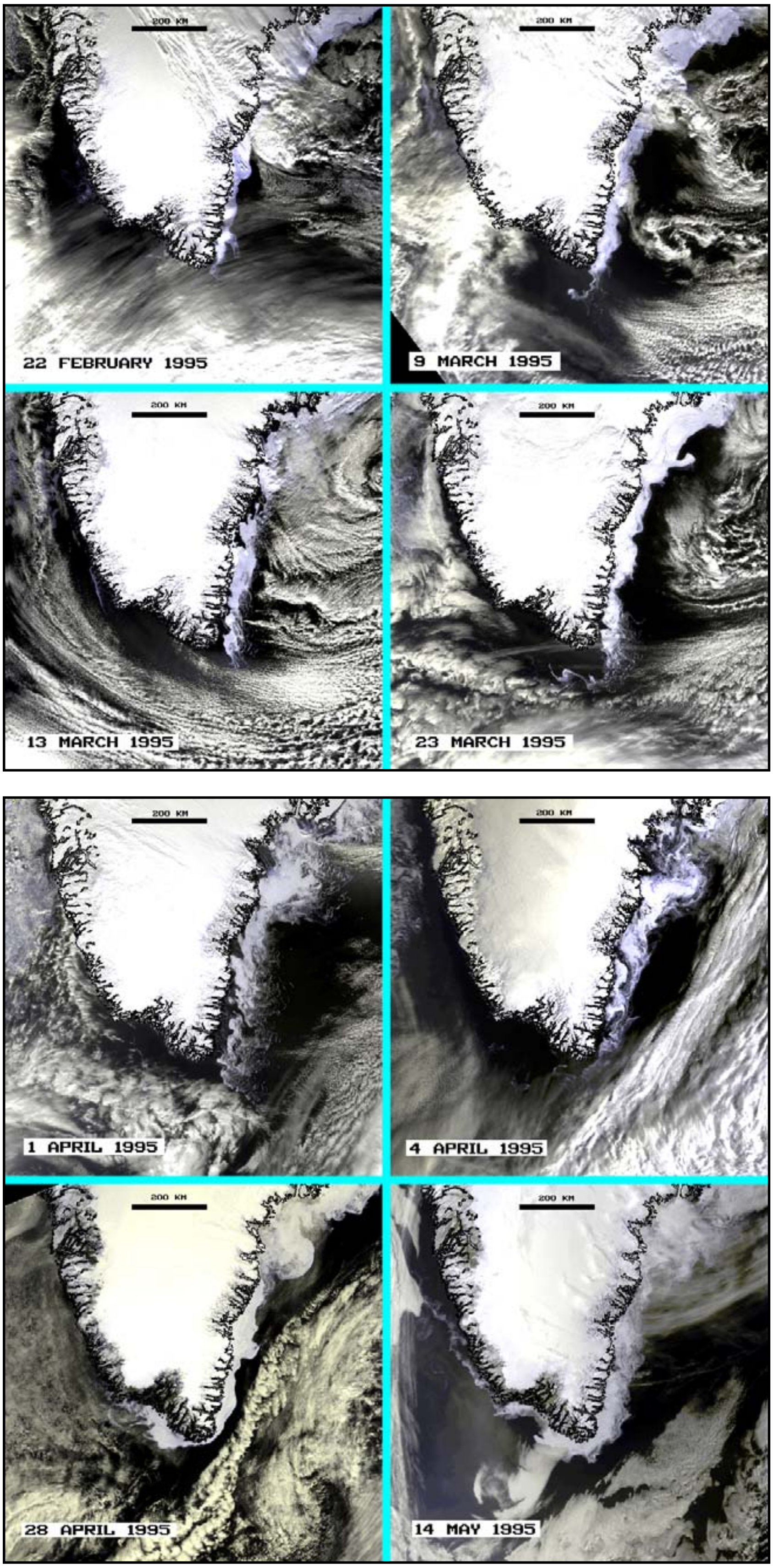
A wide belt of multi year sea ice originating from the Arctic Ocean is normally present most of the year covering the entire east coast of Greenland. Under normal conditions the multi year ice reaches the Cape Farewell area in December-January, depending on the intensity of the East Greenland Current and the amount of ice in it. The track and intensity of low pressure systems in the North Atlantic Ocean also influence the distribution of sea ice near Cape Farewell (Figure 8.13).

Due to long periods with strong northwestern winds resulting from cold air outbreaks from northern Canada during the winter, the ice often only pass by Cape Farewell for short periods. The amount of multi year ice in South Greenland waters peaks in early summer. The intensity of the atmospheric normally decrease in spring and summer and may cause the multi year ice to drift north-westwards together with the West Greenland Current along the Southwest Greenland coast. The width, concentration, and position of this ice belt vary from year to year. Some years the ice never passes Nunarsuit, while other years it passes Nuuk and the 'Fyllas Bank' area. The northernmost position of the multi year ice on the west coast is normally situated around Paamiut (Frederikshåb) at 62° N. These waters are normally free of sea ice from early August. The diameters of the multi year ice floes are always less than 100 m and normally about 5 to 20 meters. When multi year ice occurs off Southwest Greenland, it is usually characterised by low or medium concentrations when averaged over large areas, however, long, narrow belts of high concentrations are also common. In Greenland this ice regime is known as the 'Storis' ('Great Ice'), mainly because of the thickness of the ice. However, the key word for the sea ice distribution in the South Greenland waters is *variability* due to strong ocean currents and severe weather, which characterise the area.

8.4.4 Sea ice drift

The drift pattern of the sea ice off West Greenland is not very well known. The local drift is to some extent controlled by the major surface current systems, the West Greenland Current and Baffin Current, however, the strength and direction of the surface winds also affect the local drift of sea ice, especially in the southern waters.

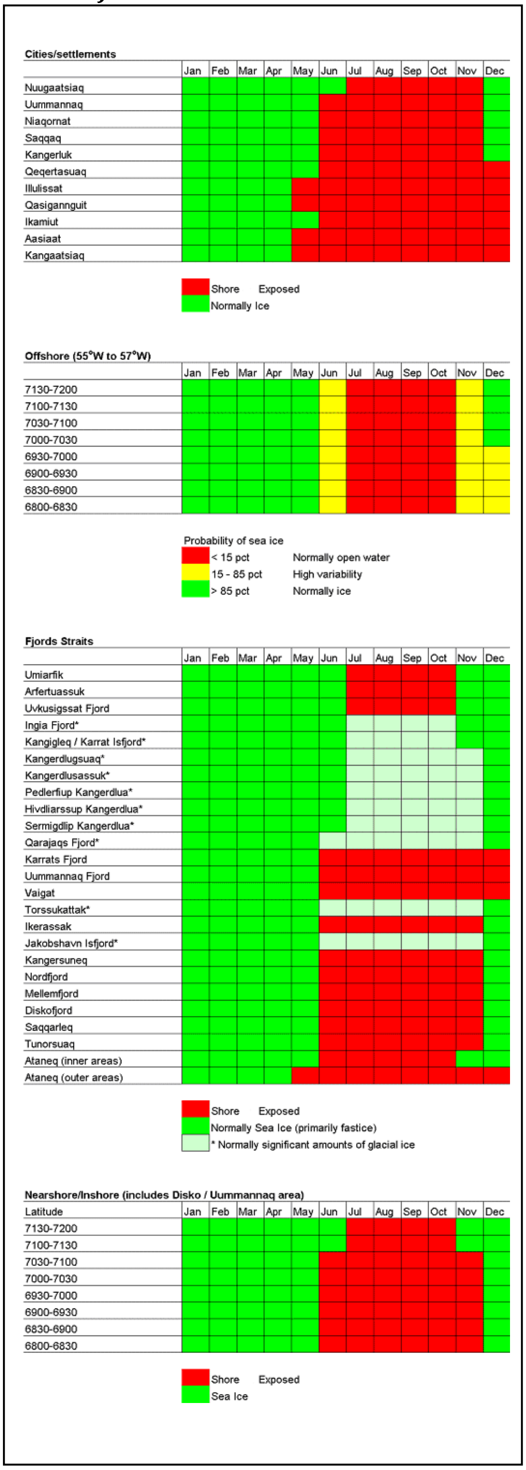
Figure 8.13. The end of the freeze-up season 1994/95. Some of the characteristic physical features:



- The 'West Ice' covers most of the Davis Strait including the 'Fyllas Bank' area, but open water areas occur north of Nuuk.
- Close to the Southwest Greenland coast sea ice often forms locally, but it is very dependent on the air temperature and the salinity stratification in the sea. Due to the changeable winds in the area this kind of ice cover normally only exists for short periods (less than one week).
- Large amounts of 'Storis' off the east coast of Greenland. Depending on the dominant wind direction the ice from time to time drifts far south of Cape Farewell. In March 1995, multi year ice was reported south of 58° N, more than 200 km from the Greenland coast, but only for a few days.

The maximum coverage of the 'West Ice' occurred in early April this year (1995). March 31st and April 1st a very violent meteorological event was observed. The pass of an atmospheric low southeast of Greenland caused 'Piteraq' (very strong katabatic winds) on most of the east coast, and this event affected the sea ice dramatically as can be observed on the satellite image. After a few days the ice conditions were back to a normal state again. From late April the 'Storis' covered most of the Julianehåb Bay and drifted later to the Davis Strait area due to dominant weak or southeasterly winds.

8.5 Fjord and coastal ice freeze-up and break-up



Isolated from the offshore ice conditions, sea ice forms locally through the winter in most West Greenland fjords. Generally freeze-up begins at the inner parts of the fjords in November or December, but the ice formation can be significantly affected by very low temperatures or a formed ice cover can be reduced by very strong winds in the fjords throughout the winter.

The presence of a sea ice cover can protect the West Greenland shores and fjords from offshore oil spills. Although large local differences are to be expected, the southern shorelines (Disko Bay) are generally free of sea ice from late May until November or December. Towards the north (Uummannaq Fjord) the ice free periods generally persist from mid June until November.

Based on historical ice charts and satellite data (Radarsat SAR and NOAA-AVHRR) it is possible to evaluate the shores likely to be susceptible to oil exposure through the year. The result of this evaluation is shown in the figure below (Figure 8.15). It is important to note that the maps and tables in this section will not necessarily reflect the actual conditions of oil exposure i.e. in a very mild winter or during exceptional oceanographically conditions. In addition strong winds frequently occur along the shorelines, resulting in a local break up of fast ice. Each figure represents the middle part of the particular month. The West Greenland (68°-72° N) shore was divided into four subgroups. A study of the potential oil exposure was conducted for each of them (Figure 8.14):

- cities/settlements,
- offshore areas between 10-20 nautical miles from the coast,
- major fjords,
- the near shore environment.

Due to the natural behaviour and variability of the sea ice of the area the tables and charts for potential oil exposure may only be regarded as guidance to the expected ice conditions at that particular time of the year.

Figure 8.14. The West Greenland (68°-72° N) shore was divided into four subgroups. A study of the potential oil exposure was conducted for each of them:

- cities/settlements,
- offshore areas 10-20 nautical miles from the coast,
- major fjords,
- the near shore environment.

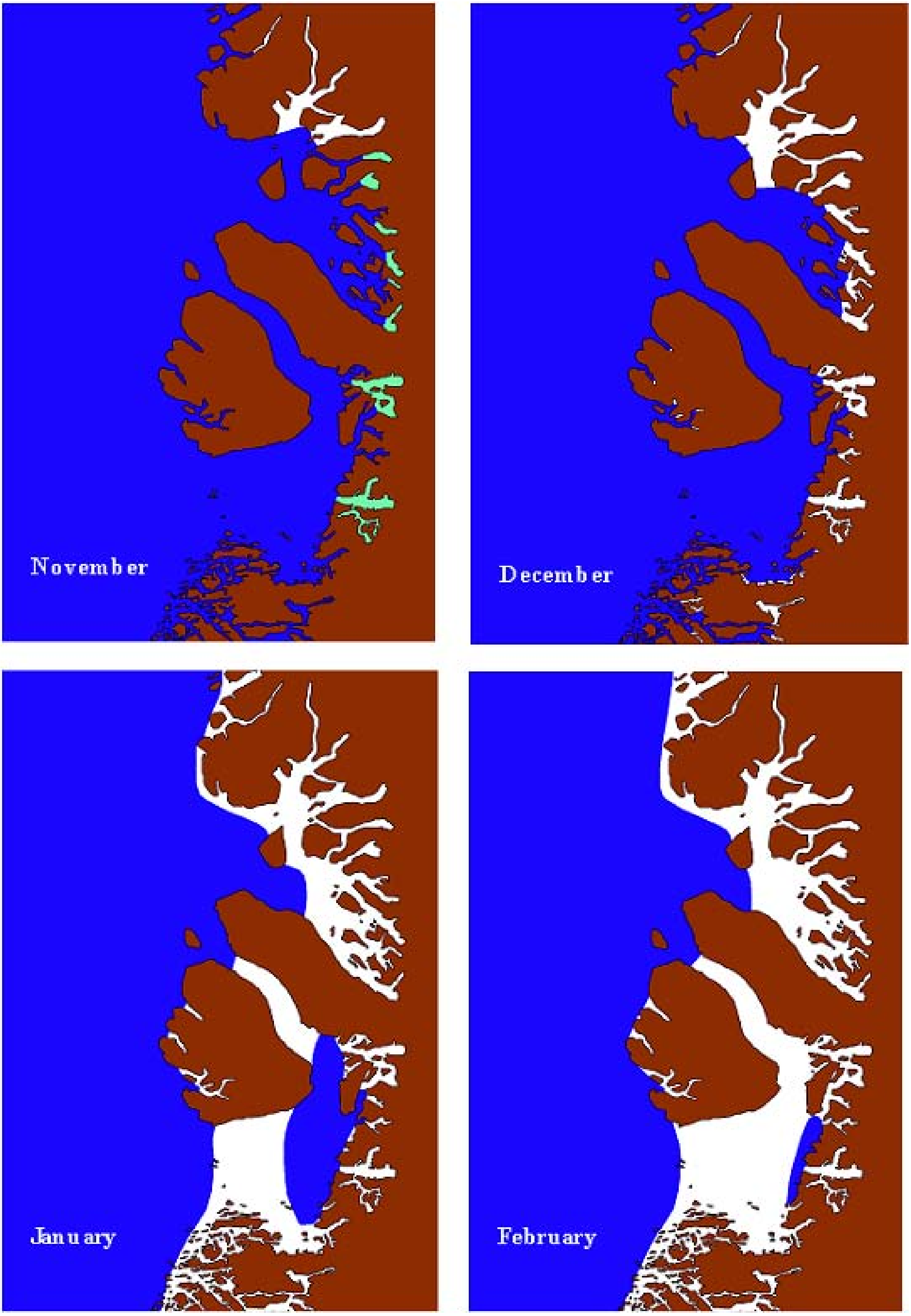


Fig. 8.15. Distribution of fast ice (white) and glacier ice (pale green) in northern West Greenland.

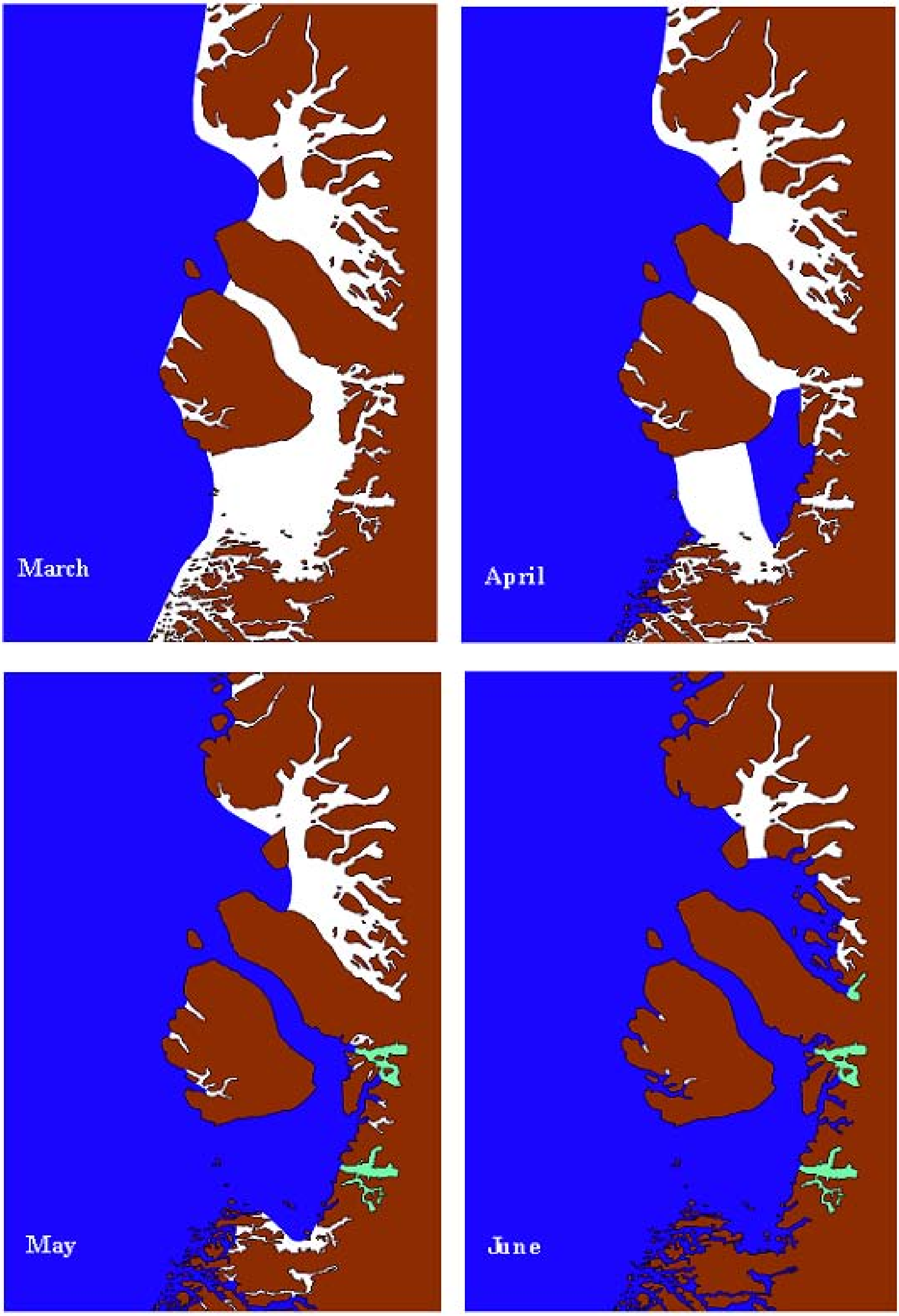


Figure 8.15 (cont.). Distribution of fast ice white) and glacier ice (pale green) in northern West Greenland.

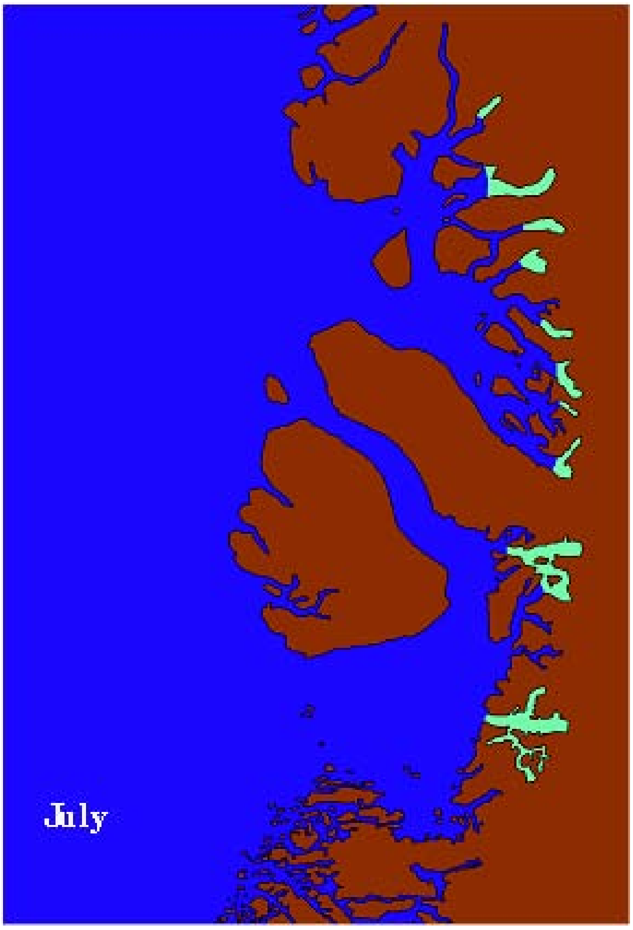


Figure 8.15 (cont.). Distribution of fast ice (white) and glacier ice (pale green) in northern West Greenland.

8.6 Summary of regional observations of sea ice in northern West Greenland (68°-72° N)

8.6.1 Uummannaq Fjord

Most of Uummannaq Fjord is normally covered with fast ice from late December until late May/early June. The medium first-year ice category is reached in the areas northwest, north and east of Ubekendt Ejland at the end of the freeze-up season. Freeze-up begins in the small fjords in the area in early November.

8.6.2 Baffin Bay, west of Ubekendt Ejland

During winter and spring, the water west of or near Ubekendt Ejland mark the shear zone between the fast ice in Uummannaq Fjord and the mobile drift ice in southeastern Baffin Bay. When sea ice is present, the area is characterised by large ice floes primarily in the thin first-year ice category. Sea ice normally is present from December until June. Wide leads or large ice free areas are also common, which is an indication of the complexity of the surface currents. During the freeze-up and break-up season, sea ice drifts out of Uummannaq Fjord.

8.6.3 Vaigat and Disko Bay

During winter sea ice normally forms in early January and melts again during May or early June, depending on the severity of the previous winter. Fast ice is generally formed in midwinter in periods of cold and calm weather conditions. Sea ice appears earlier and melts later close to the coast in southeastern Disko Bay than in the rest of the Disko Bay area. The melt and break-up of the fast ice or consolidated ice in Disko Bay is often a 'pincers process', starting from the waters around Kronprinsens Ejland and east of Disko Island. This process is mainly controlled by the anticlockwise surface currents in the Disko Bay. The occurrence of sea ice in Disko Bay can be summarised as follows:

Mild winters: freeze-up early February, young ice and thin first-year ice, mostly large drift ice floes, free of sea ice early May.

Normal winters: freeze-up mid January, young ice and thin first-year ice, very large floes or fast ice, free of sea late May.

Cold winters: freeze-up late December, thin first-year ice, mostly fast ice except in the break-up season, free of sea late June. The latest report of sea ice in Disko Bay since 1958 is early July (1970).

8.6.4 Davis Strait, west of Disko Island

The waters west of Disko Island and around Hareøen are normally free of sea-ice from mid June to mid November, however, belts of sea ice occasionally drift from the central parts of southern Baffin Bay to the area during summer. An 'ice bridge' often occurs northwest of Disko Island due to onshore currents west of Nuussuaq, even when large open water areas are present west of Uummannaq Fjord and Svartenhuk. When sea ice is present, the area is characterised by large floes of thin first year ice, however the ice cover is very variable, and large open water areas or large areas with young ice only occur from time to time.

8.6.5 Davis Strait, west of Aasiaat and Disko Bay

Kronprinsens Ejland south of Disko Island marks a north-south boundary between the ice regime of Disko Bay and the ice regime southwest of Disko Island. Here the sea ice is characterised by the young and thin first-year ice categories. The ice concentrations vary depending on the local meteorological conditions. Sea ice normally occurs from mid December until early May. In normal winters, a second west-east oriented 'ice bridge' consisting of high concentrations of slowly moving drift ice forms west of Aasiaat at 68° N, primarily due to the onshore component of the surface current. During the summer, belts of remaining sea ice in the central parts of Davis Strait occasionally drift close to the Greenland coast.

8.7 The West Greenland iceberg environment

This section applies to entire West Greenland from Cape Farewell in south (app. 60º N) to Melville Bay in the north (74º N).

To shipping the most dangerous aspect of ice in the sea is the occurrence of icebergs. They differ from sea ice in many ways:

- they originate from land,
- they produce fresh water when melting,
- they are deep-drafted with appreciable heights above sea level,
- they are always considered as an intense local hazard to navigation and offshore activity.

The process of calving from the front of a glacier produces an infinite variety of icebergs, bergy bits and growlers with calving occurring throughout the year. Icebergs are described by their size according to the following classification:

Type	Height (above sea level)	Length
Growler	less than 1 m	up to 5 m
Bergy bit	1 to 5 m	5 to 15 m
Small iceberg	5 to 15 m	15 to 60 m
Medium iceberg	16 to 45 m	61 to 120 m
Large iceberg	46 to 75 m	121 to 200 m
Very large iceberg	over 75 m	over 200 m

The production of icebergs on a volumetric basis varies only slightly from year to year. Once calving is accomplished, meteorological and oceanographic factors begin to affect the icebergs. Icebergs are carried by sea currents directed by the integrated average of the water motion over the whole draft of the iceberg. However, wind also plays an important role, either directly or indirectly.

8.7.1 Iceberg sources

Glaciers are numerous in West Greenland, however, the productive glaciers are concentrated between Nares Strait and Disko Bay. Although icebergs occur throughout West Greenland waters between 60° N and 72° N, they are rare in some areas, e.g. off Sisimiut. In other areas, e.g. in Disko Bay, hundreds of icebergs are always present (Figure 8.16 and 8.17).

Eastern Baffin Bay north of Upernavik is a major source of icebergs. More than 10,000 icebergs are calved from 19 major glaciers every year (Figure 8.18). Some of these are capable of producing icebergs of about 1 kilometre in diameter. Several active glaciers in Uummannaq Fjord and Disko Bay produce 10-15,000 icebergs per year, and they are very important for the iceberg input to the northern Davis Strait and Baffin Bay. The most active glacier is located near Ilulissat moving at the rate of 20 m/day. This glacier produces over 20 km^3 of ice per year. The total annual production of icebergs calved in the Baffin Bay and the northern Davis Strait is estimated to be about 25-30,000, estimates however vary up to as many as 40,000. Surveys conducted by USCG International Ice Patrol decades ago indicate that the total number of icebergs in Baffin Bay and the northern Davis Strait are of the same order of magnitude. Almost no icebergs are produced south of Disko Bay. Here the fjords are longer, narrower and shallower than in the northern areas of the Greenland west coast, and the calving is in the form of growlers and bergy bits rather than icebergs. Growlers and bergy bits nearly always melt before reaching the open sea. However, from time to time the glacier in Narsalik Fjord produces ice, which affects offshore areas for a couple of days.

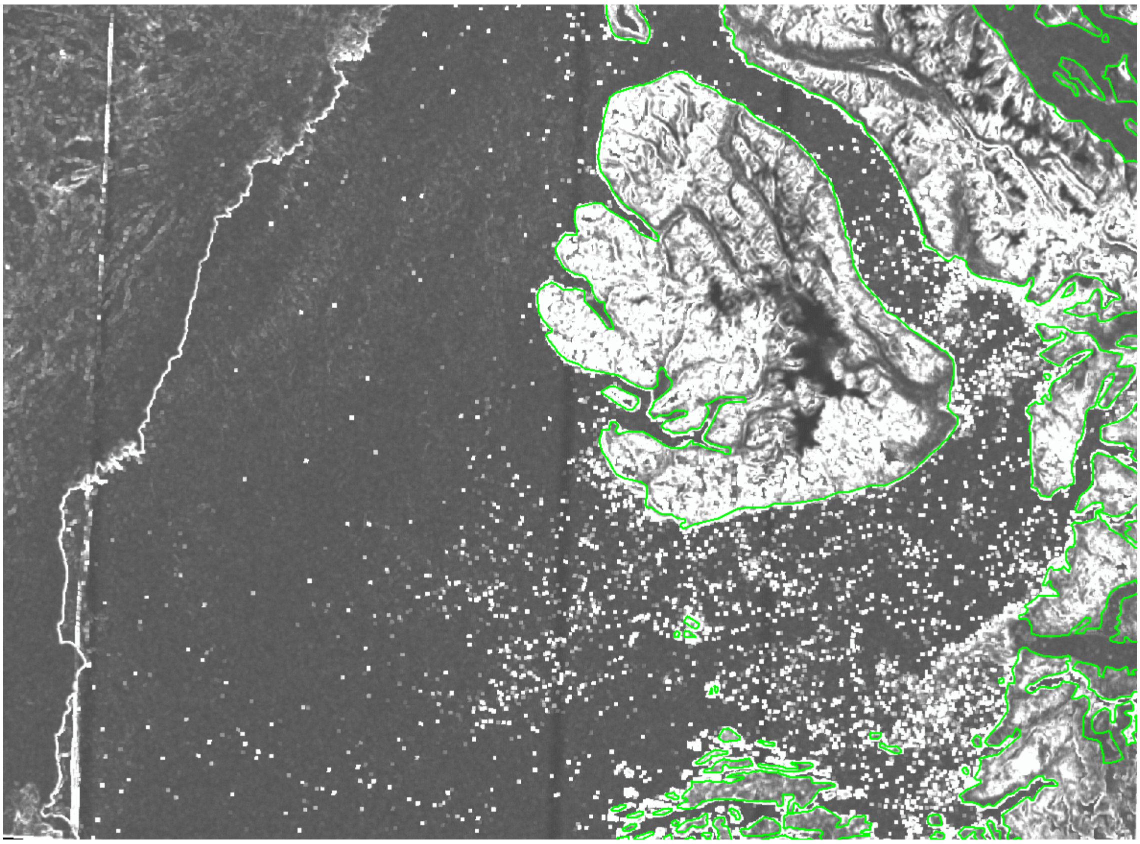


Figure 8.16. Radarsat PMR-filter image from June 14th 1999, 20 UTC of the Disko Bay area showing the distribution of targets (icebergs). The 'West Ice' - edge is found in the western part of the image (source: Radarsat).

Figure 8.17. June 12th 1997. Glacial Ice, primarily small icebergs and bergy bits, from one of the major sources in northeastern Disko Bay, Torsukattak, which produces about 16 km^3 ice/year (Photo: Keld Q. Hansen).

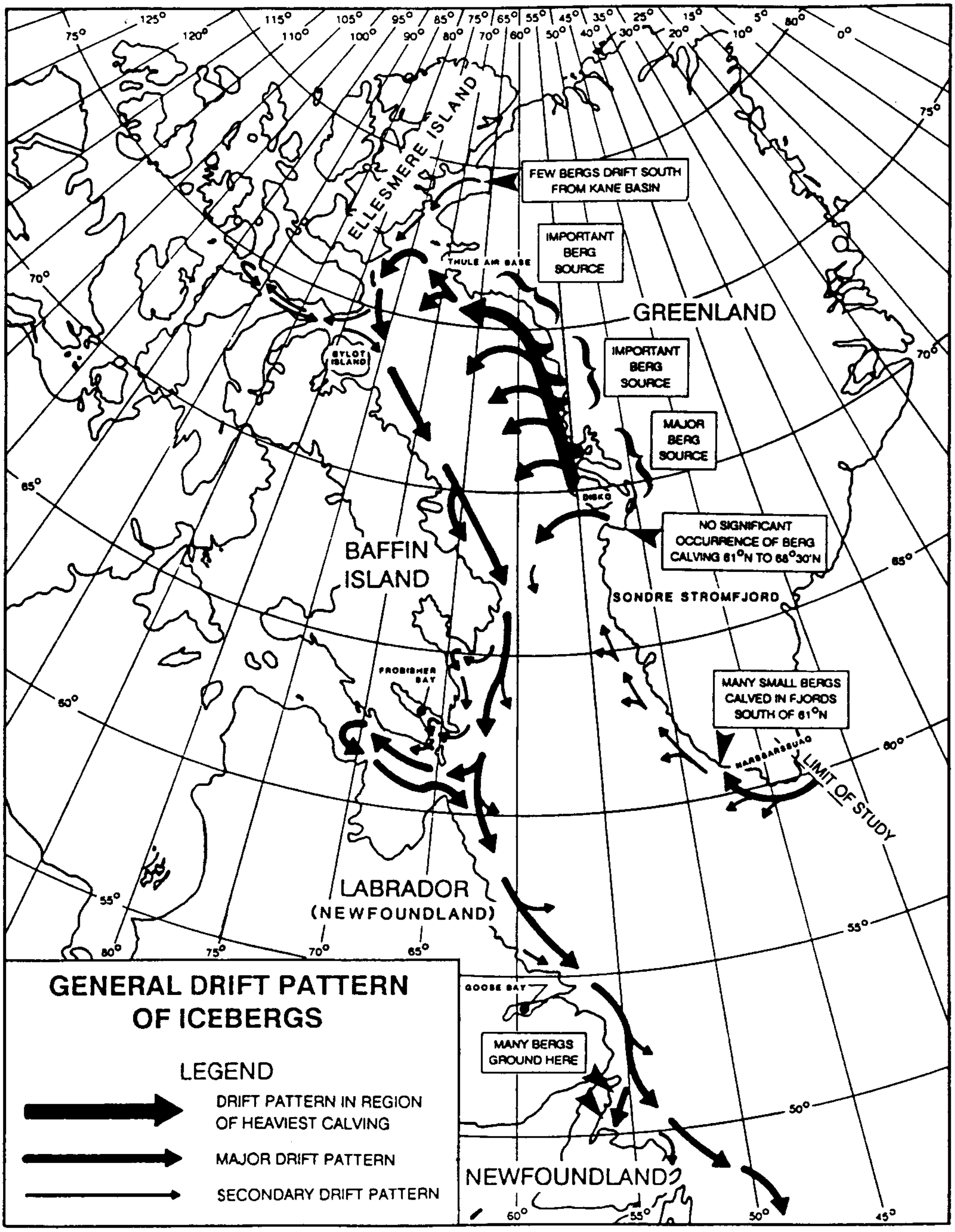


Figure 8.18. Major iceberg sources and general drift pattern in the West Greenland waters (US National Ice Center, Washington DC).

8.7.2 Iceberg drift and distribution

On a large scale the basic water currents and drift of icebergs in Baffin Bay and northern Davis Strait are fairly simple. There is a north-flowing current along the West Greenland coast and a south-flowing current along Baffin Island and the Labrador coast, giving an anti-clockwise drift pattern. However, branching of the general currents cause variations, and they can have a significant impact on the iceberg population and their residence time. Although the majority of icebergs from Disko Bay are carried northward to northeastern Baffin Bay and Cape York before heading southward, icebergs have also been observed to be diverted into one of the west-branching eddies without passing north of 70° N. Most of the icebergs from Baffin Bay drift southward in western Davis Strait, joining the Labrador Current further south, although some may enter the eastern Davis Strait area west of Disko Island instead. Icebergs produced in Disko Bay or Baffin Bay generally will never reach the West Greenland shores south of 68° N. Many icebergs produced in Disko Bay enter Davis Strait, partly through Vaigat and partly along the southern coast of Disko Island. Some icebergs manage to drift towards or into southern Disko Bay from the Davis Strait due to onshore component of the currents west of Aasiaat. Icebergs south of Sisimiut are of East Greenland origin. Occasionally many small icebergs and bergy bits calved in Southwest Greenland fjords are observed close to the coast in this area, however, these ice masses normally melt quickly and only rarely affect ocean areas farther offshore.

In a study in the late 1970'ies, DHI/GTO found the lowest iceberg densities in West Greenland at the northern part of Lille Hellefiskebanke and at the southern part of Store Hellefiskebanke between 65° and 66° N. Iceberg densities increased both towards north and south. The density of icebergs in Disko Bay was significantly higher than outside the bay, with maximum concentrations of icebergs occurring in the northeastern part of Disko Bay. The iceberg generally showed the highest density in early summer, except in the area near Disko Bay where the highest density was seen in late summer, probably due to higher calving activity of the glaciers during the summer months. A similar distribution can be derived from data from USCG International Ice Patrol and the Canadian Ice Service and can also be observed by shipping companies operating in the area.

Icebergs are only occasionally seen in eastern Davis Strait between Nuuk and 67° N as a result of the pattern of dominant currents, the bathymetry and the distance to calving glaciers. Growlers, bergy bits and a few icebergs usually do not drift out of Godthåb Fjord and could hardly ever affect the 'Fyllas Banke'. The seasonal maximum density of icebergs in this area is normally closely related to the actual distribution of 'Storis'. Thus, under normal conditions, the seasonal maximum occurs from late April until late July. Off the ice edge of the 'Storis', the deterioration of icebergs increases significantly and therefore the seasonal minimum of glacial ice in the 'Fyllas Banke' area normally occurs during the fall months of September to November. Due to the observed westward branching of the West Greenland Current and the bathymetry south of 'Fyllas Banke', the largest icebergs will probably be observed on the western side of the 'Fylla Banke' area, but some of these may manage to drift northeast into the deeper waters between 'Fyllas Banke' and 'Toqqussaq Banke'.

8.7.3 Icebergs from East Greenland glaciers

Thousands of large icebergs are calved every year from several glacier outlets on the east coast of Greenland. When the icebergs reach open sea they drift southwards in the East Greenland Current, which most of the year also contains large amounts of sea ice from the Arctic Ocean. Even in winter, most of the sea ice from high latitudes melts when it drifts southward off the southeast coast of Greenland. Many icebergs drift off the sea ice edge and melt quickly due to a higher water temperature here and to the wave/swell action. Within the sea ice edge in the cold East Greenland Current, the deterioration of the icebergs is limited. The actual positions of icebergs off Southwest Greenland is to a certain extent controlled by the occurrence and the distribution of multi year ice

1-2 months earlier. Under normal conditions, sea ice occurs in the Cape Farewell area from early winter until late summer. During spring and early summer, the sea ice sometimes drifts into the 'Fyllas Banke' area. Therefore, the maximum iceberg density off Southwest Greenland is expected to occur in early and mid summer. This pattern was indirectly observed in the DHI/GTO study in the late 1970'ies (Mangor & Zorn 1983). 'Storis' was observed off the southwest coast of Greenland for several weeks during each of both years' study, however, the sea ice distribution and length of the sea ice season was close to normal conditions.

Large variations in the number and size of icebergs rounding Cape Farewell are to be expected because of the variability of the currents, the amounts of sea ice and weather conditions. An important factor controlling the iceberg environment off Southwest Greenland is the input of icebergs to the East Greenland Current at high latitudes during summer. It is well known that sea ice is present off the east coast most of the year, although there are large seasonal and inter annual variations, especially during summer. In many cases the occurrence and drift of sea ice controls the movements of icebergs. If the fast ice in fjords with major iceberg sources, e.g. Scoresbysund or Kong Oscar Fjord, does not melt during summer, or if the East Greenland sea ice does not drift off the coast, this will probably reduce the input of icebergs to the East Greenland Current and cause a decrease in the number of icebergs at lower latitudes. However, this phenomenon has not been systematically investigated.

8.7.4 Iceberg dimensions

The characteristics of iceberg masses and dimensions off the southwest coast of Greenland are poorly investigated, and the following is mainly based on the DHI/GTO study in the late 1970'ies.

In eastern Davis Strait the largest icebergs were most frequently found south of 64° N and north of 66° N. South of 64° N, the average mass of an iceberg near the 200 m depth contour varied between 1.4 and 4.1 million tons, with a maximum mass of 8.0 million tons. Average draft was 60-80 m and maximum draft was 138 m. Between 64° N and 66° N average masses were between 0.3 and 0.7 million tons. The maximum mass was 2.8 million tons. Average draft was 50-70 m and maximum draft is estimated to be 125 m.

The largest icebergs north of 66° N were found north and west of Store Hellefiskebanke. The average iceberg mass was about 2 million tons with a maximum mass of 15 million tons. In Disko Bay the average masses of icebergs were in the range 5-11 million tons with a maximum recorded mass of 32 million tons. Average draft was 80-125 m and maximum draft was 187 m. It is worth noting that many icebergs are deeply drafted and due to the bathymetry large icebergs will not drift into shallow water regions, e.g. at 'Fyllas Banke' where the water depth in large areas is only about 100 meters. Thus, large icebergs will ground before they drift into many offshore areas in Greenland.

Maximum draft can be evaluated by studying factors, which limit the dimension: glacier thickness, topographic factors, which limits the possible size of the icebergs and thresholds in the mouths of the fjords with glaciers. The measurements of iceberg drafts north of 62° N indicate that an upper limit for a draft of 230 m will only be exceeded very rarely, however, no systematic 'maximum draft measurements' exist and the extremes remain unknown. Several submarine cable crushes or breaks have occurred at water depths of about 150-200 meters; the maximum depth recorded was 208 meters, southwest of Cape Farewell. These observations agree with the DHI/GTO conclusions, however, larger drafts of icebergs of East Greenland origin cannot be excluded because observations are sparse. The large icebergs originating from Baffin Bay are expected to have a maximum draft of about 250-300 meters.

A field program, Berg Watch 97, carried out by the Danish Meteorological Institute, Danish

Hydraulic Institute and ASIAQ/Greenland Field Investigations documented the presence of very large icebergs in eastern Baffin Bay characterised by a draft of more than 260 meters, or a mass of up to 90,000,000 tons, or a diameter of more than 1,400 meters. Due to the predominant currents in Baffin Bay and Davis Strait, these icebergs will not reach the West Greenland shores south of 68° N. Surveys conducted by the USCG International Ice Patrol and other field studies of icebergs in the East Canadian waters have improved the knowledge on the iceberg environment in the western Davis Strait and the Labrador Sea. However, the amount of iceberg data relevant for the eastern Davis Strait is very sparse.

Map legend

Base map

- Land
- Ice
- Lake
- Sea
- River
- Contour

Physical environment & logistics maps

Logistics

- Town
- Settlement
- Abandoned settlement
- Field station
- Abandoned station
- Harbour / Anchorage
- Boat harbour
- Airstrip
- Heliport
- Oilterminal
- Peak
- Safe haven
- Landing
- Inshore containment with length (100m)

Shoretype

- Outside mapping area
- Rocky coast
- Archipelago
- Glacier coast
- Moraine
- Alluvial fan
- Talus
- Beach
- Barrier beach
- Salt marsh and/or tidal flat
- Pocket beach
- Delta
- Not classified (invisible)

Shoreline sensitivty maps

Shoreline species*

Al	Alcids breeding
An	Alcids nonbreeding
Ar	Arctic char
Ca	Capelin
Co	Cormorants
De	Deep sea shrimp
Gh	Greenland Halibut
Gu	Gulls
Ha	Harbour seals
Lu	Lumpsucker
Sb	Seaducks breeding
Sc	Scallop
Se	Seaducks spring
Sm	Seaducks moulting
Tu	Tubenoses

*Icons only visible for species with a relative abundance = 3, 4 or 5

Site specific shoreline species

Al	Alcids breeding
Co	Cormorants
Gu	Gulls
Sb	Seaducks breeding
Tu	Tubenoses

Shoreline resource use

- Resource use (Human use)
- Archaeological site

Shoreline areas sensivity ranking

- Extreme (> 45)
- High (33 - 45)
- Moderate (22 - 33)
- Low (< 22)

Selected areas

- Selected area

Mapscale 1:250.000
Projection: UTM, zone 22N, WGS84
Topographic base:
G/250 Vector, Copyright Kort & Matrikelstyrelsen, 1998

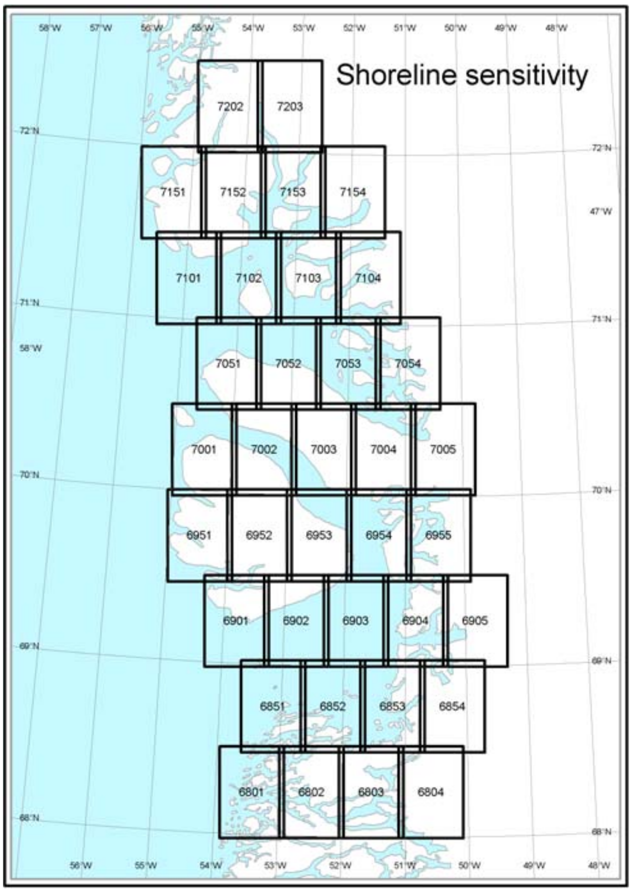
Maps produced by National Environmental Research Institute (NERI) and Geological Survey of Denmark and Greenland (GEUS), 2003

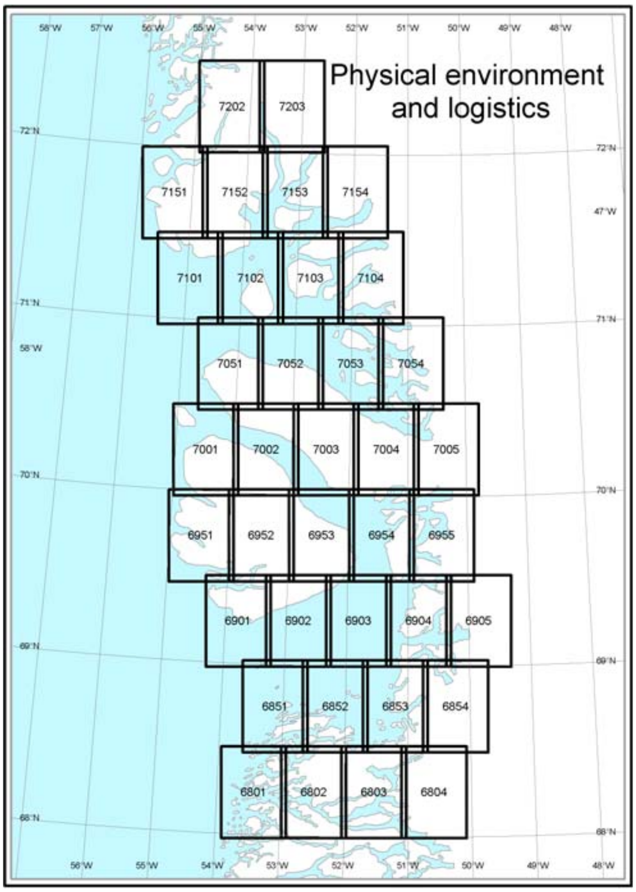
9 Operational shoreline information

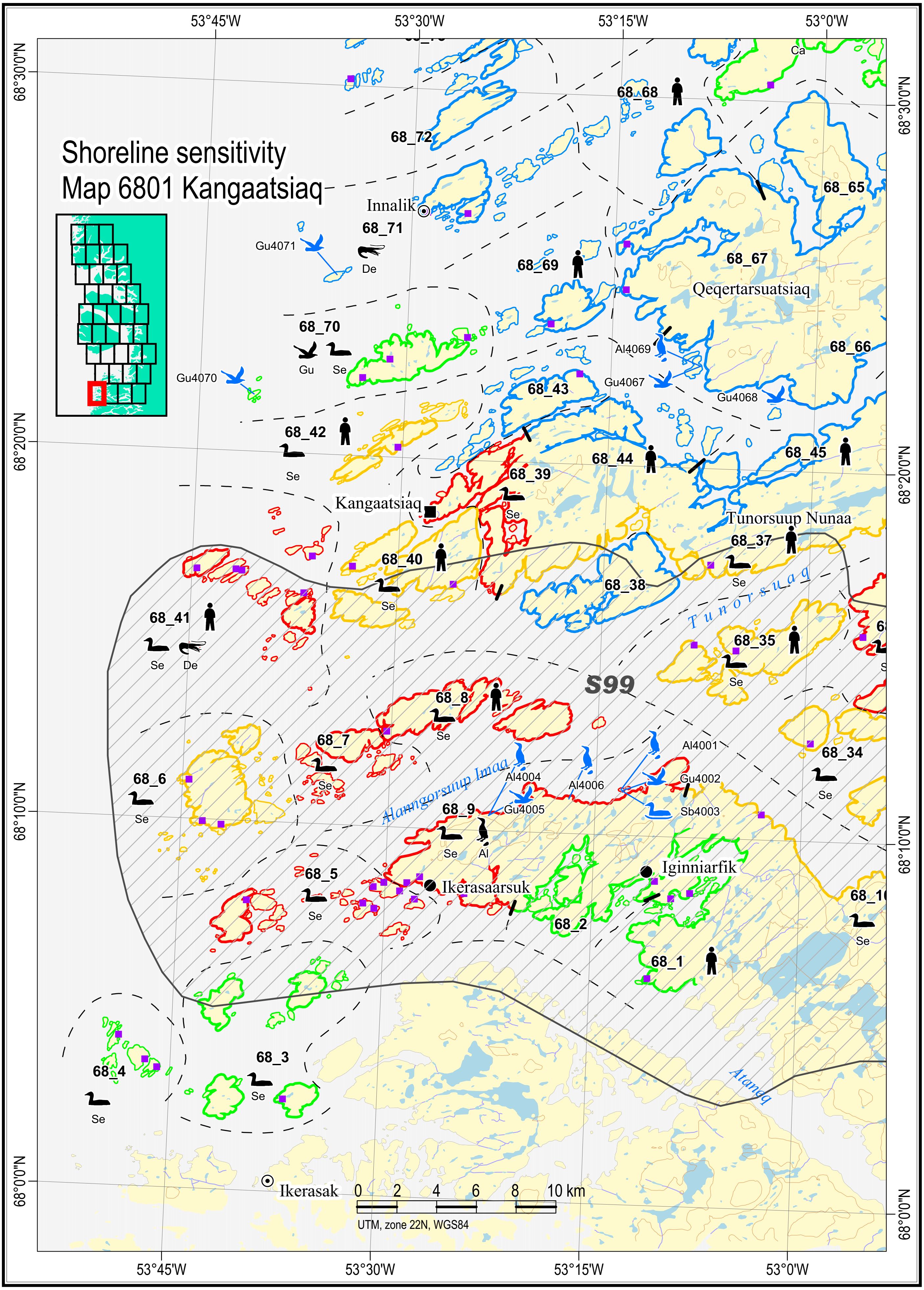
This chapter contains two series of 37 detailed maps covering the area (see key map this page; map 7201 is not included): **Shoreline sensitivity maps** and **Physical environment and logistics maps**. The Shoreline sensitivity maps are on left-hand side, and Physical environment and logistics maps are 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 7, Users guide, for further information on map interpretation.

Keymaps:







Shoreline sensitivity
Map 6801 Kangaatsiaq
53°45'W
53°30'W
53°15'W
53°0'W
68°30'0"N
68°20'0"N
68°10'0"N
68°0'0"N
Innalik
Kangaatsiaq
Qeqertarsuatsiaq
Tunorsuup Nunaa
Tunorsuaq
Ikerasaarsuk
Iginniarfik
Ikerasak
Hannorsuup Imaa
Ataneq
S99
68_72
68_71
68_70
68_69
68_68
68_67
68_66
68_65
68_45
68_44
68_43
68_42
68_41
68_40
68_39
68_38
68_37
68_35
68_34
68_9
68_8
68_7
68_6
68_5
68_4
68_3
68_2
68_1
Gu4071
Gu4070
Gu4067
Gu4068
Gu4005
Gu4002
Al4069
Al4001
Al4004
Al4006
Sb4003
Se
De
Gu
Al
Ca
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Shoreline sensitivity

Map 6801 - Kangaatsiaq

Environmental description

Resource use

R 68_1	Fishery for Atlantic cod (incl. pound net), capelin and wolffish. Hunting for seals and seabirds (**S99**).
R 68_8	Fishery for Atlantic cod and wolffish (important). Hunting for seabirds, minke and fin whales (**S99**).
R 68_35	Fishery for wolffish. Hunting for minke and fin whales, seabirds and ringed seal on ice (**S99**).
R 68_37	Fishery for Atlantic cod (pound net) and wolffish. Hunting for seabirds and ringed seal on ice (**S99**).
R 68_40	Fishery for Atlantic cod, scallop and wolffish (important). Hunting for seabirds (**S99**).
R 68_41	Fishery for Atlantic cod, redfish and wolffish (important). Hunting for seabirds and minke and fin whales (**S99**).
R 68_42	Fishery for Atlantic cod, redfish and wolffish (important).
R 68_44	Fishery for Atlantic cod (pound net) and wolffish. Hunting for ringed seal on ice.
R 68_45	Fishery for Atlantic cod (pound net) and wolffish. Hunting for ringed seal on ice (important).
R 68_68	Fishery for capelin, scallop and wolffish. Hunting for minke and fin whales.
R 68_69	Fishery for wolffish. Hunting for minke and fin whales.

Species occurrence

Al68009	3 colonies with breeding razorbills and black guillemots.
De68041, De68071	Important fishing area for deep sea shrimp.
Gu68070	1 colony with breeding Arctic terns.
Se68003, Se68004	Common eiders in winter and spring
Se68005, Se68006	Common eiders and long-tailed ducks in winter and spring (**S99**).
Se68007, Se68008	Common eiders in winter and spring (**S99**).
Se68009, Se68035	Common eiders in winter and spring (**S99**).
Se68038, Se68040	Common eiders in winter and spring (**S99**).
Se68041, Se68042	Common eiders in winter and spring (**S99**).

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

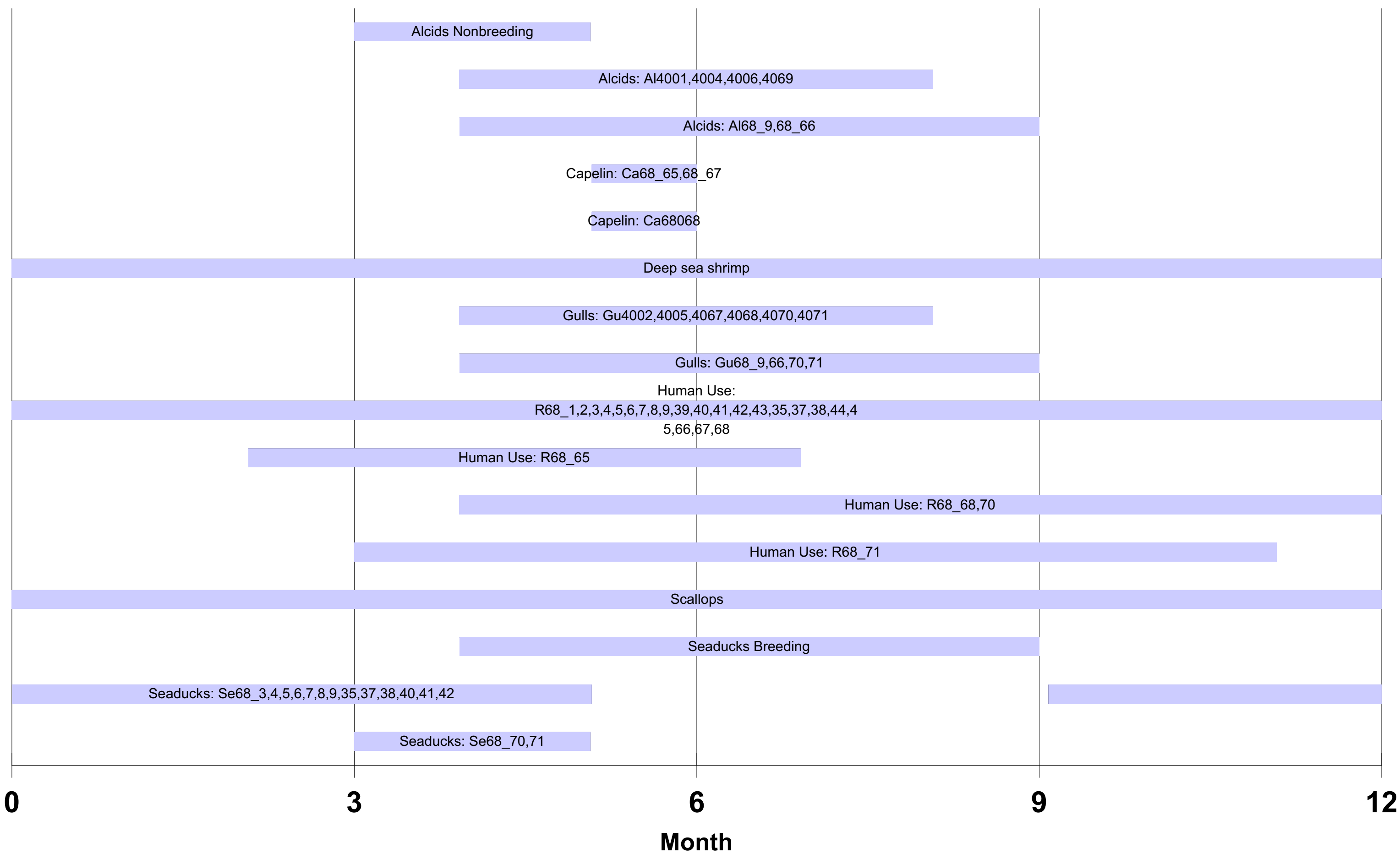
Al4001, Al4004	Breeding razorbills and black guillemots.
Al4006, Al4069	Breeding razorbills.
Gu4002	Breeding glaucous gulls.
Gu4005	Breeding glaucous gulls and kittiwakes.
Gu4067	Breeding Iceland gulls.
Gu4068	Breeding Iceland gulls and kittiwakes.
Gu4070, Gu4071	Breeding Arctic terns.
Sb4003	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_1	27	Moderate
68_2	27	Moderate
68_3	29	Moderate
68_4	25	Moderate
68_5	48	Extreme
68_6	35	High
68_7	54	Extreme
68_8	46	Extreme
68_9	60	Extreme

(Continued on page 9-5)

Map 6801 Species and Resource Occurrences



Shoreline sensitivity

Map 6801 - Kangaatsiaq

Shoreline sensitivity summary

(Continued from page 9-3)

68_35	43	High
68_37	43	High
68_38	14	Low
68_39	22	Moderate
68_40	42	High
68_41	46	Extreme
68_42	42	High
68_43	18	Low
68_44	15	Low
68_45	10	Low
68_65	13	Low
68_66	16	Low
68_67	13	Low
68_68	13	Low
68_69	13	Low
68_70	24	Moderate
68_71	19	Low

Physical environment and logistics

Map 6801 - Kangaatsiaq

Access

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

Numerous islands and hazards extend from the mainland coast and encumber the entrances to most fjords. Soundings are sparse in most fjords and caution is advised.

Depths in Alanngorsuup Imaa (Arfersiorfik) are unknown except for a single track of mid-channel soundings and those taken in Sofias Havn (map 6803), 75 km within the entrance. For the first 25 km within the entrance the fjord is encumbered with numerous islands.

Several islands lie in the entrance to Ataneq. Depths are considerable but no soundings are available. The settlement of Iginniarfik lies 10 km within the fjord. The harbour is partially protected by a chain of islets.

Physical environment and logistics Map 6801 - Kangaatsiaq

Access

(Continued from previous page)
In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. The lead widens throughout the summer, and the coast is generally ice-free by August. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break-up the ice or prevent its formation except at the inner ends of fjords.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.

At Kangaatsiaq the tide attains a maximum height of 3.3 m. The tidal streams are strong between islands and in the vicinity of Kangaatsiaq, but in the harbour they are weak.

A good harbour exists at the settlement of Kangaatsiaq, situated on the western extremity of the peninsula on the north side of Arfersiorfik. Vessels up to 50 m length, 4 m draft are reported to have used the berth.

Charts indicate an anchorage at Ikerasak, but no other information is available.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airport is at Aasiaat (map 6851).

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 both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl, and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords and the numerous islands in 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, including the selected area shown on the map.

Little information is available on water currents for the many inlets and inter-island channels on this map. The tidal range (3 to 4 m) and high reported tidal velocities in the vicinity of Kangaatsiaq suggest that exclusion booming (applicable in currents up to 0.4 m/s, 0.75 knots) in these areas would not likely be successful, and therefore it is not recommended.

If there is local knowledge to suggest that tidal velocities are less than a knot, exclusion booming could be attempted across inlets and inter-island channels that are one kilometre or less in width.

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

Shorelines shown on this map are exposed and semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operation would be marine-based given the likely nature of the shoreline.

Safe havens

The channel southwest of Kangaatsiaq is a potential safe haven for vessel lightering operations. It is in an area of relatively low to moderate sensitivity. It may be possible, using two 500 m boom, to seal off the channel to contain any further release of oil. However, tidal streams are reported to be strong in this area.

Maps

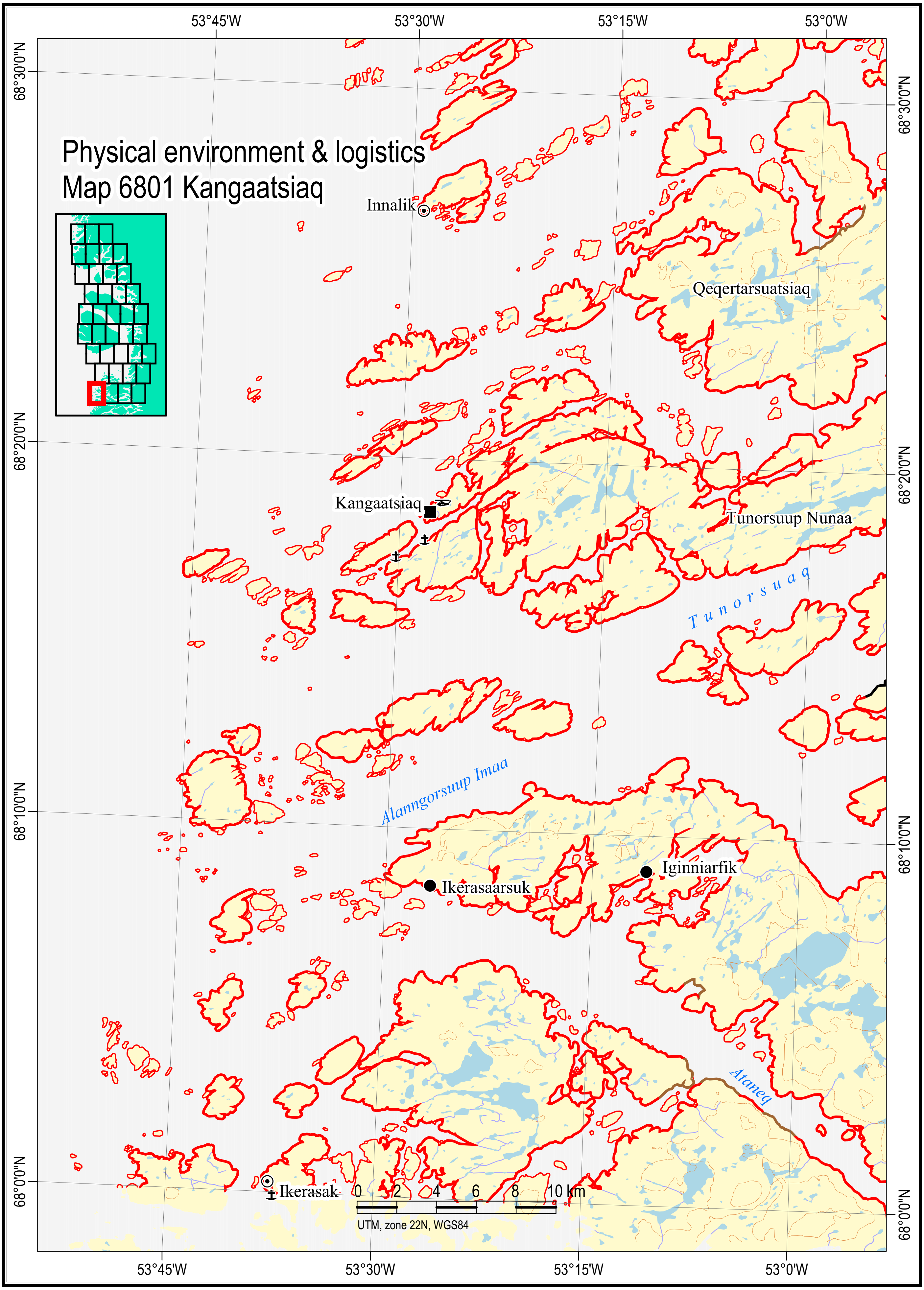
Danish Survey & Cadastre (KMS) topographical map: 68 V.1. Nautical charts: 1416, 1500, 1510, 1550.

Airphoto keymap

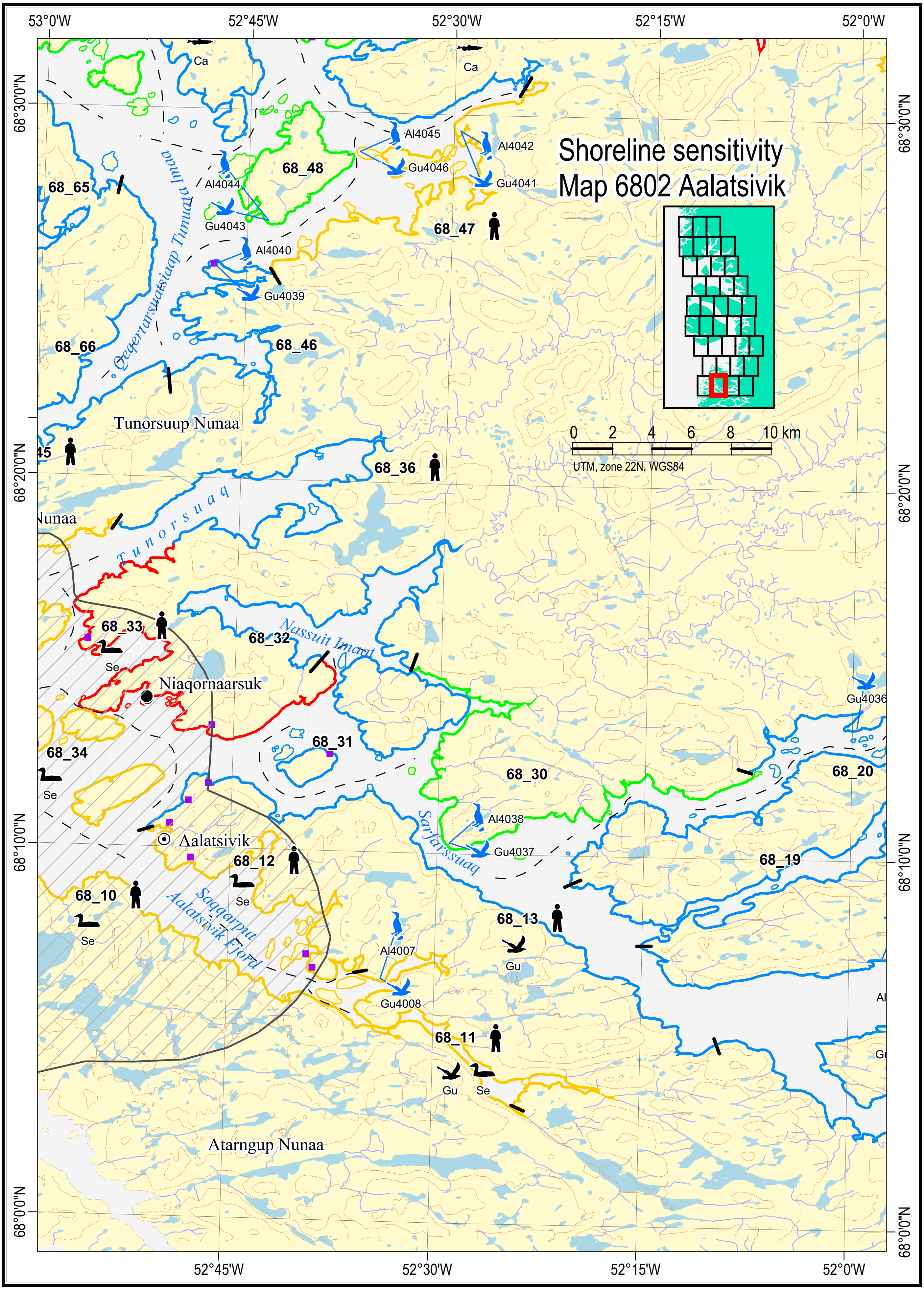
Map legend

Toggle maps

Keymaps



Airphoto keymap | Map legend | Toggle maps | Keymaps



Shoreline sensitivity

Map 6802 - Aalatsivik

Environmental description

Resource use

R 68_10	Fishery for Atlantic cod (incl. pound net), redfish and wolffish. Hunting for ringed seal on ice.
R 68_11	Fishery for Atlantic cod (incl. pound net) and capelin. Hunting for ringed seal on ice.
R 68_12	Fishery for Atlantic cod (incl. pound net), lumpsucker and redfish. Hunting for ringed seal on ice (important).
R 68_13	Fishery for Atlantic cod (pound net) and redfish. Hunting for ringed seal on ice.
R 68_33	Fishery for Atlantic cod (pound net) and wolffish. Hunting for ringed seal on ice.
R 68_36	Fishery for Atlantic cod (pound net), capelin and wolffish (important). Hunting for ringed seal on ice (important).
R 68_47	Fishery for Arctic char at three river outlets and capelin. Hunting for ringed seal on ice (important).

Species occurrence

Gu68011, Gu68013	1 colony with breeding Iceland and glaucous gulls.
Se68010, Se68012	Common eiders and long-tailed ducks in winter and spring (**S99**).
Se68033, Se68033	Common eiders and long-tailed ducks in winter and spring (**S99**).

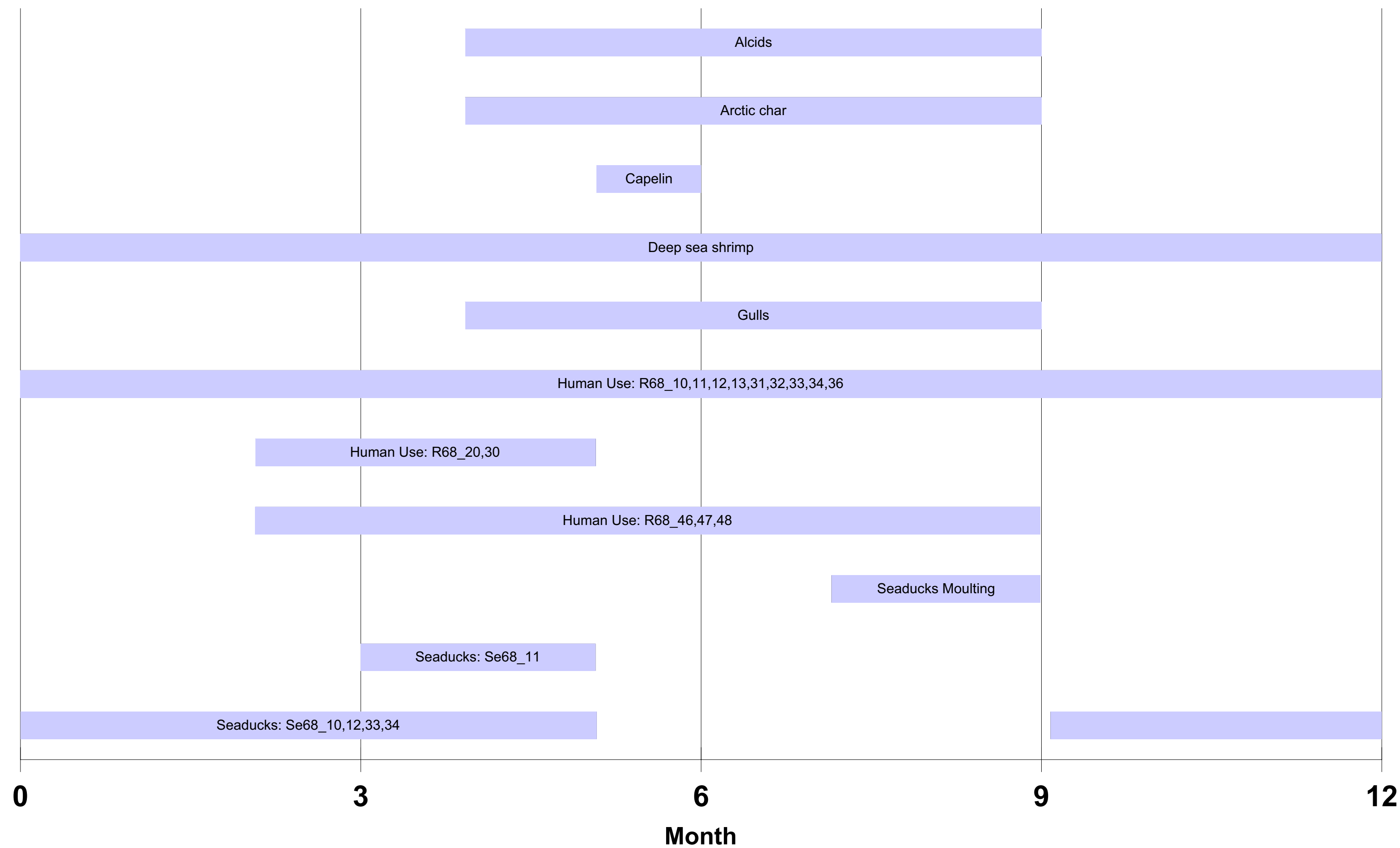
Site specific species occurrence (seabird breeding colonies); blue icons

Al4007, Al4038, Al4045	Breeding razorbills and black guillemots.
Al4040	Breeding razorbills.
Al4042, Al4044	Breeding black guillemots.
Gu4008	Breeding Iceland gulls and glaucous gulls.
Gu4037	Breeding Iceland gulls.
Gu4039, Gu4043	Breeding Iceland gulls and kittiwakes.
Gu4041	Breeding kittiwakes and Iceland/glaucous gulls.
Gu4046	Breeding Iceland gulls and glaucous gulls.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_10	43	High
68_11	33	High
68_12	42	High
68_13	21	Low
68_20	14	Low
68_30	26	Moderate
68_31	12	Low
68_32	17	Low
68_33	48	Extreme
68_34	40	High
68_36	15	Low
68_46	21	Low
68_47	45	High
68_48	23	Moderate

Map 6802 Species and Resource Occurrences



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Access

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

Depths in Alanngorsuup Imaa (Arfersiorfik) are unknown except for a single track of mid-channel soundings and those taken in Sofias Havn (map 6803) 75 km within the entrance. For the first 25 km within the entrance the fjord is encumbered with numerous islands.

Numerous islands and hazards extend from the mainland coast and encumber the entrances to most fjords. Soundings are sparse in most fjords and caution is advised.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airport is at Aasiaat (map 6851).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended when ice concentrations are down to six tenths. In open water conditions in both offshore and nearshore areas containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords in this map area: 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, including the selected area shown on the map.

There are several locations within these fjords where exclusion booming could be used to reduce the extent of inshore contamination. These include: the entrance to Nassuit Imaat, estimated 200 m width; the head of Saqqarput Aalatsivik Fjord, estimated 200 m width; and the inlets within Sarfarsuaq, estimated 800 m and 200 m widths. In each of these locations there are no informations on tidal streams but they may be strong based on the likely tidal range of 3 to 4 m and the reported strong tidal streams at Kangaatsiaq.

Shorelines shown on this map are predominantly 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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

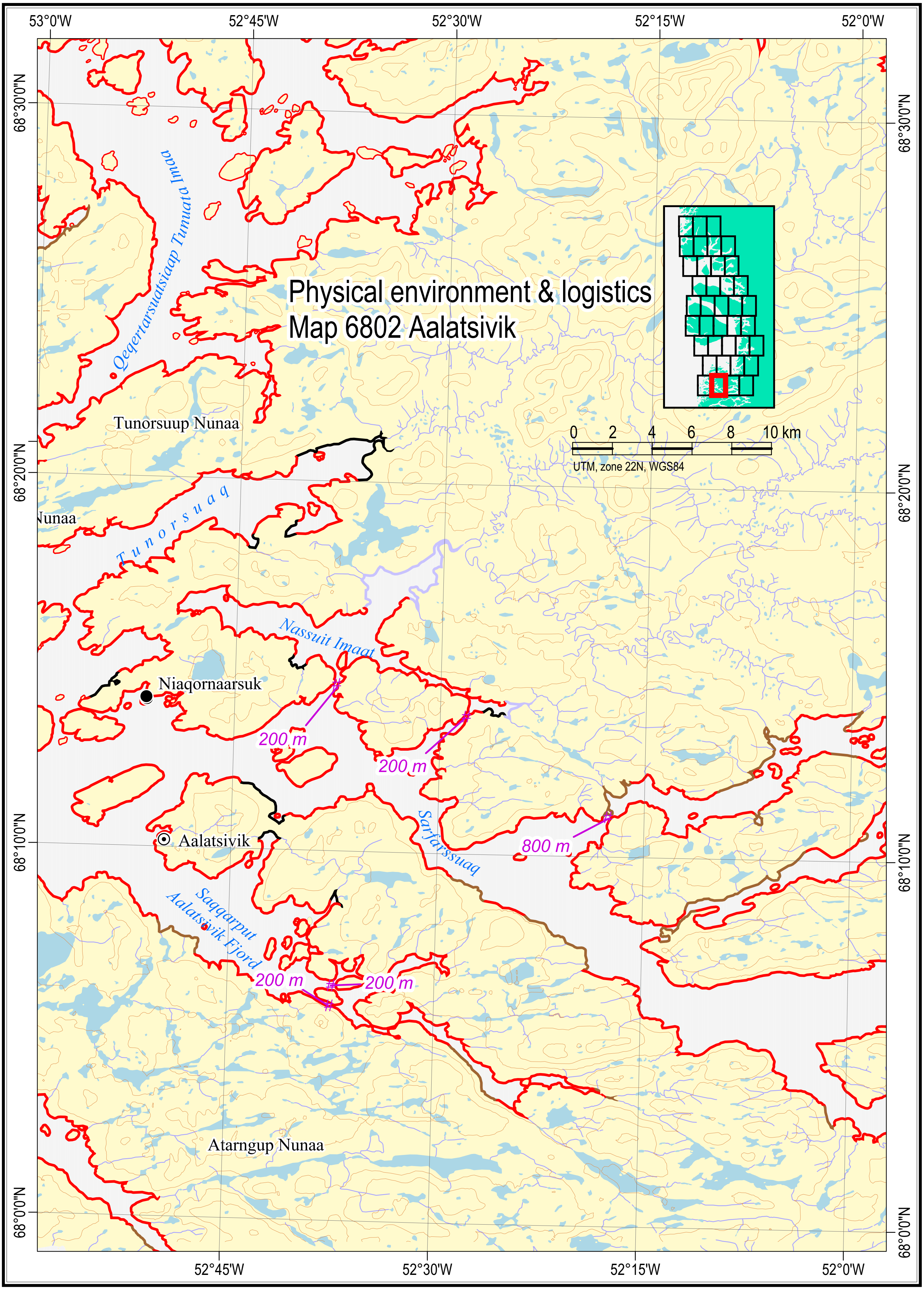
There are several areas near the head of these fjords that are designated as beaches with protected or semi-protected coastal exposure. If oiled, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

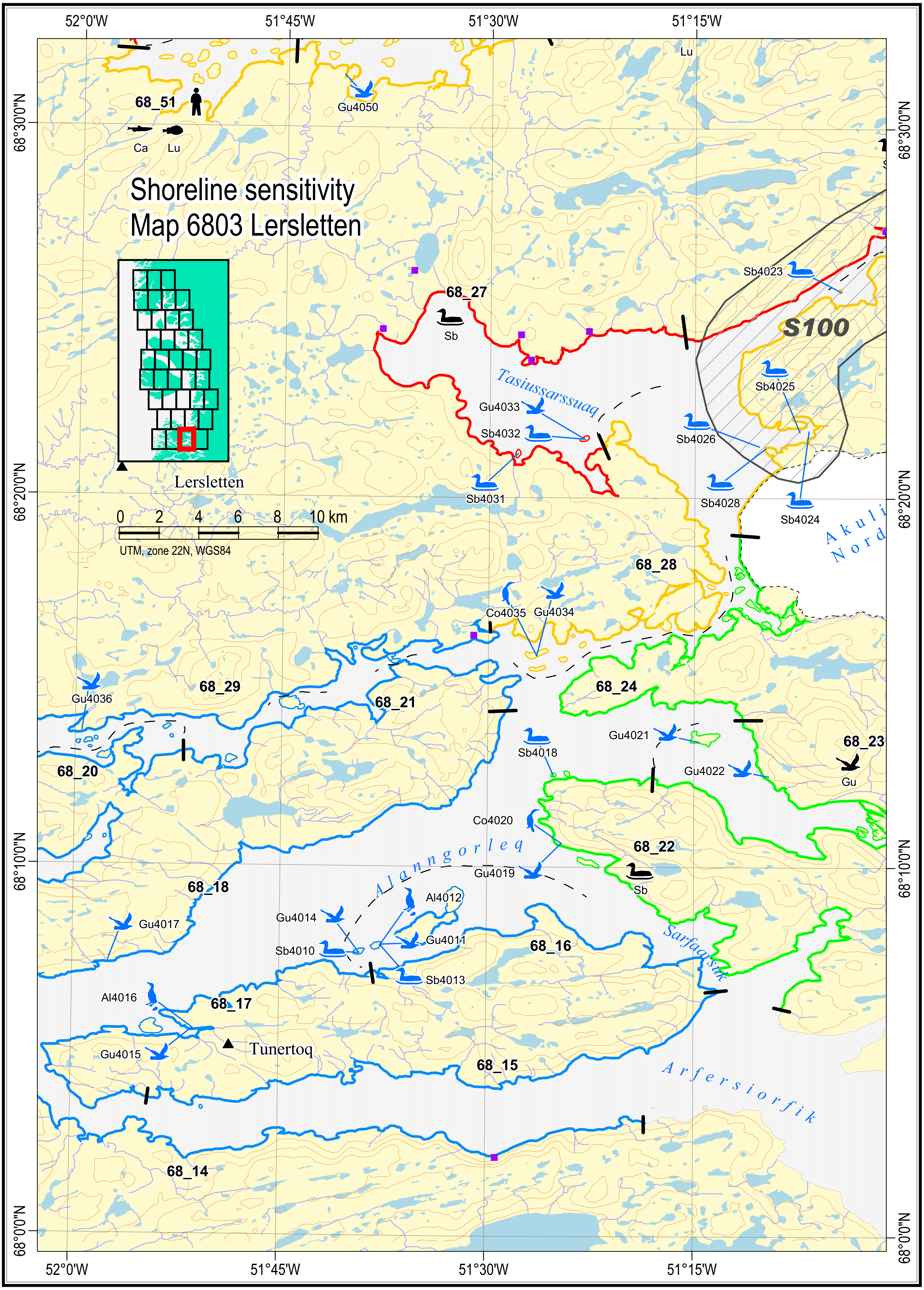
There are no potential safe havens identified on this map. Locations near the head of the fjords in this map could be investigated for their suitability as safe havens as the area is of low to moderate sensitivity, but there is no information on water currents and the area is largely uncharted.

Maps

Danish Survey & Cadastre (KMS) topographical maps: 68 V.1, 68 V.2. Nautical charts: 1500, 1510.


Physical environment & logistics
Map 6802 Aalatsivik
53°0'W
52°45'W
52°30'W
52°15'W
52°0'W
68°30'0"N
68°20'0"N
68°10'0"N
68°0'0"N
0
2
4
6
8
10 km
UTM, zone 22N, WGS84
Qeqertarsuatsiaap Tunuata Imaa
Tunorsuup Nunaa
Nunaa
Tunorsuaq
Nassuit Imaat
Niaqornaarsuk
200 m
200 m
Sarfarssuaq
800 m
Aalatsivik
Saqqarput
Aalatsivik Fjord
200 m
200 m
Atarngup Nunaa

Airphoto keymap | Map legend | Toggle maps | Keymaps



Shoreline sensitivity

Map 6803 - Lersletten

Environmental description

Resource use

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

Species occurrence

Gu68023	2 colonies with breeding Iceland gulls and kittiwakes.
Sb68022	1 colony with breeding common eiders.
Sb68027	2 colonies with breeding common eiders.
Sm68025	Common eiders, long-tailed ducks and red breasted mergansers in summer and autumn.
Sb68025	5 colonies with breeding common eiders (**S100**).

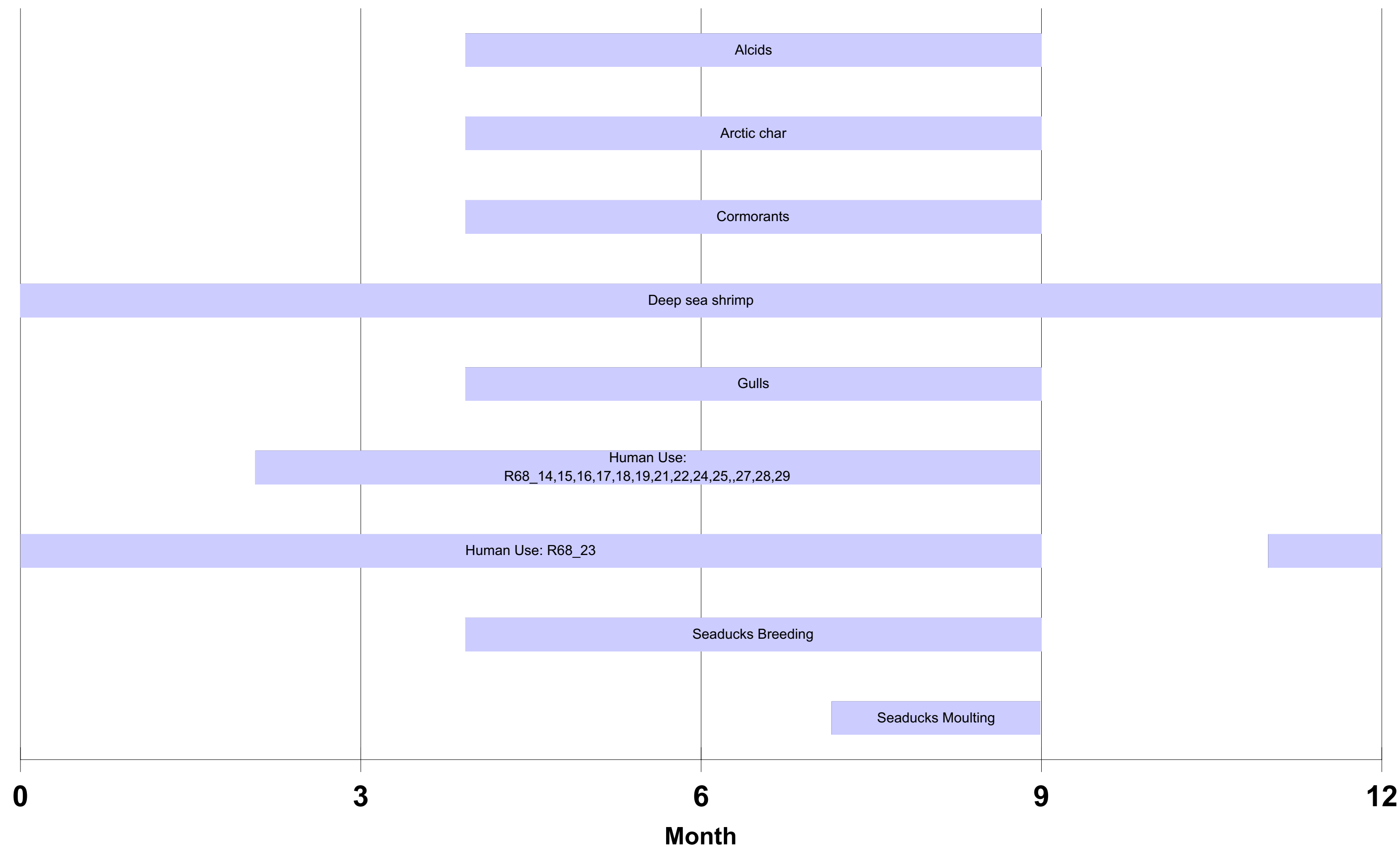
Site specific species occurrence (seabird breeding colonies); blue icons

Al4012, Al4016	Breeding black guillemots.
Co4020, Co4035	Breeding great cormorants.
Gu4011	Breeding Arctic terns and Iceland gulls.
Gu4014, Gu4033	Breeding Arctic terns.
Gu4015, Gu4022	Breeding kittiwakes and Iceland gulls.
Gu4017, Gu4021	Breeding kittiwakes.
Gu4019	Breeding Iceland gulls.
Gu4034, Gu4036	Breeding kittiwakes and Iceland gulls.
Sb4010, Sb4013	Breeding common eiders.
Sb4018	Breeding common eiders.
Sb4023	Breeding common eiders (**S100**).
Sb4024, Sb4025	Breeding common eiders (**S100**).
Sb4026, Sb4028	Breeding common eiders (**S100**).
Sb4031	Breeding common eiders.
Sb4032	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_14	9	Low
68_15	7	Low
68_16	22	Low
68_17	14	Low
68_18	12	Low
68_19	7	Low
68_21	16	Low
68_22	24	Moderate
68_23	23	Moderate
68_24	29	Moderate
68_25	40	High
68_27	47	Extreme
68_28	35	High
68_29	21	Low

Map 6803 Species and Resource Occurrences



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Access

Little information is available for marine or shoreline areas in this map.

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

Depths in Alanngorsuup Imaa (Arfersiorfik) are unknown except for a single track of mid-channel soundings and those taken in Sofias Havn 75 km within the entrance. For the first 25 km within the entrance the fjord is encumbered with numerous islands.

Anchorage is available in Sofias Havn, depths of 9 to 18 m mid-channel.

There is no information on tides or currents within fjords for this area.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airfields are the airport at Aasiaat (map 6851) and the heliport at Qasigiannguit (map 6853).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended when ice concentrations is down to six tenths. In open water conditions in both offshore and nearshore areas containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the fjords in this map area. 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 including the selected area shown on the map.

Exclusion booming could be considered at the inter-island channel at the east end of Tunertoq and at the entrance to Tasiussarsuaq, estimated 400 m width at each location. In each of these locations there is no information on tidal streams but they may be strong based on the likely tidal range of 3 to 4 m, and the reported strong tidal streams at Kangaatsiaq.

Shorelines shown on this map are predominantly semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

There are several areas designated as beach with semi-protected coastal exposure scattered through the fjords of this map. Depending on the degree of contamination, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map. Locations near the head of the fjords in this map could be investigated for their suitability as safe havens as the area is of low to moderate sensitivity, but there is no information on water currents and the area is largely uncharted.

Maps

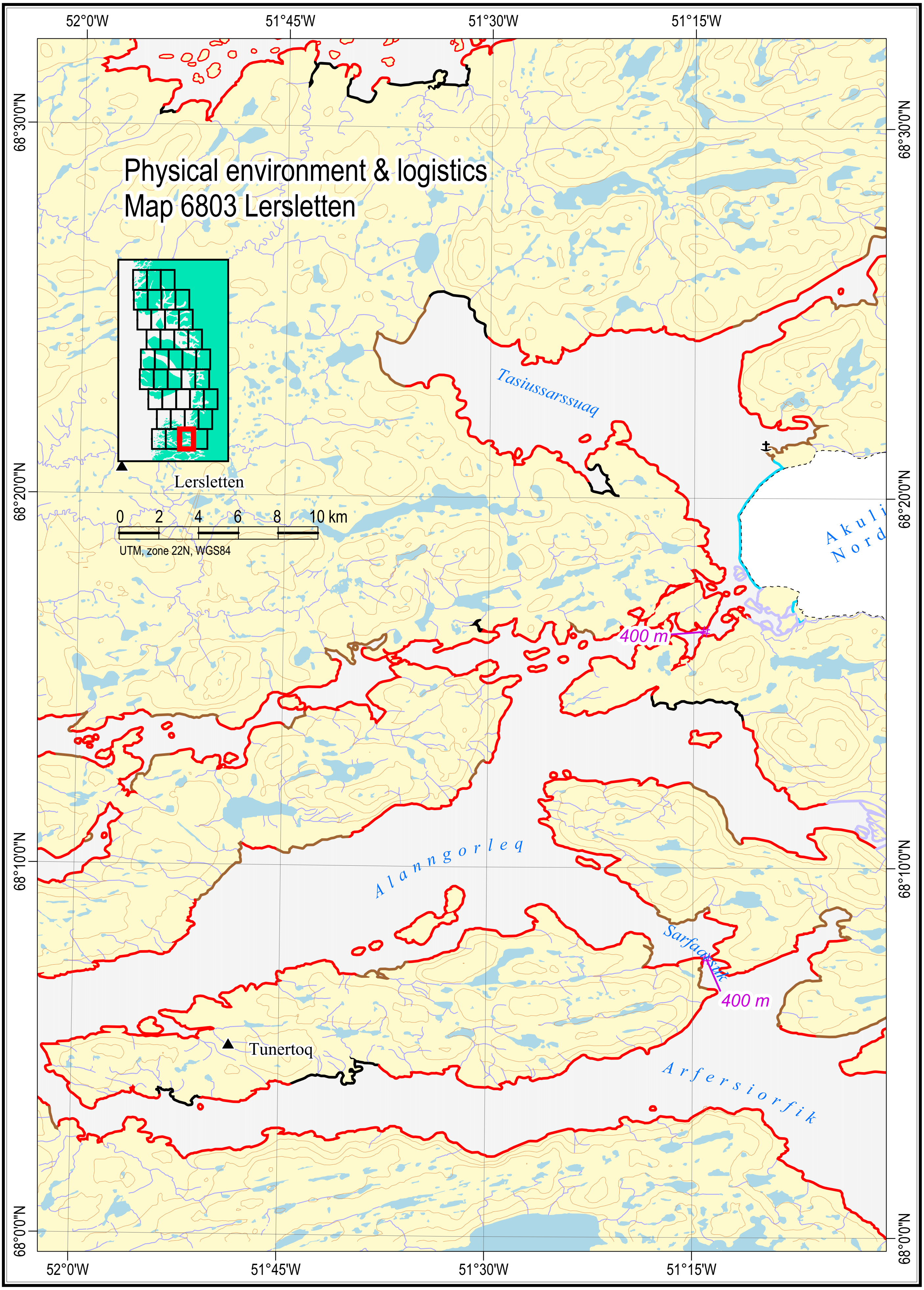
Danish Survey & Cadastre (KMS) topographical map: 68 V.2. Nautical charts: 1500.

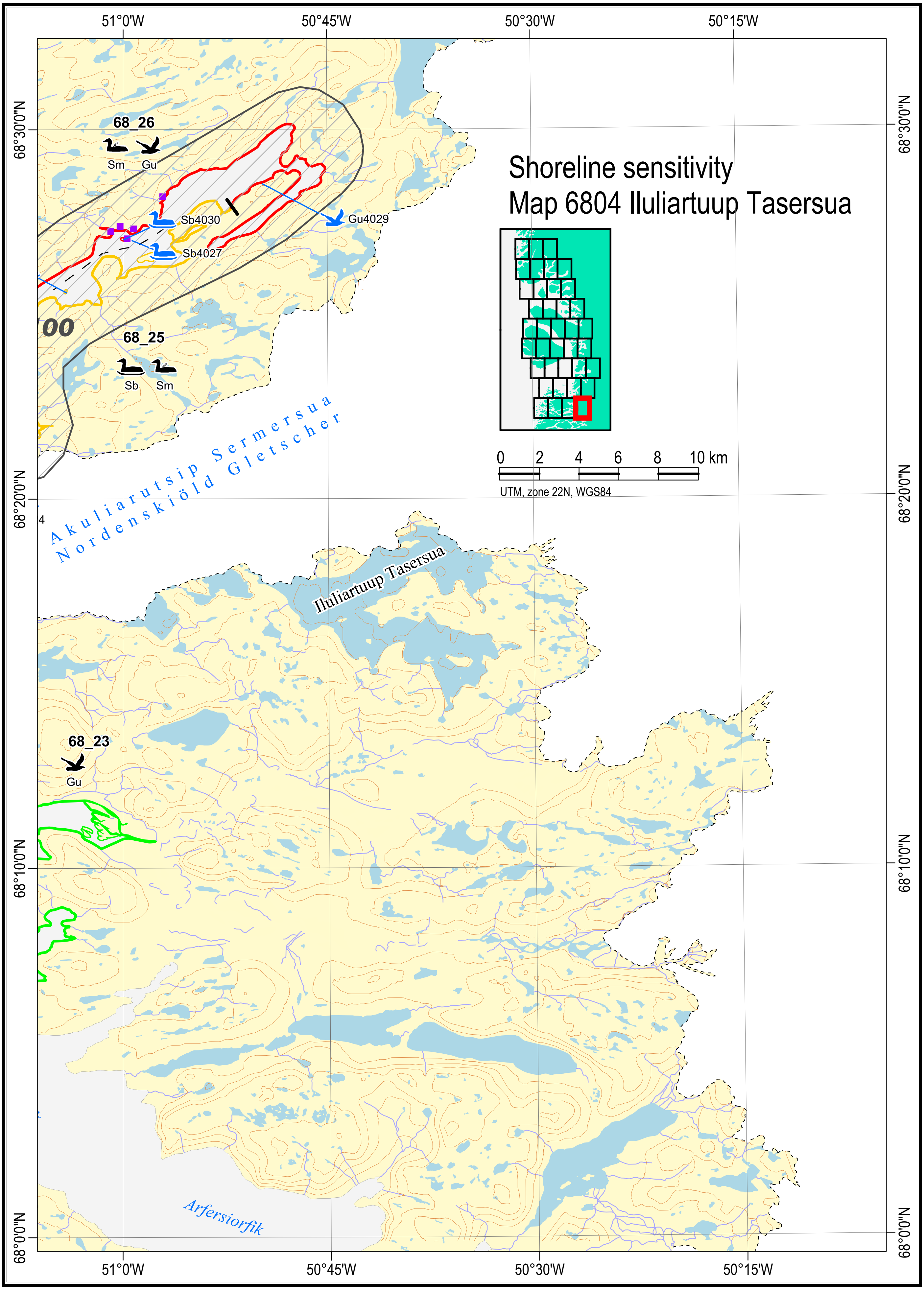
Airphoto keymap

Map legend

Toggle maps

Keymaps




Shoreline sensitivity
Map 6804 Iluliartuup Tasersua
51°0'W
50°45'W
50°30'W
50°15'W
68°30'0"N
68°20'0"N
68°10'0"N
68°0'0"N
68_26
Sm
Gu
Sb4030
Sb4027
Gu4029
68_25
Sb
Sm
68_23
Gu
Akuliarutsip Sermersua
Nordenskiöld Gletscher
Iluliartuup Tasersua
Arfersiorfik
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Shoreline sensitivity

Map 6804 - Iluliartuup Tasersua

Environmental description

Resource use

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

Species occurrence

Gu68026	1 colony with breeding Iceland and glaucous gulls.
Sm68026	Long-tailed ducks, common eiders and red breasted mergansers in summer and autumn.

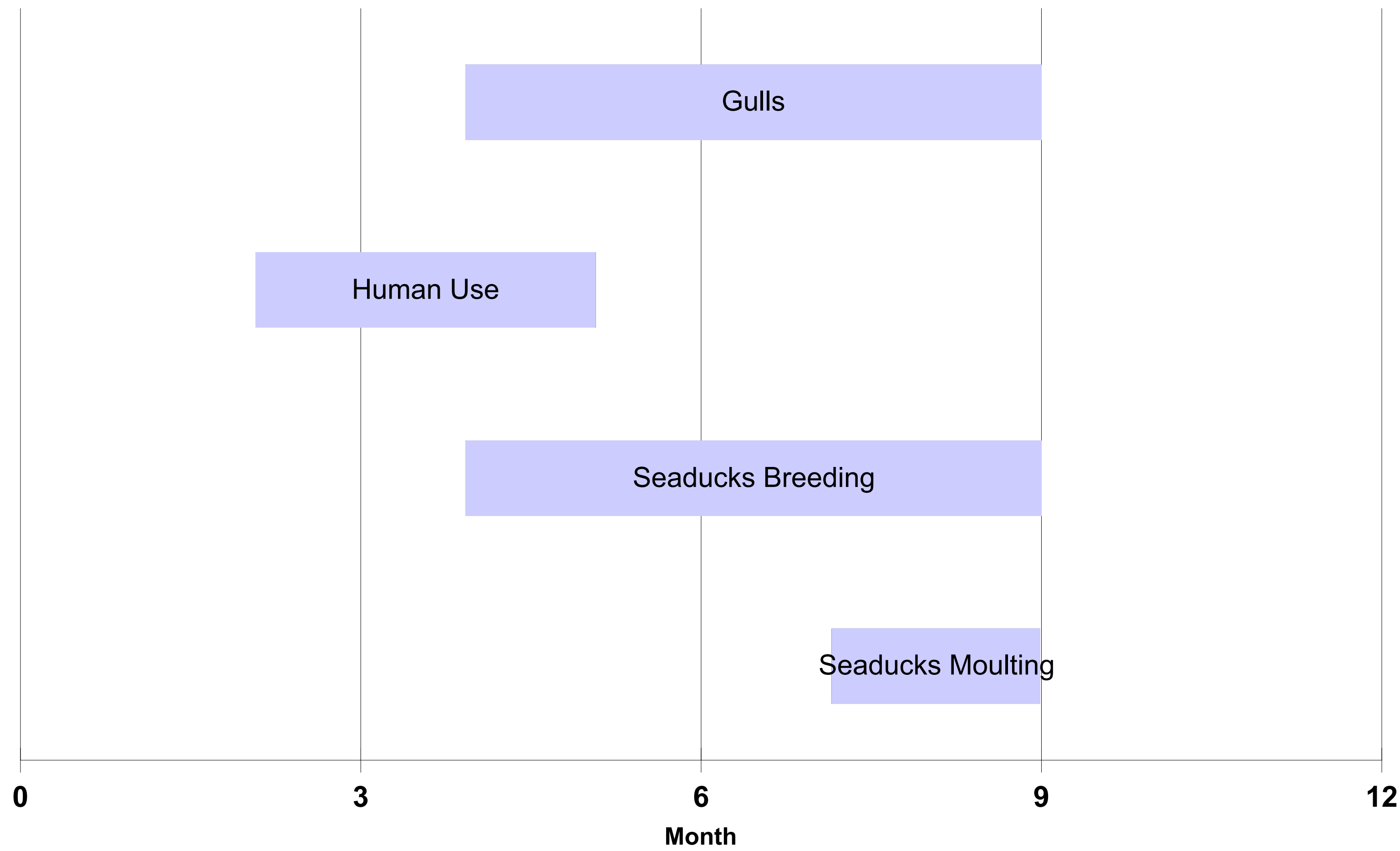
Site specific species occurrence (seabird breeding colonies); blue icons

Gu4029	Breeding Iceland gulls and glaucous gulls.
Sb4027	Breeding common eiders (**S100**).
Sb4030	Breeding common eiders (**S100**).

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_26	51	Extreme

Map 6804 Species and Resource Occurrences



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Access

Little information is available for the limited marine and shoreline areas in this map.

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

There is no information on tides or currents within fjords for this area.

Anchorage is available in Sofias Havn, depths of 9 to 18 m mid-channel.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airfields are the airport at Aasiaat (map 6851) and the heliport at Qasigiannguit (6853).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended at ice concentrations down to six tenths. Containment for recovery or burning is recommended in open water conditions in both offshore and nearshore areas. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist near the heads of the two fjords shown in 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, including the selected area shown on the map.

Should oil approach the northeast arm of Tasiussarsuaq, an estimated 1,000 m of boom could be deployed to limit the degree of inshore contamination. There is no information on tidal streams, but they may be strong based on the likely tidal range of 3 to 4 m.

Shorelines shown on this map are predominantly semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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

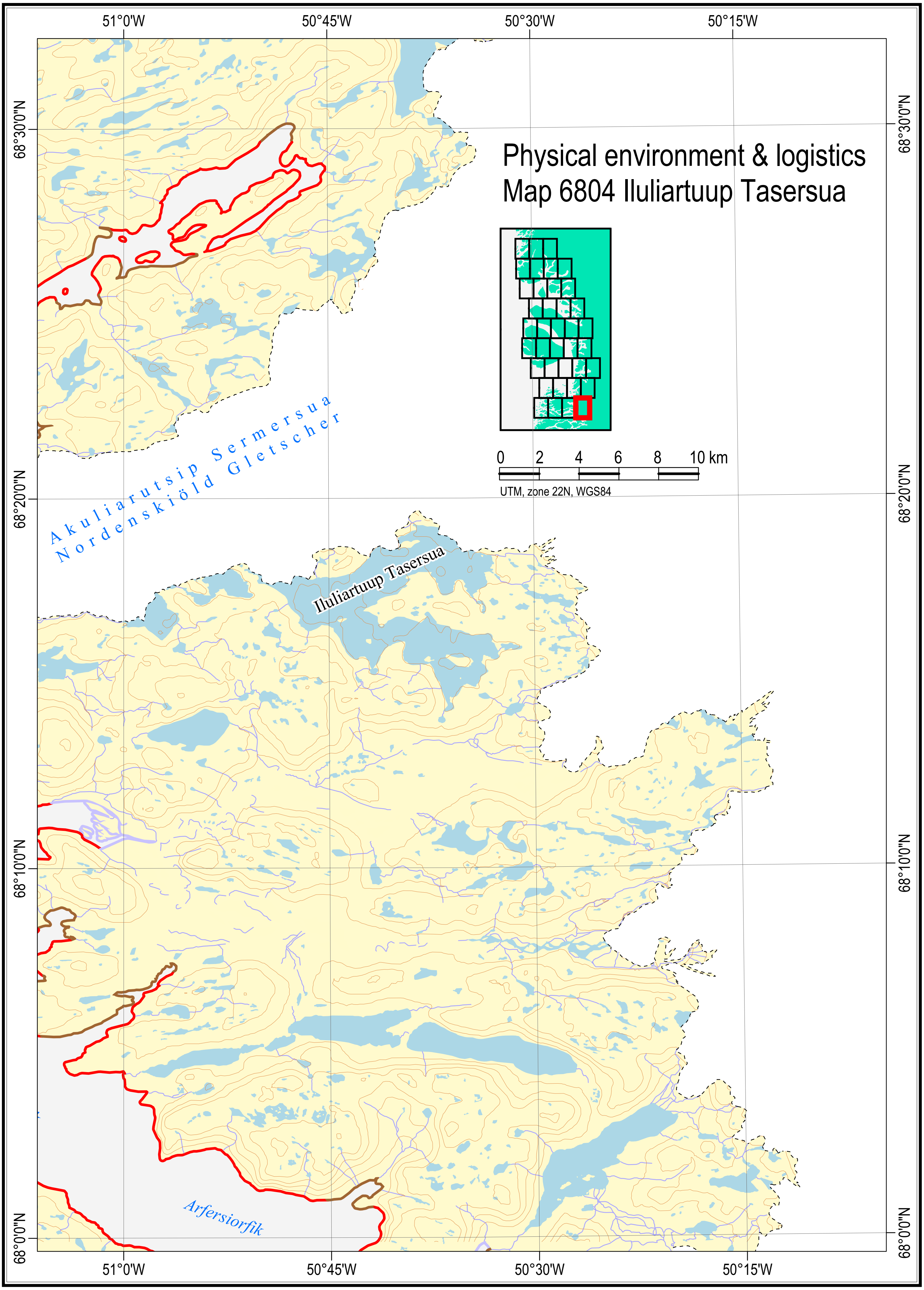
Danish Survey & Cadastre (KMS) topographical map: 68 V.2. Nautical charts: 1500.

Airphoto keymap

Map legend

Toggle maps

Keymaps

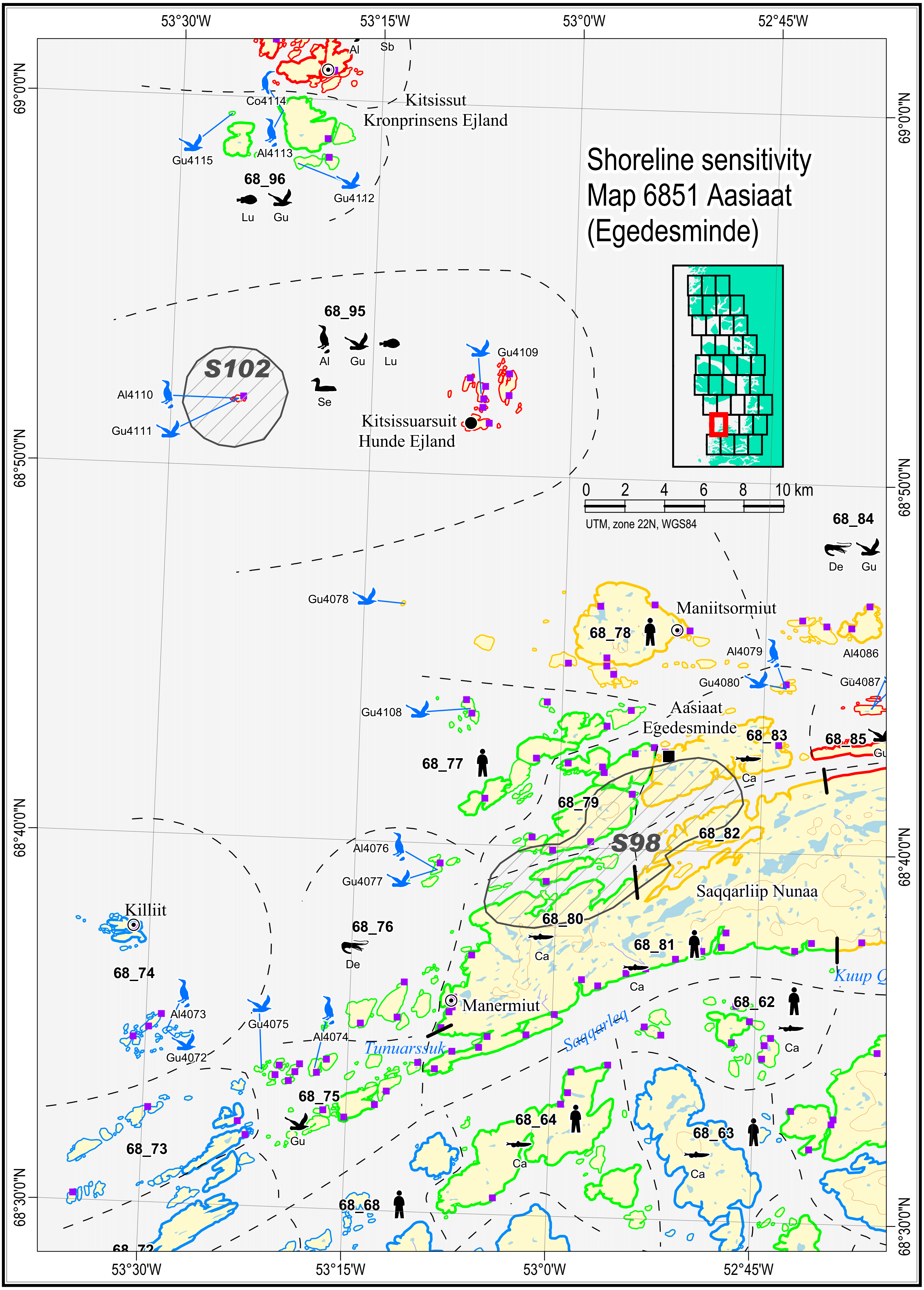


Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Shoreline sensitivity **Map 6851 - Aasiaat (Egedesminde)**

Environmental description

Resource use

R 68_62	Fishery for capelin (important) and wolffish (important). Hunting for minke and fin whales and ringed seal on ice (important).
R 68_63	Fishery for capelin (important) and wolffish. Hunting for ringed seal on ice (important).
R 68_64	Fishery for capelin (important) and wolffish. Hunting for ringed seal on ice.
R 68_77	Fishery for lumpsucker and wolffish. Hunting for minke and fin whales.
R 68_78	Fishery for lumpsucker and wolffish (important). Hunting for minke and fin whales (important).
R 68_81	Fishery for capelin (important) and wolffish (important). Hunting for ringed seals on ice (important).

Species occurrence

Ca68062	Important fishing area for capelin at some islands.
Ca68080	Important fishing area for capelin (**S98**).
Ca68083	Important fishing area for capelin along coast of Langesund (**S98**).
De68076	Important deep sea shrimp fishing area.
Gu68075	1 colony with breeding Arctic terns.
Se68095	Long-tailed ducks in autumn.
Ca68063, Ca6804	Fishing areas for capelin (some important) along most of the coasts.
Gu68095	3 colonies with breeding Arctic terns.
Gu68096	2 colonies with breeding Arctic terns.
Lu68095	Important fishing area for lumpsucker along almost all coasts.
Al68095	1 colony with breeding Atlantic puffins, little auks and black guillemots (**S102**).
Ca68081	Important fishing area for capelin along almost all coasts.
Lu68096	Important fishing area for lumpsucker along all coasts.

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

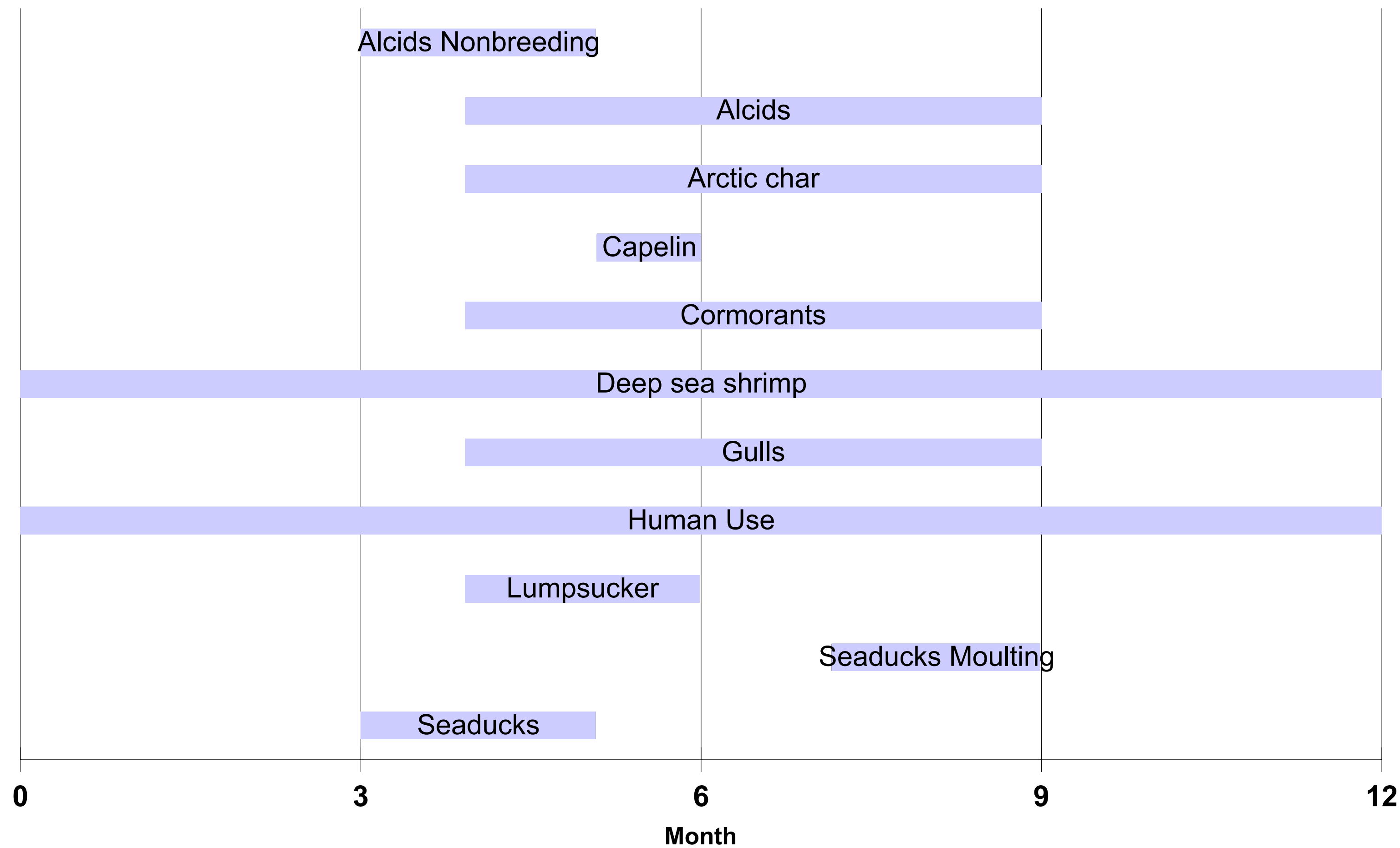
Al4073, Al4076, Al4079	Breeding black guillemots.
Al4074	Breeding black guillemots and razorbills.
Al4110	Breeding little auks, black guillemots, Atlantic puffins and razorbills (**S102**).
Al4113	Breeding black guillemots.
Co4114	Breeding great cormorants.
Gu4072, Gu4075	Breeding Arctic terns.
Gu4077, Gu4078	Breeding Arctic terns.
Gu4080, Gu4108	Breeding Arctic terns.
Gu4109	Breeding Arctic terns
Gu4111	Breeding Arctic terns (**S102**).
Gu4112, Gu4115	Breeding Arctic terns.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_62	27	Moderate
68_63	21	Low
68_64	23	Moderate
68_72	6	Low
68_73	10	Low
68_74	15	Low
68_75	25	Moderate
68_76	25	Moderate

(Continued on page 9-29)

Map 6851 Species and Resource Occurrences



Shoreline sensitivity Map 6851 - Aasiaat (Egedesminde)

Shoreline sensitivity summary

(Continued from page 9-27)

68_77	30	Moderate
68_78	38	High
68_79	27	Moderate
68_80	26	Moderate
68_81	27	Moderate
68_82	35	High
68_83	38	High
68_95	69	Extreme
68_96	24	Moderate

Physical environment and logistics Map 6851 - Aasiaat (Egedesminde)

Access

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

Numerous islands and hazards extend from the mainland coast and encumber the entrances to most fjords. Soundings are sparse in most fjords and caution is advised.

Hunde Ejland, two groups of islands 15 km NNW of Aasiaat, should be given a berth of at least 1.5 km unless local knowledge is available.

A rock awash and one with only 7 m water to the surface are reported in the approach to Aasiaat.

In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in fjords and sheltered waters, however tidal streams and stormy weather often break-up the ice or prevent its formation except at the inner ends of fjords.

Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water, and then diminishes prior to freeze-up.

Access

Between the islands in the vicinity of Aasiaat, the tidal streams sets to the east until 3 hours after high water, and to the west until 3 hours after low water.

At the town of Aasiaat, vessels up to 100 m length, 6.2 m draft can berth. The harbour is navigable, day and night from early May to early December. Tidal streams in the harbour are weak. There is a wharf with depths alongside of 6.2 m and a height above mean water of 1.5 m. Facilities in the harbour include mobile cranes, boatyard and hospital, and both water and fuel are available.

Anchorage is available in depths of 5 to 7 m at the trading station of Imerissoq within the Kronprinsens Ejlands. Two rocks below water lie on the north side of the entrance, and there is shoaling on each side. Anchorage within the islands is available at Bådeløb, with ringbolts for securing lines on each side.

Anchorage, for vessels to 50 m length is available in Hollænderhavn, a bay within the approach channel 13 km NW of Aasiaat on the north side of Natassat.

Charts indicate an anchorage at Manermiut but no other information is available.

Shorelines in this area are exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

An all-season, asphalt-surface airport (799 x 30 m) is available at Aasiaat with IFR and VFR traffic capability.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow nearshore waters, which may exist within the coastal islands and within fjords. The waters appear to be deep, but as they are not extensively charted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas including the selected area shown on the map.

There are numerous opportunities for exclusion booming in inter-island channels and inlets, however those that are narrow enough to facilitate booming are likely to have strong tidal currents. If there is local knowledge to suggest that tidal velocities are less than a knot, exclusion booming could be attempted across fjords or inlets that are one kilometre or less in width.

Alternatively, diversion booming could be attempted to protect the sensitive areas in the vicinity of Aasiaat and eastward, but the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters will complicate this.

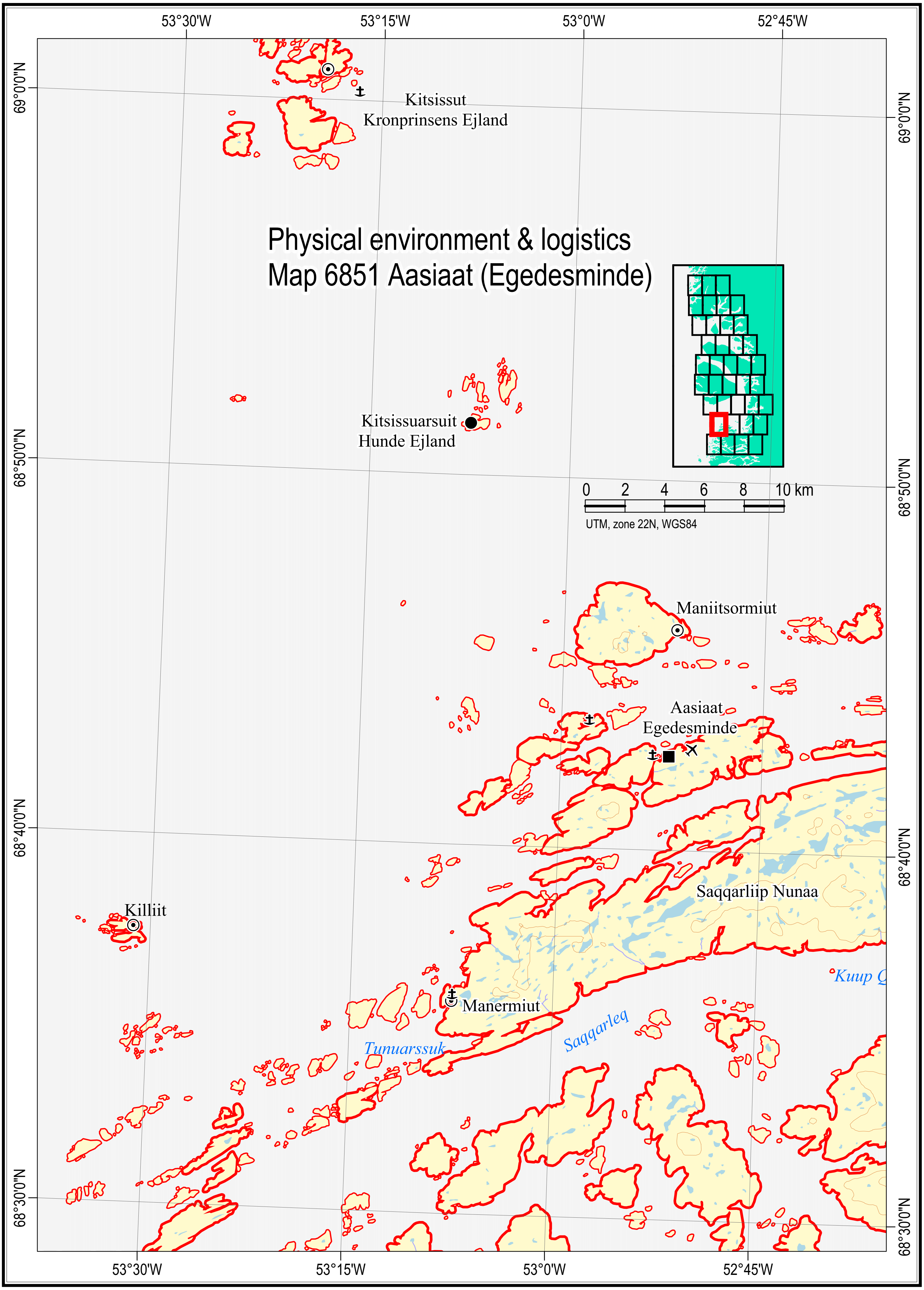
Shorelines shown on this map are exposed and semi-exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the numerous islands and small inlets. Access and trafficability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

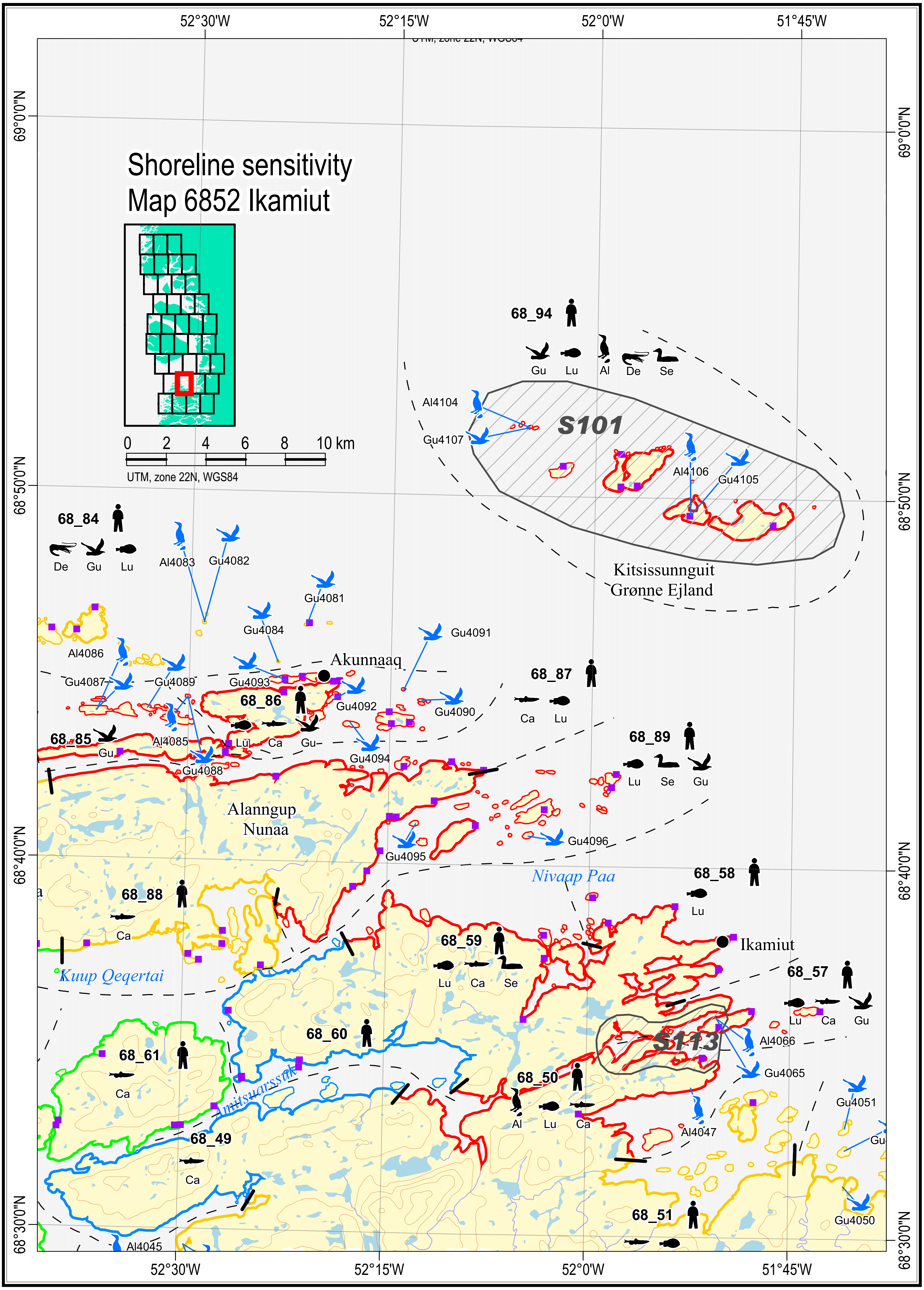
Safe havens

There are no potential safe havens identified on this map. The anchorages at Manermiut and Hollænderhavn could be investigated for their suitability as safe havens, but exclusion booming would be impractical in each one, and the latter is close to areas with high sensitivity.

Maps

Danish Survey & Cadastre (KMS) topographical map: 68 V.1. Nautical charts: 1500, 1510, 1512, 1530, 1550.


Physical environment & logistics
Map 6851 Aasiaat (Egedesminde)
53°30'W
53°15'W
53°0'W
52°45'W
69°0'0"N
68°50'0"N
68°40'0"N
68°30'0"N
Kitsissut
Kronprinsens Ejland
Kitsissuarsuit
Hunde Ejland
Maniitsormiut
Aasiaat
Egedesminde
Saqqarliip Nunaa
Killiit
Manermiut
Tunuarssuk
Saqqarleq
Kuup Q
0 2 4 6 8 10 km
UTM, zone 22N, WGS84


Shoreline sensitivity
Map 6852 Ikamiut
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
52°30'W
52°15'W
52°0'W
51°45'W
69°0'0"N
68°50'0"N
68°40'0"N
68°30'0"N
S101
S113
Kitsissunnguit
Grønne Ejland
Akunnaaq
Alanngup
Nunaa
Nivaap Paa
Ikamiut
Kuup Qeqertai
68_94
68_84
68_87
68_86
68_85
68_89
68_88
68_58
68_59
68_57
68_60
68_61
68_50
68_49
68_51
Gu
Lu
Al
De
Se
Ca
Al4104
Gu4107
Al4106
Gu4105
Al4083
Gu4082
Gu4081
Gu4084
Gu4091
Al4086
Gu4087
Gu4089
Gu4093
Gu4092
Gu4090
Al4085
Gu4088
Gu4094
Gu4096
Gu4095
Al4066
Gu4065
Gu4051
Al4047
Gu4050
Al4045

Environmental description

Resource use

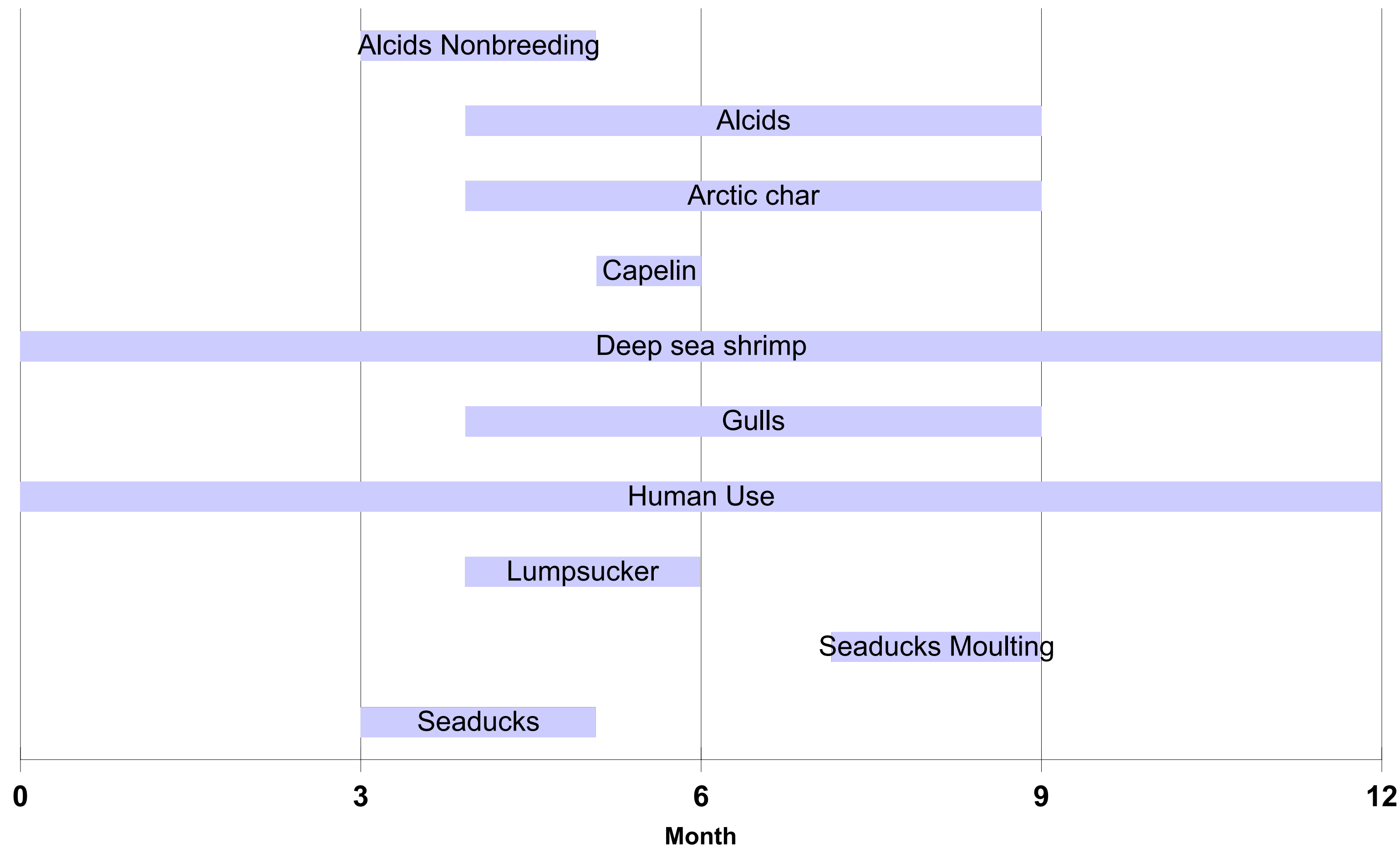
R 68_50	Fishery for Atlantic cod (incl. pound net), capelin and lumpsucker. Hunting for ringed seal on ice (**S114**).
R 68_51	Fishery for capelin (important) and lumpsucker (important). Hunting for ringed seal on ice.
R 68_57	Fishery for Atlantic cod (incl. pound net), capelin and lumpsucker. Hunting for ringed seal on ice (important) (**S114**).
R 68_58	Fishery for Atlantic cod (incl. pound net), Atlantic salmon, capelin and lumpsucker (important). Hunting for minke and fin whales and ringed seal on ice (important).
R 68_59	Fishery for Atlantic cod (incl. pound net), Atlantic salmon (important), capelin and lumpsucker (important).
R 68_60	Fishery for Atlantic salmon and wolffish. Hunting for ringed seal on ice.
R 68_61	Fishery for capelin (important) and wolffish. Hunting for ringed seal on ice (important).
R 68_84	Fishery for lumpsucker (important) and wolffish (important). Hunting for minke and fin whales.
R 68_86	Fishery for Atlantic salmon, capelin and lumpsucker (important).
R 68_87	Fishery for Arctic char at river outlet, Atlantic salmon, capelin (important) and lumpsucker (important).
R 68_88	Fishery for capelin (important), lumpsucker and wolffish. Hunting for ringed seals on ice.
R 68_89	Fishery for Atlantic salmon (important), capelin and lumpsucker (important).
R 68_94	Fishery for lumpsucker (important) and wolffish. Hunting for minke and fin whales (**S101**).

Species occurrence

Ca68049	Important fishing area for capelin at coast of Nangissat.
Ca68050, Ca68057	Important fishing area for capelin at coast of Sydostbugt.
Ca68059	Important fishing area for capelin at coast of Nivaap Paa.
Ca68086	Fishing areas (some important) for capelin along most of the coasts.
Gu68057	1 colony of breeding Arctic terns.
Gu68086	5 colonies of breeding Arctic terns.
Gu68089	2 colonies of breeding Arctic terns.
Lu68084	Important fishing area for lumpsucker at Isuamiut and other islands.
Se68059	Common eiders and long-tailed ducks in spring.
Se68094	Long-tailed ducks in spring.
Al68050	1 colony with breeding razorbills and black guillemots.
Al68094	Several colonies with breeding razorbills, black guillemots, Atlantic puffins and little auks (**S101**).
Ca68087	Important fishing area for capelin along coast of Langesund.
Ca68088	Important fishing area for capelin along most of the coasts.
De68094	Important fishing area for deep sea shrimp.
Gu68085	3 colonies with breeding Arctic terns.
Lu68050	Important fishing area for lumpsucker in interior Sydostbugt.
Lu68058	Important fishing area for lumpsucker.
Lu68087	Important fishing area for lumpsucker along almost all coasts.
Se68089	Common eiders and long-tailed ducks in spring.
Ca68051	Important fishing area for capelin at all coasts.
Ca68061	Important fishing area for capelin at most coasts of Kannala.
De68084	Important fishing area for deep sea shrimp.
Gu68084	3 colonies with breeding Arctic terns.
Gu68094	Colonies with breeding Arctic terns on most of the islands.
Lu68051, Lu68057	Important fishing area for lumpsucker along almost all coasts.
Lu68059, Lu68086	Important fishing area for lumpsucker along all coasts.
Lu68089	Important fishing area for lumpsucker along all coasts.
Lu68094	Important fishing area for lumpsucker along all coasts (**S101**).

(Continued on page 9-35)

Map 6852 Species and Resource Occurrences



Shoreline sensitivity

Map 6852 - Ikamiut

Environmental description

(Continued from page 9-33)

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

Al4047	Breeding razorbills and black guillemots.
Al4066, Al4085	Breeding black guillemots.
Al4083	Breeding little auks and black guillemots.
Al4104	Breeding little auks and black guillemots (**S101**).
Al4086	Breeding black guillemots.
Al4106	Breeding razorbills, Atlantic puffins and black guillemots (**S101**).
Gu4065, Gu4081	Breeding Arctic terns.
Gu4082, Gu4084	Breeding Arctic terns.
Gu4087, Gu4088	Breeding Arctic terns.
Gu4089, Gu4090	Breeding Arctic terns.
Gu4091, Gu4092	Breeding Arctic terns.
Gu4093, Gu4094	Breeding Arctic terns.
Gu4095, Gu4096	Breeding Arctic terns.
Gu4105	Breeding Arctic terns and glaucous gulls (**S101**).
Gu4107	Breeding Arctic terns (**S101**).

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_49	18	Low
68_50	65	Extreme
68_51	43	High
68_57	64	Extreme
68_58	48	Extreme
68_59	45	Extreme
68_60	22	Low
68_61	31	Moderate
68_84	41	High
68_85	51	Extreme
68_86	53	Extreme
68_87	48	Extreme
68_88	36	High
68_89	49	Extreme
68_94	54	Extreme

Physical environment and logistics

Map 6852 - Ikamiut

Access

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

Numerous islands and hazards extend from the mainland coast and encumber the entrances to most fjords. Soundings are sparse in most fjords and caution is advised.

A rock awash and one with 7 m below surface are reported in the approach to Aasiaat.

The area in the vicinity of Grønne Ejland, a chain of islands, islets and rocks, should be given a wide berth on the north side to avoid foul ground 5 km north of the west end of the chain.

Physical environment and logistics Map 6852 - Ikamiut

Access

(Continued from previous page)
In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in fjords and sheltered waters. However, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water and then diminishes prior to freeze-up.

Between the islands in the vicinity of Aasiaat the tidal streams sets to the east until 3 hours after high water and to the west until 3 hours after low water.

Good shelter for small vessels is available at the settlement of Akunnaaq on the south side of the eastern extremity of Akunap Nuna. It is seldom blocked by ice.

In Sydostbugten anchorage can be found at the settlement of Ikamiut.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airport is at Aasiaat (map 6851).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in both offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within the coastal islands and within fjords. The waters appear to be deep, but as they are not extensively charted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas including the selected area shown on the map.

There are numerous opportunities for exclusion booming in inter-island channels and inlets. However, those that are narrow enough to facilitate booming are likely to have strong tidal currents. If there is local knowledge to suggest that tidal velocities are less than a knot, exclusion booming could be attempted across fjords or inlets that are one kilometre or less in width.

Shorelines shown on this map are exposed and semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

Three sections of beach south of Ikamiut have semi-protected coastal exposure, and may require cleaning using sediment removal techniques, along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map.

Maps

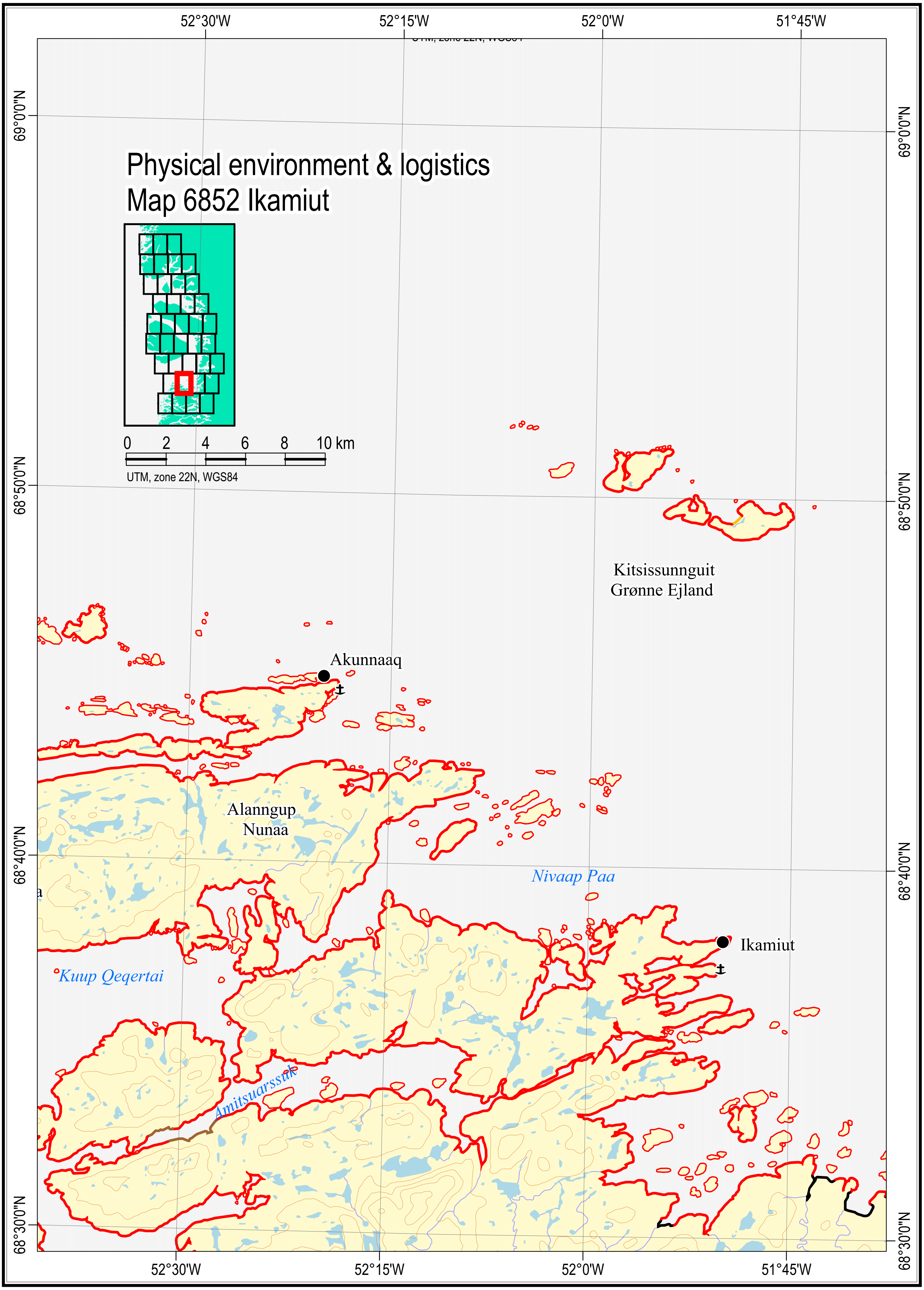
Danish Survey & Cadastre (KMS) topographical map: 68 V.1, 68 V.2. Nautical charts: 1500, 1512.

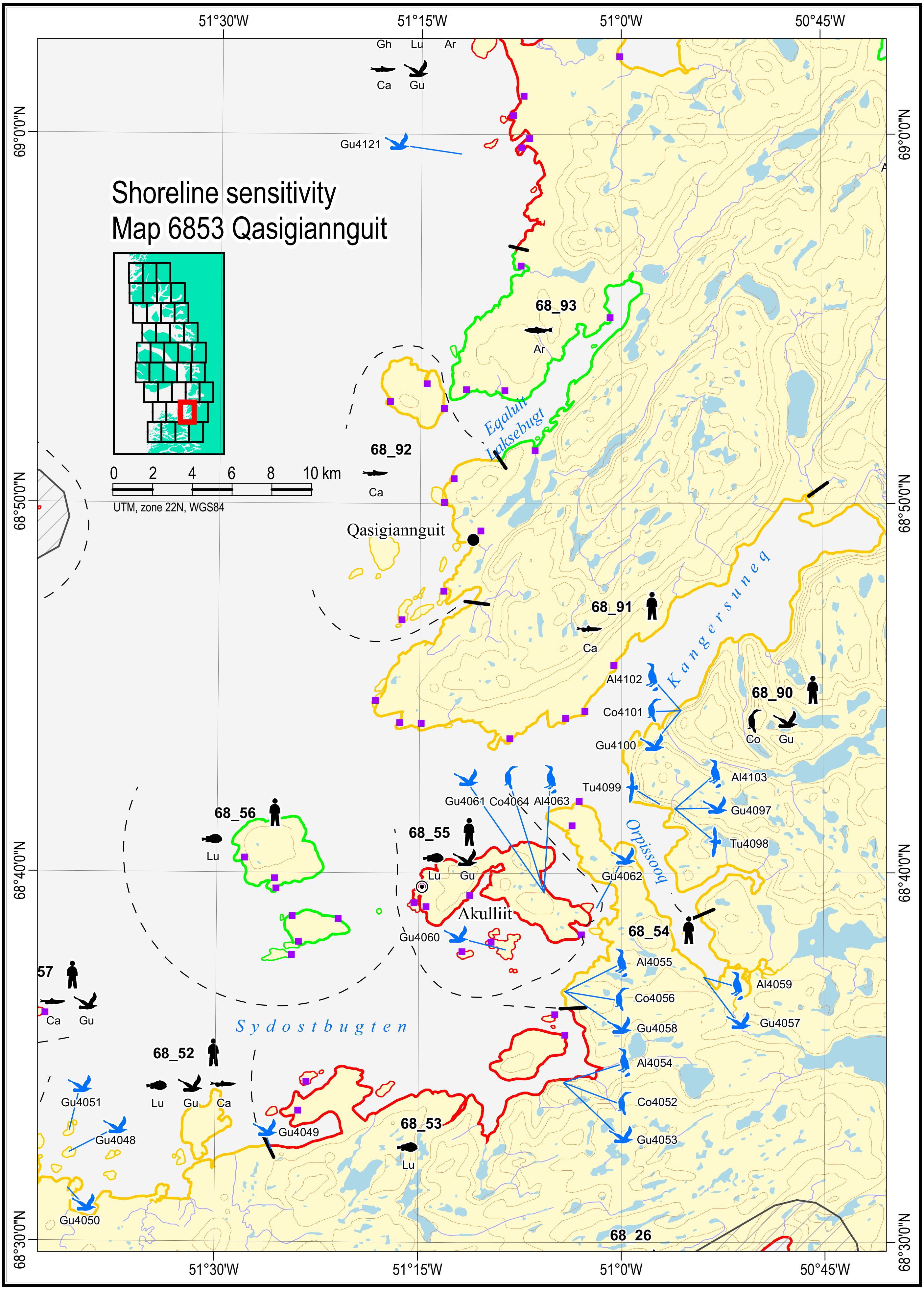
Airphoto keymap

Map legend

Toggle maps

Keymaps




Shoreline sensitivity
Map 6853 Qasigiannguit
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
51°30'W
51°15'W
51°0'W
50°45'W
69°0'0"N
68°50'0"N
68°40'0"N
68°30'0"N
Qasigiannguit
Akulliit
Eqalulit
Laksebugt
Kangersuneq
Orpissooq
Sydostbugten
68_93
68_92
68_91
68_90
68_56
68_55
68_54
68_53
68_52
68_26
57
Gh
Lu
Ar
Ca
Gu
Co
Gu4121
Al4102
Co4101
Gu4100
Al4103
Gu4097
Tu4098
Tu4099
Gu4061
Co4064
Al4063
Gu4062
Gu4060
Al4055
Co4056
Gu4058
Al4054
Co4052
Gu4053
Al4059
Gu4057
Gu4051
Gu4048
Gu4049
Gu4050

Environmental description

Resource use

R 68_52	Fishery for Arctic char at river outlet, capelin and lumpsucker (important). Hunting for ringed seal on ice.
R 68_54	Fishery for Arctic char at river outlet, Atlantic cod (incl. pound net), lumpsucker and redfish. Hunting for ringed seal on ice (important).
R 68_55	Fishery for Atlantic cod (incl. pound net), capelin, lumpsucker (important) and redfish. Hunting for ringed seal on ice (important).
R 68_56	Fishery for Atlantic cod (incl. pound net), lumpsucker (important) and redfish. Hunting for ringed seal on ice.
R 68_90	Fishery for Arctic char at river outlet and redfish. Hunting for ringed seals on ice (important).
R 68_91	Fishery for Arctic char at river outlet, capelin and redfish. Hunting for minke and fin whales, ringed seals on ice.

Species occurrence

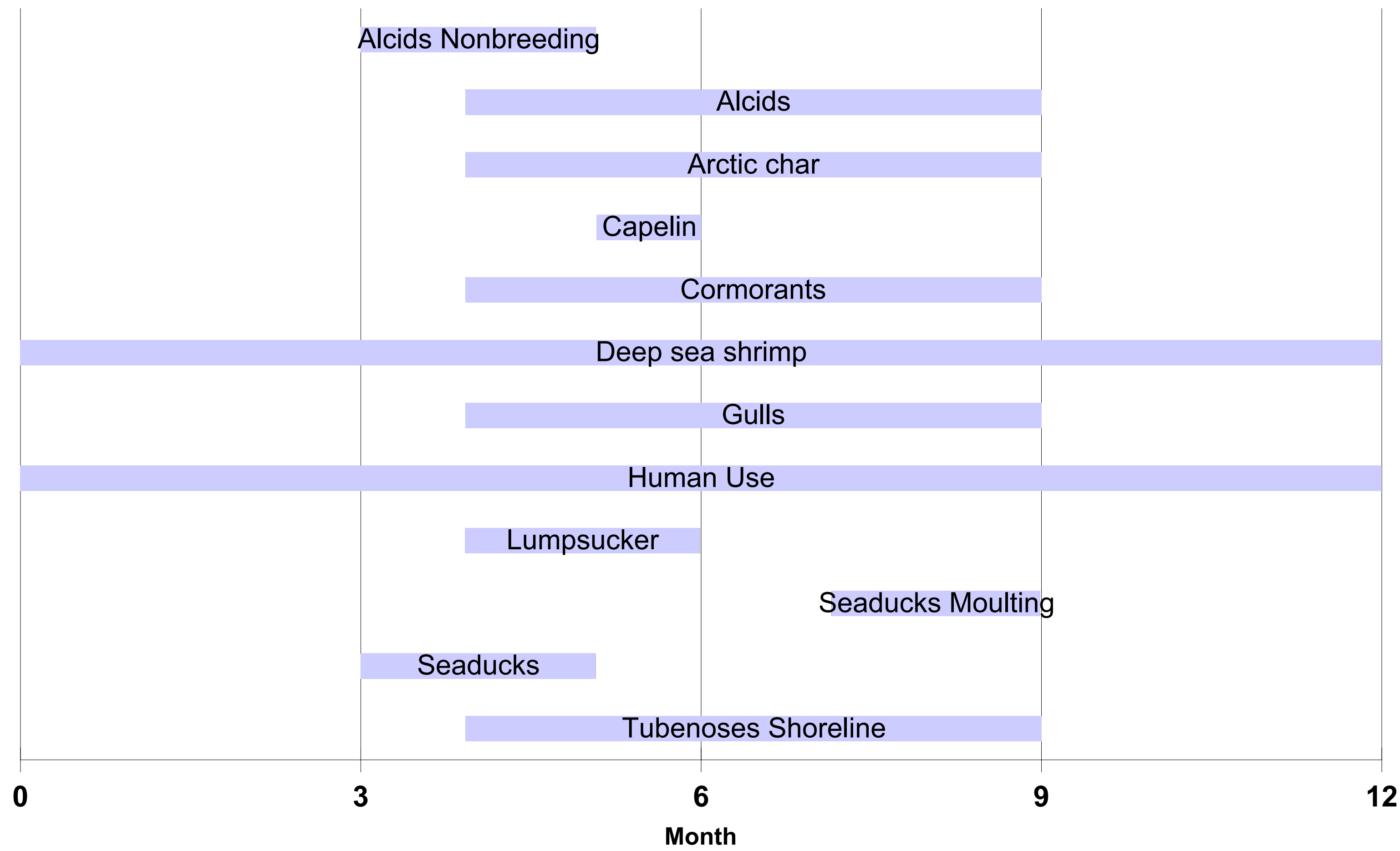
Ca68052	Important fishing area for capelin at coasts of islands.
Gu68090	2 colonies with breeding glaucous gulls, Iceland gulls and kittiwakes.
Ar68093	3 important rivers with Arctic char and important coastal fishery in Eqaluit.
Ca68091	Important capelin fishing area in western part and also in parts of Kangersuneq, where spawning occur along most of the shore.
Ca68092	Capelin fishing areas along almost all coasts, most of them important.
Co68090	1 colony of breeding great cormorants.
Gu68052	3 colonies of breeding Arctic terns and 1 with glaucous gulls.
Gu68055	2 colonies of breeding Arctic terns and 1 with Iceland gulls.
Lu68052, Lu6805	Important fishing area for lumpsucker along all coasts.
Lu68055, Lu68056	Important fishing area for lumpsucker along all coasts.

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

Al4054	Breeding black guillemots and razorbills.
Al4055, Al4059	Breeding black guillemots.
Al4063, Al4103	Breeding black guillemots.
Al4102	Breeding razorbills and black guillemots.
Co4052, Co4056	Breeding great cormorants.
Co4064, Co4101	Breeding great cormorants.
Gu4048, Gu4050	Breeding Arctic terns.
Gu4049	Breeding glaucous gulls, Iceland gulls and kittiwakes.
Gu4051, Gu4060	Breeding Arctic terns.
Gu4053, Gu4058	Breeding glaucous gulls, Iceland gulls and kittiwakes.
Gu4057	Breeding Iceland/glaucous gulls and kittiwakes.
Gu4061	Breeding Iceland gulls.
Gu4062	Breeding Arctic terns.
Gu4097	Breeding glaucous gulls.
Gu4100	Breeding glaucous gulls, Iceland gulls and kittiwakes.
Gu4121	Breeding Arctic terns.
Tu4098, Tu4099	Breeding northern fulmars.

(Continued on page 9-41)

Map 6853 Species and Resource Occurrences



Shoreline sensitivity

Map 6853 - Qasigiannguit (Christianshåb)

(Continued from page 9-39)

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
68_52	38	High
68_53	46	Extreme
68_54	44	High
68_55	52	Extreme
68_56	30	Moderate
68_90	43	High
68_91	35	High
68_92	33	High
68_93	30	Moderate

Physical environment and logistics

Map 6853 - Qasigiannguit (Christianshåb)

Access

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

Numerous islands and hazards extend from the mainland coast and encumber the entrances to most fjords. Soundings are sparse in most fjords and caution is advised.

Caution is advised in the approaches to Qasigiannguit: in places, depths of 100 m or more extend close to islets in the NE chain; soundings cannot be used to indicate the presence of land.

This area is ice-bound in the average year from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current. Icebergs rarely obstruct navigation at Qasigiannguit.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water and then diminishes prior to freeze-up.

At Qasigiannguit the tide attains a maximum height of 3.3 m. Tidal streams in the harbour are weak.

Access

(Continued from previous page)
In Sydostbugten, anchorage can be found at the abandoned settlement of Akulliit.

At Qasigiannguit anchorage is available in an outer harbour, well sheltered from seaward by a chain of islets. The inner harbour has berthing for vessels to 100 m length and 6 m draft. A jetty at Atlantkaj is 30 m long with depth alongside of 5 m, and a height of 2 m above mean high water. Facilities in the harbour include mobile cranes, forklifts and hospital, and water and fuel are available.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

The possibility of beach landings could be explored in the area north of Qasigiannguit, but there are no nearshore soundings in this area and reconnaissance would be required.

An asphalt-surface heliport, VFR daytime only, is available at Qasigiannguit. The nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within the coastal islands and within fjords. The waters appear to be deep, but as they are not extensively charted, soundings should be taken to confirm their depth prior to using dispersants.

Offshore countermeasures represent the only practical method of protecting most shoreline areas including the selected area shown on the map.

There are several opportunities for exclusion booming in inter-island channels and inlets, however those that are narrow enough to facilitate booming are likely to have strong tidal currents. If there is local knowledge to suggest that tidal velocities are less than a knot, exclusion booming could be attempted across fjords or inlets that are one kilometre or less in width.

Alternatively, diversion booming could be attempted to protect sensitive areas south of Qasigiannguit, 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 and semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

The several beaches on the south coast of Sydostbugten, north of Eqaluit/Laksebugt and near the head of the fjords, may, depending on the degree of oiling, require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

A potential safe haven for vessel lightering operations is the anchorage at Qasigiannguit. It is in an area of moderate sensitivity. If local knowledge suggests that tidal currents are sufficiently low, 500 m of boom could be deployed across the bay to contain any further release of oil. A potential alternative to this location would be within Eqaluit/Laksebugt: although it is not charted, it appears to be deep and affords good protection. It is too wide to boom effectively, but its shape may provide natural containment.

Maps

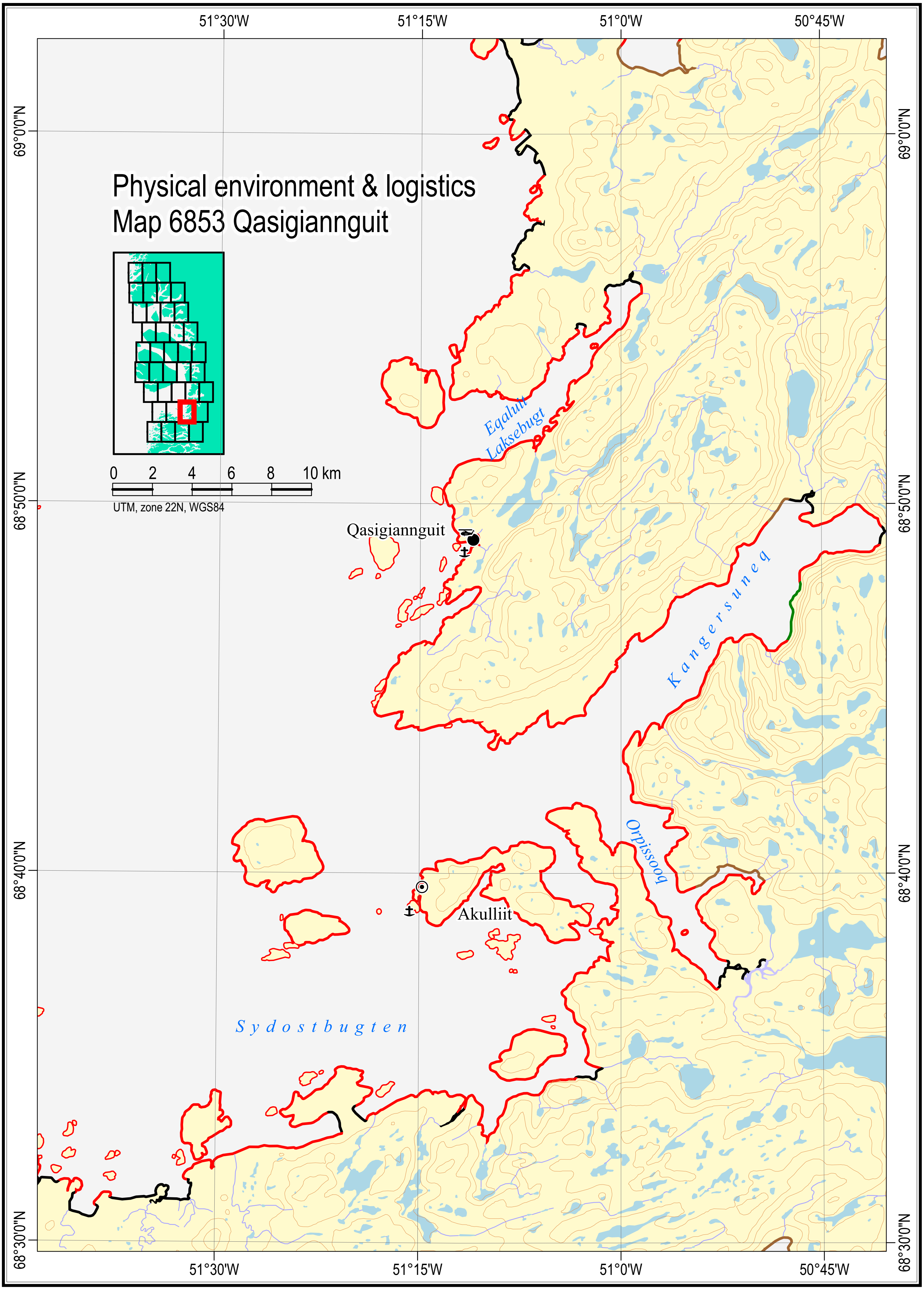
Danish Survey & Cadastre (KMS) topographical map: 68 V.2. Nautical charts: 1500, 1512, 1513, 1551.

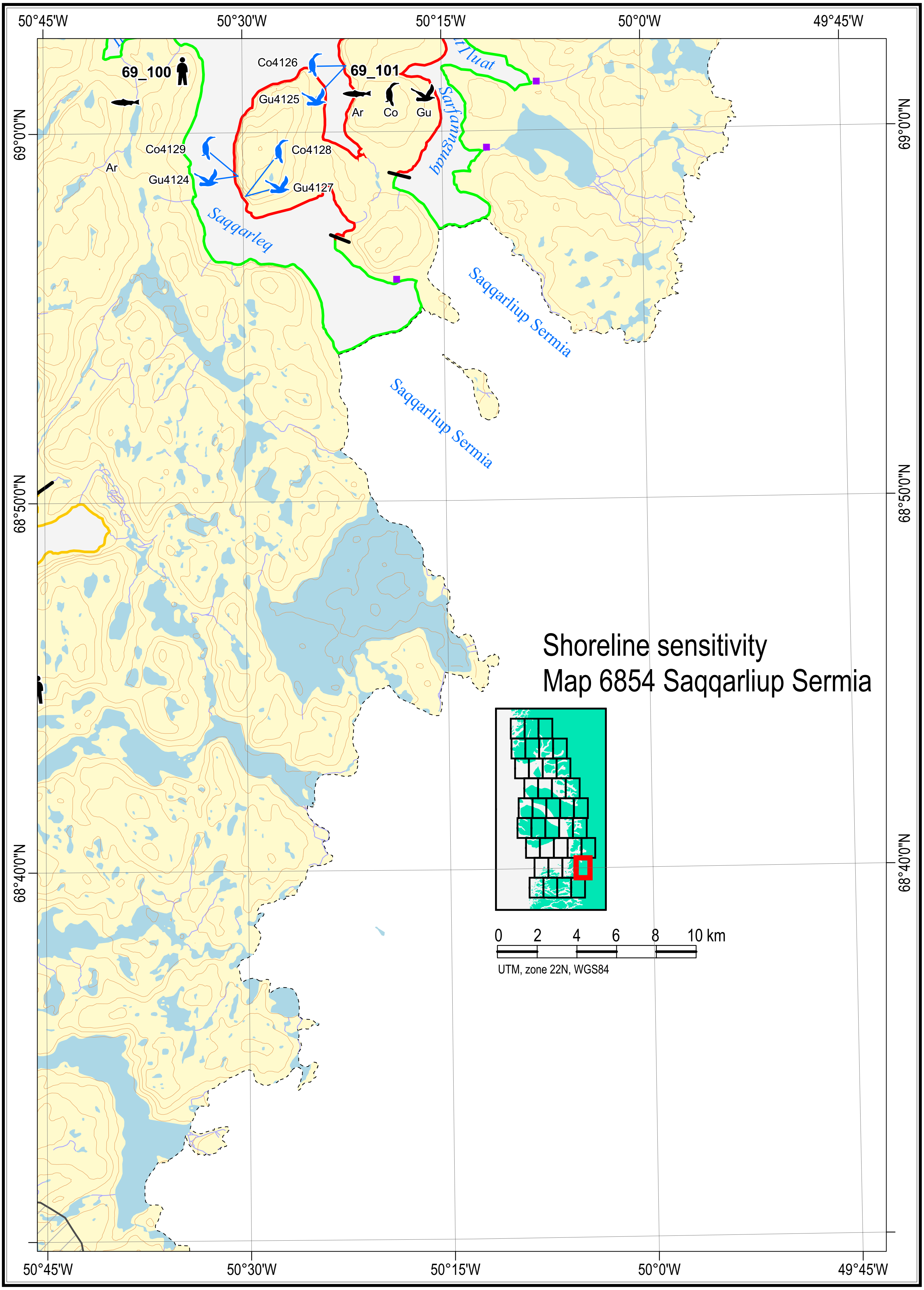
Airphoto keymap

Map legend

Toggle maps

Keymaps




50°45'W
50°30'W
50°15'W
50°0'W
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69°0'0"N
68°50'0"N
68°40'0"N
69_100
69_101
Co4126
Gu4125
Co4129
Co4128
Gu4124
Gu4127
Ar
Co
Gu
Saqqarleq
Sarfanguaq
Saqqarliup Sermia
Saqqarliup Sermia
Shoreline sensitivity
Map 6854 Saqqarliup Sermia
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Environmental description

Resource use

R 69_100	Fishery for Arctic char along coast (important) and Greenland halibut. Hunting for ringed seals on ice (important).

Species occurrence

Ar69100, Ar69101	1 important river outlet and important coastal fishing area for Arctic char along all the coasts.
Co69101	3 colonies with breeding great cormorants.
Gu69101	3 colonies with breeding glaucous and Iceland gulls.

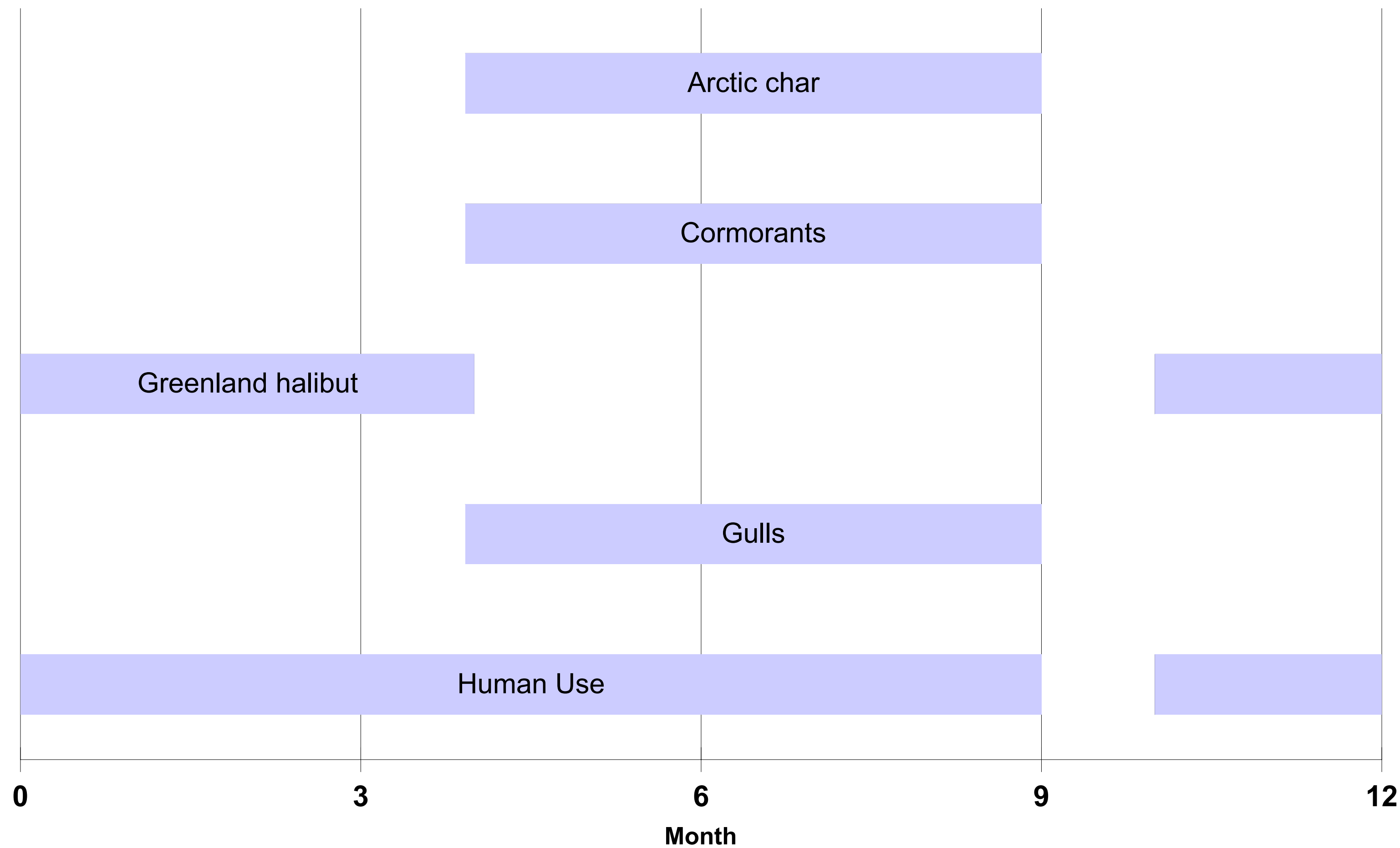
Site specific species occurrence (seabird breeding colonies); blue icons

Co4128, Co4129	Breeding great cormorants.
Gu4124	Breeding Iceland gulls and glaucous gulls.
Gu4127	Breeding Iceland gulls.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_100	24	Moderate
69_101	50	Extreme

Map 6854 Species and Resource Occurrences



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Access

There is little information on the limited marine area within this map.

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

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airfield is the heliport at Qasigiannguit (map 6853), and the nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist at the head of the fjords shown in 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.

Shorelines shown on this map are predominantly semi-exposed rock and moraine, 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 cleanup 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

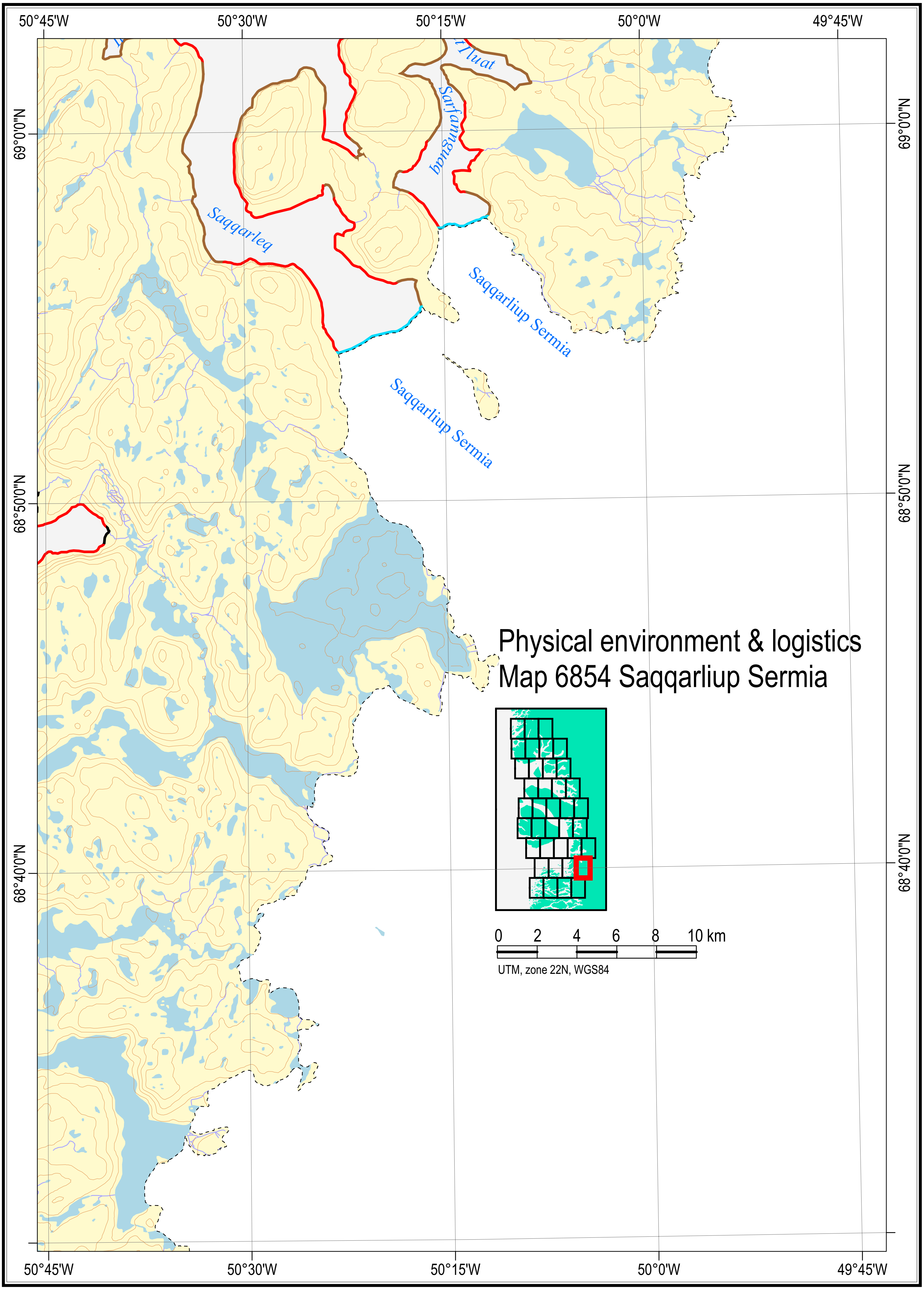
Danish Survey & Cadastre (KMS) topographical map: 68 V.2. Nautical charts: none.

Airphoto keymap

Map legend

Toggle maps

Keymaps

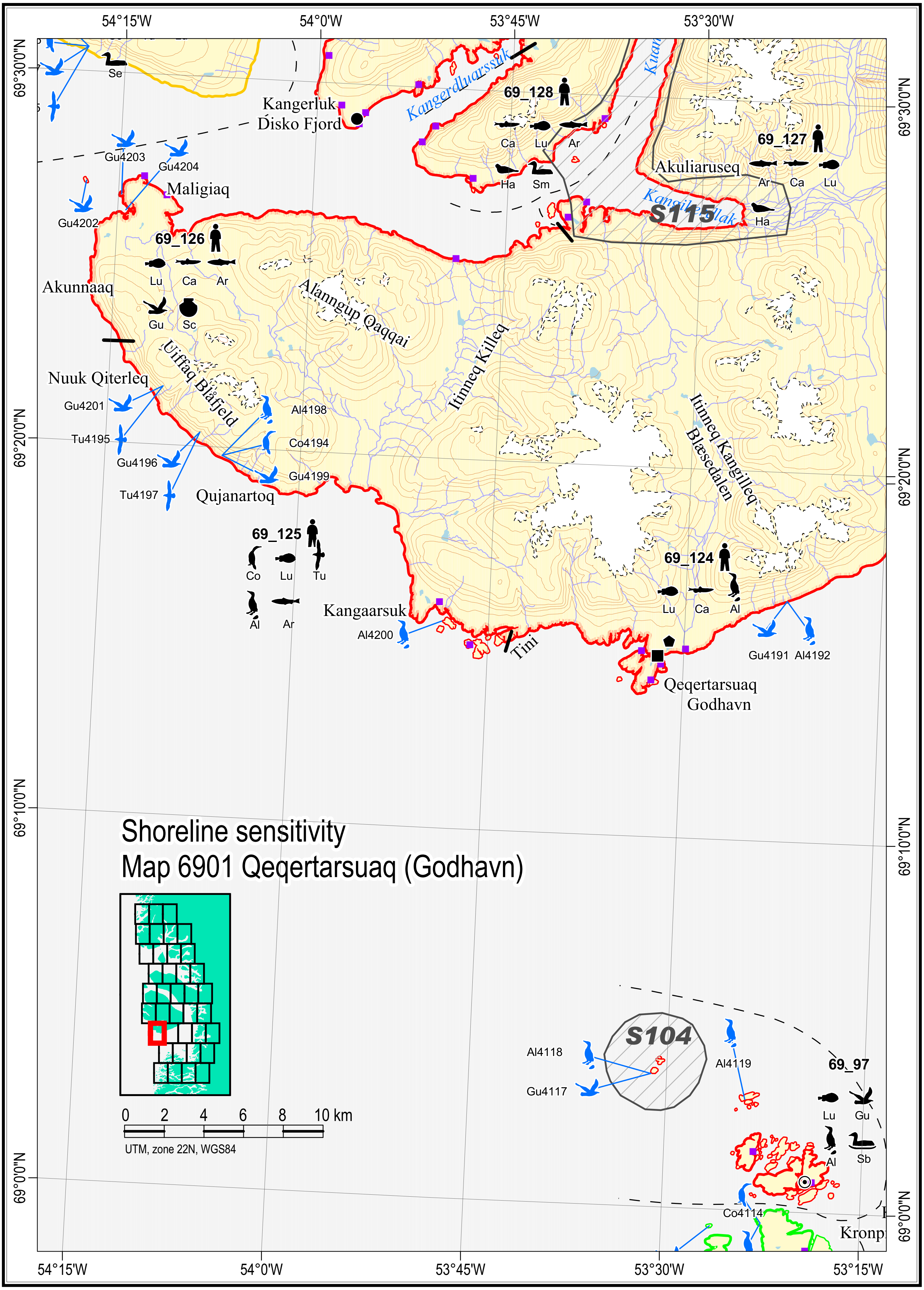


Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental description

Resource use

R 69_124	Fishery for capelin (important) and lumpsucker. Hunting for minke and fin whales (important).
R 69_125	Fishery for Arctic char along coast and at river outlet, capelin, lumpsucker (important) and scallop. Hunting for minke and fin whales (important).
R 69_126	Fishery for Arctic char along coast, Atlantic halibut, capelin, lumpsucker (important), scallop and wolffish (important). Hunting for minke and fin whales.
R 69_127	Fishery for Arctic char along coast and at 3 river outlets, capelin, lumpsucker and wolffish (important). Hunting for ringed seals on ice (important) (**S115**).
R 69_128	Fishery for Arctic char along coast and at 3 river outlets, capelin, lumpsucker and wolffish (important). Hunting for ringed seals on ice (**S115**).

Species occurrence

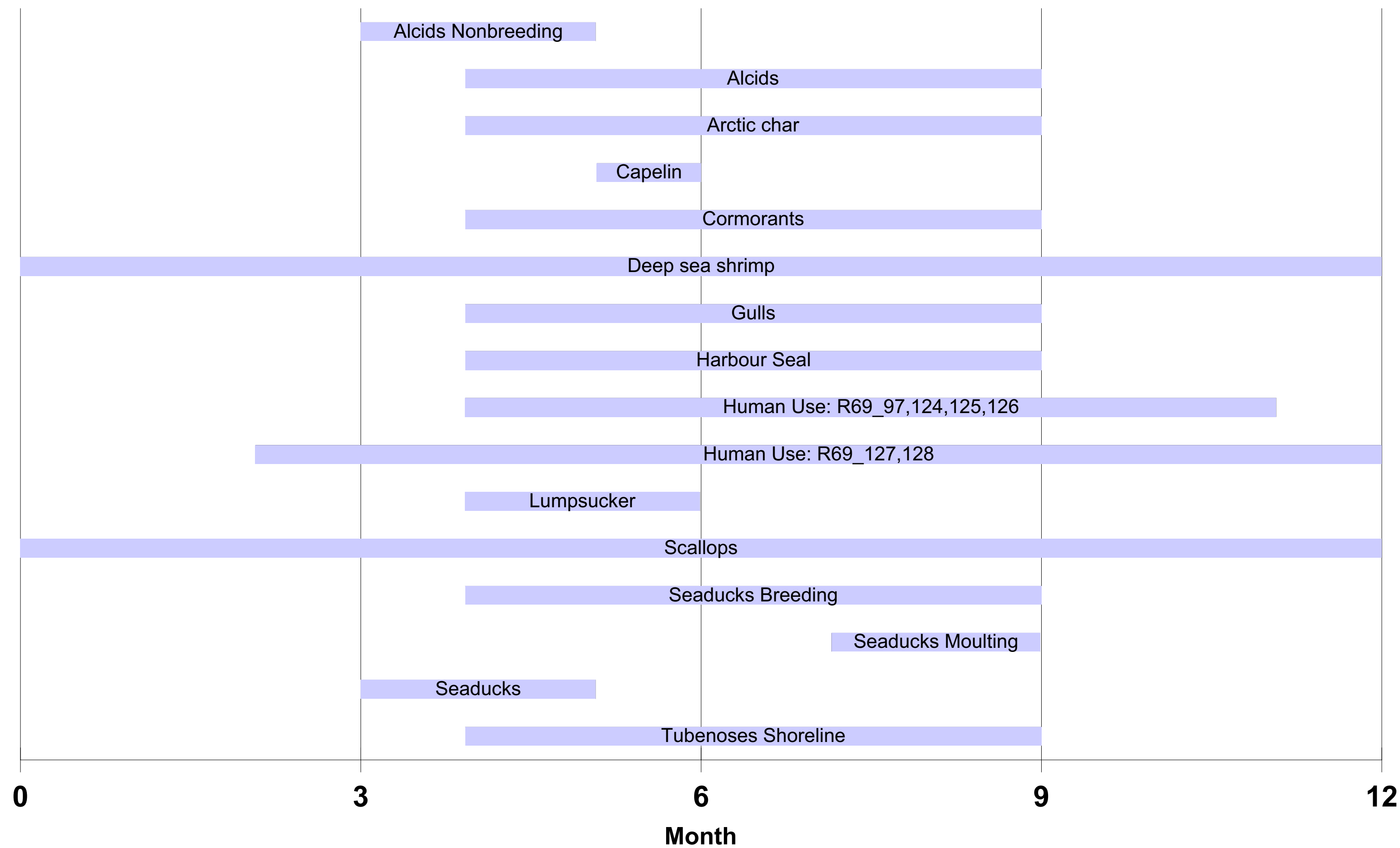
Al69097	2 colonies with breeding Atlantic puffins, razorbills, little auks and black guillemots (**S104**).
Al69124	1 colony with breeding black guillemots.
Al69125	2 colonies with breeding black guillemots.
Ar69125	Important coastal fishing area for Arctic char in eastern part and 1 important river.
Ar69126	Fishery for Arctic char along coast (important) near Nipisat and at 2 river outlets (1 important).
Ar69127, Ar69128	Fishery for Arctic char along coast (important) and at 3 important river outlets.
Ca69124	Important capelin fishing areas along most of the coast.
Ca69126	Spawning area for capelin along most of the coast, important fishery at same sites.
Ca69127, Ca69128	Capelin spawning areas along entire coast (**S115**).
Co69125	1 colony with breeding great cormorants.
Gu69097	1 colony with breeding Arctic terns and 1 with glaucous gulls.
Gu69126	3 colonies with breeding Arctic terns.
Ha69127, Ha69128	Harbour seal summer habitat (**S115**).
Lu69097	Important fishing area for lumpsucker along all coasts.
Lu69124	Fishing and spawning area for lumpsucker along all coasts.
Lu69125	Important fishing and spawning area for lumpsucker along all coasts.
Lu69126	Important fishing area for lumpsucker along all coasts.
Lu69127	Important spawning area for lumpsucker along all coasts, important fishery in the western part (**S115**).
Lu69128	Important spawning area for lumpsucker along all coasts, important fishery in some parts (**S115**).
Sc69126	Scallop fishing area.
Sb69097	1 colony with breeding common eiders.
Sm69128	King eiders and common eiders.
Tu69125	2 colonies with breeding northern fulmars.

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

Al4118	Breeding Atlantic puffins, razorbills, little auks and black guillemots (**S104**).
Al4119	Breeding Atlantic puffins and little auks.
Al4192, Al4198	Breeding black guillemots.
Al4200	Breeding black guillemots.
Co4194	Breeding great cormorants.
Gu4117	Breeding Arctic terns (**S104**).
Gu4202	Breeding Arctic terns.
Gu4191, Gu4199	Breeding Iceland gulls.
Gu4196, Gu4201	Breeding Iceland or glaucous gulls.
Gu4203, Gu4204	Breeding Arctic terns.
Tu4195, Tu4197	Breeding northern fulmars.

(Continued on page 9-53)

Map 6901 Species and Resource Occurrences



Shoreline sensitivity

Map 6901 - Qeqertarsuaq (Godhavn)

(Continued from page 9-51)

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_97	53	Extreme
69_124	45	Extreme
69_125	50	Extreme
69_126	51	Extreme
69_127	65	Extreme
69_128	71	Extreme

Physical environment and logistics

Map 6901 - Qeqertarsuaq (Godhavn)

Access

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

Few dangers are charted along the west coast of Disko Island.

Several known isolated dangers are reported in the approaches to Qeqertarsuaq.

Kronprinsens Ejland, a large group of islets, rocks, and islands south of Qeqertarsuaq, have shoals and below-water rocks in the vicinity. Local knowledge is essential for navigation.

In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.
Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water and then diminishes prior to freeze-up.

The tidal streams at Qeqertarsuaq are weak, both in the harbour and the approaches.
Anchorage is available at the trading station of Imerigssoq within the Kronprinsens Ejland in depths of 5 to 7 m. Two below-water rocks lie on the north side of the entrance, and there is shoaling on each side. Anchorage within the islands is available at Bådeløb, with ringbolts for securing lines on each side.

Access

(Continued from previous page)
In the islands marked as Tini, anchorage can be found in the bay that opens off the northeast corner in depths of 23 m. Above- and below-water rocks are reported on the east side of the entrance.

At Qeqertarsuaq, vessels up to 80 m length and 6.0 m draft have used the inner harbour, with larger vessels using the outer harbour. The port is normally navigable day and night from the end of May to the end of November. There is a wharf, 6 m long with depths of 1.0 m alongside, and a height of 1 m above mean high water. Facilities in the harbour include mobile cranes, boatyard, garage and hospital, and water and fuel are available.

Anchorage with good protection is available in Kangerluarssuk, an inlet on the north side of Disko Fjord. Anchorage is available nearby in Kuanit, a small bay on the north side of Disko Fjord, depths not reported. Close SE of the south entrance to the fjord anchorage is available in depths of 11 m, with ringbolts on the shores for securing lines. There is a small jetty with depths of 1.9 m alongside, and a height of 1 m above mean high water.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. Beaches north of Kangaarsuk may be suitable for marine landings but would require reconnaissance to confirm. Several hazards and shoaling are noted on charts.

An asphalt-surface heliport, VFR daytime only, is available at Qeqertarsuaq. The nearest airport is at Aasiaat (map 6851).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within fjords and in the bay north of Kangaarsuk. 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 including the selected area shown on the map.

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 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 and semi-exposed, and 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 cleanup operations would be marine-based given the likely nature of the shoreline.

Beaches in the vicinity of Akunnaaq and north of Kangaarsuk are exposed but may require cleaning, depending on the extent of oiling, using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map.

Maps

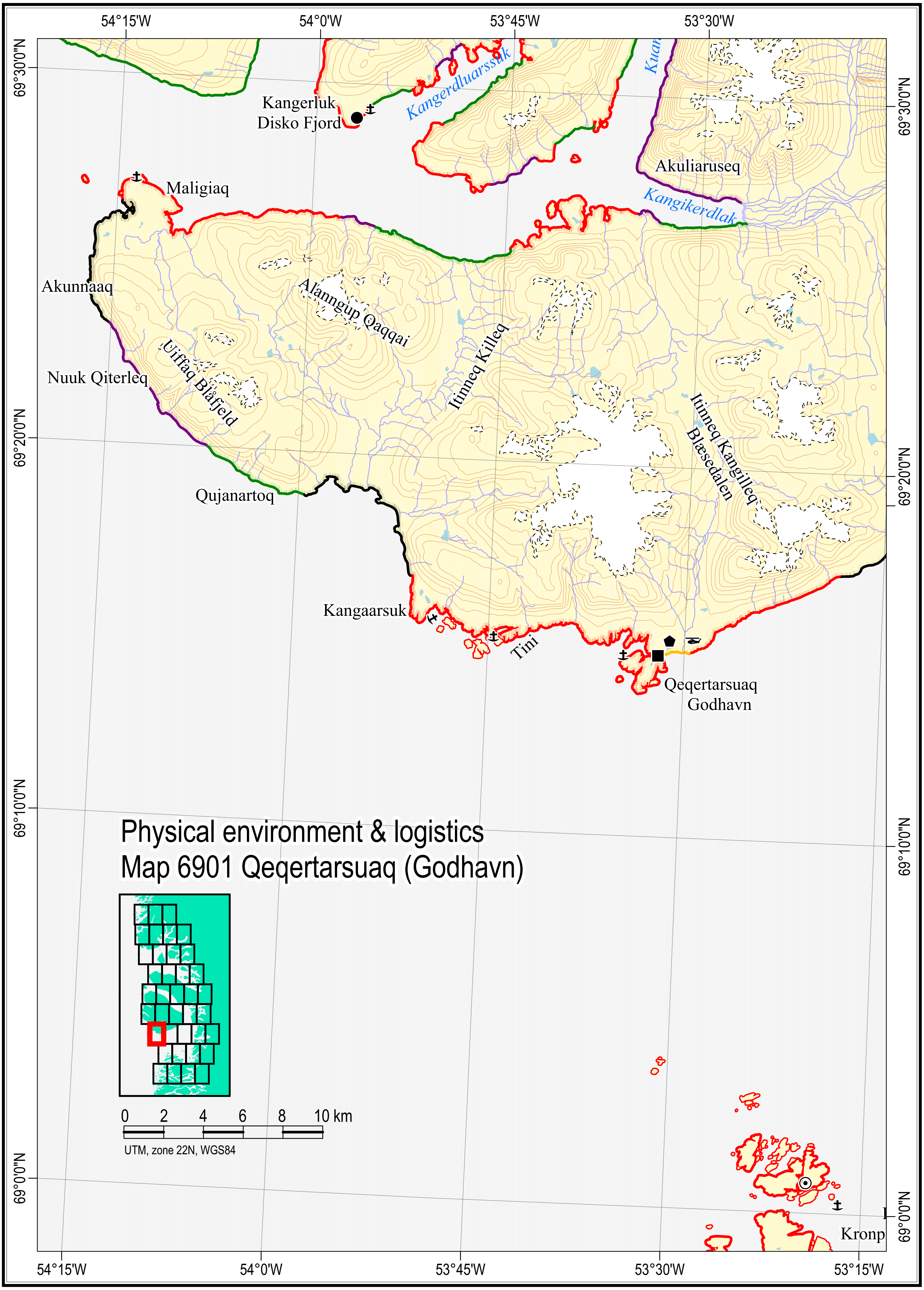
Danish Survey & Cadastre (KMS) topographical map: 69 V.1. Nautical charts: 1500, 1511, 1550, 1551.

Airphoto keymap

Map legend

Toggle maps

Keymaps



Physical environment & logistics
Map 6901 Qeqertarsuaq (Godhavn)

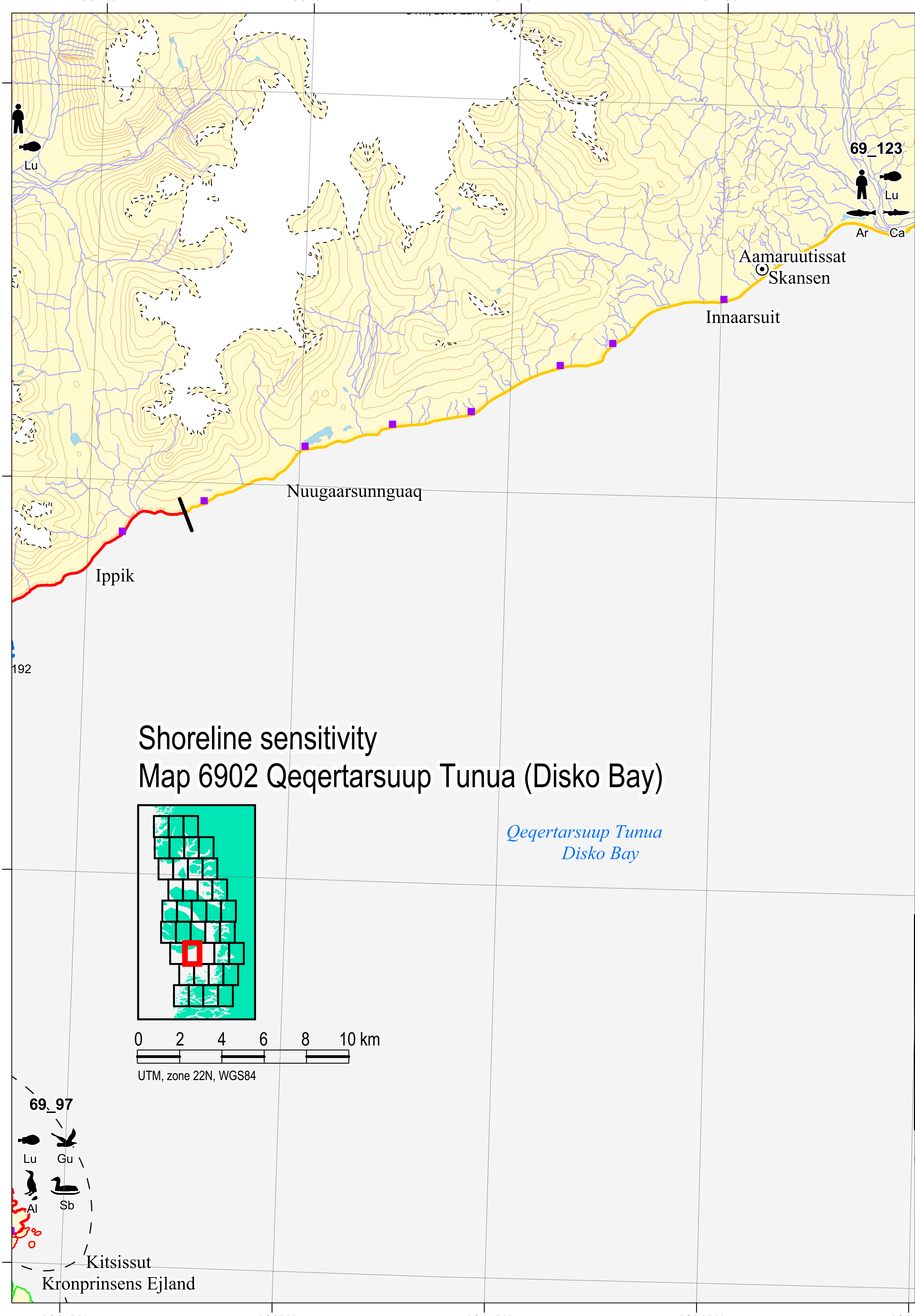
Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen, 1998

Airphoto keymap

Map legend

Toggle maps

Keymaps



Shoreline sensitivity
Map 6902 Qeqertarsuup Tunua (Disko Bay)

Environmental description

Resource use

R 69_123	Fishery for Arctic char along coast and at 2 river outlets (important), capelin (important) and lumpsucker. Hunting for minke and fin whales. Tourist attraction at abandoned settlement.

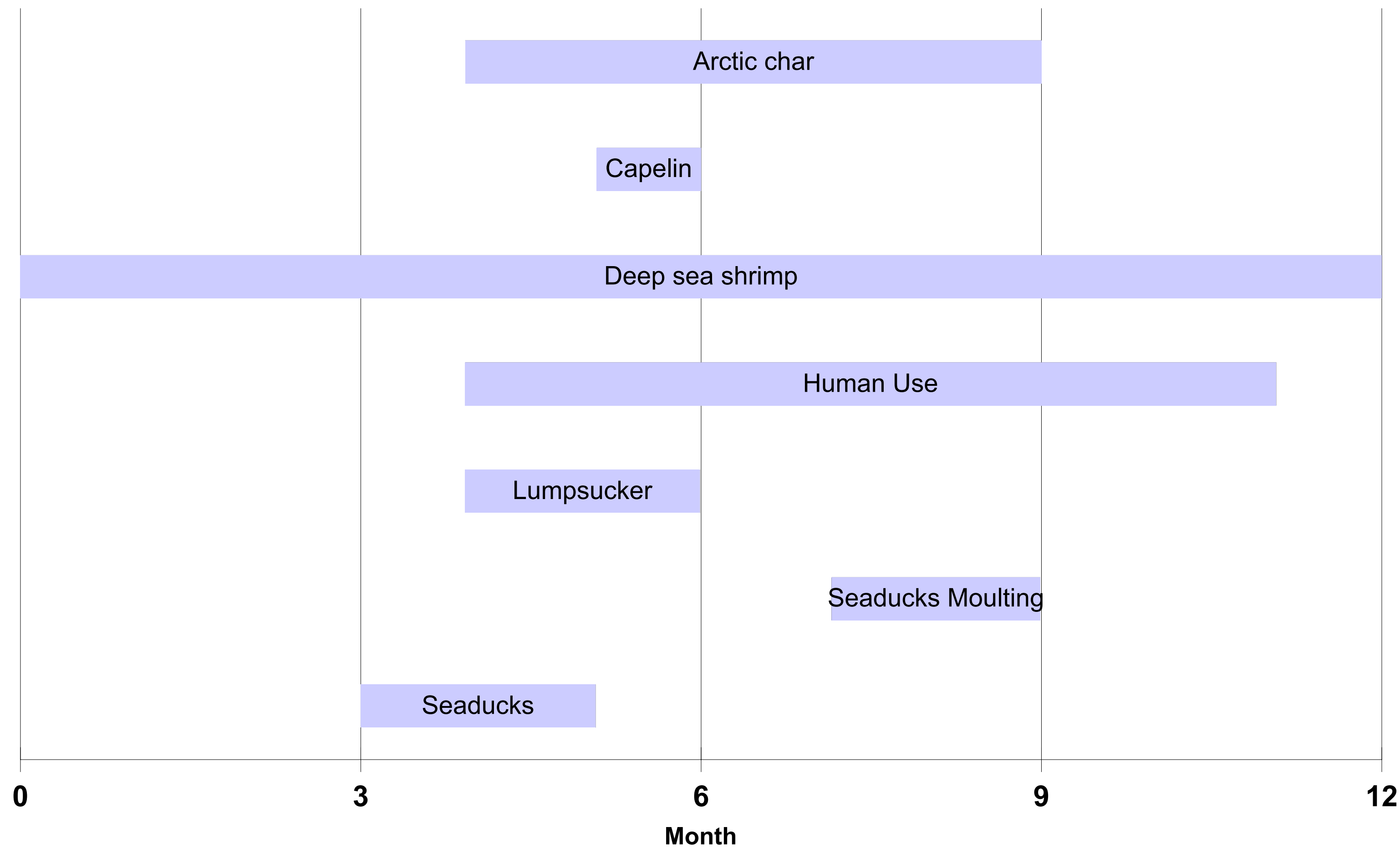
Species occurrence

Ar69123	3 important rivers with Arctic char and important coastal fishing areas.
Ca69123	Capelin spawn along entire coast.
Lu69123	Fishing and spawning area for lumpsucker along all coasts.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_123	36	High

Map 6902 Species and Resource Occurrences



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Physical Environment and logistics Map 6902 - Qeqertarsuup Tunua (Disko Bay)

Access

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

Aamaaruutissat (Skansen) is fronted by shoals, which make approach impossible in bad weather. A rock, awash, is situated in shoal ground 3 km SSW of Inaarsuit.

In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.
Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water and then diminishes prior to freeze-up.

Charts indicate an anchorage at Inaarsuit, but no other information is available.

No other anchorages are reported for this map area.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. Beaches in the vicinity of Inaarsuit may allow marine landings but would require reconnaissance to confirm. No nearshore soundings are available for coastline in this area and shoaling is likely.

There are no airports on this map. The nearest airfield is the heliport at Qeqertarsuaq (map 6901), and the nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist near river mouths along this coastline. The waters appear to be deep but some shoaling is indicated. 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 exposed nature of the coastline and the deep nearshore waters.

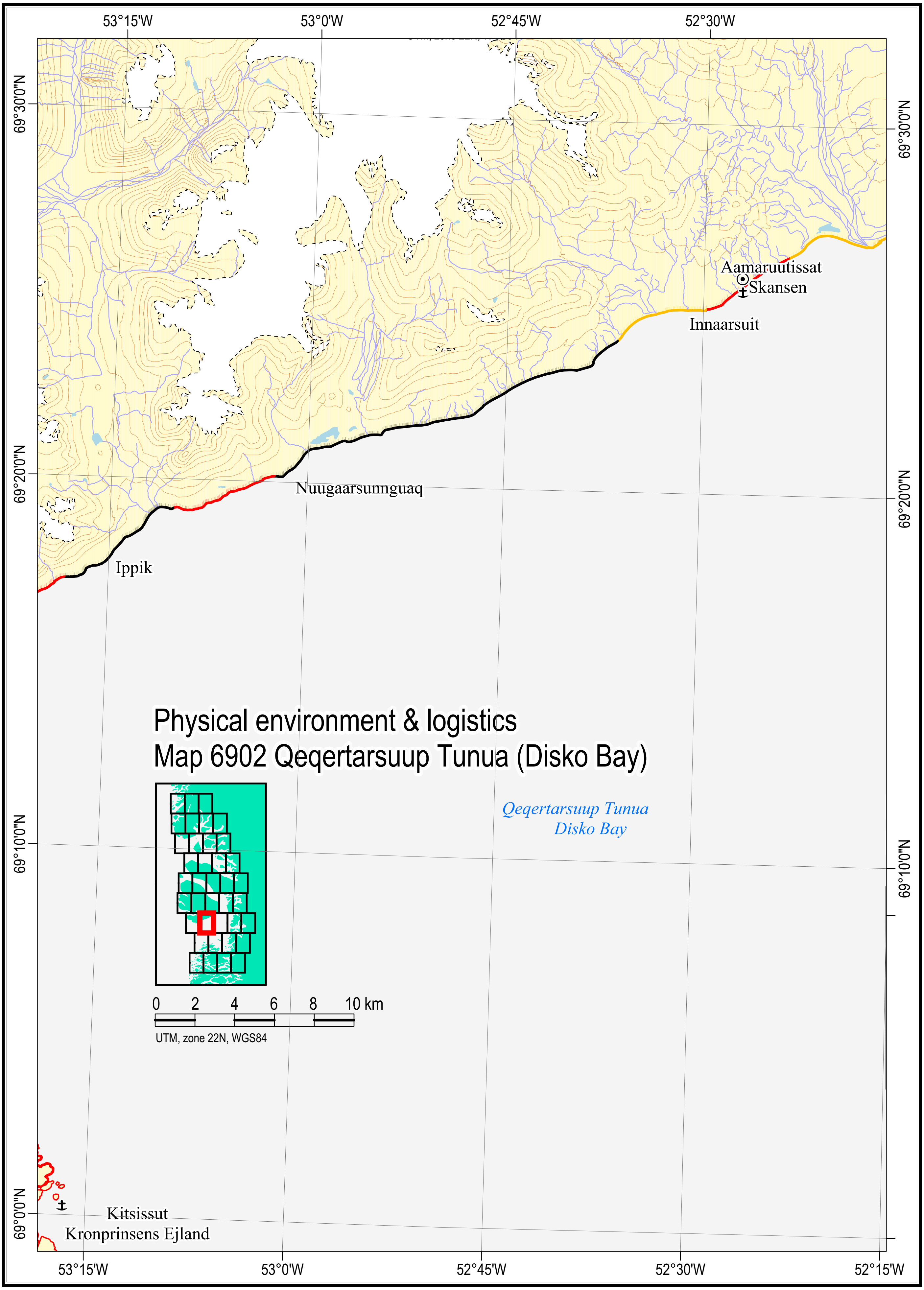
Shorelines shown on this map are predominantly highly exposed beach. Depending on the degree of contamination, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.1. Nautical charts: 1500, 1511.

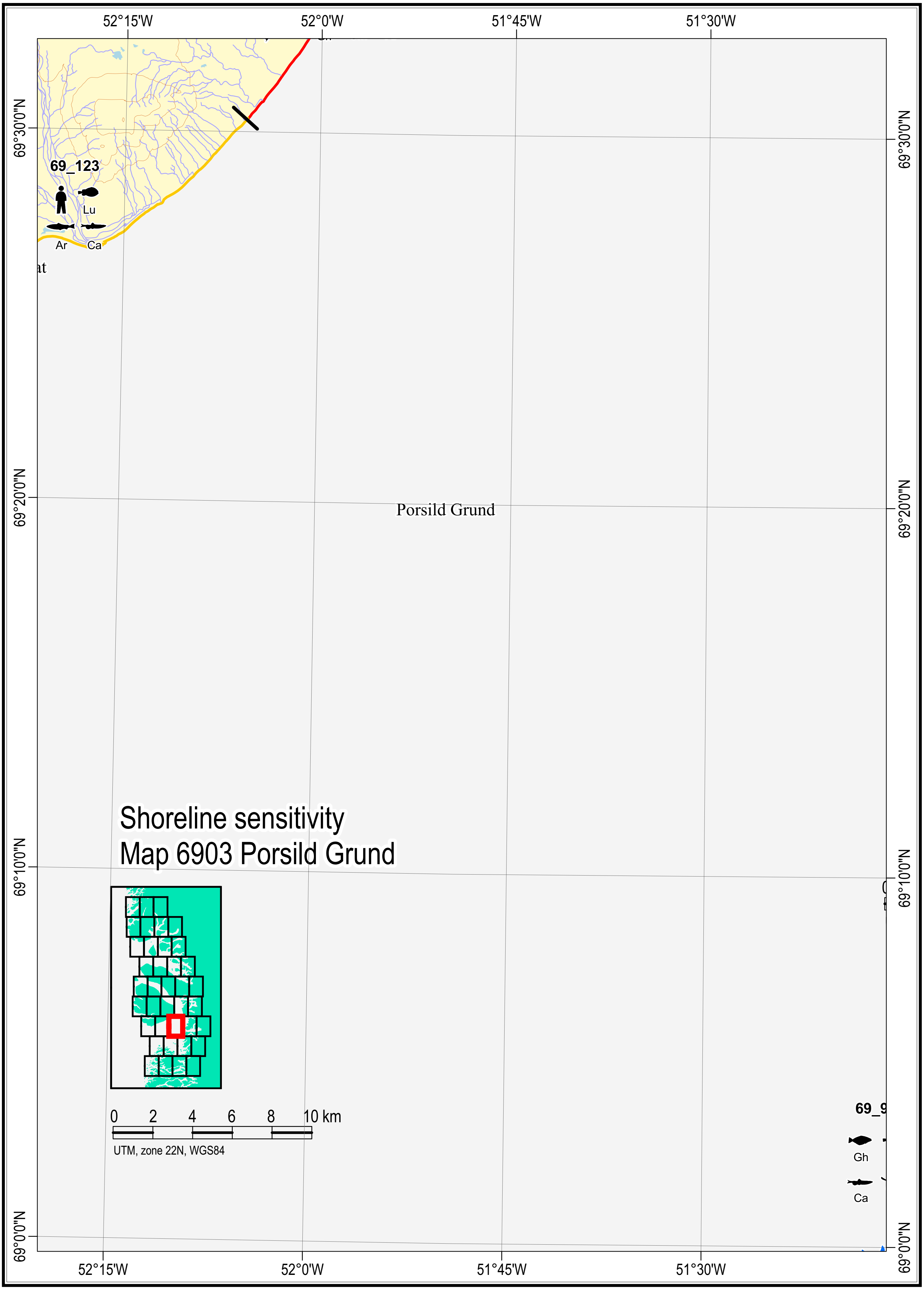

Physical environment & logistics
Map 6902 Qeqertarsuup Tunua (Disko Bay)
53°15'W
53°0'W
52°45'W
52°30'W
52°15'W
69°30'0"N
69°20'0"N
69°10'0"N
69°0'0"N
Aamaruutissat
Skansen
Innaarsuit
Nuugaarsunnguaq
Ippik
Qeqertarsuup Tunua
Disko Bay
Kitsissut
Kronprinsens Ejland
0
2
4
6
8
10 km
UTM, zone 22N, WGS84

Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental description

Resource use

R 69_123	Fishery for Arctic char along coast and at 2 river outlets (important), capelin (important) and lumpsucker. Hunting for minke and fin whales. Tourist attraction at abandoned settlement.

Species occurrence

Ar69123	3 important rivers with Arctic char and important coastal fishing areas.
Ca69123	Capelin spawn along entire coast.
Lu69123	Fishing and spawning area for lumpsucker along all coasts.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_123	36	High

For Species and resource occurrences se table for Map 6902 on page 9-58.

Physical environment and logistics

Map 6903 - Porsild Grund

Access

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

In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation.
Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko they are carried north by the prevailing current.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water, and then diminishes prior to freeze-up.

No anchorages are reported for this map area.

There is no information to indicate the potential for beach landings within this map area. Landings may be possible near the beach and barrier beach shorelines but there are no nearshore soundings and reconnaissance would be required to determine accessibility.

There are no airports on this map. The nearest airfields are the heliport at Qeqertarsuaq (map 6901) and the airport at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow, nearshore waters, which may exist near river mouths along this coastline. The waters appear to be deep but some shoaling is indicated. 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 exposed nature of the coastline and the deep nearshore waters.

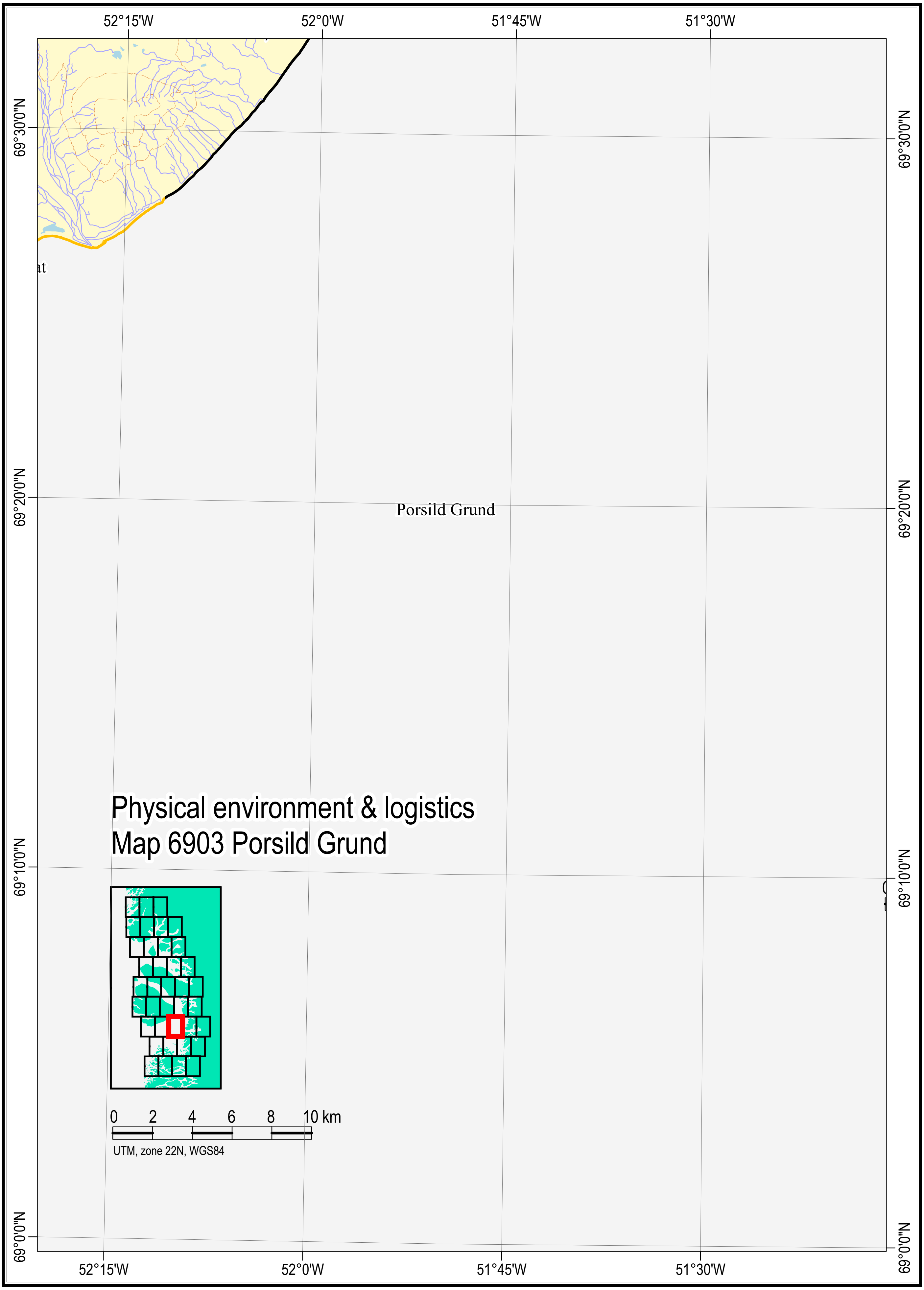
Shorelines shown on this map are predominantly highly exposed beach. Depending on the degree of contamination, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

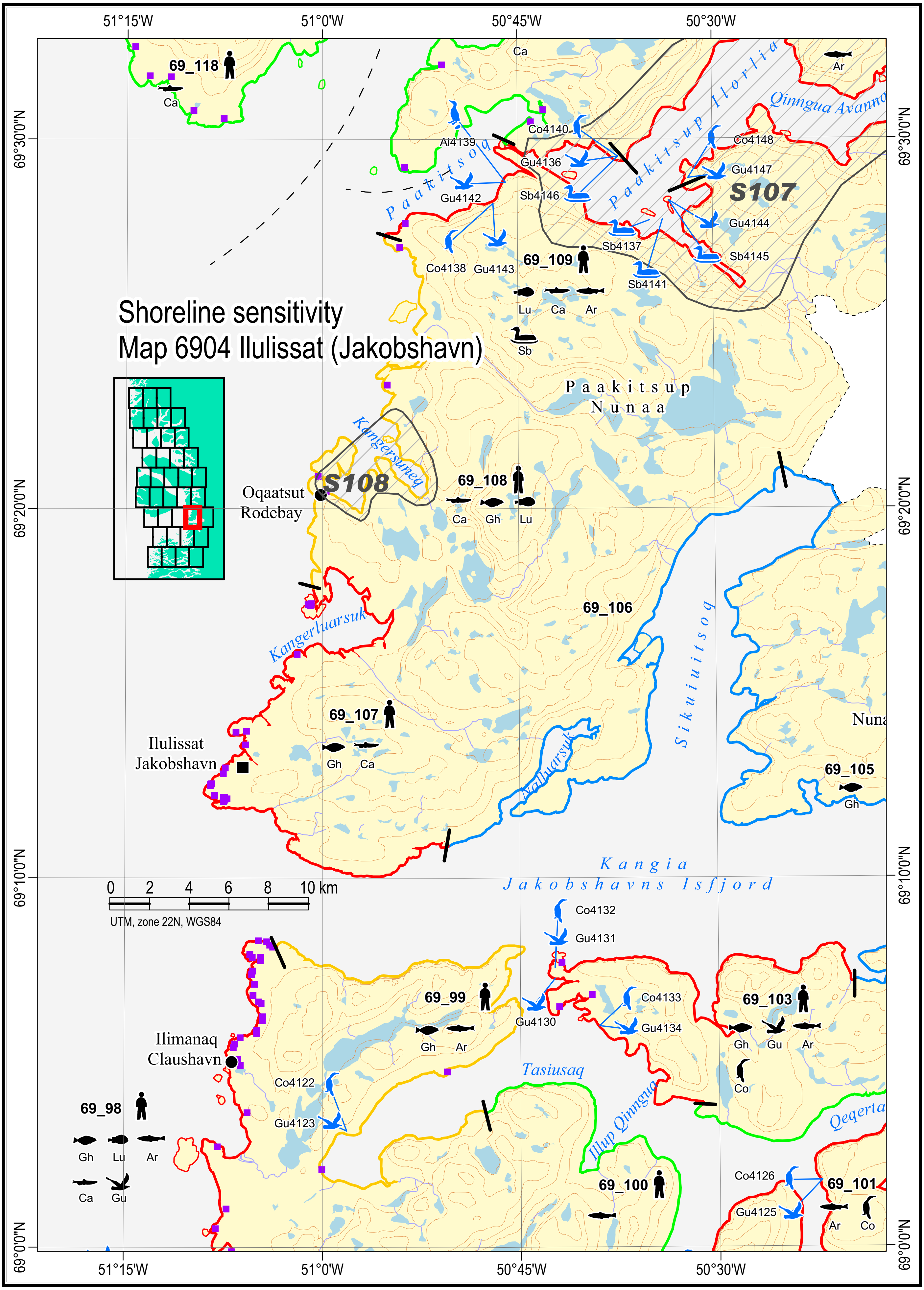
There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.1. Nautical charts: 1500, 1513.


52°15'W
52°0'W
51°45'W
51°30'W
69°30'0"N
69°20'0"N
69°10'0"N
69°0'0"N
Porsild Grund
Physical environment & logistics
Map 6903 Porsild Grund
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap Map legend Toggle maps Keymaps



Environmental description

Resource use

R 69_98	Fishery for Arctic char along coast, capelin and Greenland halibut (important). Hunting for minke and fin whales and ringed seals on ice. Tourist attractions at settlement and along shore.
R 69_99	Fishery for Arctic char along coast and Greenland halibut (important). Hunting for ringed seals on ice. Tourist attraction along shore.
R 69_103	Fishery for Arctic char along coast and Greenland halibut (important). Hunting for ringed seals on ice.
R 69_107	Fishery for Arctic char along coast, capelin, Greenland halibut (important), redfish and wolffish. Hunting for large whales and ringed seals on ice. Tourist attraction along shore (important).
R 69_108	Fishery for capelin (important), Greenland halibut (important), redfish and wolffish. Hunting for minke and fin whales. Tourist camp site at shore and attraction at settlement (**S108**).
R 69_109	Fishery for Arctic char along coast, capelin (important) and Greenland halibut. Hunting for minke and fin whales and ringed seals on ice (important) (**S107**).

Species occurrence

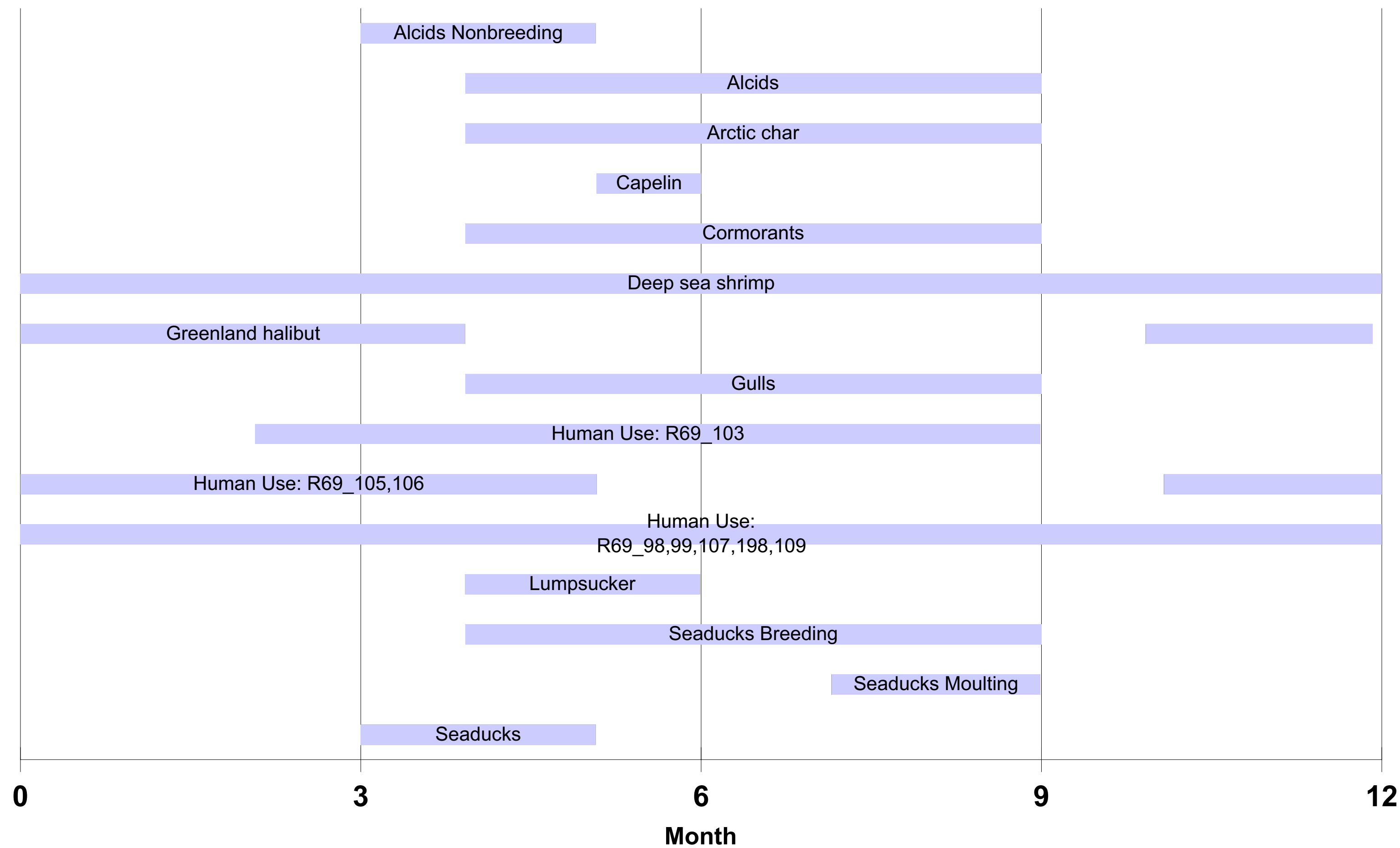
Ar69098	2 important river outlets with Arctic char and important coastal fishing area for Arctic char in southern and central part.
Ar69099, Ar69103	1 important river with Arctic char and important coastal fishing area.
Ar69109	2 important rivers with Arctic char and important coastal fishing in eastern part (**S107**).
Ca69098	Important fishing area and spawning area for capelin south of Ilimanaq.
Ca69107	Important fishing areas for capelin just south of town and in Bredebugt.
Ca69108	Important fishing areas for capelin along most of the coast (**S108**).
Ca69109	Important fishing area for capelin, except Qingua Kujalleq.
Co69103	2 colonies with breeding great cormorants.
Gh69098, Gh69099	Important fishing area for Greenland halibut.
Gh69103, Gh69105	Important fishing area for Greenland halibut.
Gh69107, Gh69108	Important fishing area for Greenland halibut.
Gu69098	1 colony with breeding Arctic terns.
Gu69103	3 colonies with breeding Iceland gulls.
Lu69098	Important spawning area for lumpsucker along all coasts
Lu69108	Important spawning area for lumpsucker along all coasts (**S108**).
Lu69109	Important spawning area for lumpsucker along all coasts (**S107**).
Sb69109	3 colonies with breeding common eiders (**S107**).

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

Al4139	Breeding razorbills and black guillemots.
Co4122	Breeding great cormorants.
Co4126, Co4132	Breeding great cormorants.
Co4133, Co4148	Breeding great cormorants.
Co4140, Co4138	Breeding great cormorants (**S107**).
Gu4123	Breeding glaucous gulls.
Gu4130, Gu4131	Breeding Iceland gulls.
Gu4134, Gu4143	Breeding Iceland gulls.
Gu4125	Breeding Iceland gulls and glaucous gulls.
Gu4136, Gu4144	Breeding Iceland gulls and glaucous gulls (**S107**).
Gu4142	Breeding Iceland gulls and kittiwakes.
Gu4147	Breeding Iceland gulls, glaucous gulls and kittiwakes (**S107**)
Sb4137, Sb4141	Breeding common eiders.
Sb4145, Sb4146	Breeding common eiders.

(Continued on page 9-69)

Map 6904 Species and Resource Occurrences



Shoreline sensitivity

Map 6904 - Ilulissat (Jakobshavn)

(Continued from page 9-67)

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_98	47	Extreme
69_99	38	High
69_103	47	Extreme
69_105	13	Low
69_106	17	Low
69_107	52	Extreme
69_108	42	High
69_109	58	Extreme

Physical environment and logistics

Map 6904 - Ilulissat (Jakobshavn)

Access

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

A heavy wire is suspended at a depth of 2.5 m across the entrances to Ilulissat (Jakobshavn) inner and outer harbours to prevent the entry of ice. Permission is required prior to entering, and vessels should confirm that the wires have been slackened prior to transit.

In average years this area is ice-bound from December to June. Break-up begins with a lead that opens up between the fast ice along the coast and the pack ice in Baffin Bay. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.
Very large icebergs come in the thousands from fjords on the east side of Disko Bay after break-up. When leaving Disko Bay they are usually carried north by the prevailing current.

At Ilulisaat calving icebergs periodically create a regular and heavy swell. This occurs without warning and produces waves to 2 m height and with a period of 6 minutes. The turbulence that is created is sufficient to tear seaweed and vegetation from the bottom. The effect may be intensified where the inlet narrows between the inner and outer harbours. The harbour can be blocked by ice floes but is usually emptied with tidal changes.

Access

(Continued from previous page)
The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast. The current does not appear to enter Disko Bay until mid-summer, when the flow of melt water from coastal areas has a greater influence.

At the beginning of June there is a weak anti-clockwise current within Disko Bay. The current strengthens through the summer with the influence of melt water and then diminishes prior to freeze-up.

At the entrance to Rodebay Bay tidal streams are so strong, that they prevent the formation of ice in mild winters.

A mooring berth is available in the inner harbour of Ilulisaat. In the outer harbour there is a wharf 40 m long, depth alongside of 7.0 m, and a height of 1.1 m above mean high water. Facilities in the harbour include mobile cranes, boatyard and hospital, and water and fuel are available.

Near Qeqertaq anchorage is available at the head of Rodebay Bay in depths of 28 to 68 m.

Shorelines in this area are almost exclusively rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

An all-season, asphalt-surface airport (845 x 30 m) is available at Ilulisaat with IFR and VFR traffic capability. There is road access from the airport to the town of Ilulisaat.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in both offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered in offshore and nearshore waters to protect waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow, nearshore waters, which may exist within fjords. 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 the contamination of inshore areas should be considered at Paakitsoq with an estimated 200 m of boom, at Kangersuneq with an estimated 800 m of boom and at Nalluarsuk within Jakobshavn Isfjord with an estimated 400 m of boom. In each of these locations there is no information on tidal streams but they may be strong.

Shorelines shown on this map are predominantly exposed and semi-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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline. The shorelines of Kangia/Jakobshavn Isfjord are always blocked by glacier ice from the very productive glacier in the head of the fjord.

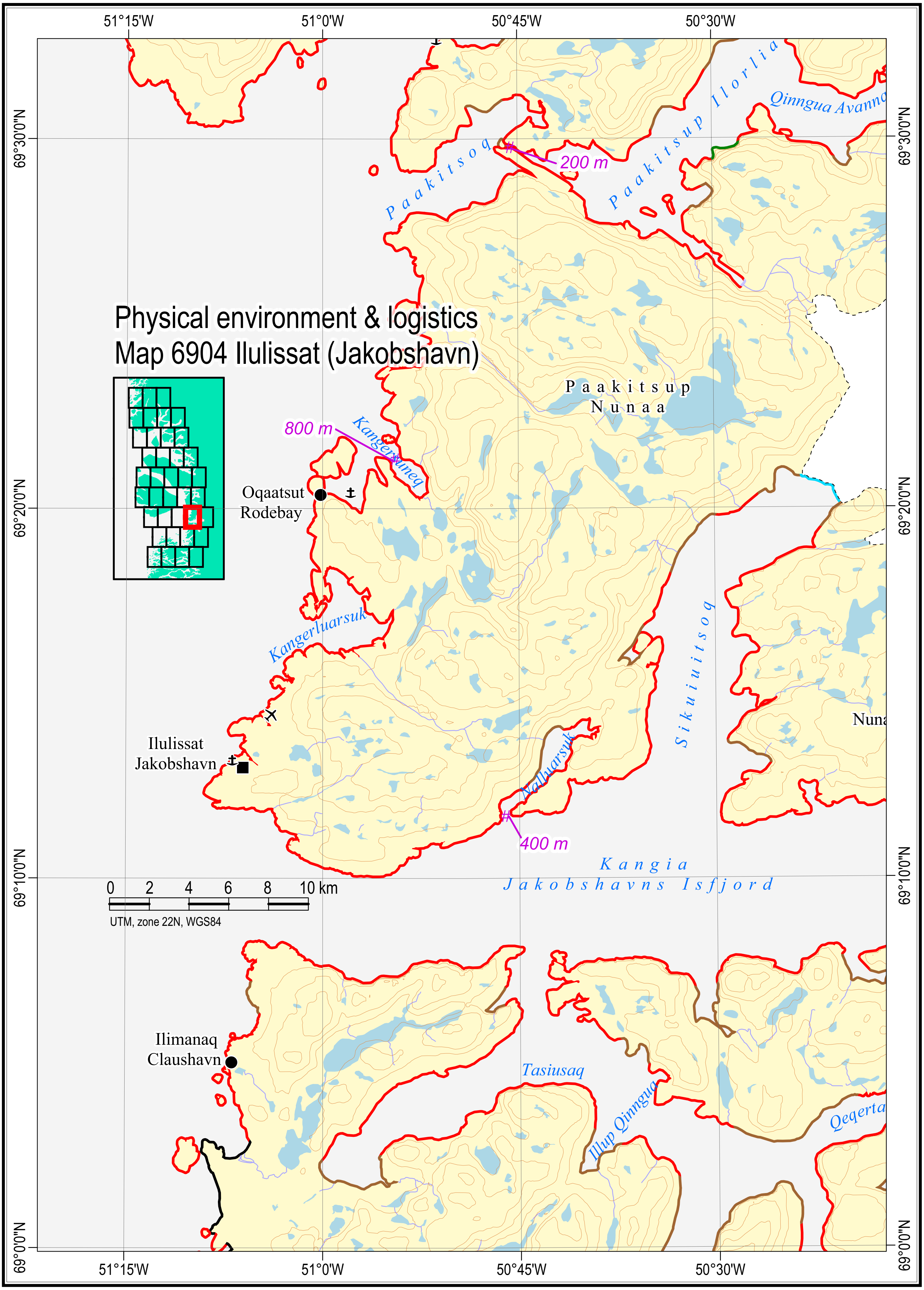
Beaches south of Ilimanaq/Claushavn are highly exposed but, depending on the degree of oiling, may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. Marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

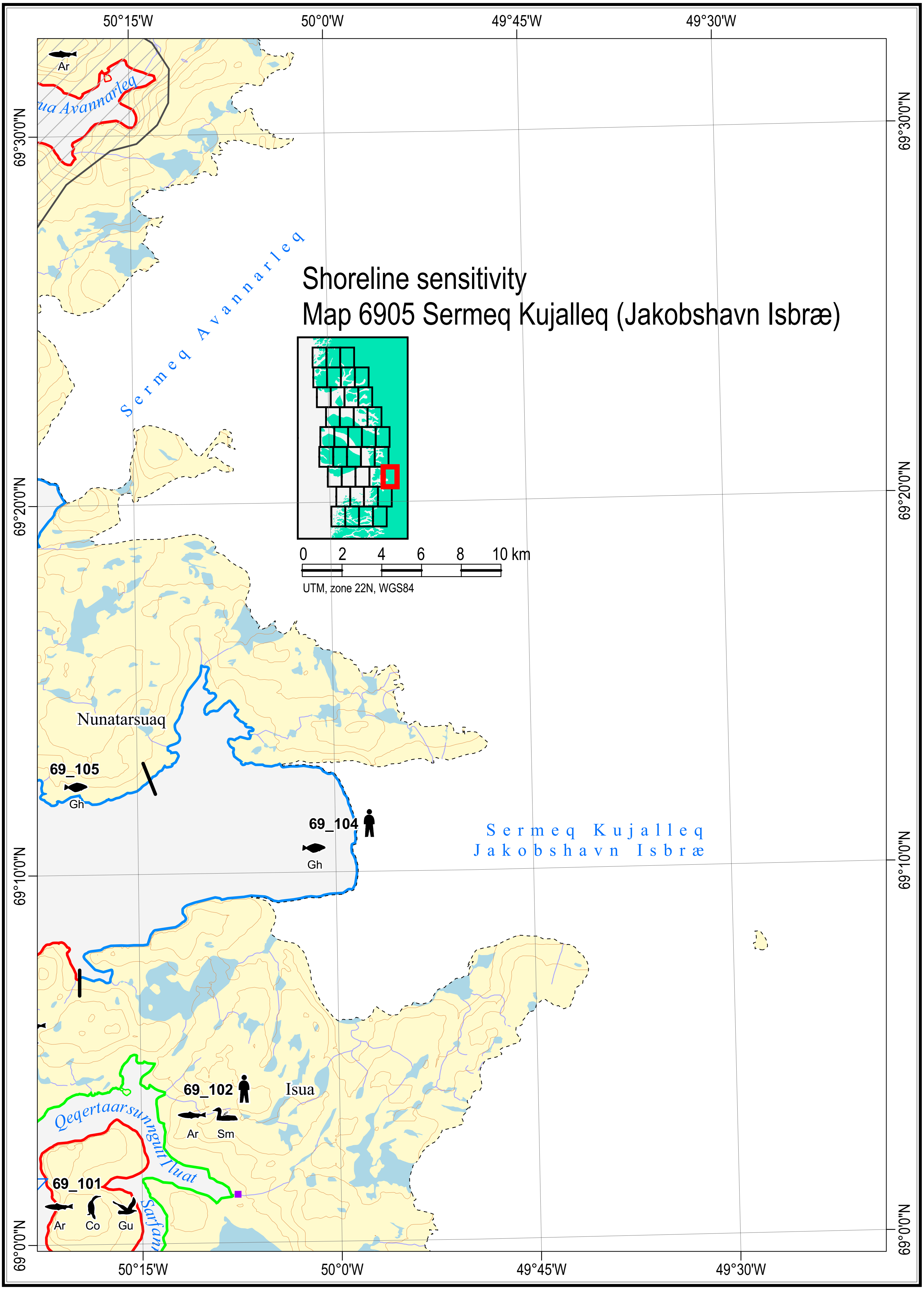
There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.2. Nautical charts: 1500, 1513, 1551, 1552.


51°15'W
51°0'W
50°45'W
50°30'W
69°30'0"N
69°20'0"N
69°10'0"N
69°0'0"N
Physical environment & logistics
Map 6904 Ilulissat (Jakobshavn)
P a a k i t s o q
200 m
P a a k i t s u p I l o r l i a
Qinngua Avanna
Paakitsup
Nunaa
800 m
Kangerluarsuk
Oqaatsut
Rodebay
Kangerluarsuk
Ilulissat
Jakobshavn
Nalluarsuk
Sikuiuitsoq
Nuna
400 m
Kangia
Jakobshavns Isfjord
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
Ilimanaq
Claushavn
Tasiusaq
Illup Qinngua
Qeqerta
51°15'W
51°0'W
50°45'W
50°30'W

Shoreline sensitivity
Map 6905 Sermeq Kujalleq (Jakobshavn Isbræ)



Shoreline sensitivity Map

6905 - Sermeq Kujalleq (Jakobshavn Isbræ)

Environmental description

Resource use

R 69_102	Fishery for Arctic char along coast (important) and Greenland halibut. Hunting for ringed seals on ice.
R 69_104	Fishery for Greenland halibut (important). Hunting for ringed seals on ice. Tourist attraction along shore.

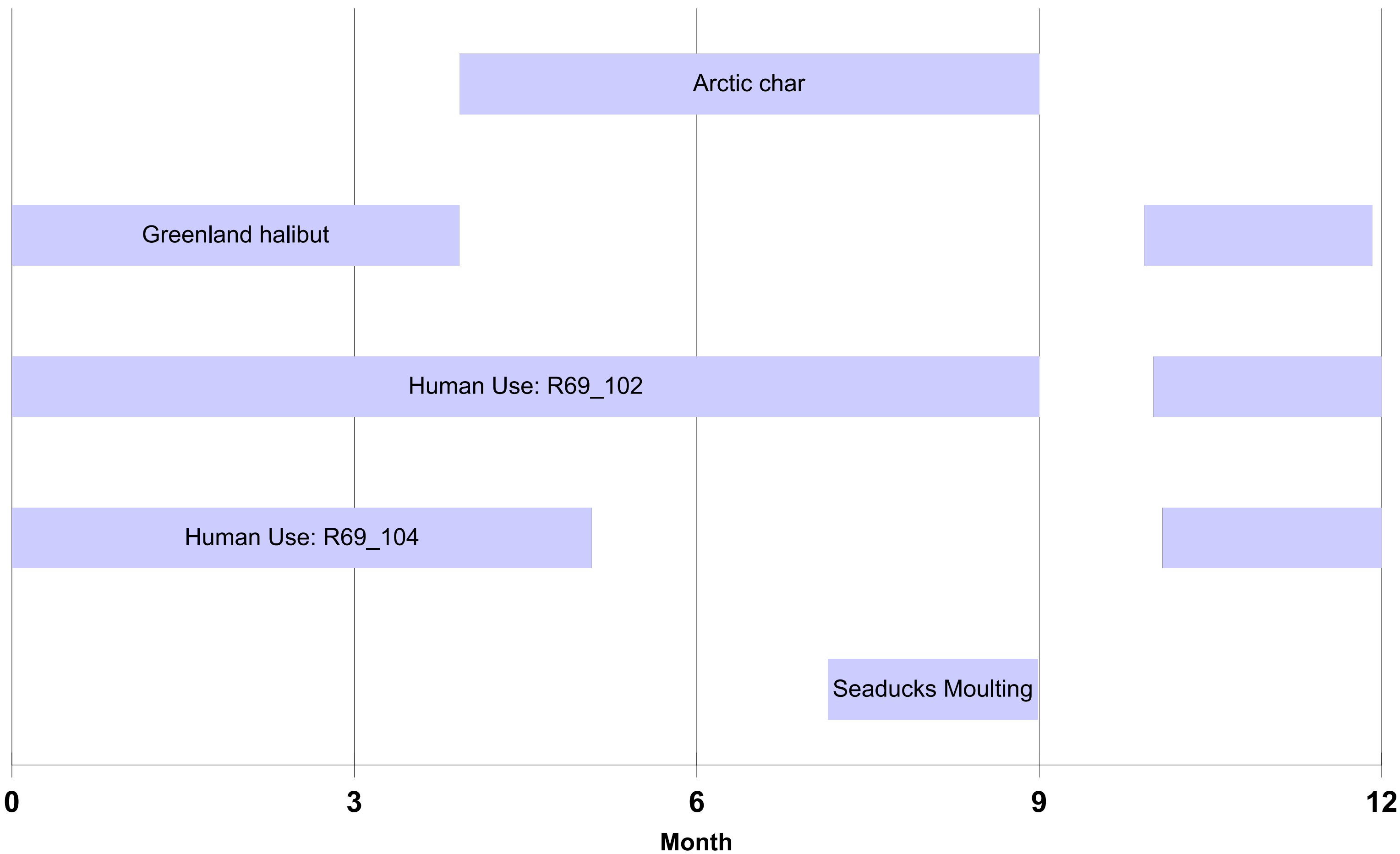
Species occurrence

Ar69102	4 important rivers with Arctic char and important coastal fishing area for Arctic char along all the coasts.
Gh69104	Important fishing area for Greenland halibut.
Sm69102	Long-tailed ducks in summer and autumn.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_102	31	Moderate
69_104	15	Low

Map 6905 Species and Resource Occurrences



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Physical environment and logistics Map 6905 - Sermeq Kujalleq (Jakobshavn Isbræ)

Access

Little information is available on the limited amount of marine area within this map.

The nearshore waters in this area are largely uncharted and caution should be exercised. In general, the waters within the fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation. The part of Kangia/Jakobshavn Isfjord depicted on this map is usually inaccessible due to large amounts of glacier ice from the very productive glacier Sermeq Kujalleq.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock and glacier allowing little opportunity for marine access. They are also blocked by glacier ice.throughout the year. There are no airports on this map. The nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. In open water conditions in offshore and nearshore areas, containment for recovery or burning is recommended. Dispersant application should be considered to protect waterfowl and to prevent oil from entering inshore areas. Dispersant-use is cautioned against in shallow, nearshore waters, which may exist at the heads of the two fjords in this map area. 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, the prescence of glacier ice and the deep nearshore waters.

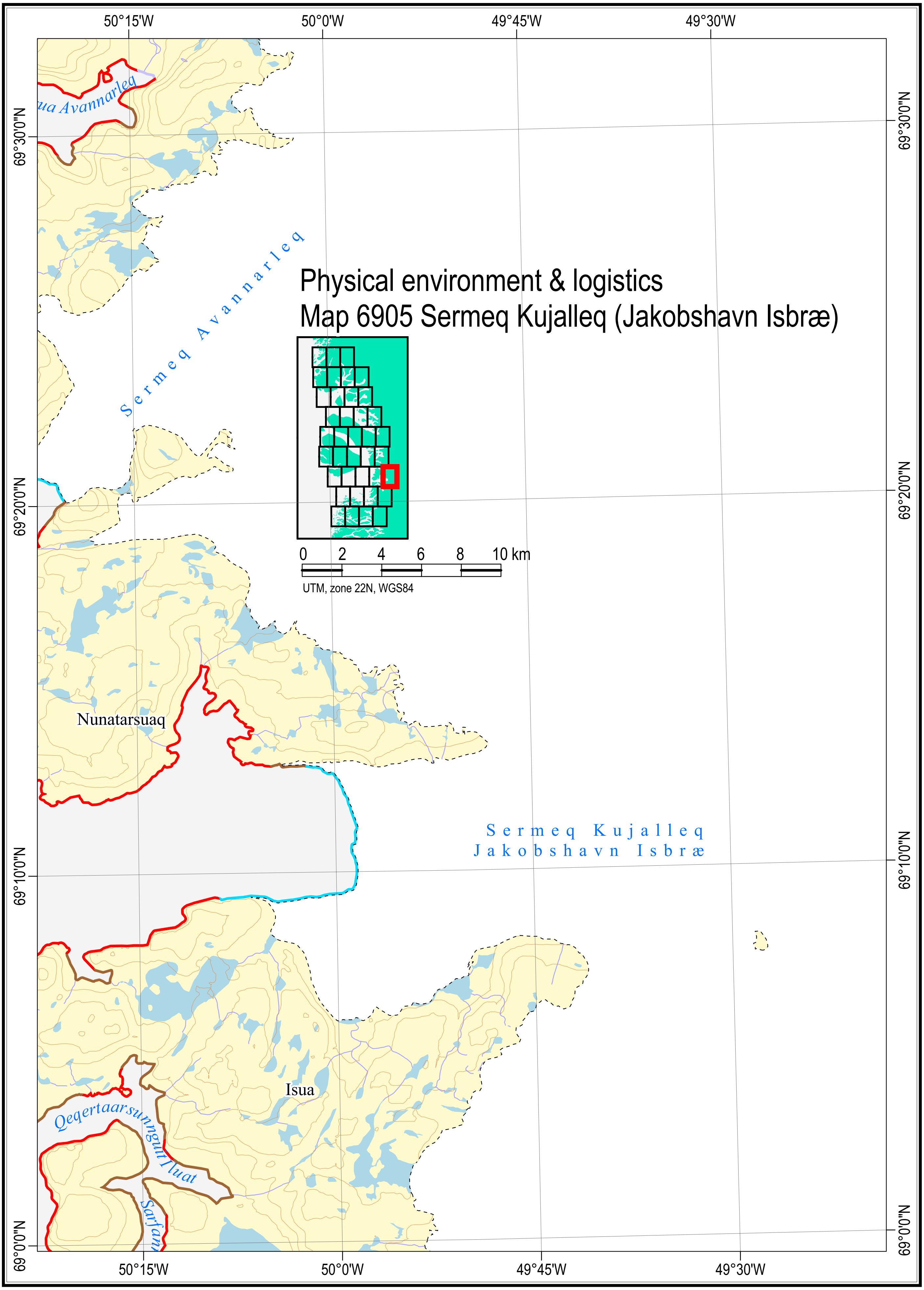
Shorelines shown on this map are predominantly semi-exposed rock and moraine, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of Jakobshavn Isfjord shores are not possible from the sea side due to the glacier ice..

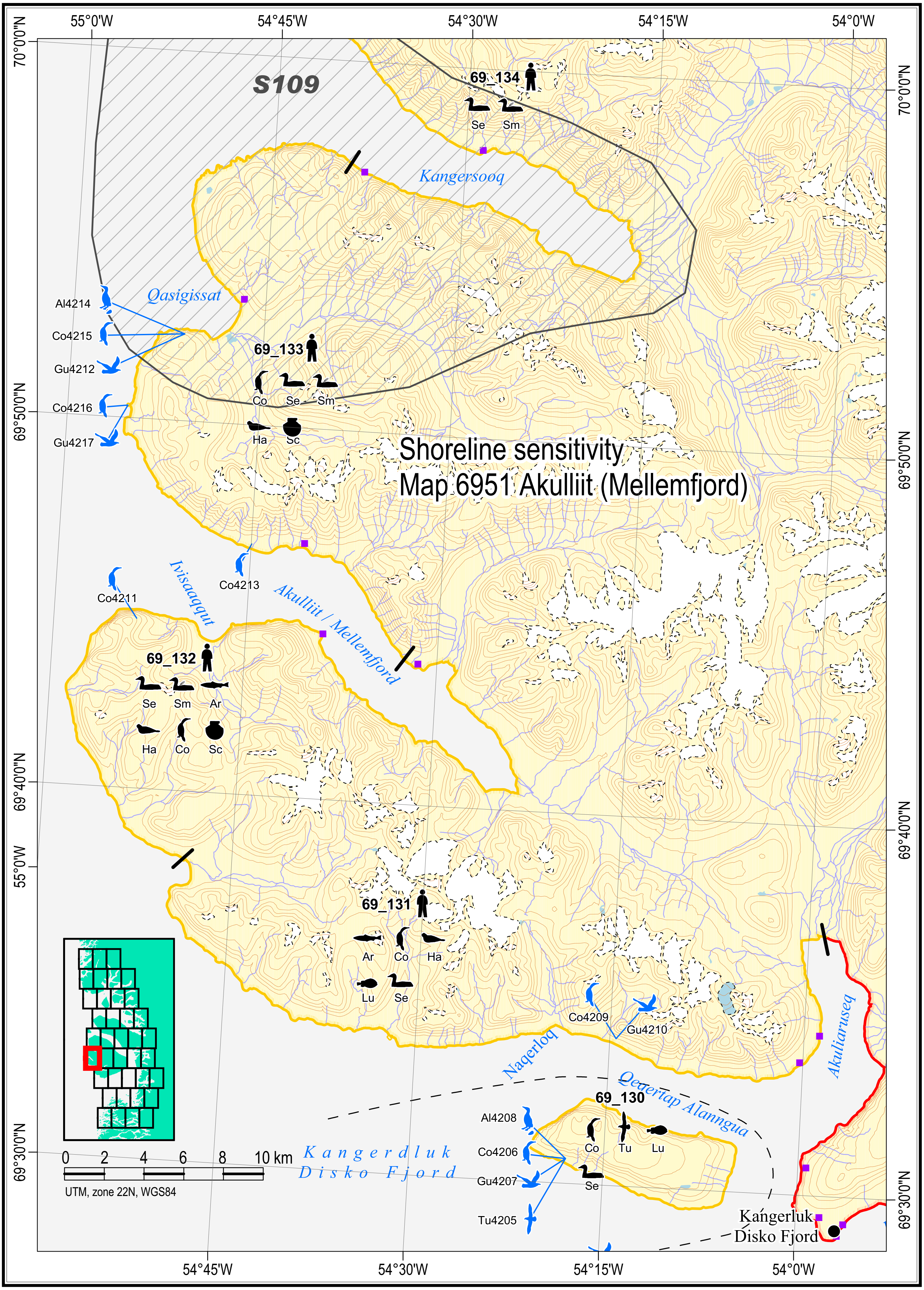
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.2. Nautical charts: none


Physical environment & logistics
Map 6905 Sermeq Kujalleq (Jakobshavn Isbræ)
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
50°15'W
50°0'W
49°45'W
49°30'W
69°30'0"N
69°20'0"N
69°10'0"N
69°0'0"N
Sermeq Avannarleq
Nunatarsuaq
Sermeq Kujalleq
Jakobshavn Isbræ
Isua
Qeqertaarsuup Tunua Avannarleq
Qeqertaarsuunnguit Tuat
Sarfaq


Shoreline sensitivity
Map 6951 Akulliit (Mellemfjord)
S109
69_134
69_133
69_132
69_131
69_130
Kangersooq
Qasigissat
Ivisaaqqut
Akulliit / Mellemfjord
Nagerloq
Qeqertap Alanngua
Akuliaruseq
Kangerluk
Disko Fjord
Al4214
Co4215
Gu4212
Co4216
Gu4217
Co4213
Co4211
Co4209
Gu4210
Al4208
Co4206
Gu4207
Tu4205
Se
Sm
Co
Ha
Sc
Ar
Lu
Tu
55°0'W
54°45'W
54°30'W
54°15'W
54°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Environmental description

Resource use

R 69_131	Fishery for Arctic char at one river outlet, Atlantic halibut, scallop and wolffish (important).
R 69_132	Fishery for Arctic char at 4 river outlets and along coasts, Atlantic halibut and scallop. Hunting for minke and fin whales and ringed seals on ice.
R 69_133	Fishery for Arctic char at 2 river outlets, Atlantic halibut, scallop (important) and wolffish. Hunting for ringed seals on ice (**S109**).
R 69_134	Fishery for Arctic char at 2 river outlets, Atlantic halibut and wolffish. Hunting for ringed seals on ice (important) (**S109**).

Species occurrence

Ar69131	5 rivers with Arctic char (4 important) and important coastal fishing area for Arctic char in Avannarput.
Ar69132	4 rivers (important) with Arctic char and coastal fishing area for Arctic char in head of Mellemfjord.
Co69130, Co69131	1 colony with breeding great cormorants.
Co69132	1 colony with breeding great cormorants.
Co69133	1 colony with breeding great cormorants (**S109**).
Ha69131	Harbour seal summer habitat.
Ha69132	Whelping and summering habitat for harbour seal.
Ha69133	Whelping and summering habitat for harbour seal (**S109**).
Lu69130, Lu69131	Spawning and fishing area for lumpsucker along all the coasts.
Sc69132	Important scallop fishing area.
Sc69133	Important scallop fishing area (**S109**).
Se69130	King eiders, common eiders and long-tailed ducks in spring.
Se69133	King eiders, common eiders and long-tailed ducks in late winter and spring (**S109**).
Se69131, Se69132	Common eiders, king eiders and long-tailed ducks in late winter and spring.
Se69134	Common eiders, king eiders and long-tailed ducks in late winter and spring.
Sm69132	Important moulting area for king eiders and common eiders.
Sm69133	Important moulting area for long-tailed ducks, king eiders and common eiders (**S109**).
Sm69134	Important moulting area for king eiders and common eiders (**S109**).
Tu69130	1 large colony with breeding northern fulmars.

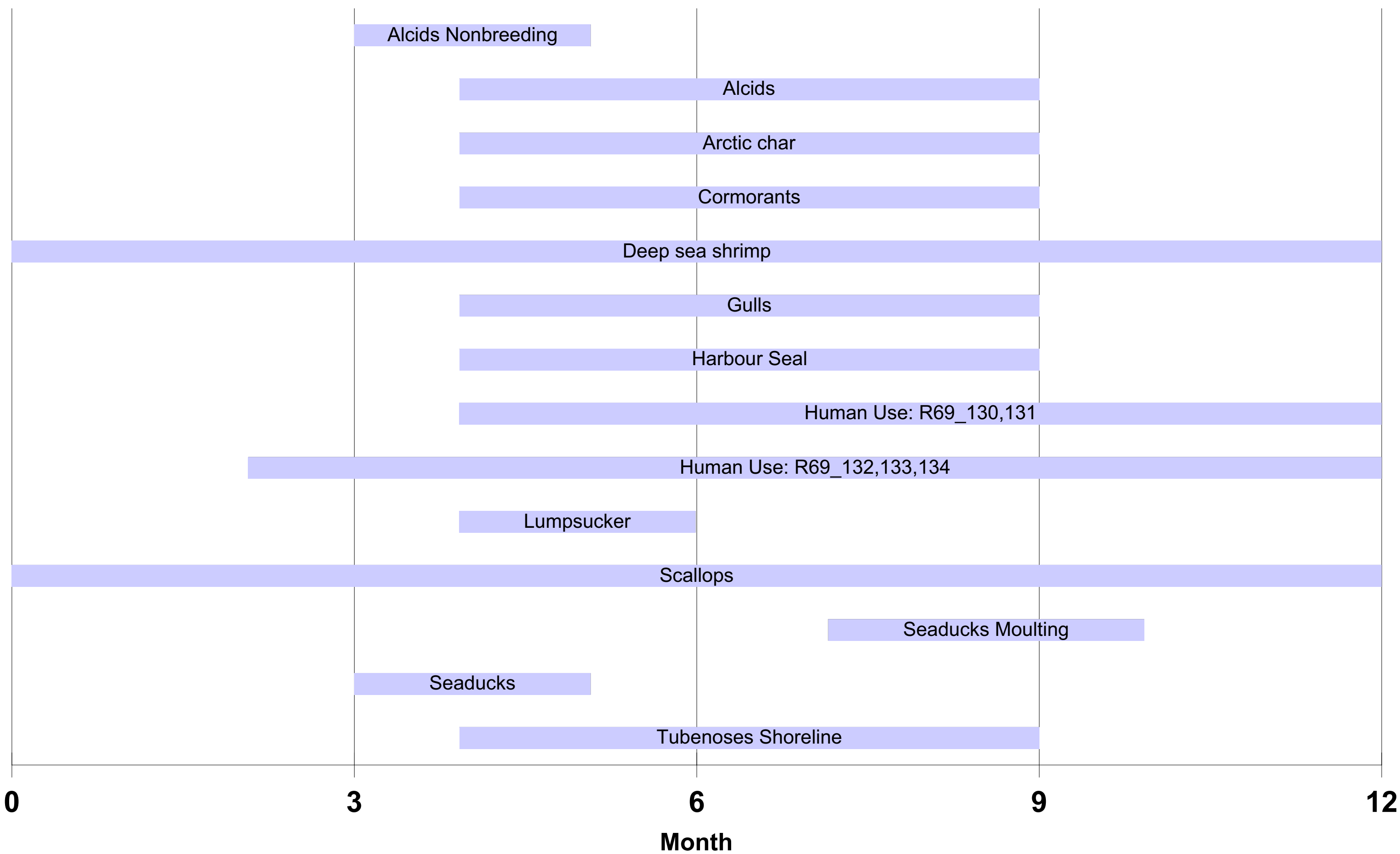
Site specific species occurrence (seabird breeding colonies); blue icons

Al4208	Breeding black guillemots.
Al4214	Breeding black guillemots and razorbills.
Co4206, Co4209	Breeding great cormorants.
Co4211, Co4213	Breeding great cormorants
Co4215, Co4216	Breeding great cormorants
Gu4207, Gu4212	Breeding glaucous gulls.
Gu4210	Breeding kittiwakes and Iceland gulls.
Gu4217	Breeding Iceland gulls.
Tu4205	Breeding northern fulmars.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_130	40	High
69_131	41	High
69_132	39	High
69_133	37	High
69_134	34	High

Map 6951 Species and Resource Occurrences



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Access

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

Few dangers are charted along most of the west coast of Disko Island.

In average years this area is ice-bound from December to June. Break-up 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 August. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.
There is no other information on tides or currents within fjords for this area.

Within Mellemfjord anchorage is available close inshore at Narsarsuaq and at Enoks Havn with good shelter from all winds andSW-winds, respectively. There are many drying shoals in the inner part of the fjord necessitating great care in navigating.

Shelter from south winds is available at Qasigissat, a small bay midway between Mellemfjord and Nordfjord/Kangersooq.

Anchorage with shelter from all winds is available on the south shore of Nordfjord/Kangersooq. There are drying shoals in the inner part of the fjord necessitating great care in navigating.

Charts indicate an anchorage at Nordre Laksebugt, the small bay south of Mellemfjord, but no other information is available.

Rock and talus shorelines through much of this area offer little opportunity for marine access. Beach shorelines within and south of Mellemfjord may allow landing. There are no nearshore soundings in this area, and reconnaissance would be required to confirm access.

There are no airports on this or adjoining maps. The nearest heliport is at Qeqertarsuaq (map 6901) and the nearest airport is at Aasiaat (map 6851).

Countermeasures

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

Offshore countermeasures represent the only practical method of protecting most shoreline areas, including the selected area in the vicinity of Nordfjord/Kangersooq.

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

Shorelines shown on this map are predominantly highly exposed and 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 cleanup operations would be marine-based given the likely nature of the shoreline.

Beaches and alluvial shores within Mellemfjord, Nordfjord/Kangersooq and Akuliaruseq may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

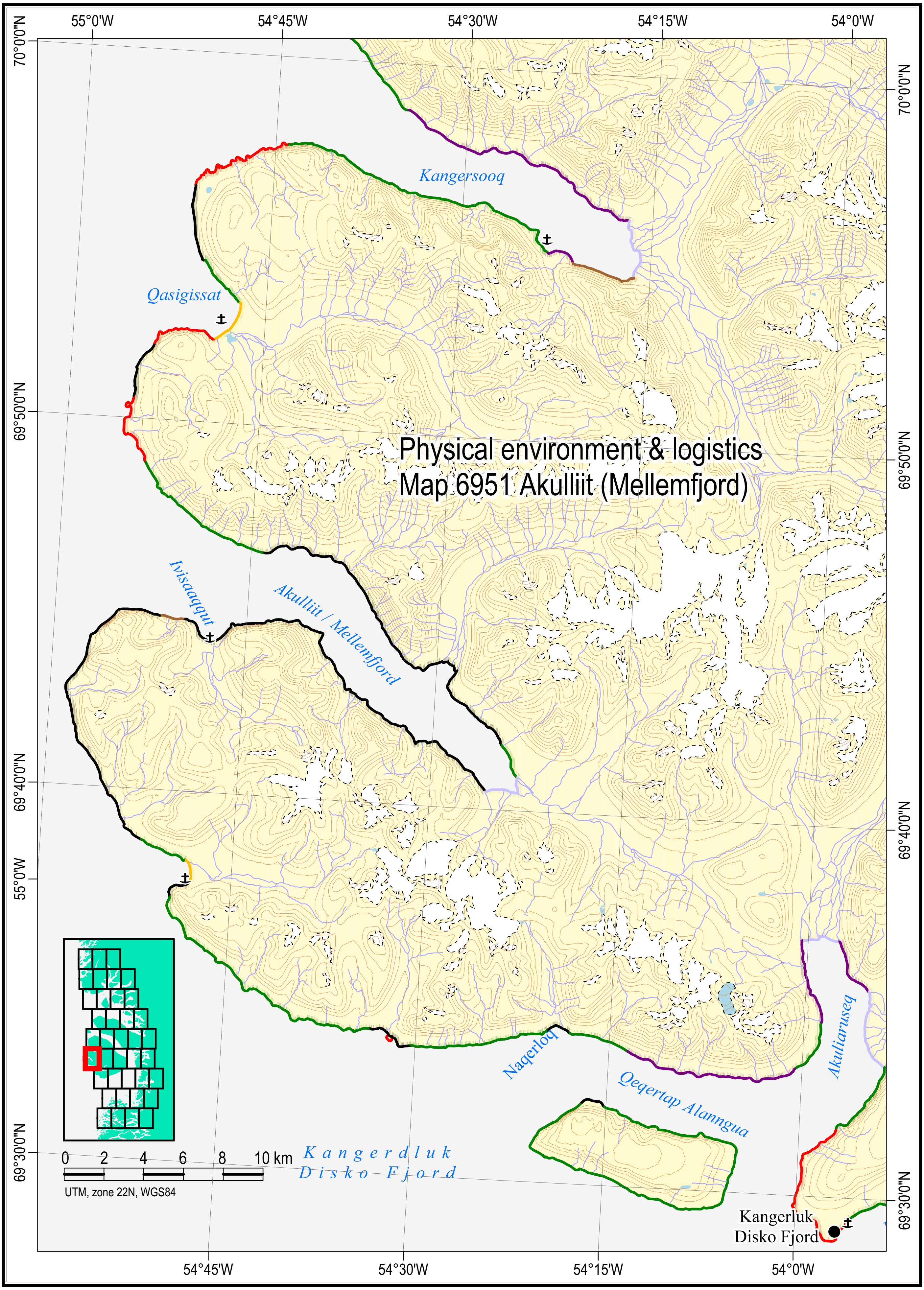
Safe havens

No potential safe havens have been located on this map.

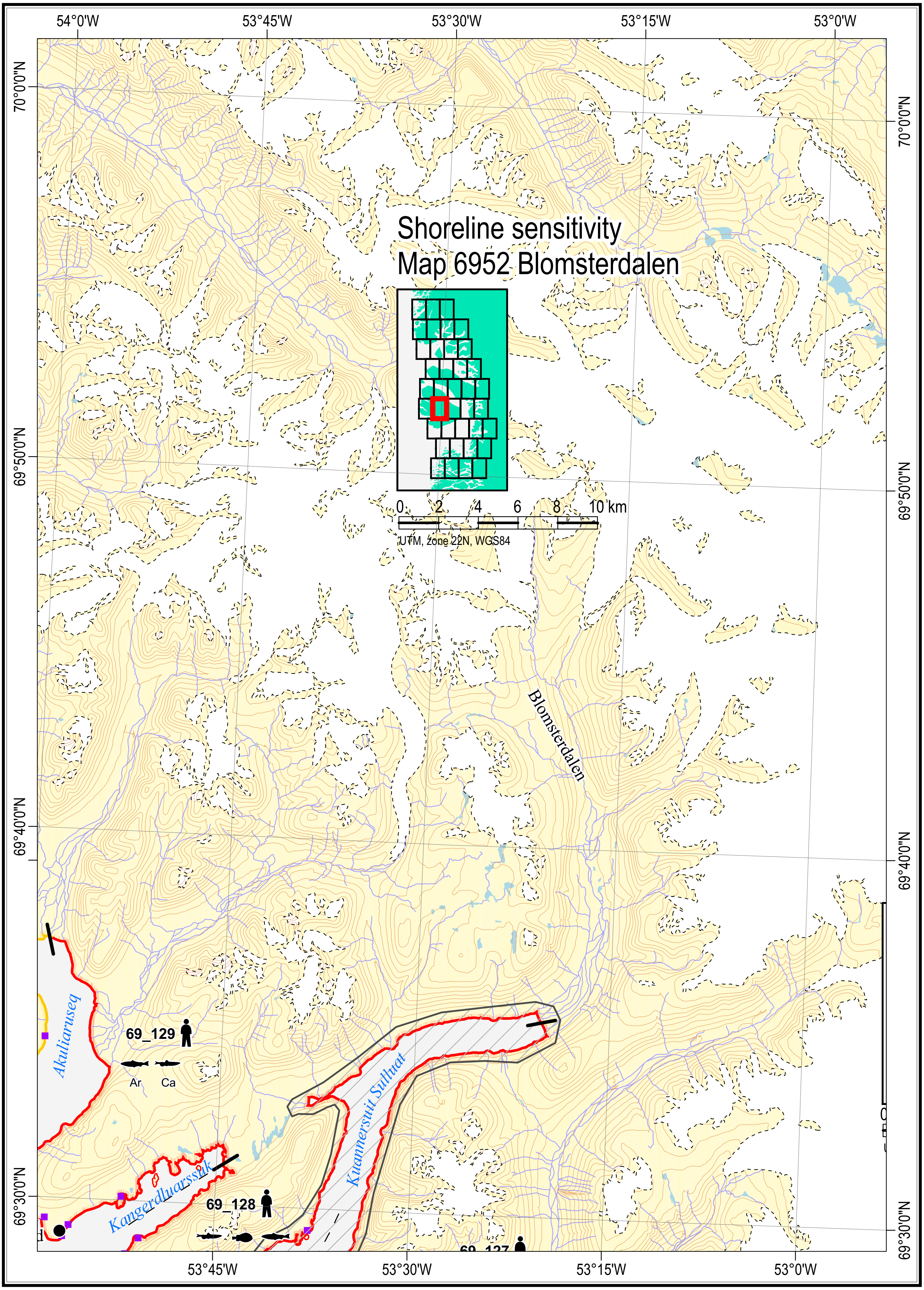
Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.1. Nautical chart: 1500.

Airphoto keymap | Map legend | Toggle maps | Keymaps



Airphoto keymap
Map legend
Toggle maps
Keymaps



Shoreline sensitivity

Map 6952 - Blomsterdalen

Environmental description

Resource use

R 69_129	Fishery for capelin, wolffish and Arctic char along coast and at 3 river outlets (2 important).

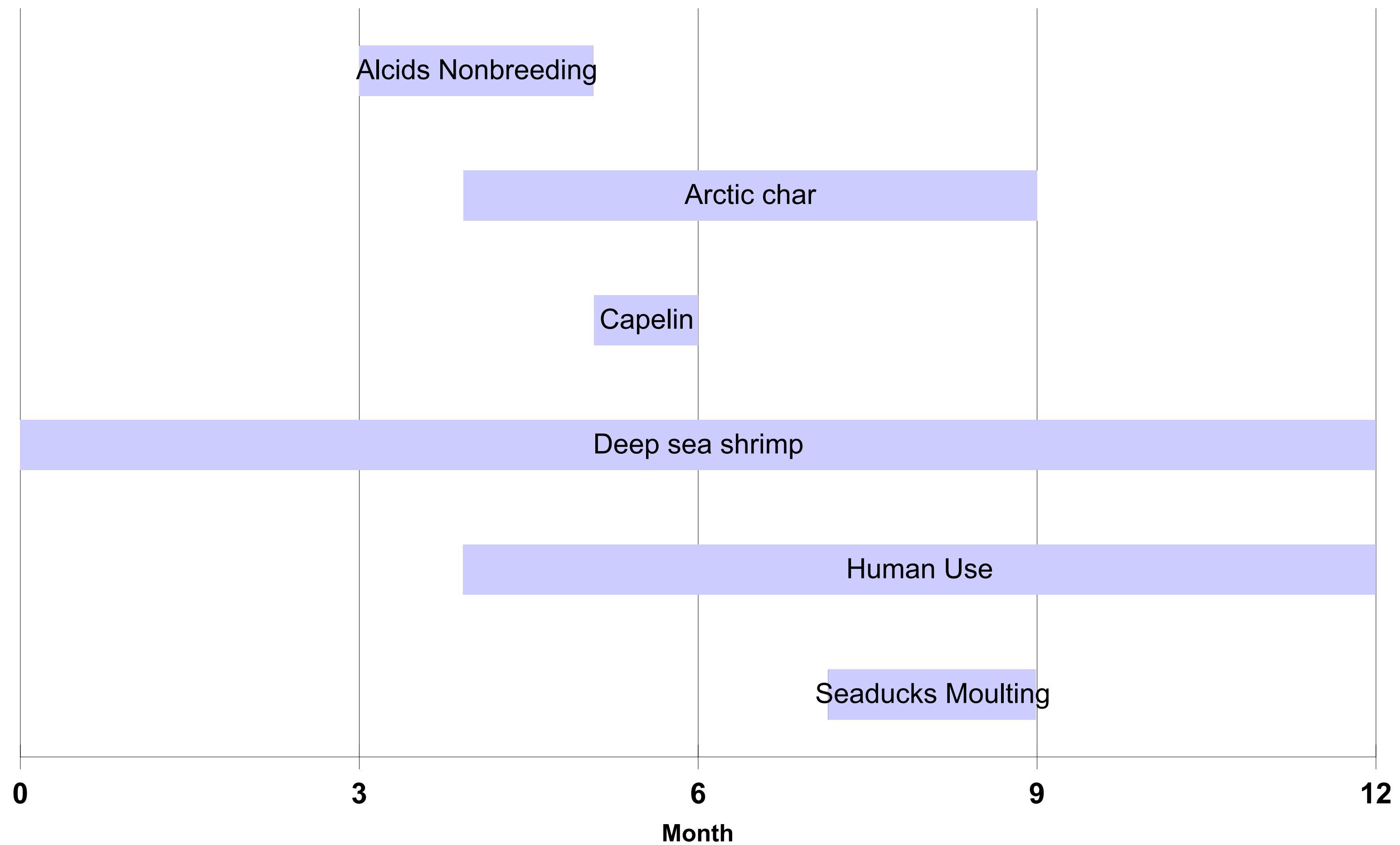
Species occurrence

Ar69129	2 important rivers and important coastal fishing area for Arctic char in Avannarput.
Ca69129	Spawning and fishing areas for capelin along coast in Avannarput.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_129	49	Extreme

Map 6952 Species and Resource Occurrences



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Physical environment and logistics

Map 6952 - Blomsterdalen

Access

Little information is available on the limited marine areas in this map.

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

First-year ice forms in fjords and sheltered waters.

There is no information on tides or currents within fjords for this area.

Anchorage with good protection is available in Kangerluarssuk, an inlet on the north side of Disko Fjord.

Shorelines in this area are predominantly rock and talus and offer little opportunity for marine access.

There are no airports on this or adjoining maps. The nearest heliport is at Qeqertarsuaq (map 6901) and the nearest airport is at Aasiaat (map 6851).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist at the heads of the three fjords shown here. 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.

Shorelines shown on this map are predominantly semi-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 the three fjords on this map. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline. Water depths are also unknown through these areas, necessitating reconnaissance at the time of a spill.

Safe havens

There are no potential safe havens identified on this map.

Maps

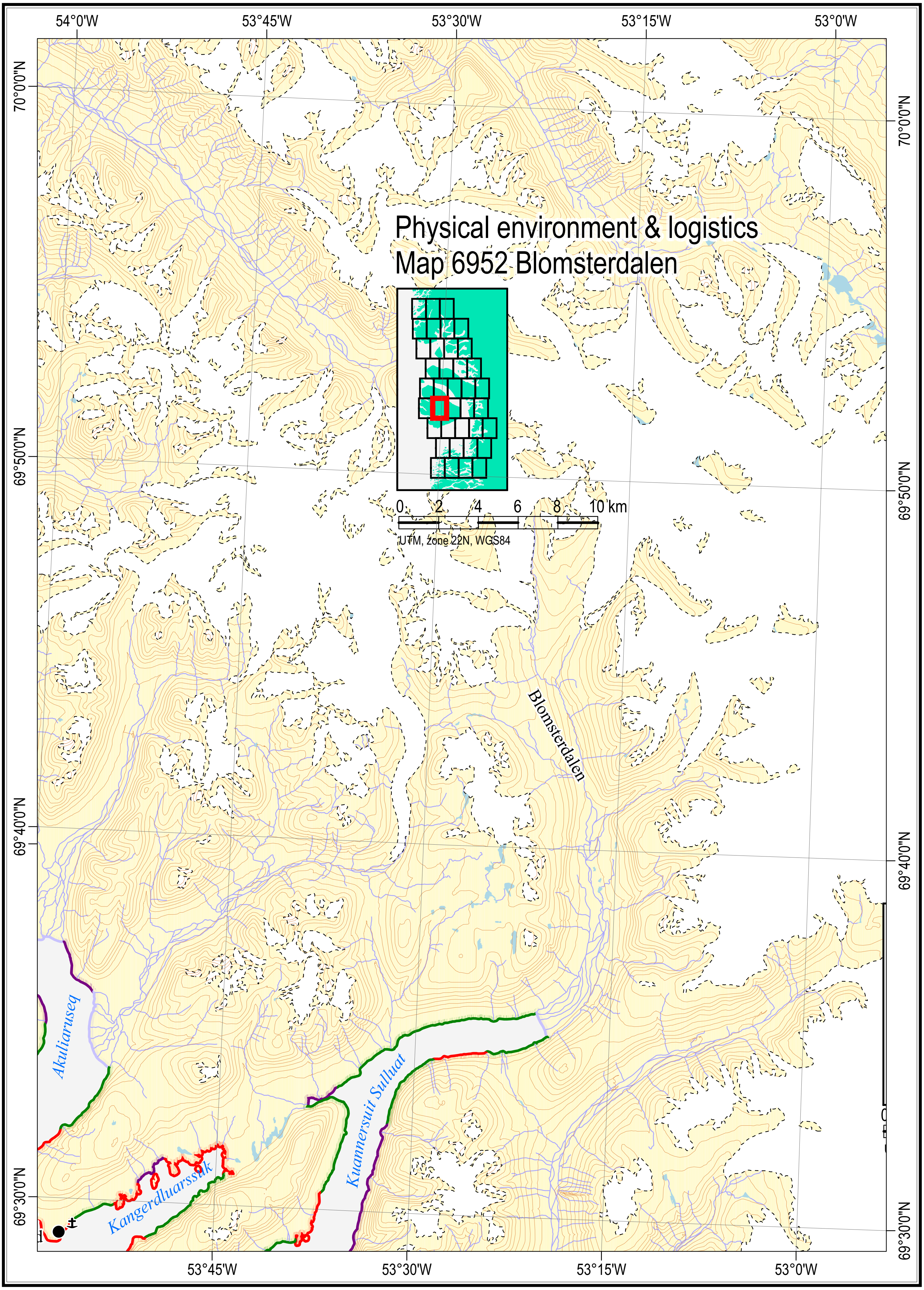
Danish Survey & Cadastre (KMS) topographical map: 69 V.1. Nautical chart: 1500.

Airphoto keymap

Map legend

Toggle maps

Keymaps

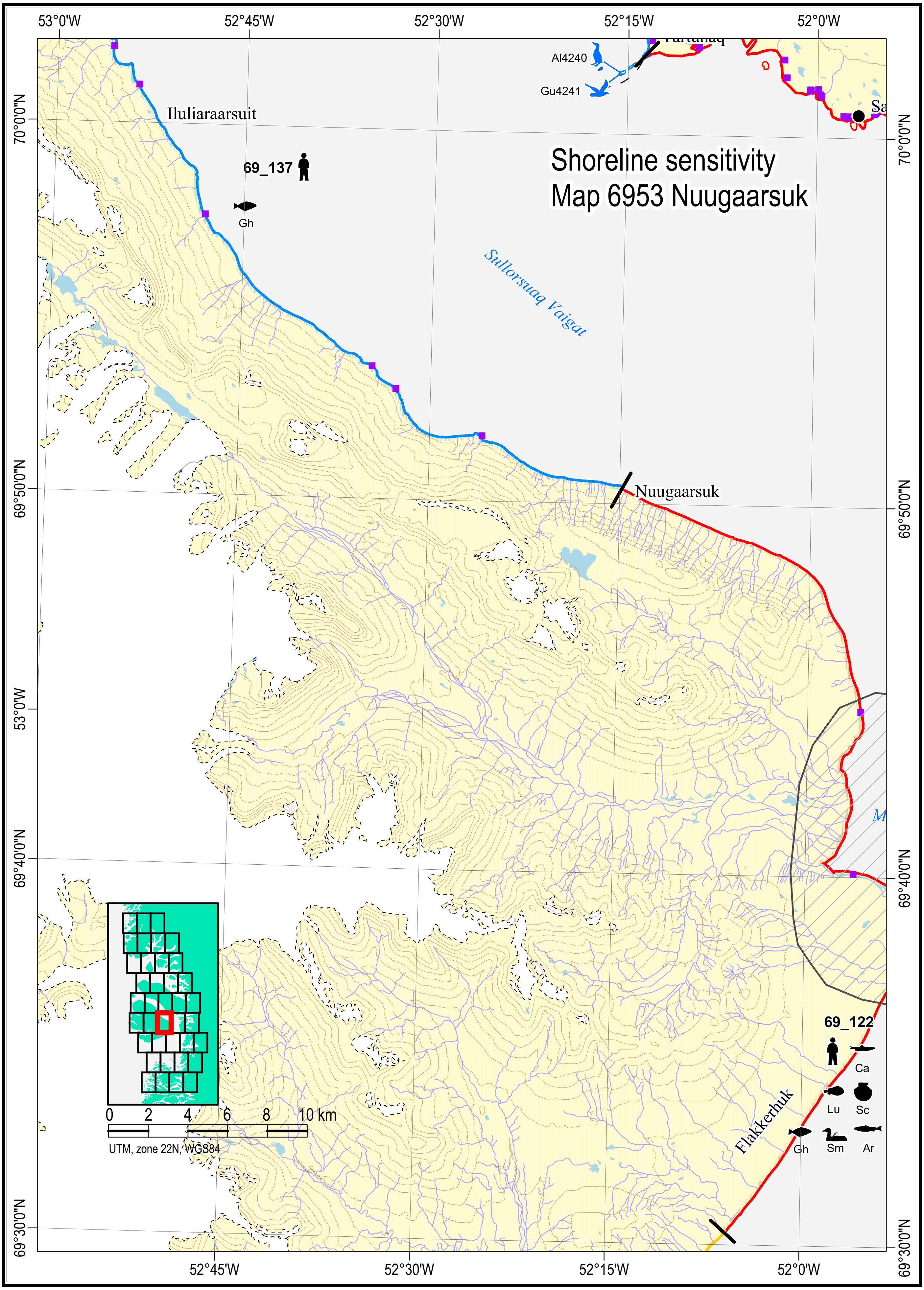


Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental description

Resource use

R 69_122	Fishery for lumpsucker, scallop (important), Greenland halibut (important), wolffish and Arctic char along coast and at 1 river outlet (important) (**S103**).
R 69_137	Fishery for Greenland halibut (important).

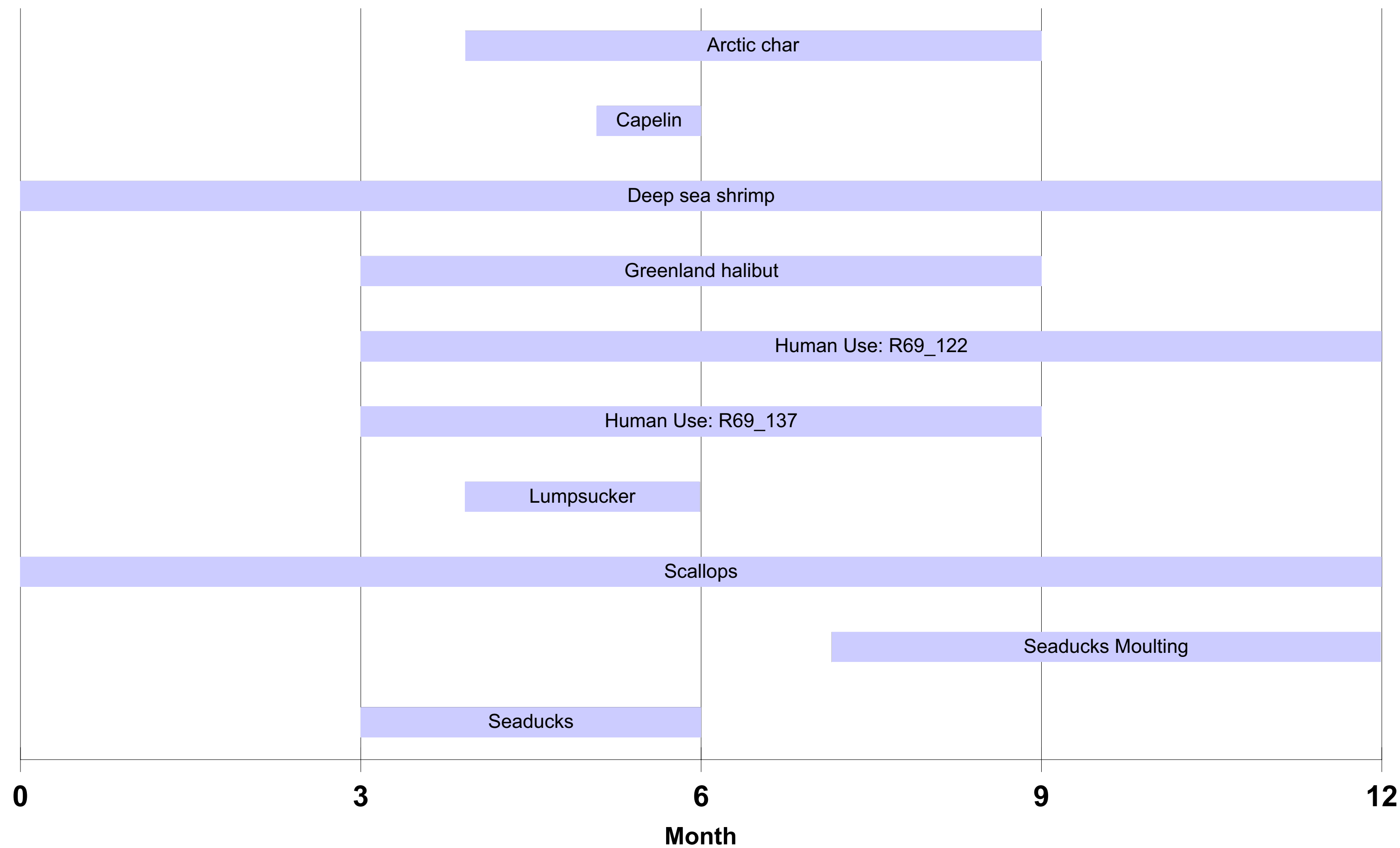
Species occurrence

Ar69122	1 important river with Arctic char and important coastal fishing areas.
Ca69122	Capelin spawning area along entire coast.
Gh69122, Gh69137	Important fishing area for Greenland halibut.
Lu69122	Important spawning area for lumpsucker along entire coast, some fishing in southern part.
Sc69122	Important scallop fishing area.
Sm69122	Long-tailed ducks, king eiders and common eiders in spring.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_122	47	Extreme
69_137	21	Low

Map 6953 Species and Resource Occurrences



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Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general the waters offshore and nearshore are deep, however uncharted dangers may exist. Local knowledge is essential for navigation. Shallow water is indicated close north and south of Mudderbugten on the eastern extremity of Disko Island.

Near Flakkerhuk the low foreshore gives poor radar response, and vessels are advised to give a wide berth. Depths of 10 m or less extend up to 1 km offshore.

The NW part of Vaigat is usually ice-bound from January to late April. The SE portion does not usually freeze over completely. In June, thousands of icebergs are released from inner fjords into Vaigat, drifting north then west at the north end of Disko Bay, rendering navigation difficult and safe anchorage almost impossible. Glacier ice frequently packs tightly against the coast.

In Vaigat a weak N to NW current is found in the SE portion in early summer. The tidal stream sets to NW on the flood and to SE on the ebb.

Anchorage with good holding but poor shelter is available at Nuugaarsuk 20 km NW of Mudderbugten. In SW winds there are heavy squalls from surrounding mountains.

Shorelines in this area are predominantly high-relief rock, talus and moraine allowing little opportunity for marine access. Beaches in the vicinity of Mudderbugten may allow marine landing, but nearshore soundings are sparse and reconnaissance would be required to confirm access.

There are no airports on this or adjoining maps. The nearest heliport is at Qeqertarsuaq (map 6901) and nearest airport at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 exposed nature of the coastline and the deep nearshore waters.

Shorelines shown on this map are highly exposed and may not require active cleaning efforts unless heavily contaminated with heavy oils. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

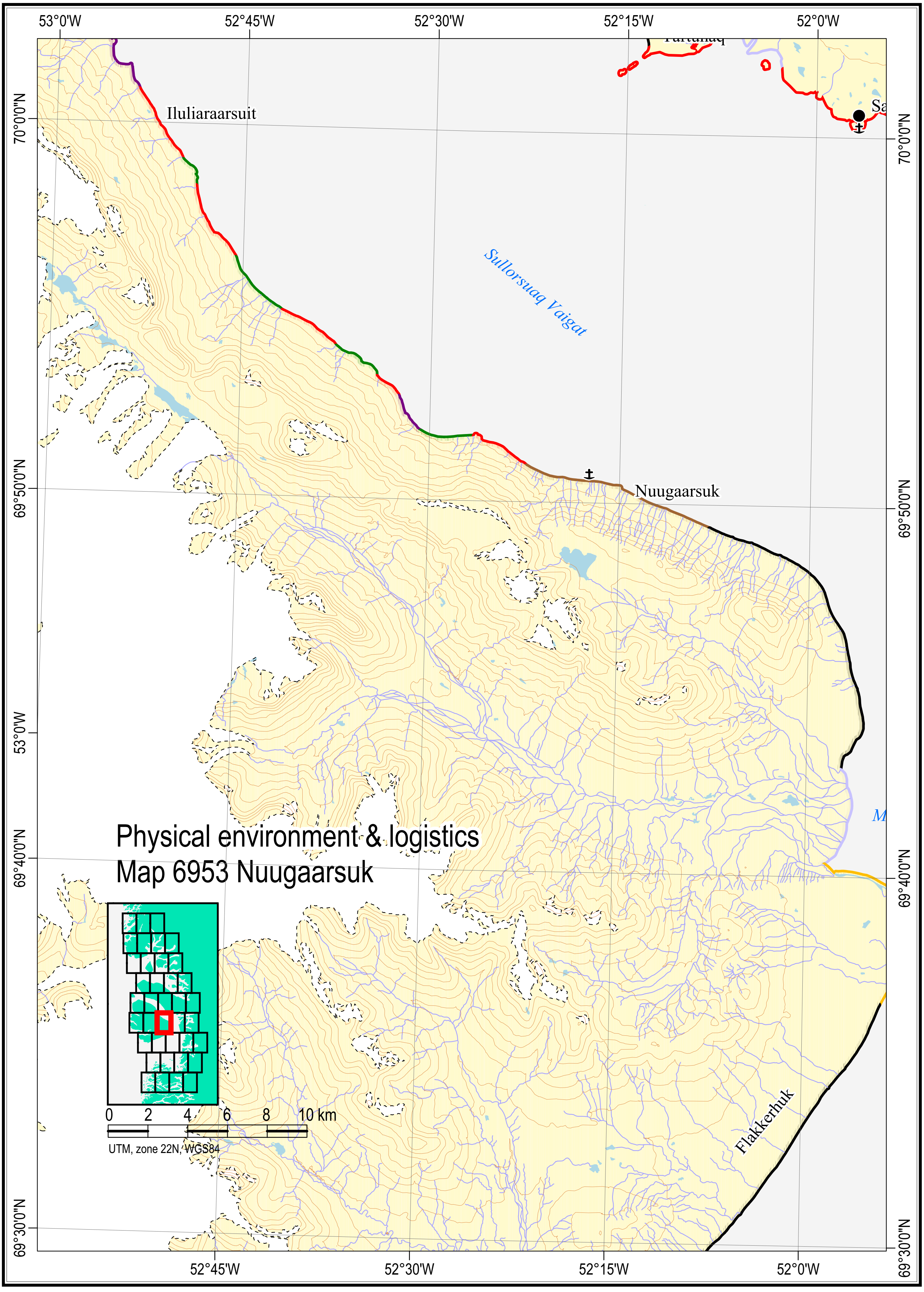
Sections of the coast north and south of Mudderbugten are designated as beach. If oiled, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In both of these areas, nearshore water depths, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

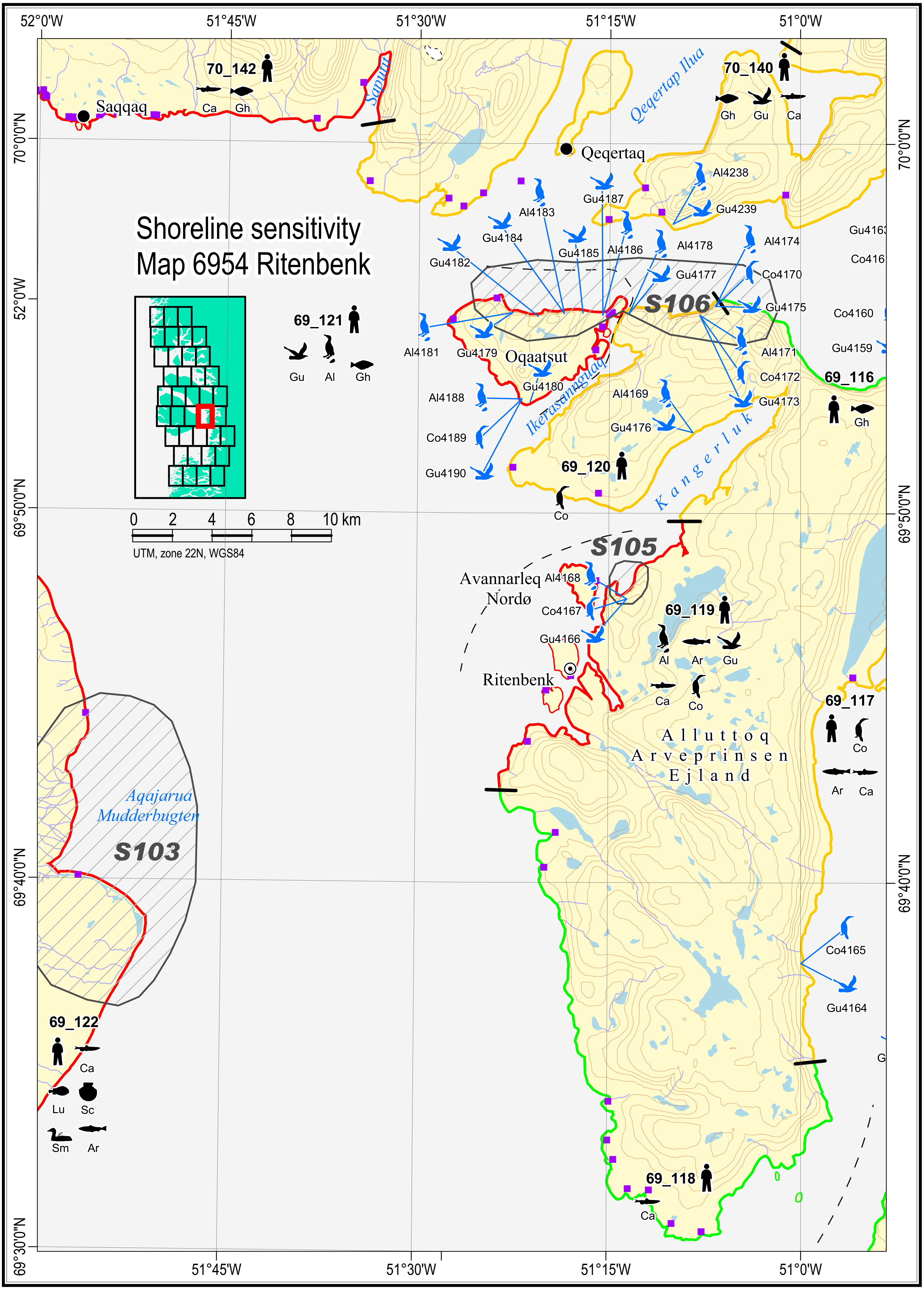
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical maps: 69 V.1, 69 V.2. Nautical chart: 1500.


53°0'W
52°45'W
52°30'W
52°15'W
52°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
Iluliaraarsuit
Sullorsuaq Vaigat
Nuugaarsuk
Flakkerhuk
Physical environment & logistics
Map 6953 Nuugaarsuk
0 2 4 6 8 10 km
UTM, zone 22N, WGS84


Shoreline sensitivity
Map 6954 Ritenbenk
52°0'W
51°45'W
51°30'W
51°15'W
51°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
Saqqaq
Qeqertaq
Qeqertap Ilua
Sapuut
Oqaatsut
Ikerasanngu aq
Kangerluk
Avannarleq Nordø
Ritenbenk
Alluttoq
Arveprinsen
Ejland
Aqajarua
Mudderbugten
S103
S105
S106
70_142
70_140
69_121
69_120
69_119
69_116
69_117
69_118
69_122
Ca
Gh
Gu
Al
Co
Ar
Lu
Sc
Sm
Al4238
Gu4187
Gu4239
Al4183
Gu4184
Gu4185
Al4186
Al4178
Al4174
Gu4182
Gu4177
Co4170
Gu4175
Al4181
Gu4179
Al4171
Co4172
Gu4173
Gu4180
Al4169
Al4188
Gu4176
Co4189
Gu4190
Al4168
Co4167
Gu4166
Gu4163
Co4160
Gu4159
Co4165
Gu4164

Environmental description

Resource use

R 69_118	Fishery for capelin, Greenland halibut, redfish, wolffish and Arctic char at river outlet and along coast. Hunting for minke and fin whales and ringed seals on ice (important).
R 69_119	Fishery for wolffish and Arctic char along coast (important) and at river outlet. Hunting for ringed seals on ice (important).
R 69_120	Fishery for capelin, Greenland halibut, redfish, wolffish (important) and Arctic char along coast. Hunting for ringed seals on ice.
R 69_121	Fishery for Greenland halibut, redfish and wolffish.
R 70_140	Fishery for capelin, Greenland halibut (important), redfish and wolffish. Hunting for ringed seals on ice (important).
R 70_142	Fishery for capelin (important), Greenland halibut (important) and wolffish. Tourist attraction at settlement.

Species occurrence

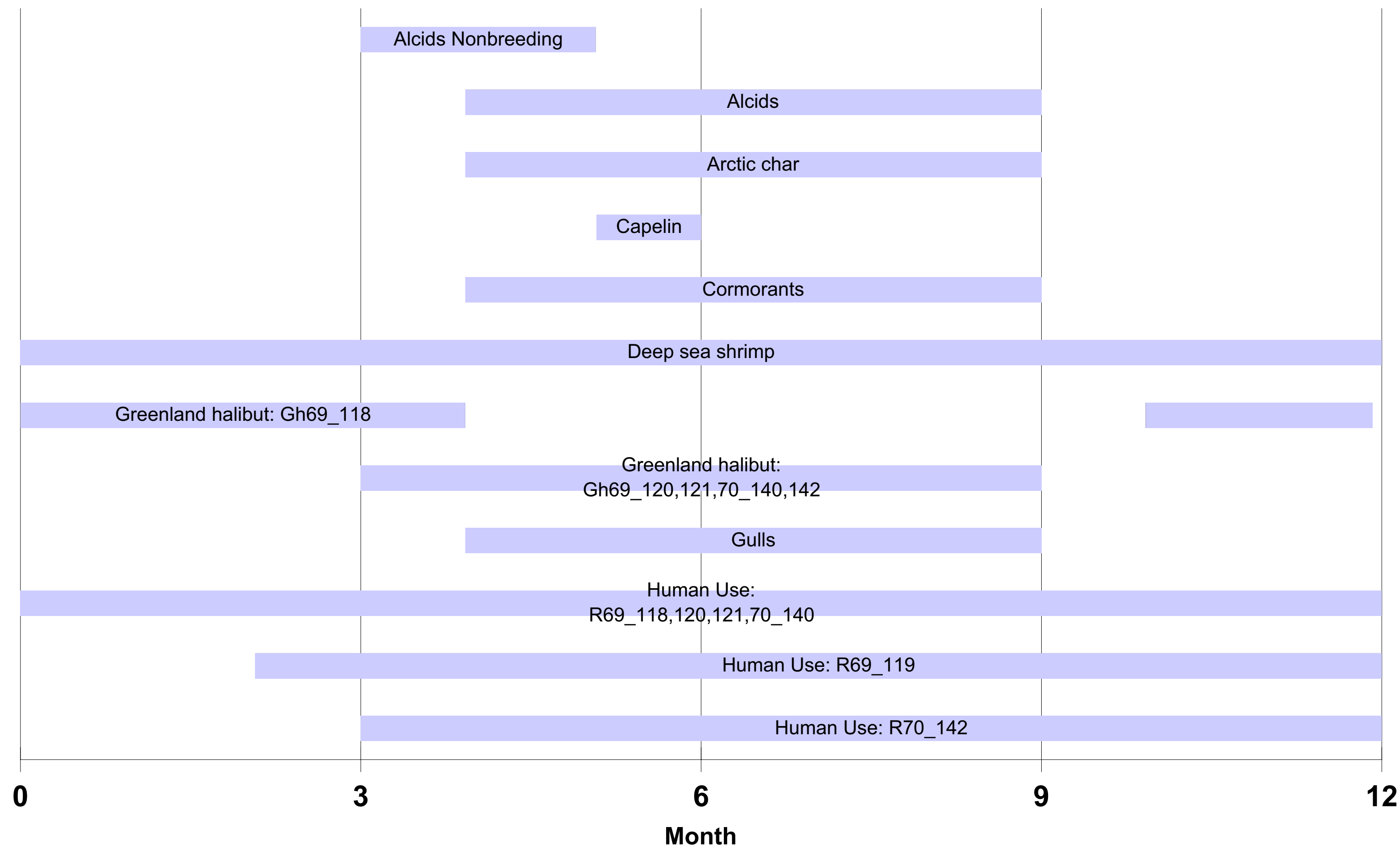
Al69119	1 breeding colony with Brünnich's guillemots, razorbills and black guillemots (**S105**).
Al69121	4 colonies with breeding razorbills and black guillemots (**S106**).
Ar69119	Important coastal fishing area for Arctic char along all coasts.
Ca69118	Capelin spawning area along all coasts.
Ca69119	capelin spawning area along most of the coast.
Ca70140	Important capelin fishing area in Qeqertap Ilua.
Ca70142	Important capelin fishing area along entire coast.
Co69119	1 colony with breeding great cormorants.
Co69120	2 colonies with breeding great cormorants.
Gh69121, Gh70140	Important fishing area for Greenland halibut.
Gh70142	Important fishing area for Greenland halibut.
Gu69119, Gu70140	1 colony with breeding Iceland gulls, glaucous gulls and kittiwakes.
Gu69121	7 colonies with breeding Iceland gulls, glaucous gulls and kittiwakes (**S106**).

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

Al4168	Breeding Brünnich's guillemots, black guillemots and razorbills (**S105**).
Al4169	Breeding razorbills.
Al4171, Al4174, Al4178	Breeding black guillemots (**S106**).
Al4181, Al4183, Al4186	Breeding black guillemots (**S106**).
Al4188	Breeding razorbills and black guillemots.
Al4238	Breeding black guillemots.
Co4165	Breeding great cormorants.
Co4172, Co4170	Breeding great cormorants (**S106**).
Co4167, Co4189	Breeding great cormorants.
Gu4164	Breeding Iceland gulls or glaucous gulls.
Gu4166	Breeding glaucous gulls, Iceland gulls and kittiwakes.
Gu4173	Breeding glaucous gulls, Iceland gulls and kittiwakes (**S106**).
Gu4175	Breeding Iceland gulls.
Gu4176	Breeding Iceland gulls and kittiwakes.
Gu4179	Breeding Iceland gulls and kittiwakes (**S106**).
Gu4177, Gu4182	Breeding glaucous gulls, Iceland gulls and kittiwakes (**S106**).
Gu4180, Gu4190	Breeding Iceland gulls, glaucous gulls and kittiwakes.
Gu4184, Gu4187	Breeding Iceland gulls and kittiwakes (**S106**).
Gu4185	Breeding kittiwakes, Iceland or glaucous gulls (**S106**).
Gu4239	Breeding kittiwakes, Iceland gull and glaucous gulls.

(Continued on page 9-99)

Map 6954 Species and Resource Occurrences



Shoreline sensitivity

Map 6954 - Ritenbenk

(Continued from page 9-97)

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_118	25	Moderate
69_119	70	Extreme
69_120	36	High
69_121	51	Extreme
70_140	42	High
70_142	53	Extreme

Physical environment and logistics

Map 6954 - Ritenbenk

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general the waters offshore and nearshore are deep, however, uncharted dangers may exist. Local knowledge is essential for navigation. Shallow water is indicated close north and south of Mudderbugten on the eastern extremity of Disko Island.

The area is normally frozen over from December to early June.

Tidal streams in the channels connecting these sounds and fjords can be strong. The general direction is setting to NE on the flood and SW on the ebb.

There is no other information on tides or currents within fjords for this area.

Anchorage for small vessels can be made in Ata Sound at an abandoned trading station close west of the sandy beach.

Anchorage can be found off the trading station at the south end of Qeqertaq. It is exposed to the south, and is frequently blocked with ice.

At Kangerluarssunguaq, a narrow inlet about 3 km SE of Ritenbenk, anchorage for small vessels is available in the westerly of two coves, depths of 40 m.

Access

(Continued from previous page)
Anchorage can be made north of Ritenbenk in Kangerluk, a short fjord, and in Ikersannguaq, which separates the island of Oqaatsoq from the larger island of Arveprinsen Ejland.

Larger vessels can anchor west of Qeqertaq in depths of 10 to 50 m.

The KMS map indicate an anchorage at the south end of Arveprinsen Ejland, but no other information is available.

Beaches in the vicinity of Mudderbugten may allow marine landing, but nearshore soundings are sparse and reconnaissance would be required to confirm access. All other shorelines in this area are predominantly rock and offer little opportunity for marine access.

There are no airports on this or adjoining maps. The nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within the several inlets and fjords shown 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, including the selected area shown on the map.

Exclusion booming to reduce the extent of inshore contamination should be considered at three possible locations. At Ikerasannguaq, the inlet width is 1,000 m, and the two coves south and southeast of Ritenbenk each have inlet widths of 800 m. Both have rock shorelines and appear to have deep water. Site surveys at the time of a spill will be required to confirm the feasibility of booming techniques.

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

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, 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 cleanup operations would be marine-based given the likely nature of the shoreline.

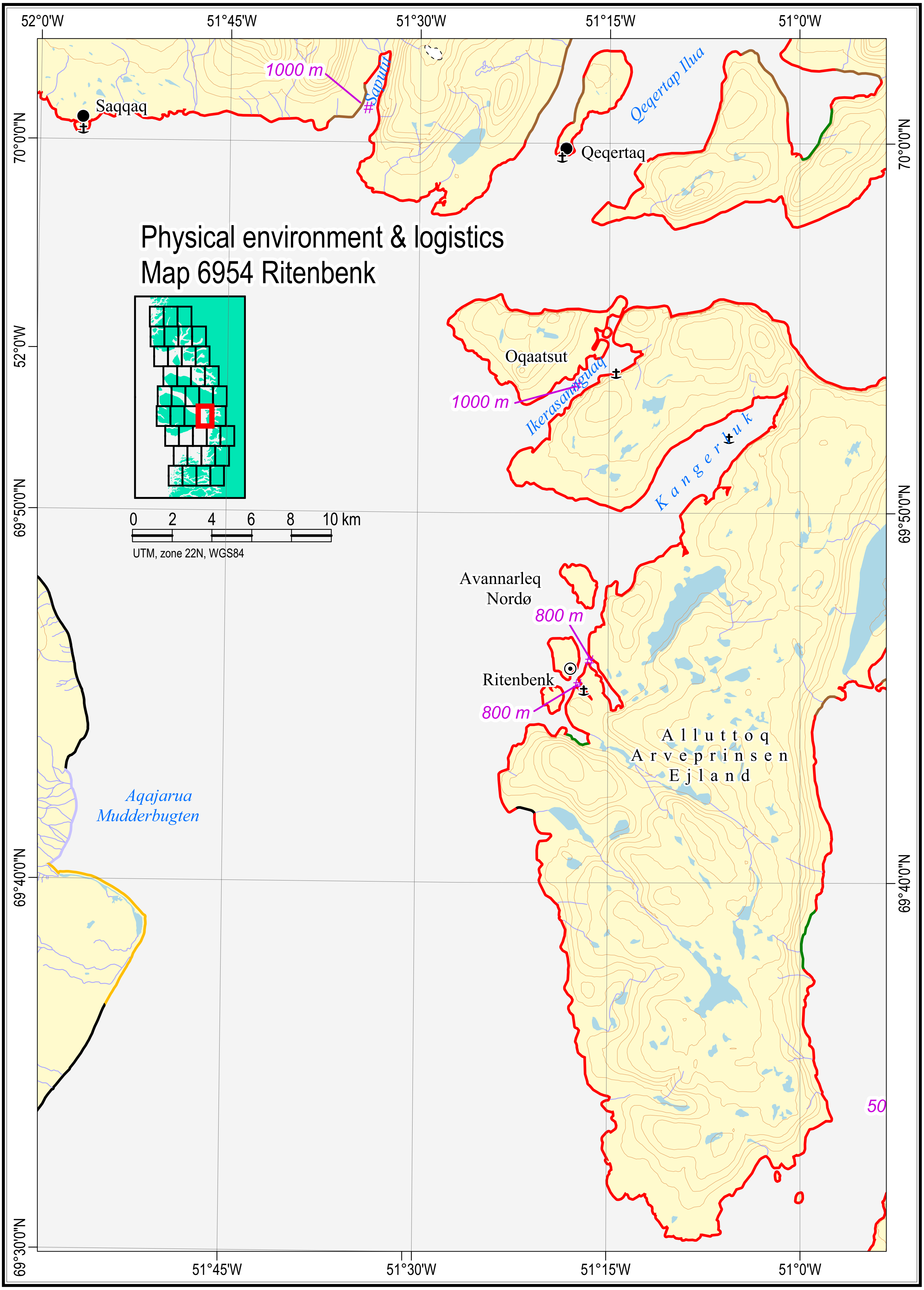
Sections of the coast north and south of Mudderbugten (Disko Island) are designated as beach. If oiled, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In both of these areas, nearshore water depths, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

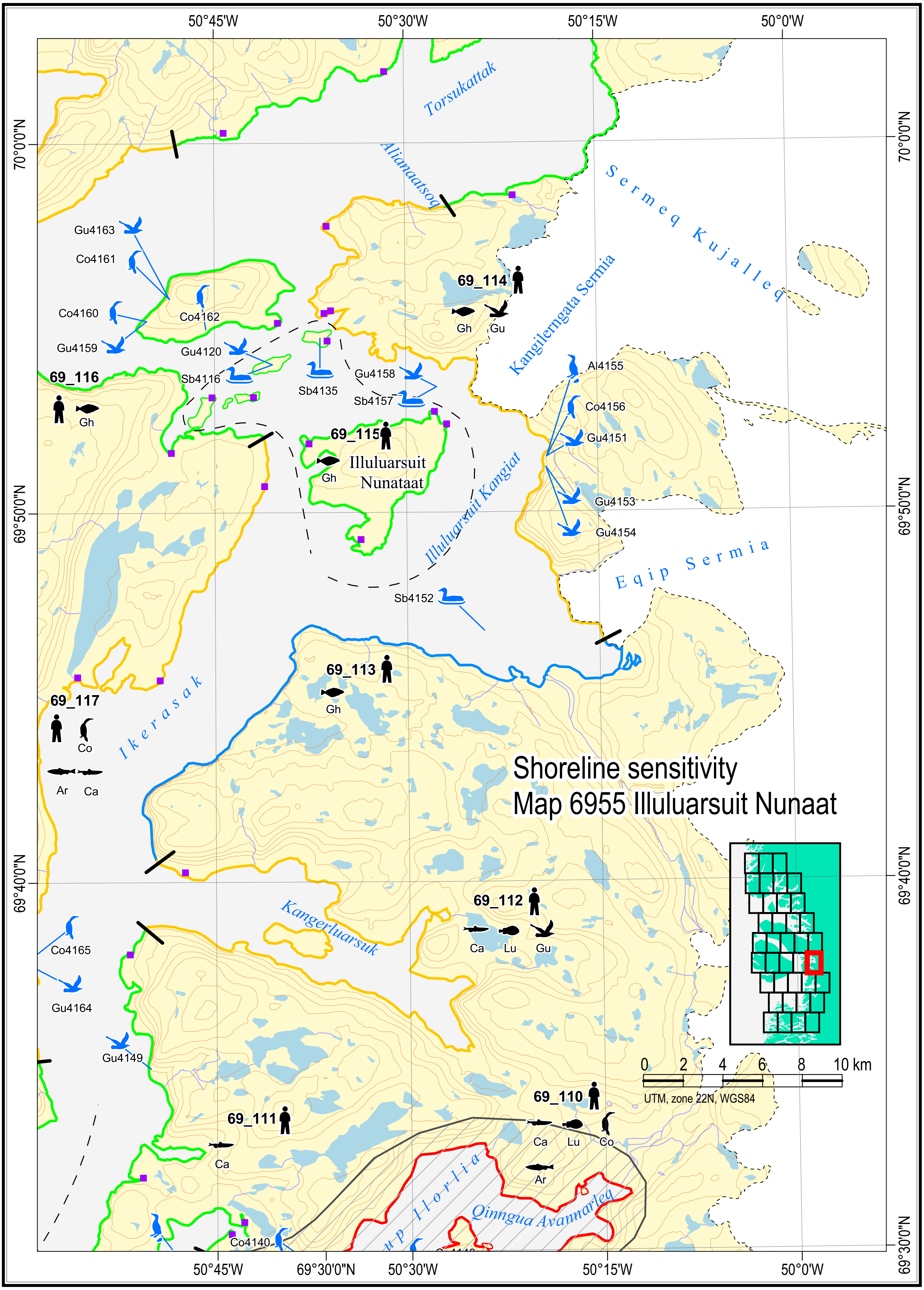
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.2. Nautical charts: 1500, 1552.


Physical environment & logistics
Map 6954 Ritenbenk
52°0'W
51°45'W
51°30'W
51°15'W
51°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
Saqqaq
Qeqertaq
Qeqertap Ilua
Saputit
1000 m
Oqaatsut
Ikerasanguaq
Kangerluk
Avannarleq
Nordø
800 m
Ritenbenk
Alluttoq
Arveprinsen
Ejland
Aqajarua
Mudderbugten
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
50


50°45'W
50°30'W
50°15'W
50°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
Torsukattak
Aliannaatsoq
Sermeq Kujalleq
Kangilerngata Sermia
Illuluarsuit Kangiat
Eqip Sermia
Ikerasak
Kangerluarsuk
Qinngua Avannarleq
Illuluarsuit
Nunataat
69_114
69_115
69_116
69_117
69_113
69_112
69_111
69_110
Gu4163
Co4161
Co4160
Co4162
Gu4159
Gu4120
Sb4116
Sb4135
Gu4158
Sb4157
Al4155
Co4156
Gu4151
Gu4153
Gu4154
Sb4152
Co4165
Gu4164
Gu4149
Co4140
Gh
Gu
Co
Ar
Ca
Lu
Shoreline sensitivity
Map 6955 Illuluarsuit Nunaat
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Environmental description

Resource use

R 69_110	Fishery for capelin (important) and Arctic char along coasts and at river outlet. Hunting for ringed seals on ice (important). Tourist attraction and angling site.
R 69_111	Fishery for capelin (important), Greenland halibut, redfish and wolffish. Hunting for ringed seals on ice.
R 69_112	Fishery for capelin (important), redfish and wolffish. Hunting for ringed seals on ice (important).
R 69_113	Fishery for Greenland halibut (important), redfish and wolffish (important). Hunting for ringed seals on ice (important). Tourist camp site at shore.
R 69_114	Fishery for Greenland halibut (important), redfish and wolffish (important). Hunting for ringed seals on ice. Tourist attraction along shore.
R 69_115	Fishery for Greenland halibut (important), redfish and wolffish (important). Hunting for ringed seals on ice.
R 69_116	Fishery for Greenland halibut (important), redfish and wolffish (important). Hunting for ringed seals on ice.
R 69_117	Fishery for capelin, redfish (important), wolffish (important), Greenland halibut and Arctic char at river outlet and along coasts. Hunting for ringed seals on ice (important). Tourist attraction and angling site.

Species occurrence

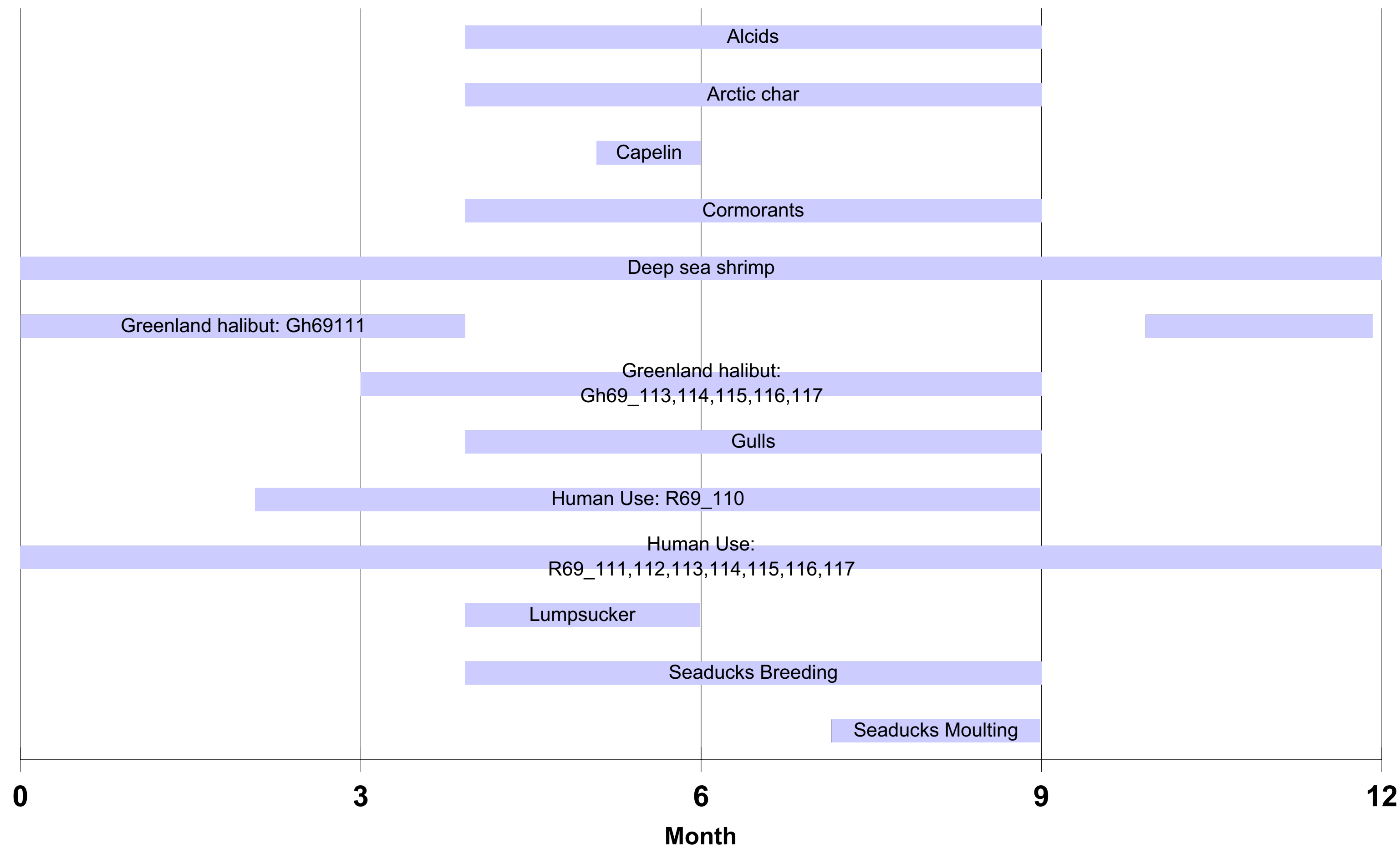
Ar69110, Ar69117	1 important river with Arctic char and important coastal fishing area
Ca69110, Ca69111	Important capelin fishing areas along almost entire coast.
Ca69112	Important capelin fishing areas along almost entire coast.
Ca69117	Important fishing area along southern part.
Co69110, Co69117	1 colony with breeding great cormorants.
Gh69113, Gh69114	Important fishing area for Greenland halibut.
Gh69115, Gh69116	Important fishing area for Greenland halibut.
Gu69112	1 colony with breeding Iceland gulls and glaucous gulls.
Gu69114	3 colonies with breeding kittiwakes and Iceland gulls.
Lu69110, Lu69112	Important spawning area for lumpsucker along entire coast.

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

Al4155	Breeding black guillemots.
Co4156	Breeding great cormorants.
Co4160, Co4161	Breeding great cormorants.
Co4162	Breeding great cormorants.
Gu4120	Breeding glaucous gulls.
Gu4149, Gu4158	Breeding glaucous gulls.
Gu4151, Gu4153	Breeding kittiwakes and Iceland gulls.
Gu4154	Breeding kittiwakes.
Gu4159, Gu4163	Breeding kittiwakes and Iceland gulls.
Sb4116, Sb4135	Breeding common eiders.
Sb4152, Sb4157	Breeding common eiders.

(Continued on page 9-105)

Map 6955 Species and Resource Occurrences



Shoreline sensitivity

(Continued from page 9-103)

Map 6955 - Illuluarsuit Nunataat

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
69_110	52	Extreme
69_111	30	Moderate
69_112	41	High
69_113	19	Low
69_114	36	High
69_115	32	Moderate
69_116	28	Moderate
69_117	42	High

Access

Little information is available for the marine areas in this map, and few soundings are reported for inshore areas and fjords. In general the waters within the fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

The area is normally frozen over from December to early June. The channels that connect Ikerasak (Ataa Sund) and Torsukattak are navigable, but passage can be limited by ice from nearby glaciers.

Currents in the channels connecting these sounds and fjords can be strong. There is no other information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

Charts indicate an anchorage in the fjord headed by Eqip Sermia, but no other information is available.

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

There are no airports on this or adjoining maps. The nearest airport is at Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within fjords. 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 the extent of inshore contamination should be considered at three possible locations. Within Kangerluarsuk, the strait on each side of the mid-channel island has a width of approximately 800 m, and the cove close south of Kangerluarsuk has an inlet width of approximately 500 m. All three locations have rock shorelines and appear to have deep water. Site surveys at the time of a spill will be required to confirm the feasibility of booming techniques.

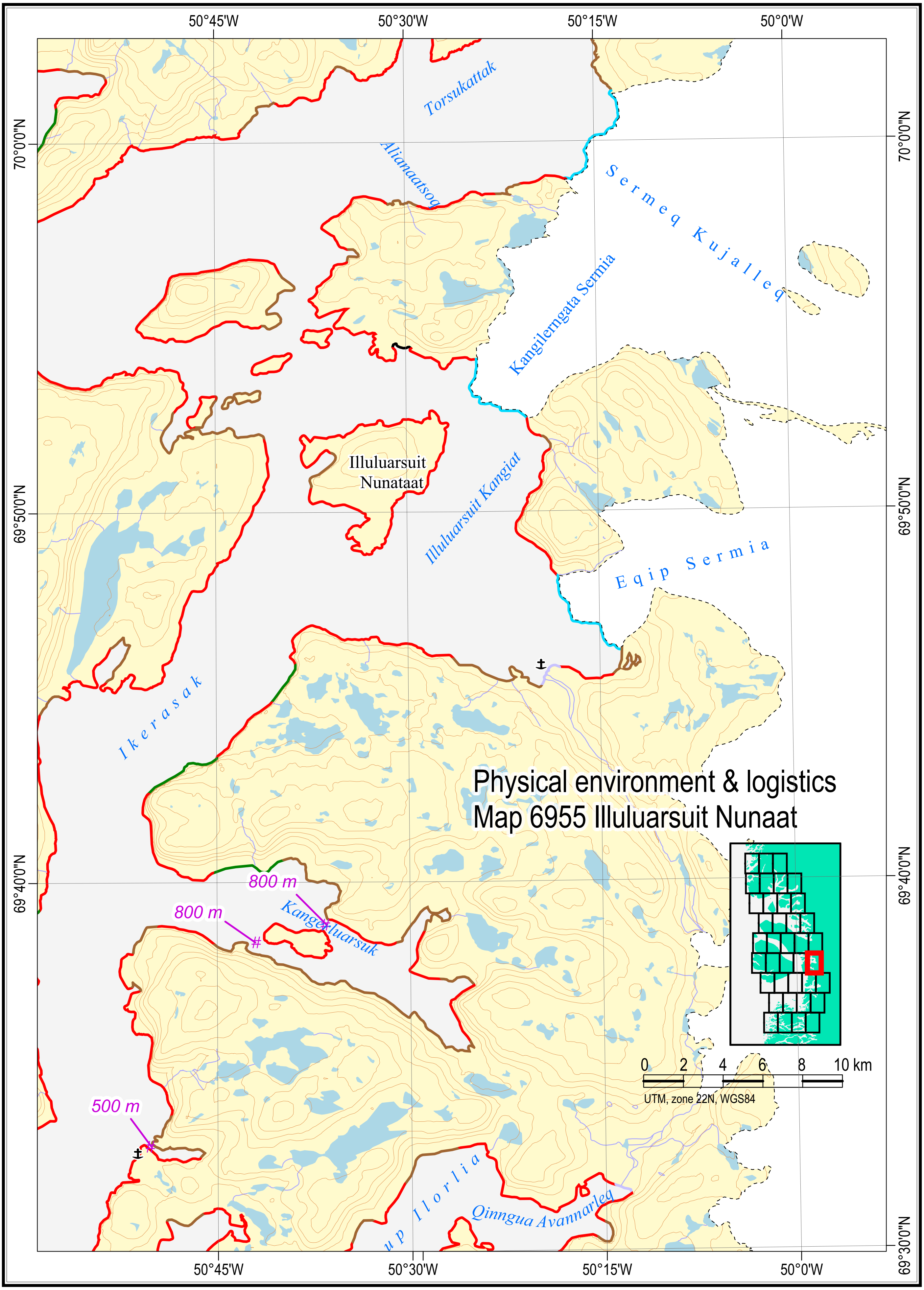
Shorelines shown on this map are predominantly exposed and semi-exposed rock and moraine, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability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

Safe havens

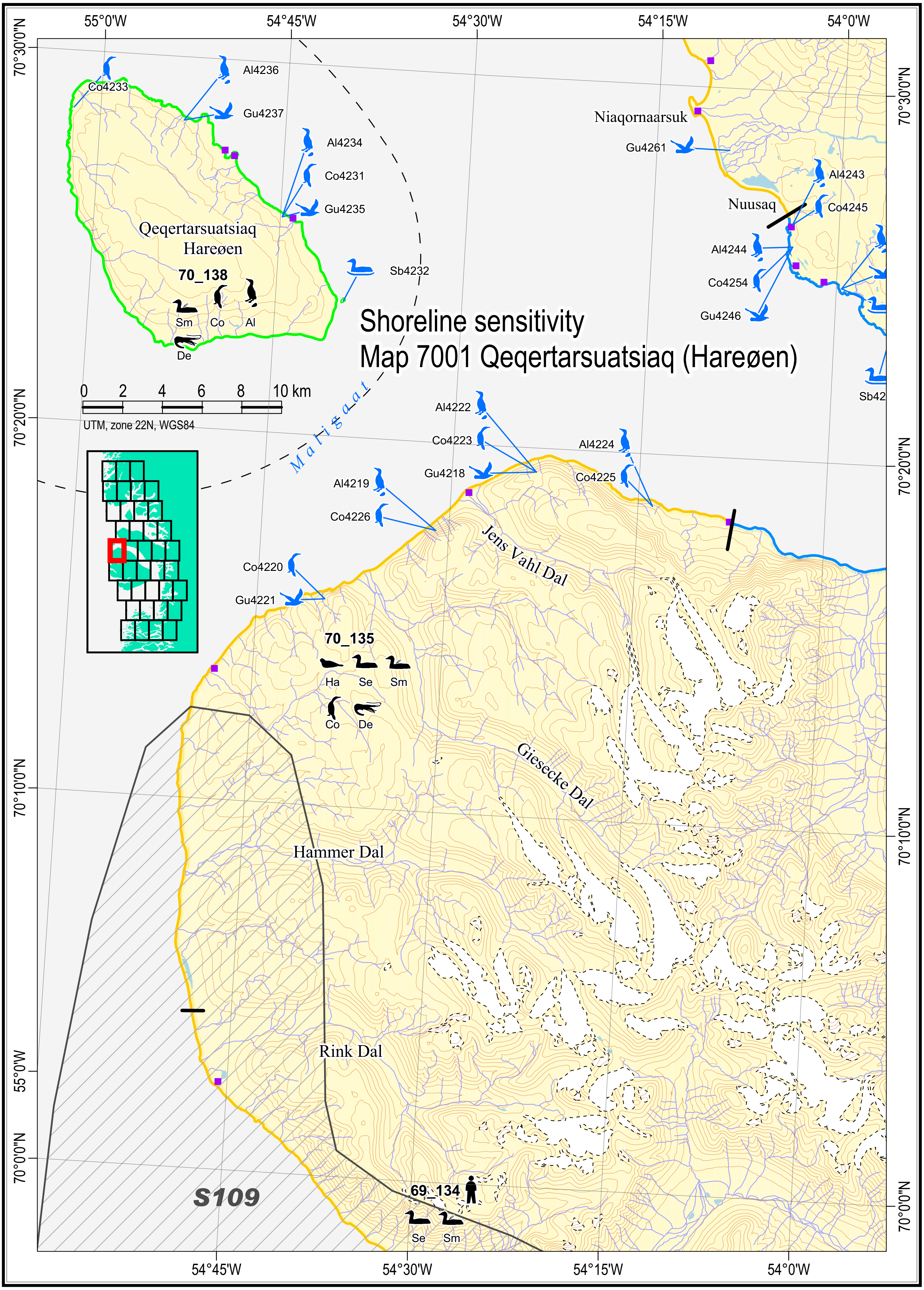
There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 69 V.2. Nautical charts: none.


50°45'W
50°30'W
50°15'W
50°0'W
70°0'0"N
69°50'0"N
69°40'0"N
69°30'0"N
Torsukattak
Alianaatsoq
Sermeq Kujalleq
Kangilerngata Sermia
Illuluarsuit Nunataat
Illuluarsuit Kangiat
Eqip Sermia
Ikerasak
800 m
800 m
Kangerluarsuk
500 m
Qinngua Avannarleq
Ilorlia
Physical environment & logistics
Map 6955 Illuluarsuit Nunaat
0
2
4
6
8
10 km
UTM, zone 22N, WGS84

Airphoto keymap
Map legend
Toggle maps
Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen, 1998

Environmental description

Resource use

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

Species occurrence

Al70138	2 colonies with breeding razorbills and black guillemots.
Co70135	4 colonies with breeding great cormorants.
Co70138	2 colonies with breeding great cormorants.
De70135	Important fishing area for deep sea shrimp.
De70138	Important fishing area for deep sea shrimp.
Ha70135	Harbour seal whelping and summer habitat (**S109**).
Se70135	Common eiders, king eiders and long-tailed ducks in late winter and spring **(S109)**.
Sm70135	Long-tailed ducks, common eiders and king eiders moulting in late summer and autumn (**S109**).
Sm70138	King eiders and common eiders moulting in late summer and autumn.

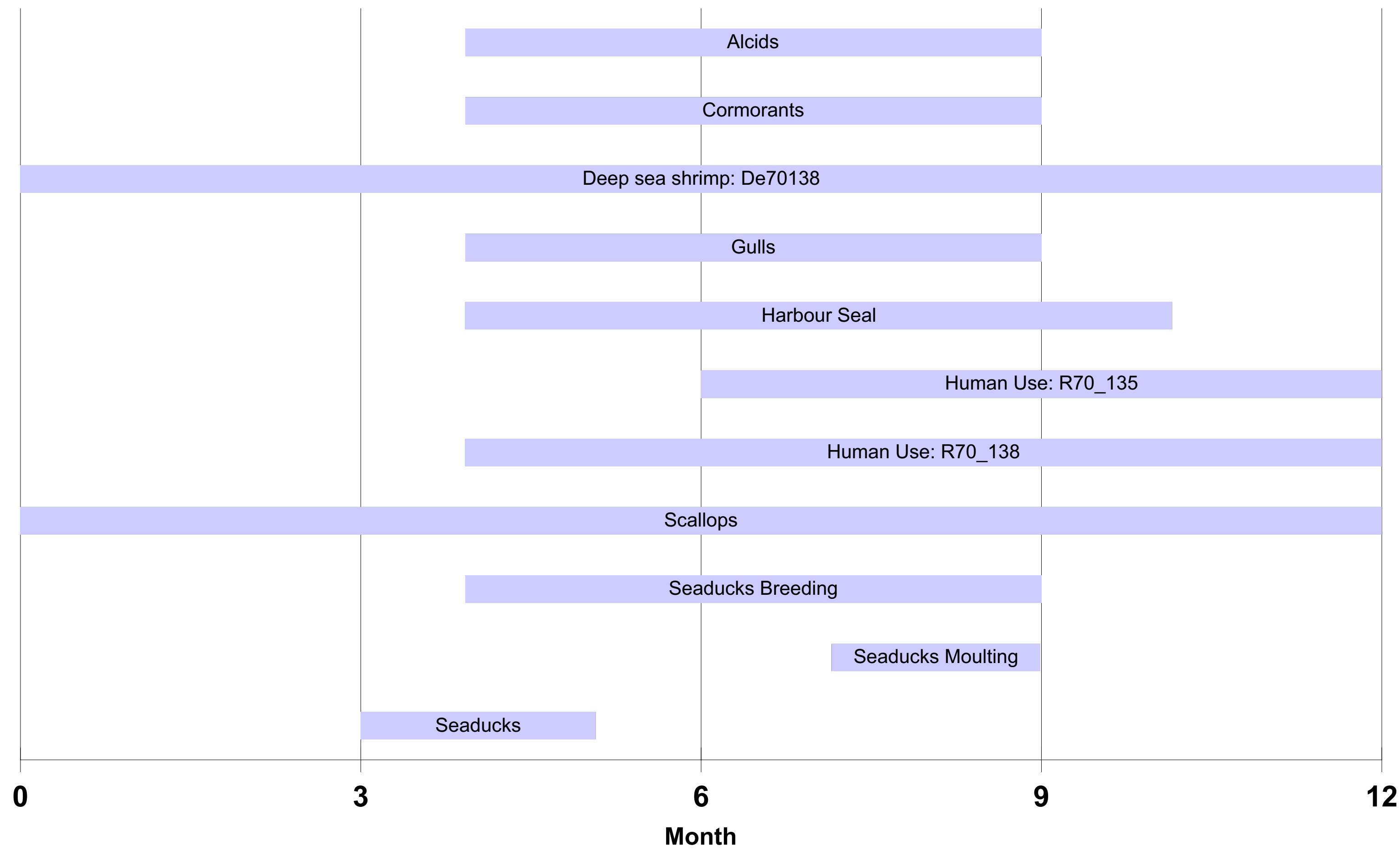
Site specific species occurrence (seabird breeding colonies); blue icons

Al4219, Al4224, Al4236	Breeding black guillemots.
Al4222, Al4234	Breeding razorbills and black guillemots.
Al4243, Al4244	Breeding black guillemots.
Co4220, Co4223	Breeding great cormorants.
Co4225, Co4226	Breeding great cormorants.
Co4231, Co4233	Breeding great cormorants.
Co4245, Co4252	Breeding great cormorants.
Gu4218, Gu4221	Breeding glaucous gulls.
Gu4235	Breeding Iceland gulls and glaucous gulls.
Gu4237	Breeding Iceland gulls or glaucous gulls.
Gu4246	Breeding kittiwakes and Iceland gulls.
Gu4261	Breeding Arctic terns.
Sb4232	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_135	37	High
70_138	24	Moderate

Map 7001 Species and Resource Occurrences



Physical environment and logistics

Map 7001 - Qeqertarsuatsiaq (Hareøen)

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general the waters offshore and nearshore are deep, however, uncharted dangers may exist. Local knowledge is essential for navigation. Rocks 1.8 m or less below water surface are reported close north and northwest of Niaqornaarsuk.

Few dangers are charted along most of the west coast of Disko Island. Numerous rivers enter the sea north of Nordfjord with foul ground up to 1.5 km offshore.

Access

(Continued from previous page)
The NW part of Vaigat is usually ice-bound from January to late April. The SE portion does not usually freeze over completely. In June, thousands of icebergs are released from inner fjords into Vaigat, drifting north then west at the north end of Disko Bay, rendering navigation difficult and safe anchorage almost impossible. Glacier ice frequently packs tightly against the coast.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.

In Vaigat, a weak N to NW current is found in the SE portion in early summer. The tidal stream sets to NW on the flood and to SE on the ebb.

There is no other information on tides or currents within fjords for this area.

A small bay at Niaqornaarsuk provides shelter from north winds for small vessels.

Good anchorage is reported in the cove Nuusaq, the northeast entrance point of Vaigat. An abandoned settlement is at the head of the cove.

Shorelines along Vaigat are predominantly rock and talus, which means that beach landing is unlikely. The possibility of beach landings could be explored close by the several river mouths. Beach access may be possible along the shoreline on the west coast of Disko but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas.

Offshore countermeasures represent the only practical method of protecting the highly exposed shoreline areas, including the selected area on the west coast of Disko.

There are no opportunities for exclusion booming in the area shown on this map due to the highly exposed nature of the shoreline and the deep nearshore waters.

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 highly exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in more protected waters. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

North of Nuusaq and on the west and north coasts of Disko the several areas designated as beach may require cleaning if oiled, using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map. The anchorage at Niaqornaarsuk could be investigated for its suitability as a safe haven given its moderate sensitivity, but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

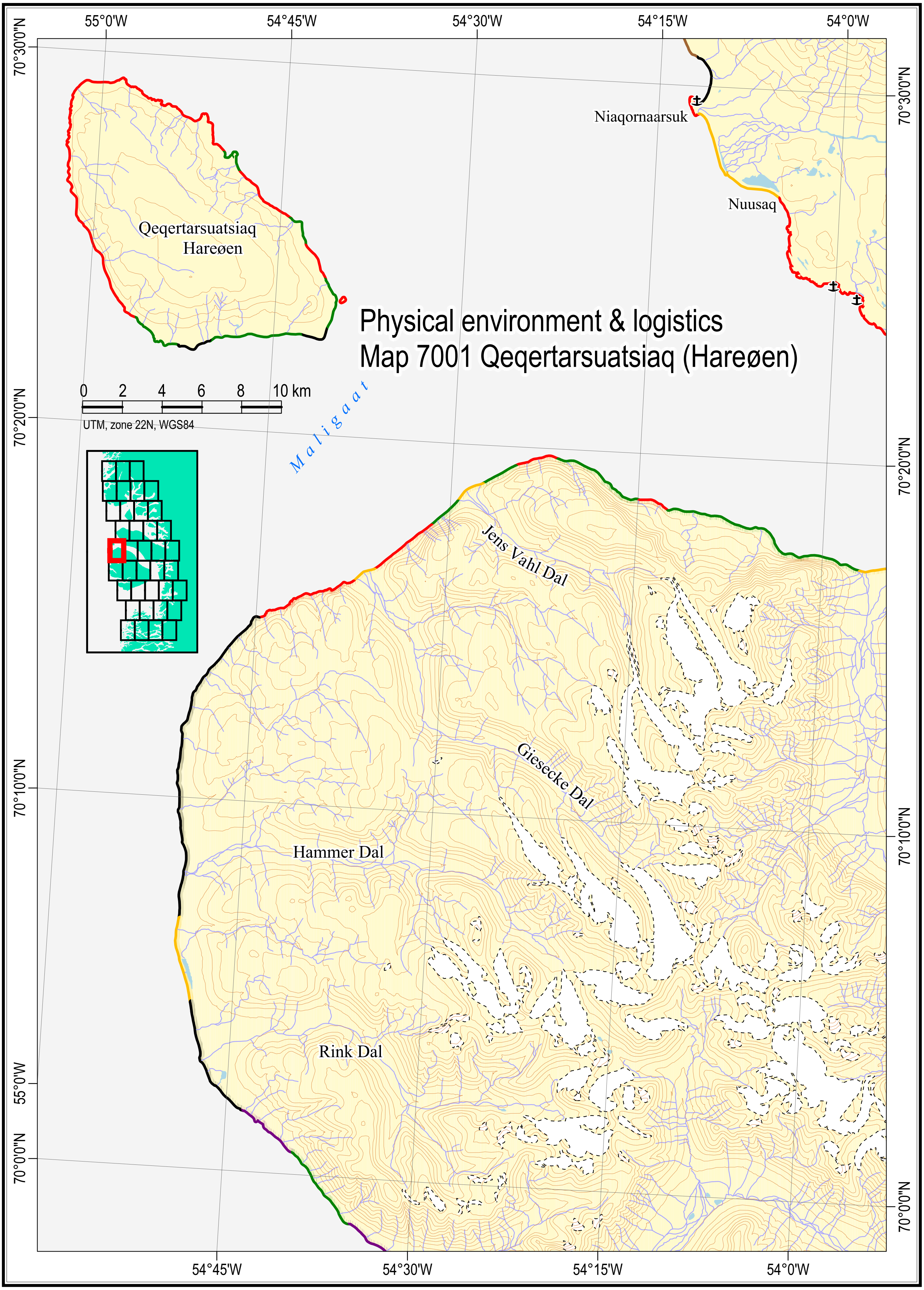
Danish Survey & Cadastre (KMS) topographical map: 70 V.1. Nautical charts: 1500, 1600.

Airphoto keymap

Map legend

Toggle maps

Keymaps

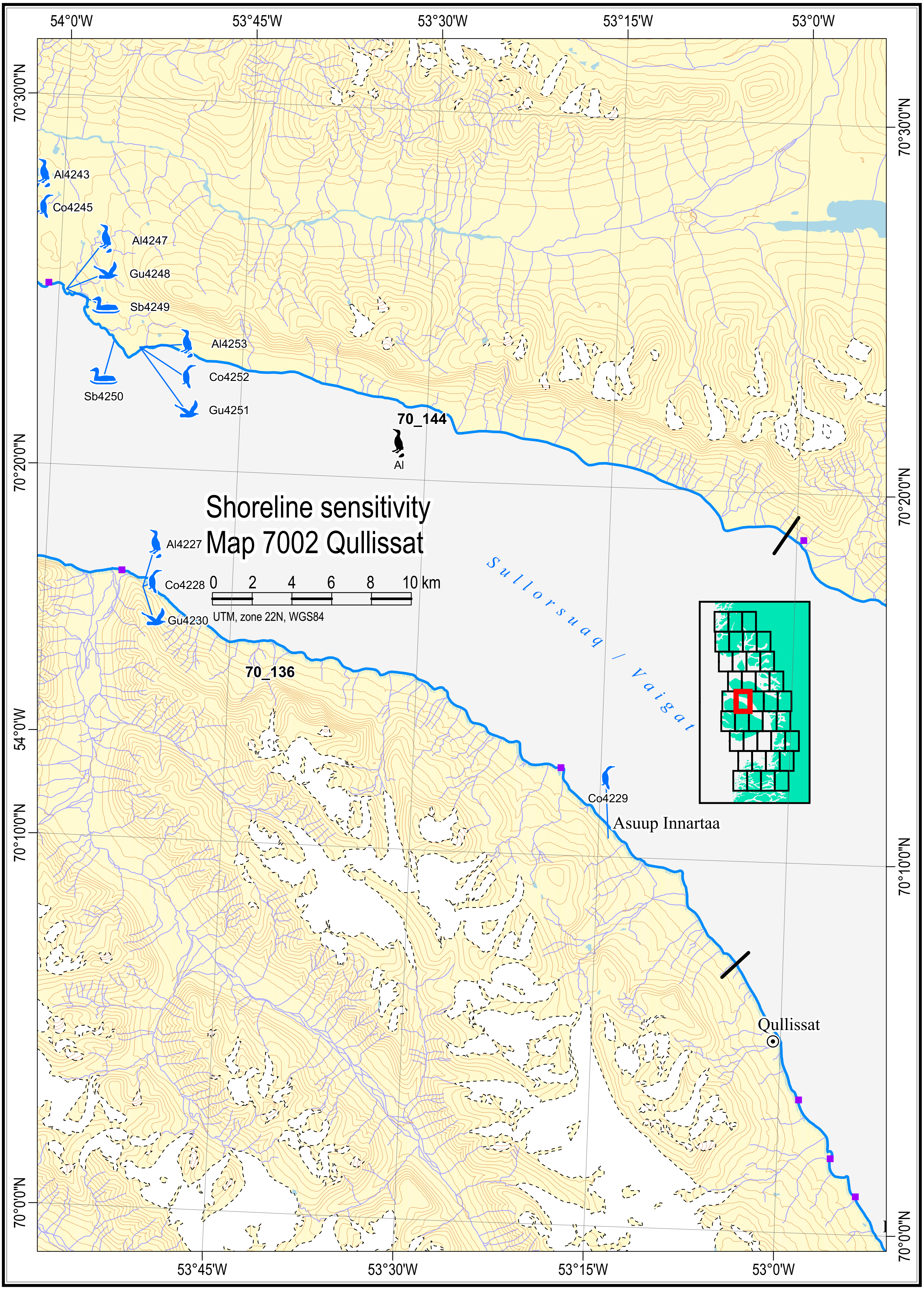


Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental description

Resource use

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

Species occurrence

Al70144	4 colonies with breeding razorbills and black guillemots

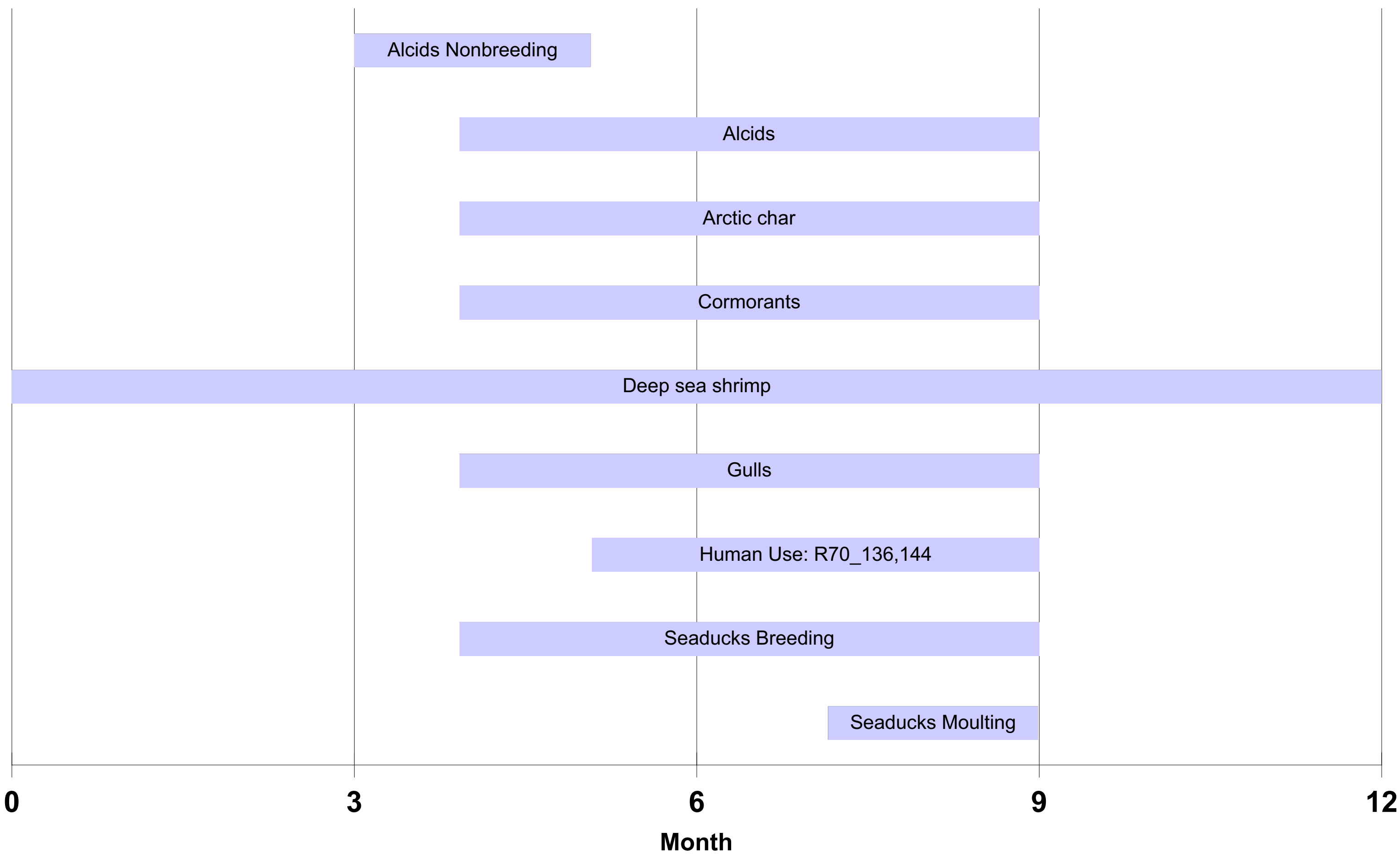
Site specific species occurrence (seabird breeding colonies); blue icons

Al4227	Breeding black guillemots.
Al4247	Breeding razorbills.
Al4253	Breeding black guillemots.
Co4228, Co4229	Breeding great cormorants.
Co4254	Breeding great cormorants.
Gu4230	Breeding kittiwakes and glaucous gulls.
Gu4248	Breeding glaucous gulls.
Gu4251	Breeding Iceland gulls.
Sb4249, Sb4250	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_136	17	Low
70_144	18	Low

Map 7002 Species and Resource Occurrences



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Access

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

The NW part of Vaigat is usually ice-bound from January to late April. The SE portion does not usually freeze over completely. In June, thousands of icebergs are released from inner fjords into Vaigat, drifting north then west at the north end of Disko Bay, rendering navigation difficult and safe anchorage almost impossible. Glacier ice frequently packs tightly against the coast.

In Vaigat, a weak N to NW current is found in the SE portion in early summer. The tidal stream sets to NW on the flood and to SE on the ebb.

Anchorage is available at Qullissat in depths of 20 m and close south of this abandoned settlement at the former coal mine in 6 m. Both locations are exposed to ice and untenable in strong winds.

Anchorage is noted on charts at Asuup Innartaa, but no other information is available.

Shorelines along the north shore of Vaigat are predominantly rock allowing little opportunity for marine access. Beach landings may be possible along the south shore of Vaigat but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The nearest airfields are at Qeqertarsuaq (map 6901) and Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 exposed nature of the coastline and the deep nearshore waters.

Shorelines shown on this map are exposed talus and rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations depending on the extent of oiling. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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 at Qullissat could be investigated for its suitability as a safe haven given its relatively low sensitivity, but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

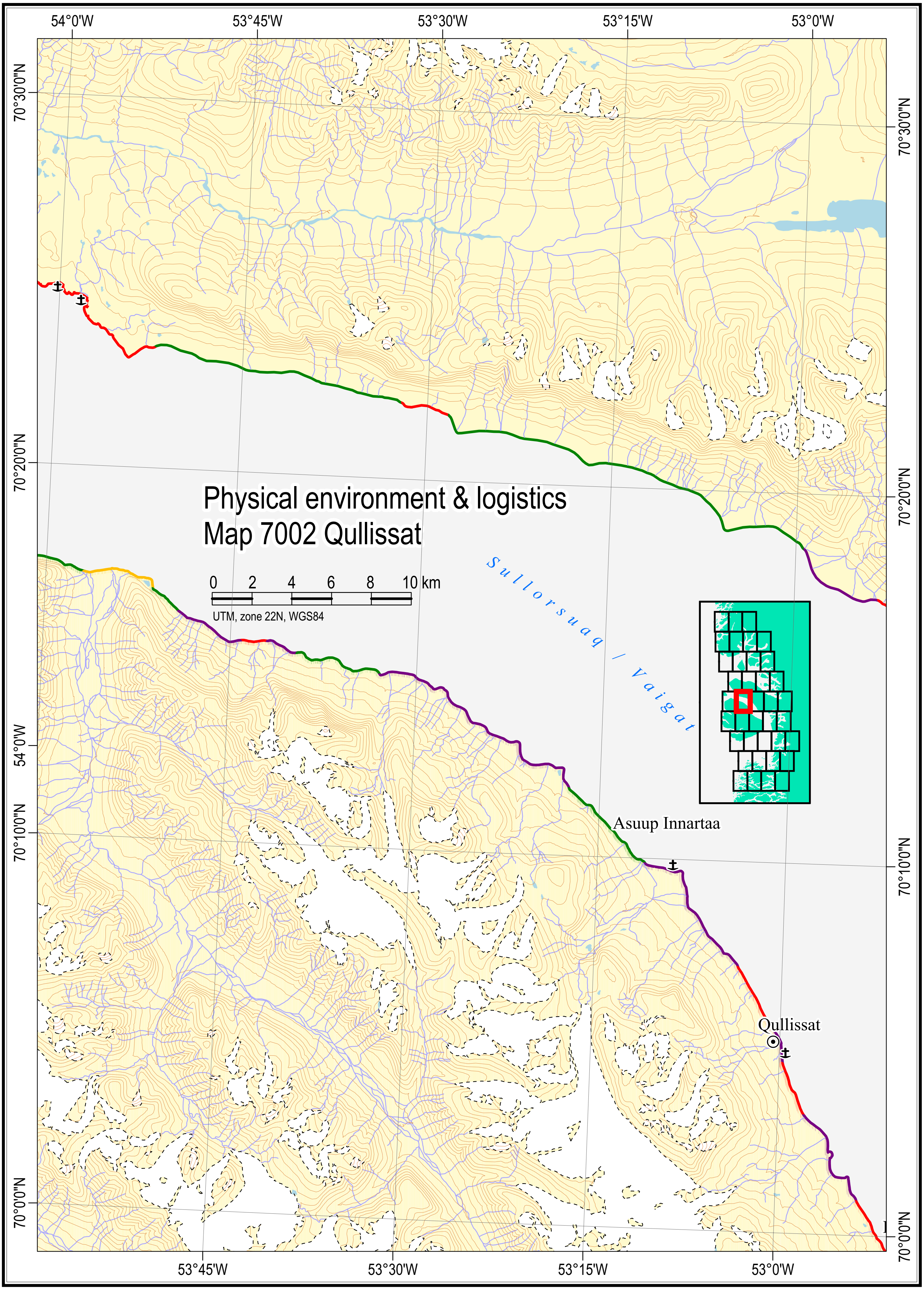
Danish Survey & Cadastre (KMS) topographical map: 70 V.1. Nautical charts: 1500, 1552, 1600.

Airphoto keymap

Map legend

Toggle maps

Keymaps

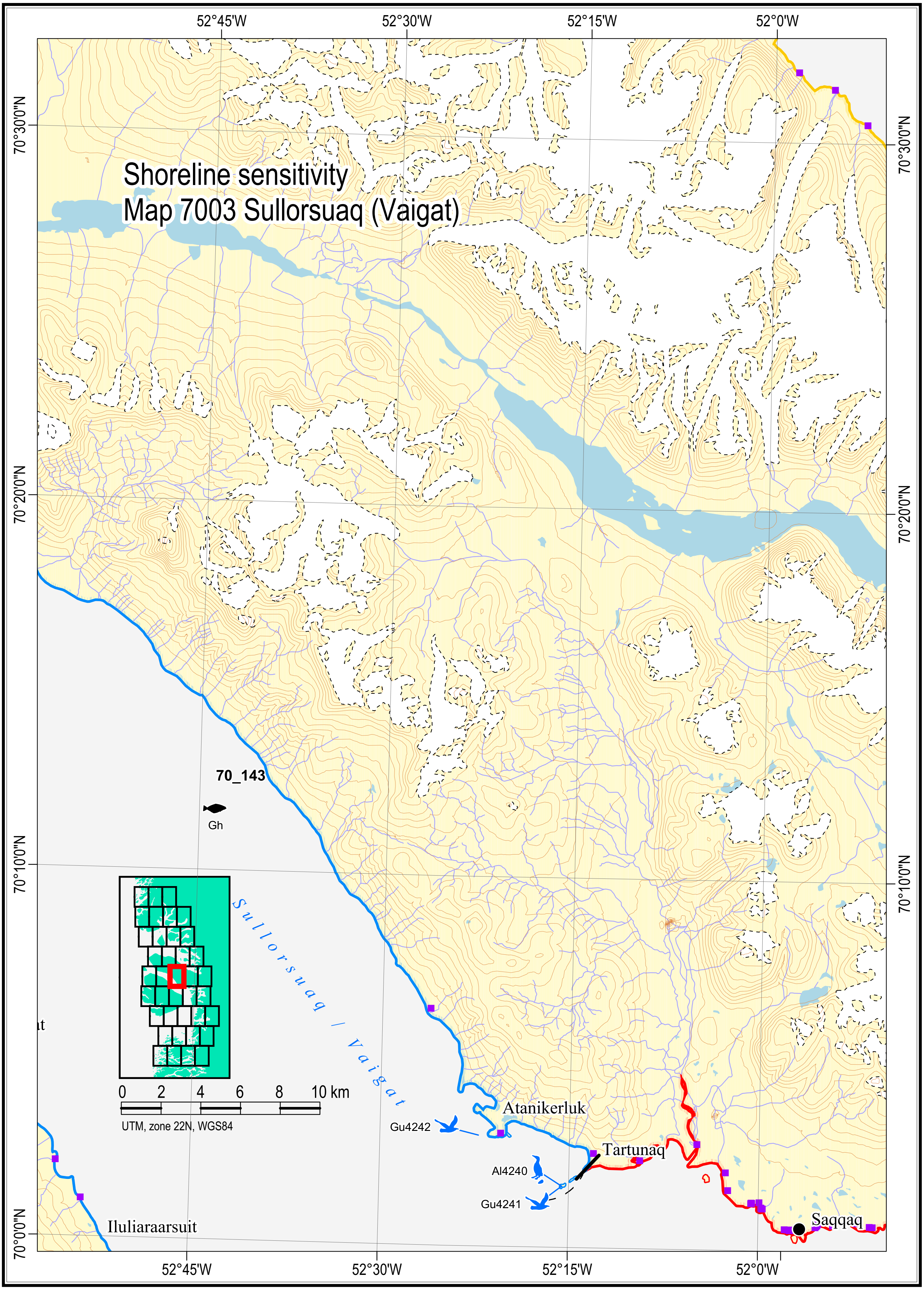


Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Environmental description

Resource use

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

Species occurrence

Gh70143	Important fishing area for Greenland halibut.

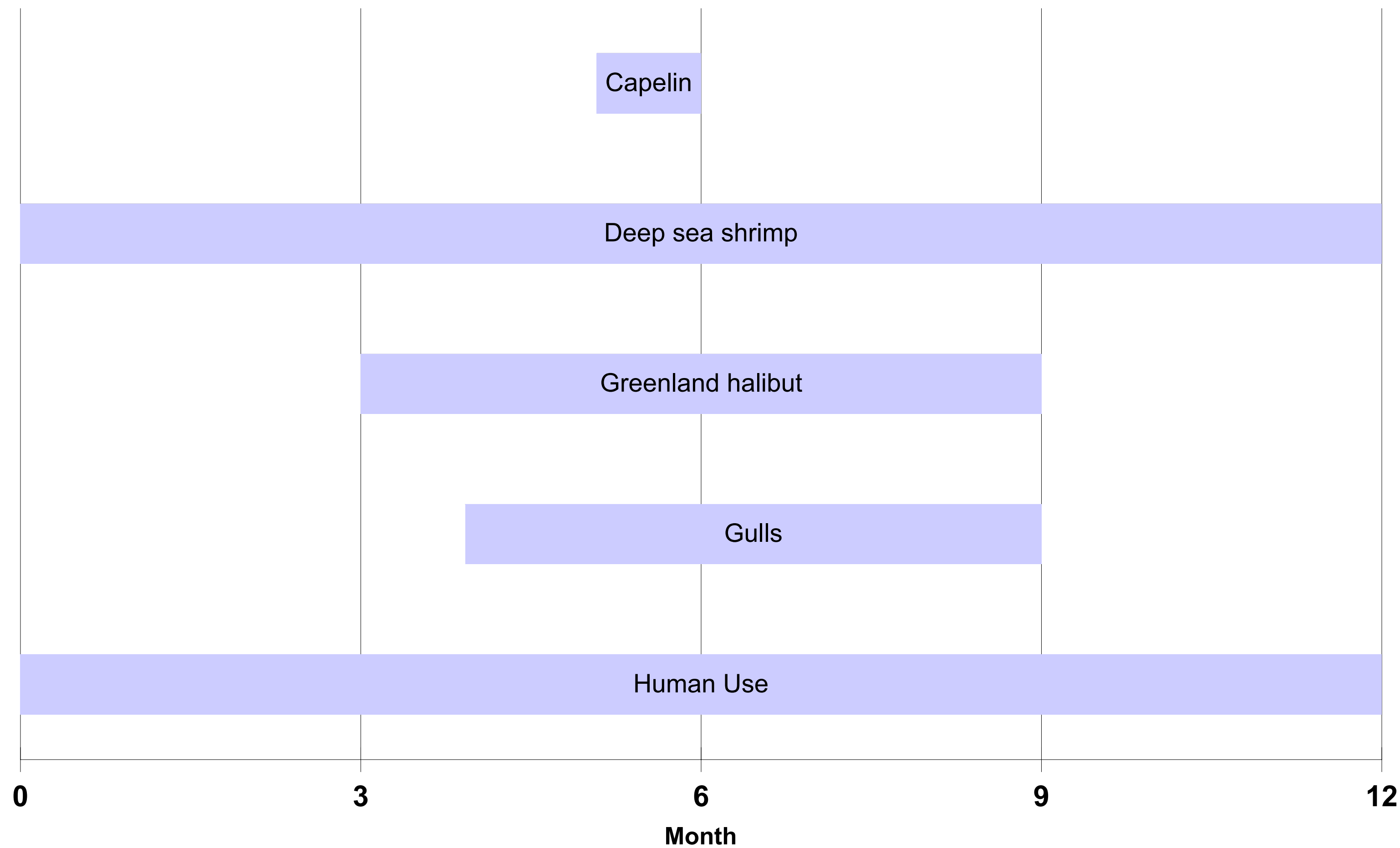
Site specific species occurrence (seabird breeding colonies); blue icons

Al4240	Breeding black guillemots.
Gu4241, Gu4242	Breeding Arctic terns.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_143	13	Low

Map 7003 Species and Resource Occurrences



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Access

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

The NW part of Vaigat is usually ice-bound from January to late April. The SE portion does not usually freeze over completely. In June, thousands of icebergs are released from inner fjords into Vaigat, drifting north then west at the north end of Disko Bay, rendering navigation difficult and safe anchorage almost impossible. Glacier ice frequently packs tightly against the coast.

In Vaigat, a weak N to NW current is found in the SE portion in early summer. The tidal stream sets to NW on the flood and to SE on the ebb.

There is no other information on tides for this area.

A good harbour for small crafts is available at the settlement Saqqaq in depths of 1 to 2 m. It is normally frozen from the end of December to early May. A small bay 5 km northwest of Saqqaq provides shelter from north winds.

Anchorage can be obtained off Tartunaq and in a cove close northeast of Atanikerluk in depths of 20 to 50 m. Ice may block both anchorages.

Shorelines along the north shore of Vaigat are predominantly rock allowing little opportunity for marine access. Beach landings may be possible along the south shore of Vaigat but would require reconnaissance to confirm.

There are no airports on this map. The nearest airports are at Qeqertarsuaq (map 6901) and Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 exposed nature of the coastline and the deep nearshore waters.

Consideration could be given to diversion booming to prevent oil from contaminating the sensitive areas in the vicinity of Saqqaq, but this will be complicated by the excessive length of boom required and the difficulty in anchoring in the deep nearshore waters.

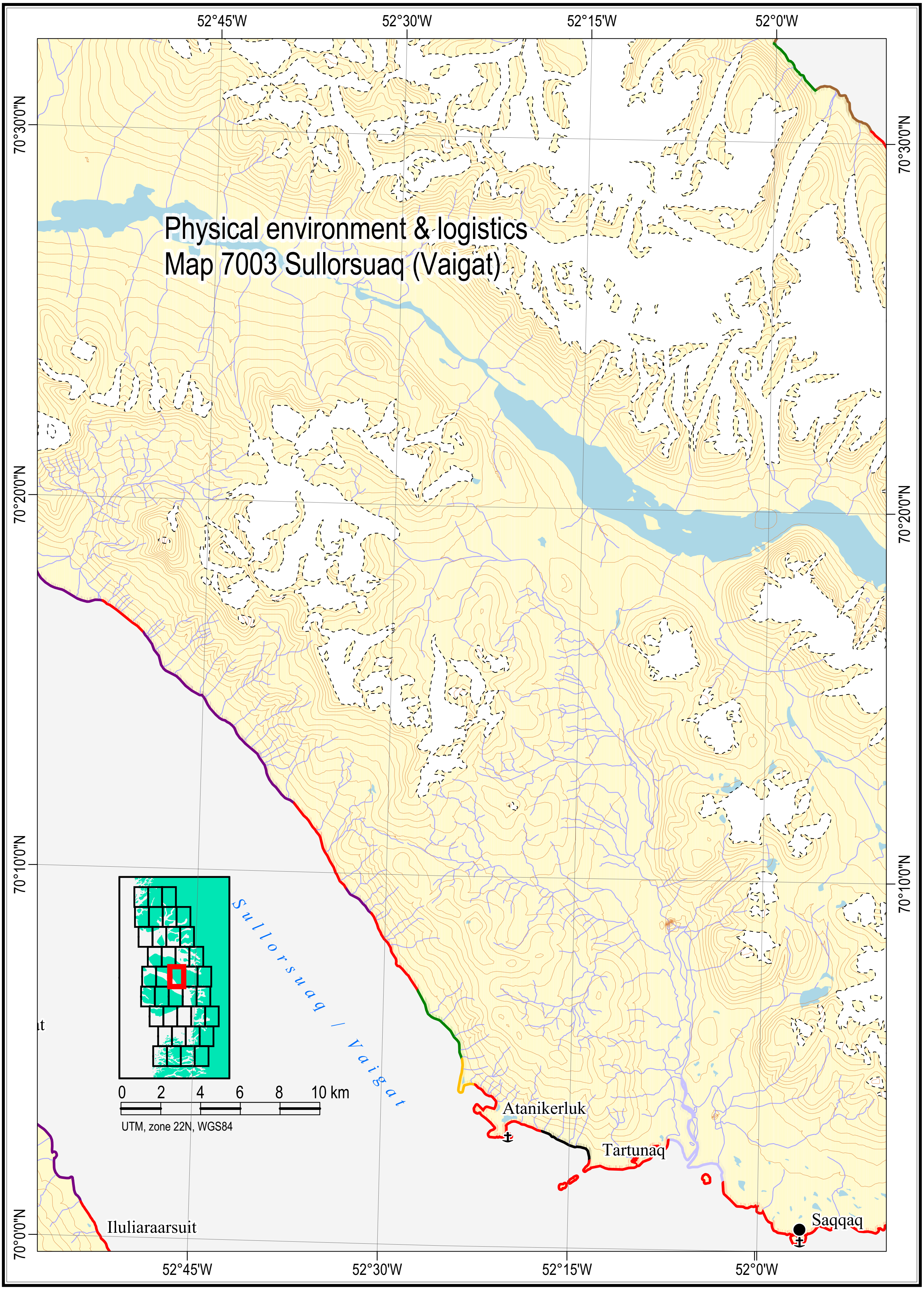
Shorelines shown on this map are predominantly exposed rock and alluvial fan, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations on the alluvial fan areas and on the few semi-protected areas northwest of Saqqaq. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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 at Tartunaq could be investigated for its suitability as a safe haven given its relatively low sensitivity, but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

Danish Survey & Cadastre (KMS) topographical map: 70 V.2. Nautical charts: 1500, 1552, 1600.

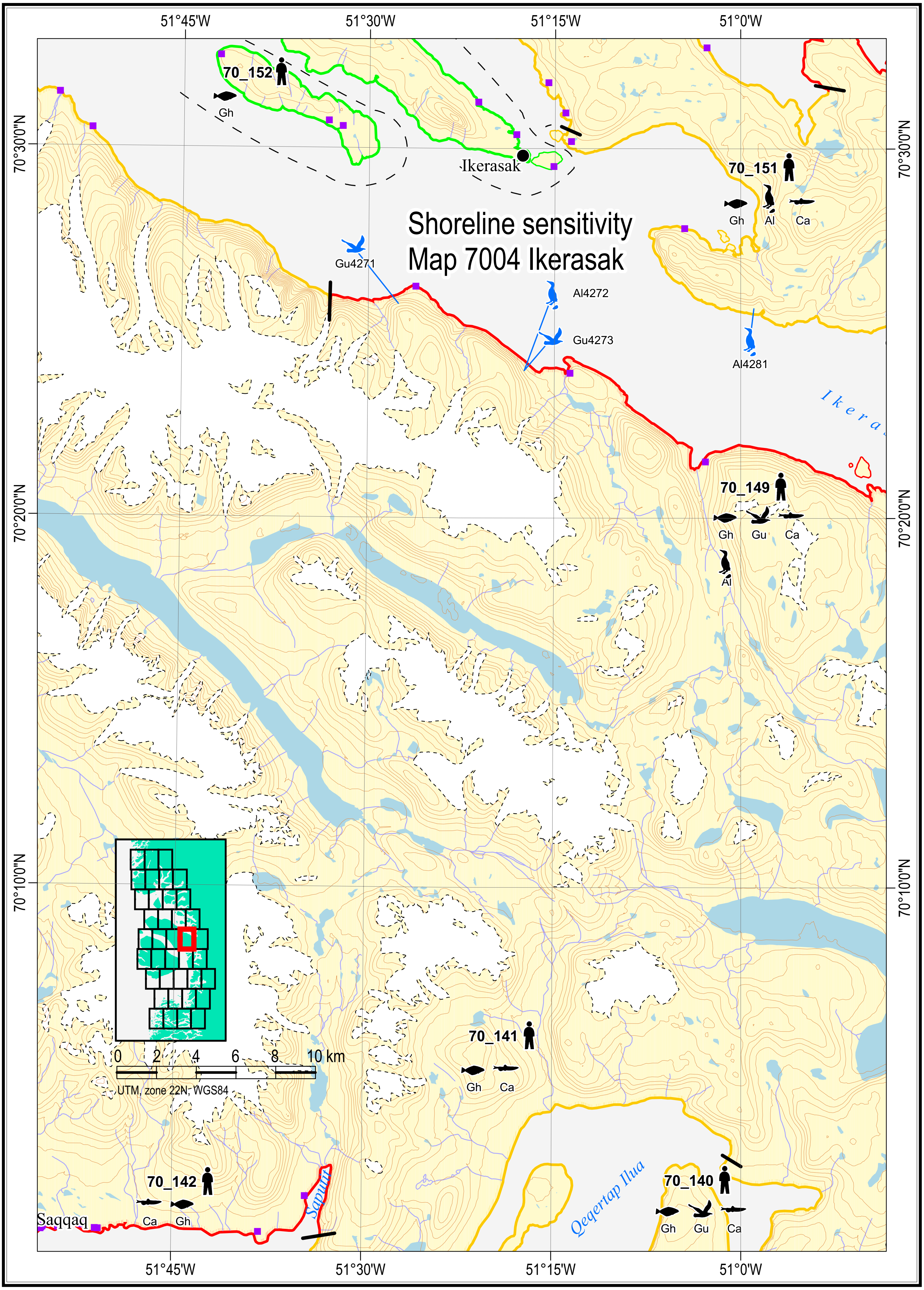

Physical environment & logistics
Map 7003 Sullorsuaq (Vaigat)
52°45'W
52°30'W
52°15'W
52°0'W
70°30'0"N
70°20'0"N
70°10'0"N
70°0'0"N
Sullorsuaq / Vaigat
Atanikerluk
Tartunaq
Saqqaq
Iluliaraarsuit
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Environmental description

Resource use

R 70_141	Fishery for capelin (important), Greenland halibut (important), redfish, wolffish and Arctic char at river outlet. Hunting for ringed seals on ice.
R 70_149	Fishery for Greenland halibut (important) and Arctic char at coast and at river outlet. Hunting for whelping ringed seals.
R 70_151	Fishery for capelin and Greenland halibut (important). Hunting for whelping ringed seals.

Species occurrence

Al70149	2 colonies with breeding black guillemots.
Al70151	1 colony with breeding black guillemots.
Ca70141	Important capelin fishing area in Qeqertap Ilua.
Ca70149	Capelin spawning areas along most parts of the coast.
Ca70151	Capelin spawning and important fishing areas.
Gh70141, Gh70149	Important fishing area for Greenland halibut.
Gh70151	Important fishing area for Greenland halibut.
Gu70149	3 colonies with breeding Iceland gulls, glaucous gulls and kittiwakes.

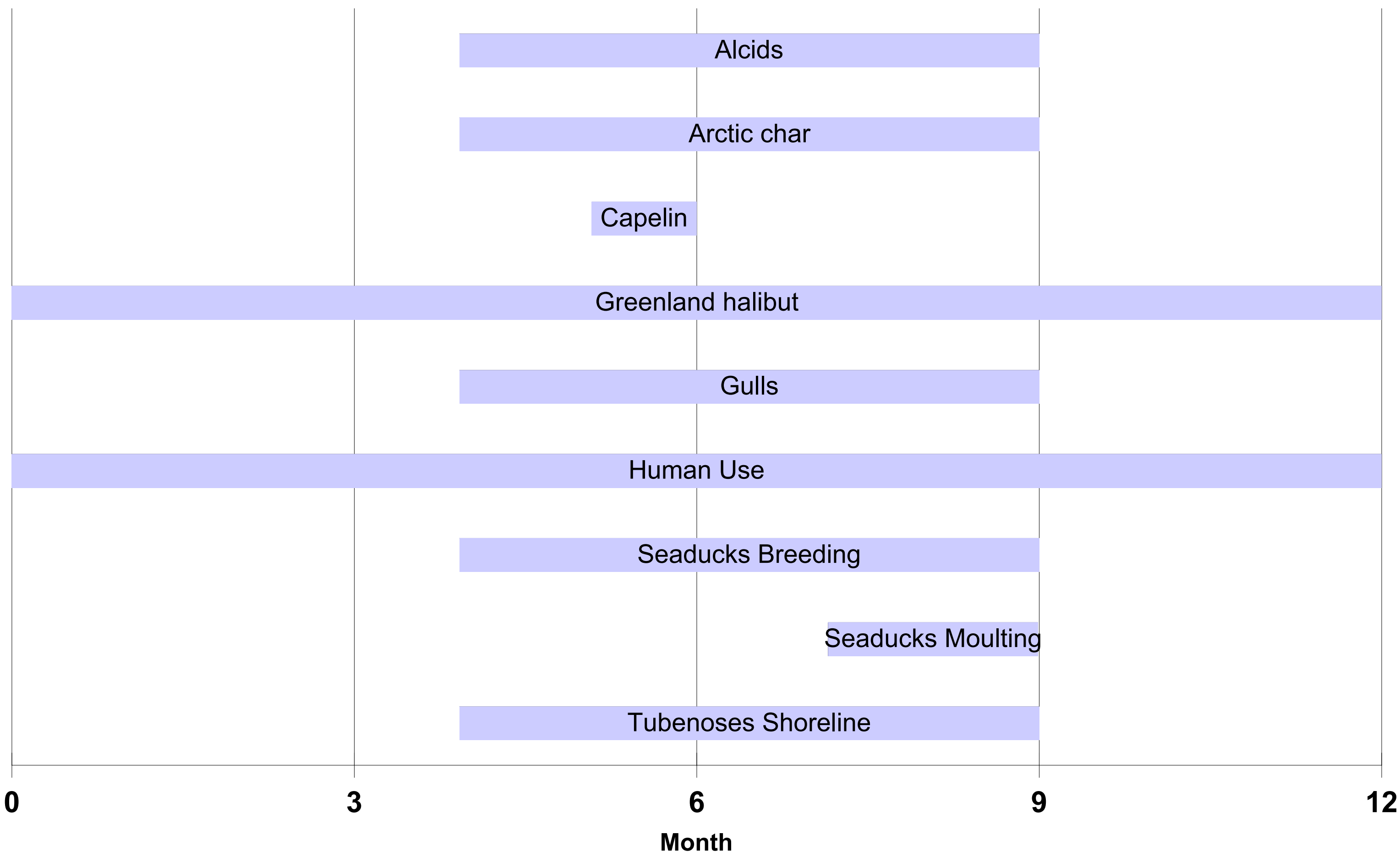
Site specific species occurrence (seabird breeding colonies); blue icons

Al4272, Al4281	Breeding black guillemots.
Gu4271	Breeding Iceland gulls or glaucous gulls.
Gu4273	Breeding kittiwakes, Iceland gulls or glaucous gulls.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_141	42	High
70_149	52	Extreme
70_151	38	High

Map 7004 Species and Resource Occurrences



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Access

Little information is available for the fjords in this area.

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

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents for this area.

Good anchorage is available at Ikerasak settlemen. Ringbolts are available for securing lines. Fresh water may be obtained from a spring near the settlement.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest airports are at Qaarsut (map 7052) and Ilulissat (map 6904).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in the shallow inshore waters which may exist in the area southeast of Ikerasak and in the inlets in Qeqertap Ilua. 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.

Exclusion booming could be attempted at the inlet marked Saputit (to the east of Saqqaq) using up to 1,000 m of boom, but depths and water currents are unknown.

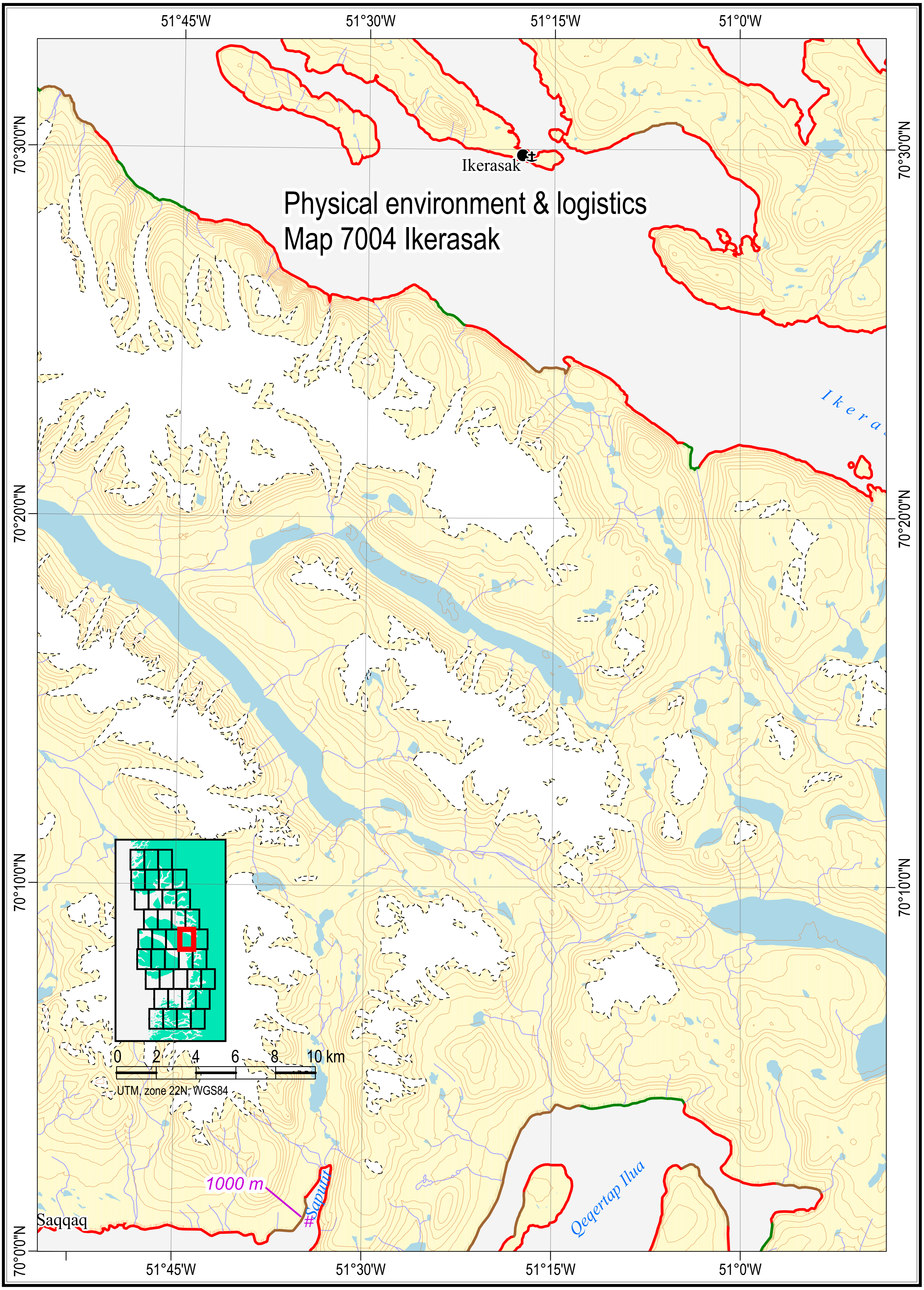
Shorelines shown on this map are predominantly exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of these areas are unknown,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

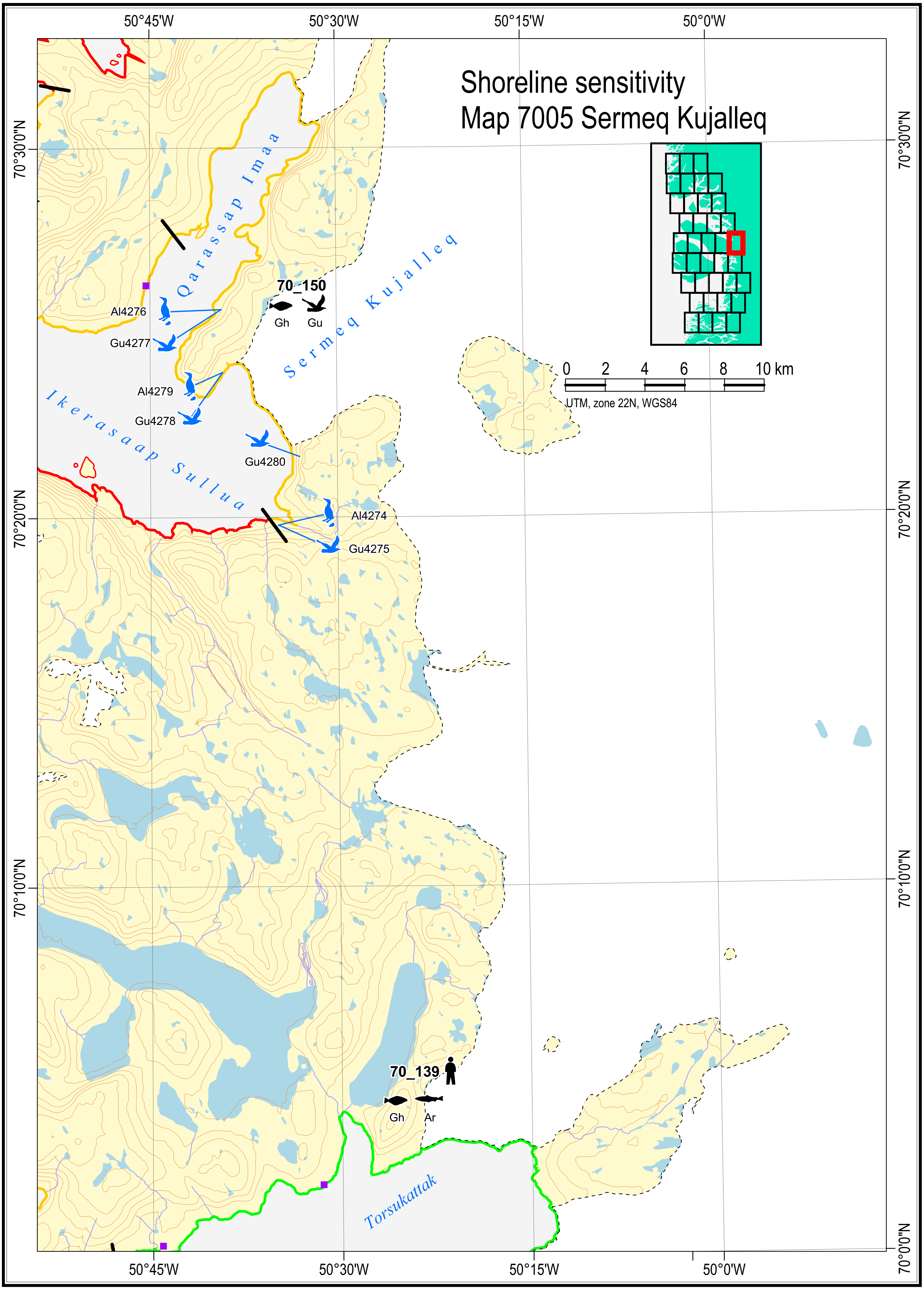
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 70 V.2. Nautical charts: 1600, 1610.


Physical environment & logistics
Map 7004 Ikerasak
Ikerasak
Saqqaq
Qeqertap Ilua
Saputit
1000 m
51°45'W
51°30'W
51°15'W
51°0'W
70°30'0"N
70°20'0"N
70°10'0"N
70°0'0"N
0
2
4
6
8
10 km
UTM, zone 22N, WGS84


Shoreline sensitivity
Map 7005 Sermeq Kujalleq
50°45'W
50°30'W
50°15'W
50°0'W
70°30'0"N
70°20'0"N
70°10'0"N
70°0'0"N
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
Qarassap Imaa
Sermeq Kujalleq
Ikerasaap Sullua
Torsukattak
70_150
Gh
Gu
Al4276
Gu4277
Al4279
Gu4278
Gu4280
Al4274
Gu4275
70_139
Gh
Ar

Environmental description

Resource use

R 70_139	Fishery for Greenland halibut (important), redfish, wolffish and Arctic char along coast and at 2 river outlets (important). Hunting for ringed seals on ice (important).

Species occurrence

Ar70139	2 important rivers and important coastal fishing area for Arctic char.
Gh70139, Gh70150	Important fishing area for Greenland halibut.
Gu70150	3 colonies with breeding Iceland gulls, glaucous gulls and kittiwakes.

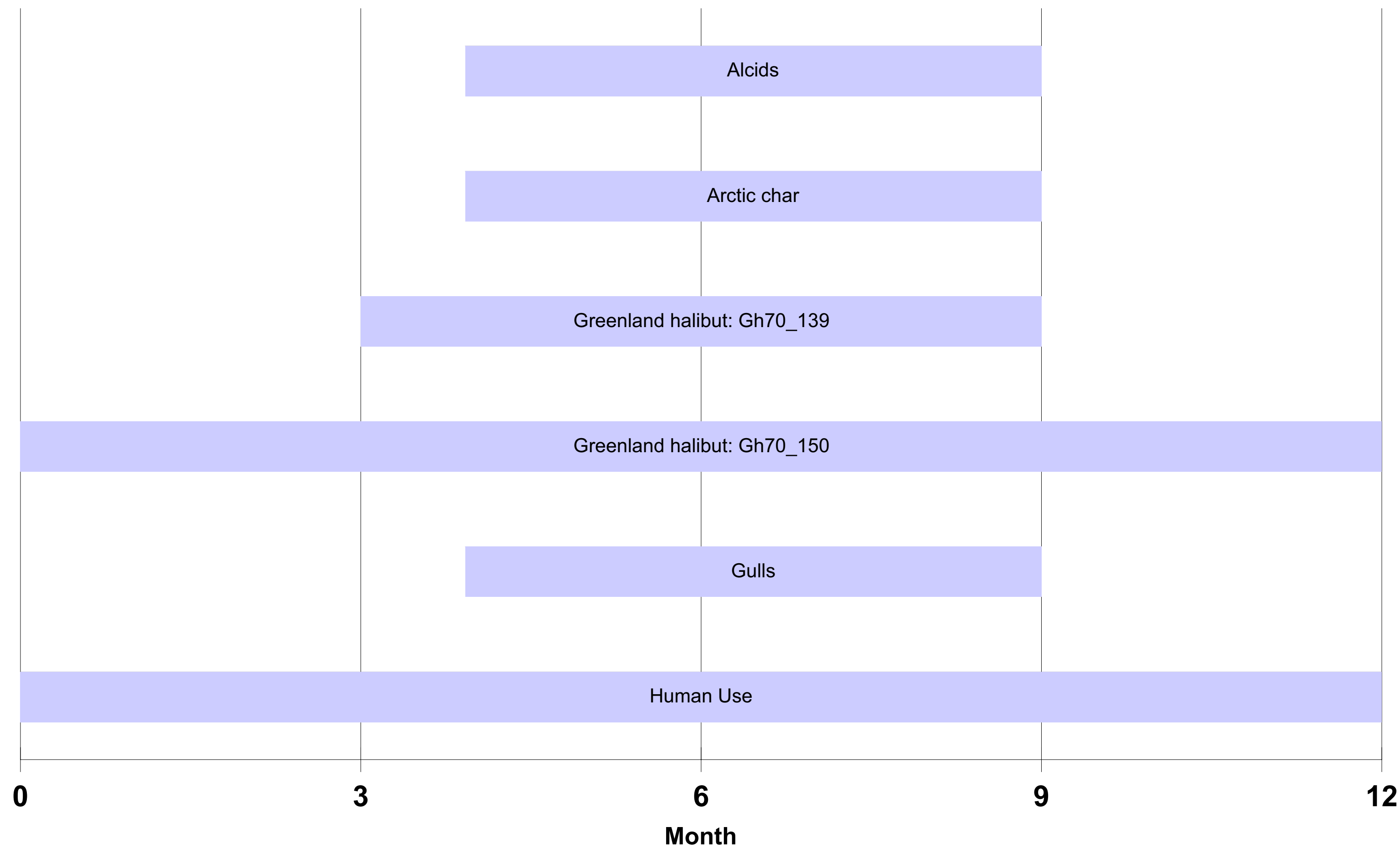
Site specific species occurrence (seabird breeding colonies); blue icons

Al4274	Breeding black guillemots.
Al4276, Al4279	Breeding black guillemots.
Gu4275, Gu4277	Breeding kittiwakes, Iceland gulls or glaucous gulls.
Gu4278, Gu4280	Breeding Iceland gulls or glaucous gulls.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_139	26	Moderate
70_150	33	High

Map 7005 Species and Resource Occurrences



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Access

Little information is available for the fjords in this area.

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

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents for this area.

No anchorages are reported for this map area.

Shorelines in this area are rock or glacier, which means that beach landing is unlikely. There is no information to indicate the potential for beach landings.

There are no airports on this map. The nearest heliport is at Qeqertarsuaq (map 6901) and the nearest airport is at Ilulissat (map 6904) and Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in the shallow inshore waters that may exist in the two fjords shown 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.

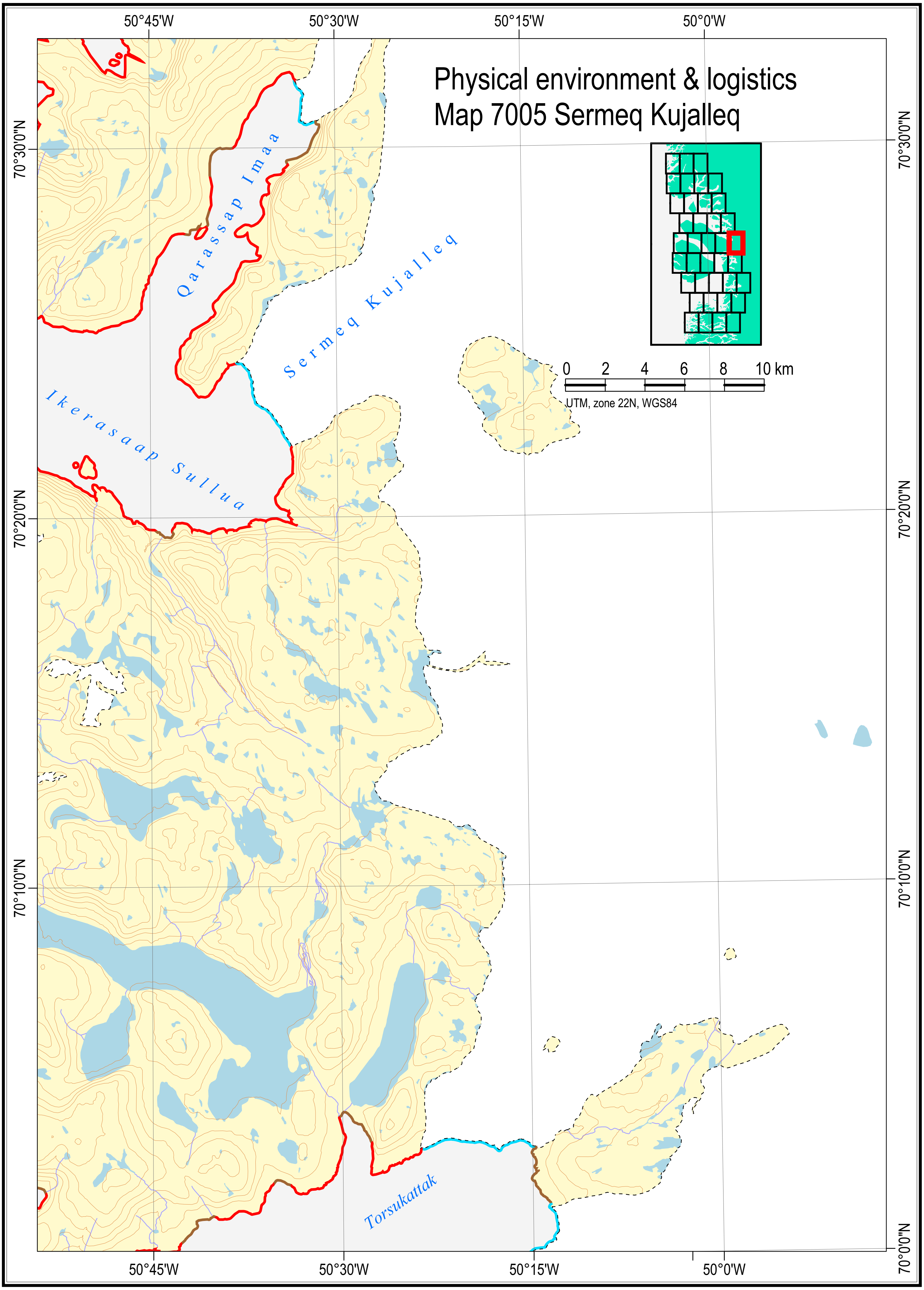
Shorelines shown on this map are predominantly semi-exposed rock and glacier, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords. Access and trafficability of these areas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

Safe havens

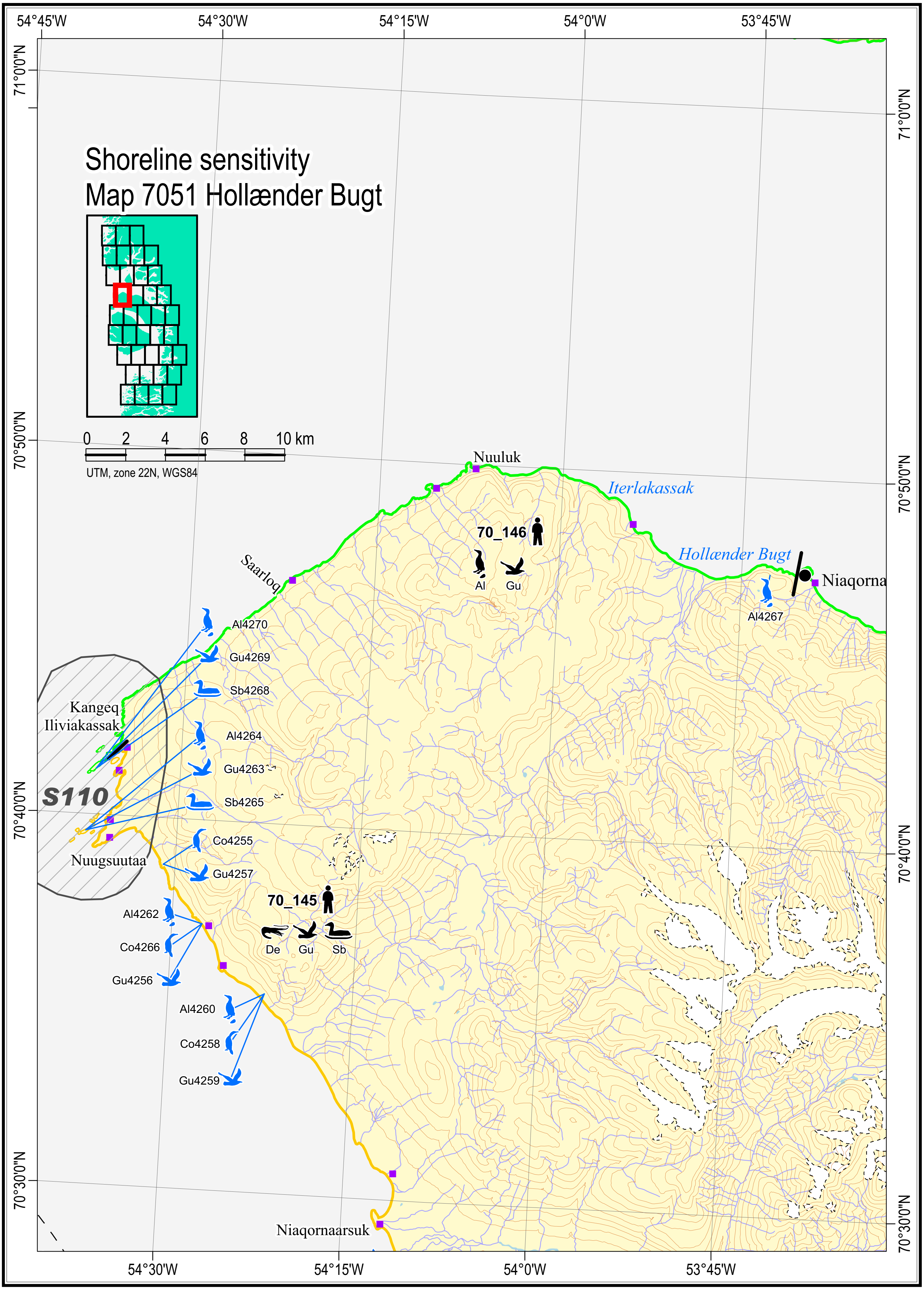
There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 70 V.2. Nautical charts: none.


Physical environment & logistics
Map 7005 Sermeq Kujalleq
50°45'W
50°30'W
50°15'W
50°0'W
70°30'0"N
70°20'0"N
70°10'0"N
70°0'0"N
Qarassap Imaa
Sermeq Kujalleq
Ikerasaap Sullua
Torsukattak
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap
Map legend
Toggle maps
Keymaps



Environmental description

Resource use

R 70_145	Fishery for lumpsucker and Arctic char along coast and at river outlet. Hunting for eiders and gulls (**S110**).
R 70_146	Fishery for Atlantic halibut, capelin, lumpsucker, Greenland halibut, redfish and wolffish.

Species occurrence

Al70146	2 colonies with breeding black guillemots (**S110**).
De70145	Important fishing area for deep sea shrimps.
Gu70145	2 colonies with breeding Arctic terns and 3 with glaucous gulls (**S110**).
Gu70146	1 colony with breeding Arctic terns (**S110**).
Sb70145	1 colony with breeding common eiders (**S110**).

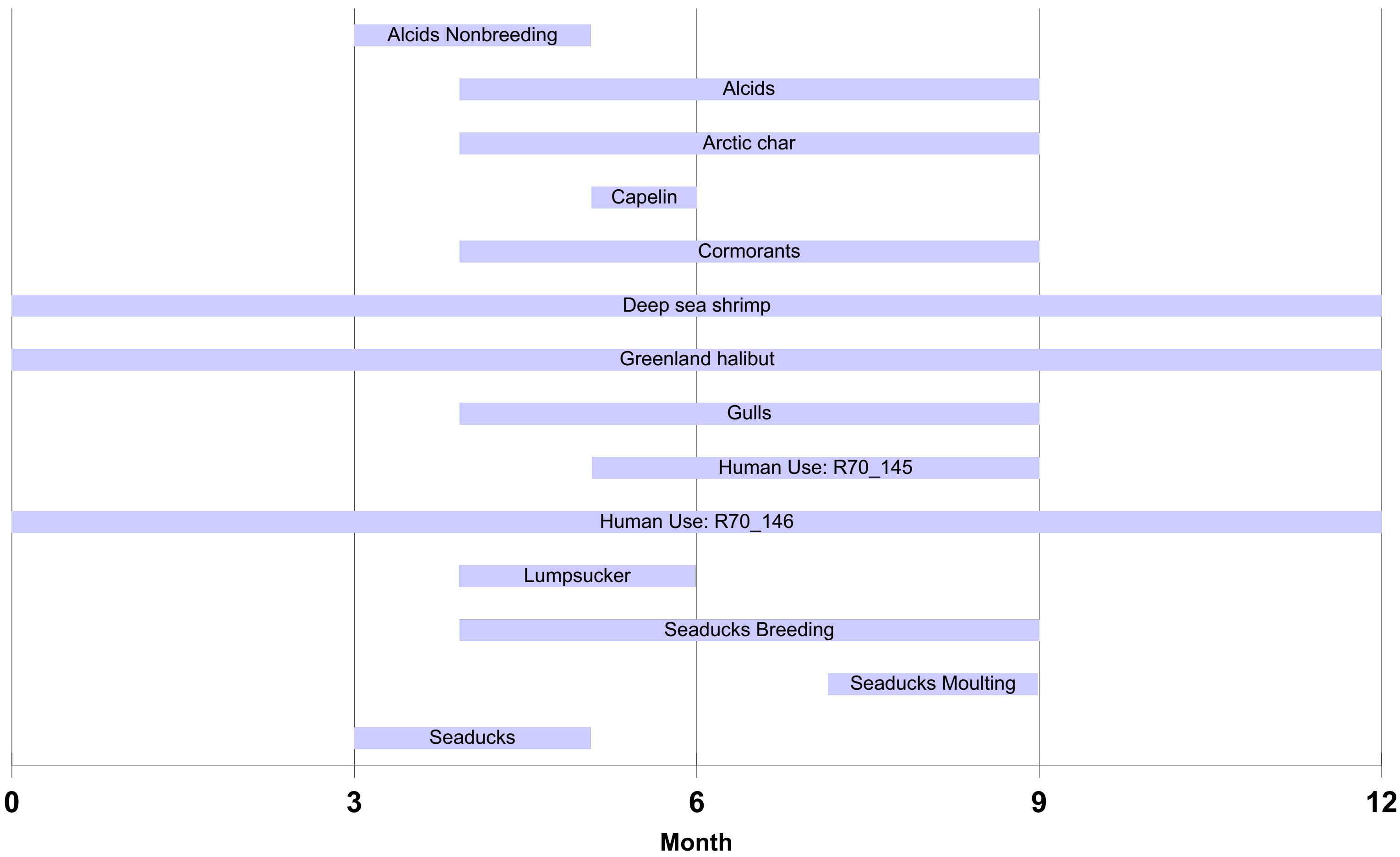
Site specific species occurrence (seabird breeding colonies); blue icons

Al4260, Al4262	Breeding black guillemots.
Al4264, Al4270	Breeding black guillemots.
Al4267	Breeding black guillemots and Atlantic puffins.
Co4255, Co4258	Breeding great cormorants.
Co4266	Breeding great cormorants.
Gu4256, Gu4257	Breeding glaucous gulls.
Gu4259	Breeding glaucous gulls.
Gu4263	Breeding Arctic terns.
Gu4269	Breeding Arctic terns.
Sb4265, Sb4268	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_145	39	High
70_146	32	Moderate

Map 7051 Species and Resource Occurrences



Physical environment and logistics

Map 7051 - Hollænder Bugt

Access

The nearshore waters in this area are largely uncharted and caution should be exercised. In general the waters offshore and nearshore are deep, however, uncharted dangers may exist. Local knowledge is essential for navigation. Between Nuussuutaa and Kangeq the coast is fronted by numerous islets and rocks.

In average years This area is ice-bound from December to June. Break-up 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 August.

Access

(Continued from previous page)
The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.

There is no other information on tides or currents within fjords for this area.

A harbour (depths of 12 to 22 m) suitable for small vessels is available north of Nuussuutaa at the site of an abandoned settlement. It is open to the west but provides shelter from north winds. Shelter from all winds can be found 1 km north. Fresh water can be found from a spring in the vicinity of the old trading station. Ice normally affects the harbour only in May and June.

Small vessels can find anchorage with limited protection in the cove 2.5 km SW of Nuuluk.

Anchorage is available at a small settlement at Niaqornat in 35 m off a cove on the west side with ringbolts for securing lines and deep water close to shore. In NW winds the cove fills with ice and large icebergs may enter. Drinking water is available from a spring in the vicinity.

Anchorage is indicated on the charts at Niaqornaarsuk, but no other information on it is available.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. The possibility of beach landings could be explored close by the several river mouths but would require reconnaissance to confirm.

There are no airports on this map. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist north of Nuussuutaa. 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 the highly exposed shoreline areas in this map, including the selected area shown.

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.

Exclusion booming to prevent oil from entering the selected area north of Nuussuutaa is not likely to be successful due to the highly exposed nature of the coast and the deep waters nearshore.

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

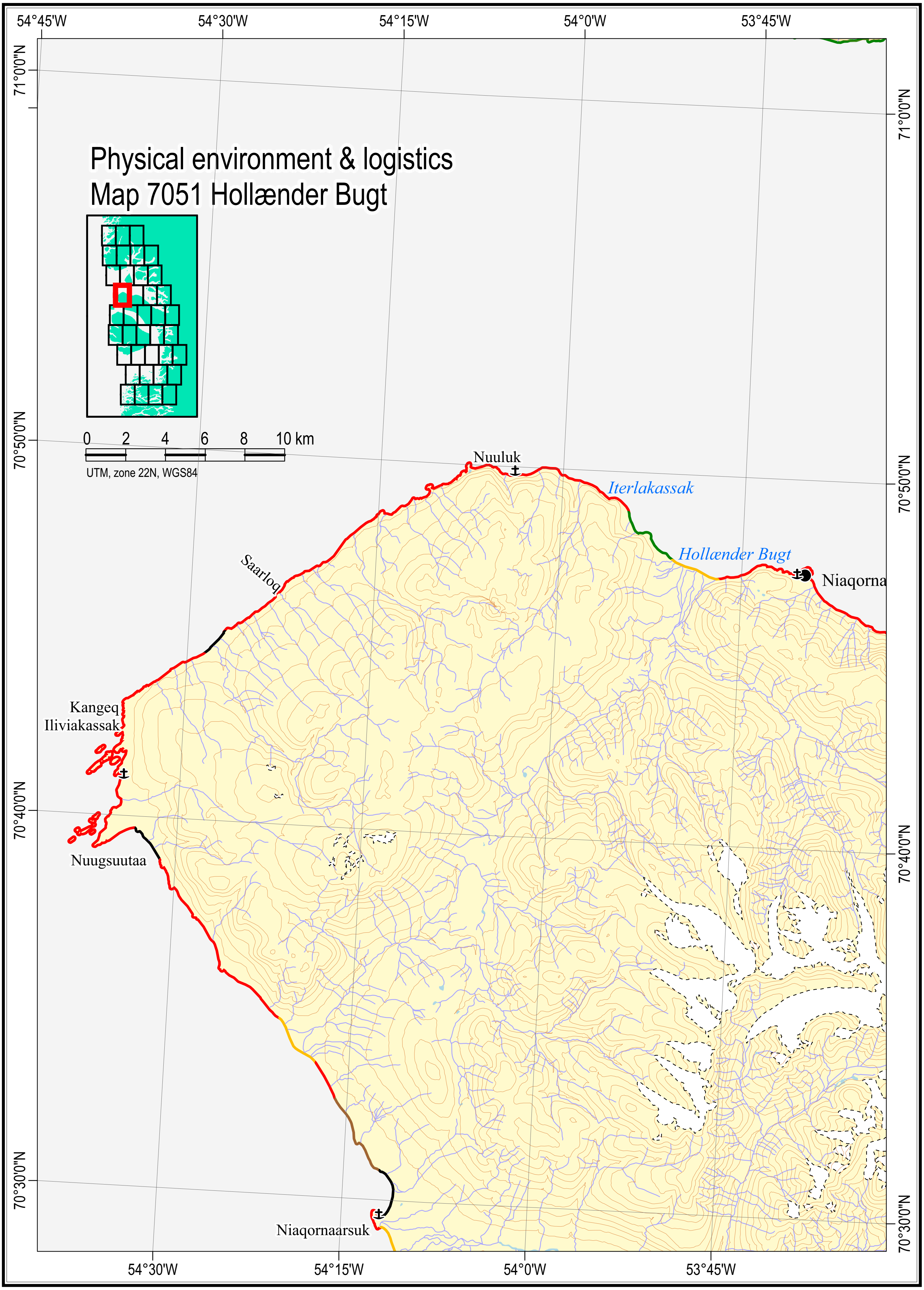
There are sections of the coast designated as beaches south of Nuussuutaa and in Hollænder Bugt. If oiled, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, nearshore depths, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

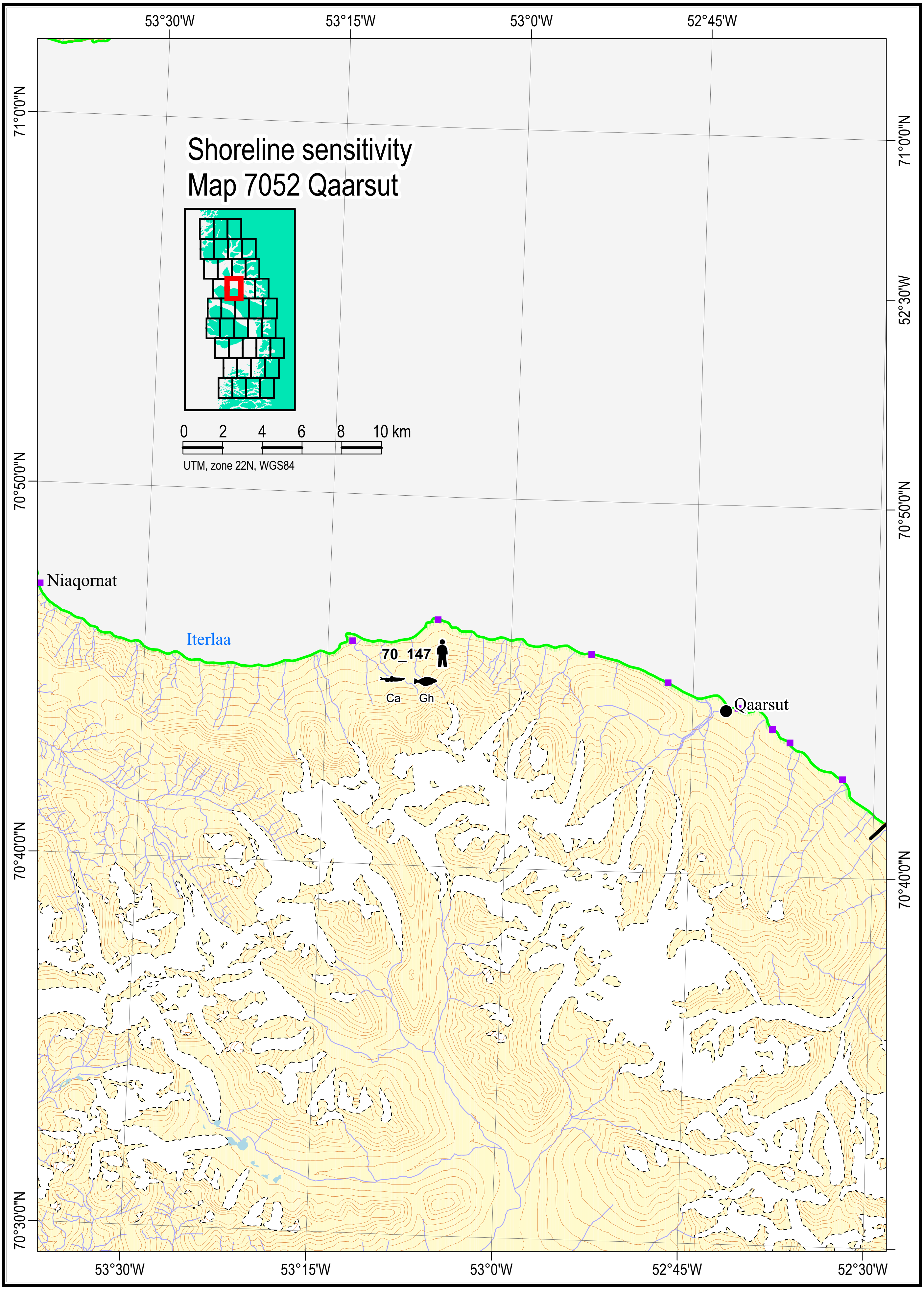
Safe havens

There are no potential safe havens identified on this map. The anchorage at Niaqornat could be investigated for its suitability as a safe haven given its relatively low sensitivity rating, but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

Danish Survey & Cadastre (KMS) topographical map: 70 V.1. Nautical chart: 1600.


54°45'W
54°30'W
54°15'W
54°0'W
53°45'W
71°0'0"N
70°50'0"N
70°40'0"N
70°30'0"N
Physical environment & logistics
Map 7051 Hollænder Bugt
0
2
4
6
8
10 km
UTM, zone 22N, WGS84
Nuuluk
Iterlakassak
Hollænder Bugt
Niaqorna
Saarloq
Kangeq
Iliviakassak
Nuugsuutaa
Niaqornaarsuk


53°30'W
53°15'W
53°0'W
52°45'W
71°0'0"N
70°50'0"N
70°40'0"N
70°30'0"N
52°30'W
Shoreline sensitivity
Map 7052 Qaarsut
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
Niaqornat
Iterlaa
70_147
Ca
Gh
Qaarsut

Environmental description

Resource use

R 70_147 Fishery for Atlantic halibut, capelin, Greenland halibut (important), redfish, wolffish and Arctic char at coast.

Species occurrence

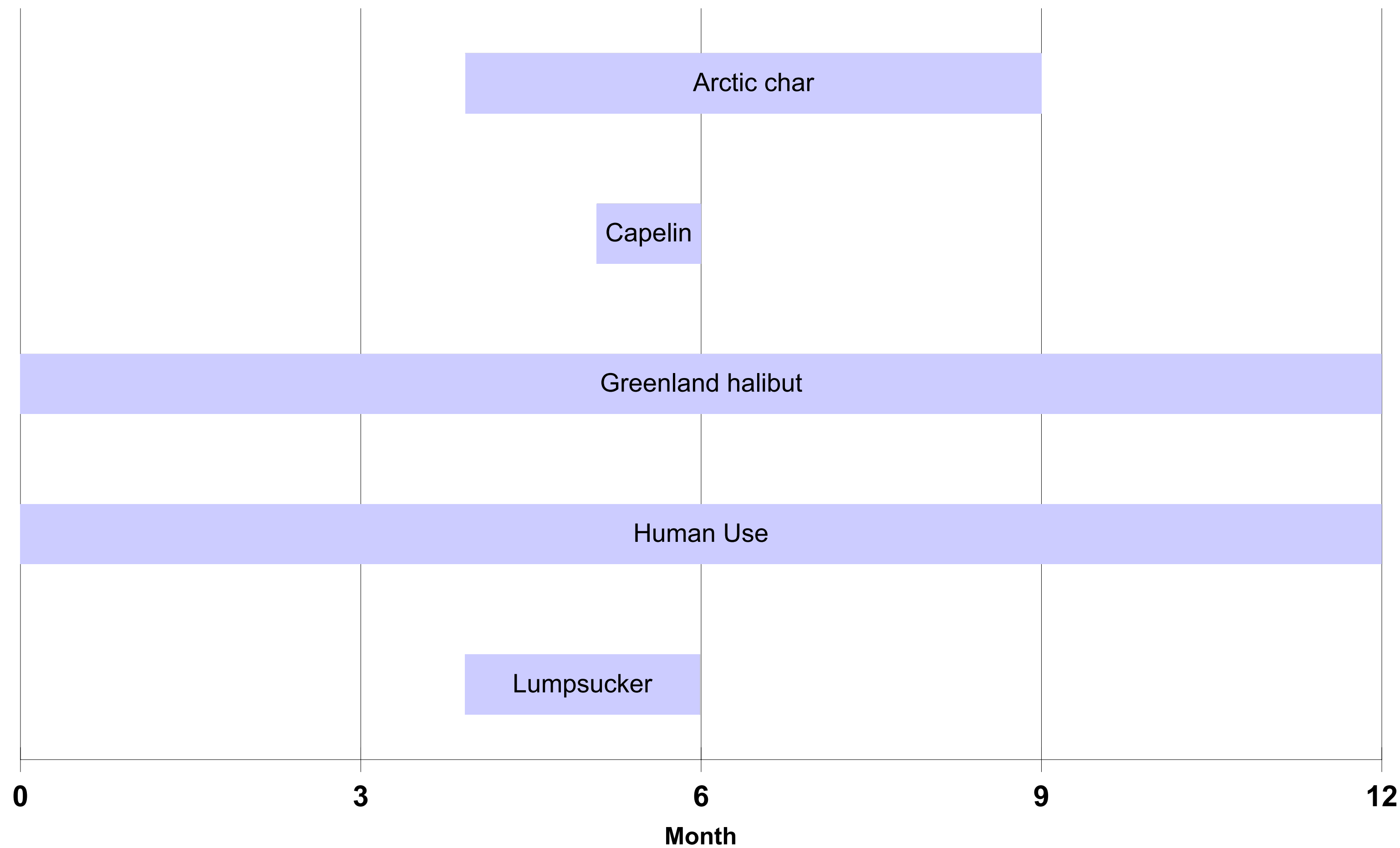
Ca70147 Capelin spawning and important fishing areas throughout the coast.

Gh70147 Important fishing area for Greenland halibut.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_147	33	Moderate

Map 7052 Species and Resource Occurrences



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Access

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

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation.

There is no information on tides or currents within fjords for this area.

Anchorage is available at a small settlement at Niaqornat in 35 m off a cove on the west side with ringbolts for securing lines and deep water close to shore. In NW winds the cove fills with ice, and large icebergs may enter. Drinking water is available from a spring in the vicinity.

Anchorage with good holding may be found at the trading station of Qaarsut. It offers no shelter from the east and only partial protection from the west.

Shorelines in this area are predominantly rock allowing little opportunity for marine access. The possibility of beach landings could be explored close by the several river mouths but would require reconnaissance to confirm.

An all-season, gravel-surface airport (900 x 30 m) is available at Qaarsut with IFR and VFR traffic capability.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas.

Offshore countermeasures represent the only practical method of protecting the highly exposed shoreline areas in this map.

There are no opportunities for exclusion booming in the area shown on this map due to its highly exposed nature and the deep nearshore waters.

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

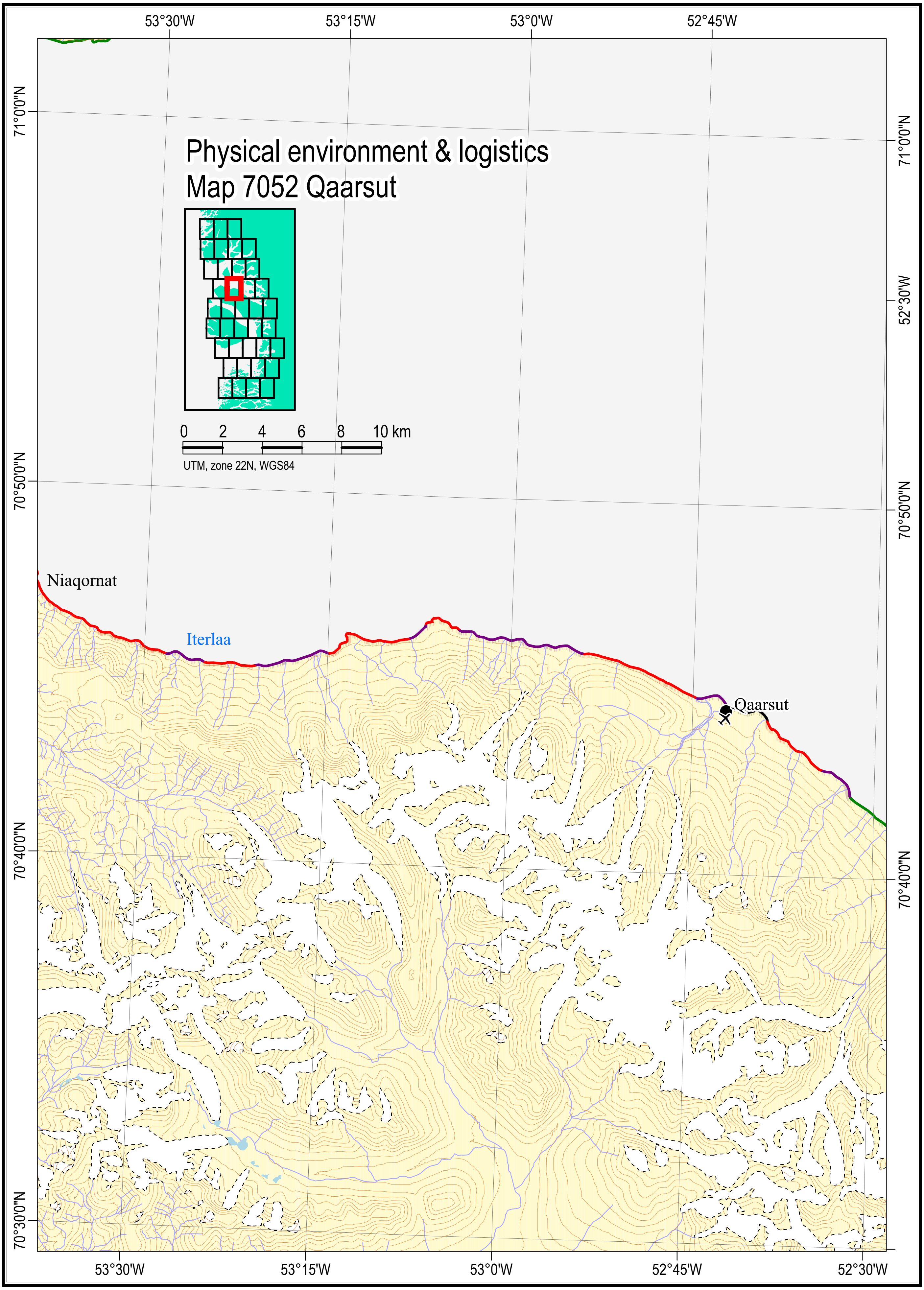
Safe havens

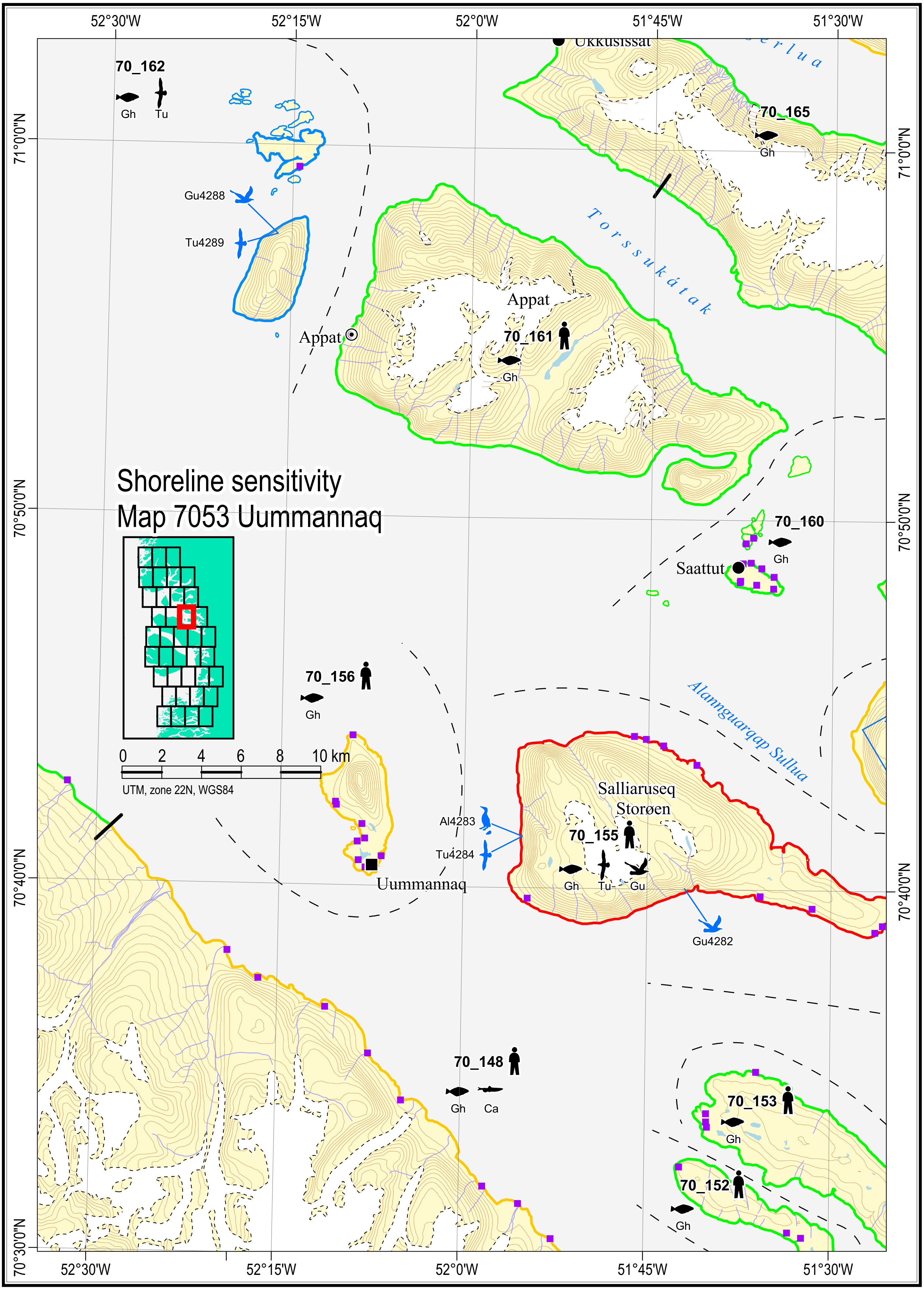
There are no potential safe havens identified on this map. The anchorage at Qaarsut could be investigated for its suitability as a safe haven but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

Danish Survey & Cadastre (KMS) topographical maps: 70 V.1, 70 V.2. Nautical chart: 1600.

Physical environment & logistics
Map 7052 Qaarsut




52°30'W
52°15'W
52°0'W
51°45'W
51°30'W
71°0'0"N
70°50'0"N
70°40'0"N
70°30'0"N
Ukkusissat
Torssukátak
70_162
Gh
Tu
70_165
Gh
Gu4288
Tu4289
Appat
Appat
70_161
Gh
Shoreline sensitivity
Map 7053 Uummannaq
70_160
Gh
Saattut
70_156
Gh
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
Alanngurarqap Sullua
Salliaruseq
Storøen
Al4283
Tu4284
70_155
Gh
Tu
Gu
Uummannaq
Gu4282
70_148
Gh
Ca
70_153
Gh
70_152
Gh

Environmental description

Resource use

R 70_148	Fishery for Atlantic halibut, capelin, Greenland halibut (important), redfish, wolffish and Arctic char at coast.
R 70_152	Fishery for Greenland halibut (important).
R 70_153	Fishery for capelin, Greenland halibut (important) and wolffish.
R 70_155	Fishery for Atlantic halibut, Greenland halibut (important) and redfish.
R 70_156	Fishery for Greenland halibut (important) and wolffish. Hunting for minke and fin whales.
R 70_161	Fishery for capelin, Greenland halibut (important) and wolffish.

Species occurrence

Ca70148	Spawning and important fishing areas in central, western and eastern part.
Gh70148, Gh70152	Important fishing area for Greenland halibut.
Gh70153, Gh70155	Important fishing area for Greenland halibut.
Gh70156, Gh70161	Important fishing area for Greenland halibut.
Gh70162, Gh70165	Important fishing area for Greenland halibut.
Gu70155	1 colony of breeding kittiwakes.
Tu70155, Tu70162	1 large colony of breeding northern fulmars.

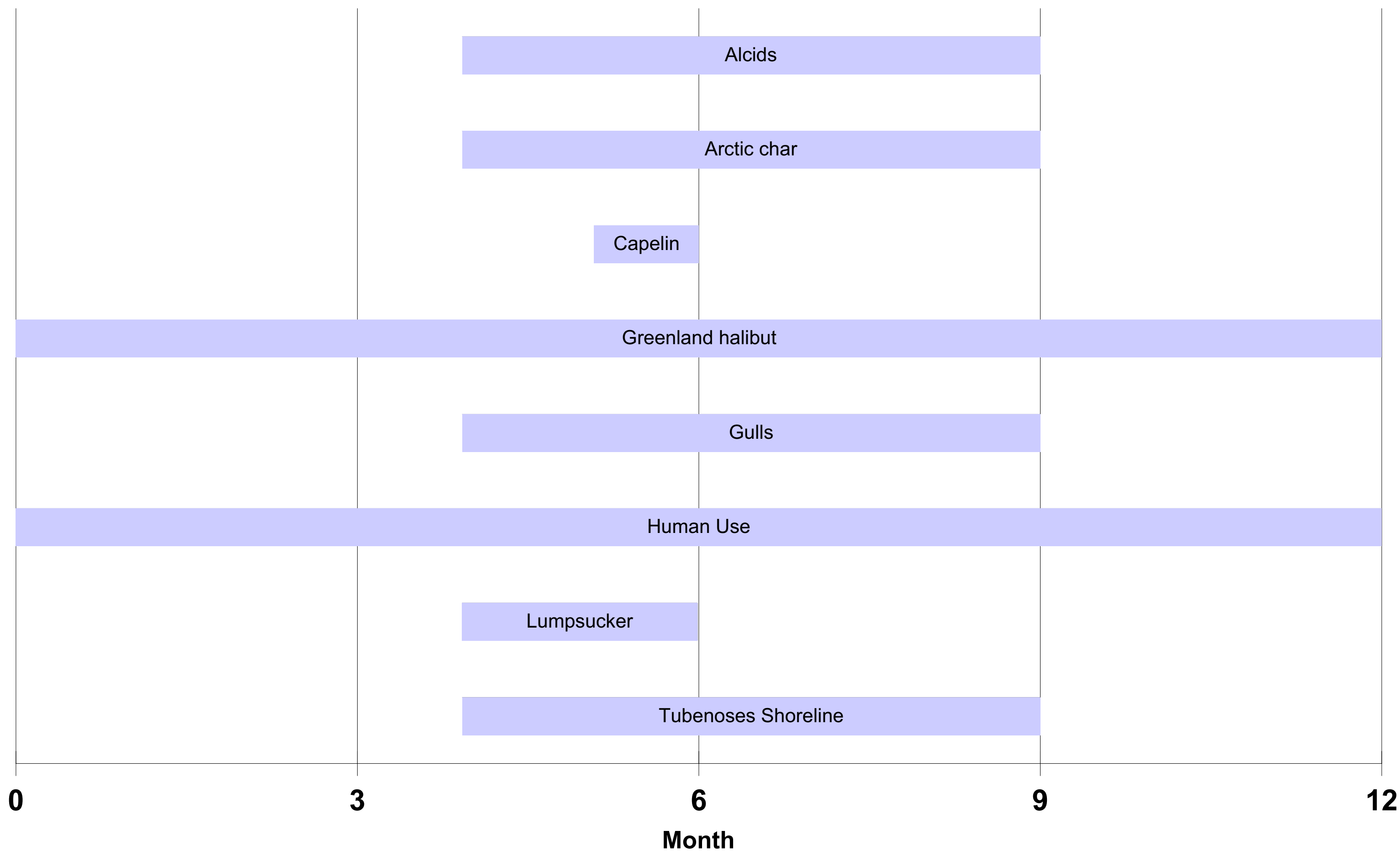
Site specific species occurrence (seabird breeding colonies); blue icons

Al4283	Breeding black guillemots.
Gu4282	Breeding kittiwakes.
Gu4288	Breeding glaucous gulls.
Tu4284, Tu4289	Breeding northern fulmars.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_148	36	High
70_152	23	Moderate
70_153	31	Moderate
70_155	49	Extreme
70_156	35	High
70_161	24	Moderate
70_162	19	Low
70_165	25	Moderate

Map 7053 Species and Resource Occurrences



Physical environment and logistics

Map 7053 - Uummannaq

Access

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

Access

(Continued from previous page)
Two rocks are charted, with depths of 16 and 2.7 m, about 2 km and 9 km north of Tunerit, the northern extremity of the island of Uummannaq.

A number of islands, islets and rocks lie in the channel between the SE end of the island of Appat and the NE end of the mainland.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

At Uummannaq, the harbour freezes over from November or December to late June. After break-up drifting ice may be present for as long as a month afterwards.

Tides in this area attain a maximum height of 2.0 m. The flood tidal stream sets strongly to the south, while the ebb sets to the north but is weak.

The harbour at Uummannaq has a mooring berth for vessels to 75 m length and 5.0 m draft. Small craft can berth alongside a wharf at the head of the harbour. The wharf is 20 m long with a height of 1.5 m above mean high water, depths alongside are 3.0 m.

Spraglebugt, a bay on the west side of Uummannaq Island, provides an alternative harbour for small vessels and is generally free of ice during the navigation season. Depths are 10 m and ringbolts are available for securing lines. Fresh water can be found in a river near the beacon towers, but the river is frequently dry in late summer.

Shorelines in this area are predominantly rock and talus allowing little opportunity for marine access. There is no information to indicate the potential for beach landings.

An asphalt-surface heliport, VFR daytime only, is available at Uummannaq. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas.

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

Exclusion booming to reduce inshore contamination could be considered for the inlet at the southeast end of the island of Appat, where the inlet width is 800 m. Water currents and depths are unknown, necessitating site surveys at the time of a spill.

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

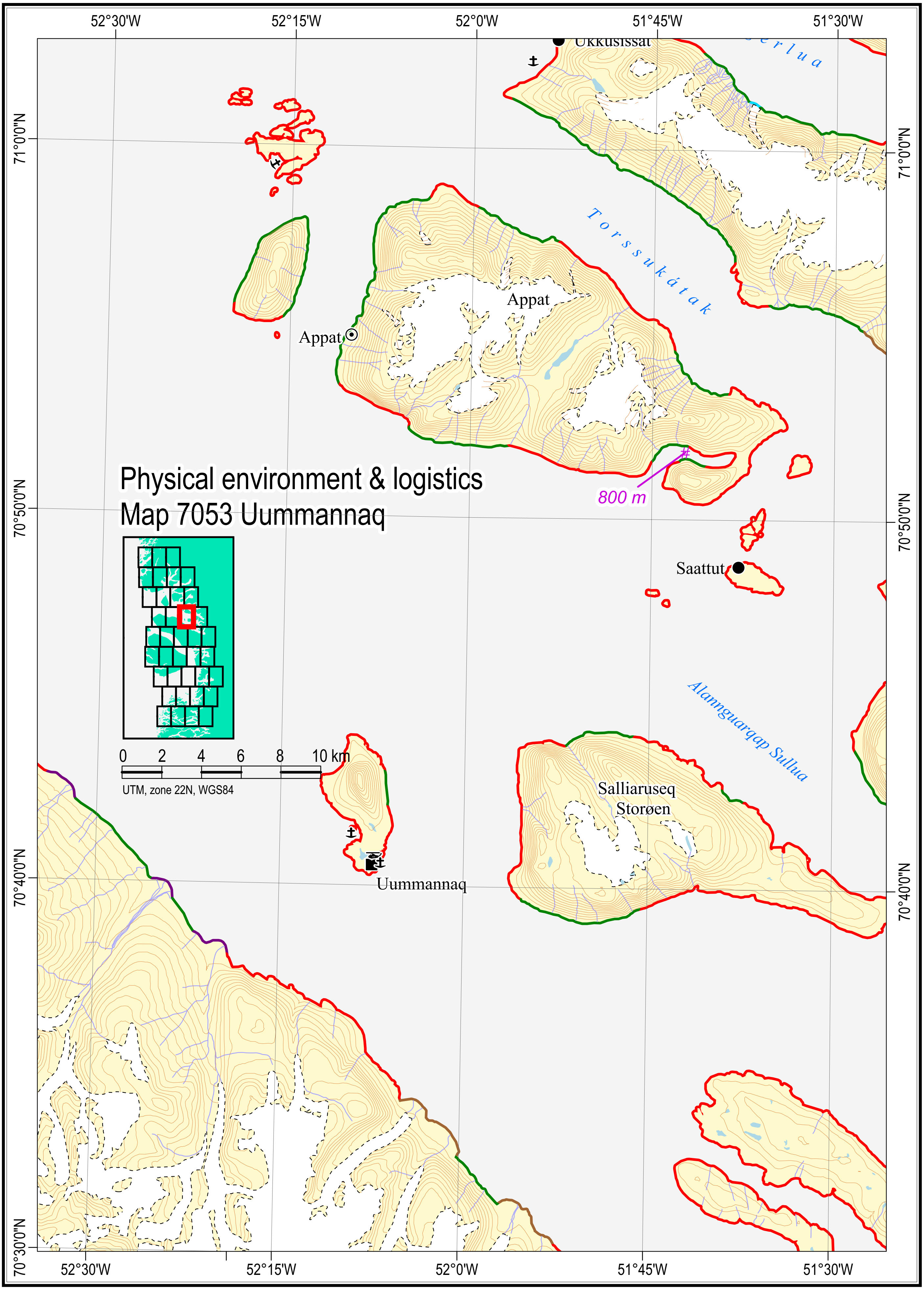
Shorelines shown on this map are predominantly exposed and semi-exposed rock and talus, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords shown on this map. Access and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

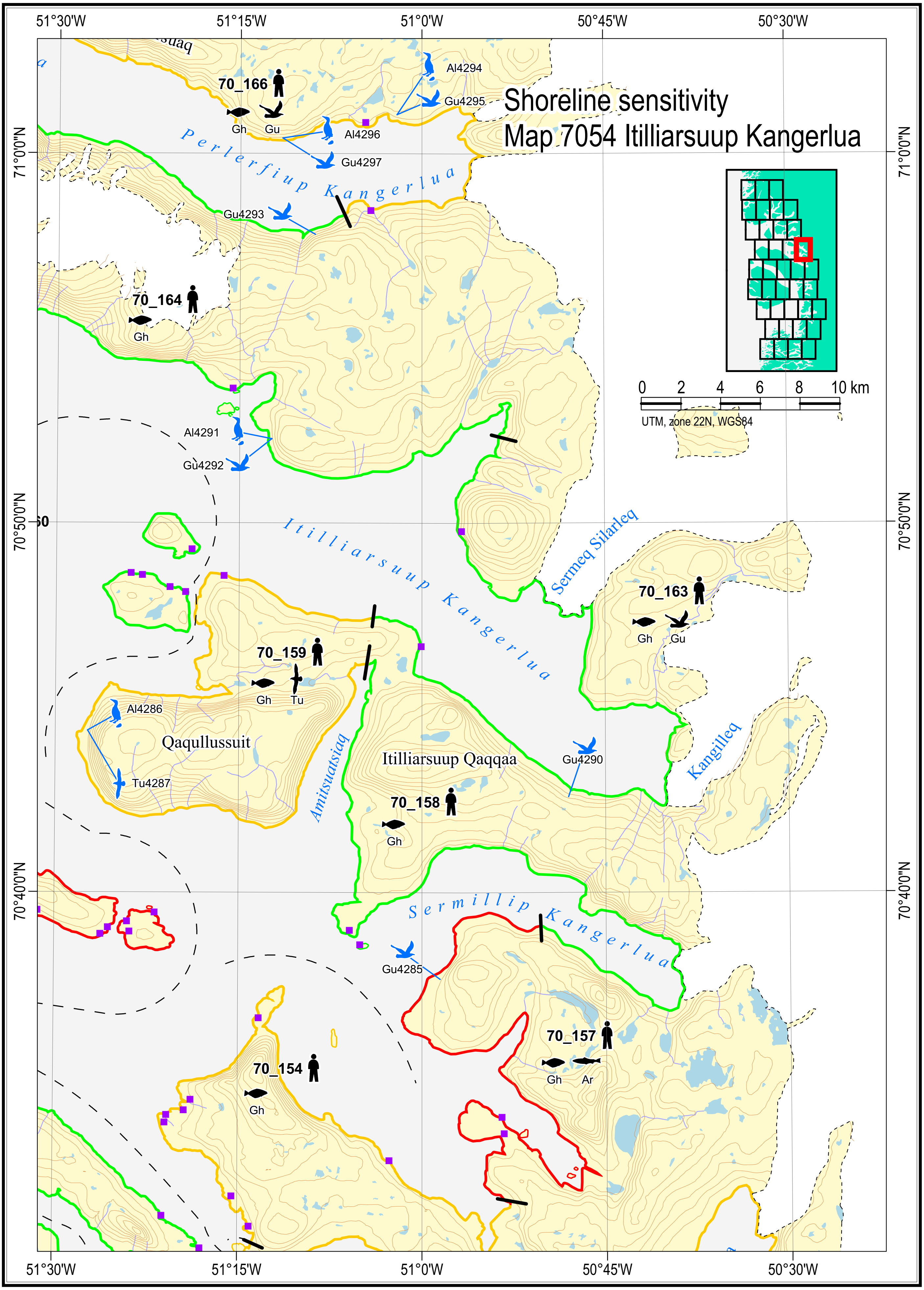
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 70 V.2. Nautical charts: 1600, 1610, 1650.


52°30'W
52°15'W
52°0'W
51°45'W
51°30'W
71°0'0"N
70°50'0"N
70°40'0"N
70°30'0"N
Ukkusissat
Torssukátak
Appat
Appat
800 m
Saattut
Alanguarqap Sullua
Salliaruseq
Storøen
Uummannaq
Physical environment & logistics
Map 7053 Uummannaq
0
2
4
6
8
10 km
UTM, zone 22N, WGS84


Shoreline sensitivity
Map 7054 Itilliarsuup Kangerlua
51°30'W
51°15'W
51°0'W
50°45'W
50°30'W
71°0'0"N
70°50'0"N
70°40'0"N
Perlerfiup Kangerlua
Itilliarsuup Kangerlua
Sermeq Silarleq
Kangilleq
Amitsuatsiaq
Sermillip Kangerlua
Qaqullussuit
Itilliarsuup Qaqqaa
70_166
70_164
70_163
70_159
70_158
70_157
70_154
Gh
Gu
Tu
Ar
Al4294
Gu4295
Al4296
Gu4297
Gu4293
Al4291
Gu4292
Al4286
Tu4287
Gu4290
Gu4285
0
2
4
6
8
10 km
UTM, zone 22N, WGS84

Shoreline sensitivity

Map 7054 - Itilliarsuup Kangerlua

Environmental description

Resource use

R 70_154	Fishery for capelin, Greenland halibut (important) and wolffish. Hunting for whelping ringed seals.
R 70_157	Fishery for capelin, Greenland halibut (important), wolffish (important) and Arctic char at coast and at 2 river outlets (important). Hunting for whelping ringed seals (important).
R 70_158	Fishery for capelin and Greenland halibut (important). Hunting for whelping ringed seals (important).
R 70_159	Fishery for capelin, Greenland halibut (important) and wolffish.
R 70_163	Fishery for capelin, Greenland halibut (important) and wolffish.
R 70_164	Fishery for capelin, Greenland halibut (important) and wolffish (important).
R 70_166	Fishery for Greenland halibut (important) and Arctic char at river outlet.

Species occurrence

Ar70157	2 important rivers and important fishing area for Arctic char
Gh70154, Gh70157	Important fishing area for Greenland halibut.
Gh70158, Gh70159	Important fishing area for Greenland halibut.
Gh70160, Gh70163	Important fishing area for Greenland halibut.
Gh70164, Gh70166	Important fishing area for Greenland halibut.
Gu70163	1 colony of breeding Iceland gulls or glaucous gulls and kittiwakes.
Gu70166	2 colonies of breeding Iceland gulls or glaucous gulls and kittiwakes.
Tu70159	1 large colony of breeding northern fulmars.

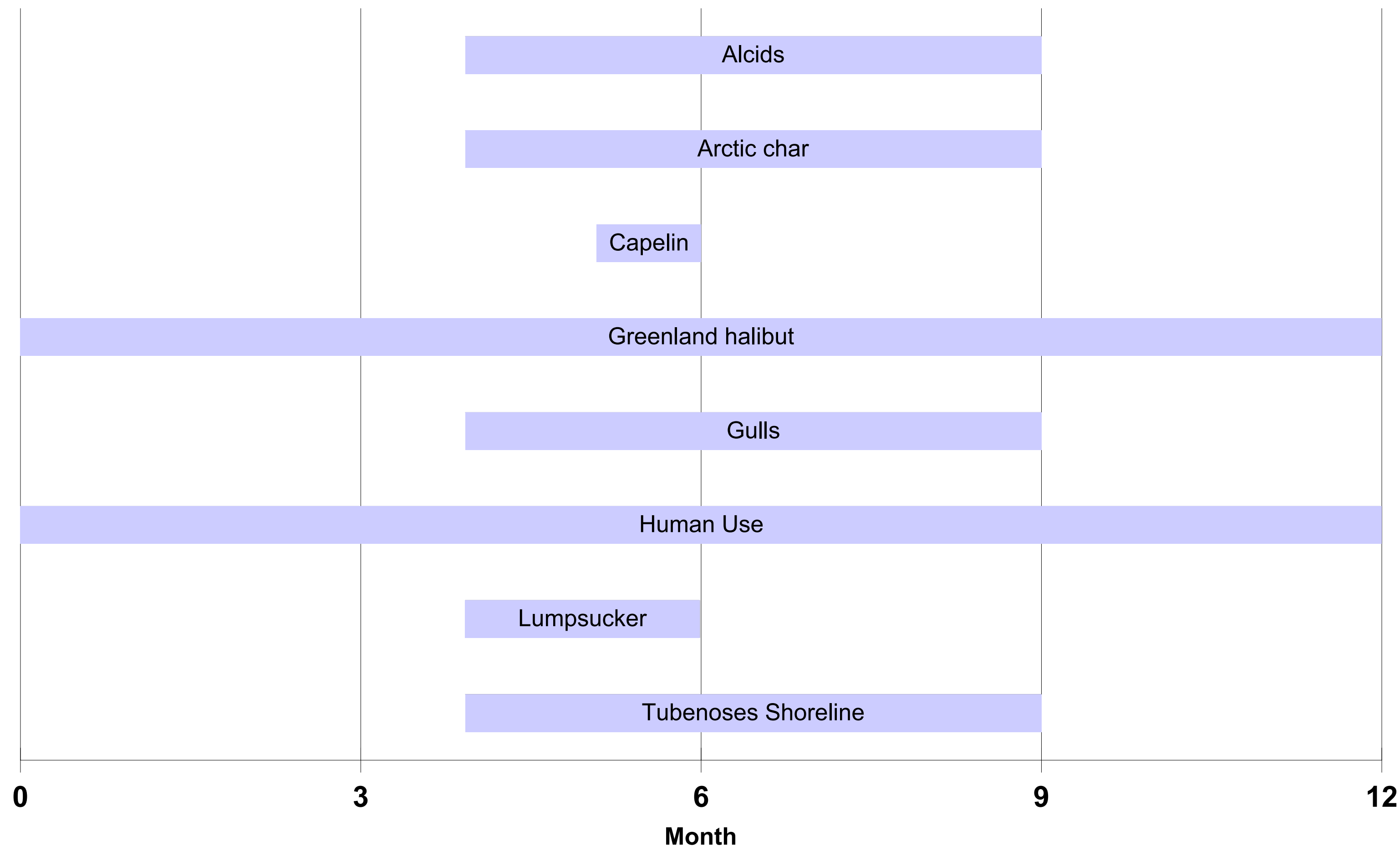
Site specific species occurrence (seabird breeding colonies); blue icons

Al4286, Al4294, Al4296	Breeding black guillemots.
Al4291	Breeding razorbills.
Gu4285, Gu4290	Breeding kittiwakes and Iceland/glaucous gulls.
Gu4292, Gu4293	Breeding kittiwakes and Iceland/glaucous gulls.
Gu4295, Gu4297	Breeding Iceland/glaucous gulls and kittiwakes.
Tu4287	Breeding northern fulmars.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
70_154	37	High
70_157	46	Extreme
70_158	23	Moderate
70_159	38	High
70_160	33	Moderate
70_163	26	Moderate
70_164	28	Moderate
70_166	37	High

Map 7054 Species and Resource Occurrences



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Access

The nearshore waters in this area are largely uncharted and caution should be exercised. The fjords in particular have few, if any, reported soundings. In general, the waters offshore, nearshore and within the fjords are deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no other information on tides or currents within fjords for this area.

Sermillip Kangerlua may offer anchorage, but has not been surveyed.

Shorelines in this area are predominantly rock which means that landing is unlikely. There is no information to indicate the potential for beach landings.

There are no airports on this or adjoining maps. The nearest airfields are the heliport at Uummannaq (map 7053) and the airport at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow inshore waters. Although the waters within these fjords appear to be deep, they are uncharted, and soundings should be taken to confirm their depth prior to using dispersants.

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

Nearshore exclusion booming utilizing up to 1,000 m of boom could protect the sensitive bay on the west side of Qaqullussuit, if currents are in an acceptable range.

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

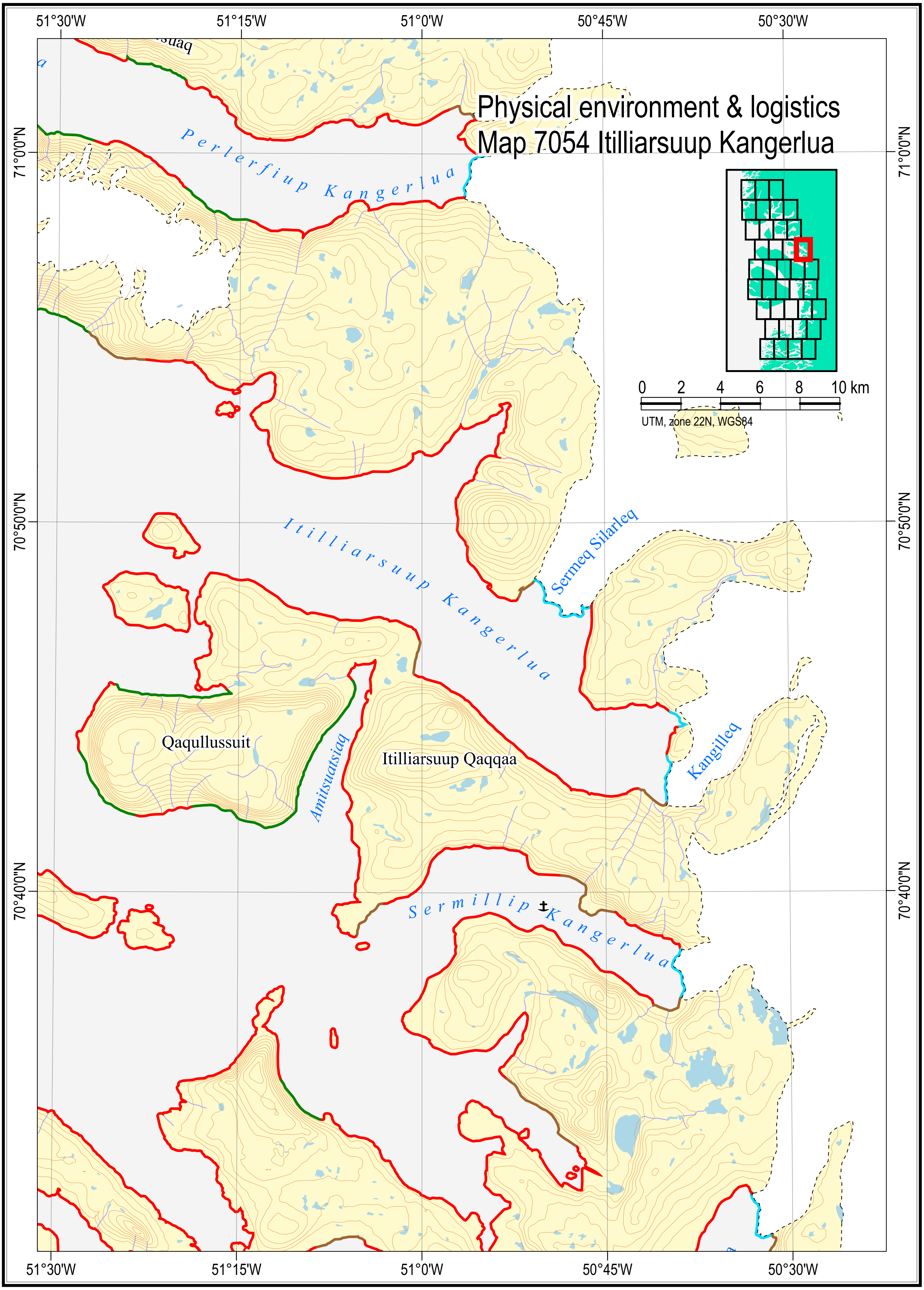
Shorelines shown on this map are predominantly exposed and semi-exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the more protected waters within the inlets and fjords shown on this map. Access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

Safe havens

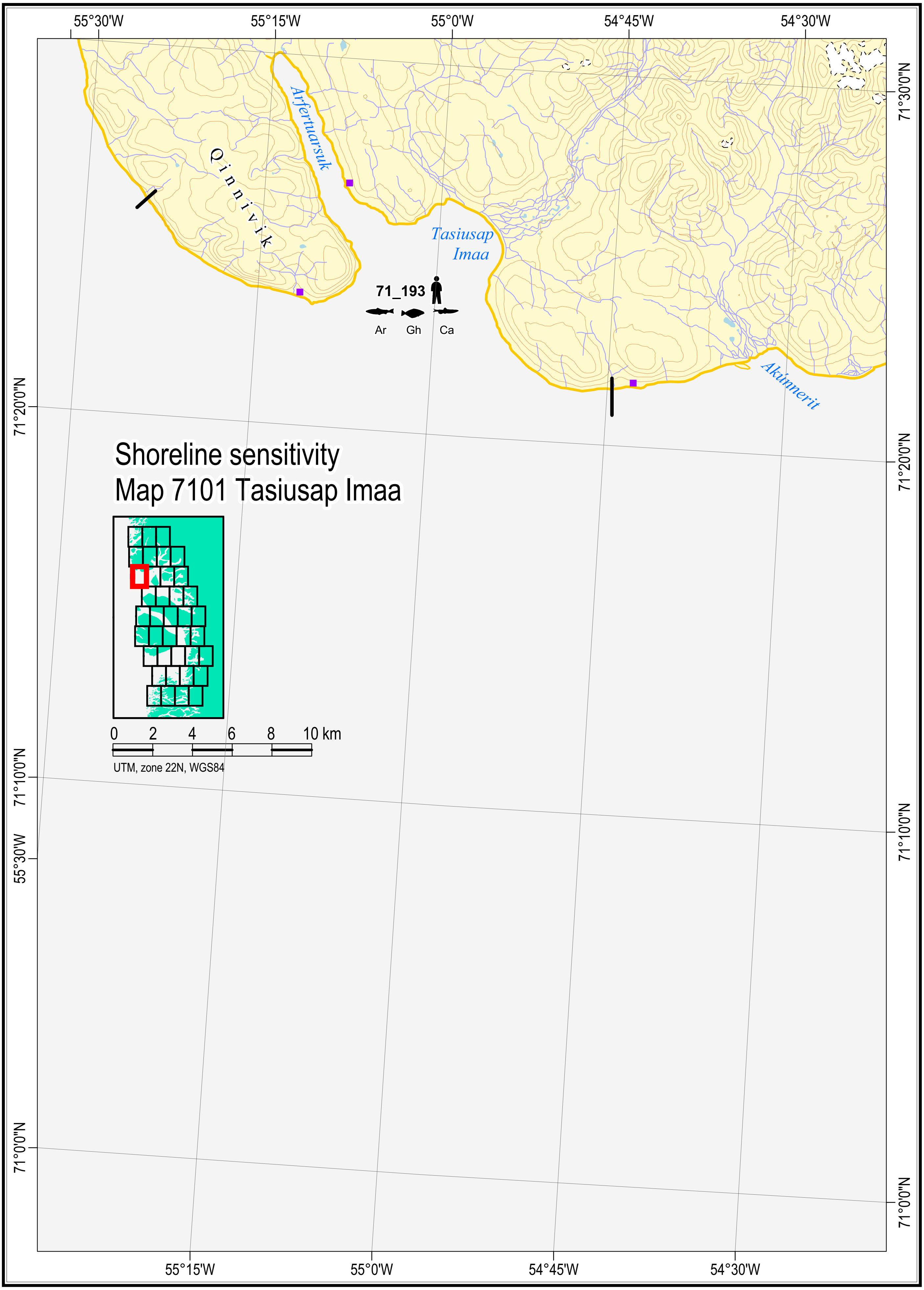
Sermillip Kangerlua, noted as having moderate sensitivity, could be investigated for its suitability as a safe haven for vessel lightering operations, however it has not been sounded. The waters appear to be deep, but if its use is considered, local knowledge and reconnaissance at the time of a spill would be required. 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: 70 V.2. Nautical chart: 1610.



Physical environment & logistics
Map 7054 Itilliarsuup Kangerlua
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
51°30'W
51°15'W
51°0'W
50°45'W
50°30'W
71°0'0"N
70°50'0"N
70°40'0"N
Perlerfiup Kangerlua
Itilliarsuup Kangerlua
Sermeq Silarleq
Qaqullussuit
Amitsuatsiaq
Itilliarsuup Qaqqaa
Kangilleq
Sermillip Kangerlua


55°30'W
55°15'W
55°0'W
54°45'W
54°30'W
71°30'0"N
71°20'0"N
71°10'0"N
71°0'0"N
55°30'W
Arfertuarsuk
Qinnivik
Tasiusap Imaa
71_193
Ar
Gh
Ca
Akunnerit
Shoreline sensitivity
Map 7101 Tasiusap Imaa
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Shoreline sensitivity

Map 7101 - Tasiusap Imaa

Environmental description

Resource use

R 71_193	Fishery for capelin, Greenland halibut (important) and Arctic char along coast and at several river outlets.

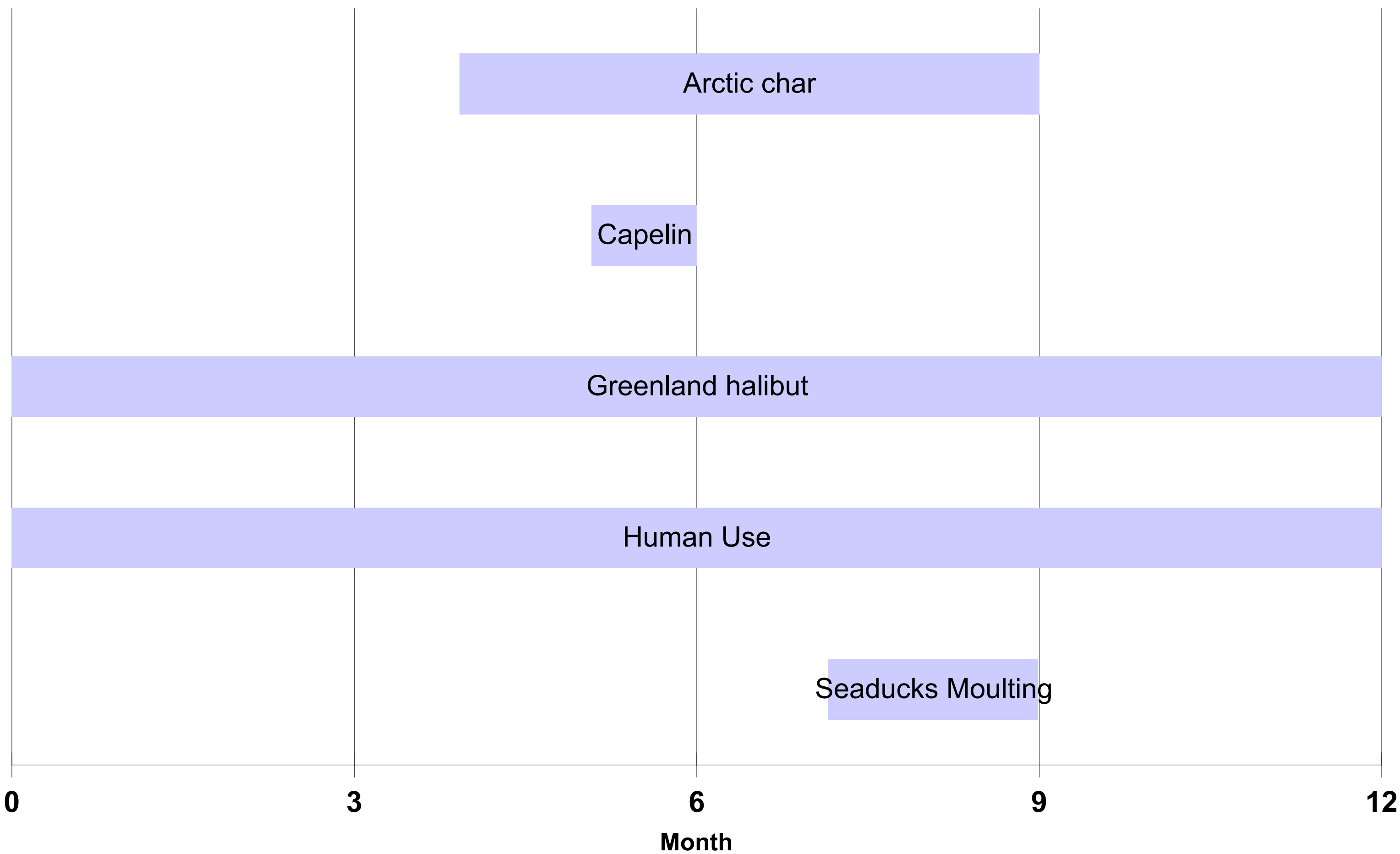
Species occurrence

Ar71193	4 important rivers and important coastal fishing areas for Arctic char.
Ca71193	Capelin spawning and important fishing areas from Arfertuarsuk and eastwards.
Gh71193	Important fishing area for Greenland halibut.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_193	36	High

Map 7101 Species and Resource Occurrences



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Access

The waters nearshore and in the fjords in this area are not charted and caution should be exercised. In general, the waters offshore, nearshore and within the fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

In averages year this area is ice-bound from December to June. Break-up 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 August. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.

There is no other information on tides or currents within fjords for this area.

Several good anchorages, with shelter from north and west winds, are available in the small fjord, Arfertuarsuk.

Shorelines in this area are predominantly rock and talus, and are highly exposed to weather, allowing little opportunity for marine access. The possibility of beach landings could be explored, particularly at beaches close by the several river mouths.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters. Depths are unknown in Arfertuarsuk and Tasiusap Imaa. It is likely that the waters are deep, but soundings are recommended to confirm depths before use of dispersant is considered.

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 highly 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 Arfertuarsuk and Tasiusap Imaa. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

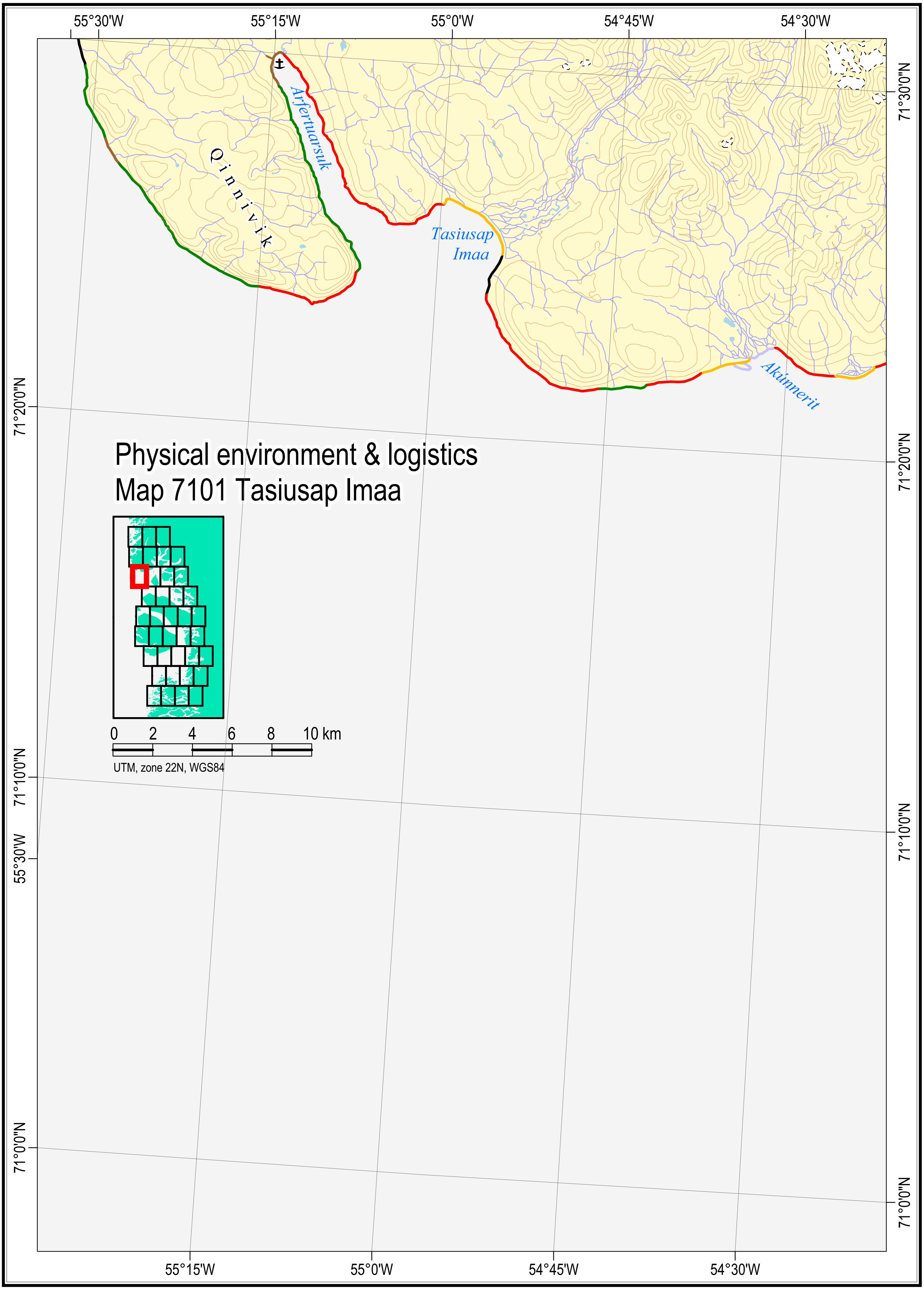
There is a small section of shoreline within Tasiusap Imaa designated as beach with semi-protected coastal exposure. If oiled, this area may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. Marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

There are no potential safe havens identified on this map. The anchorage at Niaqornat could be investigated for its suitability as a safe haven given its relatively low sensitivity rating, but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

Danish Survey & Cadastre (KMS) topographical map: 71 V.1. Nautical chart: 1600.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55°0'W
54°45'W
54°30'W
71°30'0"N
71°20'0"N
71°10'0"N
71°0'0"N
Q i n n i v i k
Arfertuarsuk
Tasiusap
Imaa
Akunnerit
Physical environment & logistics
Map 7101 Tasiusap Imaa
0
2
4
6
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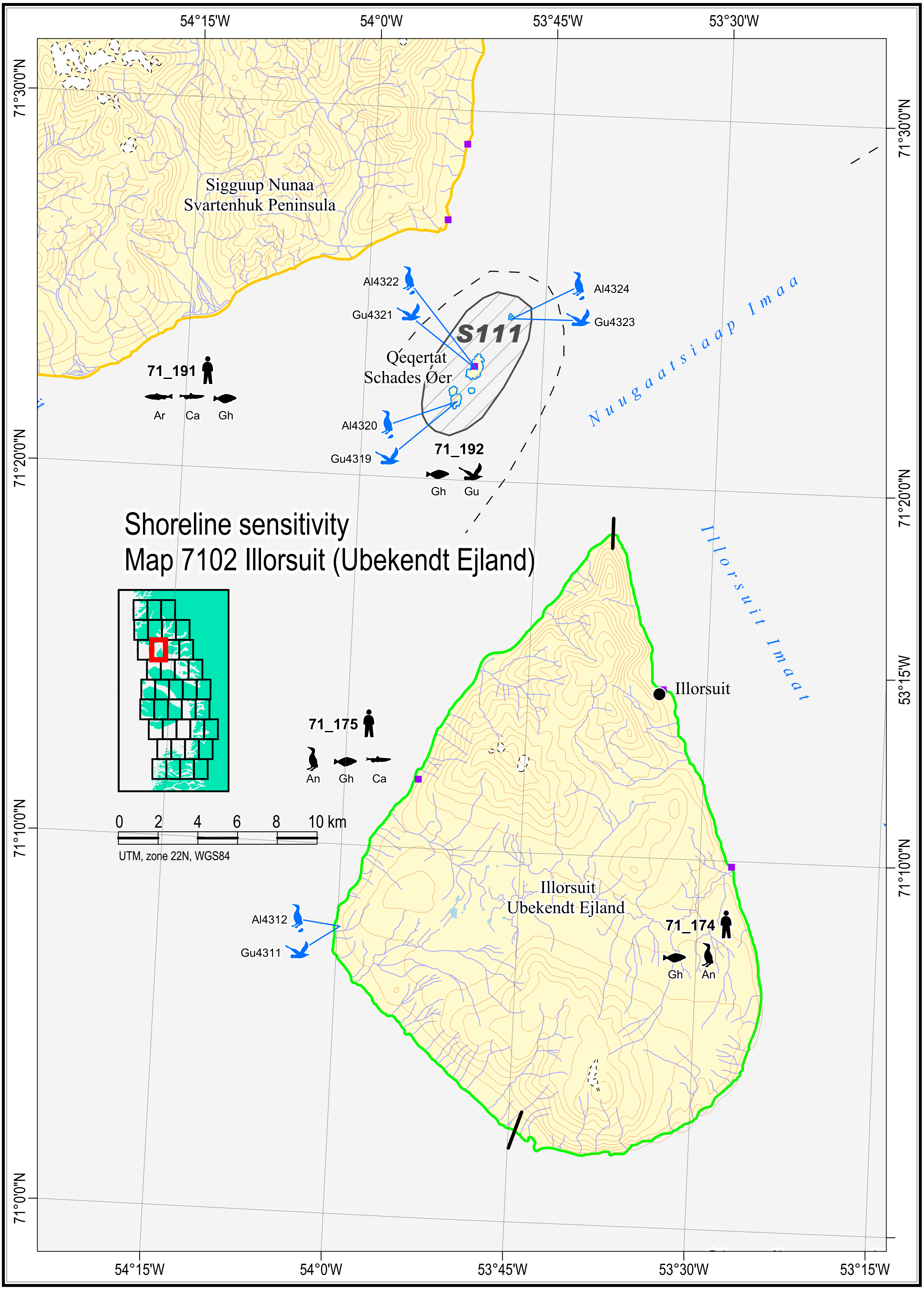
10 km
UTM, zone 22N, WGS84

Airphoto keymap

Map legend

Toggle maps

Keymaps



Shoreline sensitivity

Map 7102 - Illorsuit (Ubekendt Ejland)

Environmental description

Resource use

R 71_174	Fishery for Atlantic halibut, capelin, Greenland halibut (important), redfish and wolffish.
R 71_175	Fishery for capelin, Greenland halibut (important) and wolffish.
R 71_191	Fishery for capelin (important), Greenland halibut (important) and Arctic char along coast and at 4 river outlets.

Species occurrence

An71174, An71175	Black guillemots in spring.
Ar71191	1 river and important fishing area for Arctic char along all coasts.
Ca71175	Important capelin fishing area in northern part.
Ca71191	Important capelin fishing area along entire coast.
Gh71174, Gh71175	Important fishing area for Greenland halibut.
Gh71191, Gh71192	Important fishing area for Greenland halibut.
Gu71192	3 colonies with breeding Arctic terns (**S111**).

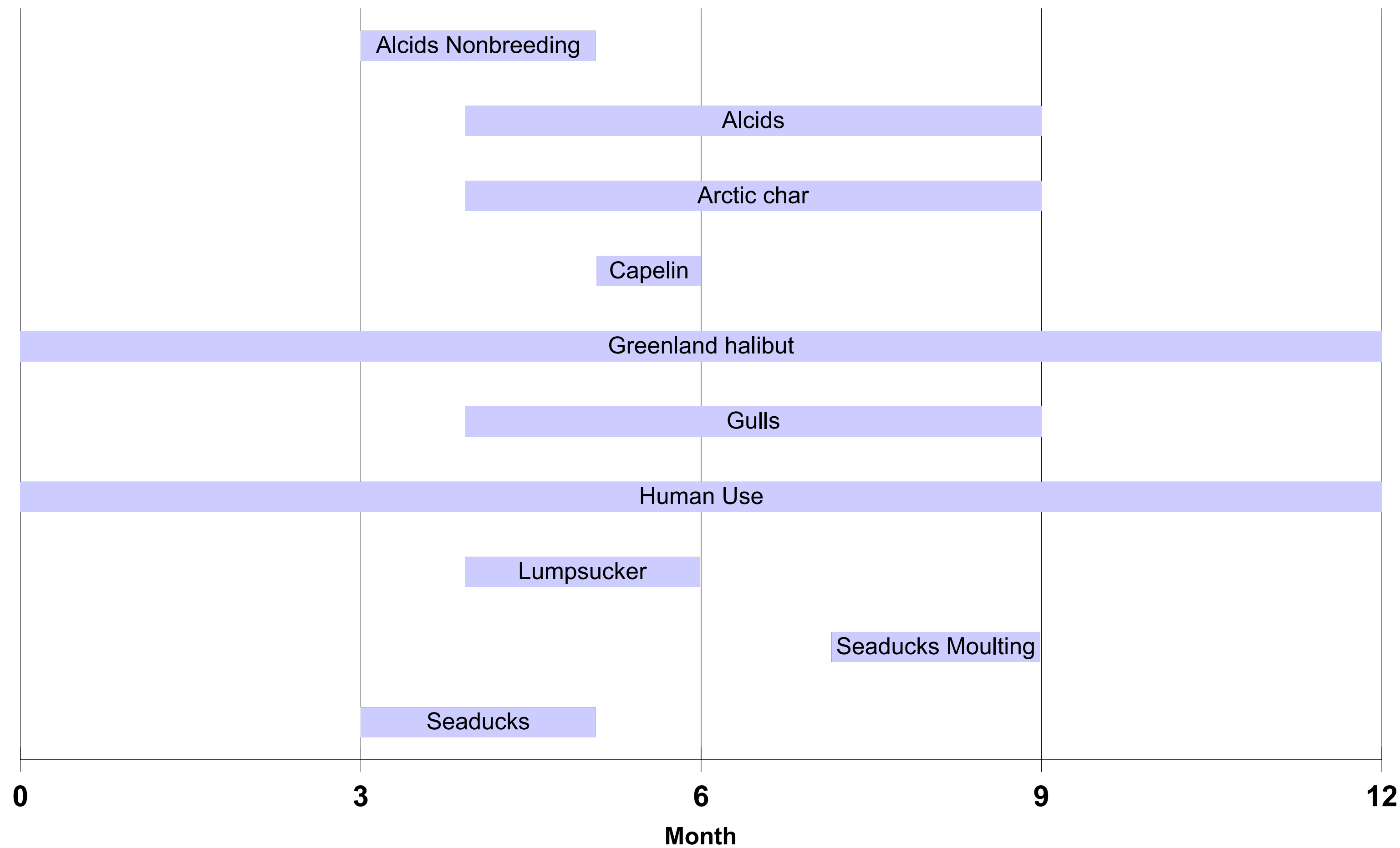
Site specific species occurrence (seabird breeding colonies); blue icons

Al4312	Breeding razorbills and black guillemots.
Al4320	Breeding black guillemots and perhaps little auks (**S111**).
Al4322, Al4324	Breeding black guillemots (**S111**).
Gu4311	Breeding glaucous gulls.
Gu4319, Gu4321	Breeding Arctic terns (**S111**).
Gu4323	Breeding Arctic terns (**S111**).

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_174	32	Moderate
71_175	24	Moderate
71_191	36	High
71_192	17	Low

Map 7102 Species and Resource Occurrences



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Physical environment and logistics

Map 7102 - Illorsuit (Ubekendt Ejland)

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. Local knowledge is essential for navigation. A below-water rock is reported in the approach to Satukujoq, the SE island of the Schades Øer (Islands).

Ice from Baffin Bay affects the coast south to 66° N, which it reaches in February.. Ice formed in winter in Umanak Fjord seldom breaks up before the latter part of June.

There is no information on tides or currents within fjords for this area.

Anchorage for small and large vessels is available at Illorsuit with depths to 40 m in the outer portion of the bight. Ringbolts for securing lines are available at the pier. The deep water and exposure to the north means that drifting ice and small icebergs are a constant hazard.

In the Schades Islands anchorage can be made in a bay on the east side of Båkeø, the SW island of the group.

Shorelines in this area are predominantly rock and talus and are highly exposed to weather allowing little opportunity for marine access. The possibility of beach landings could be explored, particularly at beaches close by the several river mouths.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

There are several sections of shoreline along the south coast of Svartenhuk Halvø that are designated as beaches. Although these have highly exposed coasts, consideration may be given to cleaning using sediment removal techniques depending on the extent of oiling. Marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

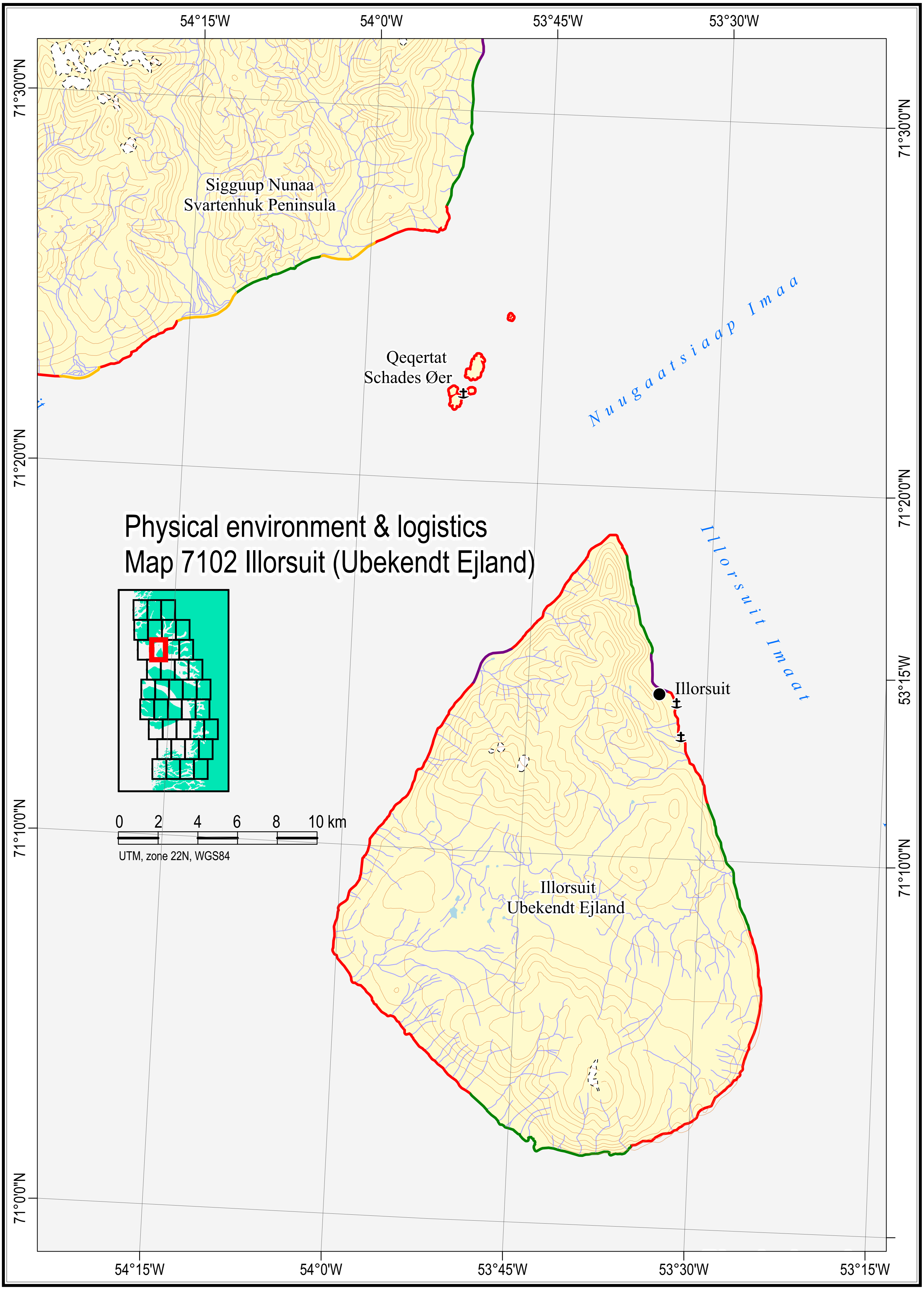
Safe havens

There are no potential safe havens identified on this map. The anchorage at Illorsuit could be investigated for its suitability as a safe haven but the anchorage offers little shelter and exclusion booming would be impractical.

Maps

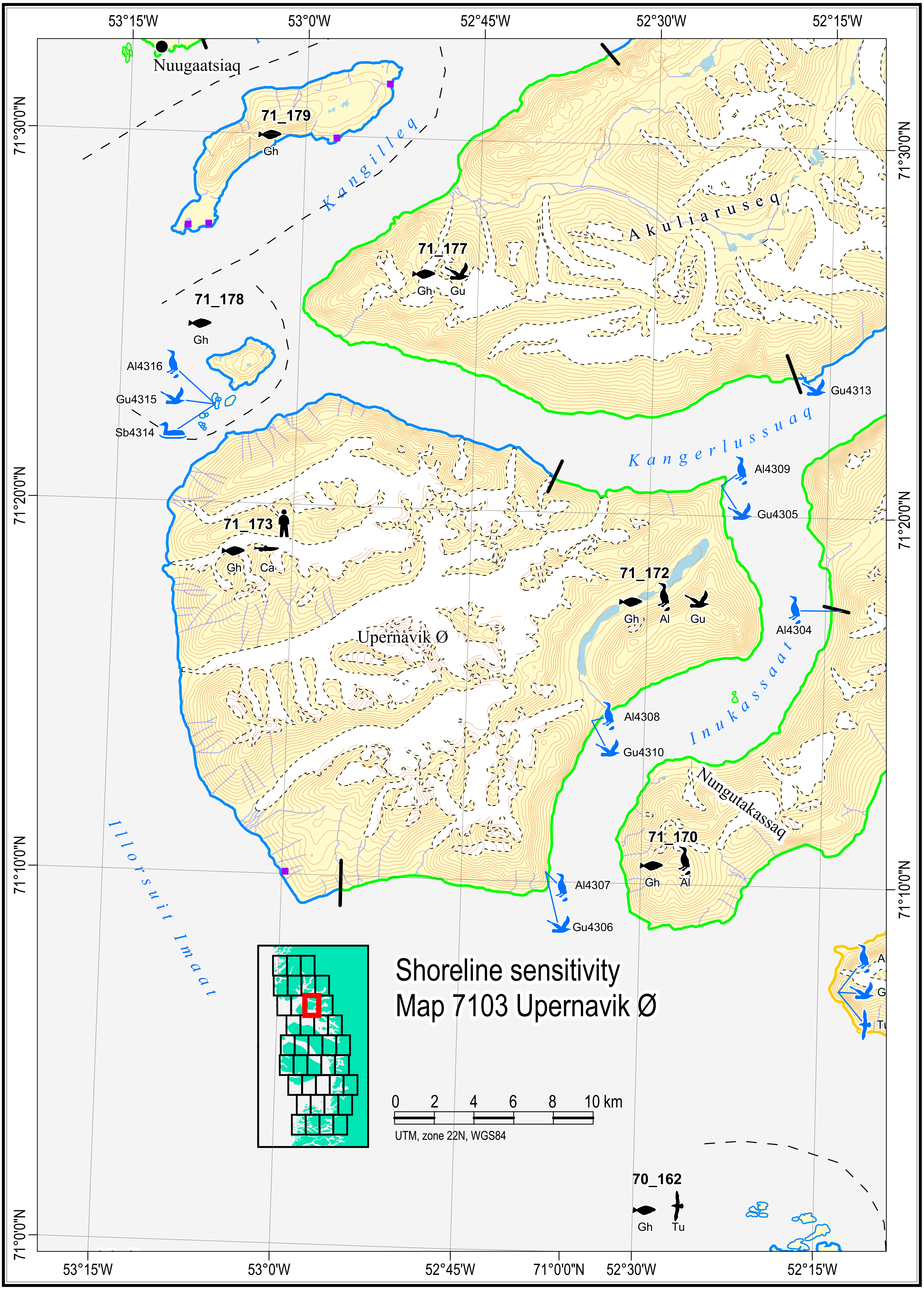
Danish Survey & Cadastre (KMS) topographical map: 71 V.1. Nautical chart: 1600.

Airphoto keymap Map legend Toggle maps Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen, 1998


53°15'W
53°0'W
52°45'W
52°30'W
52°15'W
71°30'0"N
71°20'0"N
71°10'0"N
71°0'0"N
Nuugaatsiaq
71_179
Gh
Kangilleq
71_177
Gh
Gu
Akuliaruseq
71_178
Gh
Al4316
Gu4315
Sb4314
Gu4313
Kangerlussuaq
Al4309
Gu4305
71_173
Gh
Ca
71_172
Gh
Al
Gu
Al4304
Upernavik Ø
Inukassaat
Al4308
Gu4310
Nungutakassaq
71_170
Gh
Al
Al4307
Gu4306
Illorsuit Imaat
Shoreline sensitivity
Map 7103 Upernavik Ø
0 2 4 6 8 10 km
UTM, zone 22N, WGS84
70_162
Gh
Tu

Environmental description

Resource use

R 71_173	Fishery for Atlantic halibut, capelin (important), Greenland halibut (important) and redfish.

Species occurrence

Al71170	1 colony with breeding black guillemots.
Al71172	2 colonies with breeding razorbills and black guillemots.
Ca71173	Important capelin fishing area along west and northwest coast.
Gh71170, Gh71172	Important fishing area for Greenland halibut.
Gh71173, Gh71177	Important fishing area for Greenland halibut.
Gh71178, Gh71179	Important fishing area for Greenland halibut.
Gu71172	3 colonies with breeding Iceland gulls, glaucous gulls and kittiwakes.
Gu71177	1 colony with breeding Iceland gulls or glaucous gulls.

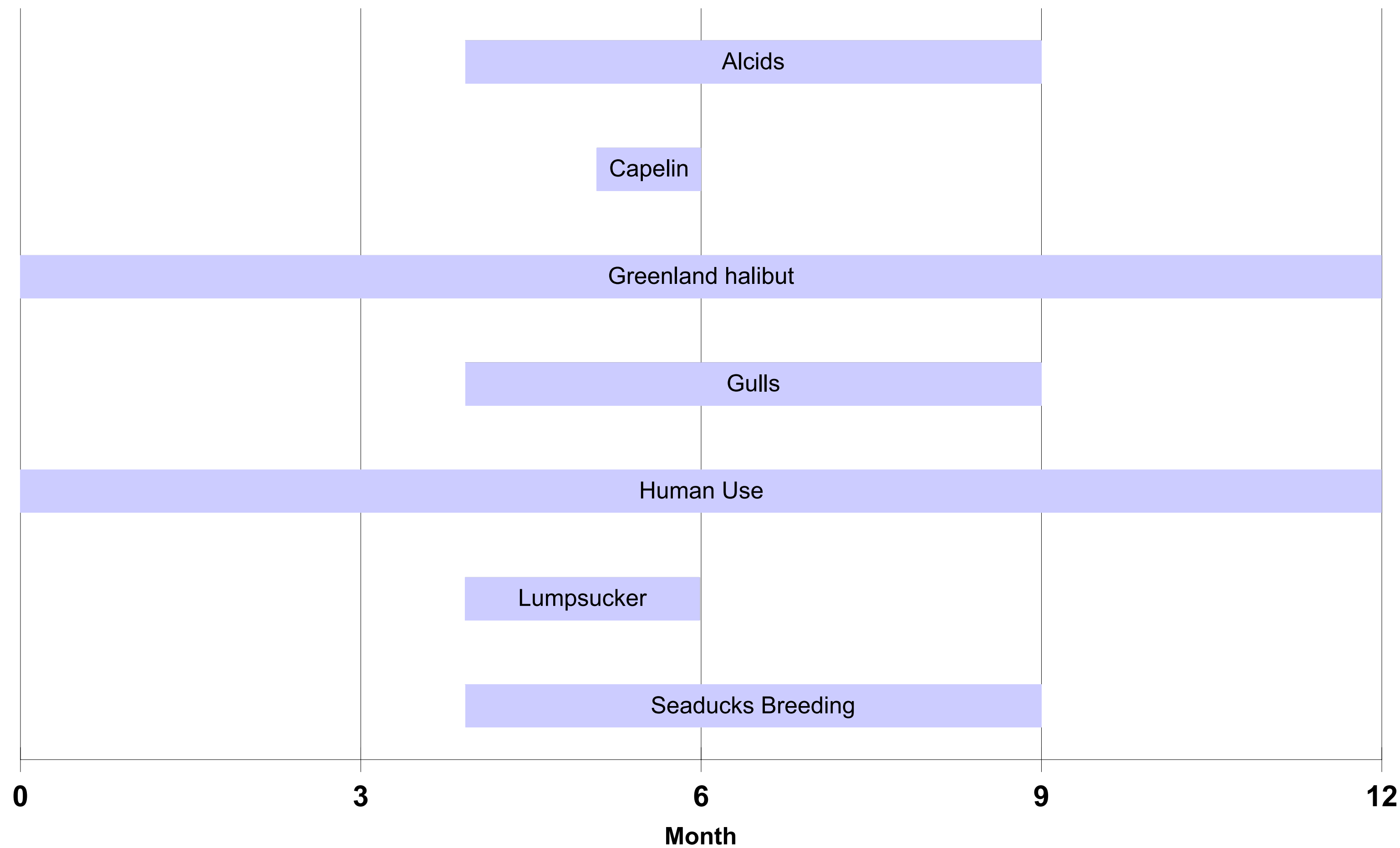
Site specific species occurrence (seabird breeding colonies); blue icons

Al4304, Al4309	Breeding black guillemots.
Al4307, Al4308	Breeding black guillemots and razorbills.
Al4316	Breeding black guillemots
Gu4305	Breeding glaucous gulls.
Gu4306	Breeding glaucous gulls and Iceland gulls.
Gu4310	Breeding kittiwakes, glaucous gulls and Iceland gulls.
Gu4313	Breeding Iceland gulls or glaucous gulls.
Gu4315	Breeding Arctic terns.
Sb4314	Breeding common eiders.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_170	25	Moderate
71_172	28	Moderate
71_173	21	Low
71_177	23	Moderate
71_178	18	Low
71_179	21	Low

Map 7103 Species and Resource Occurrences



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Access

The fjords in this area are not charted and caution should be exercised. In general the waters appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

A rock awash is reported in the NE part of Umanak Fjord SE of Upernavik Ø, with other rocks of6 m and 4 m with within 1.5 km of this location.

Depths are unknown in Kangerluarsuk, a fjord at the SW extremity of Alfred Wegener Peninsula.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within fjords for this area.

The open bight that forms the south coast of Upernavik affords temporary shelter from north winds; however, a heavy swell is common to this location.

Anchorage for small vessels can be found off Nunguutakassaq on the east shore of Inukusaat Sound, about 6 km within the entrance. Depths are 5.0 m and holding is excellent.

Shorelines in this area are predominantly rock with some talus and moraine. There is no information to indicate the potential for beach landings.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 and semi-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 the fjords shown on this map. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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 Inukassaat could be investigated for its suitability as a safe haven given its low sensitivity rating; the anchorage offers some shelter but exclusion booming would be impractical.

Maps

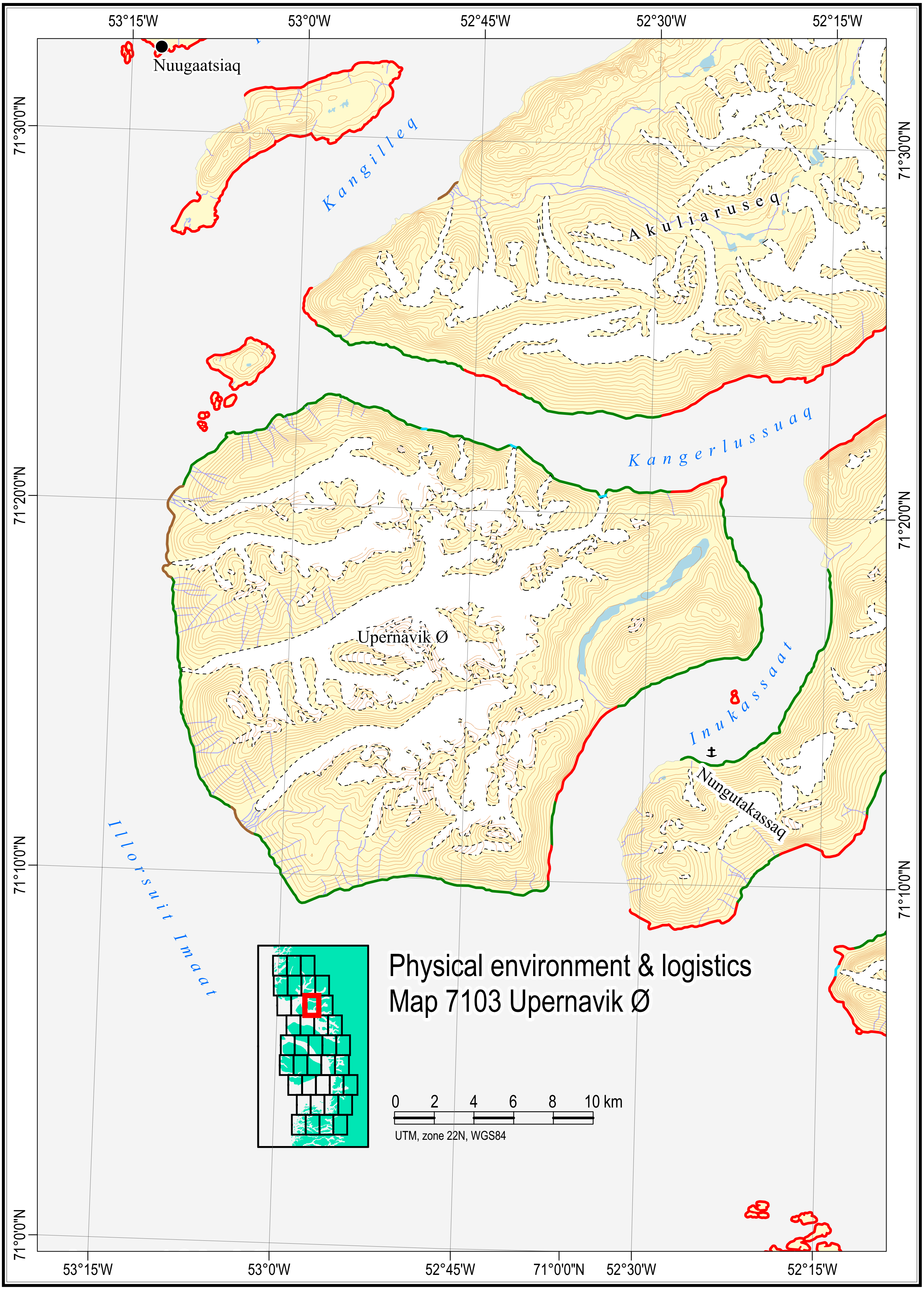
Danish Survey & Cadastre (KMS) topographical maps: 71 V.1, 71 V.2. Nautical charts: 1600, 1610.

Airphoto keymap

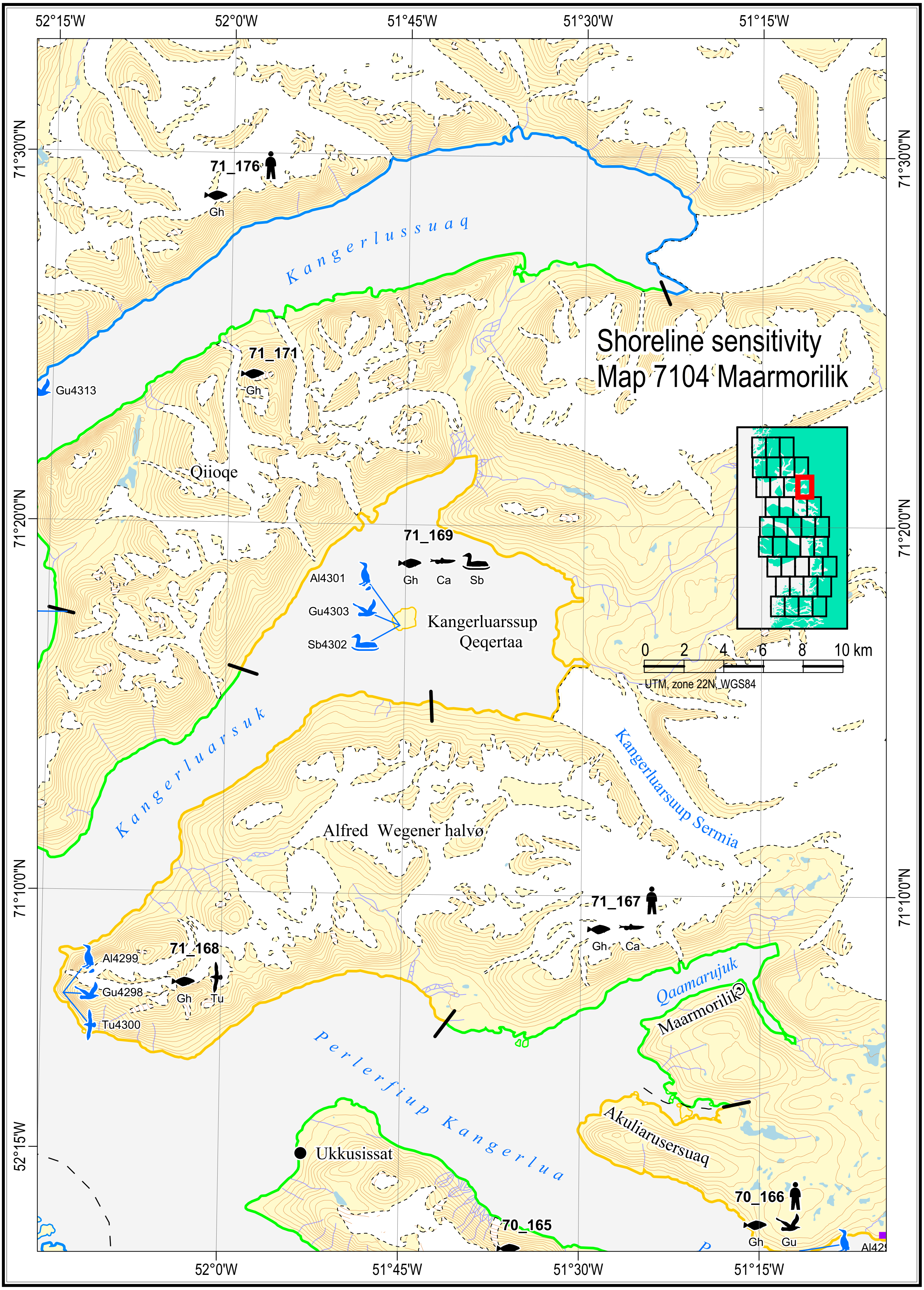
Map legend

Toggle maps

Keymaps



Topographic base: G/250 Vector, Copyright Kort & Matrikelstyrelsen, 1998


Shoreline sensitivity
Map 7104 Maarmorilik
52°15'W
52°0'W
51°45'W
51°30'W
51°15'W
71°30'0"N
71°20'0"N
71°10'0"N
52°15'W
Kangerlussuaq
71_176
Gh
71_171
Gh
Gu4313
Qiioqe
71_169
Gh
Ca
Sb
Al4301
Gu4303
Sb4302
Kangerluarssup Qeqertaa
Kangerluarsuk
Kangerluarssup Sermia
Alfred Wegener halvø
71_167
Gh
Ca
71_168
Al4299
Gu4298
Tu4300
Gh
Tu
Qaamarujuk
Maarmorilik
Perlerfiup Kangerlua
Akuliarusersuaq
Ukkusissat
70_165
70_166
Gh
Gu
0
2
4
6
8
10 km
UTM, zone 22N, WGS84

Environmental description

Resource use

R 71_167	Fishery for Arctic char at coast, capelin (important) and Greenland halibut (important).
R 71_176	Fishery for Greenland halibut (important). Hunting for whelping ringed seals (important).

Species occurrence

Ca71167	Important capelin fishing area in Qaamarujuk.
Ca71169	Important capelin fishing area in northern part and spawning area in southern part.
Gh71167, Gh71168	Important fishing area for Greenland halibut.
Gh71169, Gh71171	Important fishing area for Greenland halibut.
Gh71176	Important fishing area for Greenland halibut.
Sb71169	1 colony of breeding common eiders.
Tu71168	1 large colony of breeding northern fulmars.

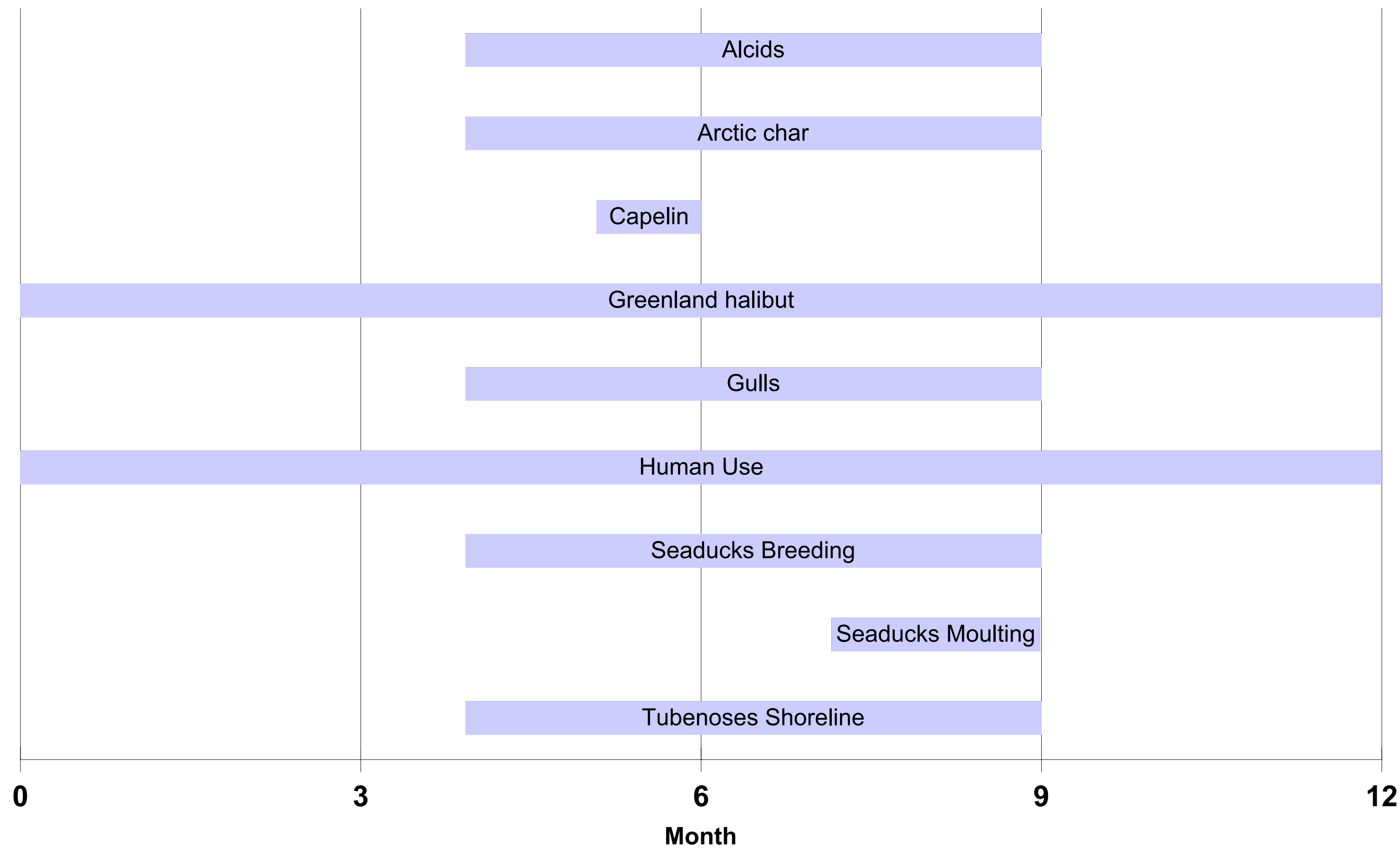
Site specific species occurrence (seabird breeding colonies); blue icons

Al4299	Breeding razorbills and black guillemots.
Al4301	Breeding black guillemots.
Gu4298	Breeding Iceland gulls, glaucous gulls and kittiwakes.
Gu4303	Breeding glaucous gulls.
Sb4302	Breeding common eiders.
Tu4300	Breeding northern fulmars.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_167	31	Moderate
71_168	39	High
71_169	42	High
71_171	23	Moderate
71_176	17	Low

Map 7104 Species and Resource Occurrences



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Access

The fjords in this area are not charted and caution should be exercised. In general the waters appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

At Maarmorilik, the tide attains a maximum height of 2.0 m. The tidal stream is weak.

There is no other information on currents for this area.

Anchorage is available in the bight at Ukkusissat with good holding. However, north winds may fill it with glacier ice.

Maarmorilik is an abandoned mine site and has mooring for large vessels in depths of 24 to 50 m. Care must be taken to avoid a rock located near the entrance.

A beach for landing is noted close north of Ukkusissat.

The rest of the shorelines in this area are predominantly rock and talus allowing little opportunity for marine access. The possibility of beach landings could be explored close by the several river mouths but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052).

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within the inlets and 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 could be used to prevent oil from entering the inlet at Maarmorilik, where the inlet width is 400 m and the tidal stream is reported to be weak. Depths are unknown and would require reconnaissance at the time of a spill.

There are no other 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 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 the fjords. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

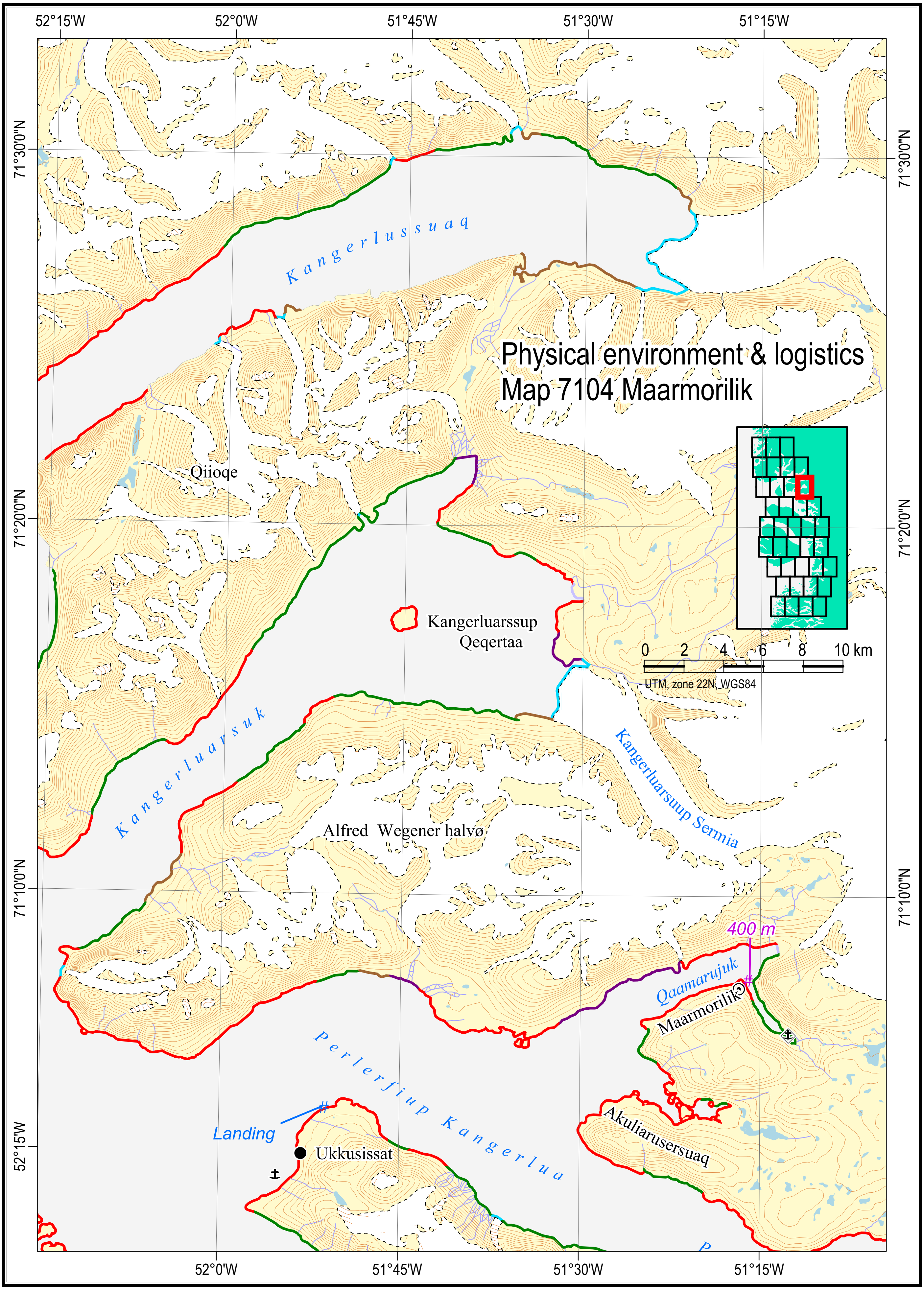
Consideration should be given to flushing operations in the more protected shorelines near the heads of Kangerlussuaq and Qaamarajuk. Access and trafficability of these areas are unknown, but it is probable that any cleanup operations would be marine-based given the likely nature of the shoreline.

Safe havens

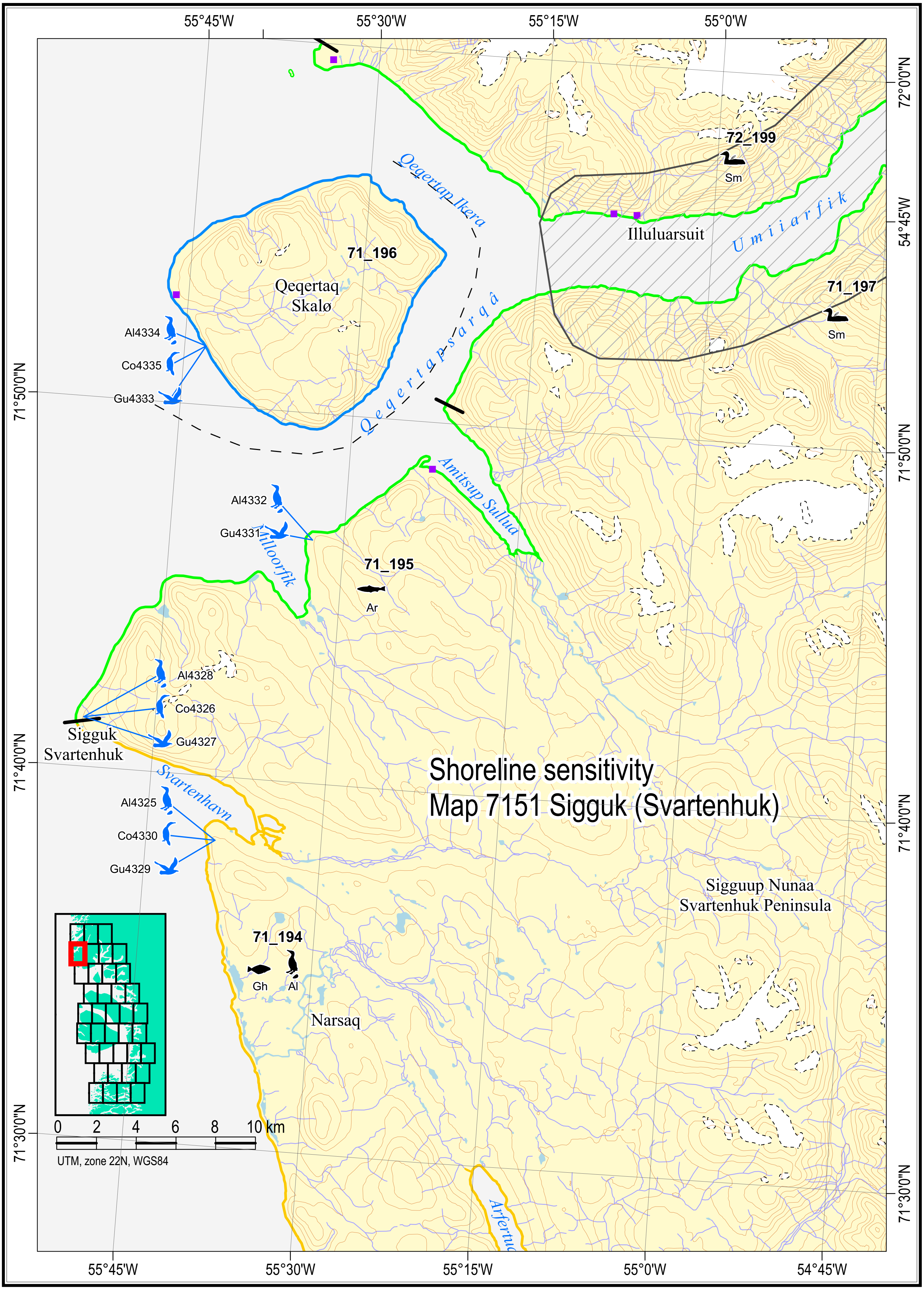
A potential safe haven for vessel lightering operations is the anchorage at Maarmorilik. It is in an area of relatively low sensitivity and tidal currents are reported to be weak. Exclusion booming of the 400 m inlet could be used to contain any further release of oil.

Maps

Danish Survey & Cadastre (KMS) topographical map: 71 V.2. Nautical charts: 1600, 1610, 1650.


Physical environment & logistics
Map 7104 Maarmorilik
52°15'W
52°0'W
51°45'W
51°30'W
51°15'W
71°30'0"N
71°20'0"N
71°10'0"N
Kangerlussuaq
Qiioqe
Kangerluarssup Qeqertaa
Kangerluarsuk
Alfred Wegener halvø
Kangerluarssuup Sermia
400 m
Qaamarujuk
Maarmorilik
Akuliarusersuaq
Perlerfiup Kangerlua
Landing
Ukkusissat
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap | Map legend | Toggle maps | Keymaps



Environmental description

Resource use

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

Species occurrence

Al71194	2 colonies with breeding Atlantic puffins, black guillemots and razorbills.
Ar71195	4 important rivers with Arctic char and important fishing area in Amitsup Sullua.
Gh71194	Important fishing area for Greenland halibut.
Sm71197	Important moulting area for common eiders, king eiders and long-tailed ducks (**S113**).

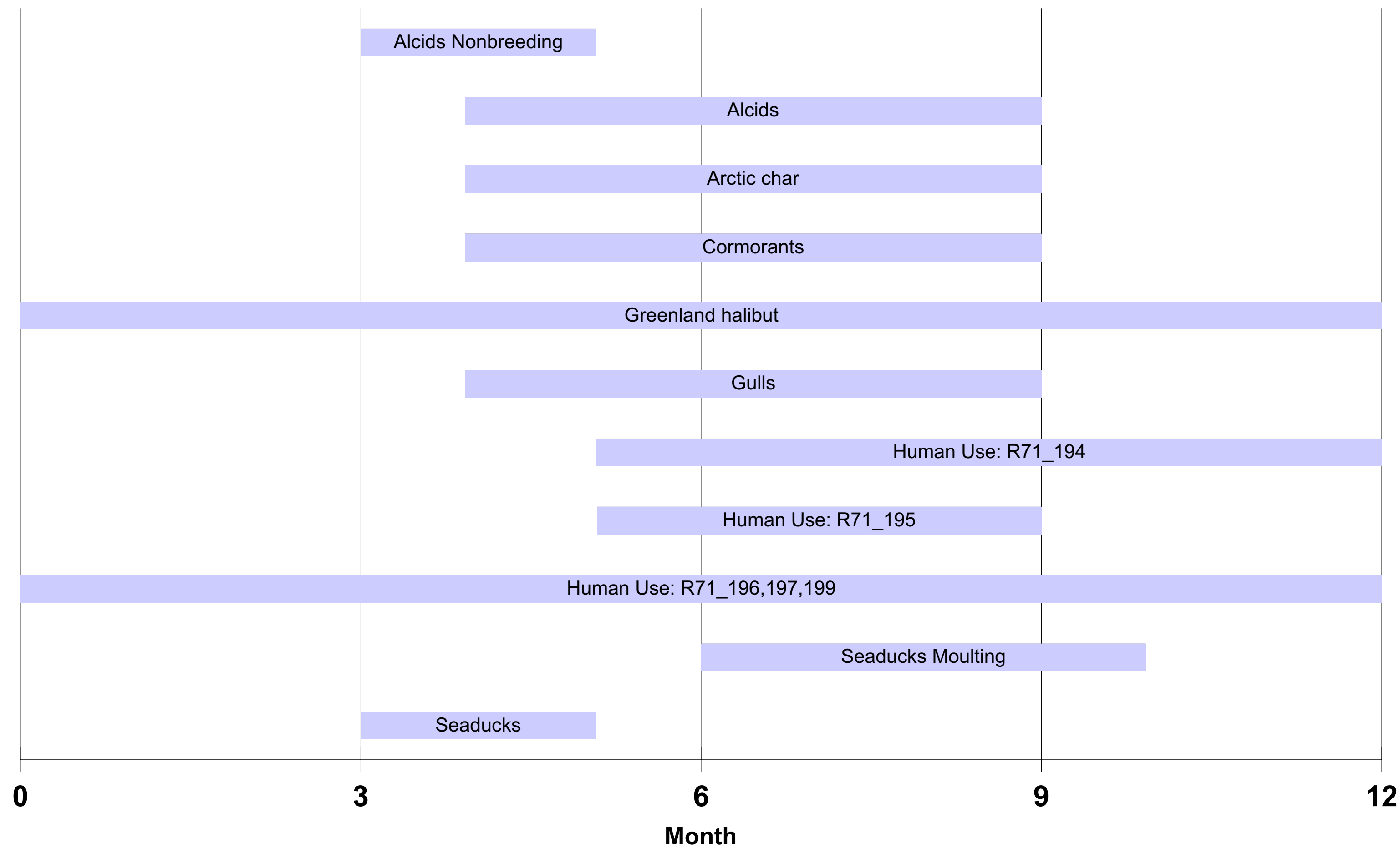
Site specific species occurrence (seabird breeding colonies); blue icons

Al4325, Al4334	Breeding black guillemots.
Al4328	Breeding Atlantic puffins, black guillemots and razorbills.
Al4332	Breeding razorbills and black guillemots.
Co4326, Co4330	Breeding great cormorants.
Co4335	Breeding great cormorants.
Gu4327, Gu4329	Breeding glaucous gulls.
Gu4331	Breeding glaucous gulls.
Gu4333	Breeding Iceland gulls or glaucous gulls.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_194	40	High
71_195	27	Moderate
71_196	11	Low
71_197	28	Moderate
72_199	24	Moderate

Map 7151 Species and Resource Occurrences



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Access

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

In average years this area is ice-bound from December to June. Break-up 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 August. First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

The prevailing West Greenland Current is 0.5 knots, setting to the north and generally parallel to the coast.

There is no other information on tides or currents within fjords for this area.

Anchorages are available at Svartenhavn in depths of 15 m but may be subject to swell in poor weather. Rocks with depths of 1.8 m and less are located about 6 km SW of the entrance to Svartenhavn.

Good anchorage is reported at Milloorfik, an inlet on the NW coast of Svartenhuk Peninsula 16 km NE of Svartenhuk.

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

Pocket beaches within Svartenhavn may allow landings in good weather.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052) and nearest heliport at Upernavik Town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow, nearshore waters, which may exist within the inlets 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, including the selected area shown on the map.

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.

Exclusion booming to protect the selected area in Umiiarfik is not likely to be successful due to its width.

Shorelines shown on this map are predominantly exposed talus and 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 cleanup operations would be marine-based given the likely nature of the shoreline.

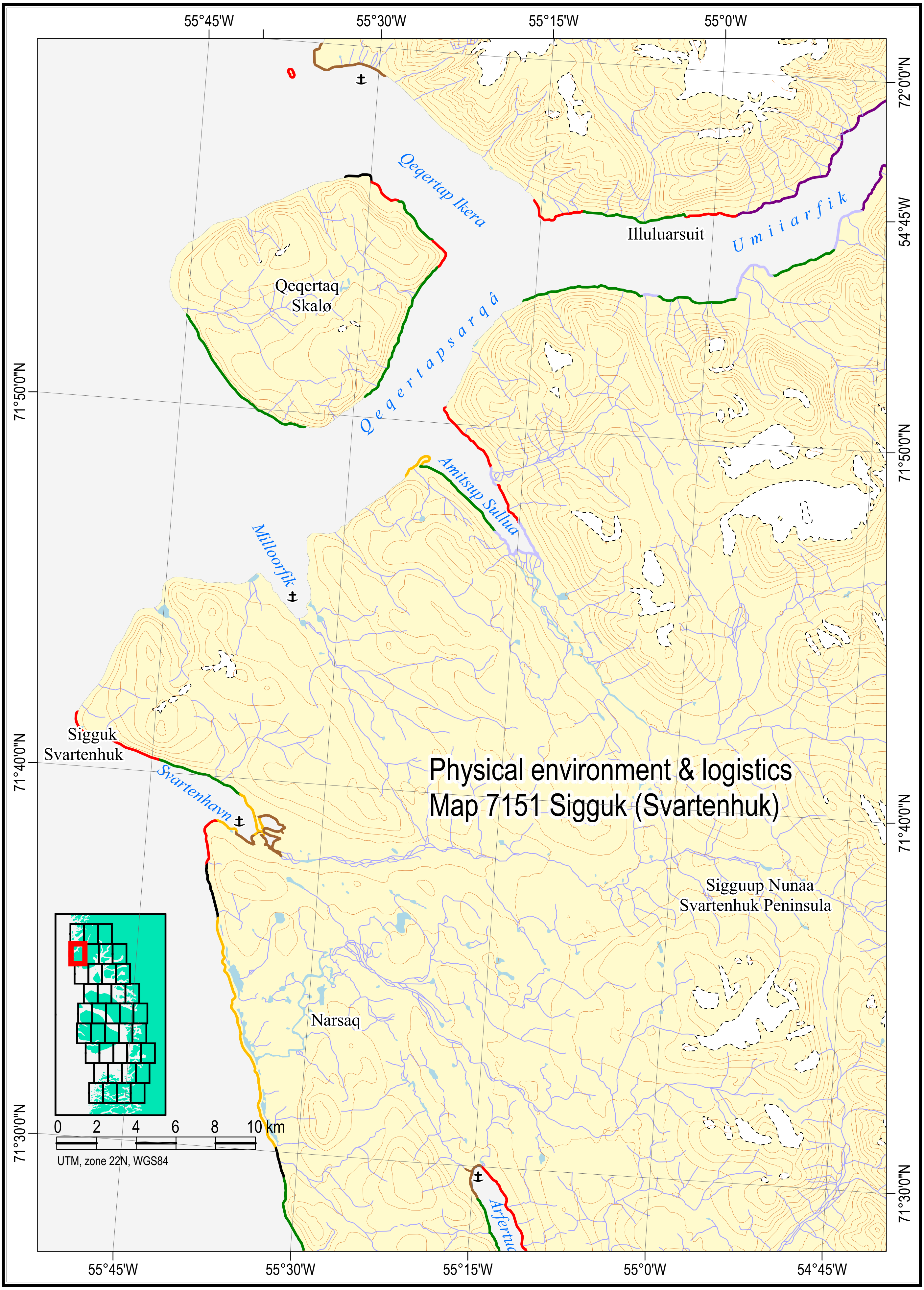
There are sections of shoreline south of and within Svartenhavn that are designated as beaches. In particular, those within the inlet have semi-protected coastal exposure. If oiled, these areas may require cleaning using sediment removal techniques along with the temporary stockpiling and subsequent removal for disposal of collected materials. In each of these areas, marine access and beach trafficability are unknown, necessitating site surveys at the time of the cleanup.

Safe havens

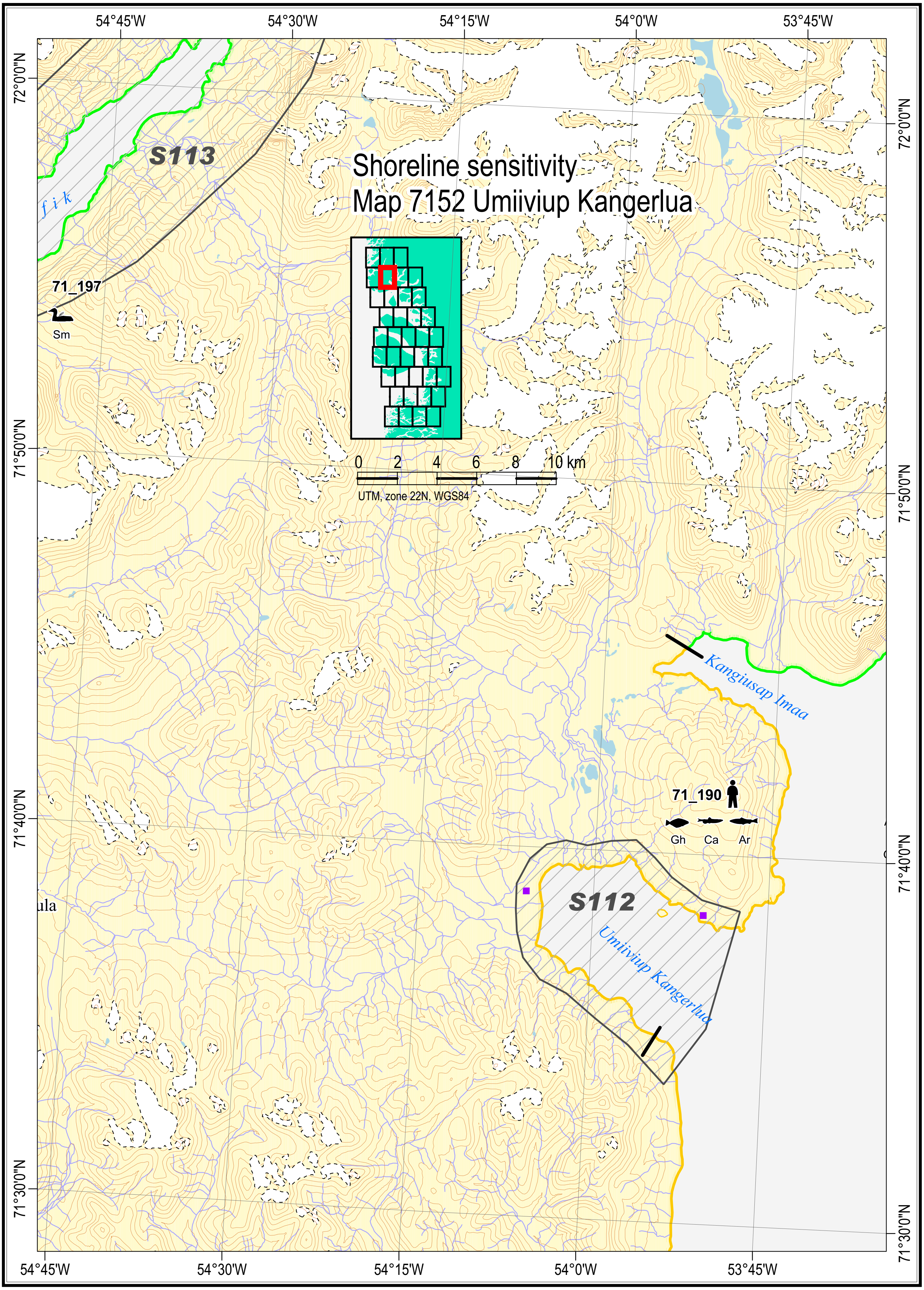
There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 71 V.1. Nautical chart: 1600.


Physical environment & logistics
Map 7151 Sigguk (Svartenhuk)
55°45'W
55°30'W
55°15'W
55°0'W
54°45'W
72°0'0"N
71°50'0"N
71°40'0"N
71°30'0"N
Qeqertap Ikera
Illuluarsuit
U m i i a r f i k
Qeqertaq
Skalø
Q e q e r t a p s a r q â
Amitsup Sullua
Millorfik
Sigguk
Svartenhuk
Svartenhavn
Sigguup Nunaa
Svartenhuk Peninsula
Narsaq
Arfertuq
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap Map legend Toggle maps Keymaps



Shoreline sensitivity

Map 7152 - Umiiviup Kangerlua

Environmental sescription

Resource use

R 71_190 Fishery for capelin (important), Greenland halibut (important) and Arctic char along coast and at 2 river outlets.

Species occurrence

Ar71190 2 important rivers with Arctic char and important fishing areas for Arctic char in the bays (**S112**).

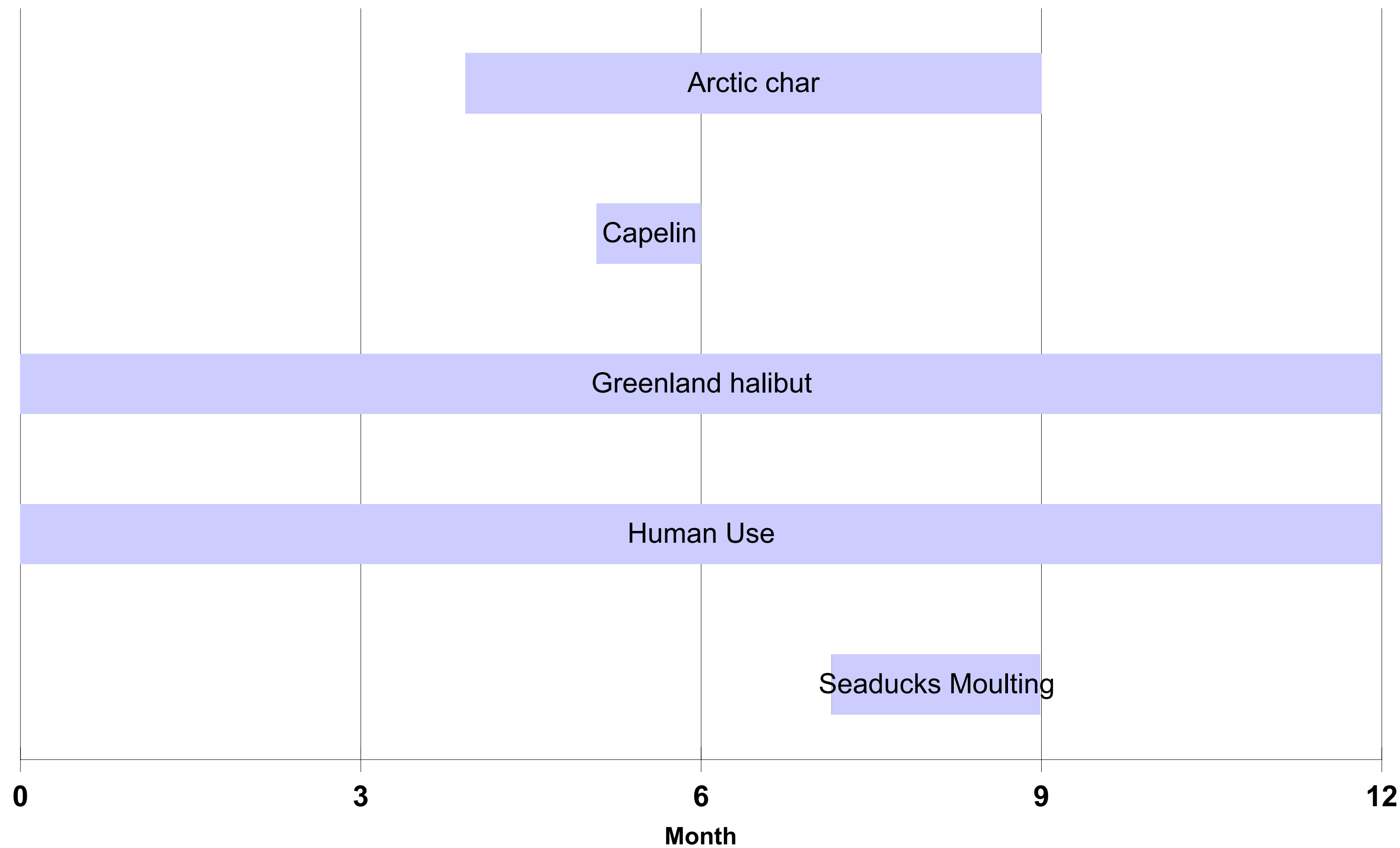
Ca71190 Capelin fishing areas (most important) along most of the coast.

Gh71190 Important fishing area for Greenland halibut.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_190	44	High

Map 7152 Species and Resource Occurrences



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Access

The nearshore waters in this area are not charted and caution should be exercised. In general, the waters offshore, nearshore, and within the fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

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

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052) and there is a heliport at Upernavik Town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow nearshore waters, which may exist within the inlets 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, including the selected area shown on the map.

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.

Exclusion booming to protect the selected area in Umiiarfik is not likely to be successful due to its width.

Shorelines shown on this map include exposed rock and talus, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Protected areas within Kangiusap Imaa and Umiiviup Kangerlua may require flushing depending on the type and degree of oiling. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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

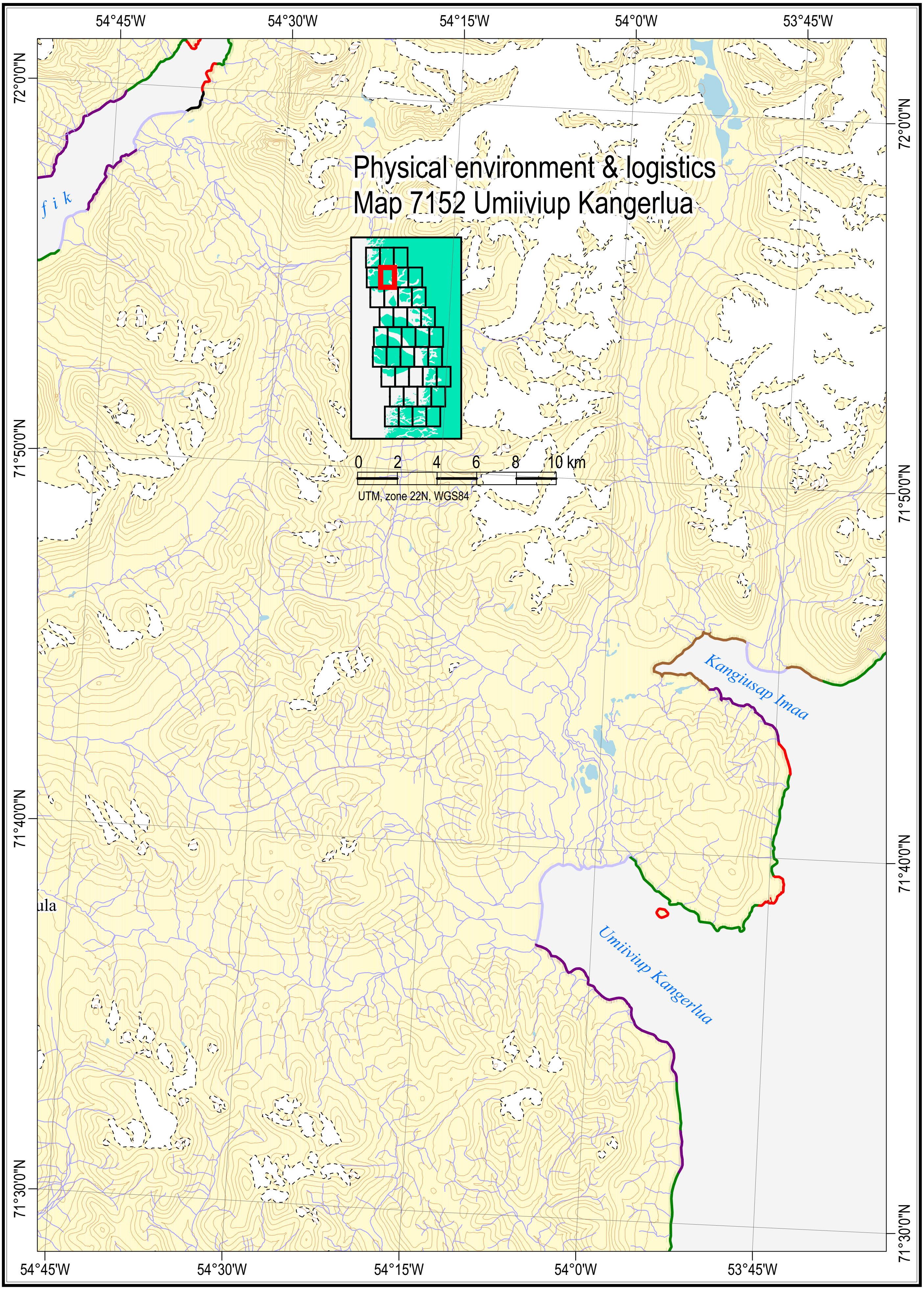
Danish Survey & Cadastre (KMS) topographical map: 71 V.1. Nautical chart: 1600.

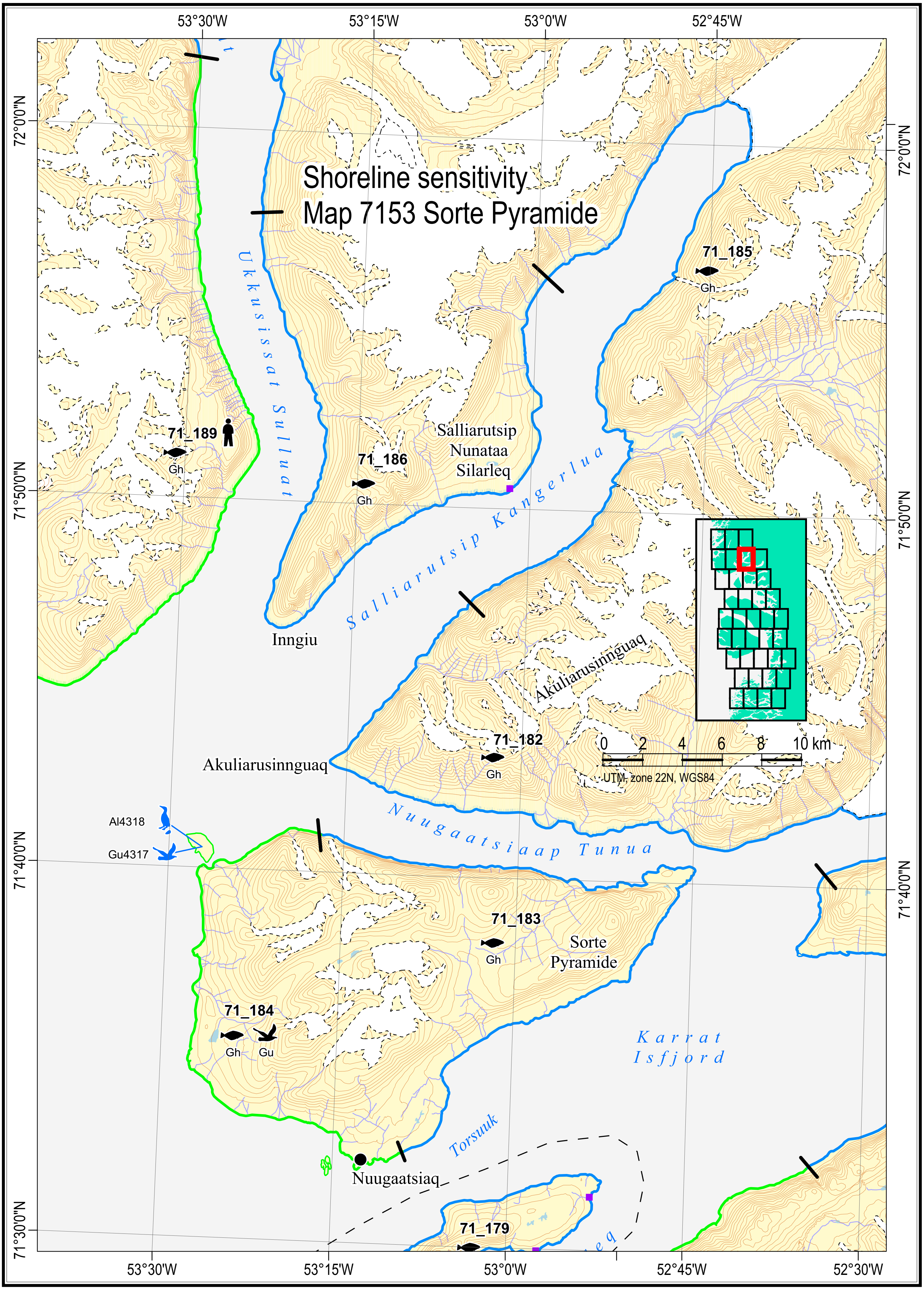
Airphoto keymap

Map legend

Toggle maps

Keymaps




Shoreline sensitivity
Map 7153 Sorte Pyramide
53°30'W
53°15'W
53°0'W
52°45'W
52°30'W
72°0'0"N
71°50'0"N
71°40'0"N
71°30'0"N
Ukkusissat Sullua
Salliarutsip Kangerlua
Nuugaatsiaap Tunua
Karrat Isfjord
Torsuuk
Salliarutsip Nunataa Silarleq
Inngiu
Akuliarusinnguaq
Akuliarusinnguaq
Sorte Pyramide
Nuugaatsiaq
71_185
71_189
71_186
71_182
71_183
71_184
71_179
Gh
Gu
Al4318
Gu4317
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Environmental description

Resource use

R 71_189	Fishery for capelin, Greenland halibut (important) and Arctic char along coasts.

Species occurrence

Gh71182, Gh71183	Important fishing area for Greenland halibut.
Gh71184, Gh71185	Important fishing area for Greenland halibut.
Gh71186, Gh71189	Important fishing area for Greenland halibut.
Gu71184	1 colony of breeding Arctic terns.

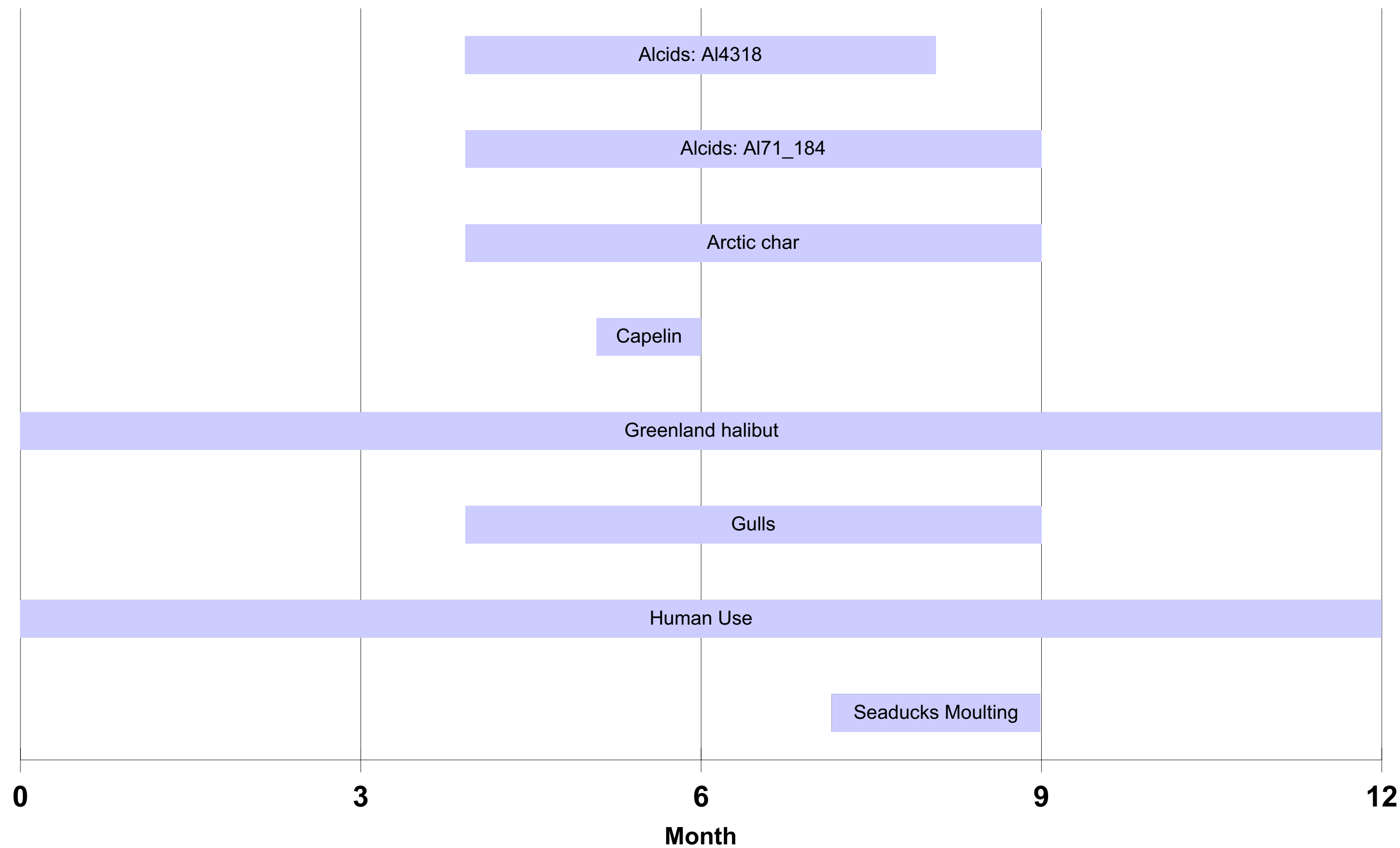
Site specific species occurrence (seabird breeding colonies); blue icons

Al4318	Breeding black guillemots.
Gu4317	Breeding Arctic terns.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_182	16	Low
71_183	20	Low
71_184	23	Moderate
71_185	17	Low
71_186	20	Low
71_189	22	Moderate

Map 7153 Species and Resource Occurrences



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Physical environment and logistics

Map 7153 - Sorte Pyramide

Access

The nearshore waters in this area are not charted and caution should be exercised. In general, the waters offshore, nearshore and within the fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

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

There are no airports on this map. The nearest airport is at Qaarsut (map 7052) and there is a heliport at Upernavik Town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas. Use of dispersants is cautioned against in shallow, nearshore waters, which may exist at the head of 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.

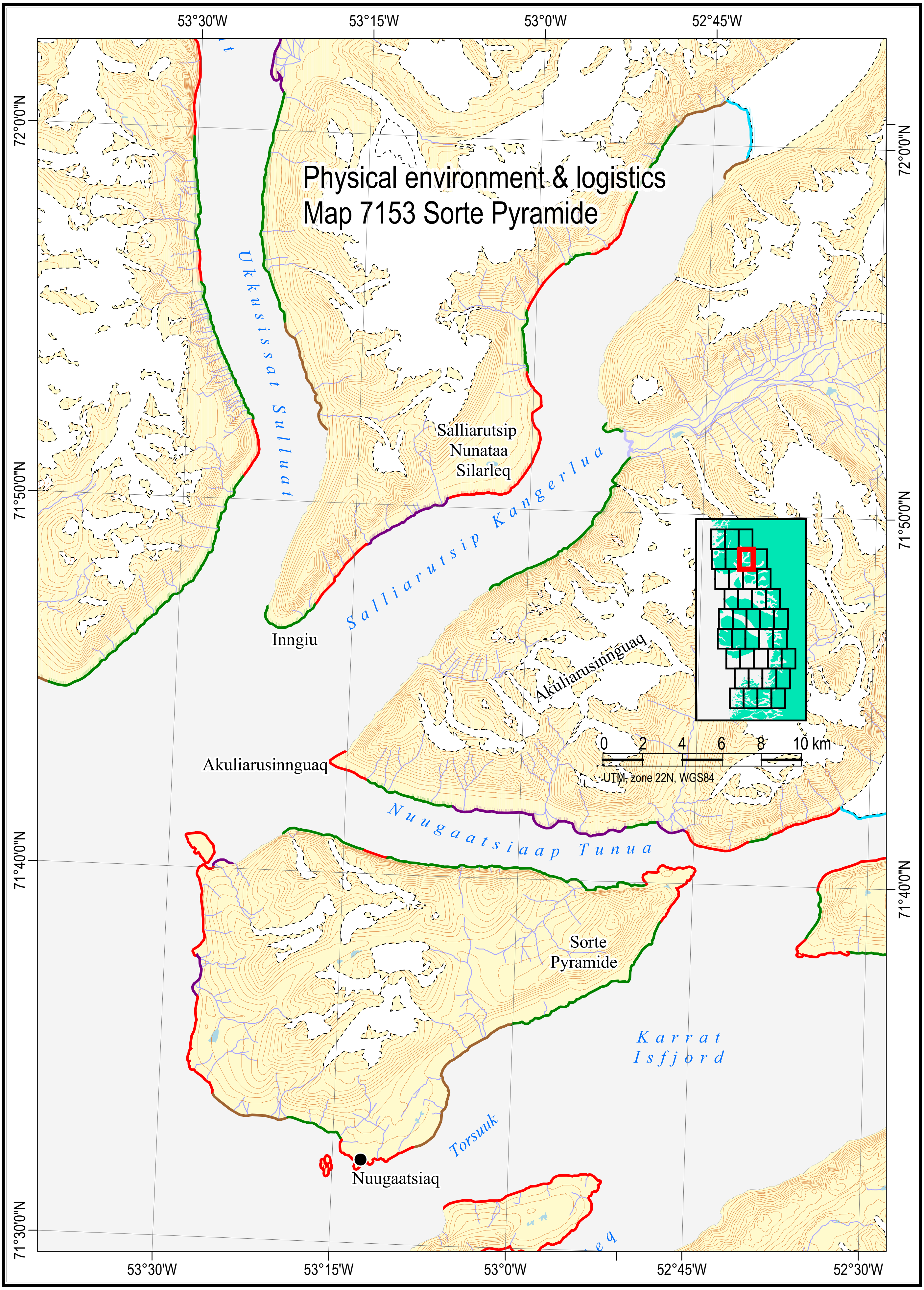
Shorelines shown on this map are predominantly exposed and semi-exposed rock and talus, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within the fjords shown on this map. Access and trafficability of these areas are unknown, but it is probable that any cleanup 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 maps: 71 V.1, 71 V.2. Nautical chart: 1600.

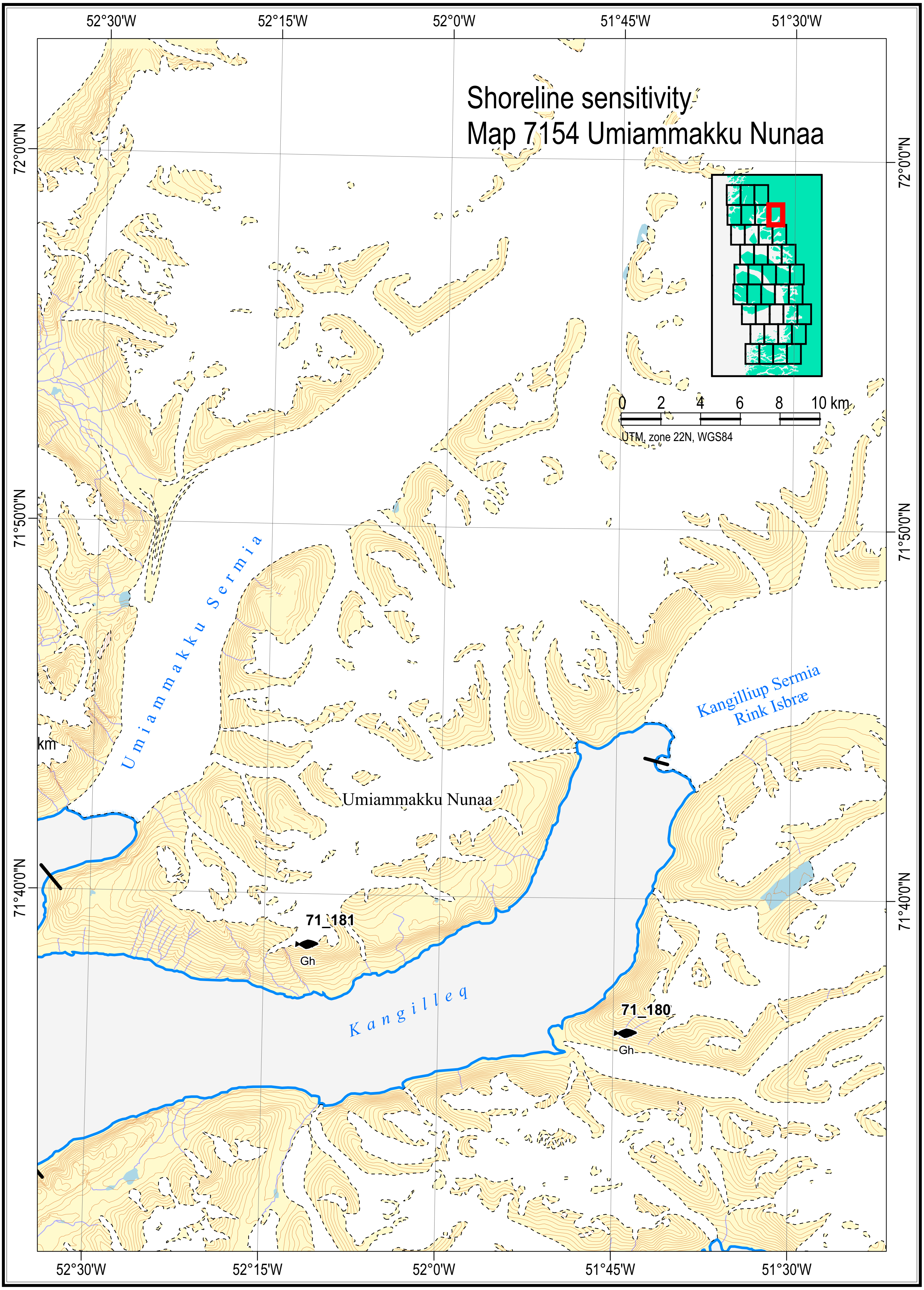

Physical environment & logistics
Map 7153 Sorte Pyramide
53°30'W
53°15'W
53°0'W
52°45'W
52°30'W
72°0'0"N
71°50'0"N
71°40'0"N
71°30'0"N
Ukkusissat Sullua t
Salliarutsip
Nunataa
Silarleq
Salliarutsip Kangerlua
Inngiu
Akuliarusinnguaq
Akuliarusinnguaq
Nuugaatsiaap Tunua
Sorte
Pyramide
Karrat
Isfjord
Torsuuk
Nuugaatsiaq
0 2 4 6 8 10 km
UTM, zone 22N, WGS84

Airphoto keymap

Map legend

Toggle maps

Keymaps



Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone (68° - 72° N)

Environmental description

Resource use

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

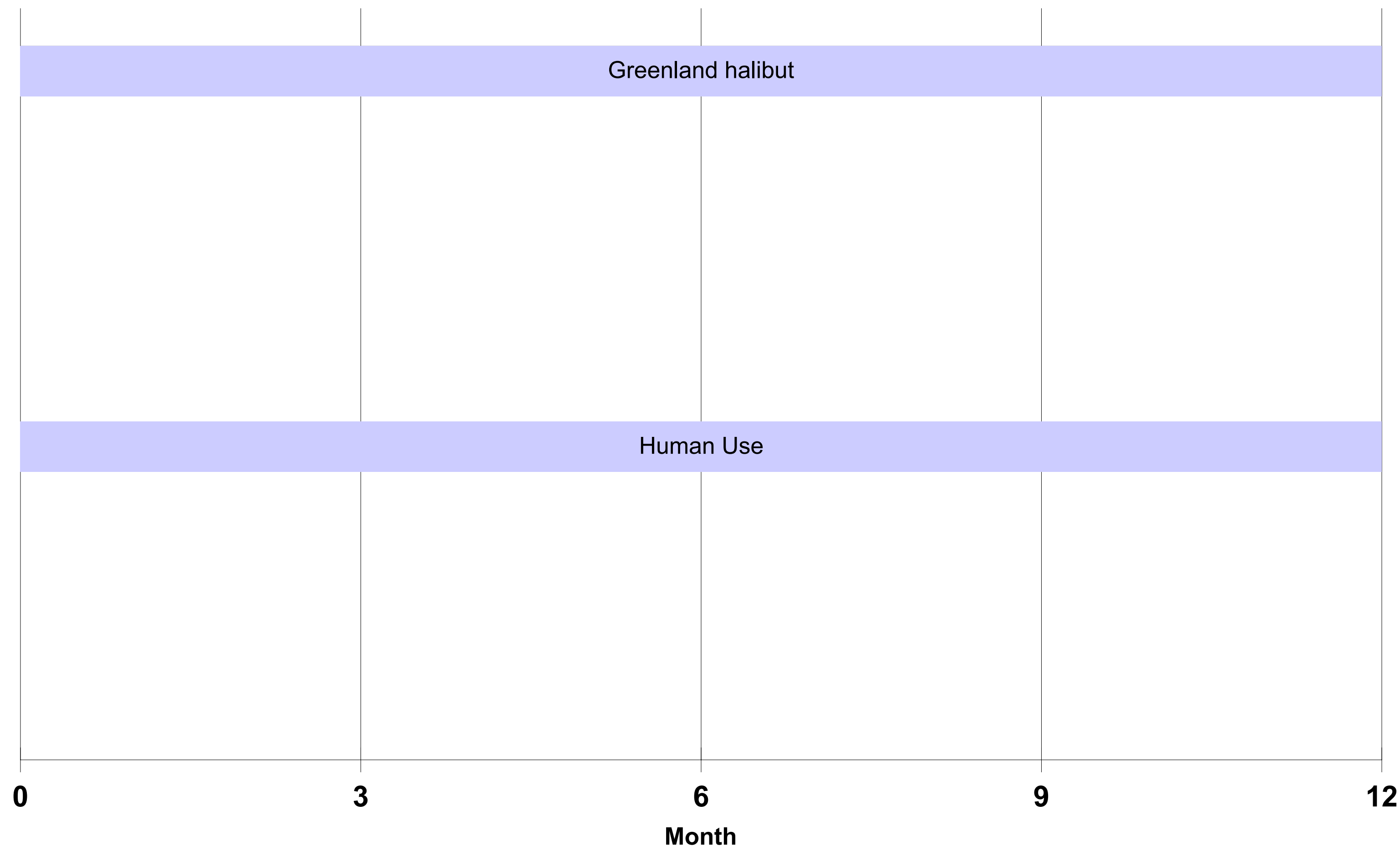
Species occurrence

Gh71180, Gh71181 Important fishing area for Greenland halibut.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
71_180	17	Low
71_181	15	Low

Map 7154 Species and Resource Occurrences



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Access

The nearshore waters in this area are largely uncharted and caution should be exercised. The fjord Kangilleq is charted with a single track of mid-channel soundings and is generally very deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within this area.

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 map. The nearest airport is at Qaarsut (map 7052) and the nearest heliport is at Upernavik Town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl 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 fjord shown on this map due to its width and the deep nearshore waters.

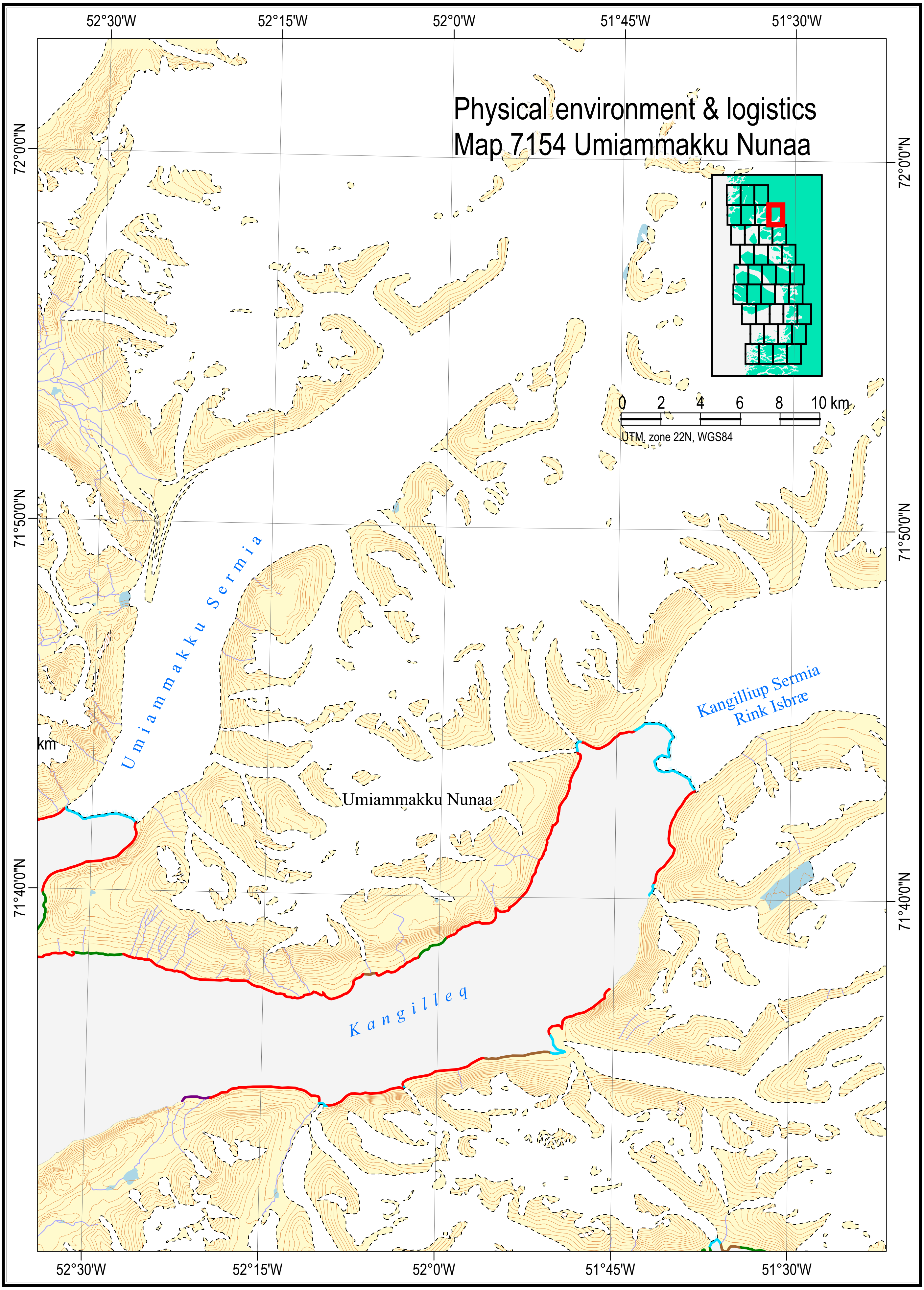
Shorelines shown on this map are predominantly semi-exposed rock, which may not require active cleaning efforts unless heavily contaminated with heavy oils. Consideration should be given to flushing operations in the protected waters within Kangilleq. Access and trafficability of this area is unknown, but it is probable that any cleanup 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: 71 V.2. Nautical charts: none.

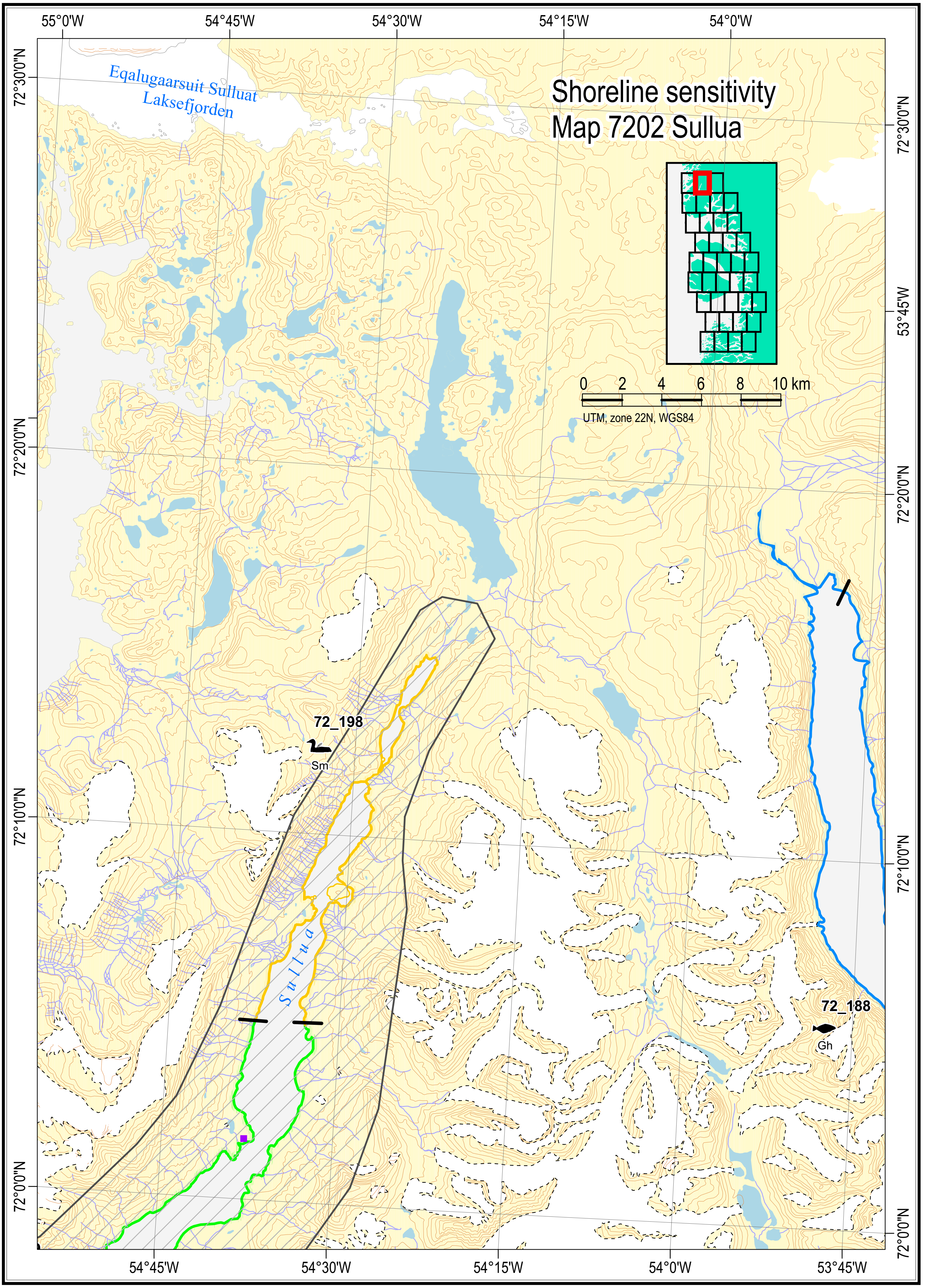

Physical environment & logistics
Map 7154 Umiammakku Nunaa
52°30'W
52°15'W
52°0'W
51°45'W
51°30'W
72°0'0"N
71°50'0"N
71°40'0"N
0
2
4
6
8
10 km
UTM, zone 22N, WGS84
Umiammakku Sermia
Kangilliup Sermia
Rink Isbræ
Umiammakku Nunaa
Kangilleq
km

Airphoto keymap

Map legend

Toggle maps

Keymaps



Shoreline sensitivity

Map 7202 - Sullua

Environmental description

Resource use

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

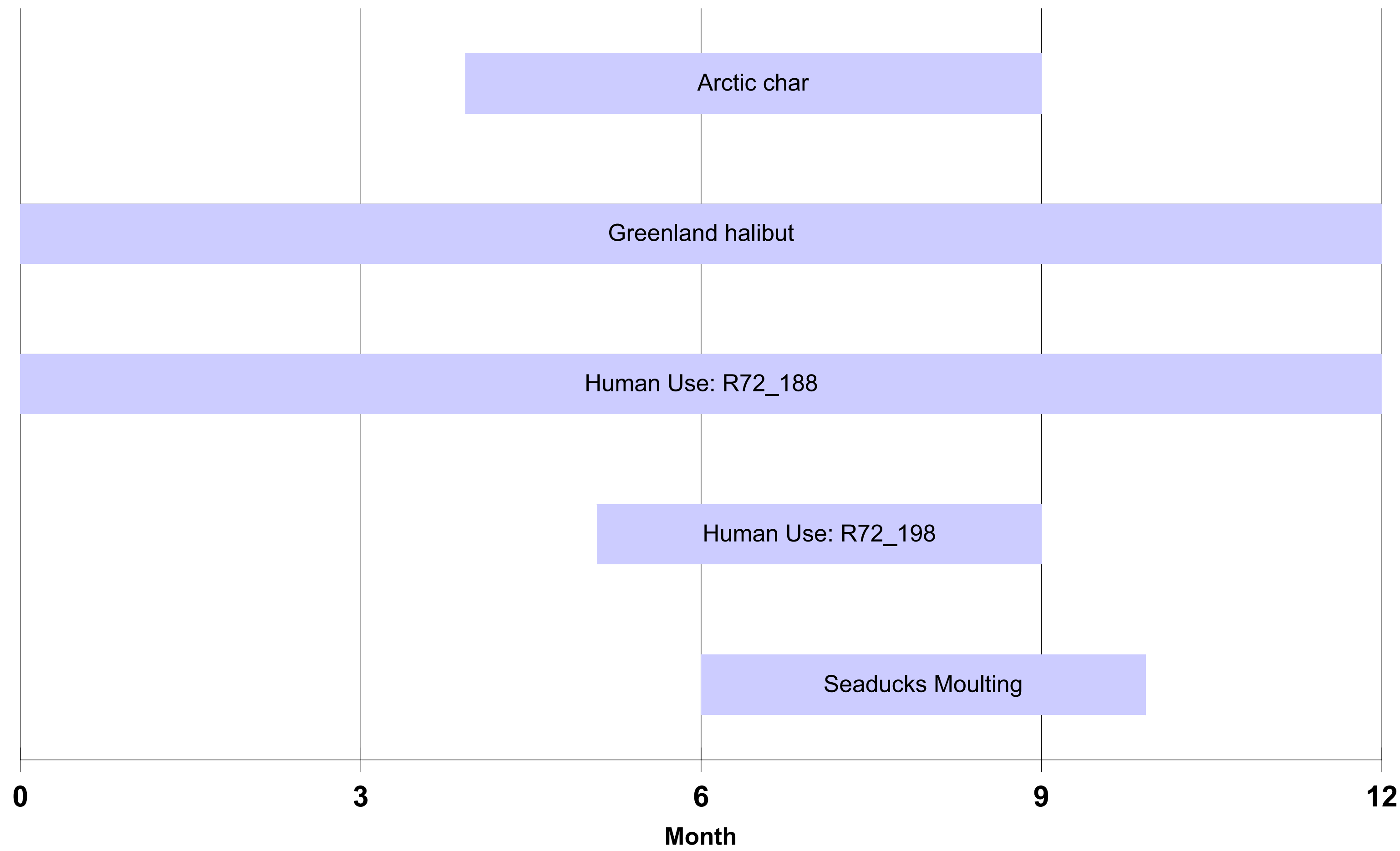
Species occurrence

Gh72188	Important fishing area for Greenland halibut.
Sm72198, Sm72199	Important moulting area for long-tailed ducks, king eiders and common eiders (**S113**).

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
72_188	18	Low
72_198	34	High

Map 7202 Species and Resource Occurrences



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Access

The nearshore waters in this area are not charted and caution should be exercised. In general, the waters within these fjords appear to be deep, however, uncharted dangers may exist. Local knowledge is essential for navigation.

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

Shorelines in this area are predominantly rock and talus 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 nearest airport is at Qaarsut (map 7052) and there is a heliport at Upernavik town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas, but is cautioned against in the protected waters at the head of fjords. 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, including the selected area shown on the map.

Although there is no information on water currents for the two fjords on this map, the tidal range (2 to 3 m) and the width of the inlets suggest that exclusion booming in these areas would not likely be successful, and therefore it is not recommended. Exclusion booming may be possible near the head of Sullua where the fjord inlet narrows. There are no soundings in this area, and shoaling is indicated.

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

One small section of the shoreline within Umiiarfik Sullua is designated as beach 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 cleanup.

Safe havens

There are no potential safe havens identified on this map.

Maps

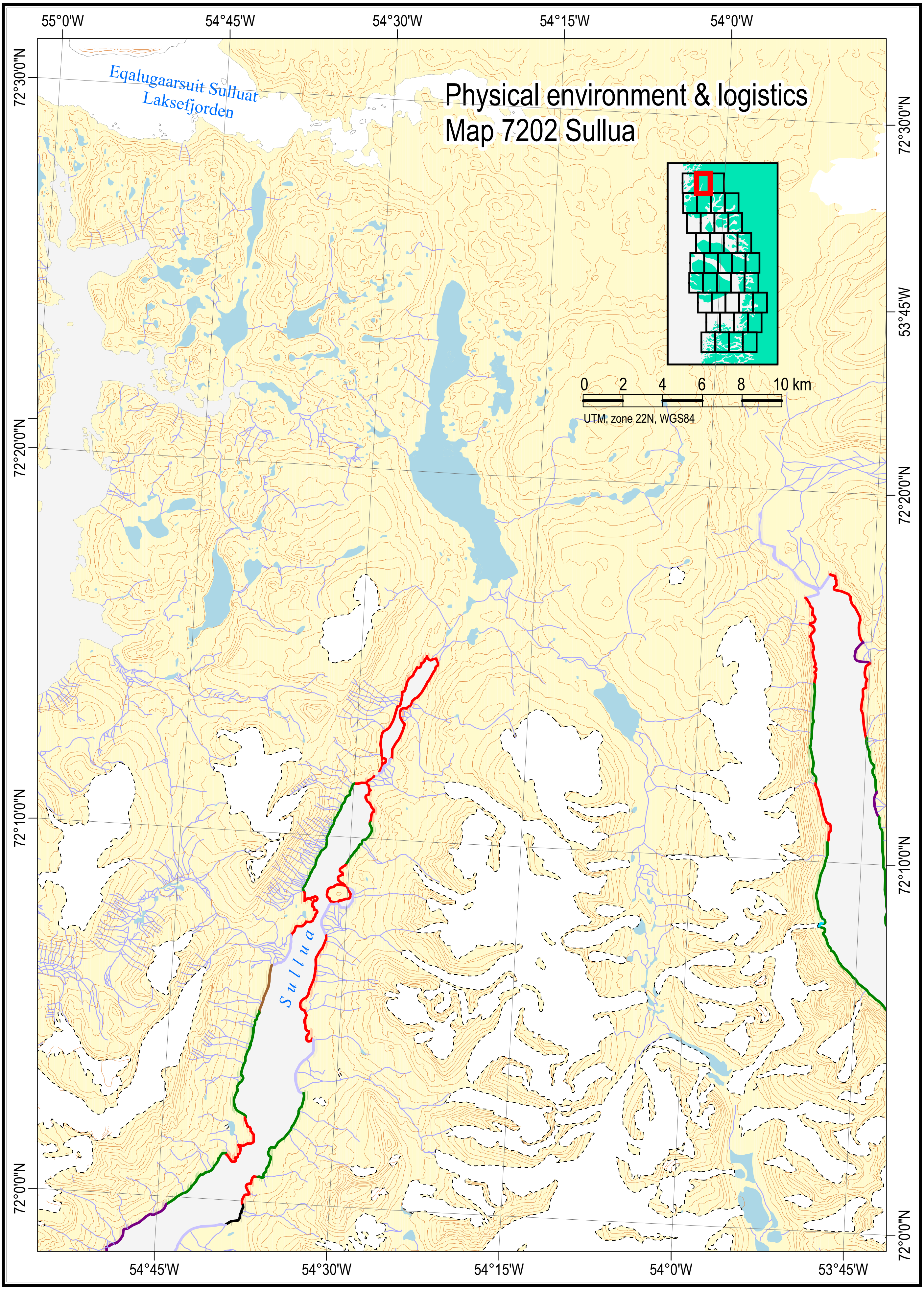
Danish Survey & Cadastre (KMS) topographical map: 72 V.1. Nautical charts: none.

Airphoto keymap

Map legend

Toggle maps

Keymaps

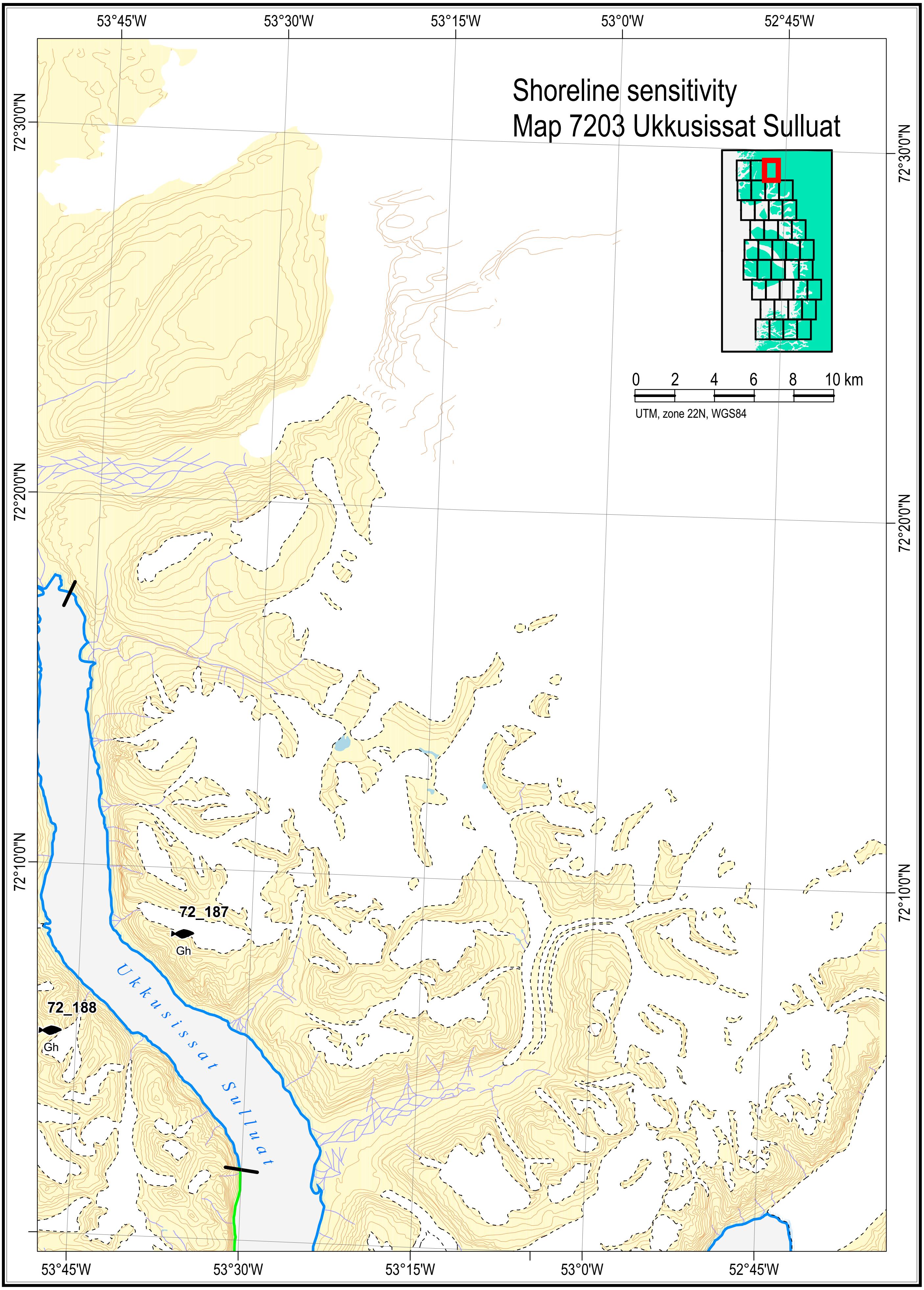


Airphoto keymap

Map legend

Toggle maps

Keymaps



Shoreline sensitivity

Map 7203 - Ukkusissat Sulluat

Environmental description

Resource use

R 72_187 Fishery for Greenland halibut (important).

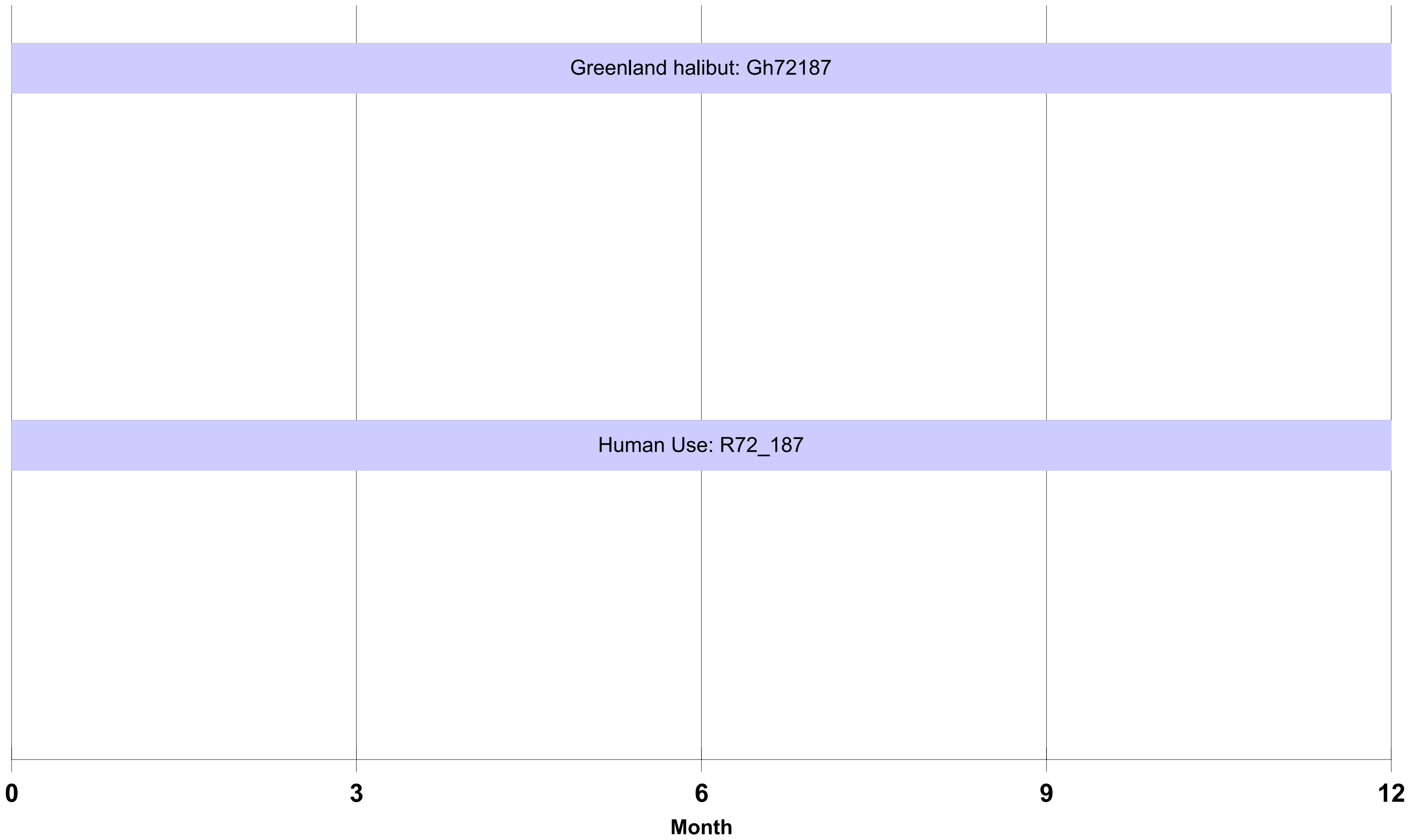
Species occurrence

Gh72187 Important fishing area for Greenland halibut.

Shoreline sensitivity summary

SEG_ID	Sensitivity	Ranking
72_187	18	Low

Map 7203 Species and Resource Occurrences



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Physical environment and logistics

Map 7203 - Ukkusissat Sulluat

Access

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

First-year ice forms in fjords and sheltered waters, however, tidal streams and stormy weather often break up the ice or prevent its formation except at the inner ends of fjords.

There is no information on tides or currents within fjords for this area.

No anchorages are reported for this map area.

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

Landings may be possible near the alluvial shoreline within this fjord but would require reconnaissance to confirm.

There are no airports on this or adjoining maps. The nearest airport is at Qaarsut (map 7052) and there is a heliport at Upernavik Town.

Countermeasures

In situ burning of oil in conjunction with tracking oiled ice is recommended in ice concentrations down to six tenths. 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 waterfowl and to prevent oil from entering inshore areas, but is cautioned against in the protected waters at the head of fjords. 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.

Although there is no information on water currents or depths for the two fjords on this map, the tidal range (2 to 3 m) and the width of the inlets suggest that exclusion booming in these areas would not likely be successful, and therefore it is not recommended.

Shorelines shown on this map are semi-exposed rock and talus, and 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 cleanup operations would be marine-based given the likely nature of the shoreline.

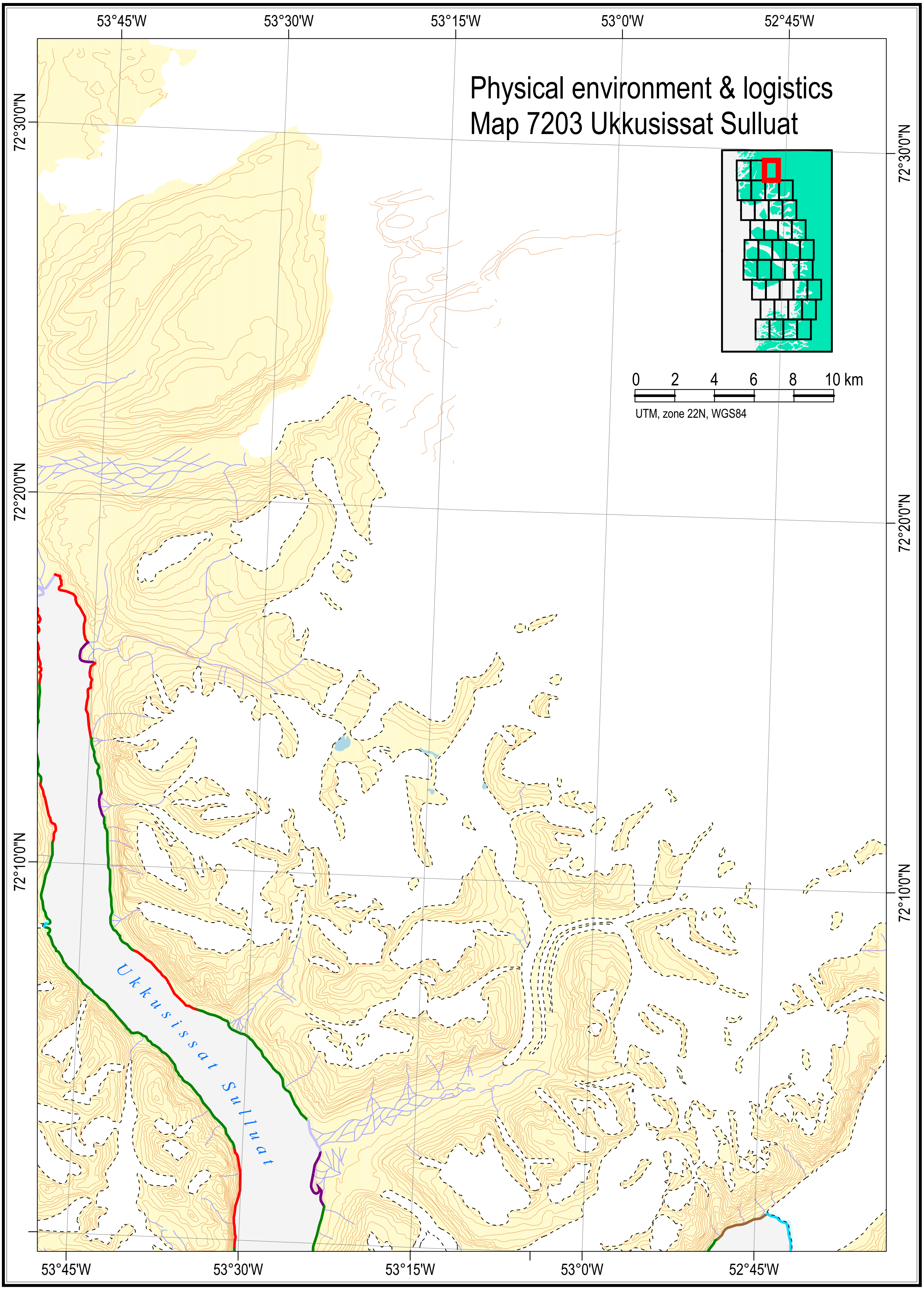
Safe havens

There are no potential safe havens identified on this map.

Maps

Danish Survey & Cadastre (KMS) topographical map: 72 V.1. Nautical charts: none.

Airphoto keymap Map legend Toggle maps Keymaps



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Addresses:

URL: http://www.dmu.dk

National Environmental Research Institute
Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

Management
Personnel and Economy Secretariat
Monitoring, Research and Advice Secretariat
Department of Policy Analysis
Department of Atmospheric Environment
Department of Marine Ecology
Department of Environmental Chemistry and Microbiology
Department of Arctic Environment

National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
Fax: +45 89 20 14 14

Monitoring, Research and Advice Secretariat
Department of Marine Ecology
Department of Terrestrial Ecology
Department of Freshwater Ecology

National Environmental Research Institute
Grenåvej 12-14, Kalø
DK-8410 Rønde
Denmark
Tel: +45 89 20 17 00
Fax: +45 89 20 15 15

Department of Wildlife Ecology and Biodiversity

Publications:
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This oil spill sensitivity atlas covers the shoreline and the offshore areas of West Greenland between 68º N and 72º N. The coastal zone is divided into nearly 200 areas and the offshore zone into 8 areas. A sensitivity index value is calculated for each area, and each area is subsequently ranked according to four degrees of sensitivity. Besides this general ranking a number of smaller areas are especially selected because they are of particular significance, they are particularly vulnerable to oil spill and, an effective oil spill response can be performed. The shoreline sensitivity ranking is shown on 37 maps (in scale 1:250,000), which also show the different elements included. These maps also show the selected areas. Coast types, logistics and proposed response methods along the coasts are shown on another 38 maps. The sensitivities of the offshore zones are depicted on 4 maps, one for each season. Based on all the information, appropriate oil spill response methods have been assessed for each area.

National Environmental Research Institute
Ministry of the Environment

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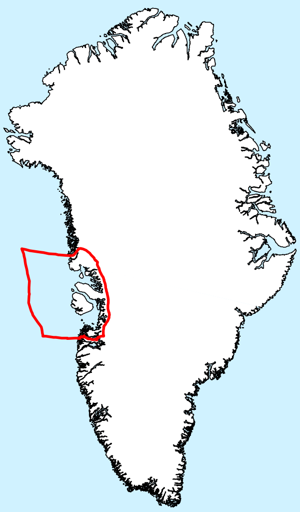
Appendices

Environmental Oil Spill Sensitivity Atlas for the West Greenland (68°-72° N) Coastal Zone



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11. Appendix A

Shoreline sensitivity ranking

Explanation to calculations used in the table

Assigned value x Weighting factor = **Prority index** **Sensitivity value =** sum of Prioty Indices

For biological elements:

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

Formula for calculation of the sensitivity value of shoreline areas. Bold abbreviations indicate factors wich appear in the column headlines for the Shoreline Sensitivity ranking table. The Oil Residence Value (ORI) is a row heading. The For further explanation see Chapter 6.3 and Chapter 14.

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_1	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				4.07	6.10		
		Deep sea shrimp	7	1	1	1.94	3.39		
								27	Moderate
68_2	6801	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				9.25	18.50		
		Oil residency index				3.21	4.82		
								27	Moderate
68_3	6801	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.65	3.30		
		Oil residency index				1.75	2.62		
		Deep sea shrimp	7	1	1	0.83	1.46		
		Seaducks	23	5	0.75	10.25	17.94		
								29	Moderate
68_4	6801	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.75	2.62		
		Seaducks	23	5	0.75	10.26	17.95		
								25	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_5	6801	Human Use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.50	9.00		
		Oil residency index				2.28	3.43		
		Deep sea shrimp	7	1	1	1.09	1.90		
		Seaducks	23	5	0.75	13.40	23.45		
								48	Extreme
68_6	6801	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.00	2.00		
		Oil residency index				2.00	3.00		
		Deep sea shrimp	7	2	1	1.90	3.33		
		Seaducks	23	5	0.75	11.73	20.54		
								35	High
68_7	6801	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				3.42	5.12		
		Seaducks	23	5	0.75	20.04	35.08		
								54	Extreme
68_8	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.70	11.40		
		Oil residency index				2.26	3.39		
		Seaducks	23	5	0.75	13.27	23.23		
								46	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_9	6801	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				7.55	15.10		
		Oil residency index				2.08	3.11		
		Alcids [hvad er det???? Auk?]	25	3	0.5	5.30	9.27		
		Gulls	17	1	0.5	1.20	2.10		
		Seaducks	23	5	0.75	12.18	21.32		
		Seaducks breeding	23	1	0.5	1.62	2.84		
								60	Extreme
68_10	6802	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.95	3.90		
		Oil residency index				2.51	3.77		
		Seaducks	23	5	0.75	14.73	25.78		
								43	High
68_11	6802	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.36	5.04		
		Alcids	25	1	0.5	2.86	5.00		
		Gulls	17	3	0.5	5.83	10.20		
		Seaducks	23	3	0.25	3.94	6.90		
								33	High
68_12	6802	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				1.55	3.10		
		Oil residency index				2.14	3.21		
		Seaducks	23	5	0.75	12.56	21.98		
								42	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_13	6802	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.35	2.70		
		Oil residency index				2.30	3.45		
		Gulls	17	3	0.5	3.99	6.98		
								21	Low
68_14	6803	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.52	3.78		
		Seaducks moulting	23	1	0.25	0.98	1.72		
								9	Low
68_15	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.47	3.70		
		Seaducks moulting	23	1	0.25	0.97	1.69		
								7	Low
68_16	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.61	3.91		
		Alcids	25	1	0.5	2.22	3.88		
		Deep sea shrimp	7	1	1	1.24	2.17		
		Gulls	17	1	0.5	1.51	2.64		
		Seaducks breeding	23	2	0.5	4.08	7.14		
								22	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_17	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.30	3.45		
		Alcids	25	1	0.5	1.95	3.42		
		Gulls	17	2	0.5	2.66	4.65		
								14	Low
68_18	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.29	3.43		
		Deep sea shrimp	7	1	1	1.09	1.91		
		Gulls	17	2	0.5	2.64	4.63		
								12	Low
68_19	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.54	5.31		
								7	Low
68_20	6802	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.84	4.26		
								14	Low
68_21	6803	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.74	4.11		
								16	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_22	6803	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.38	3.57		
		Cormorants	19	1	0.5	1.54	2.69		
		Gulls	17	1	0.5	1.37	2.41		
		Seaducks breeding	23	3	0.5	5.58	9.76		
		Seaducks moulting	23	1	0.25	0.93	1.63		
								24	Moderate
68_23	6803	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				4.13	6.19		
		Gulls	17	3	0.5	7.16	12.53		
								23	Moderate
68_24	6803	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				10.00	15.00		
		Communities				0.00	0.00		
		Oil residency index				4.39	6.59		
		Seaducks moulting	23	1	0.25	1.72	3.01		
								29	Moderate
68_25	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.92	4.39		
		Seaducks breeding	23	5	0.5	11.44	20.02		
		Seaducks moulting	23	3	0.25	3.43	6.01		
								40	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_26	6804	Human use				1.00	2.00		
		Archaeological sites				3.00	6.00		
		Special status areas				10.00	15.00		
		Communities				0.00	0.00		
		Oil residency index				2.64	3.97		
		Gulls	17	3	0.5	4.59	8.03		
		Seaducks breeding	23	2	0.5	4.14	7.24		
		Seaducks moulting	23	5	0.25	5.17	9.05		
								51	Extreme
68_27	6803	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				10.00	15.00		
		Communities				0.00	0.00		
		Oil residency index				2.65	3.97		
		Arctic char	14	1	0.5	1.26	2.21		
		Gulls	17	2	0.5	3.06	5.36		
		Seaducks breeding	23	3	0.5	6.22	10.88		
		Seaducks moulting	23	2	0.25	2.07	3.63		
								47	Extreme
68_28	6803	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				10.00	15.00		
		Communities				0.00	0.00		
		Oil residency index				4.06	6.09		
		Cormorants	19	1	0.5	2.62	4.59		
		Gulls	17	1	0.5	2.35	4.11		
		Seaducks moulting	23	1	0.25	1.59	2.78		
								35	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_29	6803	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.94	4.42		
		Deep sea shrimp	7	1	1	1.40	2.45		
		Gulls	17	1	0.5	1.70	2.98		
								21	Low
68_30	6802	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				3.34	5.01		
		Alcids	25	1	0.5	2.84	4.97		
		Deep sea shrimp	7	1	1	1.59	2.79		
		Gulls	17	1	0.5	1.93	3.38		
								26	Moderate
68_31	6802	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.10	4.20		
		Oil residency index				2.62	3.92		
								12	Low
68_32	6802	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				2.35	4.70		
		Oil residency index				4.20	6.30		
		Deep sea shrimp	7	1	1	2.00	3.50		
								17	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_33	6802	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.42	3.63		
		Seaducks	23	5	0.75	14.20	24.85		
		Seaducks moulting	23	1	0.25	0.95	1.66		
								48	Extreme
68_34	6802	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.30	10.60		
		Oil residency index				2.19	3.28		
		Seaducks	23	5	0.75	12.84	22.47		
								40	High
68_35	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				3.40	6.80		
		Oil residency index				2.41	3.62		
		Seaducks	23	5	0.75	14.15	24.77		
								43	High
68_36	6802	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				1.10	2.20		
		Oil residency index				3.28	4.92		
								15	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_37	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.75	5.50		
		Oil residency index				2.52	3.78		
		Seaducks	23	5	0.75	14.79	25.87		
								43	High
68_38	6801	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				3.35	6.70		
		Oil residency index				2.33	3.50		
								14	Low
68_39	6801	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.65	3.98		
		Deep sea shrimp	7	1	1	1.26	2.21		
		Seaducks	23	5	0.75	15.56	27.23		
								49	Extreme
68_40	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.07	3.10		
		Seaducks	23	5	0.75	12.13	21.22		
								42	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_41	6801	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				3.25	6.50		
		Oil residency index				1.71	2.57		
		Alcids nonbreeding	21	1	0.25	0.61	1.07		
		Deep sea shrimp	7	3	1	2.44	4.28		
		Seaducks	23	5	0.75	10.04	17.57		
								46	Extreme
68_42	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				1.92	2.88		
		Alcids Nonbreeding	21	1	0.25	0.69	1.20		
		Seaducks	23	5	0.75	11.27	19.72		
								42	High
68_43	6801	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				4.00	8.00		
		Oil residency index				2.83	4.24		
								18	Low
68_44	6801	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				1.70	3.40		
		Oil residency index				3.49	5.23		
								15	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_45	6801	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.63	3.94		
								10	Low
68_46	6802	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.06	4.59		
		Alcids	25	1	0.5	2.60	4.56		
		Deep sea shrimp	7	1	1	1.46	2.55		
		Gulls	17	1	0.5	1.77	3.10		
								21	Low
68_47	6802	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				4.30	6.46		
		Alcids	25	1	0.5	3.66	6.40		
		Arctic char	14	2	0.5	4.10	7.17		
		Capelin	21	1	0.25	1.54	2.69		
		Gulls	17	2	0.5	4.98	8.71		
								45	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_48	6802	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				4.02	6.03		
		Alcids	25	1	0.5	3.42	5.99		
		Capelin	21	1	0.25	1.44	2.51		
		Gulls	17	1	0.5	2.33	4.07		
								23	Moderate
68_49	6852	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				4.12	6.18		
		Capelin	21	3	0.25	4.42	7.73		
								18	Low
68_50	6852	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				2.30	4.60		
		Oil residency index				3.62	5.42		
		Alcids	25	4	0.5	12.30	21.52		
		Capelin	21	3	0.25	3.87	6.78		
		Lumpsucker	15	4	0.25	3.69	6.46		
		Seaducks moulting	23	1	0.25	1.41	2.47		
								65	Extreme
68_51	6852	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				1.50	3.00		
		Oil residency index				3.64	5.46		
		Capelin	21	5	0.25	6.50	11.38		
		Lumpsucker	15	5	0.25	4.64	8.13		
								43	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_52	6853	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.05	3.07		
		Arctic char	14	1	0.5	0.98	1.71		
		Capelin	21	3	0.25	2.20	3.84		
		Gulls	17	4	0.5	4.74	8.30		
		Lumpsucker	15	5	0.25	2.61	4.58		
		Seaducks	23	1	0.25	0.80	1.40		
								38	High
68_53	6853	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.76	4.14		
		Alcids	25	1	0.5	2.34	4.10		
		Arctic char	14	1	0.5	1.31	2.30		
		Capelin	21	1	0.25	0.98	1.72		
		Cormorants	19	2	0.5	3.56	6.24		
		Deep sea shrimp	7	1	1	1.31	2.30		
		Gulls	17	2	0.5	3.19	5.58		
		Lumpsucker	15	5	0.25	3.52	6.15		
								46	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_54	6853	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.38	5.07		
		Alcids	25	1	0.5	2.87	5.03		
		Arctic char	14	2	0.5	3.22	5.63		
		Capelin	21	2	0.25	2.41	4.22		
		Cormorants	19	1	0.5	2.18	3.82		
		Gulls	17	2	0.5	3.91	6.84		
		Lumpsucker	15	1	0.25	0.86	1.51		
		Seaducks moulting	23	1	0.25	1.32	2.31		
								44	High
68_55	6853	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.66	4.00		
		Alcids	25	1	0.5	2.27	3.97		
		Alcids nonbreeding	21	2	0.25	1.90	3.33		
		Capelin	21	1	0.25	0.95	1.67		
		Cormorants	19	2	0.5	3.44	6.03		
		Deep sea shrimp	7	1	1	1.27	2.22		
		Gulls	17	4	0.5	6.16	10.79		
		Lumpsucker	15	5	0.25	3.40	5.95		
								52	Extreme
68_56	6853	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.17	3.26		
		Alcids nonbreeding	21	2	0.25	1.55	2.71		
		Deep sea shrimp	7	1	1	1.03	1.81		
		Lumpsucker	15	5	0.25	2.77	4.85		
		Seaducks	23	2	0.25	1.70	2.97		
								30	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_57	6852	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				3.95	7.90		
		Oil residency index				3.16	4.74		
		Alcids	25	1	0.5	2.69	4.71		
		Alcids nonbreeding	21	2	0.25	2.26	3.95		
		Capelin	21	3	0.25	3.39	5.93		
		Deep sea shrimp	7	1	1	1.51	2.64		
		Gulls	17	3	0.5	5.49	9.60		
		Lumpsucker	15	5	0.25	4.03	7.06		
								64	Extreme
68_58	6852	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.79	4.18		
		Alcids nonbreeding	21	2	0.25	1.99	3.48		
		Capelin	21	2	0.25	1.99	3.48		
		Deep sea shrimp	7	1	1	1.33	2.32		
		Lumpsucker	15	4	0.25	2.84	4.97		
		Seaducks	23	2	0.25	2.18	3.81		
								48	Extreme
68_59	6852	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.90	5.80		
		Oil residency index				3.05	4.57		
		Alcids nonbreeding	21	2	0.25	2.18	3.81		
		Capelin	21	3	0.25	3.26	5.71		
		Deep sea shrimp	7	1	1	1.45	2.54		
		Lumpsucker	15	5	0.25	3.89	6.80		
		Seaducks	23	3	0.25	3.58	6.26		
								45	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_60	6852	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.72	5.59		
		Capelin	21	1	0.25	1.33	2.33		
		Lumpsucker	15	1	0.25	0.95	1.66		
								22	Low
68_61	6852	Human use				3.00	6.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.16	4.74		
		Capelin	21	5	0.25	5.64	9.88		
								31	Moderate
68_62	6851	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.71	5.57		
		Capelin	21	3	0.25	3.98	6.96		
								27	Moderate
68_63	6851	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.70	5.55		
		Capelin	21	4	0.25	5.29	9.25		
								21	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_64	6851	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.67	4.01		
		Capelin	21	4	0.25	3.81	6.68		
								23	Moderate
68_65	6801	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.42	5.14		
		Capelin	21	2	0.25	2.45	4.28		
								13	Low
68_66	6801	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.04	4.55		
		Alcids	25	1	0.5	2.58	4.52		
		Gulls	17	1	0.5	1.76	3.07		
								16	Low
68_67	6801	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.11	4.67		
		Capelin	21	1	0.25	1.11	1.95		
								13	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_68	6801	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.71	2.57		
		Capelin	21	1	0.25	0.61	1.07		
		Deep sea shrimp	7	1	1	0.82	1.43		
								13	Low
68_69	6801	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.15	0.30		
		Oil residency index				2.10	3.14		
		Deep sea shrimp	7	1	1	1.00	1.75		
								13	Low
68_70	6801	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				1.40	2.10		
		Alcids nonbreeding	21	1	0.25	0.50	0.88		
		Gulls	17	3	0.5	2.43	4.26		
		Seaducks	23	3	0.25	1.65	2.88		
								24	Moderate
68_71	6801	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.00	3.01		
		Alcids nonbreeding	21	2	0.25	1.43	2.50		
		Deep sea shrimp	7	3	1	2.86	5.01		
		Gulls	17	1	0.5	1.16	2.03		
		Seaducks	23	2	0.25	1.57	2.74		
								19	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_72	6851	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.22	1.83		
		Seaducks	23	2	0.25	0.95	1.67		
		Seaducks moulting	23	1	0.25	0.48	0.83		
								6	Low
68_73	6851	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.38	2.07		
		Deep sea shrimp	7	1	1	0.66	1.15		
		Seaducks	23	2	0.25	1.08	1.89		
		Seaducks moulting	23	1	0.25	0.54	0.95		
								10	Low
68_74	6851	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.62	2.42		
		Alcids	25	1	0.5	1.37	2.40		
		Deep sea shrimp	7	1	1	0.77	1.35		
		Gulls	17	1	0.5	0.93	1.64		
		Seaducks	23	2	0.25	1.26	2.21		
		Seaducks moulting	23	1	0.25	0.63	1.11		
								15	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_75	6851	Human use				1.00	2.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.86	2.79		
		Alcids	25	2	0.5	3.17	5.54		
		Gulls	17	3	0.5	3.23	5.65		
		Seaducks	23	2	0.25	1.46	2.55		
								25	Moderate
68_76	6851	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.93	2.89		
		Alcids	25	1	0.5	1.64	2.87		
		Deep sea shrimp	7	3	1	2.75	4.82		
		Gulls	17	2	0.5	2.23	3.90		
		Lumpsucker	15	2	0.25	0.98	1.72		
		Seaducks	23	2	0.25	1.51	2.64		
								25	Moderate
68_77	6851	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.25	8.50		
		Oil residency index				2.00	3.00		
		Alcids nonbreeding	21	2	0.25	1.43	2.50		
		Lumpsucker	15	1	0.25	0.51	0.89		
		Seaducks	23	2	0.25	1.57	2.74		
								30	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_78	6851	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.10	10.20		
		Oil residency index				2.17	3.25		
		Alcids nonbreeding	21	2	0.25	1.55	2.71		
		Deep sea shrimp	7	1	1	1.03	1.81		
		Gulls	17	2	0.5	2.51	4.39		
		Lumpsucker	15	1	0.25	0.55	0.97		
		Seaducks	23	2	0.25	1.70	2.97		
								38	High
68_79	6851	Human use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				1.96	2.95		
		Capelin	21	1	0.25	0.70	1.23		
		Seaducks	23	2	0.25	1.54	2.69		
								27	Moderate
68_80	6851	Human use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				2.50	5.00		
		Oil residency index				2.21	3.32		
		Capelin	21	3	0.25	2.37	4.15		
		Seaducks	23	2	0.25	1.73	3.03		
								26	Moderate
68_81	6851	Human use				3.00	6.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				0.30	0.60		
		Oil residency index				2.25	3.37		
		Capelin	21	5	0.25	4.02	7.03		
								27	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_82	6851	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				3.63	5.44		
		Arctic char	14	1	0.5	1.73	3.02		
		Capelin	21	2	0.25	2.59	4.53		
		Deep sea shrimp	7	1	1	1.73	3.02		
		Seaducks	23	2	0.25	2.84	4.96		
								35	High
68_83	6851	Human use				1.00	2.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.77	4.16		
		Alcids	25	1	0.5	2.36	4.13		
		Capelin	21	3	0.25	2.97	5.20		
		Gulls	17	1	0.5	1.60	2.81		
		Seaducks	23	2	0.25	2.17	3.80		
								38	High
68_84	6852	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.65	5.30		
		Oil residency index				1.74	2.60		
		Alcids	25	1	0.5	1.48	2.58		
		Alcids nonbreeding	21	2	0.25	1.24	2.17		
		Deep sea shrimp	7	5	1	4.13	7.23		
		Gulls	17	5	0.5	5.02	8.78		
		Lumpsucker	15	3	0.25	1.33	2.32		
		Seaducks	23	2	0.25	1.36	2.38		
								41	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_85	6852	Human use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				3.75	7.50		
		Oil residency index				2.82	4.23		
		Alcids	25	1	0.5	2.40	4.20		
		Alcids nonbreeding	21	2	0.25	2.01	3.52		
		Capelin	21	2	0.25	2.01	3.52		
		Gulls	17	4	0.5	6.52	11.41		
		Lumpsucker	15	2	0.25	1.44	2.52		
		Seaducks	23	2	0.25	2.21	3.86		
								51	Extreme
68_86	6852	Human use				3.00	6.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.44	3.66		
		Alcids nonbreeding	21	2	0.25	1.74	3.05		
		Capelin	21	3	0.25	2.62	4.58		
		Gulls	17	3	0.5	4.23	7.41		
		Lumpsucker	15	5	0.25	3.11	5.45		
		Seaducks	23	2	0.25	1.91	3.34		
								53	Extreme
68_87	6852	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.70	9.40		
		Oil residency index				2.68	4.02		
		Alcids nonbreeding	21	2	0.25	1.91	3.35		
		Arctic char	14	1	0.5	1.28	2.23		
		Capelin	21	4	0.25	3.83	6.70		
		Lumpsucker	15	4	0.25	2.73	4.79		
		Seaducks	23	2	0.25	2.10	3.67		
								48	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_88	6852	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				4.20	6.30		
		Capelin	21	4	0.25	6.00	10.49		
		Deep sea shrimp	7	1	1	2.00	3.50		
		Lumpsucker	15	1	0.25	1.07	1.87		
								36	High
68_89	6852	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				1.80	3.60		
		Oil residency index				2.73	4.09		
		Alcids nonbreeding	21	1	0.25	0.97	1.70		
		Capelin	21	2	0.25	1.95	3.41		
		Deep sea shrimp	7	1	1	1.30	2.27		
		Gulls	17	3	0.5	4.73	8.28		
		Lumpsucker	15	5	0.25	3.48	6.09		
		Seaducks	23	4	0.25	4.27	7.47		
								49	Extreme
68_90	6853	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.50	3.75		
		Alcids	25	1	0.5	2.13	3.72		
		Arctic char	14	2	0.5	2.38	4.17		
		Capelin	21	1	0.25	0.89	1.56		
		Cormorants	19	4	0.5	6.47	11.31		
		Deep sea shrimp	7	1	1	1.19	2.08		
		Gulls	17	3	0.5	4.34	7.59		
		Tubenoses shoreline	18	1	0.5	1.53	2.68		
								43	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_91	6853	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				3.00	6.00		
		Oil residency index				1.95	2.92		
		Alcids nonbreeding	21	1	0.25	0.70	1.22		
		Arctic char	14	2	0.5	1.85	3.24		
		Capelin	21	4	0.25	2.78	4.87		
		Deep sea shrimp	7	1	1	0.93	1.62		
		Seaducks	23	1	0.25	0.76	1.33		
								35	High
68_92	6853	Human use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				1.91	2.87		
		Capelin	21	4	0.25	2.73	4.78		
		Deep sea shrimp	7	2	1	1.82	3.18		
		Seaducks	23	2	0.25	1.50	2.62		
								33	High
68_93	6853	Human use				2.00	4.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				2.35	4.70		
		Oil residency index				1.86	2.79		
		Arctic char	14	4	0.5	3.55	6.21		
		Capelin	21	2	0.25	1.33	2.33		
		Lumpsucker	15	2	0.25	0.95	1.66		
		Seaducks	23	2	0.25	1.46	2.55		
								30	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_94	6852	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				10.00	15.00		
		Communities				0.00	0.00		
		Oil residency index				1.38	2.08		
		Alcids	25	4	0.5	4.71	8.24		
		Alcids nonbreeding	21	2	0.25	0.99	1.73		
		Deep sea shrimp	7	4	1	2.64	4.61		
		Gulls	17	5	0.5	4.00	7.00		
		Lumpsucker	15	5	0.25	1.77	3.09		
		Seaducks	23	3	0.25	1.62	2.84		
		Seaducks moulting	23	1	0.25	0.54	0.95		
								54	Extreme
68_95	6851	Human use				2.00	4.00		
		Archaeological sites				5.00	10.00		
		Special status areas				5.00	7.50		
		Communities				4.60	9.20		
		Oil residency index				1.99	2.98		
		Alcids	25	5	0.5	8.45	14.79		
		Alcids nonbreeding	21	1	0.25	0.71	1.24		
		Deep sea shrimp	7	2	1	1.89	3.31		
		Gulls	17	4	0.5	4.60	8.05		
		Lumpsucker	15	4	0.25	2.03	3.55		
		Seaducks	23	3	0.25	2.33	4.08		
								69	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
68_96	6851	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.41	2.11		
		Alcids	25	1	0.5	1.20	2.10		
		Cormorants	19	1	0.5	0.91	1.59		
		Deep sea shrimp	7	1	1	0.67	1.17		
		Gulls	17	4	0.5	3.26	5.70		
		Lumpsucker	15	5	0.25	1.80	3.14		
		Seaducks	23	2	0.25	1.10	1.93		
								24	Moderate
69_97	6901	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				1.83	2.75		
		Alcids	25	5	0.5	7.78	13.62		
		Alcids nonbreeding	21	2	0.25	1.31	2.29		
		Deep sea shrimp	7	1	1	0.87	1.53		
		Gulls	17	3	0.5	3.18	5.56		
		Lumpsucker	15	5	0.25	2.34	4.09		
		Seaducks	23	2	0.25	1.43	2.51		
		Seaducks breeding	23	3	0.5	4.30	7.52		
								53	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_98	6904	Human use				5.00	10.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				4.25	8.50		
		Oil residency index				1.12	1.68		
		Arctic char	14	4	0.5	2.14	3.74		
		Capelin	21	4	0.25	1.60	2.81		
		Deep sea shrimp	7	1	1	0.53	0.94		
		Greenland halibut	7	5	0.5	1.34	2.34		
		Gulls	17	3	0.5	1.95	3.41		
		Lumpsucker	15	5	0.25	1.43	2.51		
		Seaducks	23	2	0.25	0.88	1.54		
								47	Extreme
69_99	6904	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.60	5.20		
		Oil residency index				2.40	3.60		
		Arctic char	14	3	0.5	3.43	6.00		
		Cormorants	19	2	0.5	3.10	5.43		
		Greenland halibut	7	5	0.5	2.86	5.00		
		Gulls	17	1	0.5	1.39	2.43		
								38	High
69_100	6854	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.47	3.71		
		Arctic char	14	5	0.5	5.88	10.30		
		Greenland halibut	7	2	0.5	1.18	2.06		
								24	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_101	6854	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.78	4.18		
		Arctic char	14	5	0.5	6.63	11.60		
		Cormorants	19	5	0.5	9.00	15.74		
		Gulls	17	5	0.5	8.05	14.09		
								50	Extreme
69_102	6905	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.88	4.32		
		Arctic char	14	5	0.5	6.86	12.01		
		Greenland halibut	7	1	0.5	0.69	1.20		
		Seaducks moulting	23	3	0.25	3.38	5.92		
								31	Moderate
69_103	6904	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.77	4.16		
		Arctic char	14	3	0.5	3.96	6.93		
		Cormorants	19	3	0.5	5.38	9.41		
		Greenland halibut	7	5	0.5	3.30	5.78		
		Gulls	17	4	0.5	6.41	11.22		
		Seaducks moulting	23	1	0.25	1.08	1.90		
								47	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_104	6905	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.86	4.29		
		Greenland halibut	7	4	0.5	2.72	4.76		
								15	Low
69_105	6904	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.32	4.98		
		Greenland halibut	7	3	0.5	2.37	4.15		
								13	Low
69_106	6904	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.51	5.26		
		Greenland halibut	7	2	0.5	1.67	2.92		
		Seaducks breeding	23	1	0.5	2.74	4.80		
								17	Low
69_107	6904	Human use				5.00	10.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				6.60	13.20		
		Oil residency index				2.09	3.13		
		Alcids nonbreeding	21	1	0.25	0.75	1.31		
		Arctic char	14	2	0.5	1.99	3.48		
		Capelin	21	3	0.25	2.24	3.92		
		Deep sea shrimp	7	1	1	1.00	1.74		
		Greenland halibut	7	5	0.5	2.49	4.35		
		Lumpsucker	15	1	0.25	0.53	0.93		
								52	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_108	6904	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				4.25	8.50		
		Oil residency index				1.87	2.81		
		Alcids nonbreeding	21	1	0.25	0.67	1.17		
		Arctic char	14	1	0.5	0.89	1.56		
		Capelin	21	5	0.25	3.34	5.85		
		Deep sea shrimp	7	1	1	0.89	1.56		
		Greenland halibut	7	5	0.5	2.23	3.90		
		Lumpsucker	15	5	0.25	2.39	4.18		
								42	High
69_109	6904	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.50	3.75		
		Alcids	25	1	0.5	2.13	3.72		
		Arctic char	14	3	0.5	3.57	6.26		
		Capelin	21	4	0.25	3.57	6.26		
		Cormorants	19	2	0.5	3.23	5.66		
		Greenland halibut	7	2	0.5	1.19	2.09		
		Gulls	17	2	0.5	2.89	5.06		
		Lumpsucker	15	5	0.25	3.19	5.58		
		Seaducks breeding	23	3	0.5	5.87	10.28		
		Seaducks moulting	23	1	0.25	0.98	1.71		
								58	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_110	6955	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.86	4.28		
		Arctic char	14	3	0.5	4.08	7.14		
		Capelin	21	5	0.25	5.10	8.92		
		Cormorants	19	4	0.5	7.38	12.92		
		Gulls	17	1	0.5	1.65	2.89		
		Lumpsucker	15	5	0.25	3.64	6.37		
		Seaducks moulting	23	1	0.25	1.12	1.95		
								52	Extreme
69_111	6955	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.54	3.81		
		Capelin	21	5	0.25	4.53	7.93		
		Greenland halibut	7	2	0.5	1.21	2.12		
		Gulls	17	1	0.5	1.47	2.57		
								30	Moderate
69_112	6955	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.74	4.11		
		Capelin	21	5	0.25	4.89	8.55		
		Deep sea shrimp	7	1	1	1.30	2.28		
		Gulls	17	3	0.5	4.75	8.31		
		Lumpsucker	15	5	0.25	3.49	6.11		
		Seaducks moulting	23	1	0.25	1.07	1.87		
								41	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_113	6955	Human use				4.00	8.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.81	4.21		
		Greenland halibut	7	4	0.5	2.67	4.68		
		Seaducks moulting	23	1	0.25	1.10	1.92		
								19	Low
69_114	6955	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.09	3.14		
		Alcids	25	1	0.5	1.78	3.11		
		Cormorants	19	1	0.5	1.35	2.37		
		Greenland halibut	7	5	0.5	2.49	4.36		
		Gulls	17	4	0.5	4.84	8.47		
		Seaducks breeding	23	1	0.5	1.64	2.86		
		Seaducks moulting	23	1	0.25	0.82	1.43		
								36	High
69_115	6955	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.04	4.56		
		Greenland halibut	7	5	0.5	3.62	6.34		
		Gulls	17	1	0.5	1.76	3.08		
		Seaducks breeding	23	1	0.5	2.38	4.16		
								32	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_116	6955	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.30	3.46		
		Cormorants	19	2	0.5	2.98	5.21		
		Greenland halibut	7	5	0.5	2.74	4.80		
		Gulls	17	2	0.5	2.66	4.66		
								28	Moderate
69_117	6955	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.35	3.52		
		Arctic char	14	3	0.5	3.35	5.87		
		Capelin	21	3	0.25	2.52	4.40		
		Cormorants	19	4	0.5	6.07	10.62		
		Deep sea shrimp	7	1	1	1.12	1.96		
		Greenland halibut	7	1	0.5	0.56	0.98		
		Gulls	17	1	0.5	1.36	2.38		
								42	High
69_118	6954	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.14	1.72		
		Arctic char	14	2	0.5	1.09	1.91		
		Capelin	21	4	0.25	1.64	2.86		
		Deep sea shrimp	7	2	1	1.09	1.91		
		Greenland halibut	7	1	0.5	0.27	0.48		
								25	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_119	6954	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				1.93	2.90		
		Alcids	25	5	0.5	8.21	14.38		
		Alcids nonbreeding	21	2	0.25	1.38	2.42		
		Arctic char	14	5	0.5	4.60	8.05		
		Capelin	21	4	0.25	2.76	4.83		
		Cormorants	19	4	0.5	4.99	8.74		
		Deep sea shrimp	7	1	1	0.92	1.61		
		Gulls	17	5	0.5	5.59	9.77		
								70	Extreme
69_120	6954	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.40	0.80		
		Oil residency index				2.03	3.04		
		Alcids	25	2	0.5	3.45	6.04		
		Arctic char	14	2	0.5	1.93	3.38		
		Capelin	21	1	0.25	0.72	1.27		
		Cormorants	19	3	0.5	3.93	6.88		
		Greenland halibut	7	1	0.5	0.48	0.85		
		Gulls	17	2	0.5	2.35	4.11		
								36	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_121	6954	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				2.55	5.10		
		Oil residency index				2.14	3.22		
		Alcids	25	3	0.5	5.47	9.58		
		Capelin	21	1	0.25	0.77	1.34		
		Cormorants	19	2	0.5	2.77	4.85		
		Deep sea shrimp	7	1	1	1.02	1.79		
		Greenland halibut	7	3	0.5	1.53	2.68		
		Gulls	17	5	0.5	6.20	10.85		
								51	Extreme
69_122	6953	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				1.42	2.12		
		Arctic char	14	4	0.5	2.70	4.72		
		Capelin	21	5	0.25	2.53	4.43		
		Deep sea shrimp	7	1	1	0.67	1.18		
		Greenland halibut	7	4	0.5	1.35	2.36		
		Lumpsucker	15	5	0.25	1.81	3.16		
		Seaducks	23	2	0.25	1.11	1.94		
		Seaducks moulting	23	5	0.5	5.54	9.69		
								47	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_123	6902	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.47	2.21		
		Arctic char	14	5	0.5	3.50	6.13		
		Capelin	21	5	0.25	2.63	4.60		
		Deep sea shrimp	7	1	1	0.70	1.23		
		Lumpsucker	15	5	0.25	1.88	3.29		
		Seaducks	23	1	0.25	0.58	1.01		
		Seaducks moulting	23	2	0.25	1.15	2.02		
								36	High
69_124	6901	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.15	8.30		
		Oil residency index				1.45	2.18		
		Alcids	25	3	0.5	3.70	6.48		
		Alcids nonbreeding	21	1	0.25	0.52	0.91		
		Arctic char	14	1	0.5	0.69	1.21		
		Capelin	21	4	0.25	2.07	3.63		
		Deep sea shrimp	7	1	1	0.69	1.21		
		Gulls	17	2	0.5	1.68	2.94		
		Lumpsucker	15	5	0.25	1.85	3.24		
		Seaducks breeding	23	1	0.5	1.14	1.99		
		Seaducks moulting	23	1	0.25	0.57	0.99		
								45	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_125	6901	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.50	3.00		
		Oil residency index				1.49	2.23		
		Alcids	25	3	0.5	3.80	6.64		
		Arctic char	14	3	0.5	2.13	3.72		
		Capelin	21	1	0.25	0.53	0.93		
		Cormorants	19	5	0.5	4.81	8.41		
		Gulls	17	2	0.5	1.72	3.01		
		Lumpsucker	15	5	0.25	1.90	3.32		
		Seaducks	23	2	0.25	1.16	2.04		
		Tubenoses shoreline	18	4	0.5	3.64	6.38		
								50	Extreme
69_126	6901	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.90	3.80		
		Oil residency index				2.45	3.67		
		Alcids nonbreeding	21	1	0.25	0.87	1.53		
		Arctic char	14	3	0.5	3.49	6.12		
		Capelin	21	4	0.25	3.49	6.12		
		Gulls	17	3	0.5	4.24	7.43		
		Lumpsucker	15	5	0.25	3.12	5.46		
		Seaducks	23	2	0.25	1.91	3.35		
		Seaducks moulting	23	1	0.25	0.96	1.67		
								51	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_127	6901	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				2.62	3.93		
		Arctic char	14	5	0.5	6.24	10.91		
		Capelin	21	5	0.25	4.68	8.18		
		Deep sea shrimp	7	1	1	1.25	2.18		
		Harbour seals	18	4	0.5	6.41	11.22		
		Lumpsucker	15	5	0.25	3.34	5.85		
		Seaducks moulting	23	2	0.25	2.05	3.59		
								65	Extreme
69_128	6901	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				1.95	3.90		
		Oil residency index				2.73	4.10		
		Arctic char	14	4	0.5	5.21	9.11		
		Capelin	21	5	0.25	4.88	8.54		
		Deep sea shrimp	7	1	1	1.30	2.28		
		Harbour seals	18	4	0.5	6.69	11.71		
		Lumpsucker	15	5	0.25	3.49	6.10		
		Seaducks moulting	23	3	0.25	3.21	5.61		
								71	Extreme
69_129	6952	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.25	8.50		
		Oil residency index				3.03	4.55		
		Alcids nonbreeding	21	1	0.25	1.08	1.90		
		Arctic char	14	3	0.5	4.33	7.59		
		Capelin	21	3	0.25	3.25	5.69		
		Deep sea shrimp	7	1	1	1.44	2.53		
		Seaducks moulting	23	1	0.25	1.19	2.08		
								49	Extreme

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_130	6951	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				2.20	4.40		
		Oil residency index				1.44	2.16		
		Alcids	25	2	0.5	2.45	4.29		
		Alcids nonbreeding	21	1	0.25	0.52	0.90		
		Cormorants	19	5	0.5	4.66	8.15		
		Deep sea shrimp	7	1	1	0.69	1.20		
		Gulls	17	1	0.5	0.83	1.46		
		Lumpsucker	15	3	0.25	1.10	1.93		
		Seaducks	23	3	0.25	1.69	2.96		
		Seaducks moulting	23	1	0.25	0.56	0.99		
		Tubenoses shoreline	18	5	0.5	4.41	7.72		
								40	High
69_131	6951	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.65	1.30		
		Oil residency index				1.63	2.44		
		Arctic char	14	5	0.5	3.88	6.79		
		Cormorants	19	4	0.5	4.21	7.37		
		Gulls	17	1	0.5	0.94	1.65		
		Harbour seals	18	3	0.5	2.99	5.24		
		Lumpsucker	15	3	0.25	1.25	2.18		
		Seaducks	23	3	0.25	1.91	3.35		
		Seaducks moulting	23	1	0.25	0.64	1.12		
								41	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
69_132	6951	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.27	1.91		
		Arctic char	14	4	0.5	2.43	4.25		
		Cormorants	19	3	0.5	2.47	4.32		
		Deep sea shrimp	7	1	1	0.61	1.06		
		Harbour seals	18	4	0.5	3.12	5.46		
		Lumpsucker	15	2	0.25	0.65	1.14		
		Seaducks	23	5	0.25	2.49	4.36		
		Seaducks moulting	23	5	0.25	2.49	4.36		
								39	High
69_133	6951	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.11	1.67		
		Alcids	25	2	0.5	1.89	3.32		
		Arctic char	14	2	0.5	1.06	1.86		
		Cormorants	19	5	0.5	3.60	6.30		
		Gulls	17	1	0.5	0.64	1.13		
		Harbour seals	18	4	0.5	2.73	4.77		
		Seaducks	23	5	0.25	2.18	3.81		
		Seaducks moulting	23	5	0.25	2.18	3.81		
								37	High
69_134	6951	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				5.00	7.50		
		Communities				0.00	0.00		
		Oil residency index				1.68	2.52		
		Arctic char	14	2	0.5	1.60	2.80		
		Seaducks	23	5	0.25	3.29	5.76		
		Seaducks moulting	23	5	0.25	3.29	5.76		
								34	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_135	7001	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.13	1.70		
		Alcids	25	2	0.5	1.93	3.38		
		Cormorants	19	4	0.5	2.93	5.13		
		Deep sea shrimp	7	3	1	1.62	2.84		
		Gulls	17	1	0.5	0.66	1.15		
		Harbour seals	18	5	0.75	5.21	9.12		
		Seaducks	23	5	0.25	2.22	3.88		
		Seaducks moulting	23	5	0.25	2.22	3.88		
								37	High
70_136	7002	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.17	1.75		
		Alcids	25	1	0.5	0.99	1.74		
		Arctic char	14	2	0.5	1.11	1.95		
		Cormorants	19	2	0.5	1.51	2.64		
		Deep sea shrimp	7	2	1	1.11	1.95		
		Gulls	17	2	0.5	1.35	2.37		
		Seaducks moulting	23	1	0.25	0.46	0.80		
								17	Low
69_137	6953	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.08	1.62		
		Capelin	21	1	0.25	0.39	0.67		
		Deep sea shrimp	7	2	1	1.03	1.80		
		Greenland halibut	7	5	0.5	1.28	2.25		
		Seaducks moulting	23	1	0.25	0.42	0.74		
								21	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_138	7001	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.01	1.51		
		Alcids	25	3	0.5	2.57	4.50		
		Cormorants	19	4	0.5	2.61	4.56		
		Deep sea shrimp	7	3	1	1.44	2.52		
		Gulls	17	1	0.5	0.58	1.02		
		Seaducks	23	2	0.25	0.79	1.38		
		Seaducks breeding	23	1	0.5	0.79	1.38		
		Seaducks moulting	23	5	0.25	1.97	3.45		
								24	Moderate
70_139	7005	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.37	3.56		
		Arctic char	14	3	0.5	3.39	5.93		
		Greenland halibut	7	5	0.5	2.82	4.94		
								26	Moderate
70_140	6954	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.05	4.10		
		Oil residency index				2.29	3.43		
		Alcids	25	1	0.5	1.94	3.40		
		Capelin	21	3	0.25	2.45	4.28		
		Greenland halibut	7	5	0.5	2.72	4.76		
		Gulls	17	5	0.5	6.61	11.56		
								42	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_141	7004	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				4.15	8.30		
		Oil residency index				2.57	3.85		
		Arctic char	14	1	0.5	1.22	2.14		
		Capelin	21	4	0.25	3.67	6.42		
		Greenland halibut	7	5	0.5	3.06	5.35		
								42	High
70_142	6954	Human use				4.00	8.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				4.10	8.20		
		Oil residency index				2.45	3.67		
		Alcids	25	1	0.5	2.08	3.64		
		Capelin	21	5	0.25	4.37	7.65		
		Deep sea shrimp	7	1	1	1.17	2.04		
		Greenland halibut	7	5	0.5	2.91	5.10		
		Gulls	17	2	0.5	2.83	4.95		
								53	Extreme
70_143	7003	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.05	1.57		
		Capelin	21	1	0.25	0.37	0.66		
		Deep sea shrimp	7	2	1	1.00	1.75		
		Greenland halibut	7	3	0.5	0.75	1.31		
		Gulls	17	2	0.5	1.21	2.12		
								13	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_144	7002	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.00	1.50		
		Alcids	25	3	0.5	2.55	4.46		
		Alcids nonbreeding	21	1	0.25	0.36	0.63		
		Arctic char	14	1	0.5	0.48	0.83		
		Cormorants	19	2	0.5	1.29	2.26		
		Deep sea shrimp	7	1	1	0.48	0.83		
		Gulls	17	1	0.5	0.58	1.01		
		Seaducks breeding	23	1	0.5	0.78	1.37		
		Seaducks moulting	23	1	0.25	0.39	0.68		
								18	Low
70_145	7051	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.19	1.79		
		Alcids	25	1	0.5	1.01	1.77		
		Alcids nonbreeding	21	2	0.25	0.85	1.49		
		Arctic char	14	2	0.5	1.13	1.98		
		Cormorants	19	2	0.5	1.54	2.69		
		Deep sea shrimp	7	3	1	1.70	2.98		
		Gulls	17	3	0.5	2.07	3.62		
		Lumpsucker	15	2	0.25	0.61	1.06		
		Seaducks	23	2	0.25	0.93	1.63		
		Seaducks breeding	23	3	0.5	2.80	4.89		
		Seaducks moulting	23	1	0.25	0.47	0.82		
								39	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_146	7051	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.10	2.20		
		Oil residency index				1.04	1.57		
		Alcids	25	3	0.5	2.67	4.67		
		Alcids nonbreeding	21	1	0.25	0.37	0.65		
		Capelin	21	2	0.25	0.75	1.31		
		Deep sea shrimp	7	1	1	0.50	0.87		
		Greenland halibut	7	2	1	1.00	1.74		
		Gulls	17	3	0.5	1.81	3.17		
		Lumpsucker	15	1	0.25	0.27	0.47		
		Seaducks	23	1	0.25	0.41	0.72		
		Seaducks breeding	23	1	0.5	0.82	1.43		
		Seaducks moulting	23	1	0.25	0.41	0.72		
								32	Moderate
70_147	7052	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				3.20	6.40		
		Oil residency index				1.00	1.50		
		Arctic char	14	1	0.5	0.48	0.83		
		Capelin	21	5	0.25	1.79	3.13		
		Greenland halibut	7	5	1	2.38	4.17		
		Lumpsucker	15	2	0.25	0.51	0.89		
								33	Moderate
70_148	7053	Human use				5.00	10.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				1.50	3.00		
		Oil residency index				1.85	2.78		
		Arctic char	14	1	0.5	0.88	1.54		
		Capelin	21	4	0.25	2.65	4.63		
		Greenland halibut	7	5	1	4.41	7.72		
								36	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_149	7004	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.75	1.50		
		Oil residency index				2.20	3.30		
		Alcids	25	3	0.5	5.61	9.83		
		Arctic char	14	2	0.5	2.10	3.67		
		Capelin	21	4	0.25	3.14	5.50		
		Greenland halibut	7	5	1	5.24	9.17		
		Gulls	17	5	0.5	6.36	11.14		
								52	Extreme
70_150	7005	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.12	3.18		
		Alcids	25	2	0.5	3.60	6.31		
		Greenland halibut	7	5	1	5.05	8.83		
		Gulls	17	5	0.5	6.13	10.72		
								33	High
70_151	7004	Human Use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.75	3.50		
		Oil residency index				2.21	3.32		
		Alcids	25	3	0.5	5.64	9.87		
		Capelin	21	3	0.25	2.37	4.15		
		Greenland halibut	7	5	1	5.26	9.21		
								38	High
70_152	7053	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.85	3.70		
		Oil residency index				2.02	3.02		
		Greenland halibut	7	5	1	4.80	8.40		
								23	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_153	7053	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				2.90	5.80		
		Oil residency index				2.05	3.08		
		Capelin	21	1	0.25	0.73	1.28		
		Greenland halibut	7	5	1	4.88	8.55		
								31	Moderate
70_154	7054	Human use				4.00	8.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				2.10	4.20		
		Oil residency index				2.53	3.80		
		Capelin	21	2	0.25	1.81	3.16		
		Greenland halibut	7	5	1	6.03	10.55		
		Lumpsucker	15	1	0.25	0.65	1.13		
								37	High
70_155	7053	Human use				3.00	6.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				1.05	2.10		
		Oil residency index				1.92	2.89		
		Alcids	25	1	0.5	1.64	2.86		
		Capelin	21	1	0.25	0.69	1.20		
		Greenland halibut	7	5	1	4.58	8.02		
		Gulls	17	3	0.5	3.34	5.84		
		Tubenoses shoreline	18	5	0.5	5.89	10.31		
								49	Extreme
70_156	7053	Human use				3.00	6.00		
		Archaeological sites				3.00	6.00		
		Special status areas				0.00	0.00		
		Communities				5.00	10.00		
		Oil residency index				2.10	3.15		
		Greenland halibut	7	5	1	4.99	8.74		
		Lumpsucker	15	1	0.25	0.53	0.94		
								35	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_157	7054	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.82	4.23		
		Arctic char	14	3	0.5	4.03	7.06		
		Capelin	21	2	0.25	2.02	3.53		
		Greenland halibut	7	5	1	6.72	11.76		
		Gulls	17	2	0.5	3.26	5.71		
		Lumpsucker	15	1	0.25	0.72	1.26		
								46	Extreme
70_158	7054	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.42	3.63		
		Capelin	21	1	0.25	0.86	1.51		
		Greenland halibut	7	5	1	5.76	10.09		
								23	Moderate
70_159	7054	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.30	0.60		
		Oil residency index				2.13	3.19		
		Alcids	25	1	0.5	1.81	3.16		
		Capelin	21	2	0.25	1.52	2.66		
		Greenland halibut	7	5	1	5.06	8.86		
		Tubenoses shoreline	18	5	0.5	6.51	11.39		
								38	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_160	7054	Human use				2.00	4.00		
		Archaeological sites				5.00	10.00		
		Special status areas				0.00	0.00		
		Communities				3.60	7.20		
		Oil residency index				1.90	2.85		
		Greenland halibut	7	5	1	4.52	7.92		
		Lumpsucker	15	1	0.25	0.48	0.85		
								33	Moderate
70_161	7053	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.45	4.90		
		Oil residency index				1.73	2.60		
		Capelin	21	1	0.25	0.62	1.08		
		Greenland halibut	7	5	1	4.12	7.22		
								24	Moderate
70_162	7053	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.11	1.66		
		Greenland halibut	7	5	1	2.64	4.62		
		Gulls	17	1	0.5	0.64	1.12		
		Tubenoses shoreline	18	5	0.5	3.39	5.94		
								19	Low
70_163	7054	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.93	2.90		
		Capelin	21	1	0.25	0.69	1.21		
		Greenland halibut	7	5	1	4.60	8.05		
		Gulls	17	3	0.5	3.35	5.87		
								26	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
70_164	7054	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.10	0.20		
		Oil residency index				2.09	3.14		
		Alcids	25	1	0.5	1.78	3.12		
		Capelin	21	2	0.25	1.50	2.62		
		Greenland halibut	7	5	1	4.99	8.73		
		Gulls	17	1	0.5	1.21	2.12		
								28	Moderate
70_165	7053	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.80	5.60		
		Oil residency index				1.99	2.99		
		Greenland halibut	7	5	1	4.74	8.30		
		Gulls	17	1	0.5	1.15	2.01		
								25	Moderate
70_166	7054	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.28	3.42		
		Alcids	25	1	0.5	1.94	3.40		
		Arctic char	14	2	0.5	2.17	3.80		
		Greenland halibut	7	5	1	5.44	9.51		
		Gulls	17	4	0.5	5.28	9.24		
								37	High
71_167	7104	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.05	0.10		
		Oil residency index				2.80	4.20		
		Arctic char	14	1	0.5	1.33	2.34		
		Capelin	21	4	0.25	4.00	7.01		
		Greenland halibut	7	5	1	6.67	11.68		
								31	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_168	7104	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				1.45	2.90		
		Oil residency index				2.28	3.41		
		Alcids	25	1	0.5	1.94	3.39		
		Capelin	21	1	0.25	0.81	1.42		
		Greenland halibut	7	5	1	5.42	9.48		
		Gulls	17	2	0.5	2.63	4.61		
		Tubenoses shoreline	18	5	0.5	6.97	12.19		
								39	High
71_169	7104	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.43	3.64		
		Alcids	25	1	0.5	2.07	3.61		
		Capelin	21	4	0.25	3.47	6.07		
		Greenland halibut	7	5	1	5.78	10.12		
		Gulls	17	1	0.5	1.40	2.46		
		Seaducks breeding	23	3	0.5	5.70	9.98		
		Seaducks moulting	23	1	0.25	0.95	1.66		
								42	High
71_170	7103	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.06	3.09		
		Alcids	25	3	0.5	5.25	9.19		
		Capelin	21	2	0.25	1.47	2.57		
		Greenland halibut	7	5	1	4.90	8.58		
								25	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_171	7104	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.71	4.07		
		Capelin	21	2	0.25	1.94	3.39		
		Greenland halibut	7	5	1	6.46	11.31		
								23	Moderate
71_172	7103	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.79	2.68		
		Alcids	25	4	0.5	6.07	10.63		
		Greenland halibut	7	5	1	4.25	7.44		
		Gulls	17	3	0.5	3.10	5.42		
								28	Moderate
71_173	7103	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.24	1.86		
		Capelin	21	4	0.25	1.77	3.09		
		Greenland halibut	7	5	1	2.95	5.15		
		Lumpsucker	15	1	0.25	0.32	0.55		
								21	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_174	7102	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				2.20	4.40		
		Oil residency index				1.65	2.47		
		Alcids nonbreeding	21	3	0.25	1.76	3.09		
		Capelin	21	2	0.25	1.18	2.06		
		Greenland halibut	7	5	1	3.92	6.86		
		Lumpsucker	15	1	0.25	0.42	0.73		
		Seaducks	23	2	0.25	1.29	2.25		
								32	Moderate
71_175	7102	Human use				3.00	6.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				1.45	2.90		
		Oil residency index				1.01	1.51		
		Alcids	25	1	0.5	0.86	1.50		
		Alcids nonbreeding	21	4	0.25	1.44	2.52		
		Capelin	21	3	0.25	1.08	1.89		
		Greenland halibut	7	4	1	1.92	3.35		
		Gulls	17	1	0.5	0.58	1.02		
		Seaducks	23	1	0.25	0.39	0.69		
		Seaducks moulting	23	1	0.25	0.39	0.69		
								24	Moderate
71_176	7104	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.87	2.80		
		Greenland halibut	7	5	1	4.45	7.78		
								17	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_177	7103	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.87	2.81		
		Capelin	21	2	0.25	1.34	2.34		
		Greenland halibut	7	5	1	4.45	7.80		
		Gulls	17	3	0.5	3.25	5.68		
								23	Moderate
71_178	7103	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.35	2.03		
		Alcids	25	2	0.5	2.30	4.02		
		Greenland halibut	7	5	1	3.21	5.63		
		Gulls	17	2	0.5	1.56	2.73		
		Seaducks breeding	23	1	0.5	1.06	1.85		
								18	Low
71_179	7103	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				3.90	7.80		
		Oil residency index				1.66	2.49		
		Greenland halibut	7	5	1	3.95	6.91		
								21	Low
71_180	7154	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.24	3.37		
		Greenland halibut	7	5	1	5.35	9.35		
								17	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_181	7154	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.88	2.83		
		Greenland halibut	7	5	1	4.49	7.85		
								15	Low
71_182	7153	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.11	3.16		
		Greenland halibut	7	5	1	5.02	8.78		
								16	Low
71_183	7153	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				1.05	2.10		
		Oil residency index				2.28	3.41		
		Capelin	21	1	0.25	0.81	1.42		
		Greenland halibut	7	5	1	5.42	9.48		
								20	Low
71_184	7153	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				2.25	4.50		
		Oil residency index				1.25	1.87		
		Alcids	25	1	0.5	1.06	1.85		
		Capelin	21	2	0.25	0.89	1.56		
		Greenland halibut	7	5	1	2.96	5.19		
		Gulls	17	3	0.5	2.16	3.78		
								23	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_185	7153	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.38	3.57		
		Greenland halibut	7	5	1	5.67	9.92		
								17	Low
71_186	7153	Human use				2.00	4.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.44	3.66		
		Greenland halibut	7	5	1	5,80	10.16		
								20	Low
72_187	7203	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.82	4.22		
		Greenland halibut	7	5	1	6.70	11.73		
								18	Low
72_188	7202	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.83	4.24		
		Greenland halibut	7	5	1	6.74	11.79		
								18	Low

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_189	7153	Human use				3.00	6.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.92	2.88		
		Arctic char	14	1	0.5	0.91	1.60		
		Capelin	21	2	0.25	1.37	2.40		
		Greenland halibut	7	5	1	4.57	8.00		
		Seaducks moulting	23	1	0.25	0.75	1.31		
								22	Moderate
71_190	7152	Human use				4.00	8.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.04	4.56		
		Arctic char	14	3	0.5	4.34	7.59		
		Capelin	21	4	0.25	4.34	7.59		
		Greenland halibut	7	5	1	7.23	12.65		
		Seaducks moulting	23	1	0.25	1.19	2.08		
								44	High
71_191	7102	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.83	2.74		
		Arctic char	14	5	0.5	4.35	7.61		
		Capelin	21	5	0.25	3.26	5.71		
		Greenland halibut	7	5	1	4.35	7.61		
		Lumpsucker	15	1	0.25	0.47	0.82		
								36	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_192	7102	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.03	1.54		
		Alcids	25	1	0.5	0.87	1.53		
		Greenland halibut	7	5	1	2.45	4.28		
		Gulls	17	5	0.5	2.97	5.20		
								17	Low
71_193	7101	Human use				5.00	10.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.82	2.73		
		Arctic char	14	5	0.5	4.34	7.60		
		Capelin	21	4	0.25	2.60	4.56		
		Greenland halibut	7	5	1	4.34	7.60		
		Seaducks moulting	23	1	0.25	0.71	1.25		
								36	High
71_194	7151	Human use				2.00	4.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.89	2.83		
		Alcids	25	4	0.5	6.43	11.24		
		Alcids nonbreeding	21	2	0.25	1.35	2.36		
		Arctic char	14	2	0.5	1.80	3.15		
		Cormorants	19	2	0.5	2.44	4.27		
		Greenland halibut	7	5	1	4.50	7.87		
		Gulls	17	1	0.5	1.09	1.91		
		Seaducks	23	1	0.25	0.74	1.29		
		Seaducks moulting	23	1	0.25	0.74	1.29		
								40	High

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
71_195	7151	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.06	3.08		
		Alcids	25	2	0.5	3.49	6.12		
		Arctic char	14	5	0.5	4.89	8.56		
		Gulls	17	1	0.5	1.19	2.08		
		Seaducks moulting	23	2	0.25	1.61	2.81		
								27	Moderate
71_196	7151	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				1.29	1.94		
		Alcids	25	1	0.5	1.10	1.92		
		Alcids nonbreeding	21	1	0.25	0.46	0.81		
		Cormorants	19	1	0.5	0.83	1.46		
		Gulls	17	1	0.5	0.75	1.31		
		Seaducks	23	1	0.25	0.50	0.88		
		Seaducks moulting	23	1	0.25	0.50	0.88		
								11	Low
71_197	7151	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.15	4.73		
		Seaducks moulting	23	5	0.5	12.33	21.58		
								28	Moderate

AreaMap	Element number		Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
72_198	7202	Human use				1.00	2.00		
		Archaeological sites				0.00	0.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				3.47	5.20		
		Arctic char	14	1	0.5	1.65	2.89		
		Seaducks moulting	23	5	0.5	13.56	23.73		
								34	High
72_199	7151	Human use				1.00	2.00		
		Archaeological sites				1.00	2.00		
		Special status areas				0.00	0.00		
		Communities				0.00	0.00		
		Oil residency index				2.41	3.62		
		Seaducks moulting	23	5	0.5	9.45	16.53		
								24	Moderate

12. Appendix B

Offshore sensitivity ranking

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
Scenario	**Autumn**							
OS 19	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Alcids nonbreeding	21	3	1	9.00	15.75		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	3	1	5.57	9.75		
	Tubenoses offshore	17	5	1	12.14	21.25		
	White whales	13	5	1	9.29	16.25		
							87	Extreme
OS 20	Marine oil residency index				3	4.5		
	Special Sstatus areas				0	0		
	Human use				5	10		
	Alcids nonbreeding	21	5	1	9.00	15.75		
	Baleen whales	9	2	1	1.54	2.70		
	Bearded seals	9	5	1	3.86	6.75		
	Narwhals	13	5	1	5.57	9.75		
	Seaducks	23	5	1	9.86	17.25		
	Tubenoses offshore	17	3	1	4.37	7.65		
	White whales	13	5	1	5.57	9.75		
							84	Extreme
OS 21	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Alcids nonbreeding	21	5	1	15.00	26.25		
	Baleen whales	9	1	1	1.29	2.25		
	Bearded seals	9	3	1	3.86	6.75		
	Narwhals	13	4	1	7.43	13.00		
	Tubenoses offshore	17	3	1	7.29	12.75		
	White whales	13	5	1	9.29	16.25		
							91	Extreme

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 22	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				2	4		
	Alcids nonbreeding	21	5	1	15.00	26.25		
	Baleen whales	9	1	1	1.29	2.25		
	Narwhals	13	2	1	3.71	6.50		
	Tubenoses offshore	17	2	1	4.86	8.50		
	White whales	13	3	1	5.57	9.75		
							65	High
OS 23	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				1	2		
	Alcids nonbreeding	21	2	1	6.00	10.50		
	Narwhals	13	5	1	9.29	16.25		
	Tubenoses offshore	17	2	1	4.86	8.50		
							45	Moderate
OS 24	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Alcids nonbreeding	21	3	1	9.00	15.75		
	Narwhals	13	2	1	3.71	6.50		
	Tubenoses offshore	17	2	1	4.86	8.50		
	White whales	13	2	1	3.71	6.50		
							45	Moderate
OS 25	Marine oil residency index				4	6		
	Special status areas				0	0		
	Human use				3	6		
	Alcids nonbreeding	21	2	1	4.80	8.40		
	Narwhals	13	5	1	7.43	13.00		
	Tubenoses offshore	17	3	1	5.83	10.20		
	White whales	13	3	1	4.46	7.80		
							51	High

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 26	Marine oil residency index				3	4.5		
	Special status areas				0	0		
	Human use				4	8		
	Narwhals	13	5	1	5.57	9.75		
	Tubenoses offshore	17	3	1	4.37	7.65		
	White whales	13	3	1	3.34	5.85		
							36	Moderate
Scenario	**Spring**							
OS 19	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Alcids nonbreeding	21	2	1	6.00	10.50		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	3	1	5.57	9.75		
	Tubenoses offshore	17	5	1	12.14	21.25		
	White whales	13	1	1	1.86	3.25		
							69	High
OS 20	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Alcids nonbreeding	21	5	1	15.00	26.25		
	Baleen whales	9	5	1	6.43	11.25		
	Bearded seals	9	4	1	5.14	9.00		
	Narwhals	13	5	1	9.29	16.25		
	Seaducks	23	5	1	16.43	28.75		
	Tubenoses offshore	17	3	1	7.29	12.75		
	Walrus	18	5	1	12.86	22.50		
	White whales	13	5	1	9.29	16.25		
							161	Extreme

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 21	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Alcids nonbreeding	21	5	1	15.00	26.25		
	Baleen whales	9	4	1	5.14	9.00		
	Bearded seals	9	2	1	2.57	4.50		
	Narwhals	13	2	1	3.71	6.50		
	Tubenoses offshore	17	5	1	12.14	21.25		
	Walrus	18	5	1	12.86	22.50		
	White whales	13	5	1	9.29	16.25		
							120	Extreme
OS 22	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				2	4		
	Alcids nonbreeding	21	3	1	9.00	15.75		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	2	1	3.71	6.50		
	Tubenoses offshore	17	2	1	4.86	8.50		
	Walrus	18	3	1	7.71	13.50		
	White whales	13	3	1	5.57	9.75		
							72	High
OS 23	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	5	1	9.29	16.25		
							31	Moderate

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 24	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Alcids nonbreeding	21	3	1	9.00	15.75		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	2	1	3.71	6.50		
	White whales	13	2	1	3.71	6.50		
							43	Moderate
OS 25	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Alcids nonbreeding	21	2	1	6.00	10.50		
	Baleen whales	9	3	1	3.86	6.75		
	Narwhals	13	3	1	5.57	9.75		
	Tubenoses offshore	17	5	1	12.14	21.25		
	Walrus	18	5	1	12.86	22.50		
	White whales	13	3	1	5.57	9.75		
							94	Extreme
OS 26	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				4	8		
	Tubenoses offshore	17	5	1	12.14	21.25		
	White whales	13	3	1	5.57	9.75		
							47	High
Scenario	**Summer**							
OS 19	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Baleen whales	9	3	1	3.86	6.75		
	Tubenoses offshore	17	5	1	12.14	21.25		
							46	High

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 20	Marine oil residency indexMarine oil residency index				3	4.5		
	Special status areasSpecial status areas				0	0		
	Human useHuman use				5	10		
	Baleen whales	9	4	1	3.09	5.40		
	Tubenoses offshore	17	4	1	5.83	10.20		
							30	Moderate
OS 21	Marine oil residency indexMarine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Baleen whales	9	2	1	2.57	4.50		
	Tubenoses offshore	17	5	1	12.14	21.25		
							39	Moderate
OS 22	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				2	4		
	Baleen whales	9	2	1	2.57	4.50		
	Tubenoses offshore	17	2	1	4.86	8.50		
							25	Low
OS 23	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				1	2		
	Alcids nonbreeding	21	2	1	6.00	10.50		
	Baleen whales	9	1	1	1.29	2.25		
	Tubenoses offshore	17	2	1	4.86	8.50		
							31	Moderate

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 24	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Baleen whales	9	1	1	1.29	2.25		
	Tubenoses offshore	17	2	1	4.86	8.50		
							18	Low
OS 25	Marine oil residency index				3	4.5		
	Special status areas				0	0		
	Human use				3	6		
	Baleen whales	9	1	1	0.77	1.35		
	Tubenoses offshore	17	5	1	7.29	12.75		
							25	Low
OS 26	Marine oil residency index				3	4.5		
	Special status areas				0	0		
	Human use				4	8		
	Baleen whales	9	3	1	2.31	4.05		
	Tubenoses offshore	17	5	1	7.29	12.75		
							29	Low
Scenario	**Winter**							
OS 19	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Narwhals	13	3	1	5.57	9.75		
	White whales	13	2	1	3.71	6.50		
							34	Moderate

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 20	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				5	10		
	Alcids nonbreeding	21	4	1	12.00	21.00		
	Baleen whales	9	3	1	3.86	6.75		
	Bearded seals	9	5	1	6.43	11.25		
	Narwhals	13	5	1	9.29	16.25		
	Seaducks	23	5	1	16.43	28.75		
	Walrus	18	5	1	12.86	22.50		
	White whales	13	5	1	9.29	16.25		
							140	Extreme
OS 21	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Bearded seals	9	3	1	3.86	6.75		
	Narwhals	13	2	1	3.71	6.50		
	Walrus	18	5	1	12.86	22.50		
	White whales	13	3	1	5.57	9.75		
							59	High
OS 22	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				2	4		
	Narwhals	13	2	1	3.71	6.50		
	White whales	13	2	1	3.71	6.50		
							25	Low
OS 23	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Narwhals	13	5	1	9.29	16.25		
							24	Low

Area	Element	Relative sensitivity	Relative abundance	Temporal modifier	Assigned value	Priority index	Sensitivity value	Final ranking
OS 24	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				0	0		
	Narwhals	13	2	1	3.71	6.50		
							14	Low
OS 25	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				3	6		
	Narwhals	13	3	1	5.57	9.75		
	Walrus	18	5	1	12.86	22.50		
							46	High
OS 26	Marine oil residency index				5	7.5		
	Special status areas				0	0		
	Human use				4	8		
	Narwhals	13	1	1	1.86	3.25		
							19	Low

13 Appendix C, Climatic data for logistics

The following descriptions apply to entire West Greenland, between Cape Farewell at 60° N and Upernavik at 73° N.

13.1 West Greenland meteorology

13.1.1

Surrounded by steep coasts, Davis Strait/Baffin Bay forms a channel that provides ideal conditions for outbreaks of cold air southward, as well as for the injection of warm subtropical air deep into the Arctic Basin. Both patterns are driven by disturbances of the polar front zone. This exchange of air masses within the lower part of the troposphere largely determines the weather and climate of the area. Another essential feature is the all year round low sea surface temperatures causing the West Greenland waters to be part of the arctic zone with summer temperatures below 10° C.

The upper flow of the troposphere largely controls the movement of surface weather phenomena, such as migrating cyclones and anticyclones.

13.1.2 Sea level pressure

The sea level pressure (slp) pattern is strongly influenced by the distribution of cold and warm surfaces (Figure 13.1), although in an opposite direction. The slp pattern is essentially different from the upper level pattern, particularly during *winter*, when an area of high pressure occurs over the northernmost part of Greenland and northerly winds (a winter monsoon) prevail in the West Greenland waters. A low pressure area extending from Newfoundland via Iceland to the Norwegian Sea with a trough northward along the west coast of Greenland reflects the main zone of cyclonic activity. It appears that Greenland generally receives its weather from the southwest. About 60-70 percent of all cyclones approaching South Greenland arrives from between west and south-southeast.

In *summer*, the mean slp gradient around Greenland is slack, and no prevailing wind direction is discernible. Cyclonic activity may occur anywhere in the Greenland area. During the year, atmospheric pressure is highest (most settled weather) and normally occur around April. Atmospheric pressure is lowest in September/October over Canada and in December/January over Greenland.

13.1.3 Surface winds

Three main factors affect wind speeds:

1. The pressure gradient associated with cyclones and anticyclones
The intensity of pressure systems (particularly cyclones) is greatest in winter. Southern Greenland in particular is influenced by severe weather that is connected with the North Atlantic winter cyclones. The northern part of the Davis Strait has the lightest winds due to the moderating effect of high pressure systems. Although the main track of cyclones is south of Greenland in summer, cyclonic activity may occur anywhere in Greenland.

2. The static stability of the air near the surface
Stable layering or inversions impede vertical motions. In the coastal area orographic influences on the direction and speed of low level airflow are reinforced. On the open sea the surface wind speed is reduced under stable conditions. With the movement of cold and stable air over snow/pack ice to open water, there is a rapid destabilisation taking place due to warming from below. Vertical exchange (convection) results in an increase in the speed and gustiness of the surface wind.

3. Influence of topography (local winds)
Surface winds and pressure patterns are also substantially modified by the steep coasts surrounding the Davis Strait, particularly that of Greenland.

Down directed (katabatic) offshore winds may reach the sea level as outbursts of dry and (due to compression) relatively warm air (a *foehn wind*) accompanied by falling pressure, causing a *trough of low pressure* to develop. Foehn winds are rather frequent in southern Greenland, however, their frequency declines northward along the coast. In the fjords and in the inner part of Disko Bay (e.g. Ilulissat/Jakobshavn) the foehn winds may be very strong with gusts of hurricane force. Their occurrence is not known in detail. At sea (or the outer coast, e.g. Aasiaat/Egedesminde) the warm wind is usually insufficient to supersede the cold air near the sea surface, resulting in the formation of a pronounced low level inversion (and a wind minimum).

Onshore winds are diverted along the coast towards lower pressure and are reinforced. A *ridge of high pressure* develops. Maximum winds occur in the coastal areas, particularly around the protruding coastline (e.g. Cape Farewell, Nunarsuit). The *coastal jet* or *barrier wind* propagates more or less northwards along the coast (like a surge), causing a rapid and often dramatic change from 'foehn conditions' (broken clouds and good visibility) to 'barrier wind conditions' (strong wind, snow or rain with poor visibility and low clouds). The surge also propagates seawards, although in a weakened form.

With cold air aloft (in an unstable air mass) the orographic influence upon flow patterns are less evident. Most essential, katabatic winds from the ice cap are likely to be of the *bora* type. In defiance of the warming by compression a still cold and strong easterly wind, which, contrary to foehn winds, will spread far out over the sea. Strong winds of the bora type are infrequent in the West Greenland area. Their occurrence in the form of a cold northeasterly gale or storm is known from Disko Bay and the Nuuk/Godthåb area. At present, there is no model available to explain the extremely high winds that occur very locally in the fjords and over the archipelago, or the high winds that occur for short periods of time and extend (e.g. in heavy showers) out to the open sea.

In the northern part of West Greenland, north of lat. 65° N, the annual mean wind speed is 5-6 m/s, increasing south of lat. 65° N to 7-8 m/s and south of Cape Farewell to almost 10 m/s. It appears that maximum wind speeds occur in the northernmost part of West Greenland as early as October/November and in midwinter for other areas. The minimum wind speeds occur in midsummer all over the area.

Gale force winds
The geographical distribution of gale force winds (above 13.8 m/s) in winter and summer is shown in Figure 13.2. The percentage of gale force winds is relatively low in the northern part of the area, less than 5 % in winter and 1 % in summer increasing southward to a maximum of 30 % in winter and 4 % in summer in the southernmost part.

Most of the cyclones affecting West Greenland arrive from between south and west. Weather systems approaching from directions between northeast and southeast are essentially modified by the passage of the ice cap, however, they may regenerate over the Davis Strait.

In winter, southern Greenland in particular is influenced by severe weather connected with the North Atlantic cyclones. Figure 13.3 outlines typical tracks for major cyclones. Cyclones approaching southern Greenland from southwest or south usually split in the vicinity of Cape Farewell with one part moving northward along the west coast, while the other moves off toward Iceland. In summer, eastward moving cyclones often develop along the boundary line between the cold Canadian archipelago and the warm continent to the south of it, affecting the Davis Strait region. Therefore, West Greenland weather, although less severe, often appears more unsettled in summer than in winter.

Cyclones may develop locally on a small scale any time of the year. Often they will be the result of topographic influence, i.e. *lee lows*. Another type is the *polar low.* In this case the cyclone develops over open water with very cold air aloft. The diameter of a polar low is generally 200-300 km. Wind speeds exceed (as per definition) gale force, 15 m/s, and the system is accompanied by heavy snow showers. Occasionally, polar lows can be rather intense with a structure in their mature stage resembling that of a tropical cyclone. The lifetime of a polar low is limited, usually less than 24 hours, and it dies rapidly when making landfall.

13.1.4 Air temperature

The sea west of Greenland belongs to the Arctic region with mean air temperatures two meters above the sea surface of below 10° C all year round. The coldest month is February and the warmest month August (in the coastal area: July). The distribution of mean air temperatures for the two months is shown in Figure 13.4.

To the north (with sea ice occurring much of the year) the pattern is of the *continental* or *high arctic* type (cool summers and very cold winters) with temperatures ranging by as much as 30° C between the coldest and warmest month. To the south (over open water) the pattern is *oceanic* (cool summers and relatively mild winters) with a temperature range of less than 10° C.

In *summer*, temperatures close to the sea surface will deviate little from those of the seawater. Freezing temperatures may occur over sea ice and/or within fog. In *winter*, very low temperatures occur over snow covered areas due to radiation cooling of the surface. Over open water air temperatures are normally below those of the sea surface due to advection of cold air. In the coastal zone temperatures may reach 15° C or more in summer and, under foehn conditions, even in winter. Away from the coast the warm air mass is generally incapable of displacing the cool air nearest to the surface.

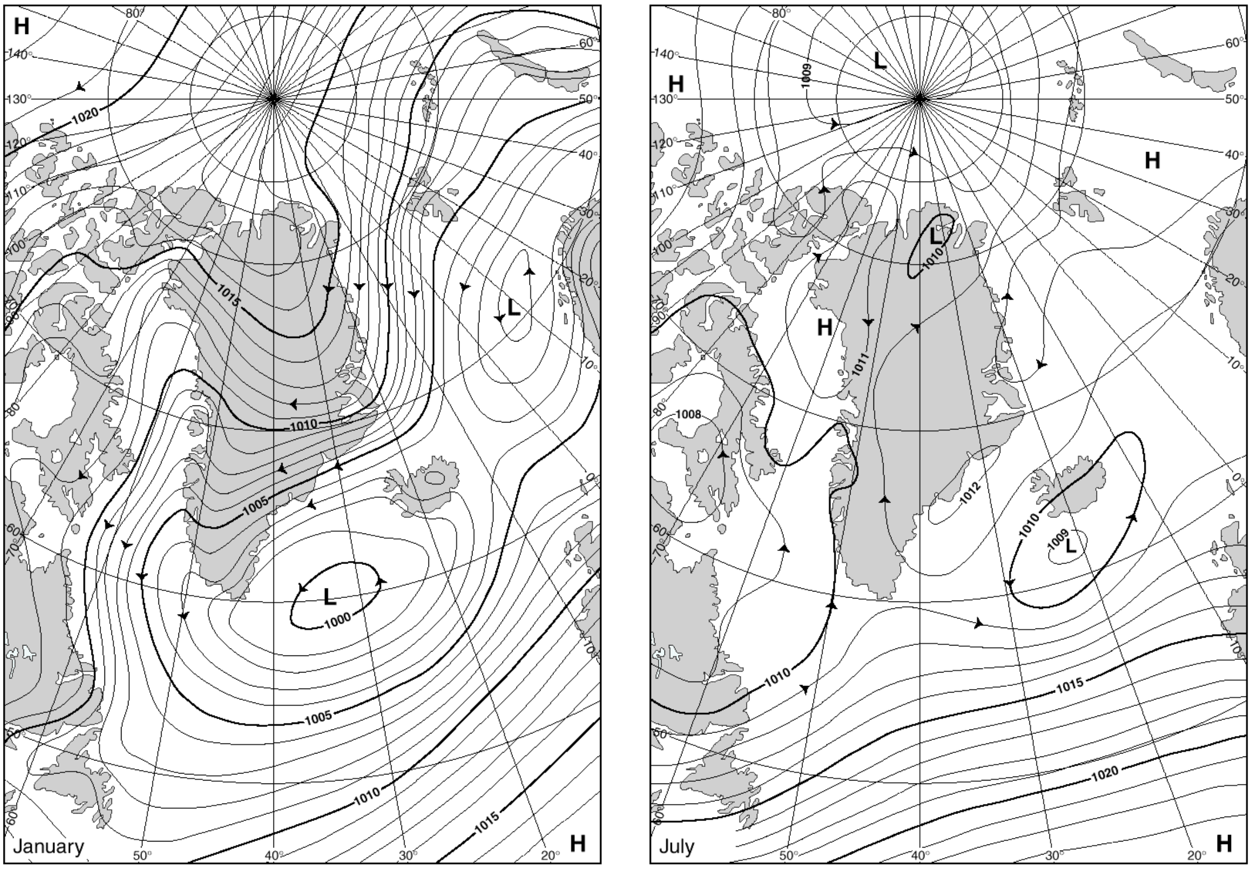


Figure 13.1. Mean atmospheric pressure (hPa) at sea level in winter (left) and summer (right).

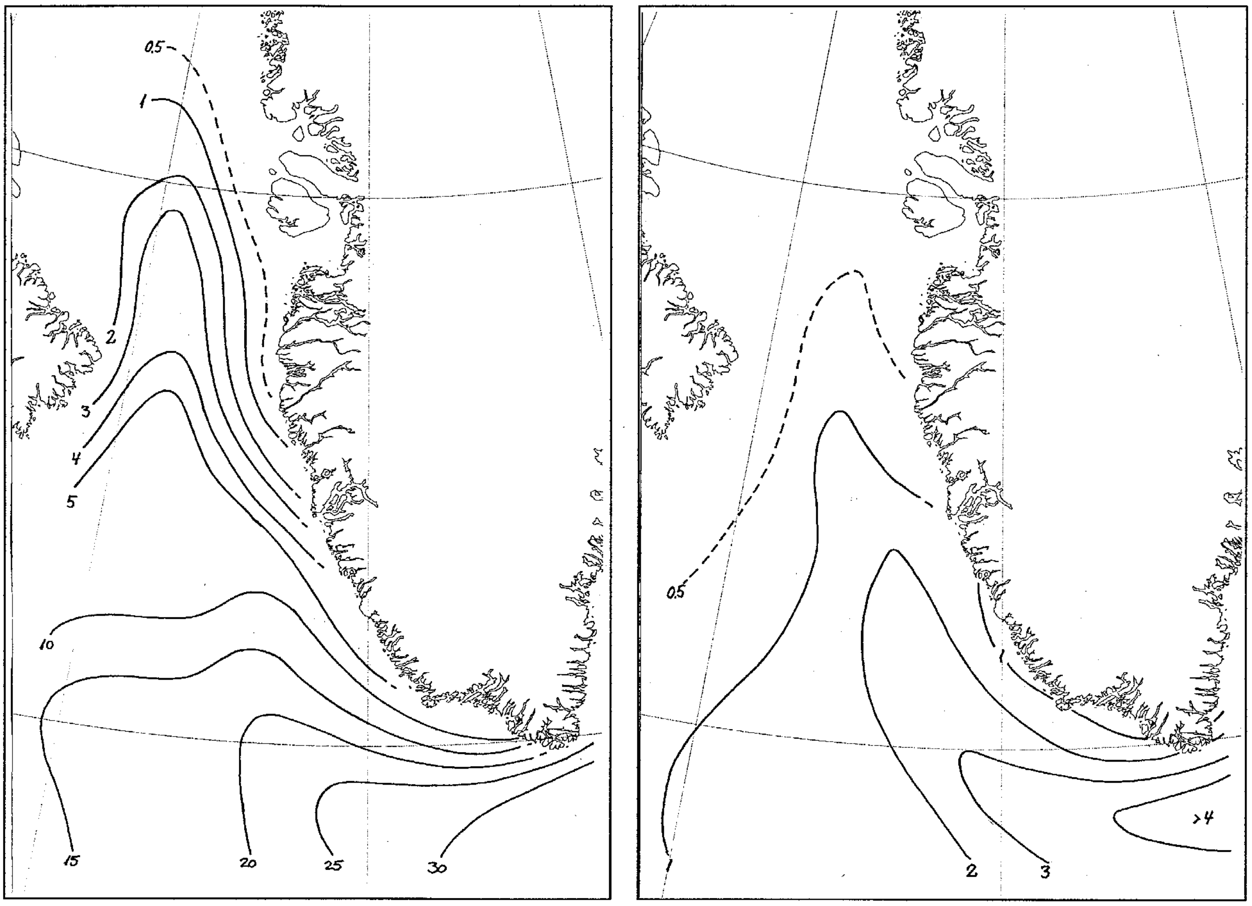


Figure 13.2. Geographical distribution in percentages of gale force winds (above 13.8 m/s).
Left: winter. Right: summer (ECMWF-data, 1980-93).

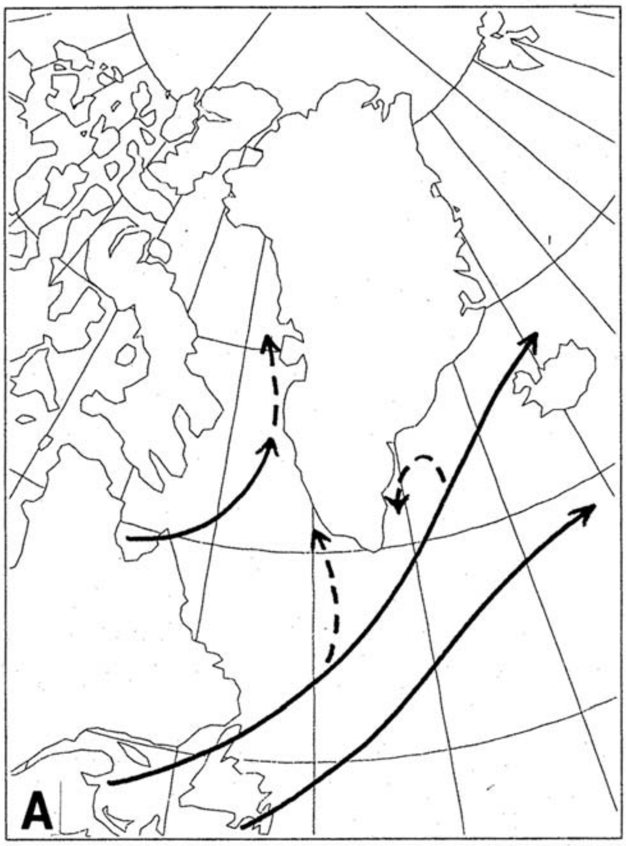


Figure 13.3. Typical tracks for major cyclones, (A) in winter and (B) in summer.

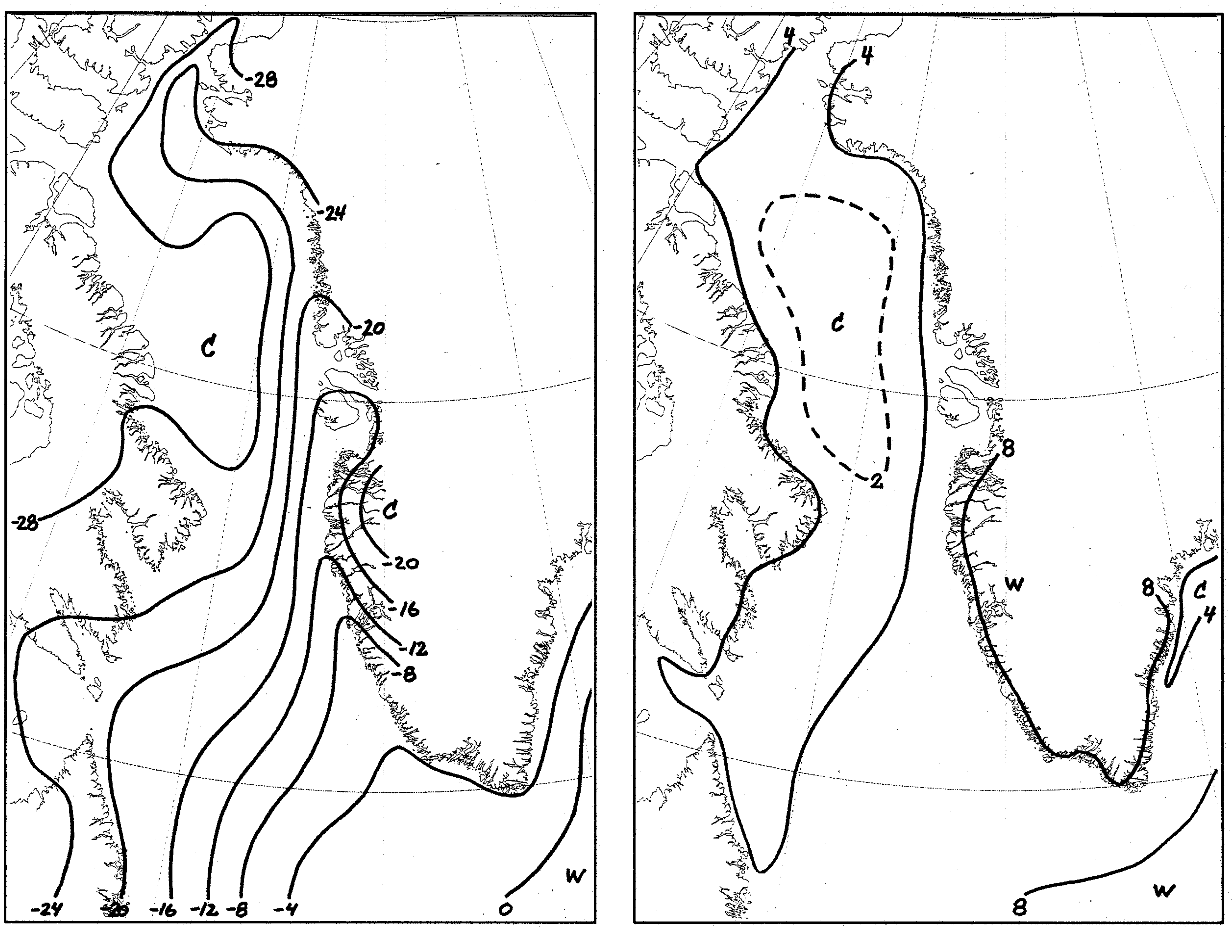


Figure 13.4. Mean temperatures for February (left) and August (right) (partly based on ECMWF-data).

13.1.5 Fog and precipitation

Visibility is reduced mainly by the occurrence of *fog*, although *precipitation*, *snow* in particular, is another important cause. Fog (visibility less than 1 km) is primarily a *summer* phenomenon. The frequency of fog increases during May and peaks in June/July, when the temperature contrast between the cool sea surface and the relatively warm atmosphere is at a maximum. It fades out in late August. The frequency of fog in July is 20-30 % of the total time over the coldest parts of the sea area (Figure 13.5).

Fog is less frequent over the coastland. It is often within sight when facing west from the inhabited places of West Greenland. Summerfog is of the advection type. It typically develops with moist air drifting slowly across a water surface with (not necessarily large) temperature variations, which occur almost everywhere in the West Greenland waters. The sun will often be visible through the fog. Once formed, fog may persist even with increasing wind, however, it will gradually become patchy. Advection of an air mass to a warmer surface causes the fog to evaporate or lift to low clouds.

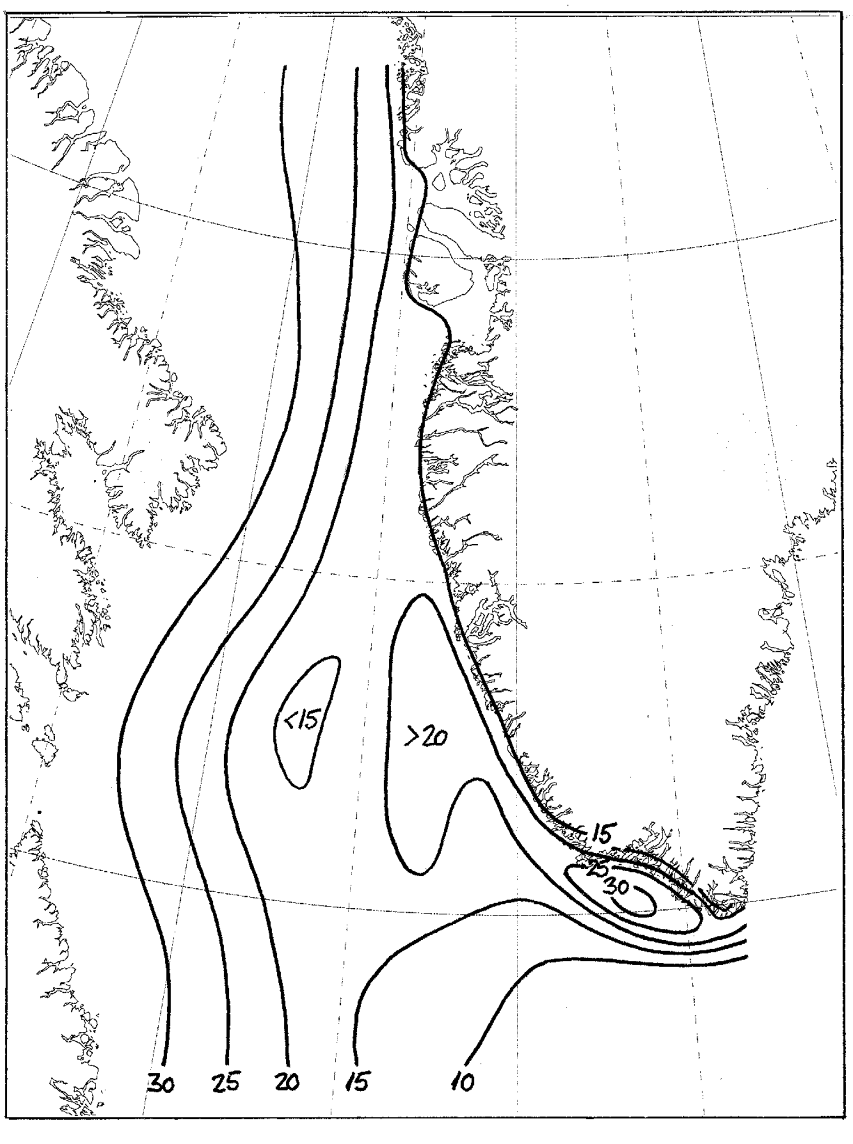


Figure 13.5. Geographical distribution of fog in July (percentage of time).

When there are clear skies above, temperatures within fog are often a few degrees below that of the sea surface due to radiation cooling. Freezing temperatures within fog over a cold water surface are not unusual, and icing with rime ice or clear ice may occur. In *winter*, advection fog may occasionally form within a warm and moist air mass advected from the south. Fog may even form with a warm foehn wind blowing aloft. Radiation fog may develop under clear calm conditions over snow covered and solid pack ice. However, the air will often be too dry for the fog formation, unless there is a source of moisture (an open lead in the ice) nearby, due to sublimation of rime on the cold surface. Steam fog (sea smoke) forms within cold air flowing from pack ice or from cold land out over open water. The occurrence of steam fog is often very localised, however, it may be more widespread in a very cold air mass.

Visibility may also be reduced more or less by precipitation (particularly snow) and drifting snow. In winter, snow showers are present much of the time over open water causing moderate or poor visibility. The amount of precipitation is known only from coastal stations. It is high in the south due to open water and frequent cyclonic activity. Precipitation is low in the north, where the moisture content of the air is low, particularly in winter and spring. The annual precipitation ranges from 200-300 mm in the Disko area to more than 1,000 mm in southernmost Greenland. In Nuuk/Godthåb it is about 600 mm.

With winds blowing onshore orographic intensification takes place in the outer coastal areas. On the other hand offshore winds tend to reduce precipitation. Winterly showers over open water are very frequent; often kept away from the coast by the land breeze they contribute to the amount of precipitation at sea. Most of the precipitation falls in late summer or in autumn, due to maximum occurrence of open water combined with high cyclonic activity. In winter, precipitation is usually in the form of snow.

13.2 West Greenland oceanography

13.2.1 Introduction

Along the West Greenland fishing banks two current components are dominating. Closest to the shore the East Greenland Current component is found bringing water of polar origin northward along the West Greenland coast. On it's way this water is diluted by run-off water from the various fjord systems. the East Greenland Current component looses its momentum on the way northward and at the latitude of Fyllas Banke it turns westward towards Canada where it joins the Labrador Current. West and below the Polar Water a current component is found originating from the Irminger Sea and the North Atlantic Current. This relatively warm and salty water can be traced all the way along West Greenland from Cape Farewell to Thule.

The oceanographic conditions in the West Greenland Waters are dominated by the following water masses:

- *Polar Water,* originating from the Arctic Ocean and carried to West Greenland by the East Greenland Current
- *Irminger Water, Irminger Mode Water and North Atlantic Mode Water,* all originating from the North Atlantic Current.

The inflow of Polar Water is strongest during spring and early summer (May-July), and since the East Greenland Current carry large amount of Polar Ice with it, the distribution of Polar Ice (Storis) along the coasts of West Greenland will attain its maximum during the same period. The inflow of water masses of Atlantic origin is strongest during autumn and winter explaining why the waters of Southwest Greenland normally are ice-free during wintertime.

A fifty year long time-series of temperature and salinity from West Greenland oceanographic observation points reveal strong inter-annual variability in the oceanographic conditions off West Greenland as well as some distinct climatic events of which three cold periods within the recent thirty years are the most dominant. The inter-annual variability is caused by changes in the atmospheric circulation or by variations in the strength of the ocean currents transporting water to the West Greenland area, and both seem to be related to the North Atlantic Oscillation Index (NAO-index) reflecting the difference in mean sea level air pressure between the Icelandic Low and the Azores High.

13.2.2 Circulation

The ocean currents around Greenland is an integral part of the circulation and water mass balance of the North Atlantic and the arctic regions, where the bottom topography is of vital importance to the circulation and the distribution of water masses (Figure 13.6).

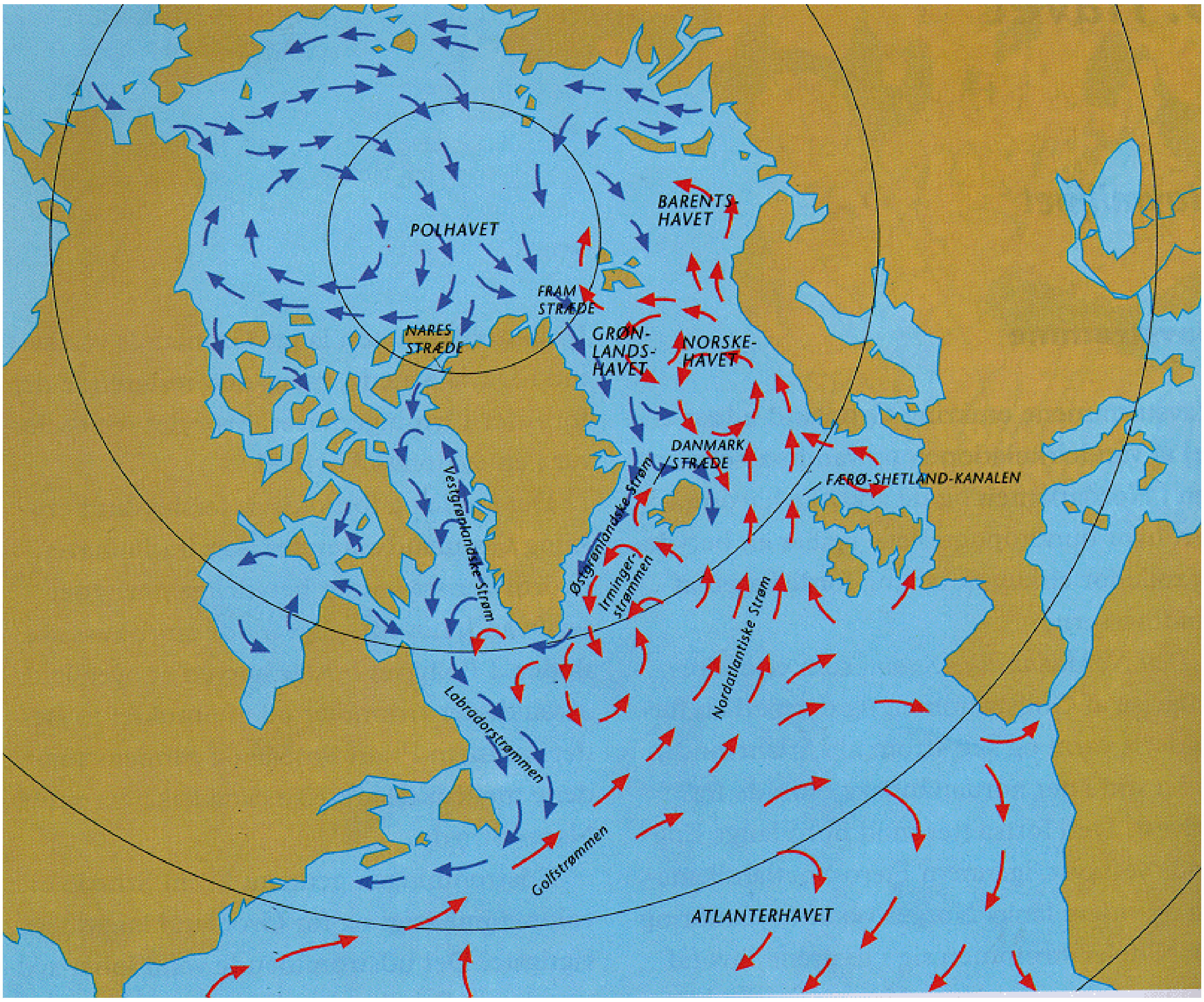


Figure 13.6. Surface currents in the northern North Atlantic. Blue arrows = cold water. Red arrows = warm water.

From southwest the North Atlantic Current, which is a continuation of the Gulf Stream, enters the area. It flows northward along the westcoast of Great Britain, through the Faeroe-Shetland Channel and continues along the continental slope off Norway. At around 70° N the current splits up into two components. One of them continuing along the west coast of Norway into the Barents Sea, the other following the continental slope northwards to the Spitsbergen region. Here it converges with the colder, less saline arctic surface water, sinks and continues as a subsurface current into the Arctic Ocean. Part of the North Atlantic Current branches off westwards into the East Greenland Current, where it underlies the Polar Water from 150 m to approximately 800 m.

Before entering the Faeroe-Shetland Channel, part of the North Atlantic Current turns westward as the Irminger Current, which occupies the ocean area south of Iceland. Part of this current follows the Icelandic coastline to the north through the Denmark Strait and continues along the north coast of Iceland, where it meets the cold, less saline East Icelandic Current. The other part of the Irminger Current turns towards Greenland south of the Denmark Strait, where it flows southward along the east coast of Greenland. Some of this water rounds Cape Farewell, while a second portion remains within the Irminger Sea, where it recirculates in a cyclonical gyre.

Turning our attention to the cold water, it originates from the Arctic Ocean, which throughout the year is supplied with fresh water primarily from the large Russian rivers. This surplus of water leaves the area mainly at two locations:

a. Through the Fram Strait i.e. the area between Greenland and Spitsbergen.

b. Through the Canadian Arctic Archipelago i.e. the area between Greenland and Canada.

The Fram Strait is by far the most important of the two outflow regions, making up about 75 % of the water outflow from the Arctic basin. The water is transported southward along the east coast of Greenland and constitutes the East Greenland Current. This current flows on top of the Greenlandic shelf from the Fram Strait to Cape Farewell and continues northward along the west coast of Greenland up to a latitude of about 65-66°N, where it turns westward and unites with the south flowing current off the Canadian east coast. This current, called the Baffin Current, also transports water from the Arctic Ocean, leaving the area through the second major outflow region, the Canadian Arctic archipelago. It follows the Canadian coast and continues into the Labrador Current, which meets the North Atlantic Current at around 40-45°N.

The water in the Cape Farewell area is relatively stagnant. In the southern part of the area water from the Labrador Current is swept east- to northeast by the North Atlantic Current. It flows side by side and gradually mix with the North Atlantic Current and later the Irminger Current in the Irminger Sea and returns to the area south of Cape Farewell. Therefore the current system in this area can be regarded as a great cyclonic gyre, in which the velocities are relatively small.

Along the West Greenland fishing banks two current components are dominating. Closest to the shore the East Greenland Current component is found bringing the water of polar origin northward along the West Greenland coast. On it's way the water is diluted by run-off water from the various fjord systems. The East Greenland Current component looses its momentum on the way northward, and at the latitude of Fyllas Bank it turns westward towards Canada where it joins the Labrador Current. West and below the Polar Water a current component is found originating from the Irminger Sea and the North Atlantic Current. This relatively warm and salty water can be traced all the way along West Greenland from Cape Farewell to Thule.

It has recently been shown (Pickart et al. 2001) that the East Greenland Current component undergoes a major change from one side of Greenland to the other. On the eastern side the current is tightly trapped to the shelf break, while it on the western side extends far offshore over the deep basin, Figure 13.7. This is a year-round phenomenon.

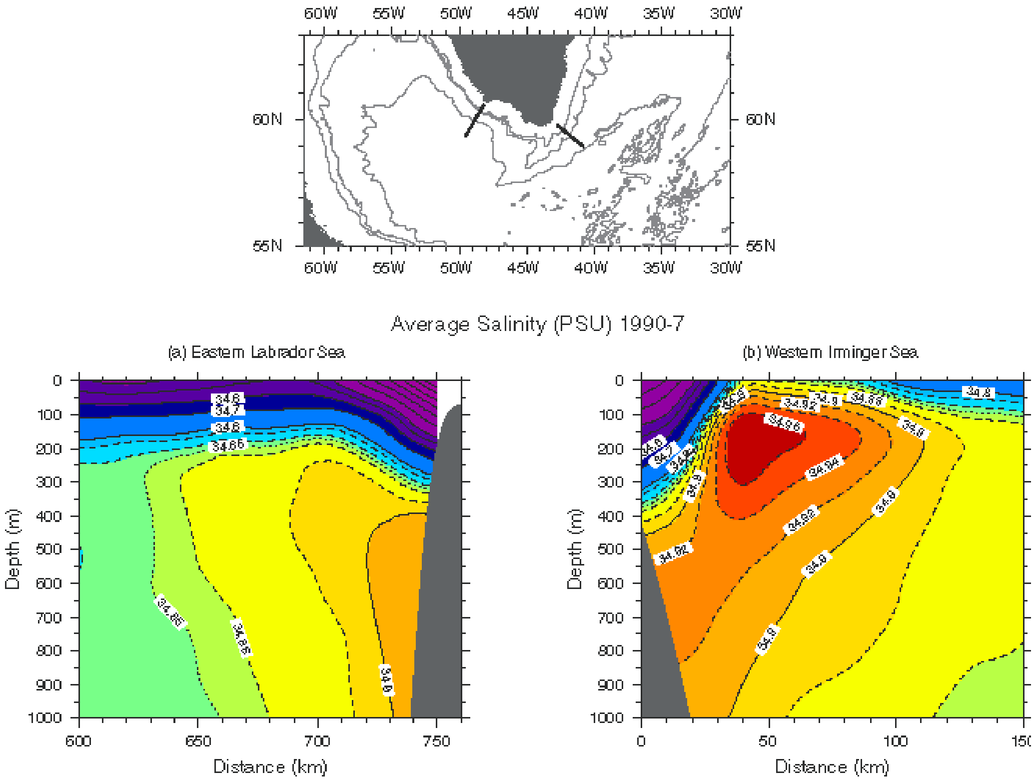


Figure 13.7. Mean upper-layer salinity for the period 1990-97. a) Eastern Labrador Sea. b) Western Irminger Sea (source: Pickart et al. 2001).

Several processes could explain this phenomenon:

- The East Greenland Current has trouble negotiating the "sharp corner" of Cape Farewell.
- Winds, which are predominantly northwesterly in this region. This implies onshore Ekman transport on the east side of Greenland and offshore on the west side.
- Fluctuations in the Irminger Current component.

The first two are not regarded as likely explanations, since annual oceanographic surveys show that polar water still is close to the coast just west of Cape Farewell (Buch & Nielsen 2001) and the wind influence has large annual variability.

The most likely candidate therefore is fluctuations in the Irminger Current. Recent analysis of Topex-Poseidon altimetry data (Prater 2000) as well as data from surface drifters and subsurface floats (Fratantoni et al. 1999, Lavander 2000, Cuny et al. 2001) has revealed interesting support for this theory, all showing the presence of a localised source of high eddy variability off West Greenland, Figure13.10.

The reason for the formation of eddies in this particular region is believed to be due to baroclinic instability of the Irminger Current as a result of the underlying bathymetry, with the continental slope being particularly steep in this area.

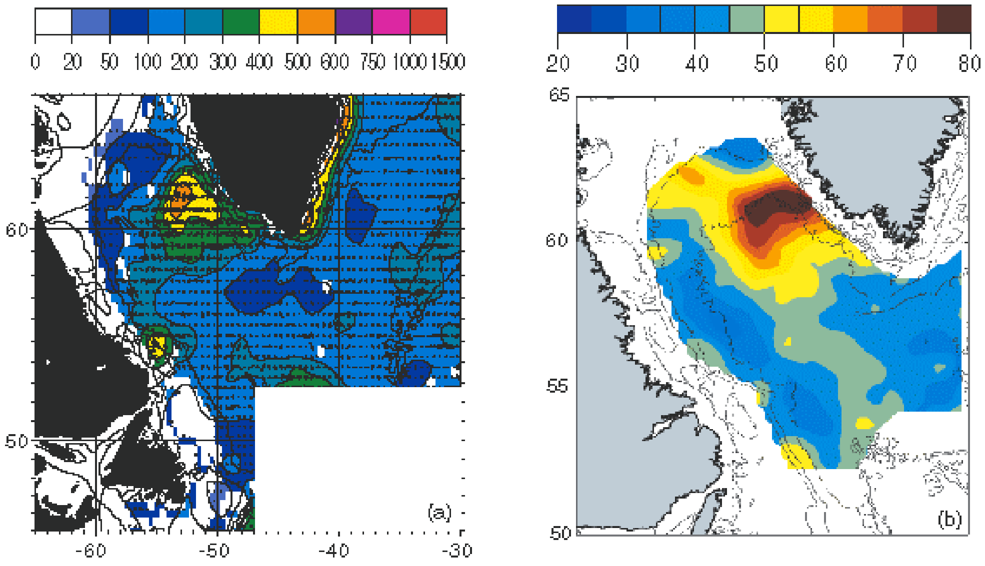


Figure 13.8. a) EKE from WOCE surface drifters (from Fratantoni et al. 1999). b) Sea-surface height variability from POPEX (from Prater 2000).

This picture of the surface circulation in the ocean off Greenland only reflects the average condition, and great seasonal and inter-annual variations do, however, occur. Recent research has demonstrated that the North Atlantic Oscillation (NAO) is the major source of inter-annual variability of weather and climate in the North Atlantic region and thereby also to variations in the ocean circulation and the oceanic environment (see Section 3).

13.2.3 North Atlantic Oscillation (NAO)

The NAO, which is associated with changes in the surface westerlies across the Atlantic onto Europe, refers to a meridional oscillation in the atmospheric mass with centres of action near the Iceland Low and the Azores High (van Loon & Rogers 1978). Although it is evident throughout the year, it is most pronounced during winter and accounts for more than one-third of the total variance of the Sea Level Pressure (SLP) field over the North Atlantic. Because the signature of the NAO is strongly regional, a simple index of NAO was defined by Hurrell (1995) as the difference between the normalised mean winter (December-March) SLP anomalies at Lisbon, Portugal and Stykkisholmur, Iceland. The SLP anomalies at each station were normalised by dividing each seasonal pressure by the long-term mean (1964-1995) standard deviation. The variability of the NAO index since 1864 is shown in Figure 13.9 (Hurrell & van Loon 1997), where the heavy solid line represents the low pass filtered meridional pressure gradient. Positive values of the index indicate stronger than average westerlies over the middle latitudes associated with low-pressure anomalies over the region of the Icelandic Low and anomalous high pressures across the subtropical Atlantic.

In addition to a large amount of inter-annual variability, there have been several periods when the NAO index persisted in one phase over many winters (van Loon & Rogers 1978, Barnett 1985, Hurrell & van Loon 1997).

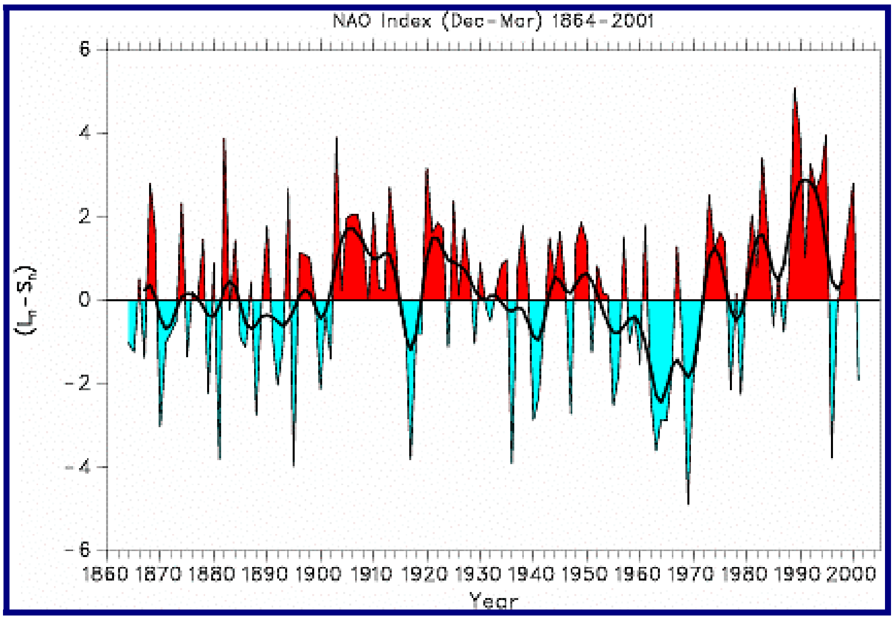


Figure 13.9. Time series of the winter (December-March) index of the NAO (as defined in the text) from 1864-1995. The heavy solid line represents the meridional pressure gradient smoothed with low pass filter to remove. Fluctuations with periods less than 4 years (update from Hurrell & van Loon 1997).

Over the region of the Icelandic Low seasonal pressures were anomalously low during winter from the turn of the century until about 1930 (with exception of the 1916-1919 winters), while pressures were higher than average at lower latitudes. Consequently, the wind onto Europe had a strong westerly component and the moderating influence of the ocean contributed to higher than normal temperatures over much of Europe (Parker & Folland 1988). From the early 1940's until the early 1970's the NAO index exhibited a downward trend and this period was marked by European wintertime temperatures that were frequently lower than normal (van Loon & Williams 1976, Moses et al. 1987). A sharp reversal has occurred over the past 30 years and, since 1980, the NAO has remained in a highly positive phase with SLP anomalies of more than 3 mb in magnitude over both the subpolar and the subtropical Atlantic. The 1983 and 1989-1995 winters were marked by some the highest positive values of the NAO index recorded since 1864 (Figure 13.11).

A detailed analysis by Hurrell (2000) shows that the NAO exerts a dominant influence on wintertime temperatures across much of the Northern Hemisphere. Surface air temperature and sea surface temperature (SST) across wide regions of the North Atlantic Ocean, North America, the Arctic, Eurasia and the Mediterranean are significantly correlated with NAO variability. Such changes in surface temperature (and related changes in rainfall and storminess) can have significant impacts on a wide range of human activities as well as on marine and terrestrial ecosystems.

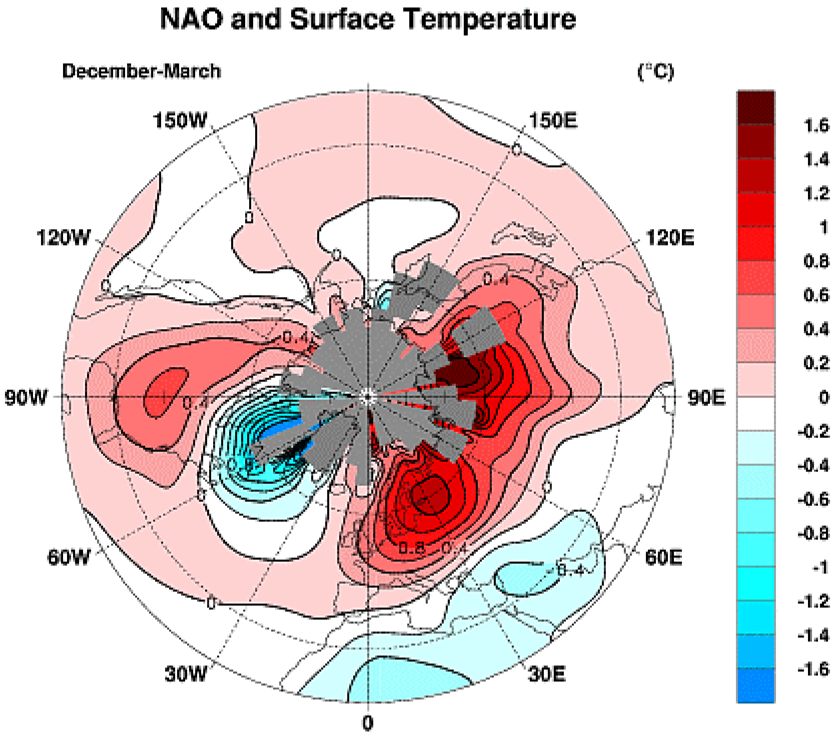


Figure 13.10. Changes in land surface and sea surface temperature (° C) corresponding to a unit deviation of the NAO index for the winter months (December-March) from 1935-1999. The contour increment is 0.2° C. Regions of insufficient data are not contoured (after Hurrell 2000).

When the NAO index is positive, enhanced westerly flow across the North Atlantic during winter moves relatively warm (and moist) maritime air over much of Europe and far downstream across Asia, while stronger northerlies over Greenland and northeastern Canada carry cold air southward and decrease land temperatures and SST over the northwest Atlantic (Figure 13.10).

This can be illustrated further by comparing the temperature over Greenland from a low NAO period (1960-69) to a high NAO period (1990-99), Figure13.13. It is noticed that especially offshore West Greenland was significantly warmer in the 1960's than in the 1990's.

Changes in the wind pattern in the Greenland area are minor as illustrated in Figure 13.12. A more detailed analysis using wind observations (6 hour intervals) from a number of observation sites in Greenland confirms this statement.

The influence of the changing NAO-index on the atmosphere naturally is reflected to the ocean and the ocean circulation. In Figure 13.13 the general ocean circulation of the North Atlantic is show under NAO^+ and NAO^- - conditions.

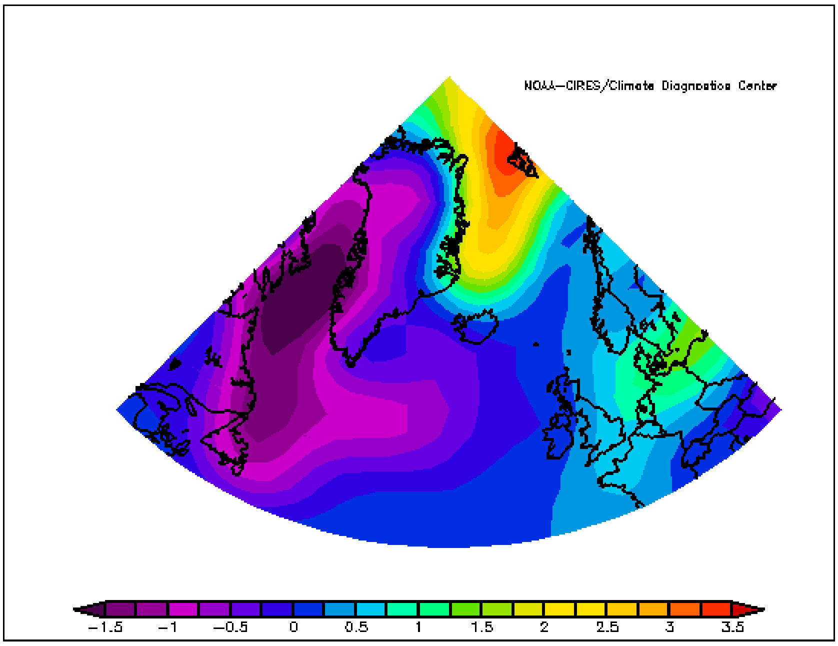


Figure 13.11. Difference in air temperatures at the 1,000 mb level between 1960-69 and 1990-99 . Calculated using the NCEP/NCAR reanalysis database.

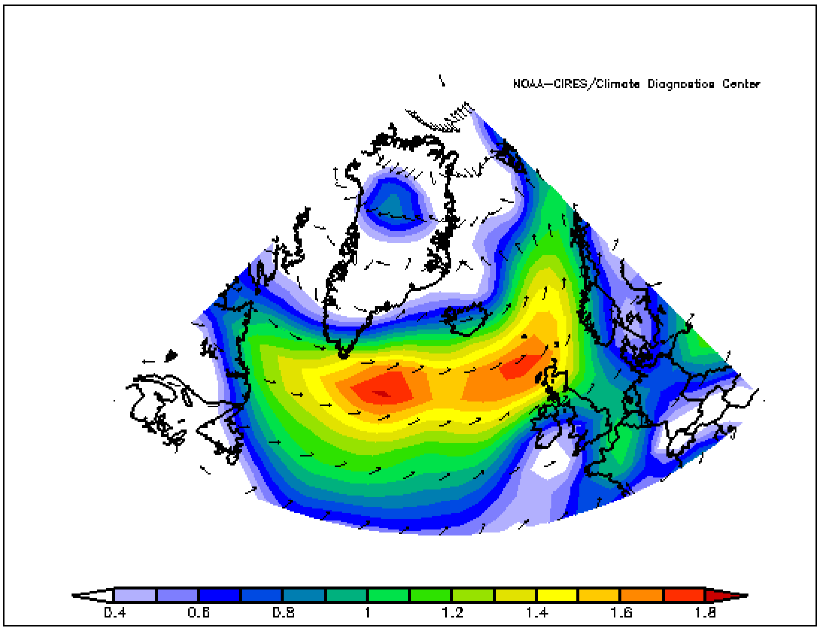


Figure 13.12. Changes in the 1,000 mb winds between the 1960-69 and 1990-99. Calculated using the NCEP/NCAR reanalysis database.

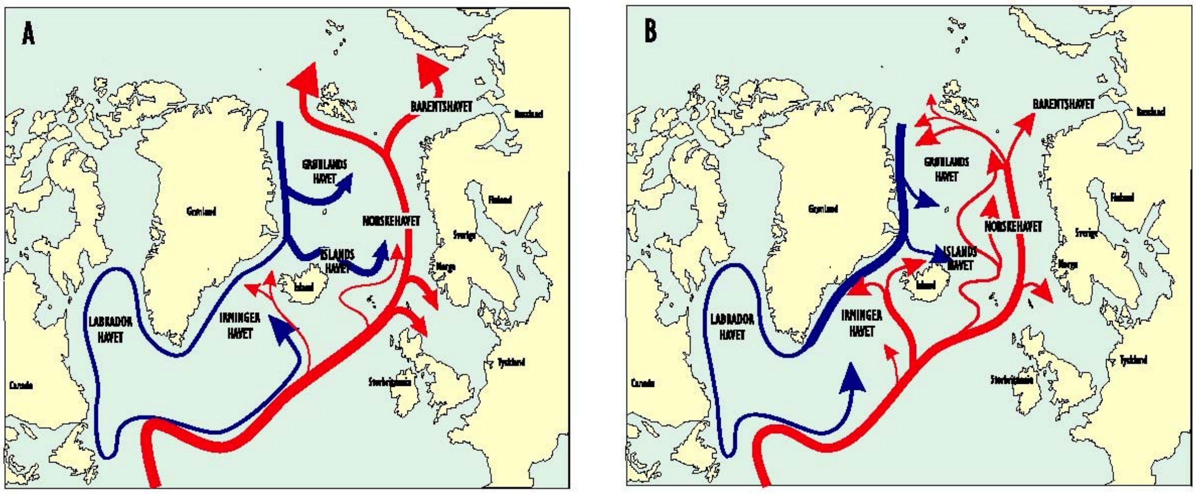


Figure 13.13. Ocean circulation under high (A) and low (B) NAO-index conditions (after Blindheim et al. 2001).

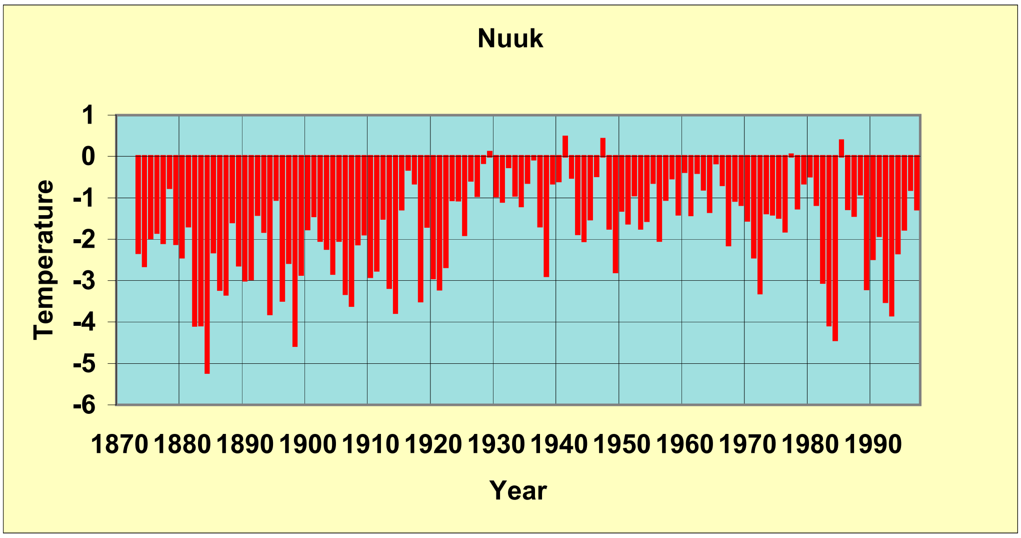
Positive values of NAO result in an intensification of the North Atlantic Current, which is deflected towards the east having the result that the Irminger Current has low intensity, while the inflow to the North Sea and the Arctic Ocean are strong. This results in warm conditions in Europe and the Arctic region. The East Greenland Current has high intensity north of the Denmark Strait but low intensity south of the strait, because water is flowing into the Greenland Sea and the Iceland Sea via the Jan Mayen- and the East Icelandic Currents.

During negative NAO conditions the intensity of the North Atlantic Ocean circulation is almost quite opposite. The intensity of the North Atlantic Current is weaker resulting in several side branches, strong Irminger Current, reduced inflow to the North Sea and the Arctic Ocean. The East Greenland Current has a high intensity all the way to Cape Farewell with weak inflows to the Greenland- and Iceland Seas.

The above given description of the NAO index clearly illustrates the strong correlation between the strength of the westerlies across the North Atlantic - the NAO index - and the climate in Greenland and Europe. It also shows that the climate in Greenland and Europe are negatively correlated to each other, a phenomenon named Seesaw in the literature.

Conditions over Greenland

Time series of annual mean air temperatures from Nuuk in West Greenland and Tasiilaq in East Greenland is shown in Figure 13.14. In addition to the inter-annual variability all stations reflects the general picture of variability outlined above in the description of the NAO index (Figure 13.11, 13.12), i.e. high NAO conditions normally reflect in cold condition in Greenland. The late 1990'es are however an exception from this pattern, since both NAO and Nuuk air temperatures show relatively high values. This was due to a slight displacement of the NAO pattern towards the East or Northeast (ICES 2000).



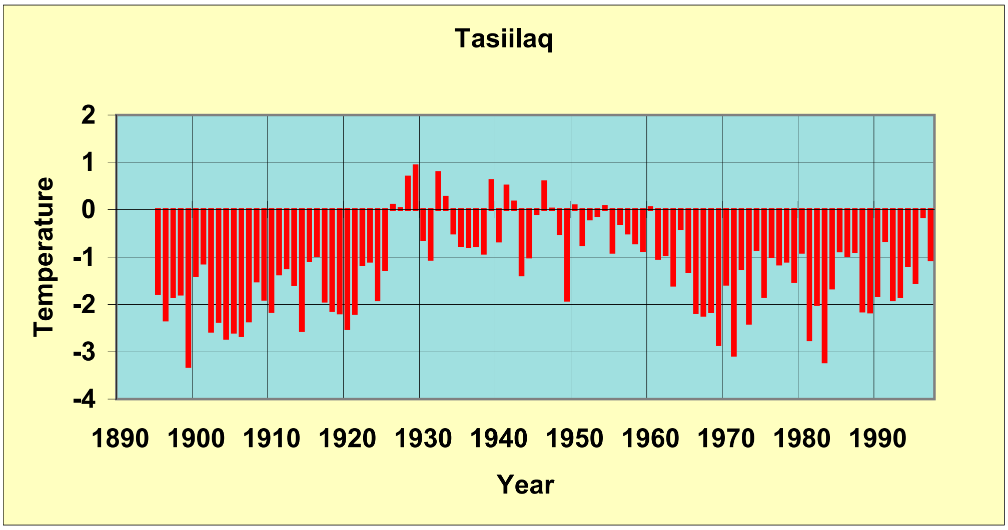
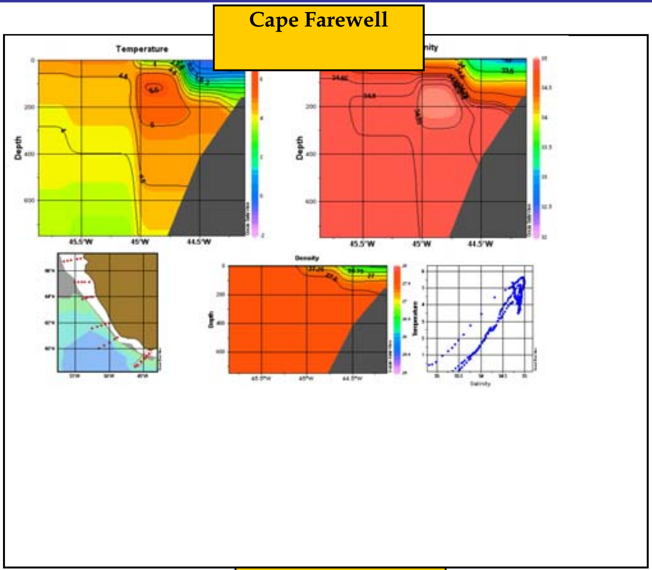


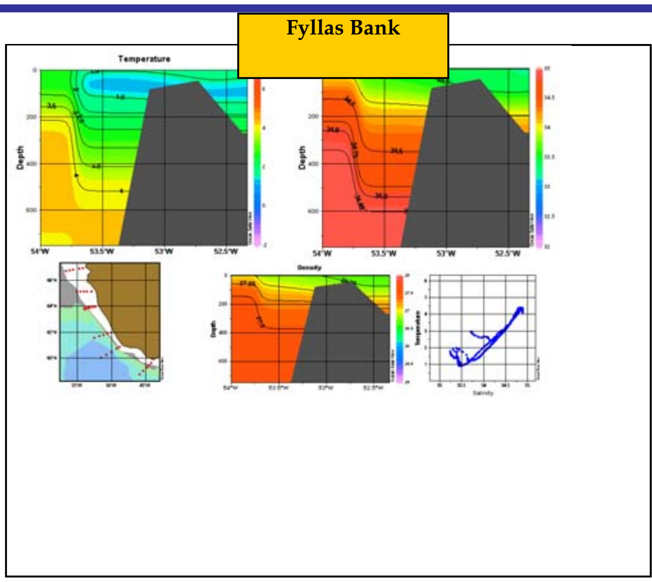
Figure 13.14. Annual mean air temperatures from Nuuk and Tasiilaq.

Some geographical differences can be recognised of which one of the most significant is the relatively long cold period experienced in Tasiilaq, East Greenland in the late 1960'es and early 1970's. These cold conditions can also be traced at the southernmost West Greenland stations around 1970. The cause for the cold conditions at East- and West Greenland around 1970 has been thoroughly discussed in the literature as the well known "Mid-seventies anomaly" or the "Great salinity anomaly", which was traced all over the North Atlantic area during the 1970'es and early 1980'es. It was a result of a period of extremely high frequency of northerly winds over the Arctic Ocean and northern North Atlantic in the 1960'es (Dickson et al. 1988). The northerly winds caused a greater than normal outflow of cold and relatively fresh Polar Water from the Arctic Ocean. This water together with large amounts of polar ice was carried along the east coast of Greenland to the West Greenland area by the East Greenland Current. It is therefore logical that the most extreme air temperature conditions was experienced at Tasiilaq

Focusing on the 1981-1995 period attention must be paid to two remarkably cold periods: 1982-1984 and 1989-1994. These two cold periods coincide well in time with the occurrence of the highest positive values of NAO index (1983, 1989 and 1990) as shown in Figure 13.11.

The 1982–1984 period has been discussed by Rosenørn et al. (1985) who showed that the cold conditions was due to the inflow of an extremely cold air mass from arctic Canada to the Davis Strait region with the centre in the vicinity of Aasiaat. Judging from the annual mean temperatures given in Figure 13.14, it is seen that the 1982-1984 period is one of the coldest ever recorded at Greenland although not the coldest. Rosenørn et al. (1985) showed that negative temperature anomalies were observed every month from February 1982 to November 1984, but especially the winter months were extremely cold. The mean temperatures for the winter months December, January and February was in 1984 the coldest ever recorded (-15.2° C in Nuuk) and that we shall 99 years back in time to find similar conditions (-15.1° C in 1885).





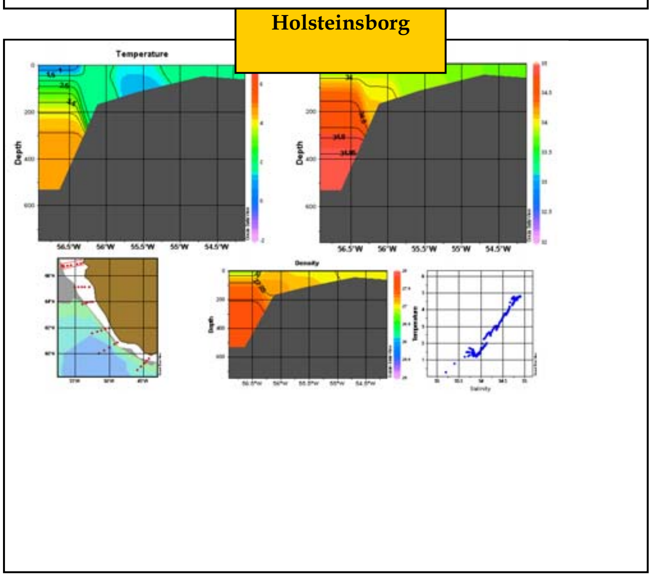


Figure 13.15. Vertical distribution of temperature, salinity and density medio June 2001 at three NAFO standard sections – Cape Farewell, Fyllas Bank and Holsteinsborg – along the west coast of Greenland.

13.2.4 Water masses

The waters off West Greenland are dominated by four water masses all formed outside the Davis Strait (Buch 1990/2000):

- In the surface layer close to the coast cold and low saline Polar Water is found. It is carried to West Greenland by the East Greenland Current.
- Below and west of the Polar Water we find water originating from the North Atlantic Current
- North East Atlantic Deep Water and Northwest Atlantic Bottom Water are found at great depths.

The two deep water masses are not discussed in the present context since they are found at great depths.

In Figure 13.15 the vertical distribution of temperature, salinity and density is shown on three NAFO standard sections off West Greenland. At the southernmost section at Cape Farewell the front between the Polar Water and the Atlantic Water is clear and sharp. Further north the front is much more diffuse - as discussed in section 2 - and the core of the Polar Water is here located at a depth of around 100 m.

The T/S-characteristics of Polar Water as it is found in the East Greenland Current are temperatures generally below 0^{o} C but they may rise to $3\text{-}5^{o}$ C in the surface layer during the summer. Salinity is below 34.4. Buch (1990/2000) however showed that the T/S-characteristics of Polar Water are altered on its way to West Greenland due to mixing with surrounding water masses. Along the West Greenland fishing banks Polar Water therefore is characterised by temperatures below 1^{o} C, which may rise to $3\text{-}5^{o}$ C during summer, salinities are below 33.75-34.0. This classification is quite similar to the one given by Kiilerich (1943).

The Atlantic water component has until recently been referred to as Irminger Water, but a more detailed analysis questions this statement. Lee (1968) and Clarke (1984) have defined Irminger Water as a mixture of Irminger Sea Water, formed in the Irminger Sea during winter, and North Atlantic Water and they characterised Irminger Water to have temperatures between 4 and 6^{o} C and salinities between 34.95 and 35.1.

In order to study the water masses of Atlantic origin in more detail, all available observational data from West Greenland as published in World Ocean Atlas 1994 are used for a T/S-plot analysis. Due to the seasonal variability of the inflow of Atlantic Water T/S-diagrams have been prepared using the Ocean Data View Software for each of the four seasons (Figure 13.16. a-d, $S < 34.0$ has been disregarded).

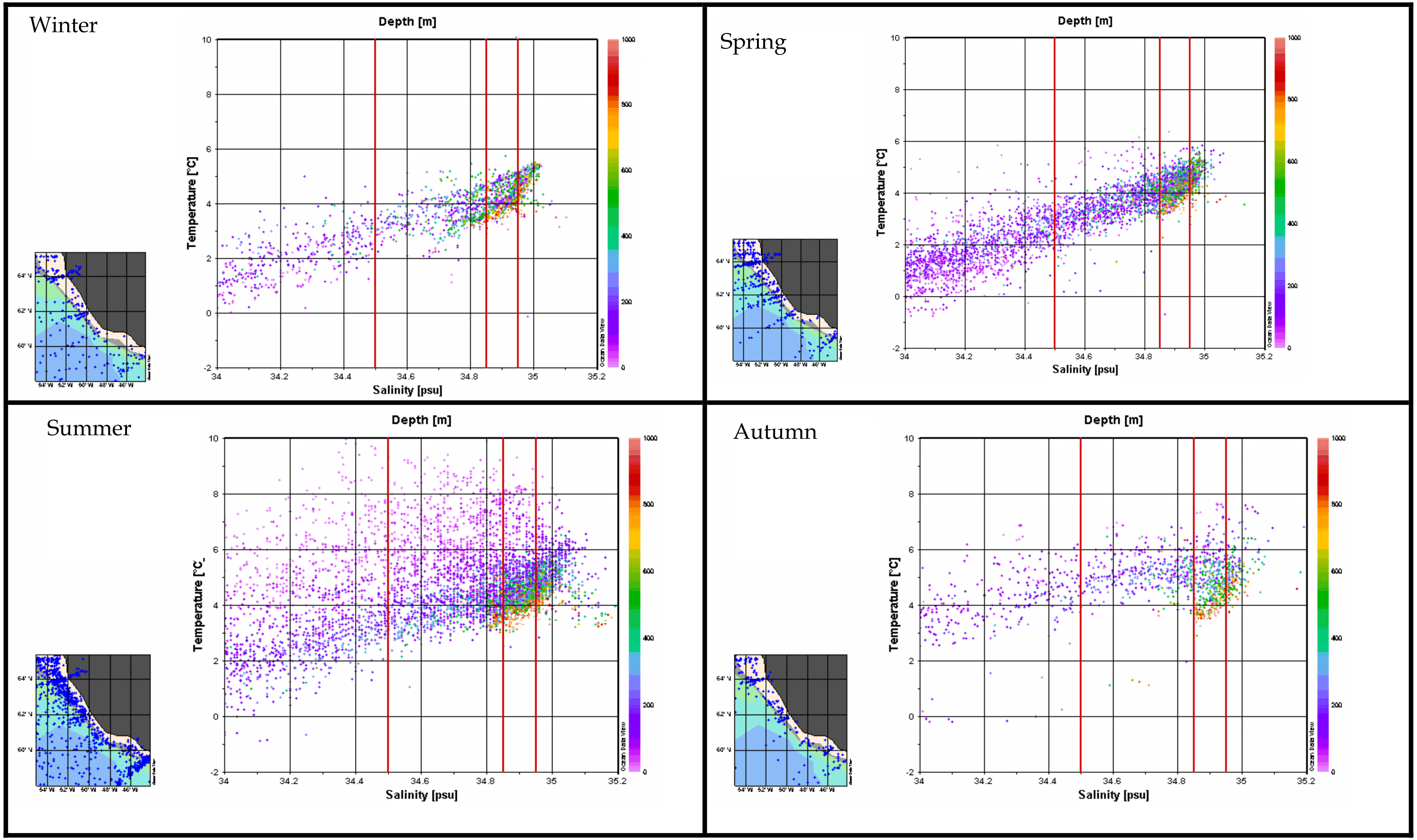


Figure 13.16. Seasonal T-S-plots from the West Greenland area using all available data in the World Ocean Atlas 1994. The colour indicates the observation depth.

These T/S-diagrams clearly indicate the presence of Irminger Water (T~4.5° C, S > 34.95) during all seasons. A more detailed analysis producing T/S-plot for each decade shows great decadal variability in the inflow of Irminger Water to the West Greenland area. It can for instance be seen in Figure 13.17 that the inflows during the 1960'es were much higher than during the 1980'es.

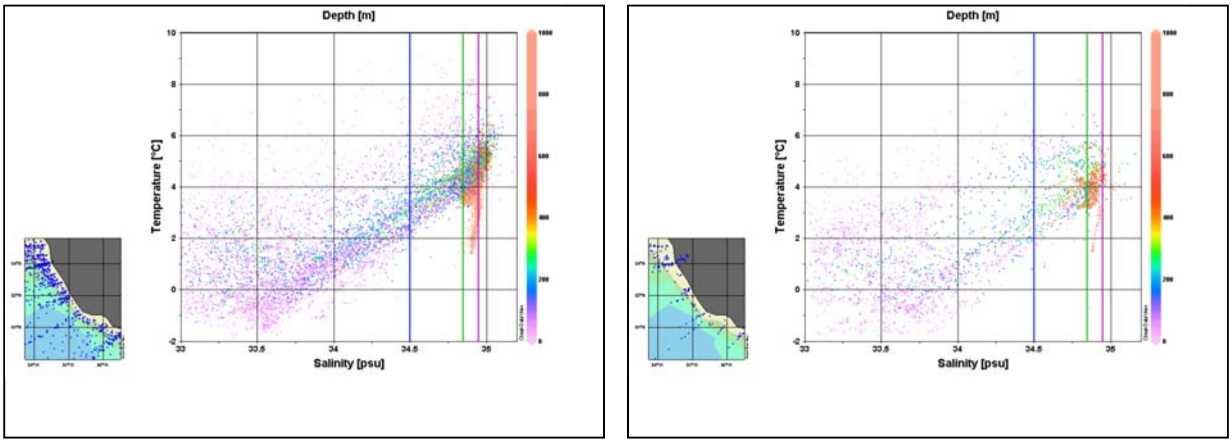


Figure 13.17. TS-plots from the West Greenland area using all available data in the World Ocean Atlas 1994 for the 1960'es (left) and the 1980'es (right).

Figure 13.16 additionally shows that throughout the year there is a body of water in the West Greenland area with salinities above 34.85 and temperatures around 4° C. This body of water most likely have been formed by the Irminger Water mixing with the surrounding water as it flows towards West Greenland resulting in a decrease in temperature and salinity. Water off West Greenland with temperatures above 4° C and salinities between 34.85 and 34.95 is therefore named ***Irminger Mode Water***. This water mass can always be observed off West Greenland, while pure Irminger Water (T around 4.5° C; S > 34.95) only occasionally is observed in the area and then primarily in the southernmost part.

The T/S-plots in Figure 13.16 and the example of a vertical temperature and salinity distribution plot in Figure 13.15 show that there exists a huge volume of water with temperatures above 2.5° C and salinities in the interval 34.50-34.85. Additionally it is seen in Figure 13.16 that the temperature increases during autumn. Water with salinities above 34.5 is found at depths excluding the possibility of a temperature rise due to atmospheric heating (see Figure 13.16 where the colour coding indicates the observation depth). The high temperatures, especially during autumn, support the assumption that water with salinities in the interval 34.5-34.85 are originating from the North Atlantic Current.

Along the Cape Farewell sections of the NORWESTLANT surveys (Lee 1968) a rather thick layer (200 to 250 metres) with salinities between 34.6-34.85 was observed at a distance of around 100 nm south of Cape Farewell. The temperatures were around 2.5° C during the first two NORWESTLANT surveys and increased to above 4.5° C during the third survey. Clarke (1984) reported observations from a section between Cape Farewell and Flemish Cap taken in early 1978. North of the North Atlantic Current to about 100 nm south of Cape Farewell a 200-300 thick layer with temperatures above 2.5° C and salinities below 34.85 was observed, Figure 13.18.

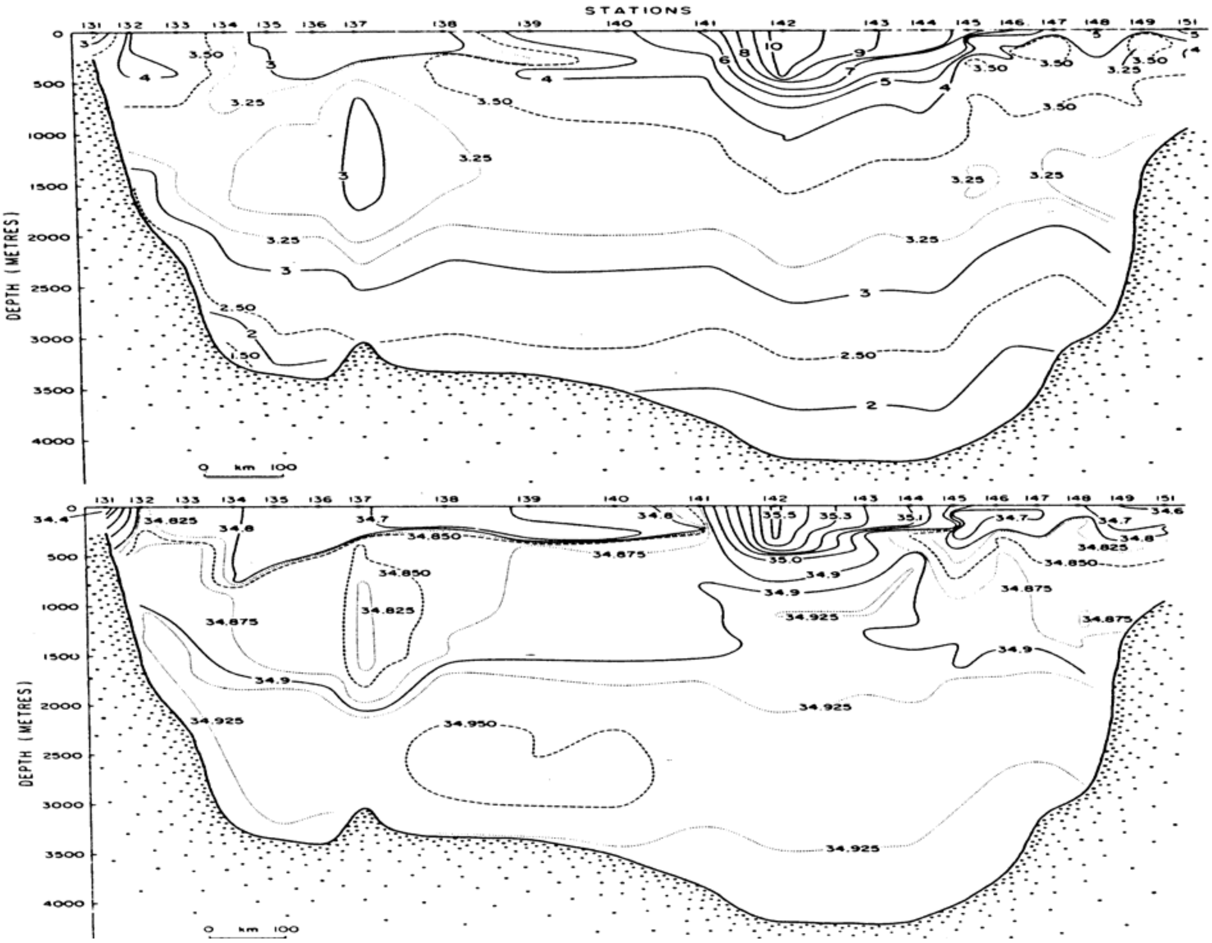


Figure 13.18. Potential temperature and salinity fields along the Cape Farewell to Flemish Cap Section, 1978. After Clarke (1984).

There is therefore reason to believe that the water mass observed off West Greenland characterised by salinities between 34.5 and 34.85 and temperatures above 2° C –(late in the year often above 5° C) has its origin in the northern part of the North Atlantic Current. The relatively low salinities most likely are due to influence from the Labrador Current. This water mass was named "***Northwest Atlantic Mode Water*",** by Buch (2000). A possible path towards West Greenland can be seen in Figure 13.6, where water from the northern rim of the North Atlantic Current turns north at around 40° W flowing towards the area off Southeast Greenland. Here it turns southward flowing towards the Cape Farewell area, where it turns northward again. In the Davis Strait at around 63-65° N the water flows towards west until it reaches the Labrador Current.

The analysis of T/S-data from West Greenland therefore indicates the presence of three water masses of Atlantic origin:

- ***Irminger Water*** - temperature around 4.5° C and salinity above 34.95 psu,
- ***Irminger Mode Water*** - Irminger Water mixed with surrounding water masses on it way to West Greenland - temperature around 4° C and salinities between 34.85 and 34.95 psu,
- ***Northwest Atlantic Mode Water*** - Temperature above 2.5° C and salinities between 34.5 and 34.85 psu. In late autumn the temperatures rise to above 5° C.

13.2.5 Fronts

Along the westcoast of Greenland a front between the low saline Polar Water (mixed with fresh water from land runoff) and the saline water of Atlantic origin is found in the surface layer just west of the West Greenland fishing banks.

In Figure 13.19 it is seen that the front is very sharp at the southernmost sections and becoming increasingly diffuse further north. At the Sisimiut/Holsteinsborg section the front seen further south has almost vanished, while another front at the westernmost part of the section has revealed itself reflecting the presence of newly melted Westice (drift ice from Baffin Bay and Davis Strait).

A more detailed study of temperature and salinity observations throughout the year shows that the front between the two water masses is weak from January to May and relatively strong the remaining part of the year with maximum strength in September and October, see Figure 13.20.

The weak stratification during the winter months is a combined effect of the upper layer being homogenised by vertical overturning due to atmospheric cooling and the fact that the inflow of Polar Water is relative low in this part of the year.

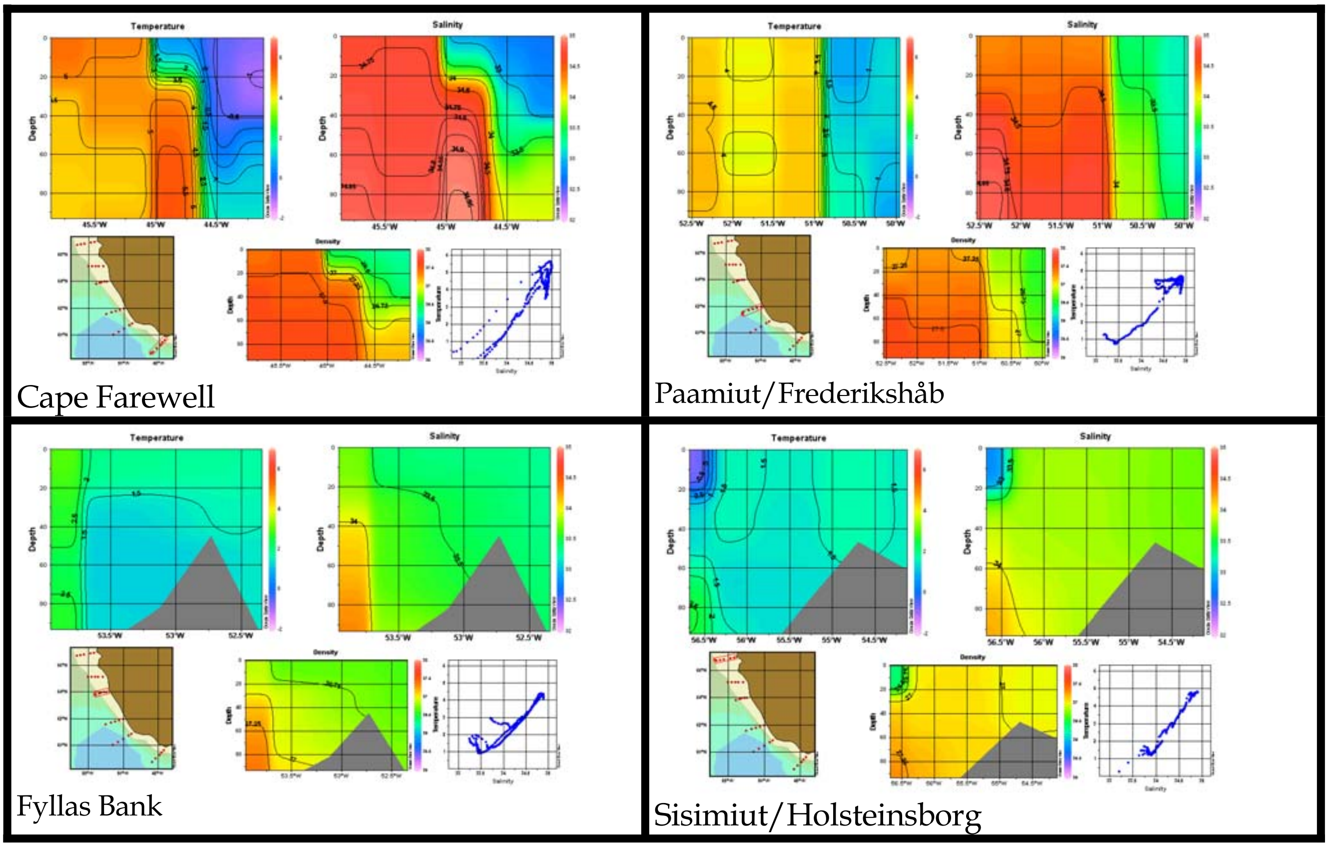


Figure 13.19. Vertical distribution of temperature, salinity and density in June 2001 in the upper100 m at the NAFO standard sections Cape Farewell, Paamiut/Frederikshåb, Fyllas Bank and Sisimiut/Holsteinsborg.

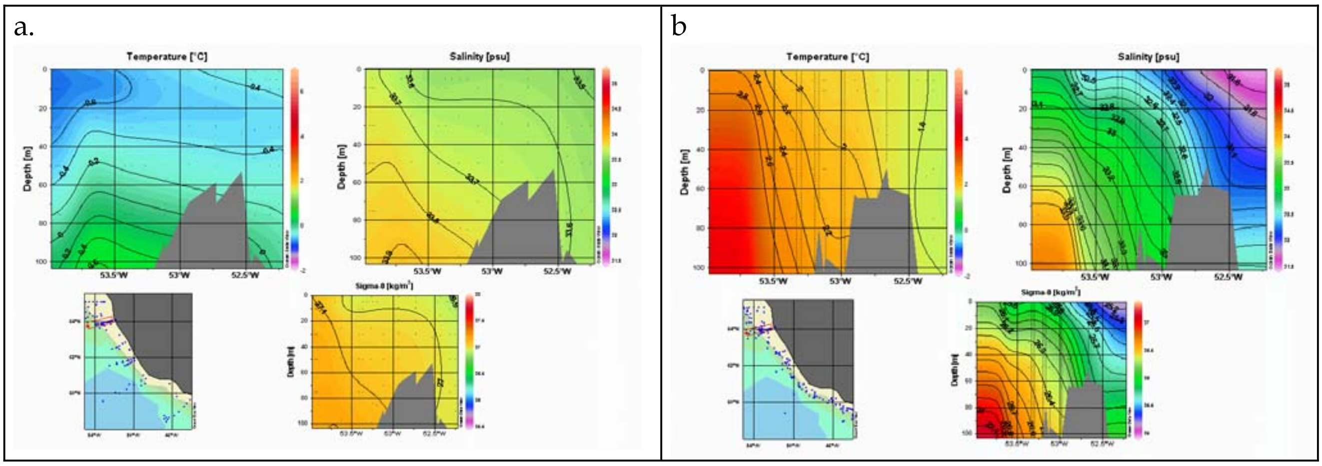


Figure 13.20. Vertical distribution of temperature, salinity and density in the upper100 m at Fyllas Bank in a) March and b) October. Mean Values for the period 1950-1999.

It shall also be noticed that strength of the front is primarily governed by the differences in salinity.

From the perspective of biological productivity the vertical velocities across the front transporting nutrient rich water from greater depth to the surface layer is of interest. Upwelling is generally found west of the West Greenland fishing grounds and to a lesser extent in the deep channels separating the banks, and it is highest from the Fyllas Bank to the Disko Bay in the area of strongest tides, Figure 13.21. Model calculations reveal that the vertical velocities can reach values of 7 x 10^{-5} m/s and the simulations additionally show that there is – as could be expected – good correlation between northerly winds and positive (upward) vertical velocities.

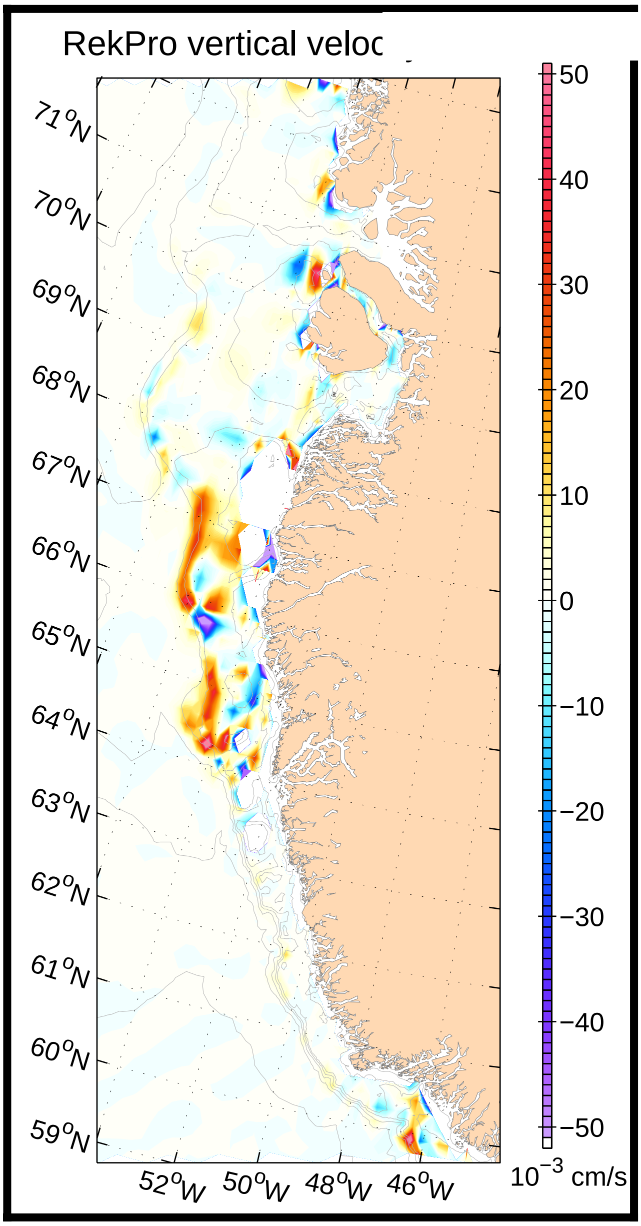


Figure 13.21. Mean vertical velocity at 50 m modelled in 2000 (April to November). Only the barotropic component is included. Red is upwelling and blue is downwelling. Bathymetry lines drawn with grey.

13.2.6 Inter-annual variability

Surface conditions

The most well known oceanographic time series from West Greenland is the mid-June mean temperature on top of Fyllas Bank (Fyllas Bank St. 2, 0-40 m), Figure 13.22.

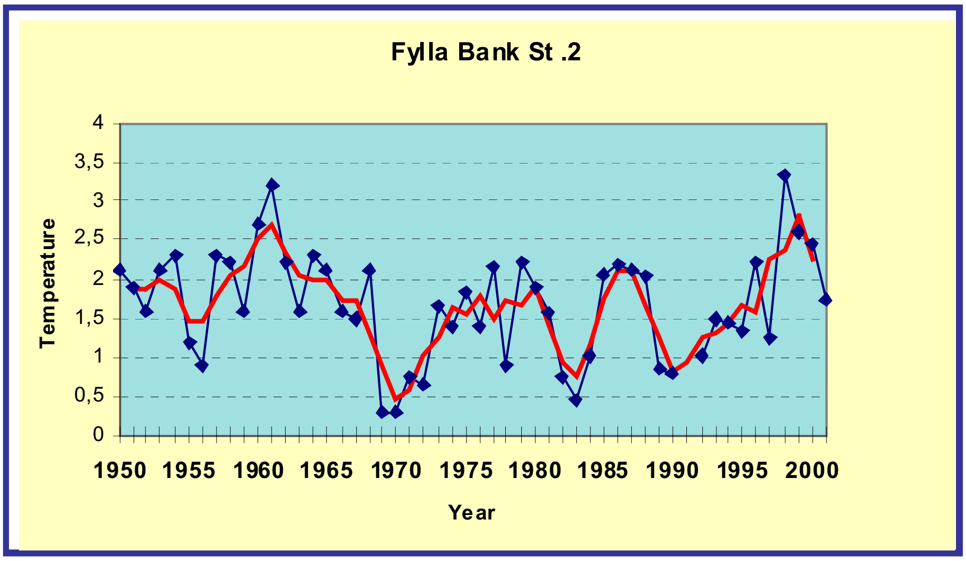


Figure 13.22. Mean temperatures of the upper 40 m on Fyllas Bank St. 2, medio June 1950-1997. Blue line = observations; red line = 3 year running mean.

The temperature may vary quite drastically from one year to the next, often more than 1° C, reflecting the variability of both the atmospheric influence and the inflow of Polar Water. The curve showing the 3-year running mean values naturally smoothens out the variations and reflects therefore better the large scale climatic variability.

The almost 50 year long temperature time-series reveal some very distinct climatic events:

- The 1950-1968 period generally showed high temperatures around 2° C.
- Around 1970 a cold period - the coldest - was experienced. The cold climate of this period was due to an anomalous high inflow of Polar Water (Buch 1990/2000), which was closely linked to the "Great Salinity Anomaly", Dickson et al. (1988).
- The early 1980'es and early 1990'es, two extremely cold periods, were observed reflecting the cold atmospheric conditions in the Davis Strait area as discussed above.
- A remarkably low temperature was observed in 1997 although the atmospheric conditions were quite warm, Figure 13.14, which could indicate a high inflow of Polar Water.
- During recent years temperatures have been rather high most likely due to increased inflow of Irminger Water, se below.

Figure 13.23 shows the time-series of the mid-June salinity on top of Fyllas Bank (actual observations as well as a 3 years running mean). The "Great Salinity Anomaly" around 1970 is clearly reflected in this data set, while the climatic anomalies in the early 1980'es and 1990'es do not expose themselves in any significant way in the surface salinities at Fyllas Bank, which of course was not to be expected because these cold periods was due to atmospheric cooling.

Relatively low salinities were observed in 1996 and 1997 indicating that the inflow of Polar Water have been above normal in these years.

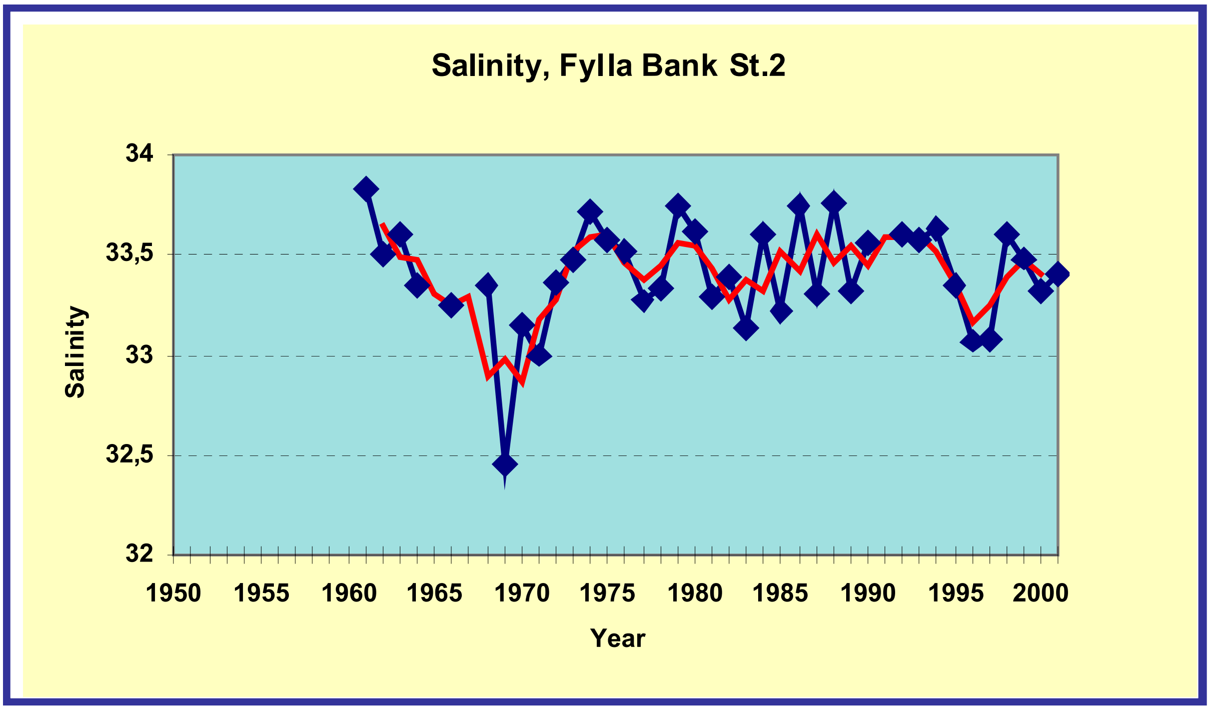


Figure 13.23. Mean salinity of the upper 40 m on Fyllas Bank St. 2, medio June 1961 - 1997. Blue line = observations; red line = 3 year running mean.

Further offshore - just west of the fishing banks there exists relatively long time series of July temperatures and salinities from the following sections and stations:

- Fyllas Bank St. 4, start 1952
- Maniitsoq/Sukkertoppen St. 5, start 1970
- Sisimiut/Holsteinsborg St. 5, start 1970

The mean temperatures and salinities of the upper 50 metres from the three stations are shown in Figure 13.24.

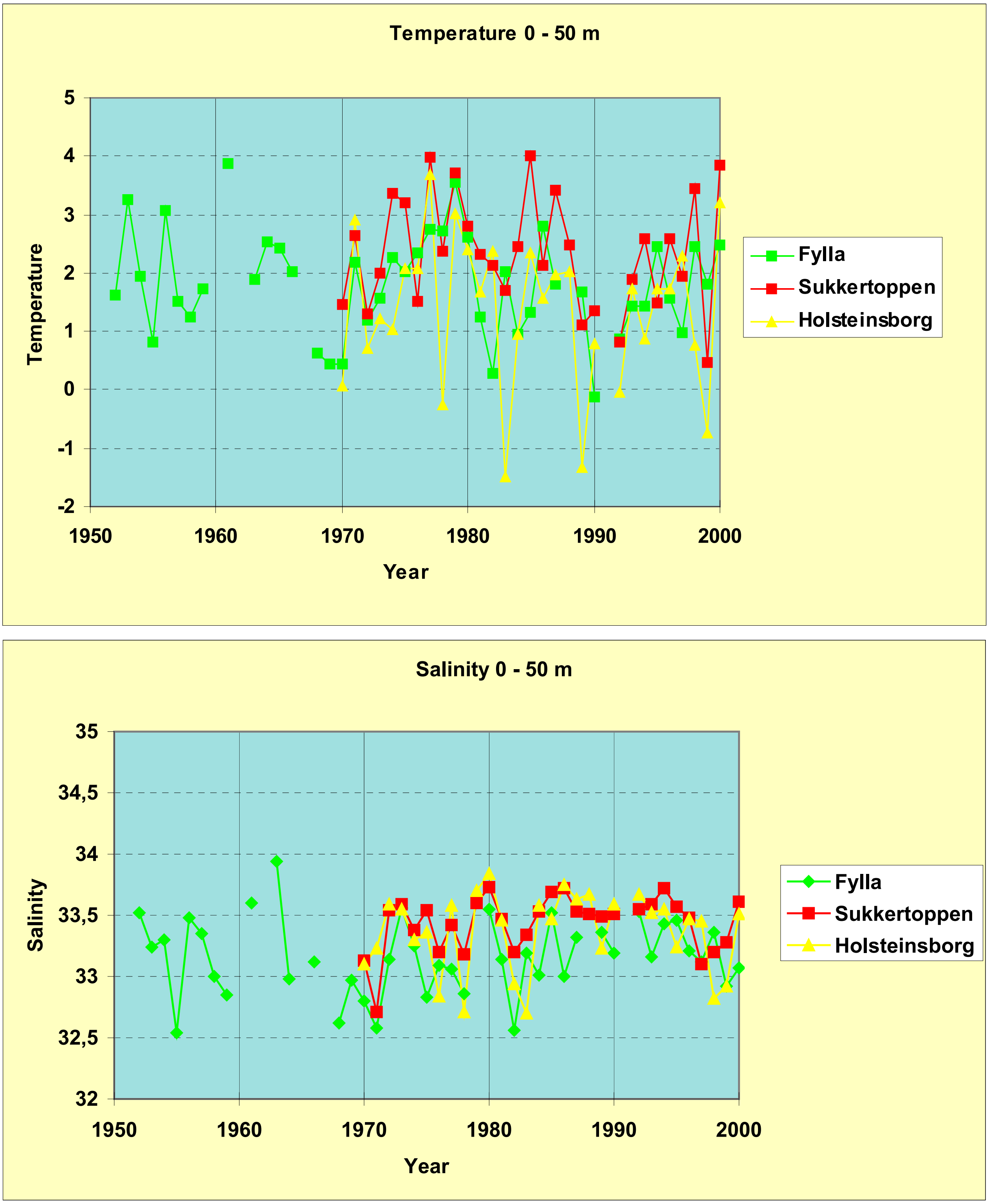


Figure 13.24. Mean temperature and salinity in the upper 50 m at Fyllas Bank St. 4, Maniitsoq/Sukkertoppen St. 5 and Sisimiut/Holsteinsborg St. 5.

The time series reveal that

- The overall tendency in the inter-annual variability at the three stations are comparable although individual years may show large differences in temperature and salinity as well as opposite signs in the development from the preceding year.
- Generally the highest temperatures and salinities are observed at the Maniitsoq/Sukkertoppen, while the lowest salinities most often are observed at Fyllas Bank. This is due to the fact that the Fyllas Bank area is influenced by Polar Water and the Sisimiut/Holsteinsborg station at this time of the year often is influenced by melting west ice and possibly also by cold, relatively fresh water of Polar origin flowing southward on the Canadian side of the Davis Strait; but none of these reach the Maniitsoq/Sukkertoppen area.
- The three cold periods mentioned above is also reflected in these time series. Opposite to the conditions at Fyllas Bank St. 2 a significant decrease in salinity was observed at all three stations during the 1982-84 period, especially in 1982, which was caused by a high inflow of polar ice to the West Greenland area in 1982 combined with the heavy formation of ice in the Davis Strait during the extremely cold winters in 1983 and 1984.
- Relatively warm and saline conditions were experienced in 1979-80.
- Some years extremely cold and low saline conditions were observed at the Sisimiut/Holsteinsborg station, which is due to the presence of ice at the time of observation.

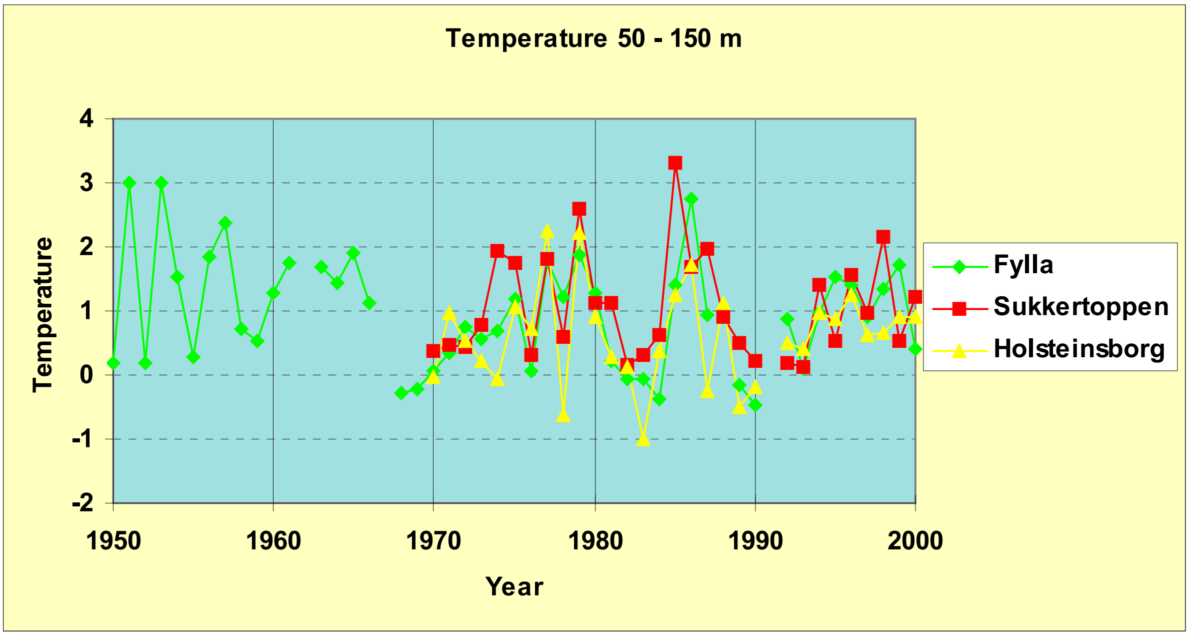
Deeper layers

The variability in the deeper layers are illustrated by the July time series of temperature and salinity from the same three stations just west of the fishing banks that were used above. In Figures 20, 21 and 22 the mean values of temperature and salinity is given for the 50-150 m, 150-400 m and 400-600 m water column. This layering has been chosen for the following reason:

I. The 50-150 m layer is mainly influenced by Polar Water
II. The 150-400 m layer is the transition zone between Polar Water and water of Atlantic Origin
III. The 400-600 m layer is occupied by Atlantic water masses.

It is seen from the three figures that there is great inter-annual variability at all depth levels, although the amplitude of the fluctuations naturally decreases with depth. This is a clear indication of the fact that the West Greenland waters are influenced by the dynamics of several currents having their origin in different parts of the North Atlantic. The variability of the oceanographic conditions in the West Greenland area therefore reflects the individual strengths of the various currents the particular year but also the climatic signal that the currents carry with them from their respective area of formation.

In the 50-150 m layer the temperature fluctuations in general follows the same pattern as was observed in the surface layer, i.e. the cold periods are clearly seen also in this layer, because vertical convection caused by the extreme atmospheric cooling during wintertime creates cold conditions in this layer and superimposed on this is the inflow of cold Polar Water (Figure 13.25). The fluctuations in the salinity signal have, as expected, decreased compared to the surface layer. In 1982 the salinity was extremely low at the Fyllas Bank station; actually it was even lower than during the period with the “Great Salinity Anomaly” around 1970. This is a clear sign of a great inflow of Polar Water, and as mentioned above 1982 was a year with a great inflow of Polar Ice to the West Greenland area, which is a clear reflection of a high transport rate in the East Greenland Current.



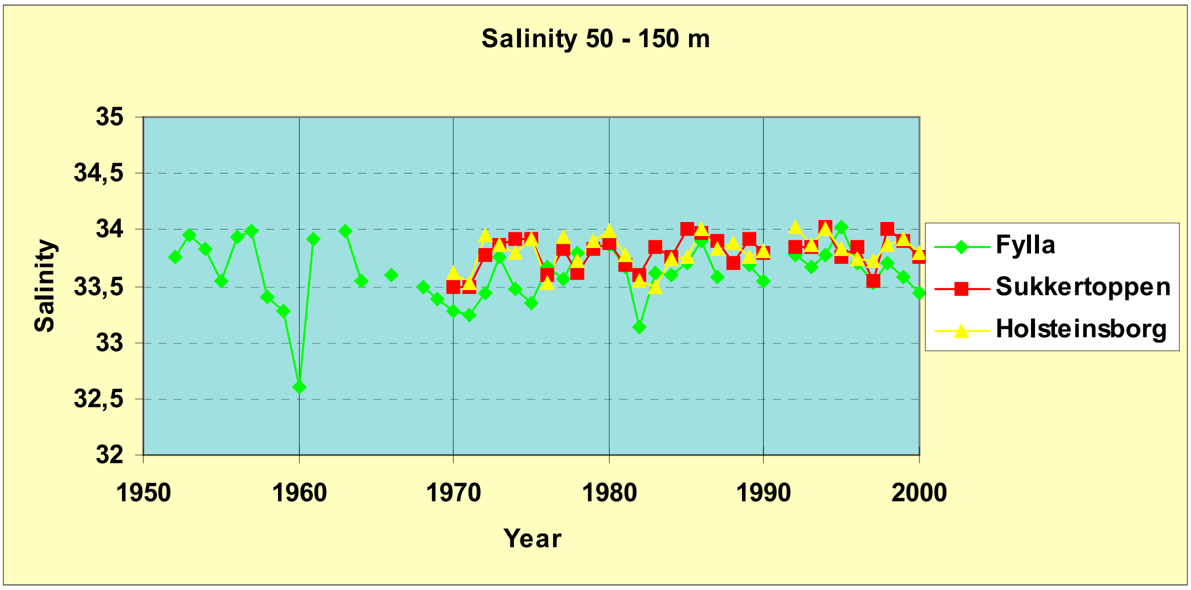
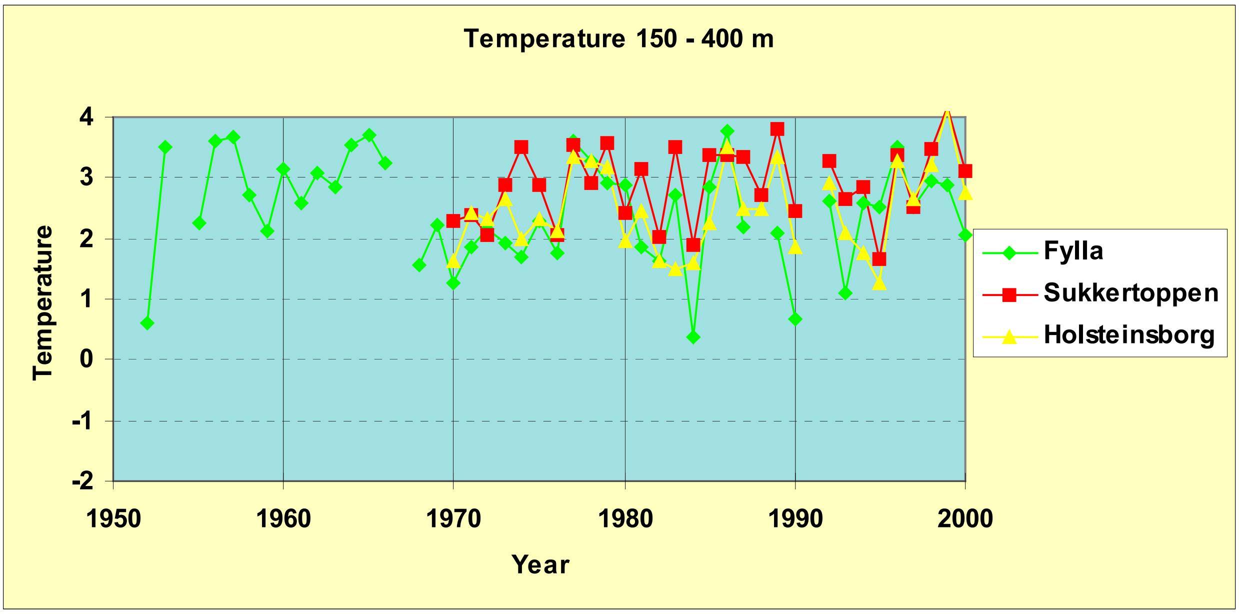


Figure 13.25. Mean temperature and salinity in the 50-150 m layer at Fyllas Bank St. 4, Maniitsoq/Sukkertoppen St. 5 and Sisimiut/Holsteinsborg St. 5.

In the 150-400 m layer the temperature fluctuations still are sizeable (Figure 13.26). The cold periods still can be recognised, but it is evident that other signals play a dominant role in this layer, which off course was to be expected in a layer forming the transition between two different current regimes.



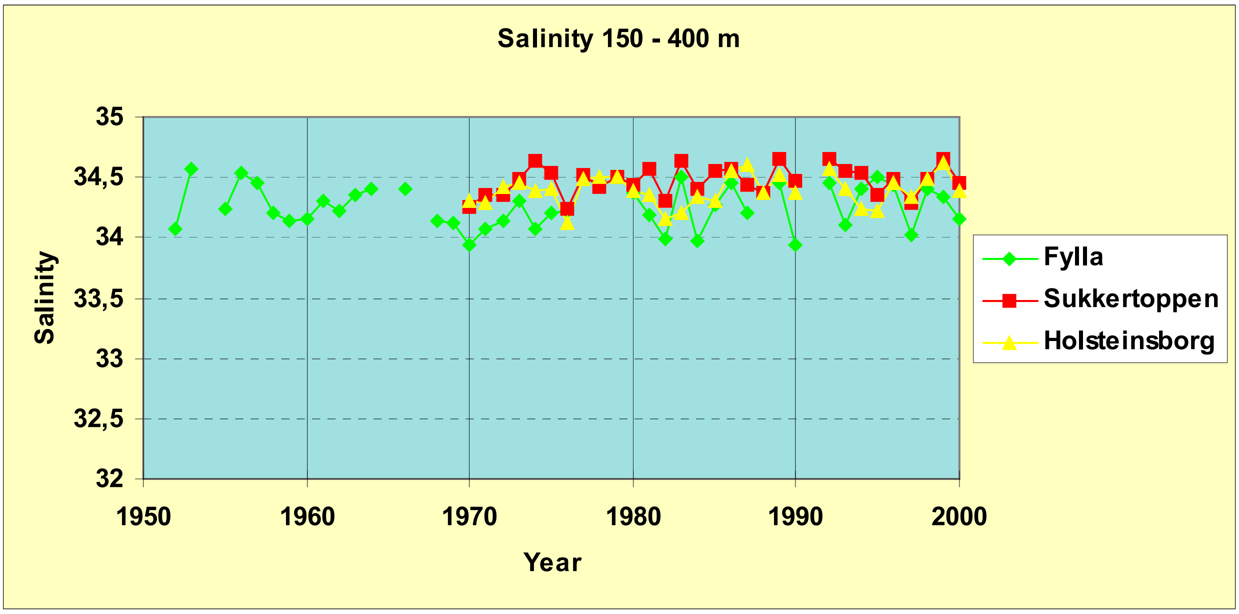
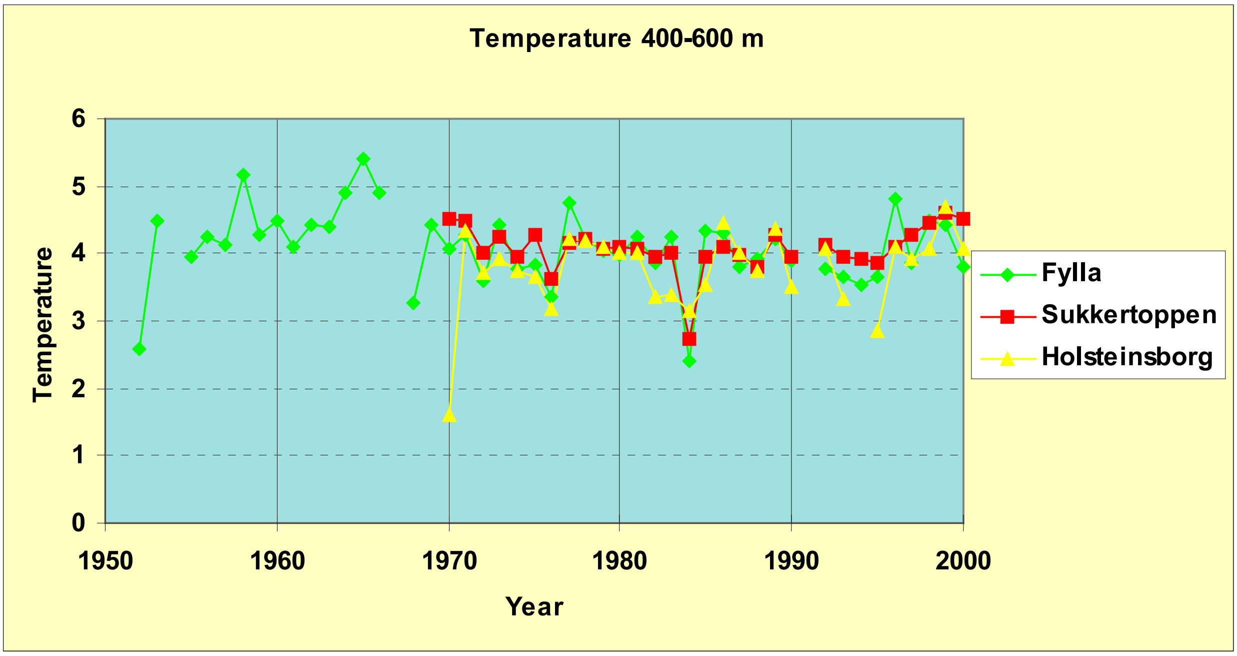


Figure 13.26. Mean temperature and salinity in the 150-400 m layer at Fyllas Bank St. 4, Maniitsoq/Sukkertoppen St. 5 and Sisimiut/Holsteinsborg St. 5.



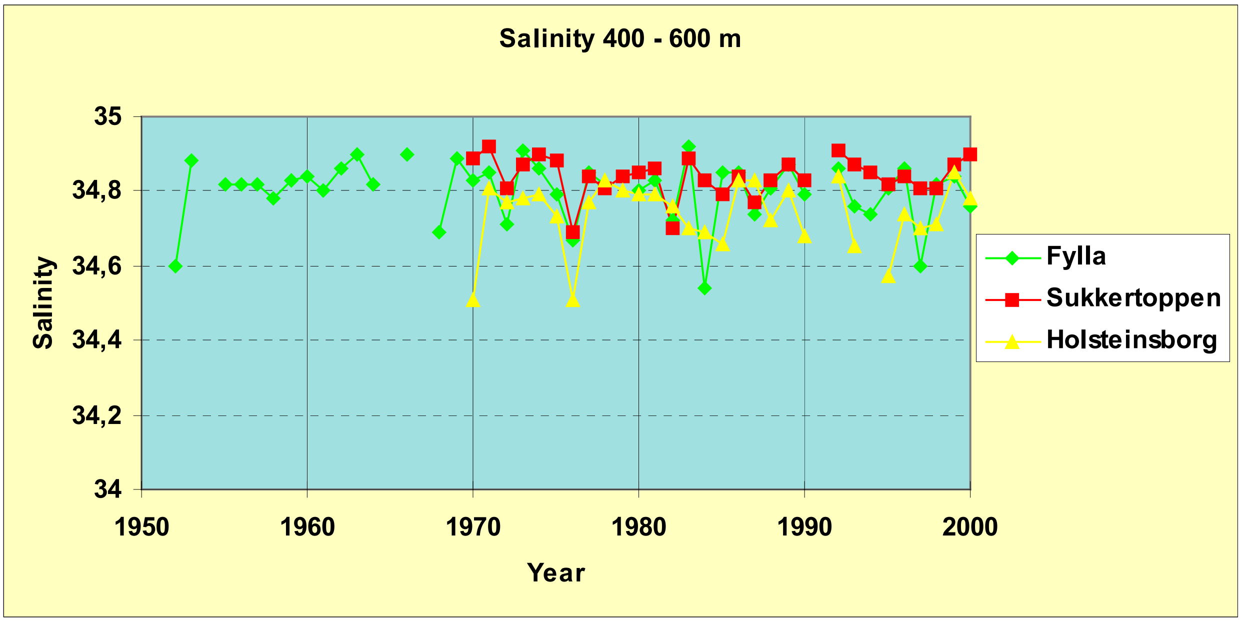


Figure 13.27. Mean temperature and salinity in the 400-600 m layer at Fyllas Bank St. 4, Maniitsoq/Sukkertoppen St. 5 and Sisimiut/Holsteinsborg St. 5.

The warm conditions, as experienced in the late 1970'es and late 1980'es, therefore reflect a dominance of water of Atlantic origin i.e. Sub-Atlantic Water. The salinity is generally highest at the Maniitsoq/Sukkertoppen, which properly is due to the fact that at this depth interval the Fyllas Bank and the Sisimiut/Holsteinsborg stations are more influenced by Polar Water than the Lille Hellefiske Station. Extremely low salinity values were observed at the Fyllas Bank station around 1970 and in 1982, 1984, 1990 and 1997, which can be interpreted as a sign of Polar Water dominance and confirms the trends observed in the shallower layer except for the 1984 situation. The low saline conditions at Fyllas Bank in 1984 was discussed by Buch (1990/2000), who argued that vertical convection during the previous extremely cold winter had caused huge amounts of low saline surface water to sink to great depth off West Greenland preventing inflow of Sub-Atlantic Water at normal rates.

The 400-600 m layer is characterised by temperatures around 4º C and salinities around 34.8 (Figure 13.27). Salinities higher than 34.8, and especially values close to 34.9, indicate high inflow rates of Irminger Water. The salinity at the Sisimiut/Holsteinsborg station is at this depth interval generally lower than on the other stations, which is because the Atlantic components, especially the Irminger component, do not in full strength reach as far north as the Sisimiut/Holsteinsborg area. The most extreme event was observed in 1984 at Fyllas Bank and in the temperature signal also at Maniitsoq/Sukkertoppen. The explanation to these low temperature and salinity conditions is believed to be the same as given above for the similar observations in the 150-400 m layer.

The observations performed during the summer cruises at the southernmost sections in recent years have not been incorporated into the time series discussed above because the series still are to short; but it can briefly be mentioned that the late 1990'es were characterised by a higher inflow of Irminger Water than normal. A tongue of high saline water (S > 34.95) was reaching as far north as to an area between the Paamiut/Frederikshåb- and the Fyllas Bank sections, and in 1997 water with salinities above 35 was observed at the Cape Farewell section.

Analysis of temperature and salinity data collected off West Greenland over the past 6-7 decades (Buch et al. 2002) are given in Figure 13.28 showing time series plot of temperature, salinity and density from stations just west of the shelf at the Cape Farewell- and Fyllas Bank sections, respectively. It is seen that the inflow of water of Atlantic Origin has changed. Before the 1970'es pure Irminger Water (S > 34.95) was present at the Cape Farewell St. 3 in large quantities at depths greater than 100-400 m, although the inflow was gradually decreasing. It is also noticed that the heat inflow was markedly greater at that time with temperatures above 4.5º C in the entire upper 600 m water column, the upper 200 m even had temperatures above 5.5º C. After 1970 Irminger Water has only been observed in smaller quantities after 1995, and a similar statement can be given for temperatures above 5.5º C. In the intermediate period the dominant water mass was Irminger Mode Water. The increased activity in the circulation of Irminger Water has also been observed in the interior of the Irminger Sea after 1995 (Mortensen & Valdimarsson 1999).

At the Fyllas Bank St. 4 we observe a similar trend in reduced inflow of salt and heat. The Irminger Mode Water was present in much higher quantities before mid 1970'es than after, and it is noticed that the three cold periods are clearly reflected in the temperatures of the upper 200 m. A weak freshening in the upper 150-200 m is additionally observed since 1965 resulting in a less dense water mass within this layer. This freshening, however, is most dominant in the upper 50-100 m. A similar freshening during the same period has also been observed in the Irminger Water component north of Iceland (Malmberg 1985), indicating a reduction of the strength of the Irminger Current after 1965 and/or a more dominant influence of Polar Water. From mid 1965'es to the early 1970'es, the freshening was caused by an anomalous high inflow of Polar Water closely linked to the "Great Salinity Anomaly", whereas afterwards it is believed to be caused by a high NAO anomaly reducing the strength of the Irminger Current.

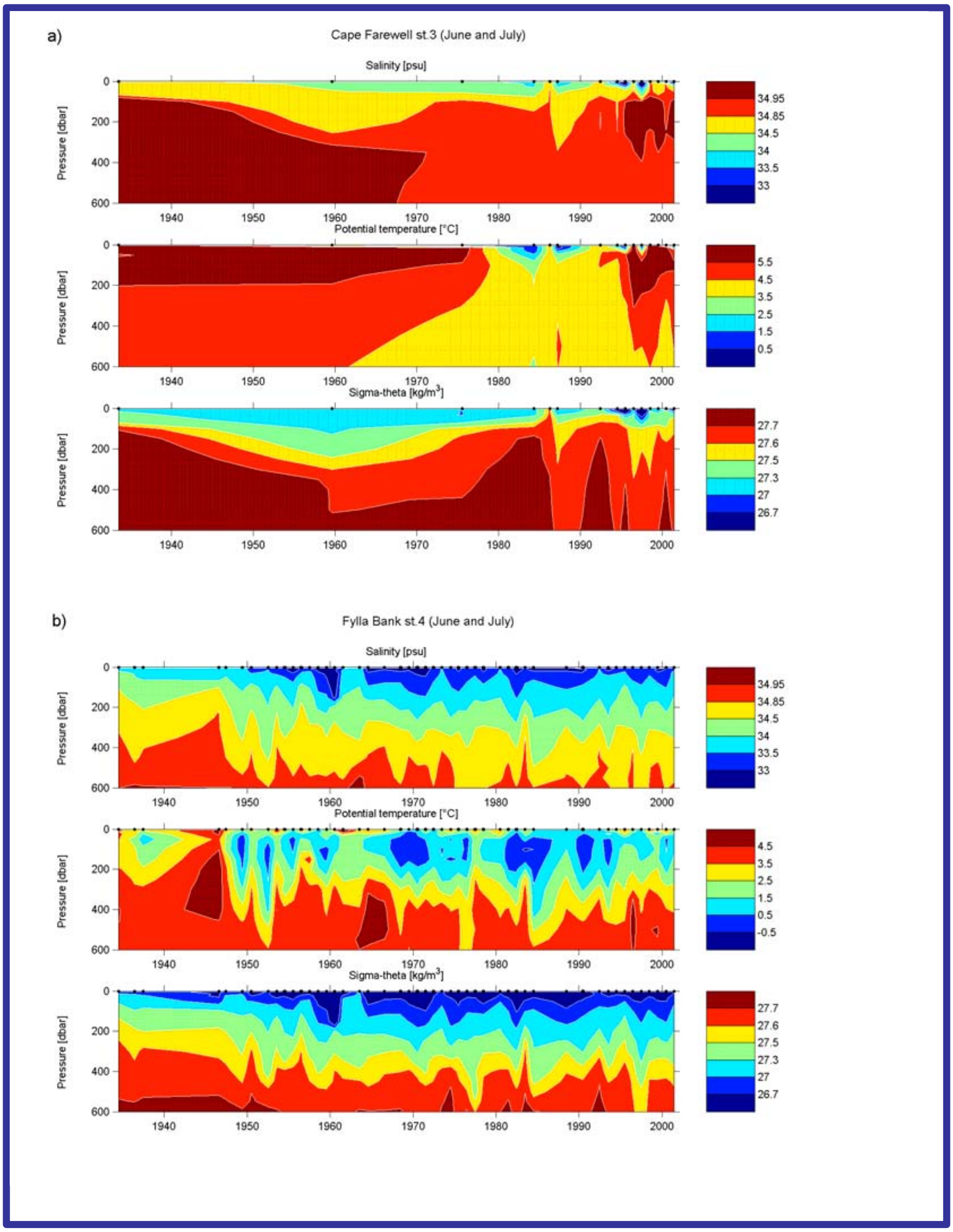


Figure 13.28. Time series of summer (June and July) salinity, temperature and density at: a) Cape Farewell St. 3, and b) Fyllas Bank St. 4. From Buch et al. (2002).

13.2.7 Tides

The tide is the name given to the alternate rise and fall of sea level with an average period of 12.4 h (24.8 h in some places). Locally, the periods varies by an hour or so on either side of the average figure and the rise and fall sequence shows an almost infinite variety around the globe. Tides are a consequence of the simultaneous action of the gravitational forces from the moon, sun and earth and the revolution about one another of the earth-moon and the earth-sun. The fact that the paths of the rotation of the sun and the moon about the earth are not circles but ellipses, and that the planes of rotation are not always in the equatorial plane but move north and south with the annual cycle for the sun and a monthly cycle for the moon, add further complications to the resultant tide producing forces. The motions of the sun and moon are known very exactly, and it is possible to express the resultant tide producing forces as the sum of a number of simple harmonic constituents, each of which has its own characteristic period, phase and amplitude - the most important is given in Table 13.1.

Table 13.1

Name	Symbol	Period (solar hours)	Relative size
Semi-diurnal			
• Principal lunar	M_2	12.42	100
• Principal solar	S_2	12.00	47
• Large lunar elliptic	N_2	12.66	19
• Luni-solar	K_2	11.97	13
Diurnal			
• Luni-solar	K_1	23.93	58
• Principal lunar	O_1	25.82	42
• Principal solar	P_1	24.07	19
• Larger lunar elliptic	Q_1	26.87	8
Long period			
• Lunar fortnightly	M_f	327.9	17
• Lunar monthly	M_m	661.3	9
• Solar semi-annual	S_{sa}	4383	8

The most important tidal constituent in the Davis Strait-Baffin Bay area is the semidiurnal M_2 with a amphidromic[1] point at about 70° N almost in the middle of the Baffin Bay, Figure 13.29. Along West Greenland the greatest amplitude (120 cm) is found in the Nuuk area, decreasing to around 40 cm north of Disko Island.

The strongest tidal signal - *Spring tide* - is experienced when the sun, earth and moon are lying on a line, which happens every 14 days at new moon and full moon. The lowest tidal signal - *Nip tide* - is experienced 7 days after spring tide at half moon (when the line between the moon and earth is perpendicular to the line between the sun and earth). The difference between high and low water at a few location along the west coast of Greenland at spring tide and nip tide are given en the table below:

	Difference in water level between high- and low water	
Location	Spring tide	Nip tide
Nanortalik	2.7 m	0.9 m
Paamiut	3.3 m	1.0 m
Nuuk	4.6 m	1.5 m
Maniitsoq	4.3 m	1.2 m
Sisimiut	4.3 m	1.2 m
Aasiaat	2.5 m	0.8 m

[1] Amphidromic Point = point with no tidal amplitude around which cotidal lines rotate in anti-clockwise.

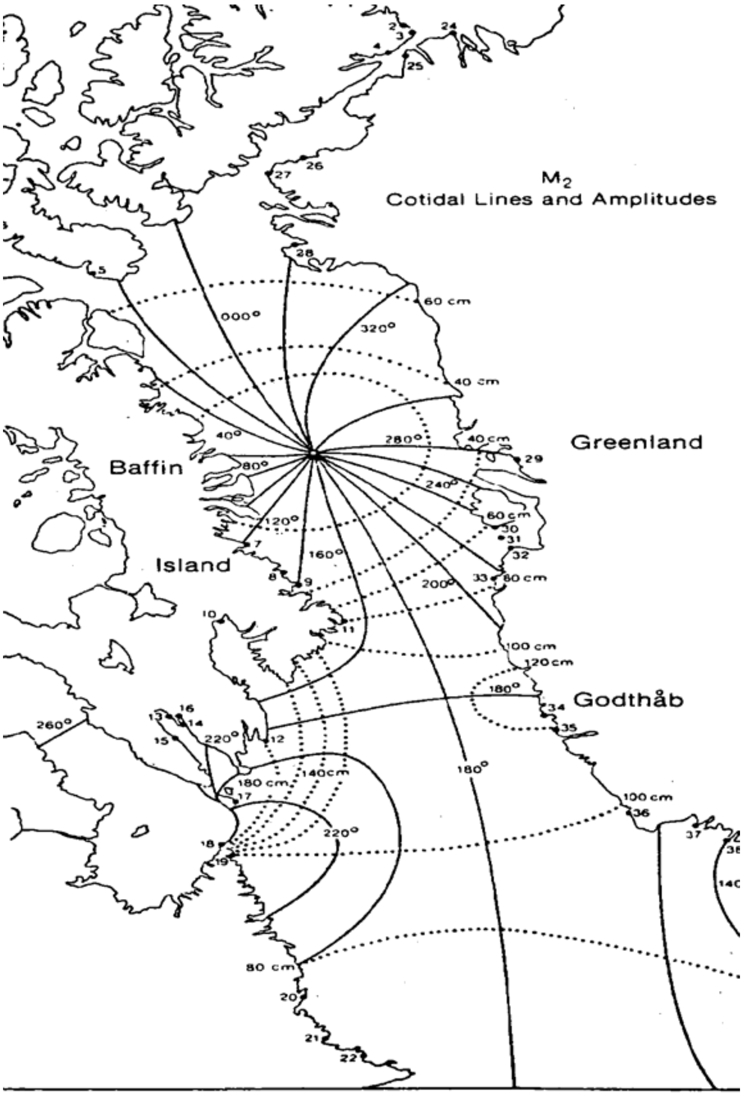


Figure 13.29. M_2-cotidal lines and amplitudes based on coastal observations.

13.2.8 Fjord oceanography

Most fjords in West Greenland are sill fjords i.e. resulting in strong limitations to the exchange of water between the deeper parts of the fjord and the open, Figure 13.30.

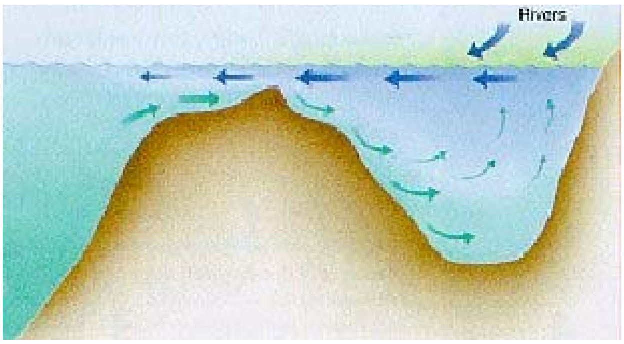


Figure13.30. Large-scale fjord circulation.

The large-scale circulation in a fjord depends on three factors: bottom conditions, water exchange with the open ocean and the supply of fresh water from land. Schematically, the circulation consists of a surface current with brackish water which flows out of the fjord, and a current in deeper layers with more saline water going in the opposite direction. The fresh water largely comes from rivers in the drainage area, an area that normally is several times larger than the fjord itself. Direct precipitation on the sea surface is of minor importance.

The inflow of fresh water to the fjord may be described as the engine which drives the large-scale circulation. The inflow generally causes a higher water level in the fjord than outside. This difference in water level forces the brackish surface water out of the fjord. On its way to the mouth of the fjord the brackish water becomes increasingly saline since the surface water mixes with the underlying water. In order to replace the water entrained into the surface current an undercurrent of more saline water is flowing into the fjord at intermediate depth levels. During the winter the fresh water inflow to Greenland fjords are reduced to almost zero because lakes and rivers freeze and the precipitation on land falls as snow. The surface salinity in the fjords will thereby increase to the level found in the coastal waters outside the fjord, and the circulation in the fjord will decrease to a minimum. These conditions will facilitate convection in the fjord.

The deep water in West Greenland fjords are renewed through two different mechanisms:

- Inflow of water from the open ocean with higher density than the deep water of the fjord. This process normally requires strong northerly winds along the west coast of Greenland, which will cause high density water to rise above sill level outside the fjord.
- Vertical convection during autumn and winter cooling and freezing of the surface water causing salt rejection from the freezing water.

The latter mechanism is functioning every winter and it is therefore seldom to observe anoxic conditions in the deep water of Greenland fjords.

13.2.9 References

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14 Appendix D, Methods and documentation

14.1 Introduction

In the Chapters 6, 7 and 8 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 is presented here. Appendix D should thus be seen as supplementary to the descriptions in Chapters 6, 7 and 8.

This chapter contains the detailed settings used for calculating the sensitivity index values with the Greenland oil spill sensitivity application (Chapter 14.2):

- a description of the data and methods used in the geomorphological coast classification (Chapter 14.3),
- a description of the data and methods used to assess abundance values for the biological occurrences for each area (Chapter 14.4),
- a description of the data and method used to assess assigned values for the archaeological sites for each shoreline area (Chapter 14.5),
- an account of the selected areas (Chapter 14.6).

14.2 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	1-10*
Special status area score (Ramsar sites)	5
Resource (human) use, range**	0-5
Archaeological sites, range	0-5
Animal relative abundance, range	0-5

* Calculated in GIS using a 10 km buffer zone around each community, and the value is proportional to the length of shoreline segments included within this buffer zone.
*Range from 0 (no importance) to 5 (extreme importance).

Shoreline exposure class modifier for shoreline ice cover:
For maximum open water periods less than 8 weeks the exposure modifier is –1.

Shoreline ORI modifiers
A few modifications to the basic classification of the ORI value (see Chapter 6) are made to account for shoreline slope, and to account for a few geomorphological coast types considered to have longer residence times. However the maximum ORI value is limited to 5 and the minimum to 1.

ORI slope modifiers

Steep	-1
Flat	+1

ORI shore type modifiers

Archipelagos	+1
Pocket beach	+1
Barrier beach	+1
Delta	+1

Offshore ORI

Offshore oil residence index values have been defined for the offshore areas to approximately corresponds to the shoreline ORI values. However, the offshore ORI have been defined for each of the four seasons. In the Davis Strait the presence of the dynamic pack ice with floes and ice edges will act to restrict oil movement and thus significantly increase the potential oil exposure time. The offshore ORI values have been defined with values increasing from 3 to 5 for the open water period (period with less than 5/10th of ice) decreasing from more than 90 % to less than 50 % of the season.

Offshore ORI values (ORI for offshore areas)

0-50 % of season with open water	5
51-90 % of season with open water	4
91-100 % of season with open water	3

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)	14.7
Biological resource constant (offshore)	35
Maximum ORI value	5

With these settings the average contributions (PI-values) to the final sensitivity values for the shoreline areas are: biological occurrences 53 %, resource (human) use 20 %, oil residence index 11 %, archaeological sites 8 %, communities 8 % and special status areas (Ramsar sites) 3 %. 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.

14.3 Geomorphological information

The geomorphology of the West Greenland coast between c. 68º N and 72º N has been classified according to shore type, sediment type, slope and exposure. The classification covers the coastline from about 40 km south of Kangaatsiaq to the west coast of northern Sigguup Nunaa/Svartenhuk. The total shore-line length is c. 10,106 km (Figure 14.1).

14.3.1 Methods
The classification is based on air photo interpretation of digital stereo images using a digital photogrammetric workstation (DPW).

The images used were in scale 1:150,000 (taken in 1985). The pictures were scanned (pixel size 14µm) imported and oriented by aero triangulation. A digital vector coastline was imported from G250-vector database of Kort & Matrikelstyrelsen (KMS). The aerial stereo images and the coastline vector were synchronised by the use of PRO600 Socet Set software. This facilitates an interactive assignment of attributes to the coastline while inspecting the stereo images.

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.

In few cases the images were supplemented with interpretations of air photos in a scale of c. 1:40,000 (taken in the period 1959-1968) using a manual stereoscope. In total c. 200 images were used for the classification between 68° N and 72° N. Furthermore, topographic maps (scale 1:250,000), quaternary geological maps (scale 1:500,000) and geological maps (scale 1:100,000) have been used for the classification.

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 14.1). However, in the atlas the seventeen shore types have been reduced to twelve shore types for simplicity (Table 7.1). This has been done by lumping shore types with erosional cliffs together with the corresponding shore types without erosional cliffs.

A lower segment length of app. 2 km was applied. Therefore, shore segments with a shore extent less than app. 2 km were not categorised separately but were included in the neighbouring segments. Segments less than 2 km classified as deltas or glaciers are preserved.

For each segment the shore type (Table 14.1), the sediment type (Table 14.2), the slope (Table 14.3) and the exposure (Table 14.4) were classified. The segments were marked and classified directly on a corresponding digital shoreline. The shore type "Talus" and the corresponding "Talus with erosional cliff" include shorelines, which consist of rock-glaciers and larger landslide areas. These special shore types occur in the area of Disko and Nuussuaq.

All islands within archipelagos are classified with unique attributes concerning shore type, sediment type, slope and exposure. Landscape elements of special geomorphologic interest (e.g. cuspate forelands and tombolos) have been classified where possible.

14.3.2 Statistics
The total number of segments identified is 3,819. Of these 1,267 segments (4,952 km) are on the mainland coast 964 segments (3,679 km) are on bigger islands (perimeter > 6 km) and 1,588 segments (1,474 km) are on smaller islands (perimeter < 6 km).

The distribution of segments on shore type, sediment type, slope and exposure categories respectively are given in Tables 14.5-14.8. In terms of shoreline length, the 'Rocky coast' is the dominant shore type (60.8 %). 'Rock' is the dominant substrate (71.4 %). 'Inclined' is the dominant slope (58.0 %) and 'Semi-protected' is the dominant exposure type (60.1 %). The majority of the coasts within the 'Archipelago' shore type are rocky coasts. Together the Archipelago' and 'Rocky coast' shore types by length constitute 72.2 % of the total investigated shoreline.

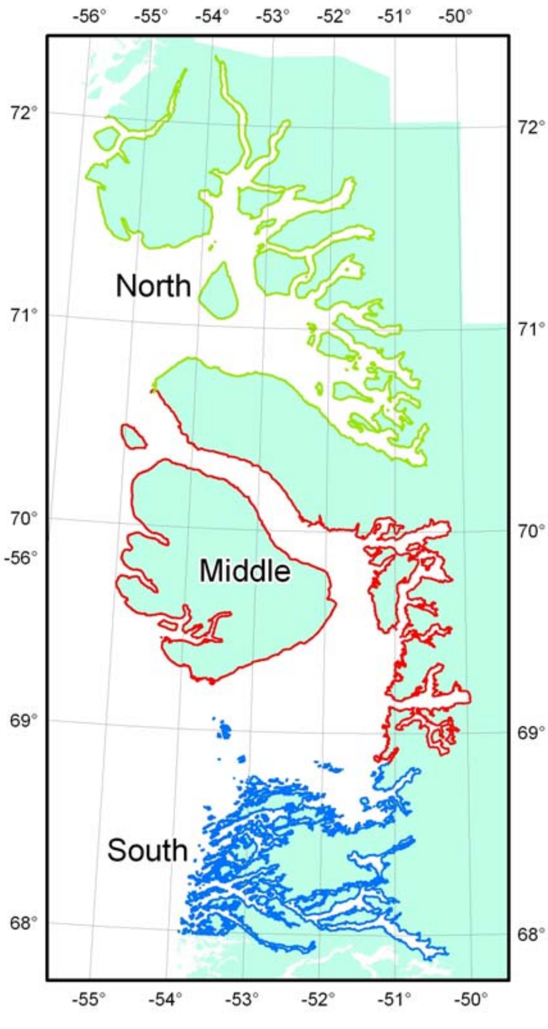

Figure 14.1. The study area in West Greenland between 68° N and 72° N. Length of coastline: South 5,062 km, Middle 2,449 km and North 2,594 km.

Table 14.1. Classification of shore types in South Greenland between 60° and 62° N.

Shores developed in solid rock.

Shore type no.	Shore type	Segment-type	Characteristics
1	Rocky coast	Line	- 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 (Table 14.3).
2	Rocky coast with erosional cliff	Line	- As shore type 1, but with steep or vertical erosional cliff.
3	Archipelago	Polygon	- Several smaller islands normally developed in solid rock. - Rocky coasts and pocket beaches might occur but have only been classified individually if the perimeter of the island exceeds 6 kilometres.
4	Glacier coast	Line	- Occurrence of a glacier in the intertidal zone.

Shores developed in sediments of glacial alluvial or colluvial origin

Shore type no.	Shore type	Segment -type	Characteristics
5	Moraine	Line	- Shore developed in unconsolidated glacial sediments. - Narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur. - The occurrence of abraded intertidal platforms is indicated by the gradient (Table 14.3).
6	Moraine with erosional cliff	Line	As shore type 5 but with steep or vertical erosional cliff.
7	Alluvial fan	Line	- 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 (Table 14.3).
8	Alluvial fan with erosional cliff	Line	- As shore type 7 but with steep or vertical erosional cliff.
9	Talus	Line	- Shore developed in talus (colluvial fan) of varying gradient. - Narrow beach with coarse sediment consisting of boulders, cobbles and pebbles might occur.
10	Talus with erosional cliff	Line	- As shore type 9 but with steep or vertical erosional cliff.

Shores developed in marine sediments

Shore type no.	Shore type	Segment-type	Characteristics
11	Beach	Line	- Long, linear depositional beaches of well-sorted sand, gravel, pebbles, cobbles or boulders. - Beach ridge plains often occur landwards the beach.
12	Beach ridge plain with erosional cliff	Line	- Coastal cliff cut in beach ridge plain. - Narrow beach with well sorted sediment consisting of boulders, cobbles, pebbles, granules or sand might occur.
13	Barrier beach	Line	- 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. - Tidal flats consisting of mud.
14	Salt marsh and/or tidal flat	Line	- Wide salt marshes with or without salt marsh cliff and/or wide intertidal flats. - Consisting of relatively fine sediments (mud, sand, silt and clay).
15	Pocket beach	Line	- Beach developed in the inner part of an embayment in 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

Shore type no.	Shore type	Segment-type	Characteristics
16	Delta	Line	- 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

Shore type no.	Shore type	Segment-type	Characteristics
17	Not classified	Line	- The shore has not been classified due to lack of air photo information (cloudcover, shadow, etc.).

Table 14.2. Sediment classification for West Greenland coasts between 68º and 72º N.

Substrate class	Substrate, general	Substrate, specific	Shore description
1	Ice	Ice	Glacial ice within the intertidal zone.
2	Rock	Rock	Bedrock within the intertidal zone.
3	Rock and sediment	Rock and coarse sediment	A combination of bedrock and coarse sediment including boulders, cobbles and pebbles, either as veneers over the bedrock or as small pocket beaches interspersed with bedrock.
4		Rock and fine sediment	A combination of bedrock and fine sediment including mud, sand or mixtures of sand and boulders, cobbles or pebbles. Sediments most likely to occur as small pocket beaches interspersed with bedrock.
5	Sediment	Coarse sediment	Boulders, cobbles and pebbles. Collectively referred to as 'gravel'. Includes 'shingle-type' beaches.
6		Fine sediment	Mud, sand and combinations of sand and gravel.

Table 14.3. Slope classification for West Greenland coasts between 68º and 72º N.

Slope class	Slope
1	Steep
2	Inclined
3	Flat

Table 14.4. Exposure classification for West Greenland coasts between 68º and 72º N.

Exposure class	Exposure
1	Protected
2	Semi-protected
3	Semi-exposed
4	Exposed

Table 14.5. Shore type statistics.

Shore type	No. of segments	Km	%
0	0	0	0
1	1,639	6,140	60.8
2	27	85	0.8
3	1,288	1,148	11.4
4	49	131	1.3
5	214	637	6.3
6	11	28	0.3
7	82	231	2.3
8	0	00	0.0
9	236	863	8.5
10	19	59	0.6
11	32	78	0.8
12	89	248	2.5
13	33	94	0.9
14	0	00	0.0
15	0	00	0.0
16	69	187	1.9
17	31	177	1.8
Total	**3,819**	**10,106**	**100.0**

Table 14.6. Sediment type statistics.

Sediment type	No. of segments	Km	%
1	50	132	1.3
2	2,902	7,217	71.4
3	11	35	0.3
4	41	123	1.2
5	533	1,841	18.2
6	282	758	7.5

Table 14.7. Slope statistics.

Slope type	No. of segments	Km	%
1	972	3,896	38.6
2	2,713	5,865	58.0
3	134	344	3.4

Table 14.8. Exposure statistics.

Exposure type	No. of segments	Km	%
1	364	1,061	10.5
2	1,974	6,074	60.1
3	778	1,685	16.7
4	703	1,285	12.7

14.4 Biological and resource use information

14.4.1 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 to 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: NERI-AE = National Environmental Research Institute, Denmark department of Arctic Environment, GINR = Greenland Institute of Natural Resources.

14.4.2 Marine mammals

Harbour seal

This seal species occur within the area throughout the year, although winter ice occasionally may force the seals to move out of the region. All the presented information is retrieved from Teilmann & Dietz (1994), supplemented with more general information from Mosbech et al. (1998).

Bearded seal

Bearded seals are widespread in the West Greenland waters during winter. However, only in small numbers except for some areas on Store Hellefiskebanke and west of Disko, where concentrations have been observed. Only information from these areas is included in this atlas.

The information derive from aerial NERI-AE surveys (unpublished) in the years 1995, 1996 and 1997 supplemented with data from spring 1998 (Heide-Jørgensen et al. 1999) and data from spring 1981 (MacLaren & Davis 1983). All the data are collected from March to May. Hunting statistics indicate that bearded seals are present in largest numbers from November to May, and may occur in few numbers throughout the year all over the area covered by this atlas (Mosbech et al. 1998).

Walrus

Walruses are winter visitors in the area and occur from February to May. The presented information is retrieved from Born et al. (1994), Heide-Jørgensen et al. (1999) and from our NERI-AE surveys (unpublished). More general information is derived from Boertmann et al. (1998).

Baleen whales

This group comprise three species: fin whale, minke whale and bowhead whale. Fin whale and minke whale, both summer visitors to the area, and both hunted under regulation by the International Whaling Commission. The presented data on these two species are from NERI-AE surveys (Mosbech et al. 1998, unpublished data) and from the Greenland catch statistics (Witting 2000). The third species is the bowhead whale, which is a winter visitor to the area. The presented information is retrieved from Reeves & Heide-Jørgensen (1996) and Heide-Jørgensen et al. (1999, 2003). A few more species occur in the area: Humpback whale, which is an increasingly more common summer visitor and blue whale, which is a rare summer visitor.

White whale (Beluga)

The white whale is a winter visitor to the region, and the presented data are compiled from following sources: Heide-Jørgensen et al. (1993), Heide-Jørgensen & Reeves (1996) and Heide-Jørgensen et al. (1999, 2003). These data represents observations in March and April in the years

1981, 1982, 1990, 1991, 1993, 1995, 1998 and 1999. The whales are present in the area from October to late May, somewhat dependent of the ice conditions.

Narwhal
This whale is also a winter visitor. It occurs mainly in the drift ice areas off shore but also in Uummannaq Fjord and Disko Bay. The presented data are compiled from Heide-Jørgensen et al. (1993), Heide-Jørgensen & Reeves (1996) and Heide-Jørgensen et al. (1999, 2003). These data represents observations in March and April in the years 1981, 1982, 1990, 1991, 1993, 1995, 1998 and 1999. Narwhals are present in the area from October to late May, somewhat dependent of the ice conditions.

14.4.3 Seabirds

The seabird species have been assembled in some seabird groups:

- Alcids, comprising breeding occurrence of Brünnich's guillemot (Thick-billed murre), razorbill, black guillemot, Atlantic puffin and little auk (dovekie).
- Alcids nonbreeding, comprising the autumn, winter and spring occurrence of Brünnich's guillemot.
- Seaducks breeding, comprising breeding occurrence of 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, long-tailed duck, harlequin duck and red-breasted merganser.
- Gulls, comprising Iceland gull, glaucous gull, great black-backed gull, kittiwake and Arctic tern.
- Cormorants, comprising only great cormorant.
- Tubenoses comprising only northern fulmar.

Breeding seabirds at shorelines
The selection of seabird breeding colonies included in this atlas derive from NERI-AE's database of seabird breeding colonies covering entire Greenland (see Boertmann et al. 1996). The selection is based upon the geographical range between 68° N and 72° 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 14.9.

Table. 14.9. ***.*** *Criteria for inclusion of seabird colonies.*

Species	Criteria	No. of colonies meeting the criterion	No. of colonies included because other species meet their criterion (mixed colonies)
Northern fulmar	all colonies	9	-
Great cormorant	all colonies	49	-
Common eider:	colonies with ≥ 5 indvs.	23	-
Iceland gull	colonies with ≥ 500 indvs.	9	48
Glaucous gull	colonies with≥ 500 indvs.	2	45
Unsp. glaucous/Iceland gull	colonies with ≥ 500 indvs.	7	12
Black-legged kittiwake	colonies with ≥ 50 indvs.	47	3
Arctic tern	colonies with ≥ 30 indvs.	48	2
Brünnich's guillemot	all colonies	1	-
Razorbill	colonies with ≥ 5 indvs.	27	6
Black guillemot	colonies with ≥ 250 indvs.	7	80
Little auk (dovekie)	all colonies	5	-
Atlantic puffin	all colonies	6	-

Taking into account that most colonies have a mixed species assemblage, the total number of colonies (with different geographical position) selected is 158.

Comments to the criteria
The criteria take into account the sensitivity to oil spill of the bird species both on individual level and on population level. These sensitivities are dependent on the behaviour and ecology of the birds but also 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.

Breeding sites for northern fulmar are few, but most of them with very high numbers of birds (> 10,000 pairs).

Great cormorant colonies are found both within the fjords and on exposed coasts. The Greenland cormorant population is small and most likely isolated from other populations in the North Atlantic. The breeding population is widely dispersed, and presently it seems to increase and disperse southwards.

The breeding population of common eider in West Greenland has decreased seriously for a century, and within the sensitivity mapping region there are no large and dense colonies today. Large parts of the study region have recently been surveyed for eider colonies (Merkel 2002).

Red-breasted mergansers are included where they occur in moulting concentrations. Within the study region such are located deep inside the long fjords south of Disko Bay (Boertmann & Mosbech 2001a).

Iceland gull, glaucous gull (incl. unsp. Iceland/glaucous gull) are widespread breeders in West Greenland (68º-72º N). As gulls are only moderately sensitive to oil spill only largest colonies are included. A few large colonies situated at lakes far from the sea are excluded.

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 size range from very few to tens of thousands. Colonies less than 50 pairs are excluded, as they tend to be less stable over time.

Arctic terns breed usually in dense colonies on low islands. The population in West Greenland is generally decreasing. A characteristic feature is that colonies in large areas are in certain years (with adverse weather in spring) abandoned. Small colonies less than 30 pairs are excluded. Terns are moderately sensitive to oil spill, 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 Brünnich's guillemot, 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 have high priority. Moreover is the breeding population of Brünnich's guillemot in West Greenland seriously decreasing due to disturbance and hunting, and the single breeding site within the sensitivity mapping region is naturally included.

Razorbill breeds in small colonies (rarely more than a 100 pairs) scattered throughout the sensitivity mapping 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 black guillemot is the most widespread and numerous alcid within the region, where colony size range from a few pairs to some hundred. The colonies are often very loose and difficult to delimit, and all in all only very large colonies with more than 250 pairs are included.

There are only a few sites with breeding little auks within the atlas region and all are included.

The population of Atlantic puffin is small in West Greenland, the largest colonies holding a few hundred pairs. The population was moreover decreasing until hunting and egging was prohibited in 1960. The population seems to be slowly increasing now. 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
	Brünnich's guillemot	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	201-400	2
	Great black-backed	401-1,000	3
		1,001-2,000	4
		> 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
Tubenoses			
	Northern fulmar	1-200	1
		201-1,000	2
		1,001-2,000	3
		2,001-10,000	4
		> 10,001	5
Cormorants			
	Great cormorant	1-20	1
		21-50	2
		51-100	3
		101-200	4
		> 201	5

Non-breeding coastal seabirds
Included are seaducks (separated in spring and autumn occurrence). Alcids are only related to offshore areas, as they are not dependent of the coast for resting, as seaducks are.

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
	red-breasted merganser		
		1-10	1
		11-50	2
		51-100	3
		100-200	4
		> 201	5
	long-tailed duck		
		300-500	3
		> 501-1,000	4
		> 1,000	5

Offshore seabirds
The information regarding offshore occurrence of seabirds have been retrieved from Brown (1986), Mosbech et al. (1996, 1998), Durinck & Falk (1996), Boertmann & Mosbech (1997, 2001a, b), Mosbech & Johnson (1999), Merkel et al. (2002), Boertmann et al. (in print) and is supplemented with unpublished information from NERI-AE.

14.4.4 Fish, shellfish and fisheries

Capelin, lumpsucker and Arctic char
The information on capelin, lumpsucker and Arctic char derive from an interview survey in West Greenland (68º-72º N) carried out in summer 2002 (Olsvig & Mosbech 2003) supplemented with a follow up study in the same area in summer 2003 (NERI-AE unpublished). The data mainly reflect areas where the resources are utilised, however the data is also used as an indicator of the presence of the species. Moreover information from Petersen (1983a, b, c, d, e, f & g) and more general information from Mosbech et al. (1998) is included.

Greenland halibut
GINR has supplied the data regarding Greenland halibut fishery. The data are from 2001 and include both inshore and offshore fishery. The offshore fishery is however, limited (about 660 tons in 2001) but may develop in the future.

Snow crab
GINR provided the information, which is unpublished. The data set covers the reported catches in the years 1995 to 1998. The data are probably not complete, mainly because the fishery is still in development. The snow crab fishery in West Greenland is of a new date (since mid-1990'es).

Scallop
GINR has supplied the data regarding scallop fishery. The data are distributed between the years 1991 to 1999 and each single catch is referred to a geographical position. More general information is derived from Mosbech et al. (1998). According to GINR, these areas are fairly stable in time. However, new fishing grounds may turn up and some may be overexploited and subsequently given up.

Resource use
Data are extracted from the NERI-AE interview survey (Olsvig & Mosbech 2003) regarding fishery for capelin, lumpsucker and Arctic char. From the large unpublished material collected by Petersen (1993a, b, c, d, e, f & g) more information of human use of living resources is derived mainly on fishery of capelin, lumpsucker, Arctic char, cod (mainly pound net fishing in fjord areas), Greenland halibut, wolffish (mainly spotted), redfish, snow crab and scallop and hunting for seabirds (mainly guillemots and eiders) seals and whales. Data on the location of fin- and minke whales hunting sites were provided by GINR (Witting 2000). Finally unpublished material from NERI-AE is included.

Resource use includes also the use of the coast as tourist attraction and activity area. However in the region covered by this atlas most information have been obtained in Ilulissat municipality (NERI-AE unpubl.).

The relative human use figures for each segment is based on the number of exploited resources (incl. tourism). Max. number of exploited resources in a segment = 8.

No. of resources exploited	No. of segments	Human use figure
6-8	17	5
4-5	43	4
3	48	3
2	51	2
0-1	40	1

Are there more than 3 important Arctic char rivers in a segment the figure is raised with 1.

14.4.5 References

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14.5 Archaeological and historic information

14.5.1 Introduction

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 68º N up to 72º N.

As the crow flies this is about 500 km, but in practice it is much farther because of fjords, islands and sounds. In this area there are for example some 720 archaeological sites that is man-made remains 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 c. 720 known sites the main part are coastal ones included in this atlas.

The natural conditions within the mapped coastal stretch vary greatly from north to south and from the outer coast to the inner fjords. Climatically, the region is in the Low Arctic zone. Islands, peninsulas and narrow strips of land between the inland ice sheet and the sea consists 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 down 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 Thule area.

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 West Greenland (68º-72º N) the oldest part of the Palaeo-eskimo 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 Disko Bay. At some of these settlement sites the finds also include implements of organic material, something otherwise extremely rare in the Palaeo-eskimo context.

In Uummannaq and Upernavik municipalities there are very few reports of Palaeo-eskimo settlement sites. This must be due to among other things:

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

In the areas there are no settlement sites from the Late Dorset period (c. 1000-1200 AD). 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 far to the north in the Thule area. Although the Norsemen sailed around in 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 off 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 Thule 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 in their hunting.

Around 1500 the Norse Greenlanders had gone, and the Thule people had settled along the coast all the way round Greenland. In the centuries after that 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 for example in the view of the population one of the biggest settlements at the beginning of the eighteenth century.

The Palaeo-eskimo period is richly represented, with many settlement sites and fine finds in Disko Bay, but it is very poorly represented farther to the north - despite the fact that this was the immigration route. The very scanty evidence of Palaeo-eskimo presence will therefore quite naturally be given a higher risk assessment than the same kinds of features would be given in other parts of the country.

Which items of archaeological and historical interest are included?
All known coastal archaeological and historical find-sites (minus colonial trading posts, villages and the like) are included in this atlas, but with a 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, telephone (+299) 32 26 11 or e-mail: grnatmus@greennet.gl

The Conservation Act
If a man-made feature is from before 1900, it is protected by the terms of "Landstingslov nr. 5/1980 af 16. oktober 1980 om fredning af jordfaste fortidsminder og bygninger" ("the Conservation Act"). The Greenland National Museum & Archives administers this act and is responsible for the registration of antiquities.

14.5.2 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 began the colonisation of Greenland, and when the Christian mission entered the picture in earnest. The first missionaries were much preoccupied with the fate of the Norse Greenlanders and visited the ruins of their settlements. Thus throughout the 1800’s a large body of material was submitted 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. At the beginning of the 1930’s proper archaeological investigation of the prehistory of the Inuits began.

In the 1950's 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 the area that the Greenland Home Rule has recommended as a World Heritage area under the auspices of UNESCO.

With the transfer of the conservation and museum acts to the Greenland Home Rule 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 field surveys and other ways of gathering information about the archaeological sites. Most recently all this material has been entered in a database, which is subject to ongoing expansion and quality assurance.

The data

Information about the individual sites is a mixture of experts' inspections in older and more recent times and various items of information from past and present. It is a mixture of high quality site information, less good information 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 included 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. An attempt has been made to update the information up to and including the summer of 2002.

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, how old they are believed to be, how close to the present sea level they are, their state of preservation etc. Information which today is important for the assessment of their sensitivity in the event of oil spill.

For most of the coastal sites we have no information on their position in terms of metres 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 altitude above sea level are treated in this atlas as being in the risk zone for oil spills, that is in Group 2, until proved otherwise.

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

a) the site could no longer be found
b) the site no longer exists

The first of these indicates that the site is not at the place indicated, but that it may exist somewhere else nearby, or that it may have disappeared due to erosion. 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 which have not yet been registered.

The second comment means that we have positive knowledge that there was once a feature or features at the place, but that they have now disappeared. This may have happened for example 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 maps (not included here) of the antiquities each 'antiquity circle' covers an area with a

diameter of 500 metres. The transfer of 'points' from paper maps to a digital map has only increased the precision if more recent GPS positions have been obtained.
In the section "Sensitivity assessment" there is an account of the principles underlying the assessment of the individual sites.

14.5.3 Geographical coverage
Besides the geographical conditions - and thus the presence of available resources - there are many factors, which must be considered when one is assessing the representatively of the registered coastal sites. The following remarks should be noted with regard to the various municipalities:

Kangaatsiaq municipality has never been systematically investigated. The municipality has a wealth of islands. Experience suggests that there is considerable potential for archaeological "gains" on these.

The municipality is not fully covered. It must be expected that new sites will appear.

Aasiaat municipality has been subjected to some archaeological reconnaissance and exploration in recent years. There is still a considerable gap in our knowledge of most of the islands. Experience suggests that there is substantial potential for archaeological "gains" on these.

The coastal sites of the municipality are considered to be fairly well known. It must however be expected that new sites will appear.

Qeqertarsuaq municipality has only been surveyed around the town of Qeqertarsuaq and around Kangerluk/Disko Fjord. Experience suggests that there is considerable potential for archaeological “gains” on other parts of the coastline especially on the west- and northeast side of the island.

The municipality is not fully covered. It must be expected that new sites will appear.

Qasigiannguit municipality was comprehensively inspected in the 1980’s and 1990’s in large areas. Much of the outer coast was carefully surveyed, but we still lack detailed archaeological mapping of several islands.

The coastal sites of the municipality are considered to be fairly well known. It must however be expected that new sites will appear.

Ilulissat municipality was subject to some archaeological reconnaissance and exploration in the 1980’s and 1990’s. This is a municipality rich in cultural history, where there is considerable potential for new material to appear.

The coastal sites of the municipality are considered to be fairly well known. It must be expected that many new sites will appear.

Uummannaq municipality has only been covered to a small extent, for example parts of the north coast of the Nuussuaq Peninsula and areas east of the town of Uummannaq. Information about other localities is mostly scattered with hardly any details. We lack systematic archaeological mapping.

The municipality is not fully covered. It must be expected that new sites will appear.

Upernavik municipality saw a certain amount of archaeological reconnaissance in the twentieth century. There is very little up-to-date information - mainly scattered information about individual sites, and hardly any details. We lack systematic archaeological mapping. The municipality has a wealth of islands. Experience suggests that there is considerable potential for archaeological sites on these.

The municipality is not fully covered. It must be expected that new sites will appear.

14.5.4 Explanations of the classification and terms used in the table

Identification

Fmnr.

Each archaeological site entered in the Greenland Archive of Antiquities (GFA) has a *fredningsnummer* ('conservation number'). All man-made remains from before 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.

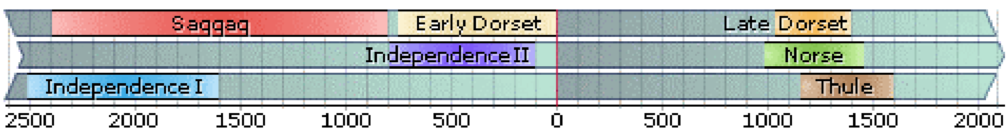
Datings

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 at the place 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 belong in Northwest Greenland.



The Palaeo-eskimo period is considered as lasting until the end of "Late Dorset". With "Thule" begins the Neo-eskimo period, which lasts until 1900 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 Denmark's colonisation of Greenland began.

Colonial

The period from 1721 until 1900 AD.

Recent

All cultural traces that are 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 traces of activity at the individual sites have been entered in the database if they are available.

14.5.5 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 may today 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 will in several ways 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 datings will be destroyed

- indirectly, because emergency measures or land-based action 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 recognise 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 archaeological sites between 62º N and 68º 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 at present is no more detailed information" from Group 1 to Group 2. This until we have proof that 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 impacted by marine oil spill.
2. Sites considered likely to be directly impacted by marine oil spill.
3. Sites of special importance, which requires 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 traces 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 spill.

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 at present is no further information.

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

Group 3 meets the criteria for Group 2 items a and b, but these sites are further considered to have quite special importance, 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 spill.

See also: Photos from archaeological sites.

14.6 Selected areas

14.6.1 Brief description of the selected areas

This is a short description to the selected areas referred to in chapter 6.4.

S98. The western part of Langesund. Important area for fishery of snow crab and capelin. Important hunting area, particularly for seabirds. The coasts are generally rather low and rocky.

S99. The mouth of the fjord Afersiorfik. This is a very important area to wintering seabirds - mainly common eiders, king eiders, cormorants and Brünnich's guillemots. The strong tidal currents keep the area more or less free of ice during the winter, creating a recurrent open water area (a polynya). The area is also an important hunting area for the residents of the many settlements in and near the area. The coastal morphology is predominated by rocky coasts and extensive rocky archipelagos, and there are many archaeological sites.

S100. The fjord Tassiusarsup Qinngua and Sofia Havn. There are several breeding colonies of common eiders on the small islands in this area, and the fjord is an important moulting site for red-breasted mergansers.

S101. The archipelago Kitsissunnguit/Grønne Ejland. These islands have a rich bird life in the summer time. The largest breeding colony of Arctic terns in Greenland is found here (18,000 pairs in 2002), and many other species breed: razorbills, little auks and Atlantic puffins. There is important fishery for lumpsucker in the shallow waters around the islands. The coasts are mainly rocky, but there are also several sheltered lagoons and salt marshes and here and there beaches with well-sorted sand or gravel.

S102. The island Nunatsiaq/Rotten. This is an important breeding site for Atlantic puffins. Arctic terns also breed on the island.

S103. Aqajarua/Mudderbugten. A shallow bay, which once was very important to moulting king eiders. Today disturbance has driven off the moulting king eiders, but they still occur before and after the moulting season. The bay is a popular fishing area for Arctic char. The area is designated as a Ramsar-site (international convention for the protection of wetlands). The coast in the head of the bay is an extensive delta with tidal flats and salt marshes. To the north and south sandy beaches are found and particularly to the north there are lagoons and barrier beaches (Figure 7.10).

S104. Assissut/Brændevinskæret. A small rocky island with an important breeding colony for seabirds. The species include Arctic terns, razorbills, little auks and Atlantic puffins. Moulting harlequin ducks occur on the coast July-August.

S105. Innaq/Ritenbenk. A very important seabird breeding colony with great cormorants, Brünnich's guillemots, razorbills and kittiwakes.

S106. South coast of Torsukattaq. Several very large breeding colonies with kittiwakes on the steep north-facing cliffs.

S107. The fjord Paakitsoq. There are several seabird breeding colonies in this fjord: great cormorants, Iceland gulls, kittiwakes and common eiders. Qinqua Avannarleq is an important angling site (Arctic char) for tourists. There are also fisheries for capelin and lumpsucker.

S108. The bay including Kangersuneq east of Oqaatsut/Rodebay. Important site for capelin and lumpsucker fishery. There are some archaeological sites, and the area is an important camp and excursion site for tourist.

S109. The fjord Kangersooq/Nordfjord and adjacent coasts. This is the most important site for moulting king eiders in Greenland. They occur in July-September. Later many king eiders and common eiders stage in the area and also in the spring these coasts are important to staging eiders. Harbour seals may still occur in the area. There are Arctic char in some rivers, and ringed seals are hunted on the ice in spring. The head of the fjord is included in a Ramsar-area.

S110. The archipelago Nuussuutaa Qeqertaa and adjacent islands and coasts. Breeding colonies for seabirds like Arctic terns, black guillemots and common eiders. In spring and autumn many eiders stage in this archipelago. Important hunting area for seabirds. The coasts are mainly rocky.

S111. Qeqertat/Schades Øer. A group of small and low islands with rocky shores. They hold a large breeding colony of Arctic terns and some black guillemots. Common eiders probably also bred in small numbers (Figure 7.4).

S112. The bay of Umiiviup Kangerlua. The head of this bay displays a delta with extensive muddy tidal flats and salt marshes. There is fishery for Arctic char and capelin, and the salt marshes are important feeding grounds for moulting and staging geese. There are also some archaeological sites. (Figure 7.13).

S113. The fjord Umiiarfik. This shallow fjord is a very important site to moulting king eiders in July to September. The coasts are low moraine coasts with some rocky outcrops, and there are several alluvial fans (Figure 7.7).

S114. Ikerasak (eastern part) in western part of Sydostbugten, south of Ikamiut. A narrow strait with rocky shores. Hunting and fishing grounds, a.o. for lumpsucker.

S115. Kuannersuit Sulluat and Kangikerlak/Inner Disko Fjord. A very scenic fjord with several Arctic char rivers, spawning areas for capeling and lumpsucker and which is an important moulting area for king eiders in late summer and autumn. The head of Kuannersuit Sulluat is included in a Ramsar area.

14.6.2 Pinpointing the selected areas using a grid-based GIS-analysis

The selection of these areas is based on the principles from a Norwegian system (Anker-Nilssen 1994), which gives priorities to oil spill sensitive areas for oil spill contingency planning. While the Canadian index system covers the entire coast in 50-km units, and thus gives a general overview of the sensitivity, the system of selected areas uses actual topographic borders and thus pinpoints the sensitive areas and leaves the rest unclassified.

The basis for their selection is, compared to the coastline in general, that 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.

The last criterion is important because it elucidates the rather limited possibilities to protect all coastlines during a large oil spill.

The selection process was supported by a grid-based GIS analysis of biological, human use, cultural and geomorphological data. The GIS analysis was performed using ESRI's spatial analyser and a grid-cell size of 2.5 km.

Table 14.10. Overview of input data and data layers for the selected areas GIS-analysis.

Data type	**Data layer**	**Potential range of grid cell values**
Coastal morphology	Oil residence index (ORI) calculated layer based on exposure, shore type, substrate and slope (1 layer) Exposure Shore type Substrate Slope	1-5
Tourism	Hiking, angling, excursions, attractions and tours (1 layer).	0 or 10 or 20
Archaeological and historic sites	Coastal sites (class 2 and 3) (1 layer)	0-22
Birds	Birds colonies (13 species with a layer each) Winter seabirds (5 species with a layer each) Birds moulting (1 layer)	0-25 0-2.5 0-24
Shellfish	Snow crabs (1 layer) Scallops (1 layer) Deep Sea Shrimps (1 layer)	0 or 9 0-18 0 or 6
Fish	Arctic char (1 layer) Capelin (1 layer) Lumpsucker (1 layer) Greenland halibut (1 layer)	0-14 0-21 0-15 0-7

All data were gridded in 2.5 x 2.5 km cells, and calculations of sensitivity index values for each cell followed largely the index calculation of assigned values for the 50-km segments. However, not only geographic resolution but also the resolution in number of species and relative abundance was higher in the selected area GIS analysis. The GIS analysis was based on 29 data layers (Table 14.10).

A GIS layer with oil residence index (ORI) values was calculated based on exposure, shore type, substrate and slope. For biological occurrences GIS layers with relative abundance (RA) x relative sensitivity (RS) values were produced. Abundance data were normalised to give the relative abundances on a scale from 0 to 1 for all species, except for winter seabirds which were so widespread that a scale from 0-0.1 was applied to balance their importance. Relative sensitivity values are given in Table 14.11. Layers with values representing value and sensitivity of archaeological and historic sites and areas important for tourism were also produced. Values in all layers (except ORI) were summed and multiplied by ORI to produce a priority index value layer.

Preparation of GIS layers
(References see 14.4.5)

Bird colonies, winter seabirds and moulting birds
Abundance data:
Bird colony data comes from the Seabird Colony Database NERI 2003.
Winter seabirds data comes from Merkel et al. (2002) and NERI (unpubl.).
Moulting birds data comes from Mosbech & Boertmann (1999) and Boertmann & Mosbech (2002).

Fish
Abundance for each grid cell has been calculated by summation of values for spawning (10), fishing (5 or 10) and fishing sites (5 or 10). Data comes from GINR, Olsvig & Mosbech (2003) and Olsvig & Mosbech (in prep.).

Shellfish
Abundance of scallops was classified by the fishery intensity measured by numbers of hauls (0 to 1). The relative abundance of deep sea shrimps and snow crabs was classified as fishery present (1) or fishery not present (0). Data comes from GINR.

Tourism
For tourism data a buffer zone of 1 km has been applied to the vector data before gridding, and the values 20, 10 and 0 has been applied to the grid cells with important tourism, some tourism and no tourism respectively. Tourism input data comes from interviews in 2003.

Archaeological and historical sites
Archaeological and historical site data comes from The National Museum and Archives database 2003.

Oil residence index
A layer with oil residence index (ORI) grid cell values was calculated based on exposure, shore type, substrate and slope using the same algorithm as for the 50-km segments (see chapter 6.3 and 14.2). The full spatial resolution (approx. 2 km) of the geomorphologic data set has been used.

Priority index value layer
The priority index values were calculated for each grid cell by multiplying the sum of all the other layers with the ORI value.

Final selection
The final process of deciding on the selected areas was done based on a series of maps showing priority index values for different combinations of data layers (maps included on CD-version).

This process of pinpointing small areas using data with high spatial resolution is more sensitive to lack of data and imprecise data than the classification of the 50-km segments. This was taking into account in the final selection process were the results of the GIS analysis was used as support for a selection based on best professional judgement.

Site specific information already presented as site specific on the operational maps (bird colonies and archaeology) was toned down in the selection process to allow the other data to pinpoint the high value sites otherwise averaged out on the 50-km segments.

The assessment of the potential for oil spill protection was on a site by site basis for a number of preliminary selected sites. Some rather large sites were accepted although it will only be realistic to protect them partially in an oil spill situation. This was done because of the high importance of these sites and that protection of even a minor part will be valuable. Furthermore we do not have detailed data to reasonably split them up in a number of smaller selected areas representing zones of sensitivity.

Example 1
Example of GIS-analysis used in support of pinpointing "selected areas". The map shows grid-cells (2,5 x 2,5 km) with priority index values higher than 100 as black squares. The priority index values in this example are calculated including layers for tourism, bird colonies, seabird wintering areas, fish (including both spawning and fishing areas), shellfish fishing areas (including shrimp), coastal archaeological sites and coastal morphology (including wave exposure) . The final "selected areas" used on the sensitivity maps are indicated with green borders. It is seen that some of the "selected areas" do not have grid-cells with high priority index values, these areas have been selected based on professional judgement (including assessment of data limitations) and local consultation.

Example 2
Example of GIS-analysis used in support of pinpointing "selected areas". The map shows grid-cells (2,5 x 2,5 km) with priority index values higher than 75 as black squares. The priority index values in this example are calculated as above, but without layers for bird colonies and coastal archaeological sites. The final selected areas area indicated with green borders. See text for further explanations.

Table 14.11. Relative Sensitivity values of resources and species.

Species name	Vulnerability	Mortality potential	Sublethal potential	Recovery period	Relative sensitivity
Arctic char	Moderate	Low/Short	Moderate	Moderate	14
Capelin	Very high/ No recovery	High/Long	High/Long	Moderate	21
Lumpsucker	Moderate	Moderate	High/Long	Low/Short	15
Greenland halibut	Very low/ Very short	Very low/ Very short	Low/Short	Low/Short	7
Snow crab	Very low/ Very short	Low/Short	Moderate	Low/Short	9
Deep sea shrimp	Very low/ Very short	Very low/ Very short	Low/Short	Very low/ Very short	6
Scallop	High/Long	Low/Short	High/Long	High/Long	18
Breeding Arctic tern	Moderate	High/Long	Very high/ No recovery	Very high/ No recovery	20
Breeding Atlantic puffin	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	High/Long	24
Breeding black guillemot	High/Long	Very high/ No recovery	Very high/ No recovery	Moderate	21
Breeding Brünninch's Guillemot	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Breeding common eider	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	High/ Long	24
Breeding glaucous gull	Moderate	High/Long	Very high/ No recovery	Low/Short	17
Breeding great black-backed gull	Moderate	High/Long	Very high/ No recovery	Low/Short	17
Breeding Iceland gull	Moderate	High/Long	Very high/ No recovery	Low/Short	17
Breeding kittiwake	High/Long	High/Long	Very high/ No recovery	Low/Short	19
Breeding lesser black backed gull	Moderate	High/Long	Very high/ No recovery	Low/Short	17
Breeding little auk	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	High/Long	24
Breeding northern fulmar	Moderate	High/Long	High/Long	High/Long	18
Breeding razorbill	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	High/Long	24
Wintering Brünninch's guillemot	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Wintering king eider	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Wintering black guillemot	High/Long	Very high/ No recovery	Very high/ No recovery	Moderate	21
Wintering common eider	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	25
Wintering long tailed duck	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	Moderate	23
Moulting harlequin duck	Very high/ No recovery	Very high/ No recovery	Very high/ No recovery	High/Long	24

14.7 Defining offshore areas for the sensitivity analysis

In order to map the sensitivity of the offshore habitat this has been divided into a suitable number of offshore areas for which the sensitivity index values has been calculated. Consideration has been given to the spatial resolution of available physical, biological and human use data when deciding on the size of the offshore areas and moreover should the areas be of a more or less similar size. For making it easier to use the Atlas it was decided to use the same offshore area boundaries for all seasons.

The available biological data from the offshore region are very unevenly distributed while some of the physical data (especially bathymetry and the satellite data) has a uniform coverage throughout the entire region. Therefore the delimitation of the offshore areas is based on the physical data.

A cluster analysis of oceanographic, bathymetric and climatic data was applied to support the definition of the single offshore areas, so their limits more or less would follow natural boundaries.

We performed cluster analyses using the statistical software SAS (PROC FASTCLUS and PROC CLUSTER). The aim of the cluster analyses was to support the definition of ecological meaningful offshore areas for the sensitivity mapping with a statistical robust procedure. The variables available for the cluster analysis are listed in Table 14.12a, b.

For the cluster analysis all data was resampled to a grid with a spatial resolution of 25 km x 25 km. The data coverage throughout the year of the environmental variables was quite different. E.g. there is a lack of many variables during winter month in areas mostly covered by ice. It was therefore decided to split the year into the seasons used in the sensitivity analysis (January – March, April – May, June – August and September to December). Cluster analyses were performed separately for each of these seasons and for the whole year. Furthermore, the number of environmental variables included in the analyses varied to test the sensibility of the results. Table 14.13 shows the environmental variables and seasons included in the cluster analyses performed.

Table 14.12a. The 12 variables included in the cluster analyses.

Variable	Description	Units
AirTemp (°C)	Air temperature	°C
Pressure (mb)	Air pressure	mb
SST (°C)	Sea surface temperature	°C
Wind (m/s)	Windspeed	m/s
Ice (%)	Ice coverage	%
Depth (m)	Sea depth	m
Slope (deg.)	Slope of seabottom	degrees
Dist2GL (Km)	Distance to Greenland coast	km
Temp0m (°C)	Temperature at surface (0 meter)	°C
Temp30m (°C)	Temperature at 30 meter depth	°C
Sal0m (psu)	Salinity at surface (0 meter)	psu
Sal30m (psu)	Salinity at 30 meter depth	psu

Table 14.12b. Technical information on the environmental variables included in the cluster analyses.

Environmental variable	**Data source**	**Data product**	**Spatial resolution**	**Time period covered and time resolution**
AirTemp	NOAA (satellite)	COADS	1x1 degree	Monthly mean 1988-1997
Pressure	NOAA (satellite)	COADS	1x1 degree	Monthly mean 1988-1997
SST	NOAA (satellite)	COADS	1x1 degree	Monthly mean 1988-1997
Wind	NOAA (satellite)	COADS	1x1 degree	Monthly mean 1988-1997
Ice	NSIDC (satellite)	DMSP SSM/I Monthly Polar Gridded Sea Ice Concentrations	25x25 km	Monthly averaged 1988-1997
Depth	NGDC (NOAA)	IBCAO	2,5x2,5 km	(2000)
Slope	Calculated from "Depth"	-	2,5x2,5 km	(2000)
Dist2GL	Calculated from "Depth"	-	2,5x2,5 km	(2000)
Temp0m	NODC (NOAA) (satellite)	WOD01	Point measurements	Sporadic coverage 1988-1997
Temp30m	NODC (NOAA) (satellite)	WOD01	Point measurements	Sporadic coverage 1988-1997
Sal0m	NODC (NOAA) (satellite)	WOD01	Point measurements	Sporadic coverage 1988-1997
Sal30m	NODC (NOAA) (satellite)	WOD01	Point measurements	Sporadic coverage 1988-1997

NOAA = National Oceanic and Atmospheric Administration
NSIDC = National Snow and Ice Data Center
NGDC = National Geophysical Data Center
NODC = National Oceanographic Data Center
COADS = Comprehensive Ocean-Atmosphere Data Set
DMSP SSM/I = Defence Meteorological Satellite Program's Special Sensor Microwave/Imager.
WOD01 = World Ocean Database 2001
IBCAO = International Bathymetric Chart of the Arctic Ocean
Links:
COADS: http://web1.cdc.noaa.gov/cdc/data.coads.1deg.html
DMSP SSM/I: http://nsidc.org/data/nsidc-0002.html
IBCAO: http://www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html
WOD01: http://www.nodc.noaa.gov/OC5/SELECT/dbsearch/dbsearch.html

Table 14.13. Environmental variables and seasons used in the cluster analyses.

Season	**Environmental variables**
January-March	Ice, Depth, Slope, Dist2GL
April-May	Ice, Depth, Slope, Dist2GL
June-August	Ice, Depth, Slope, Dist2GL, Airtemp Pressure, SST, Wind
June -August	All 12 environmental variables
September-December	Ice, Depth, Slope, Dist2GL, Airtemp Pressure, SST, Wind
September-December	All 12 environmental variables

The environmental variables were standardised to have the mean value zero and the standard deviation of one because the variable are measured in different units. In order to decide the appropriate number of clusters in each case a preliminary cluster analyses with a number of clusters of 30 were performed. Based on the cubic clustering criteria, the pseudo F statistic and the pseudo t^2 statistic the number of clusters was decided in each occasion. The selected number of clusters varied between 5 and 7. The method used to measure the distance between clusters were the centroid method, which is defined as the squared euclidean distance between their centroids.

After deciding on an appropriate number of clusters in the preliminary cluster analysis, the cluster analyses were performed with a fixed number of clusters and the resulting clusters were mapped in a GIS. By comparing the cluster maps for the different seasons general tendencies became apparent and the boundaries for the offshore areas were drawn on overlays of the cluster maps for the four seasons.

For the West Greenland region (68-72) this method resulted in 8 offshore areas (including two large inshore areas: Disko Bay and Uummannaq Fjord).

For the resulting offshore areas the monthly mean values for the environmental variables used in the cluster analysis are summarised in table 14.14

Table 14.14. Average of available environmental data (1988-1997) by month for the offshore areas OS 19-25. OS 26(inner Uummannaq Fjord) not included due to lack of data comparable to the offshore data.

		Offshore Area						
Month	Parameter	OS 19	OS 20	OS 21	OS 22	OS 23	OS 24	OS 25
01	AirTemp (°C)	-5.9	-7.4	--	--	--	--	--
	Pressure (mb)	993.0	995.2	--	--	--	--	--
	SST (°C)	--	--	--	--	--	--	--
	Wind (m/s)	8.2	5.3	--	--	--	--	--
	Ice (%)	78.0	77.1	79.2	86.9	96.8	93.4	82.3
02	AirTemp (°C)	--	--	--	--	-0.5	--	--
	Pressure (mb)	--	--	--	--	1009.3	--	--
	SST (°C)	--	--	--	--	--	--	--
	Wind (m/s)	--	--	--	--	1.0*	--	--
	Ice (%)	92.1	90.0	91.9	96.2	98.2	97.6	93.1
03	AirTemp (°C)	--	--	--	--	--	--	--
	Pressure (mb)	--	--	--	--	1015.3	--	--
	SST (°C)	--	--	--	--	--	--	--
	Wind (m/s)	--	--	--	--	3.1*	--	--
	Ice (%)	94.6	87.9	89.2	95.7	98.1	97.5	94.7
04	AirTemp (°C)	-3.2*	-6.0	--	--	7.5*	--	--
	Pressure (mb)	1007.7*	1017.9	--	--	--	1012.30*	--
	SST (°C)	-1.9*	-1.3	--	--	--	--	--
	Wind (m/s)	4.1*	4.9	--	--	7.7*	8.2*	--
	Ice (%)	91.7	74.9	78.5	92.6	97.6	96.3	89.8
05	AirTemp (°C)	1.0	-1.1	2.9	-0.3	-1.4	-6.2	2.8
	Pressure (mb)	1016.2	1015.1	1009.9	1015.9	1013.4	1012.7	1012.6
	SST (°C)	-0.2	-0.4	-0.4	0.8	-0.80*	-0.4	-0.2
	Wind (m/s)	3.5	3.7	2.0	3.9	7.1	6.3	2.9
	Ice (%)	72.4	38.3	46.5	74.1	95.9	89.7	73.3
06	AirTemp (°C)	5.9	2.7	2.3	2.1	1.9	0.4	1.3
	Pressure (mb)	1013.5	1011.6	1011.3	1010.0	1007.3	1011.5	1010.6
	SST (°C)	4.0	2.1	1.2	2.0	0.9	1.1	0.4
	Wind (m/s)	3.7	3.7	3.5	3.7	5.8	5.9	3.1
	Ice (%)	38.4	5.7	19.4	29.7	85.5	50.9	30.7

Table 14.14 (cont.). Average of available environmental data (1988-1997) by month for the offshore areas OS 19-25. OS 26 not included due to lack of data.

07	AirTemp (°C)	7.4	5.1	5.1	4.3	3.0	4.6	5.6
	Pressure (mb)	1010.8	1010.4	1009.2	1009.7	1007.9	1008.9	1009.6
	SST (°C)	5.5	4.4	4.4	4.1	2.9	3.5	3.2
	Wind (m/s)	3.3	3.8	4.2	5.3	4.4	5.5	3.6
	Ice (%)	33.6	5.5	17.9	3.3	40.4	10.3	15.3
08	AirTemp (°C)	6.6	5.3	5.0	4.3	2.8	4.1	4.9
	Pressure (mb)	1010.3	1009.5	1007.3	1007.6	1006.2	1009.5	1006.3
	SST (°C)	5.1	4.6	4.4	4.1	2.9	4.3	4.6
	Wind (m/s)	2.9	4.8	5.0	5.4	5.6	5.4	4.3
	Ice (%)	32.0	5.6	18.5	0.3	5.7	1.0	15.0
09	AirTemp (°C)	3.4	2.7	2.4	2.7	2.6	2.8	2.1
	Pressure (mb)	1009.8	1009.1	1007.6	1007.3	1008.5	1009.4	1008.2
	SST (°C)	3.4	3.7	4.3	3.4	3.1	3.3	3.0
	Wind (m/s)	3.8	6.1	5.7	6.4	6.3	5.3	5.5
	Ice (%)	29.3	4.0	14.7	0.2	0.1	0.1	12.4
10	AirTemp (°C)	-1.1	-0.6	-1.3	-0.3	-1.1	-0.8	-2.0
	Pressure (mb)	1010.8	1012.0	1013.0	1008.4	1008.3	1006.8	1011.6
	SST (°C)	2.0	1.7	0.9	1.5	1.9	0.9	0.9
	Wind (m/s)	6.0	6.9	8.3	8.1	6.9	9.5	7.9
	Ice (%)	30.3	3.3	12.8	0.0	3.1	0.8	11.3
11	AirTemp (°C)	-3.7	-4.2	-3.9	-6.1	-4.2	-5.3	-4.9
	Pressure (mb)	1005.4	1005.5	1006.9	1009.8	1011.2	1012.5	1007.9
	SST (°C)	0.7	0.6	0.6	0.0	-1.0	1.2	0.7
	Wind (m/s)	5.0	7.0	7.3	7.3	11.9	8.7	7.7
	Ice (%)	31.9	5.2	14.4	9.2	54.8	24.8	17.1
12	AirTemp (°C)	-7.0	-7.2	-7.1	-12.2	-3.9	-5.0*	-5.9
	Pressure (mb)	1002.4	1004.2	998.1	1003.3	983.3	990.5*	992.3
	SST (°C)	-0.2	-0.3	0.2*	-0.4*	0.0*	--	--
	Wind (m/s)	6.5	7.9	5.1	5.7	10.0*	5.9*	5.5
	Ice (%)	40.1	28.0	32.4	51.6	92.6	68.8	38.7
01-12	Depth (m)	288	267	75	235	949	354	295
	Slope (°)	0.30	0.28	0.68	0.14	0.85	0.20	0.49
	Dist2GL (Km)	32	61	25	113	195	108	37

--no data

** only data from one year*

Point measurements of temperature and salinity in 0 and 30 m depth were not available in the northern offshore areas.

15 Appendix E, Place names

This is an index to all the place names used on the maps in Chapter 8 and 9. Some place names also have a name in Danish, which are 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. If the place name occurs on several map-sheets, it is listed once for each map-sheet. Please note that on older maps the pre-1973 orthography of the names in Greenlandic are used.

Greenlandic	Danish	Map sheet	Latitude	Longitude
Aalatsivik		6802	52°50'	68°10'
Aamaruutissat	Skansen	6902	52°27'	69°25'
Aasiaat	Egedesminde	6851	52°52'	68°43'
Akuliaruseq		7103	52°34'	71°28'
Akuliaruseq		6951	53°58'	69°33'
Akuliaruseq		6952	53°58'	69°33'
Akuliaruserssuaq		7104	51°25'	71°40'
Akuliarusinnguaq		7153	53°16'	71°43'
Akuliarusinnguaq		7153	52°54'	71°46'
Akuliarutsip Sermersua	Nordenskiöld Gletscher	6803	51°80'	68°19'
Akulliit		6853	51°15'	68°40'
Akulliit	Mellemfjord	6951	54°38'	69°45'
Akunnerit		7101	54°33'	71°22'
Akunnaaq		6852	52°20'	68°45'
Akunnaaq		6901	54°17'	69°25'
Alanngorleq		6803	51°40'	68°90'
Alanngorsuup Imaa		6801	53°31'	68°10'
Alannguarqap Sullua		7053	51°43'	70°46'
Alanngup Nunaa		6852	52°28'	68°41'
Alanngup Qaqqai		6901	54°20'	69°25'
Alianaatsoq		6955	50°31'	69°59'
Alluttoq	Arveprinsen Ejland	6954	51°80'	69°45'
Amitsuarssuk		6852	52°28'	68°33'
Amitsuatsiaq		7054	51°90'	70°42'
Amitsup Sullua		7151	55°23'	71°49'
Appat		7053	52°10'	70°55'
Aqajarua	Mudderbugten	6954	51°56'	69°43'
Aqajarua	Mudderbugten	6953	51°56'	69°43'
Arfersiorfik		6804	50°56'	68°10'
Arfersiorfik		6803	51°18'	68°50'
Arfertuarsuk		7151	55°14'	71°29'
Arfertuarsuk		7101	55°14'	71°29'
Asuup Innartaa		7002	53°90'	70°10'
Atarnup Nunaa		6802	52°41'	68°20'
Ateneq		6801	53°50'	68°40'
Avannarleq	Nordø	6954	51°17'	69°48'
Avannarput		6901	53°35'	69°28'
Eqalugaarsuit Sulluat	Laksefjorden	7202	54°55'	72°31'
Eqaluit	Laksebugt	6853	51°11'	68°52'
Eqip Sermia		6955	50°15'	69°48'
Iginniarfik		6801	53°11'	68°90'

Greenlandic	Danish	Map sheet	Latitude	Longitude
Ikamiut		6852	51°50'	68°38'
Ikera		7201	55°46'	72°15'
Ikerasak		6955	50°53'	69°43'
Ikerasak		7004	51°18'	70°30'
Ikerasannguaq		6954	51°22'	69°52'
Ikerasaap Sullua		7005	50°50'	70°23'
Ikerasaap Sullua		7004	50°50'	70°23'
Ikerasaarsuk		6801	53°27'	68°80'
Ikeresak		6801	53°38'	68°00'
Ilimanaq	Claushavn	6904	51°70'	69°50'
Iliviakassak		7051	54°35'	70°43'
Illorsuit	Ubekendt Ejland	7102	53°46'	71°90'
Illorsuit		7102	53°34'	71°14'
Illorsuit Imaat		7103	53°13'	71°10'
Illorsuit Imaat		7102	53°28'	71°16'
Illu		7201	55°45'	72°50'
Illuluarsuit		7151	55°70'	71°56'
Illuluarsuit Kangiat		6955	50°29'	69°48'
Illuluarsuit Nunataat		6955	50°35'	69°51'
Illup Qinngua		6904	50°40'	69°20'
Iluliartuup Tasersua		6804	50°47'	68°17'
Iluliaraarsuit		7003	52°53'	70°00'
Iluliaraarsuit		7002	52°53'	70°00'
Iluliaraarsuit		6953	52°53'	70°00'
Ilulissat	Jakobshavn	6904	51°60'	69°13'
Innalik		6801	53°29'	68°27'
Innerit		7201	55°25'	72°40'
Inngiu		7153	53°21'	71°47'
Innaarsuit		6902	52°32'	69°25'
Inukassaat		7103	52°33'	71°12'
Ippik		6902	53°15'	69°18'
Isua		6905	50°50'	69°40'
Iterlakassak		7051	53°56'	70°49'
Iterlaa		7052	53°27'	70°46'
Itilliarsuup Kangerlua		7054	51°13'	70°50'
Itilliarsuup Qaqqaa		7054	51°40'	70°44'
Itinneq Kangilleq	Blæsedalen	6901	53°31'	69°22'
Itinneq Killeq		6901	53°50'	69°21'
Ivisaaqqut		6951	54°48'	69°44'
Kangeq		7051	54°35'	70°43'
Kangerdluarssuk		6901	53°52'	69°29'
Kangerluarssup		7104	51°45'	71°17'
Kangerluarsuk		7104	52°40'	71°13'
Kangerluarsuk		6952	53°52'	69°29'
Kangerluarsuk		6955	50°43'	69°40'
Kangerluarsuk		6904	51°30'	69°16'
Kangerluarsuup Sermia		7104	51°31'	71°16'
Kangerluk	Disko Fjord	6901	53°57'	69°29'
Kangerluk		6954	51°12'	69°50'
Kangerluk	Disko Fjord	6951	53°57'	69°29'
Kangerluk	Disko Fjord	6951	54°30'	69°30'
Kangerluk	Disko Fjord	6952	53°57'	69°29'

Greenlandic	Danish	Map sheet	Latitude	Longitude
Kangerlussuaq		7201	55°18'	72°24'
Kangerlussuaq		7103	52°35'	71°22'
Kangerlussuaq		7104	51°57'	71°26'
Kangersooq		6951	54°35'	69°58'
Kangersuatsiaq	Prøven	7201	55°33'	72°23'
Kangersuneq		6853	50°59'	68°45'
Kangersuneq		6904	50°57'	69°22'
Kangia	Jakobshavn Isfjord	6904	50°36'	69°10'
Kangikerdlak		6901	53°35'	69°27'
Kangilernata Sermia		6955	50°22'	69°54'
Kangilleq		7054	50°39'	70°43'
Kangilleq		7103	52°59'	71°28'
Kangilleq		7154	52°90'	71°36'
Kangilliup Sermia	Rink Isbræ	7154	51°39'	71°45'
Kangiusap Imaa		7152	53°50'	71°45'
Kangaarsuk		6901	53°51'	69°16'
Kangaatsiaq		6801	53°28'	68°19'
Karrat	Isfjord	7153	52°51'	71°35'
Kigataq		7201	55°52'	72°60'
Killiit		6851	53°31'	68°37'
Kitsissuarsuit	Hunde Ejland	6851	53°80'	68°51'
Kitsissunnguit	Grønne Ejland	6852	52°00'	68°49'
Kitsissut	Kronprinsens Ejland	6851	53°19'	69°10'
Kitsissut	Kronprinsens Ejland	6901	53°19'	69°10'
Kuannersuit Sulluat		6901	53°36'	69°30'
Kuannersuit Sulluat		6952	53°36'	69°30'
Kuup Qeqertai		6851	52°39'	68°37'
Kuup Qeqertai		6852	52°39'	68°37'
Maligiaq		6901	54°12'	69°27'
Maligaat		7001	54°44'	70°20'
Manermiut		6851	53°8'	68°36'
Maniitsormiut		6851	52°52'	68°46'
Millorfik		7151	55°37'	71°46'
Maarmorilik		7104	51°17'	71°80'
Nalluarsuk		6904	50°46'	69°12'
Naqerloq		6951	54°20'	69°34'
Narsaq		7151	55°31'	71°34'
Nassuit Imaat		6802	52°43'	68°16'
Niaqornat		7051	53°40'	70°47'
Niaqornaarsuk		6802	52°51'	68°14'
Niaqornaarsuk		7001	54°12'	70°30'
Niaqornaarsuk		7051	54°12'	70°30'
Nivaap Paa		6852	52°50'	68°40'
Nunatarsuaq		6904	50°25'	69°14'
Nuugsuutaa		7051	54°38'	70°38'
Nuugaarsuk		6953	52°15'	69°50'
Nuugaarsunnguaq		6902	53°20'	69°20'
Nuugaatsiaq		7153	53°13'	71°32'
Nuugaatsiaap Imaa		7102	53°42'	71°22'
Nuugaatsiaap Tunua		7153	53°50'	71°41'
Nuuk Qiterleq		6901	54°14'	69°22'
Nuuluk		7051	54°80'	70°50'

Greenlandic	Danish	Map sheet	Latitude	Longitude
Nuussaq		7001	54°50'	70°27'
Oqaatsut	Rodebay	6904	51°00'	69°20'
Oqaatsut		6954	51°23'	69°55'
Orpissooq		6853	50°59'	68°42'
Perlerfiup Kangerlua		7104	51°44'	71°50'
Perlerfiup Kangerlua		7054	51°13'	70°59'
Paakitsoq		6904	50°52'	69°29'
Paakitsup Ilorlia		6904	50°32'	69°30'
Paakitsup Nunaa		6904	50°43'	69°24'
Qaqullussuit		7054	51°22'	70°44'
Qarassap Imaa		7005	50°43'	70°26'
Qasigiannguit		6853	51°11'	68°49'
Qasigissat		6951	54°49'	69°53'
Qeqertap Alanngua		6951	54°11'	69°32'
Qeqertap Ikera		7151	55°28'	71°57'
Qeqertap Ilua		6954	51°14'	70°00'
Qeqertap Ilua		7004	51°14'	70°00'
Qeqertap Sarqaa		7151	55°31'	71°49'
Qeqertaq	Skalø	7151	55°39'	71°53'
Qeqertaq		6954	51°18'	69°59'
Qeqertarsuaq	Godhavn	6901	53°32'	69°15'
Qeqertarsuatsiaq	Hareøen	7001	54°55'	70°26'
Qeqertarsuatsiaq		6801	53°20'	68°25'
Qeqertarsuatsiaap		6802	52°55'	68°23'
Qeqertarsuup Tunua	Disko Bugt	6902	52°45'	69°11'
Qeqertat	Schades Øer	7102	53°55'	71°23'
Qeqertaarsunnguit Iluat		6905	50°18'	69°40'
Qeqertaasaq Iterlaa		7201	55°38'	72°15'
Qiioqe		7104	52°50'	71°21'
Qinngua Avannarleq		6904	50°24'	69°30'
Qinngua Avannarleq		6955	50°24'	69°30'
Qinnivik		7101	55°20'	71°27'
Qujanartoq		6901	54°30'	69°19'
Qullissat		7002	53°10'	70°50'
Qaamarujuk		7104	51°24'	71°70'
Qaarsut		7052	52°42'	70°44'
Salliaruseq	Storøen	7053	51°49'	70°41'
Salliarutsip Kangerlua		7153	52°57'	71°54'
Salliarutsip Kangerlua		7153	53°12'	71°47'
Salliarutsip Nunataa		7153	53°40'	71°52'
Saputit		6954	51°35'	70°10'
Saputit		7004	51°35'	70°10'
Saqqaq		7003	51°57'	70°10'
Saqqaq		6953	51°57'	70°10'
Saqqaq		6954	51°57'	70°10'
Saqqarleq		6854	50°32'	68°58'
Saqqarleq		6851	52°59'	68°35'
Saqqarliip Nunaa		6851	52°40'	68°40'
Saqqarliip Nunaa		6852	52°40'	68°40'
Saqqarliup Sermia		6854	50°13'	68°57'
Saqqarliup Sermia		6854	50°19'	68°53'
Saqqarput Aalatsivik		6802	52°51'	68°90'

Greenlandic	Danish	Map sheet	Latitude	Longitude
Sarfannguaq		6905	50°16'	69°20'
Sarfannguaq		6854	50°16'	69°20'
Sarfarssuaq		6802	52°32'	68°11'
Sarfaarsuk		6803	51°18'	68°90'
Sermeq Avannarleq		6905	50°16'	69°23'
Sermeq Kujalleq	Jakobshavn Isbræ	6905	49°50'	69°11'
Sermeq Kujalleq		7005	50°35'	70°24'
Sermeq Kujalleq		6955	50°14'	69°59'
Sermeq Silarleq		7054	50°49'	70°48'
Sermillip Kangerlua		7054	50°57'	70°40'
Sikuiuitsoq		6904	50°32'	69°14'
Sullorsuaq	Vaigat	7003	52°48'	70°90'
Sullorsuaq	Vaigat	6953	52°30'	69°58'
Sullorsuaq	Vaigat	7002	53°25'	70°16'
Sullua		7201	55°20'	72°90'
Sullua		7202	54°34'	72°60'
Saarloq		7051	54°23'	70°46'
Saattoq	Store Fladø	7201	56°40'	72°16'
Saattut		7053	51°38'	70°49'
Tasiusap Imaa		7101	55°10'	71°26'
Tasiusaq		6904	50°46'	69°50'
Tasiussarssuaq		6803	51°31'	68°23'
Tikeqqap Iterlaa		7201	55°59'	72°90'
Tini		6901	53°44'	69°15'
Torssukattak		7053	51°53'	70°59'
Torsukattak		7005	50°28'	70°10'
Torsukattak		6955	50°28'	70°10'
Torsuuk		7153	53°50'	71°32'
Tunertoq		6803	51°49'	68°50'
Tunorsuaq		6801	53°10'	68°16'
Tunorsuaq		6802	52°52'	68°18'
Tunorsuup Nunaa		6801	53°60'	68°18'
Tunorsuup Nunaa		6801	52°59'	68°20'
Tunuarssuk		6851	53°15'	68°35'
Uiffaq	Blåfjeld	6901	54°11'	69°23'
Ukkusissat		7104	51°53'	71°30'
Ukkusissat Sulluat		7202	53°48'	72°13'
Ukkusissat Sulluat		7203	53°48'	72°13'
Ukkusissat Sulluat		7153	53°28'	71°59'
Ukkusissat Sulluat		7203	53°39'	72°60'
Umiammakku Nunaa		7154	52°90'	71°43'
Umiammakku Sermia		7154	52°28'	71°42'
Umiiarfik		7151	54°59'	71°55'
Umiiviup Kangerlua		7152	53°59'	71°38'
Upernavik Kujalleq		7201	55°33'	72°90'
Upernavik Ø		7103	52°55'	71°17'
Uummannaq		7053	52°80'	70°41'
	Hammer Dal	7001	54°42'	70°90'
	Sydostbugten	6853	51°30'	68°36'
	Porsild Grund	6903	51°55'	69°20'
	Blomsterdalen	6952	53°25'	69°43'
	Ritenbenk	6954	51°18'	69°46'

Greenlandic	Danish	Map sheet	Latitude	Longitude
	Lersletten	6803	51°57'	68°21'
	Rink Dal	7001	54°44'	70°4'
	Giesecke Dal	7001	54°25'	70°12'
	Jens Vahl Dal	7001	54°28'	70°18'
	Giesecke Dal	7001	54°25'	70°12'
	Hollænder Bugt	7051	53°48'	70°48'
	Alfred Wegener Halvø	7104	51°53'	71°12'
	Sorte Pyramide	7153	52°58'	71°38'
	Svartenhavn	7151	55°43'	71°40'

16 Appendix F, Names of animals in English, Danish and Greenlandic

English and *scientific* name Engelsk og *videnskabeligt* navn Tuluttut ilisimatuussutsik kullu taaguutaat	Danish name Dansk navn Qallunaatut taaguutaat	Greenlandic name Grønlandsk navn Kalaallisut taaguu-taat
Fish and shellfish **Fisk m.m.** **Aalisakkat il. il.**		
American plaice *Hippoglossoides platessoides*	Håising	Oquutaq
Arctic char *Salvelinus alpinus*	Fjeldørred	Eqaluk
Arctic cod *Arctogadus glacialis*	Istorsk	
Atlantic cod *Gadus morhua*	Torsk	Saarullik
Atlantic halibut *Hippoglossus hippoglossus*	Helleflynder	Nataarnaq
Atlantic salmon *Salmo salar*	Laks	Kapisilik
Atlantic wolffish *Anarichas lupus*	Havkat	Qeeraaraq
Beaked redfish *Sebastes mentella*	Dybhavsrødfisk	Suluppaagaq itisoor-miu
Blue mussel *Mytilus edulis*	Blåmusling	Uiloq
Butterfish *Pholis gunnellus*	Tangspræl	Pilaatalik
Capelin *Mallotus villosus*	Lodde	Ammassak
Cutthroat trout *Salmo clarki*	Cutthroat ørred	-
Deep sea shrimp *Pandalus borealis*	Dybvandsreje	Kinguppak
Golden redfish *Sebastes marinus*	Stor rødfisk	Suluppaagaq
Greenland cod *Gadus ogac*	Uvak	Uugaq
Greenland halibut *Reinhardtius hippoglossoides*	Hellefisk	Qaleralik
Long rough dab *Hippoglossoides platessiodes*	Håsing	Oquutaq
Lumpsucker *Cyclopterus lumpus*	Stenbider	Nipisa

Fish and shellfish cont. **Fisk m.m.** **Aalisakkat il. il.**		
Polar cod *Boreogadus saida*	Polartorsk	Eqalugaq
Redfish *Sebastes spp.*	Rødfisk	Suluppaagaq
Sand eel *Ammodytes sp.*	Tobis	-
Scallop *Chlamys islandica*	Kammusling	Uiluiq
Shorthorn sculpin *Myoxocephalus scorpius*	Almindelig ulk	Kanajoq
Spottet wolffish *Anarhicas minor*	Plettet havkat	Qeeraq milattooq
Snow crab *Chionoecetes opilio*	Krabbe	Saattuaq
Starry skate *Raja radiata*	Tærbe	Allernaq
Three-spined stickleback *Gasterosteus aculeatus*	Trepigget hundestejle	Kakilisak pingasunik kapinartulik
Wolffish *Anarhicas sp.*	Havkat	

Birds **Fugle** **Timmisat**		
Arctic skua *Stercorarius parasiticus*	Almindelig kjove	Isunngaq
Arctic tern *Sterna paradisaea*	Havterne	Imeqqutaalaq
Atlantic puffin *Fratercula arctica*	Lunde	Qilanngaq
Black guillemot *Cepphus grylle*	Tejst	Serfaq
Black-legged kittiwake *Rissa tridactyla*	Ride	Taateraaq
Common eider *Somateria mollissima*	Ederfugl	Miteq siorartooq
Common guillemot (common murre) *Uria aalge*	Almindelig lomvie	Appa sigguttooq
Cormorant *Phalacrocorax sp.*	Skarv	Oqaatsoq
Glaucous gull *Larus hyperboreus*	Gråmåge	Naajarujussuaq
Great black-backed gull *Larus marinus*	Svartbag	Naajarluk
Great cormorant *Phalacrocorax carbo*	Storskarv	Oqaatsoq
Great northern diver *Gavia immer*	Islom	Tuullik
Great shearwater *Puffinus gravis*	Storskråpe	Qaqullunnaq
Great skua *Stercorarius skua*	Storkjove	-
Grey phalarope *Phalaropus fulicarius*	Thorshane	Kajuaraq
Harlequin duck *Histrionicus histrionicus*	Strømand	Toornarviarsuk
Iceland gull *Larus glaucoides*	Hvidvinget måge	Naajarnaq
Ivory gull *Pagophila eburnea*	Ismåge	Naajavaarsuk
King eider *Somateria spectabilis*	Kongeederfugl	Miteq siorakitsoq
Little auk (dovekie) *Alle alle*	Søkonge	Appaliarsuk
Long-tailed duck *Clangula hyemalis*	Havlit	Alleq

Birds cont. **Fugle** **Timmisat**		
Longtailed skua *Stercorarius longicaudus*	Lille kjove	Papikkaaq
Mallard *Anas platyrhynchos*	Gråand	Qeerlutooq
Northern fulmar *Fulmarus glacialis*	Mallemuk	Qaqulluk
Pomarine skua *Stercocarius pomarinus*	Mellemkjove	Isunngarsuaq
Purple sandpiper *Calidris maritima*	Sortgrå ryle	Saarfaarsuk
Raven *Corvus corax*	Ravn	Tulugaq
Razorbill *Alca torda*	Alk	Apparluk
Red-breasted merganser *Mergus merganser*	Toppet skallesluger	Paaq
Red-necked phalarope *Phalaropus lobatus*	Odinshane	Naluumasortoq
Red-throated diver *Gavia stellata*	Rødstrubet lom	Qarsaaq
Sabine's gull *Larus sabini*	Sabinemåge	Taateraarnaq
Brünnich's guillemot (Thick-billed murre) *Uria lomvia*	Polarlomvie	Appa
White-tailed eagle *Haliaeetus albicilla*	Havørn	Nattoralik

Mammals **Pattedyr** **Uumasut miluumasut**		
Bearded seal *Erignathus barbatus*	Remmesæl	Ussuk
Bedlamer *Phoca groenlandica*	Grønlandssæl (blåside)	Allattooq
Blue whale *Balaenoptera musculus*	Blåhval	Tunnulik
Bottlenose whale *Hyperoodon ampullatus*	Døgling	Anarnak
Bowhead whale *Balaena mysticetus*	Grønlandshval	Arfivik
Fin whale *Balaenoptera physalis*	Finhval	Tikaagulliusaaq
Harbour porpoise *Phocoena phocoena*	Marsvin	Niisa
Harbour seal *Phoca vitulina*	Spættet (spraglet) sæl	Qasigiaq
Harp seal *Phoca groenlandica*	Grønlandssæl (sort-side)	Aataaq
Hooded seal *Cystophora cristata*	Klapmyds	Natsersuaq
Humpback whale *Megaptera novaeangliae*	Pukkelhval	Qipoqqaq
Killer whale *Orcinus orca*	Spækhugger	Aarluk
Minke whale *Balaenoptera acutorostrata*	Vågehval (sildepisker)	Tikaagullik
Narwhal *Monodon monoceros*	Narhval	Qilalugaq qernertaq
Polar bear *Ursus maritimus*	Isbjørn	Nanoq
Ringed seal *Phoca hispida*	Ringsæl (netside)	Natseq
Sei whale *Balaenoptera borealis*	Sejhval	Tunnullit ilaat
Sperm whale *Physeter macrocephalus*	Kaskelot	Kigutilissuaq
Walrus *Odobenus rosmarus*	Hvalros	Aaveq
White whale (Beluga) *Delphinapterus leucas*	Hvidhval (hvidfisk)	Qilalugaq qaqortaq

Seabird breeding colony no. 68013. Two low island in Disko Bay. Breeding birds include Arctic tern, black guillemot and little auk.

Seabird breeding colony no. 68020. A steep cliff in the fjord Orpissoq. Breeding birds include kittiwake, Iceland gull, glaucous gull and black guillemot.

Seabird breeding colony no. 68100. Akuliarutsip Qeqertai, a small island and some skerries in the fjord Tasiussarsuaq. This site is important to breeding common eiders.

Seabird breeding colony no. 68102. Saattut a small island in the fjord Tasiussarsuup Qingua. This site is important to breeding common eiders.

Seabird breeding colony no. 68108. A steep cliff in the bay of Sydostbugten. Breeding birds include razorbill and black guillemot.

Seabird breeding colony no. 68035. A steep cliff in the fjord Sarqalleq. Breeding birds include great cormorant, Iceland gull and possibly kittiwake.

Seabird breeding colony no. 68166, Ujarattarfik. Two low islands in Disko Bay. Breeding birds include Arctic tern and black guillemot.

Seabird breeding colony no. 68174, Qilangaleeraq. An island and two islets in Disko Bay. Breeding birds include Arctic tern and black guillemot.

Seabird breeding colony no. 68175, Saattuarsiut, low island in Disko Bay. Breeding site for Arctic terns.

Seabird breeding colony no. 69023, Qaqullit in Ataa Sund. Breeding birds include gulls and great cormorants.

Seabird breeding colony no. 69033, Naajaat in Torsukattaq. Steep cliff with breeding kittiwakes (10,000-15,000 nests in 1994), Iceland gulls and black guillemots.

Seabird breeding colonies nos 69034, -035 and -036. Steep cliffs on southern coast of Torsukattaq. Breeding birds include kittiwakes (among the largest colonies in Greenland), Iceland gulls and black guillemots

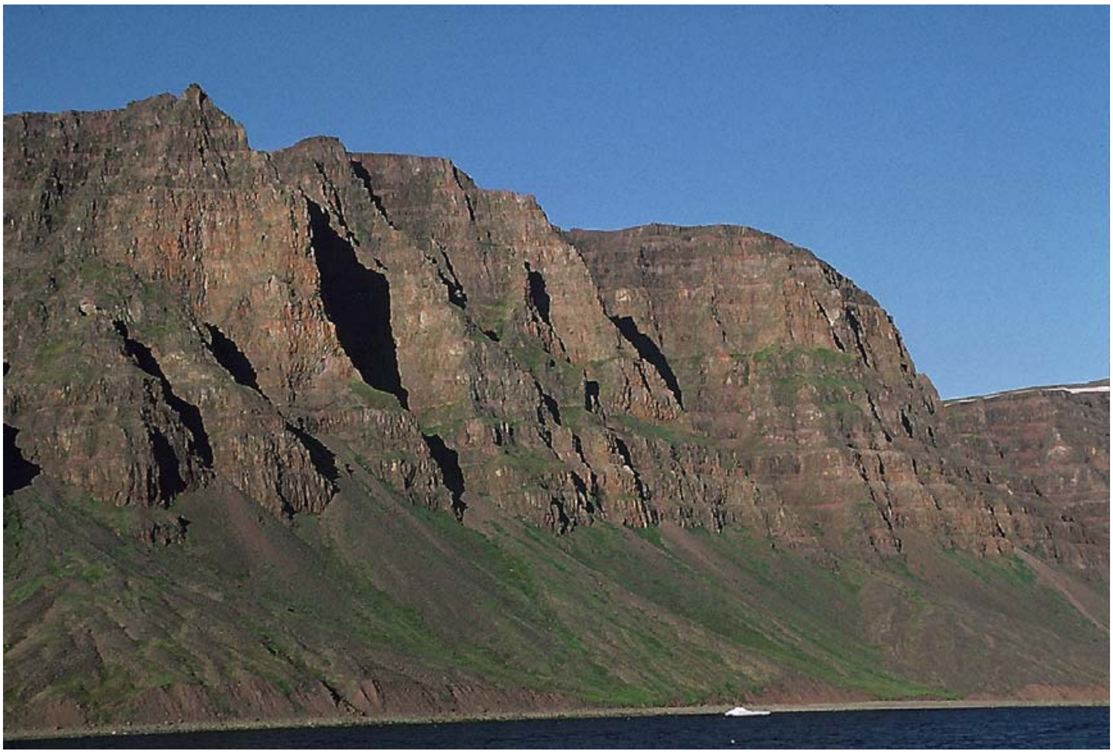
Seabird breeding colony no. 69037, Oqaatsut in Torsukattaq. Breeding birds include kittiwake, Iceland gull and black guillemot.

Seabird breeding colony no. 69038, Oqaatsut in Torsukattaq. Breeding birds include kittiwake, Iceland gull and black guillemot.

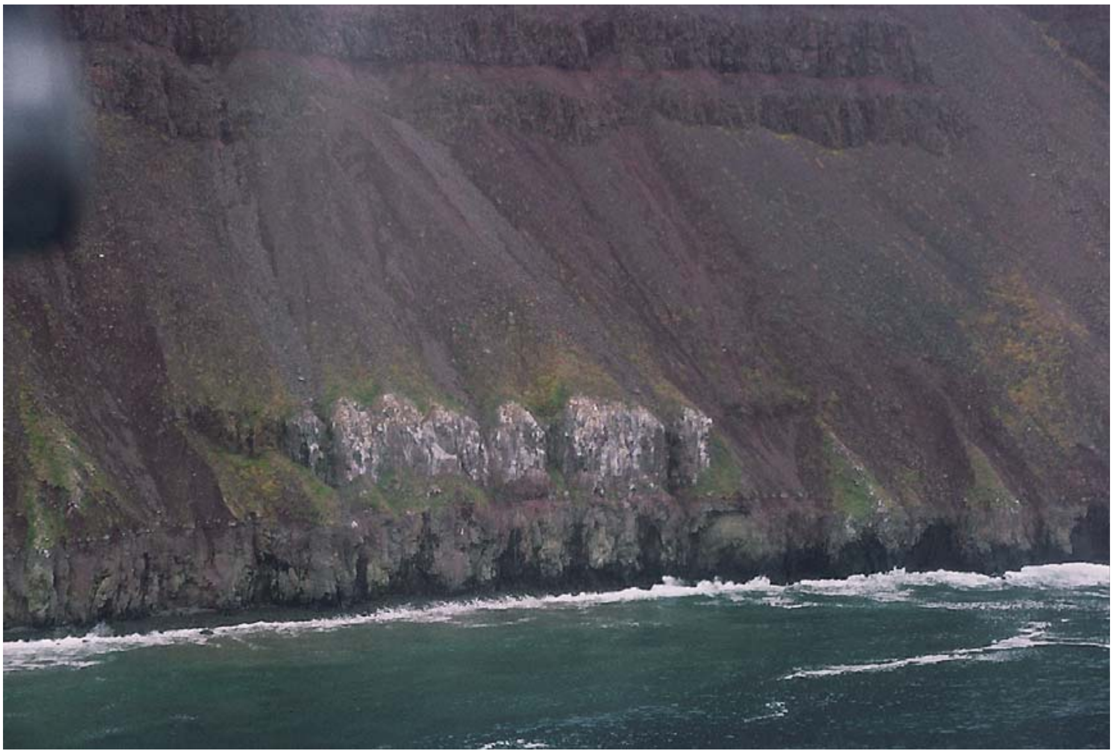
Seabird breeding colony no. 69049, Innaq/Ritenbenk. Steep cliff in Disko Bay. Breeding birds include great cormorant, kittiwake, Iceland gull, Brünnich’s guillemot, razorbill and black guillemot. This is the only breeding site for Brünnich’s guillemot within the region 68º - 72º N, and the site is one of the most important and significant seabird breeding colonies in the Disko Bay region.

Seabird breeding colony no. 69050, Qasigissat on west coast of Disko. Breeding birds include great cormorant, glaucous gull, black guillemot and perhaps razorbill.

Seabird breeding colony no. 69062. Steep side on the island of Qeqertaq in Kangerluk/Diskofjord. This is one of the largest colonies of great cormorant in Greenland, and counted in 2002 240 nests. Above the cormorants, and outside the image, northern fulmars breed in large numbers.



Seabird breeding colony no. 69071. Oqaatsunnguit/Blåfjeld on south coast of Disko. Breeding birds include large numbers of northern fulmar (on the almost vertical sides) and small numbers of glaucous gulls.



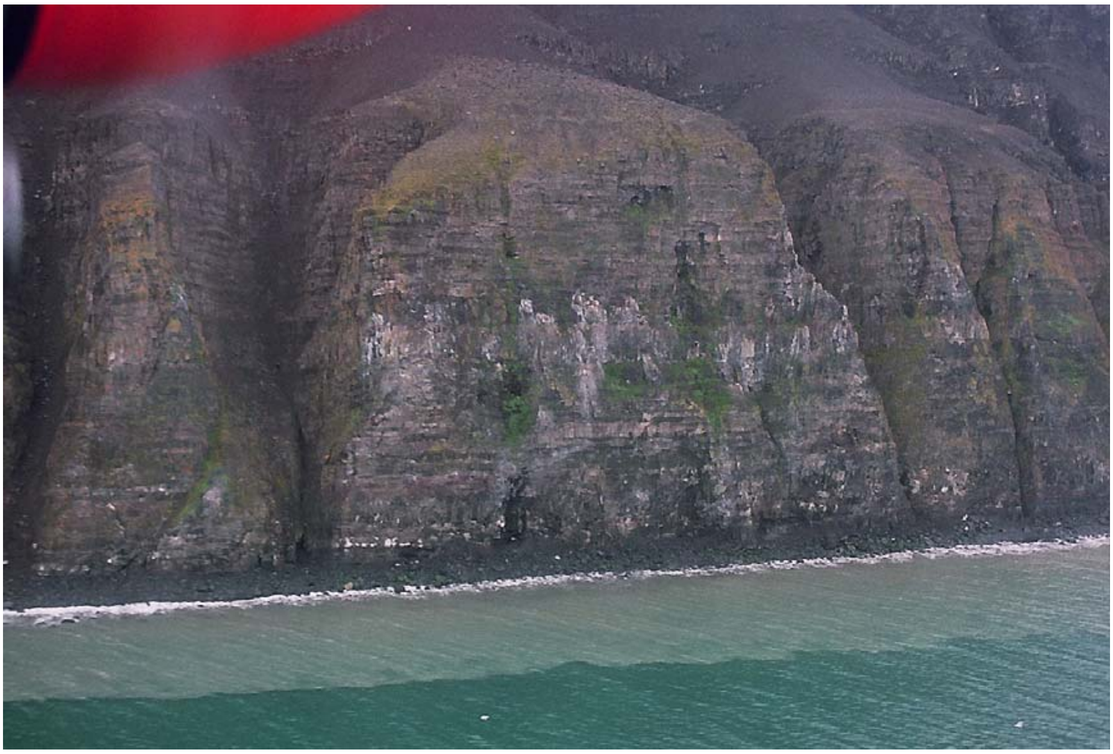
Seabird breeding colony no. 69072, Qujanartoq/Blåfjeld on south coast of Disko. Breeding birds include great cormorant (181 nests in 2001), Iceland gull and black guillemot, and higher on the cliff northern fulmars.

Seabird breeding colony no. 69074, Innarsuaq/Skarvefjeld. Steep cliff on south coast of Disko. Breeding birds include black guillemot and Iceland gull.

Seabird breeding colony no. 69098, Killit. A small island off south coast of Disko. Breeding site for black guillemots.

Seabird breeding colony no. 70005, Kuugannguup Innartaa, steep cliff on north coast of Disko. Breeding birds include kittiwakes, Iceland gulls and possible great cormorants.

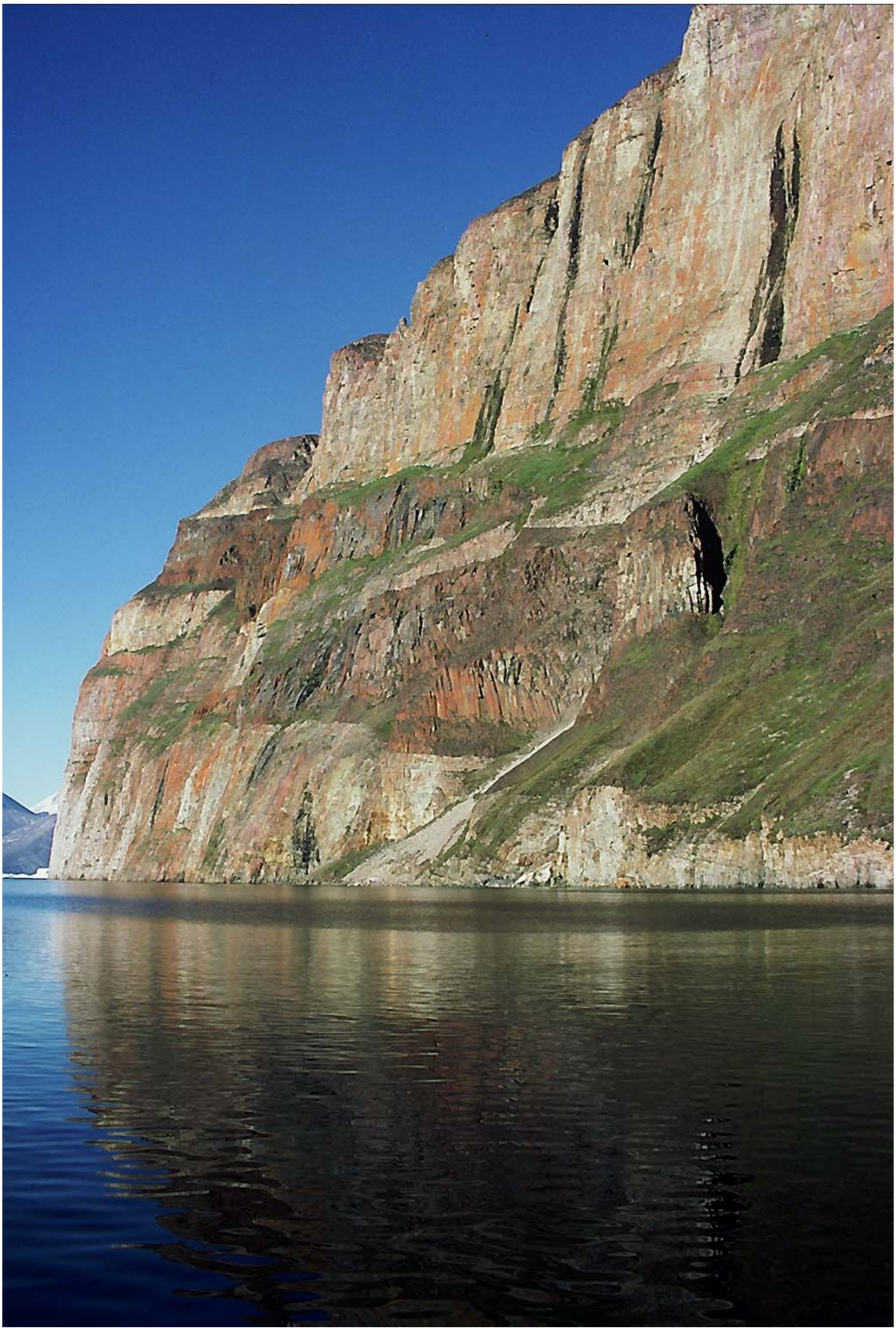
Seabird breeding colony no. 70006, Oqaatsunnguit. Steep cliff on north coast of Disko. Breeding birds include great cormorant, Iceland gull, black guillemot and possible razorbill.



Seabird breeding colony no. 70007, Serfarsuit. Steep cliff on north coast of Disko.
Breeding birds include great cormorant, glaucous gull, razorbill and black guillemot.

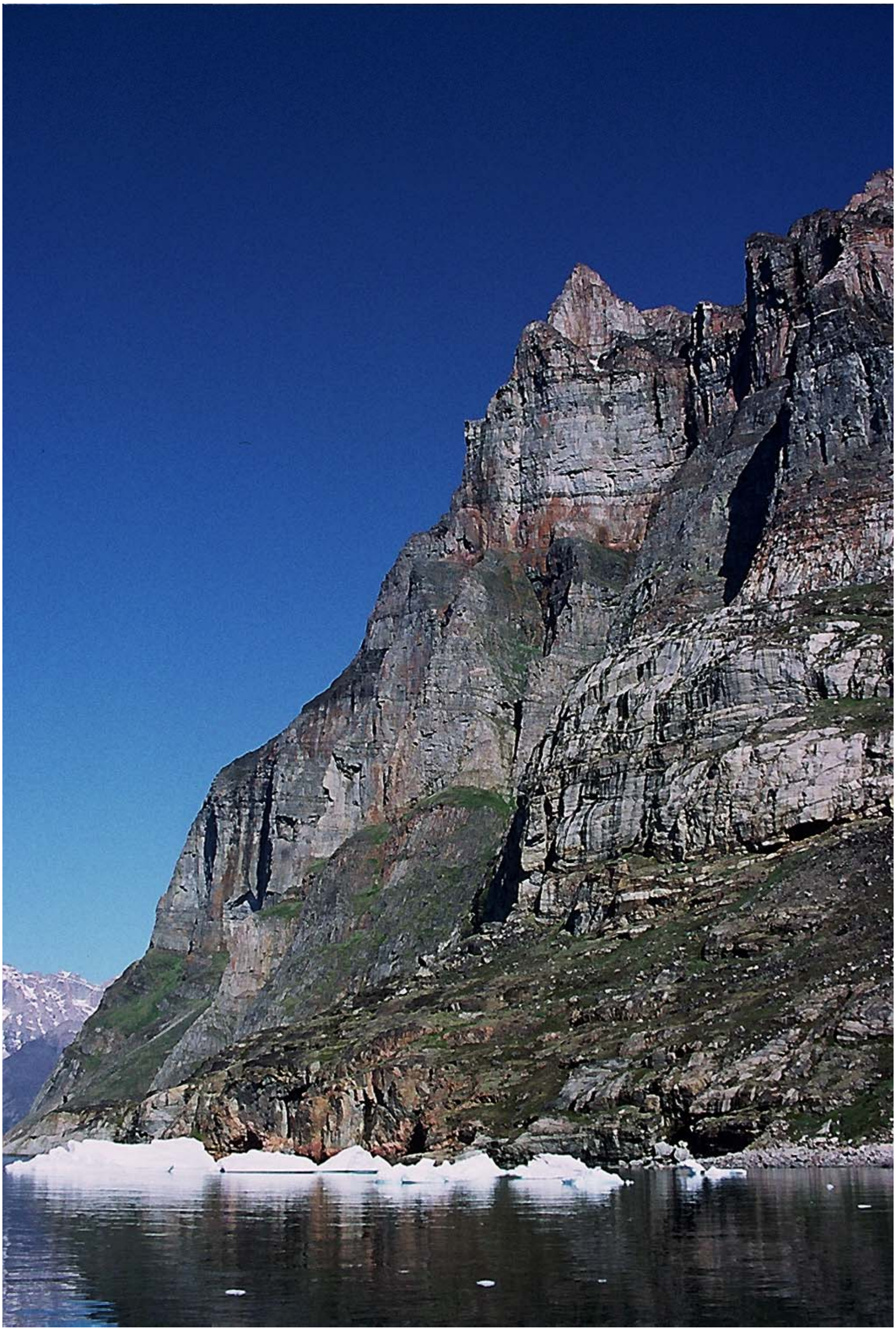
Seabird breeding colony no. 70020, Innartaa. Steep cliff with talus on Hareøen.
Breeding birds include great cormorant and gulls.

Seabird breeding colony no. 70036, Salissaq. Steep cliff on north coast of Nuussuaq peninsula. Breeding birds include black guillemot and perhaps Atlantic puffin.



Seabird breeding colony no. 70101, Salleq. A steep mountain side in Uummannaq Fjord. Formerly a very important breeding site for Brünnich's guillemot. Now the site only holds a large colony of breeding northern fulmars, which nest on narrow ledges on the vertical cliffs.

Seabird breeding colony no. 70121, on southwest side of Nuussuaq peninsula.
Breeding birds include great cormorant, black guillemot and glaucous gull



Seabird breeding colony no. 71015. Appatsiaat in Uummannaq Fjord. These tall cliffs hold a large colony of breeding northern fulmars. Other breeding birds include kittiwake, Iceland gull, black guillemot and razorbill.

Seabird breeding colony no. 71024. Uiffaq in the fjord Kangerlussuaq. Breeding birds include black guillemots and Iceland gulls.

Seabird breeding colony no. 71025, Qalattoq in the fjord Inukassaat. Breeding birds include kittiwake, Iceland gull, glaucous gull and black guillemot.

Seabird breeding colony no. 71026, Paakassaa. A steep cliff in the fjord Inukassaat.
Breeding birds include razorbill, black guillemot and Iceland gull.

Seabird breeding colony no. 71064, Sigguk/Svartenhuk on the west coast of Svartenhuk peninsula. Breeding birds include Atlantic puffin, razorbill, black guillemot, glaucous gull and great cormorant.

Photos from archaeological sites in West Greenland

Figure 1. The remains of a winterhouse very near the coast.

Figure 2. Endangered paleo-eskimo (Dorset) dwellings, Disko Bay.

Figure 3. Settlement-area from the Thule-period. Disko Bay.

Figure 4. Stone-and-turf winterhouse slowly sliding into the sea. Disko Bay.

Figure 5. Stone-and-turf winterhuse from the Thule-culture sliding slowy towards the sea.

Figure 6. Settlement-area with the most recent turfhouses still clearly visible.

Figure 7. Large winterhouse, with one wall still left.

Figure 8. Exposed midden layers covering almost 4.500 years of the past.

Figure 9. Coastal erosion on site with archaeological remains from several millennia.

Figure 10. Accelerated coastal erosion of very old midden remains due to modern activities.

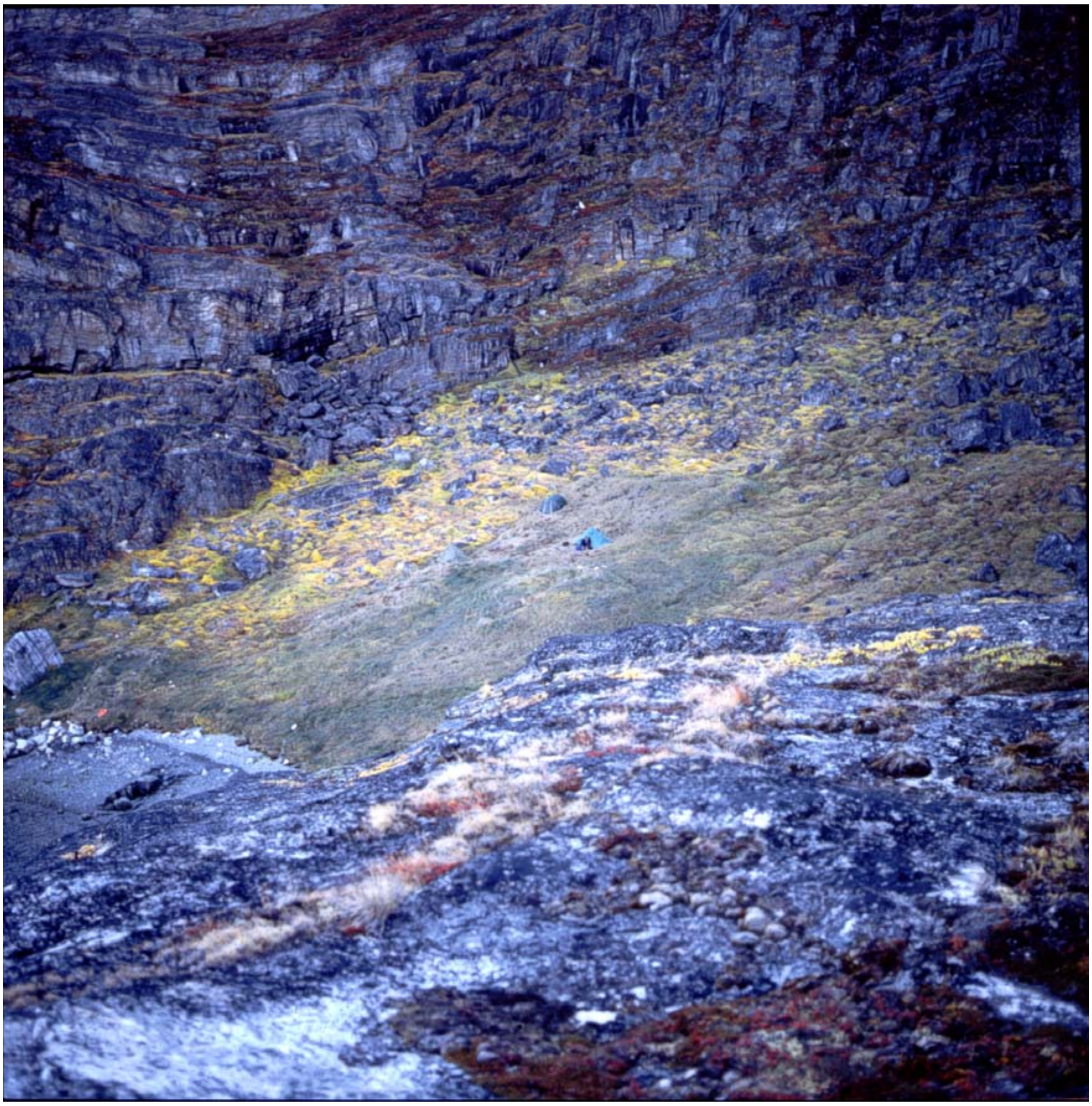
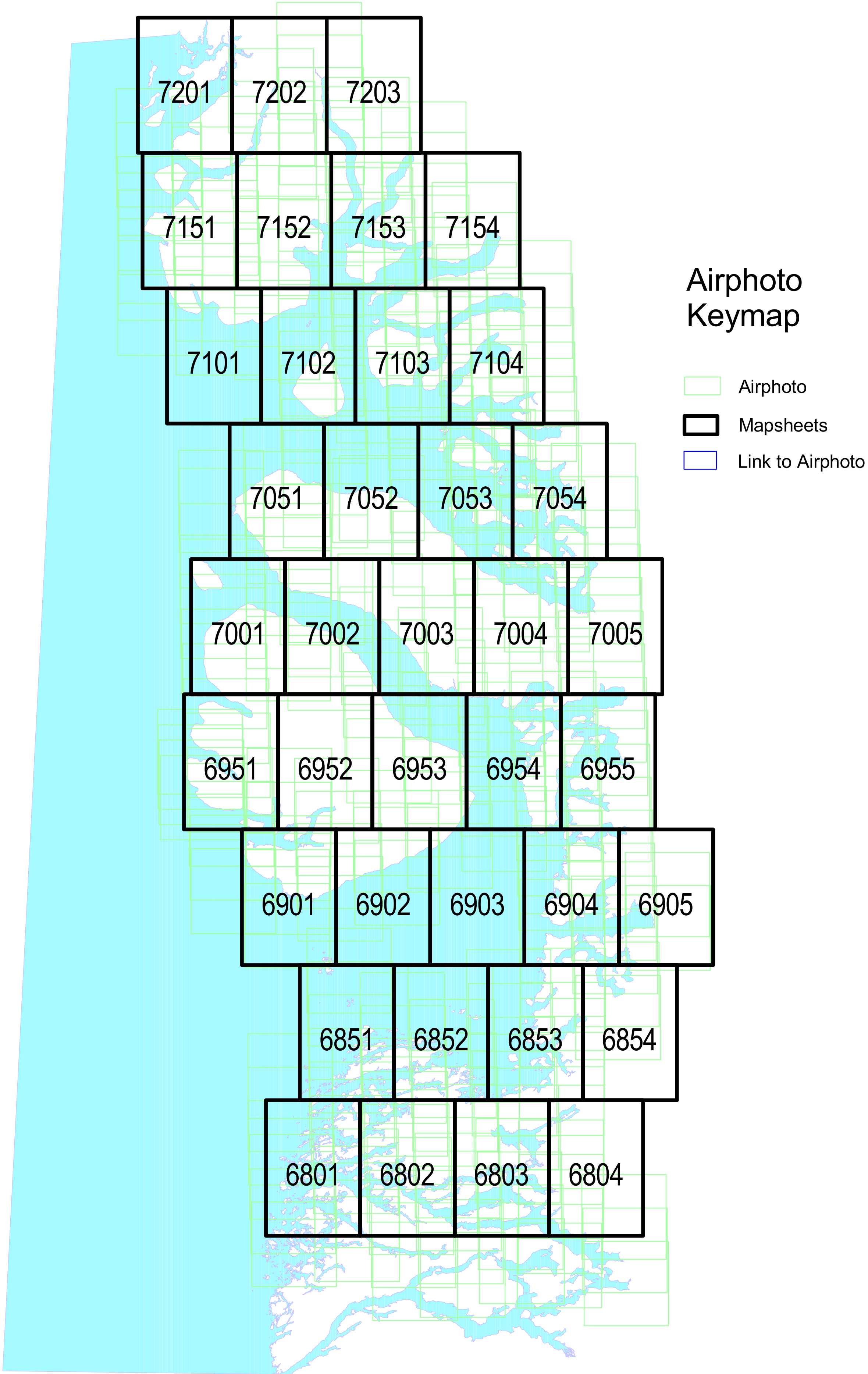


Figure 11. Grass-covered settlement area from 15th Century.

Figure 12. Strong wind erosion has exposed a paleo-eskimo site.

Figure 13. Remains of a large communal winter house.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Airphoto Keymap
Airphoto
Mapsheets
Link to Airphoto

Approximate scale 0 2 4 6 8 10 km

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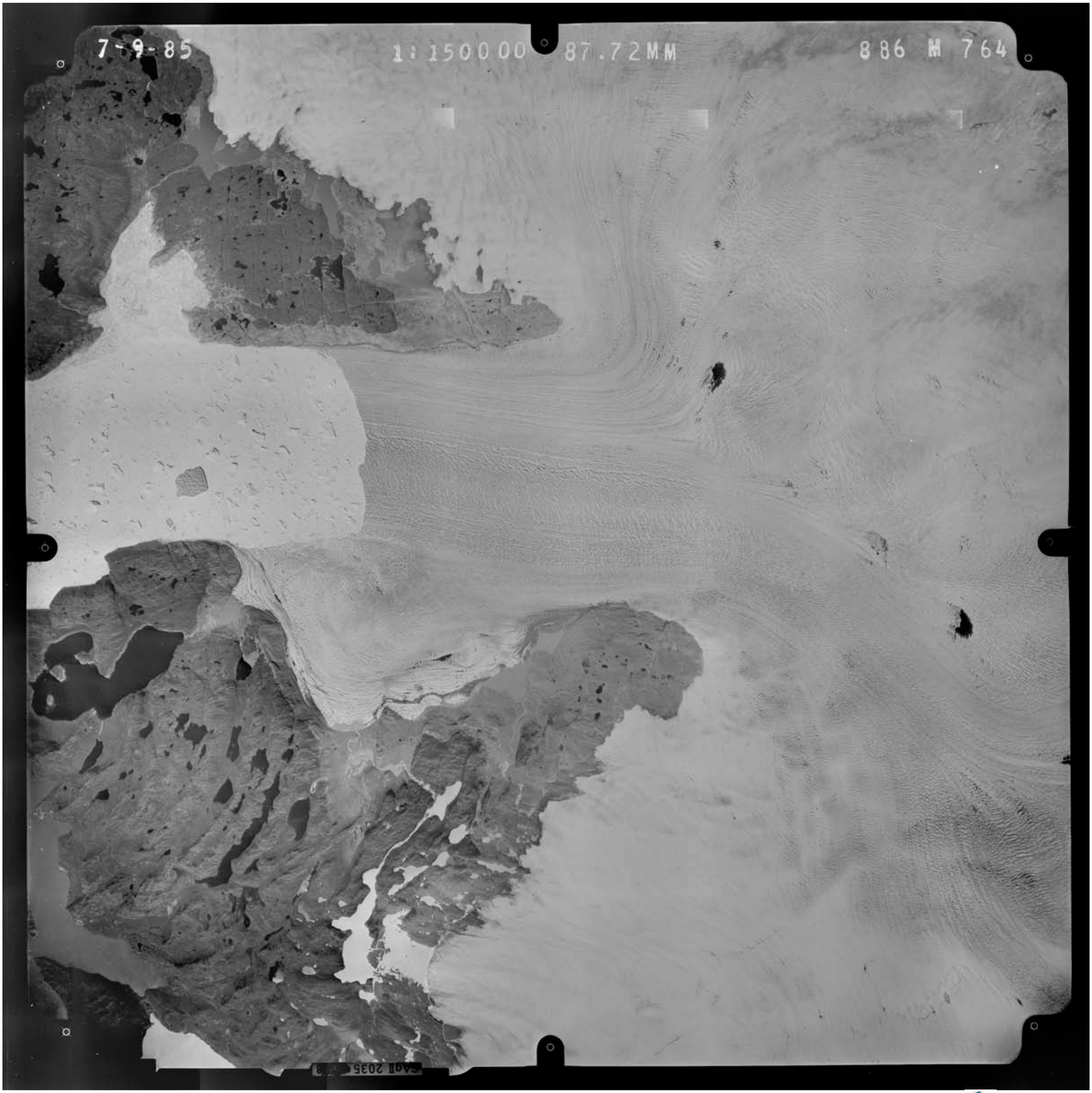

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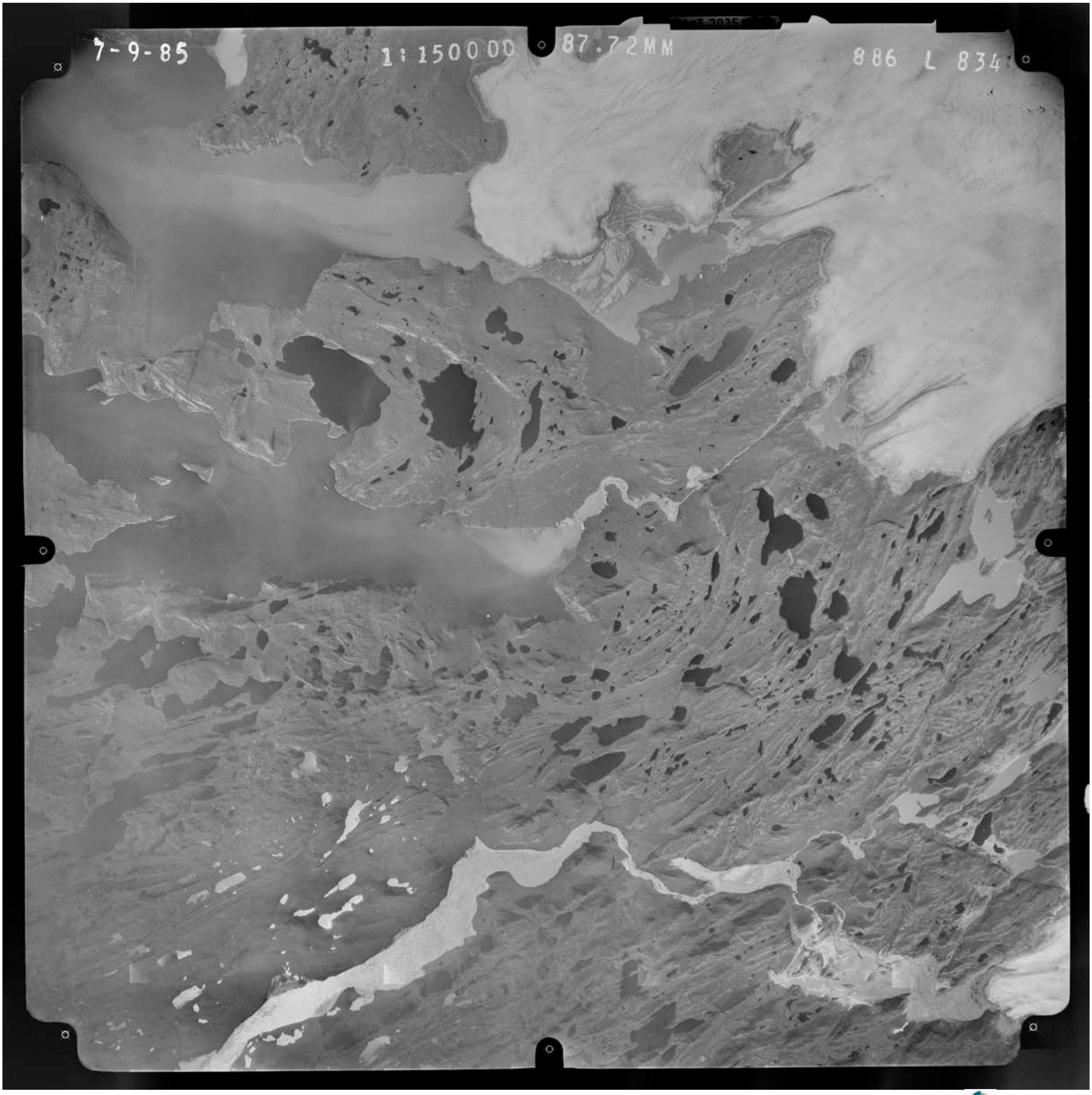

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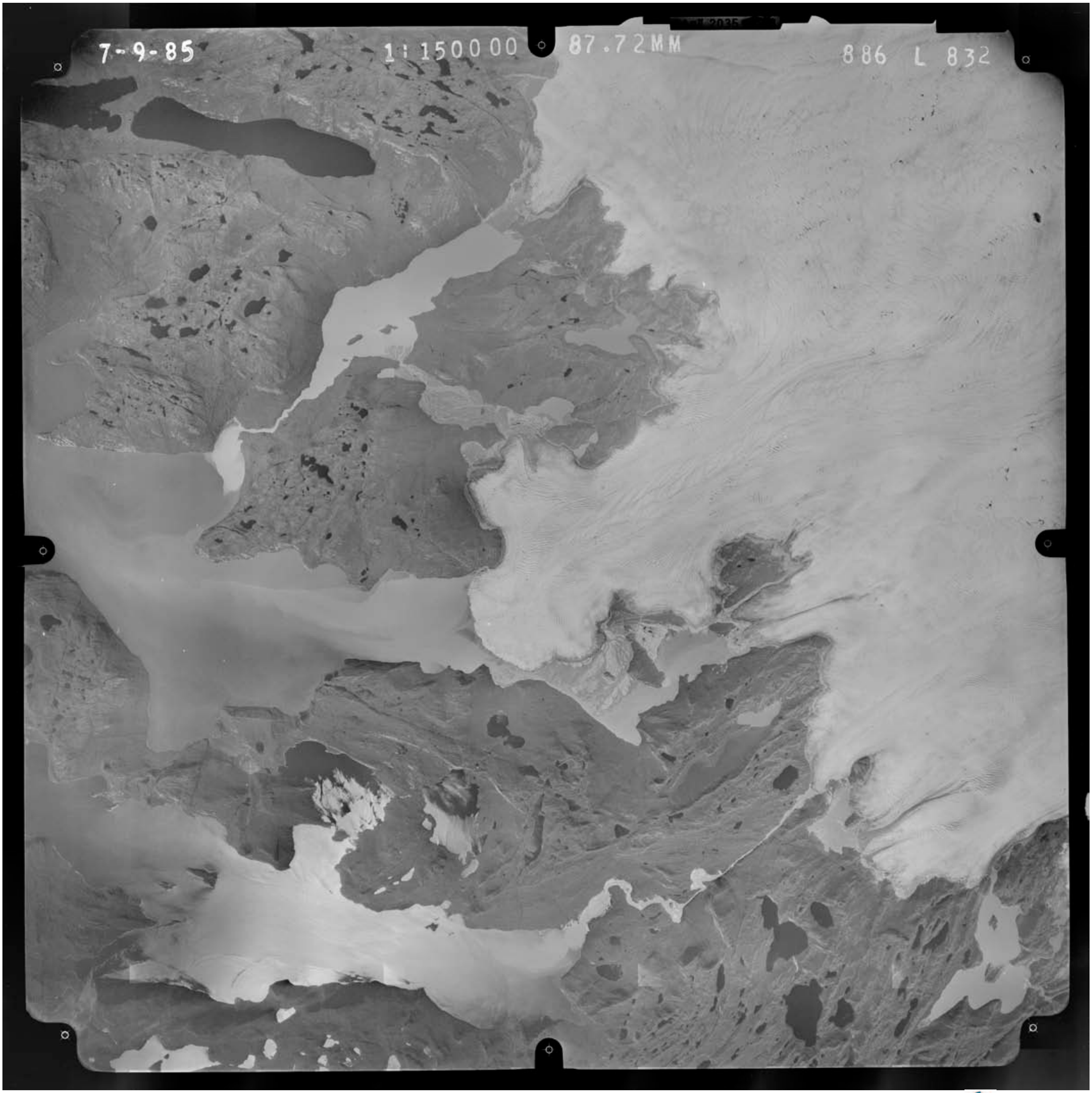

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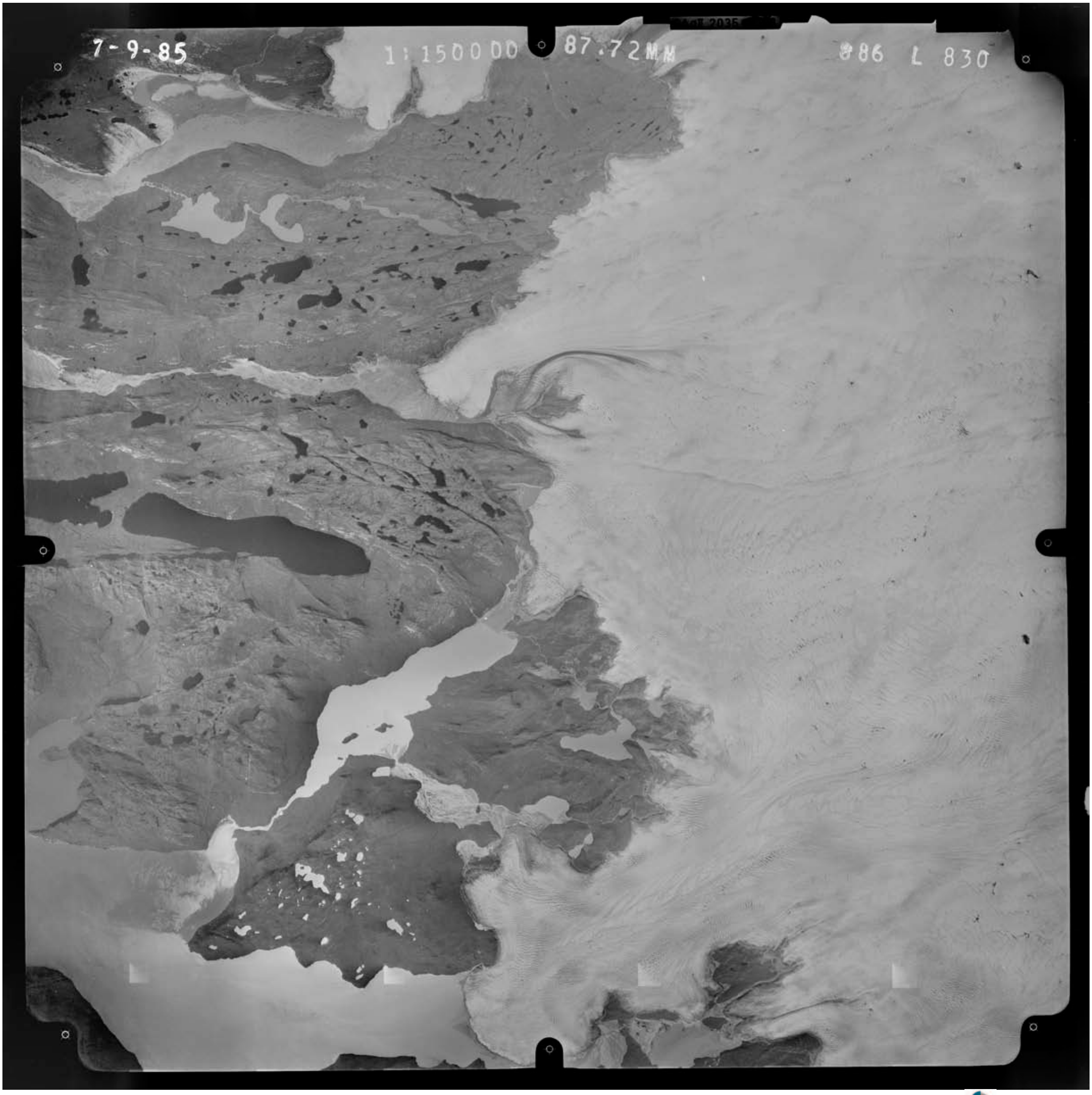

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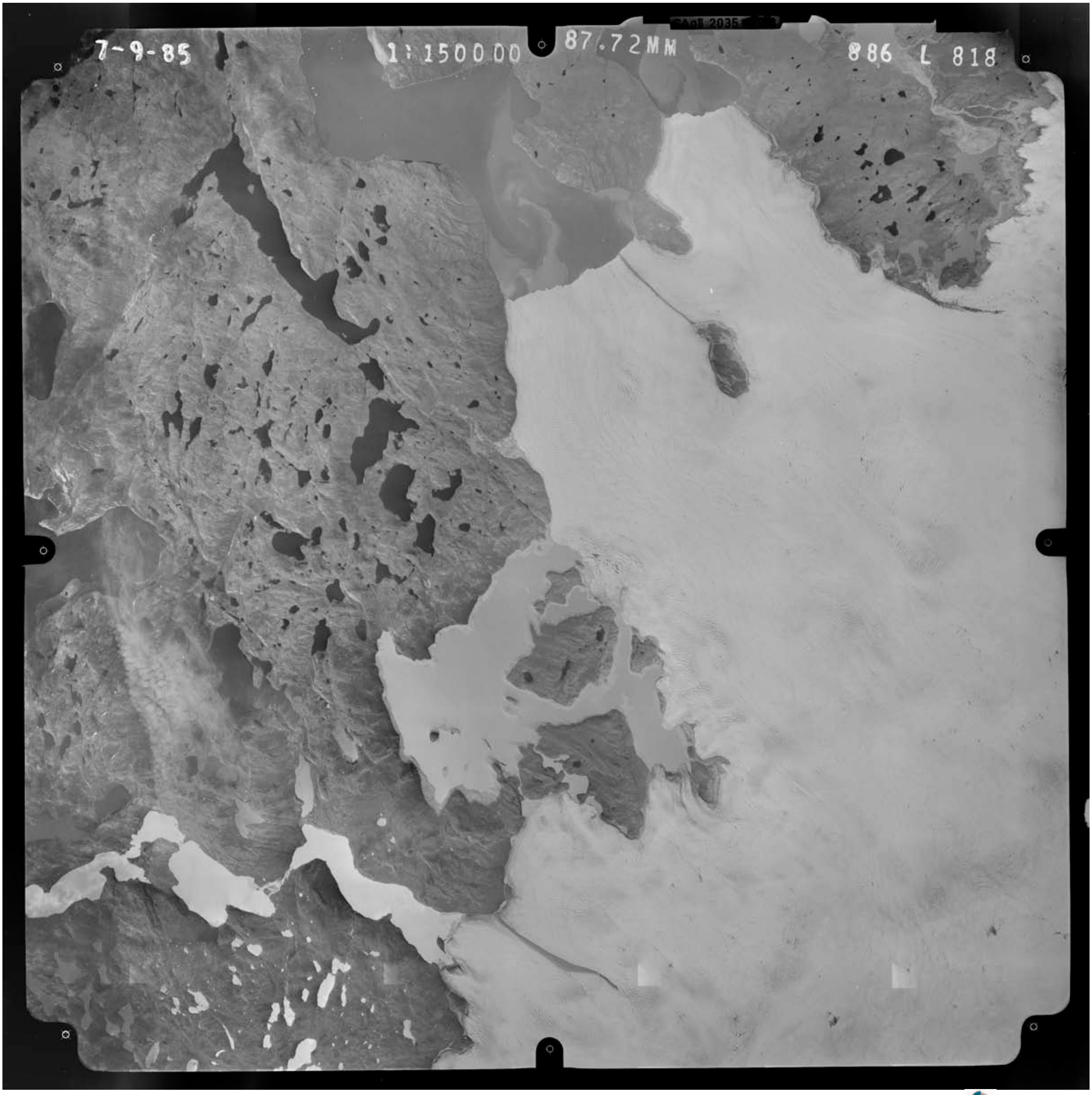

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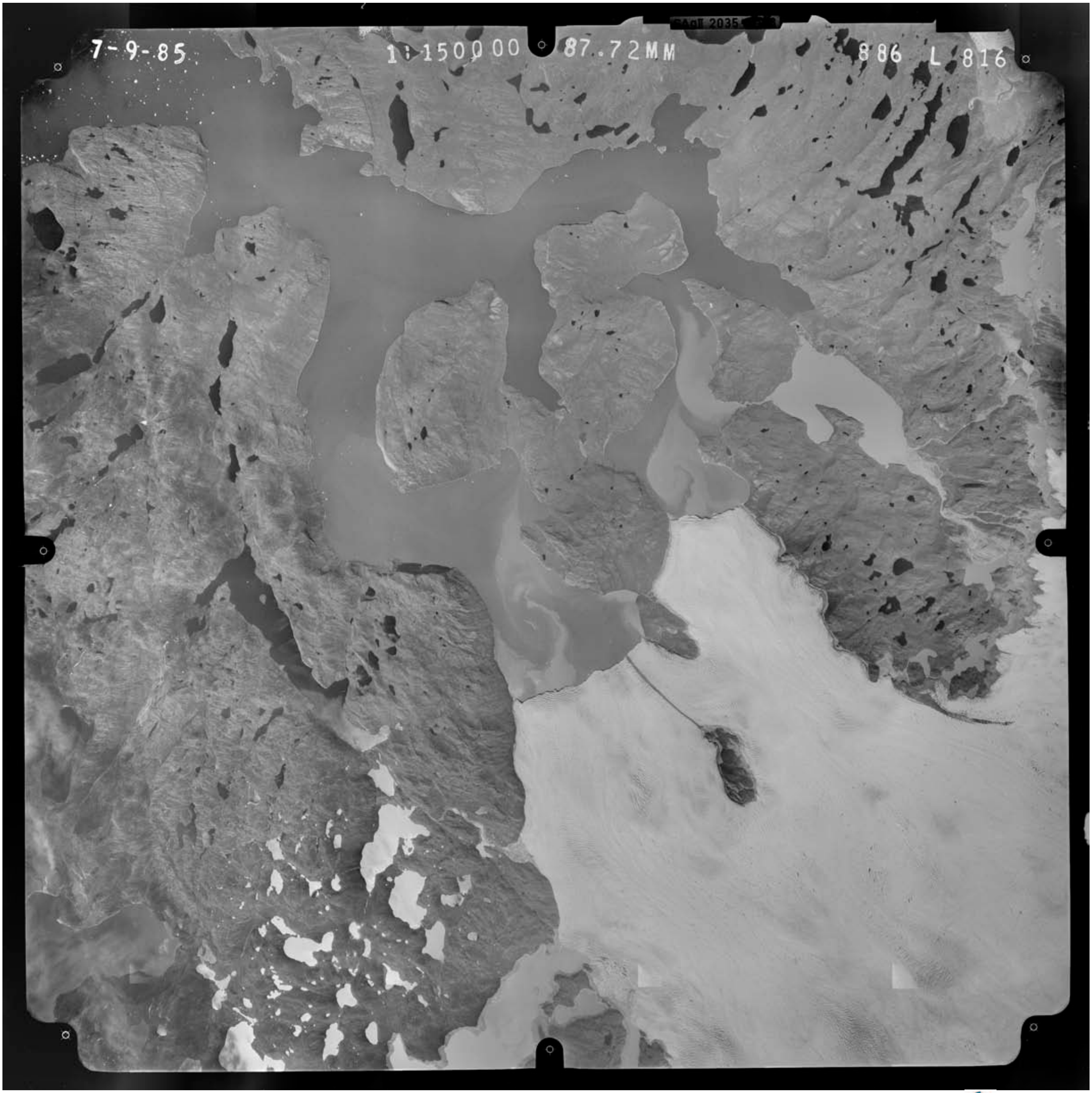

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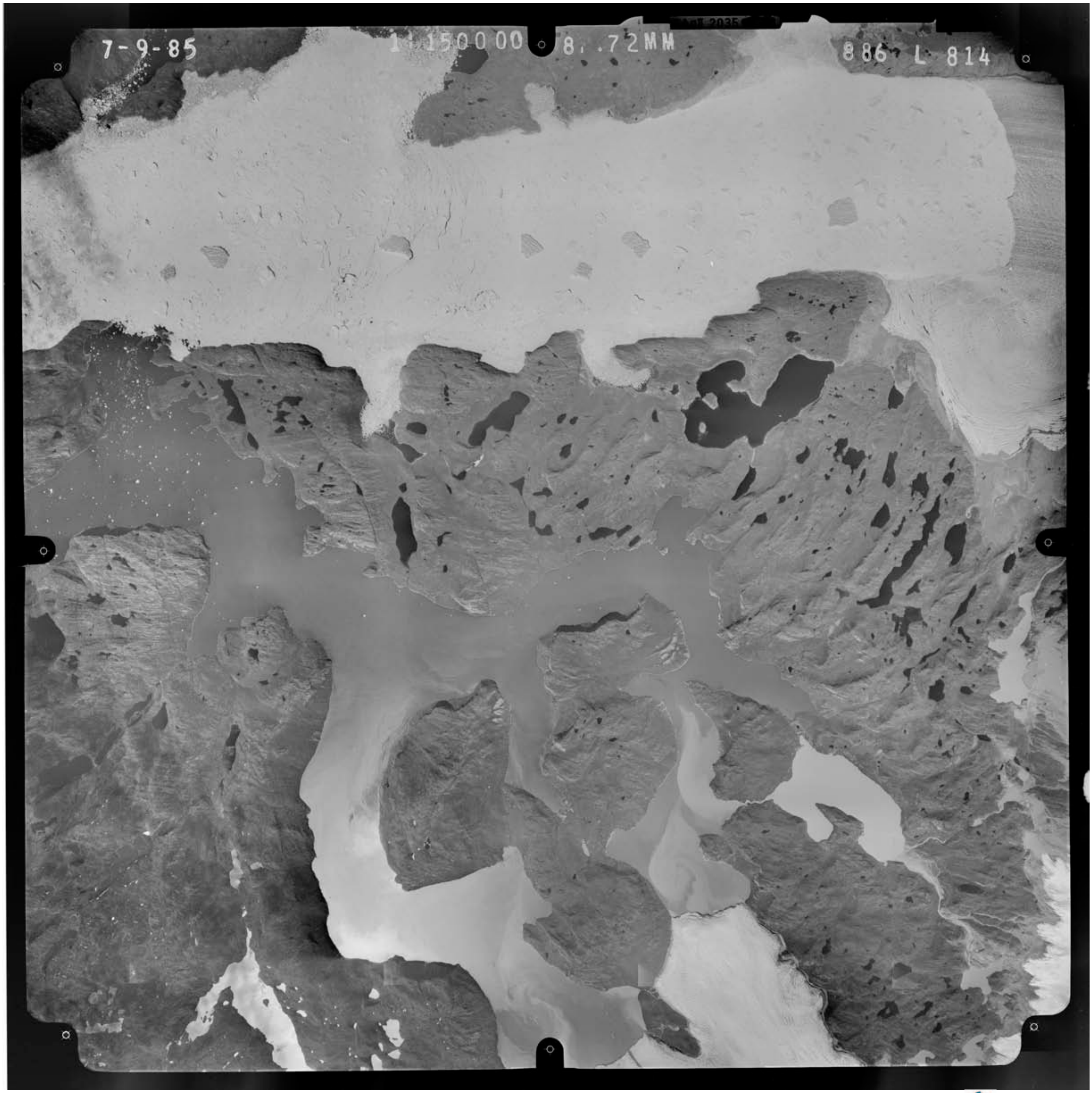

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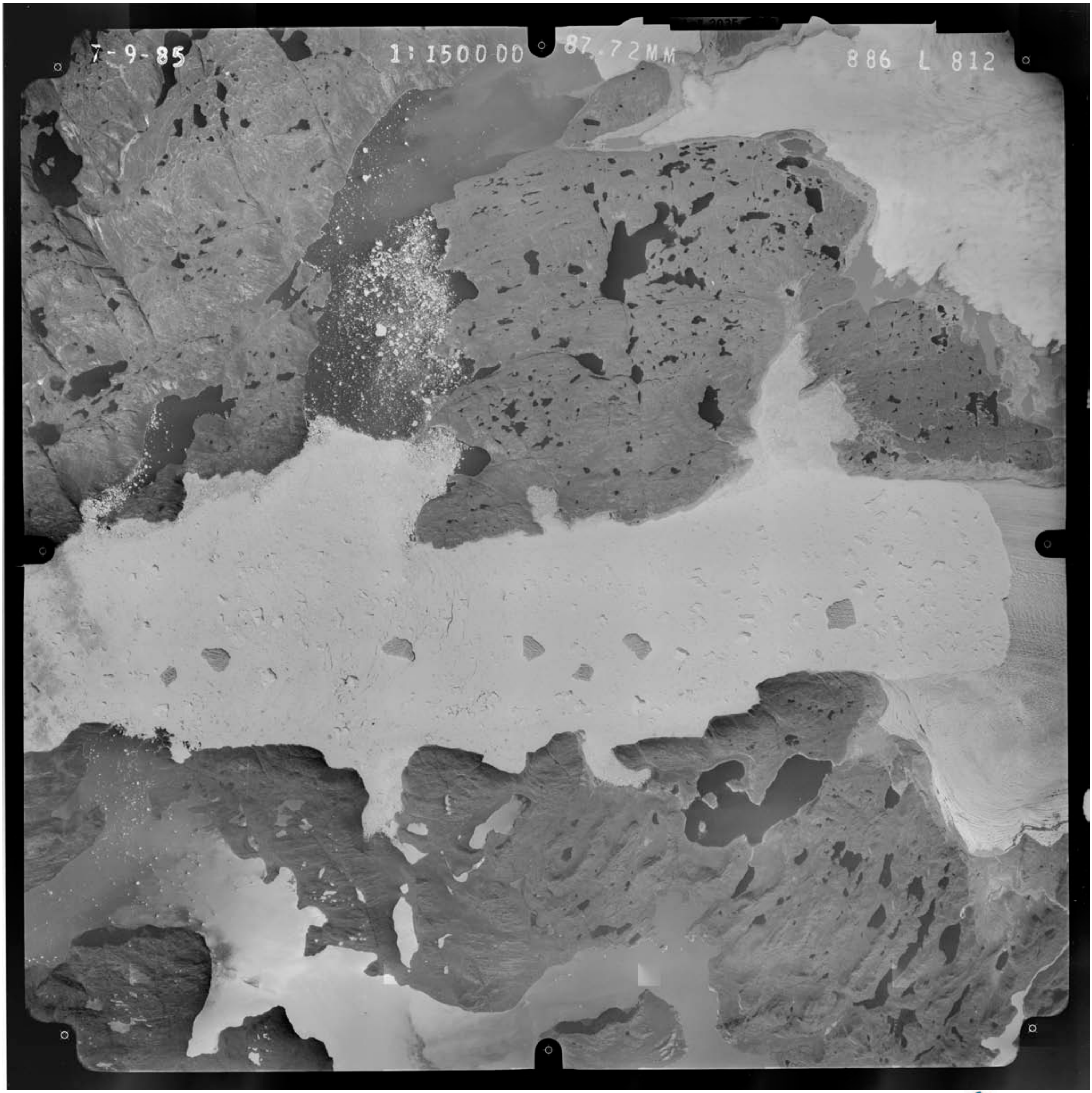

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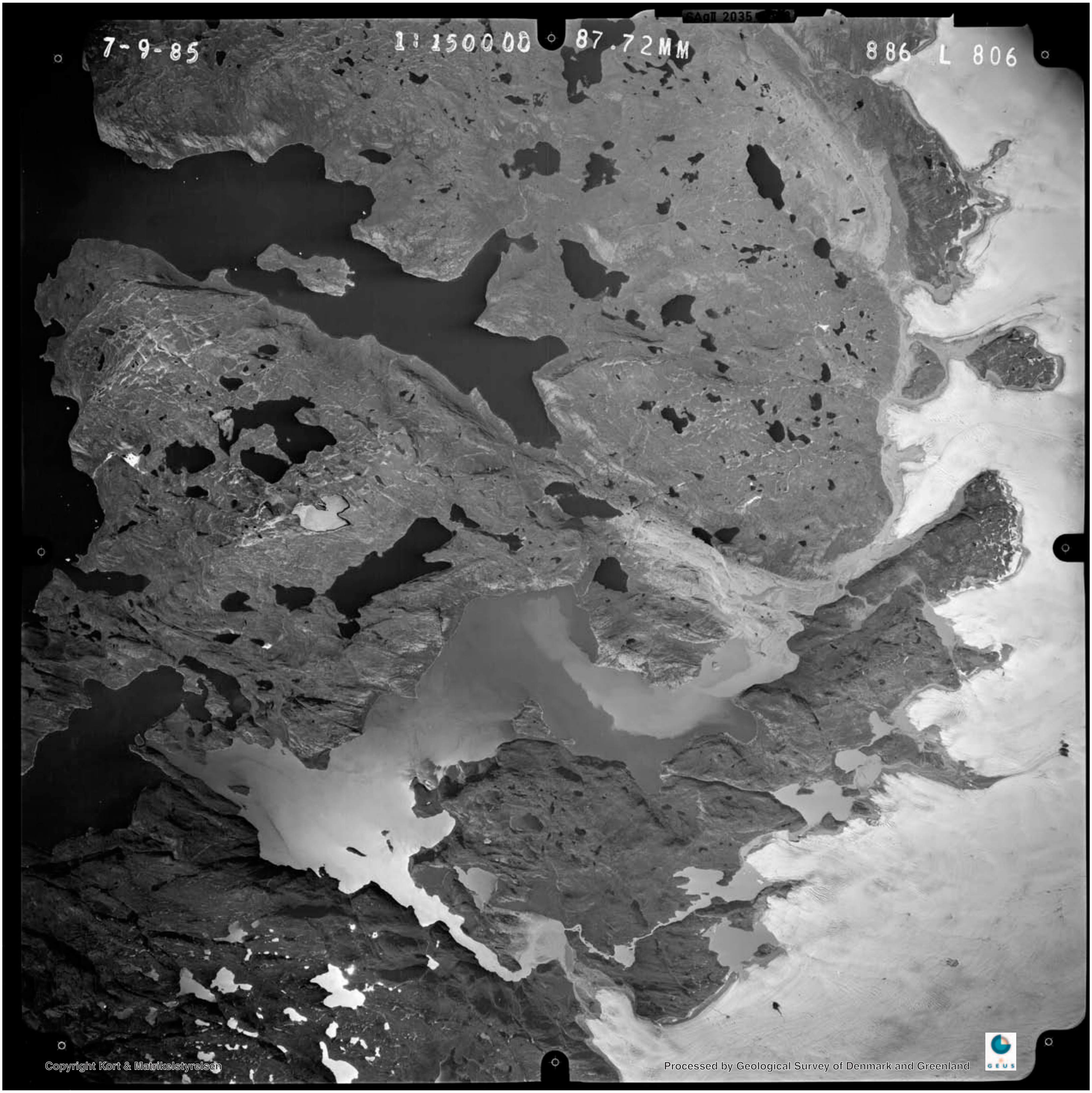

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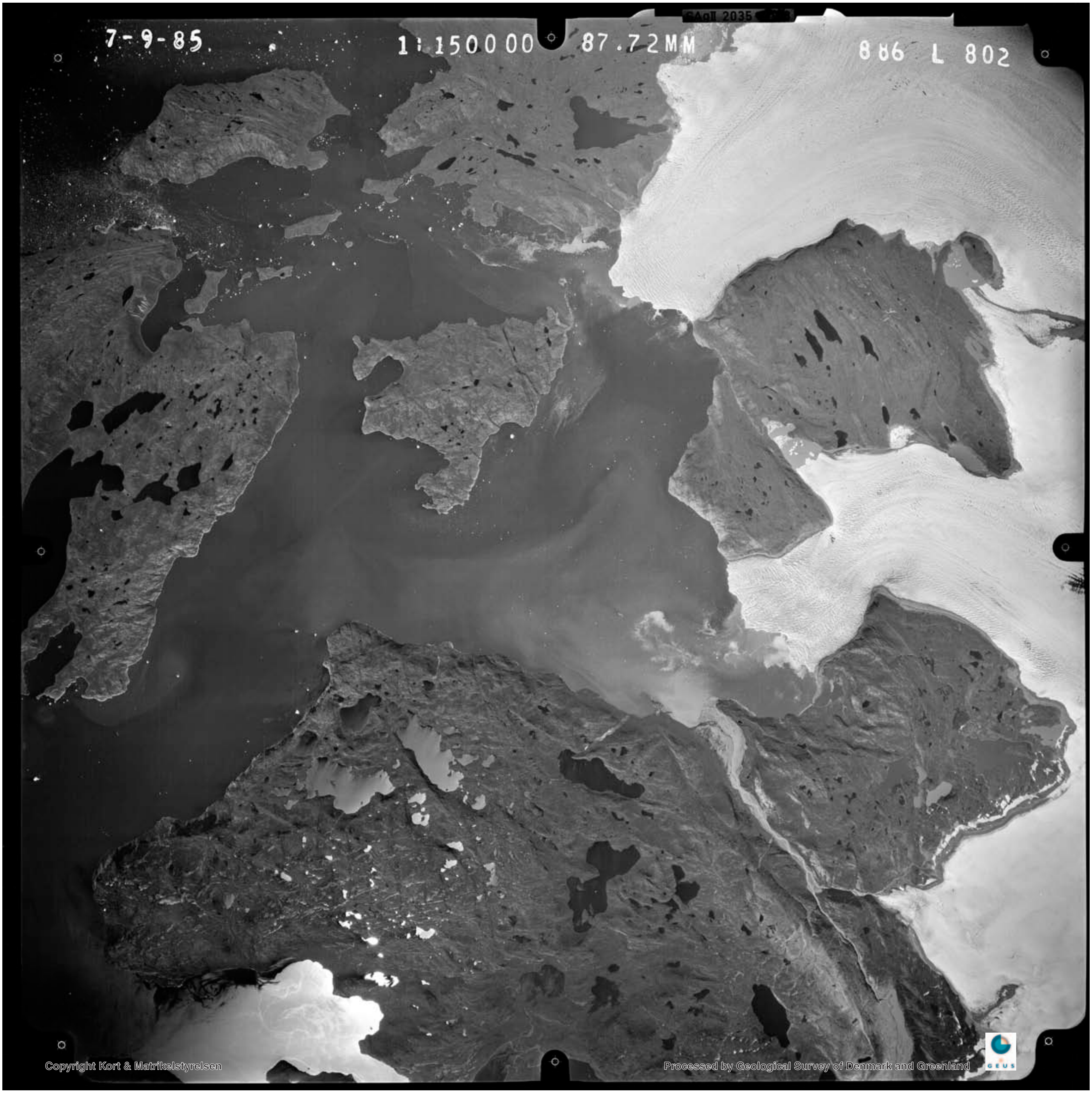

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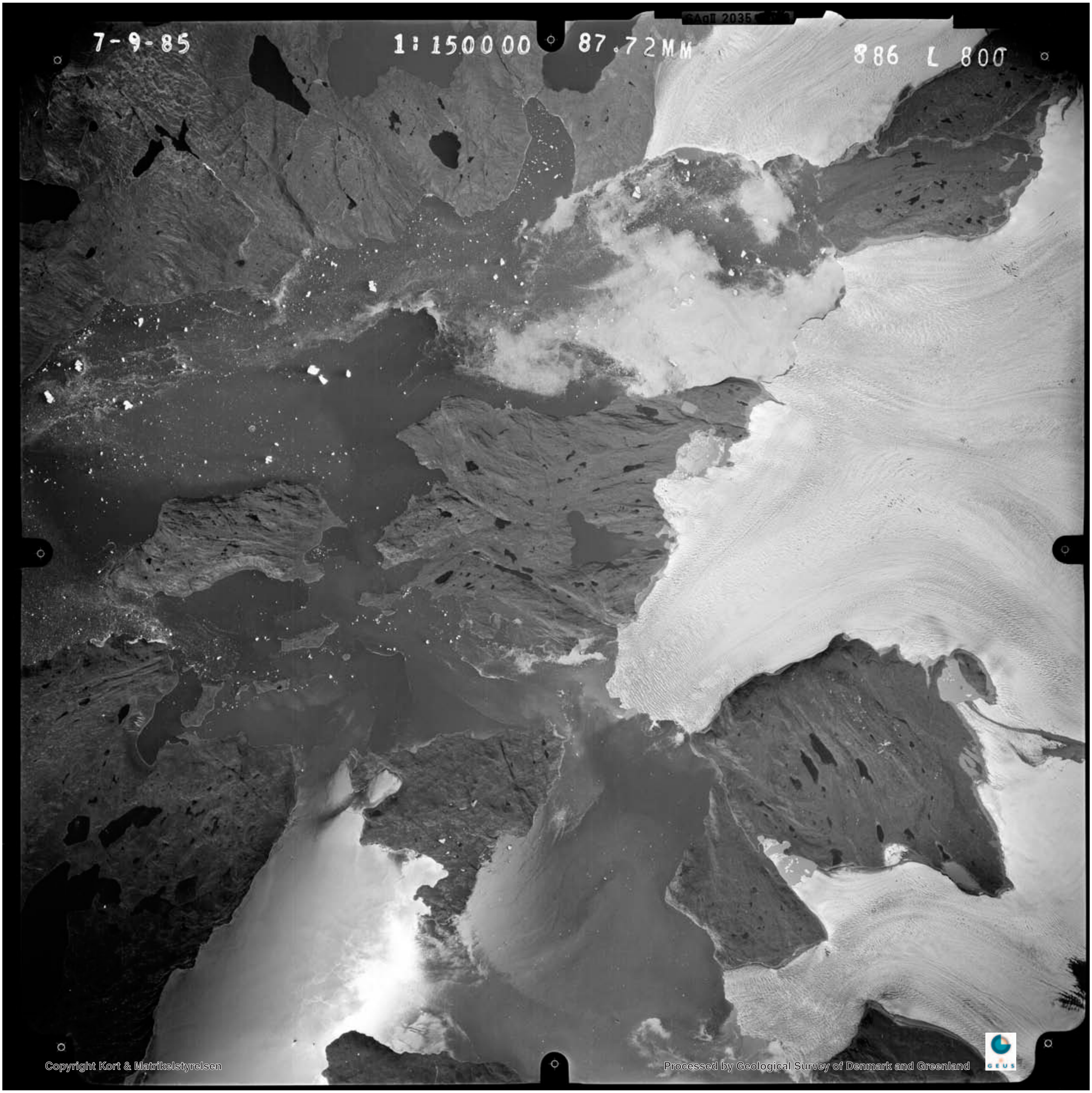

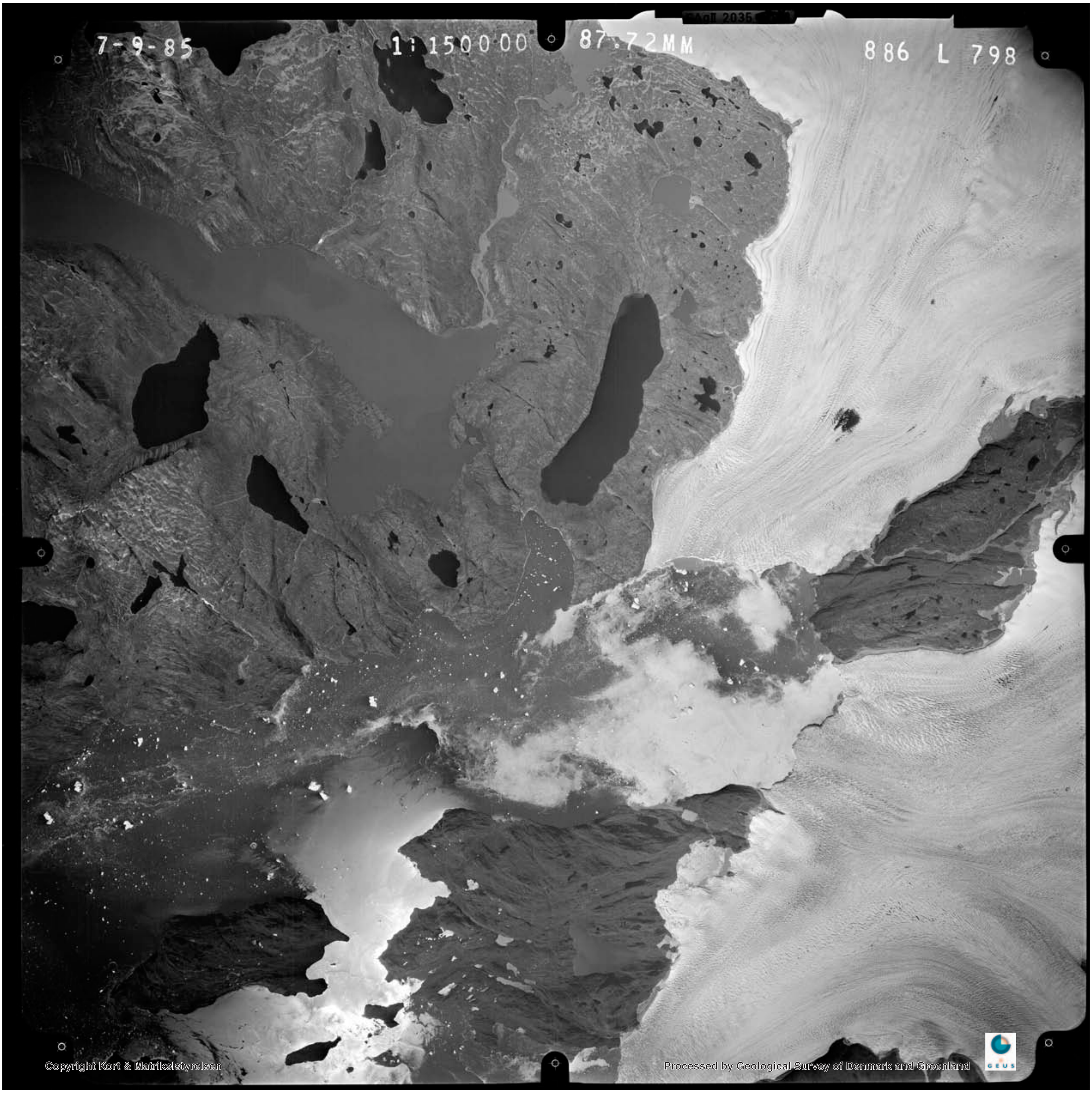
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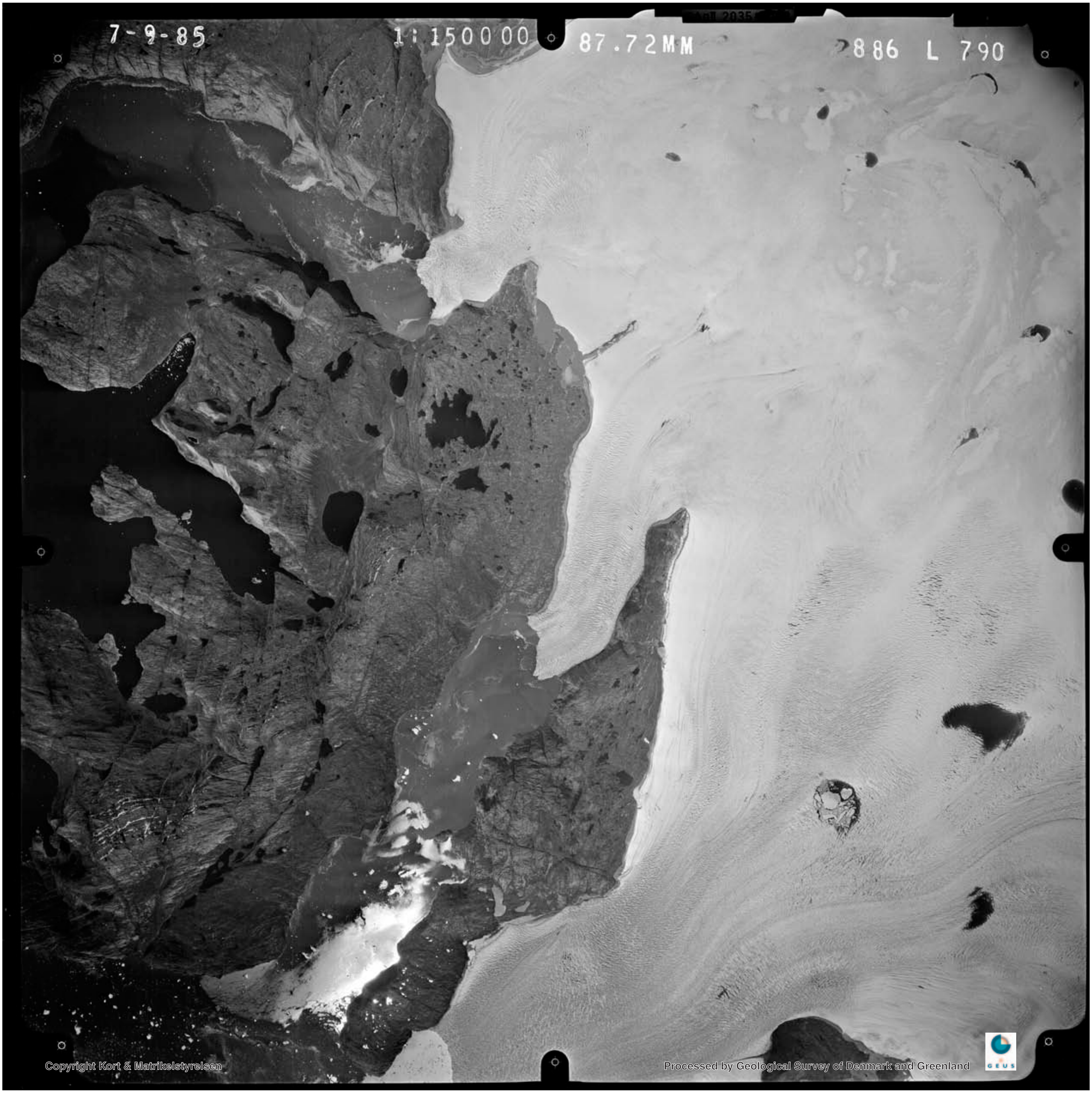

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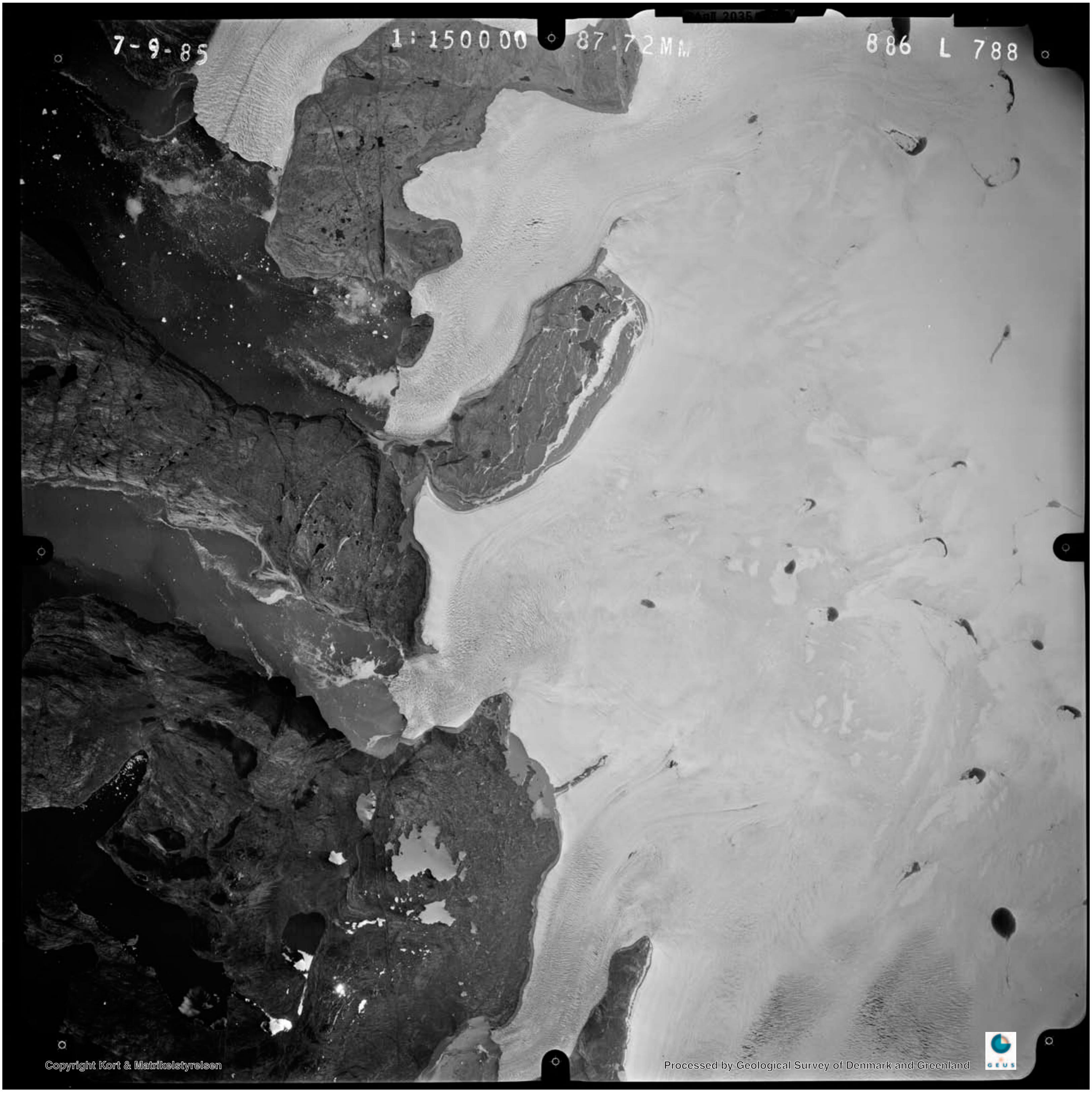

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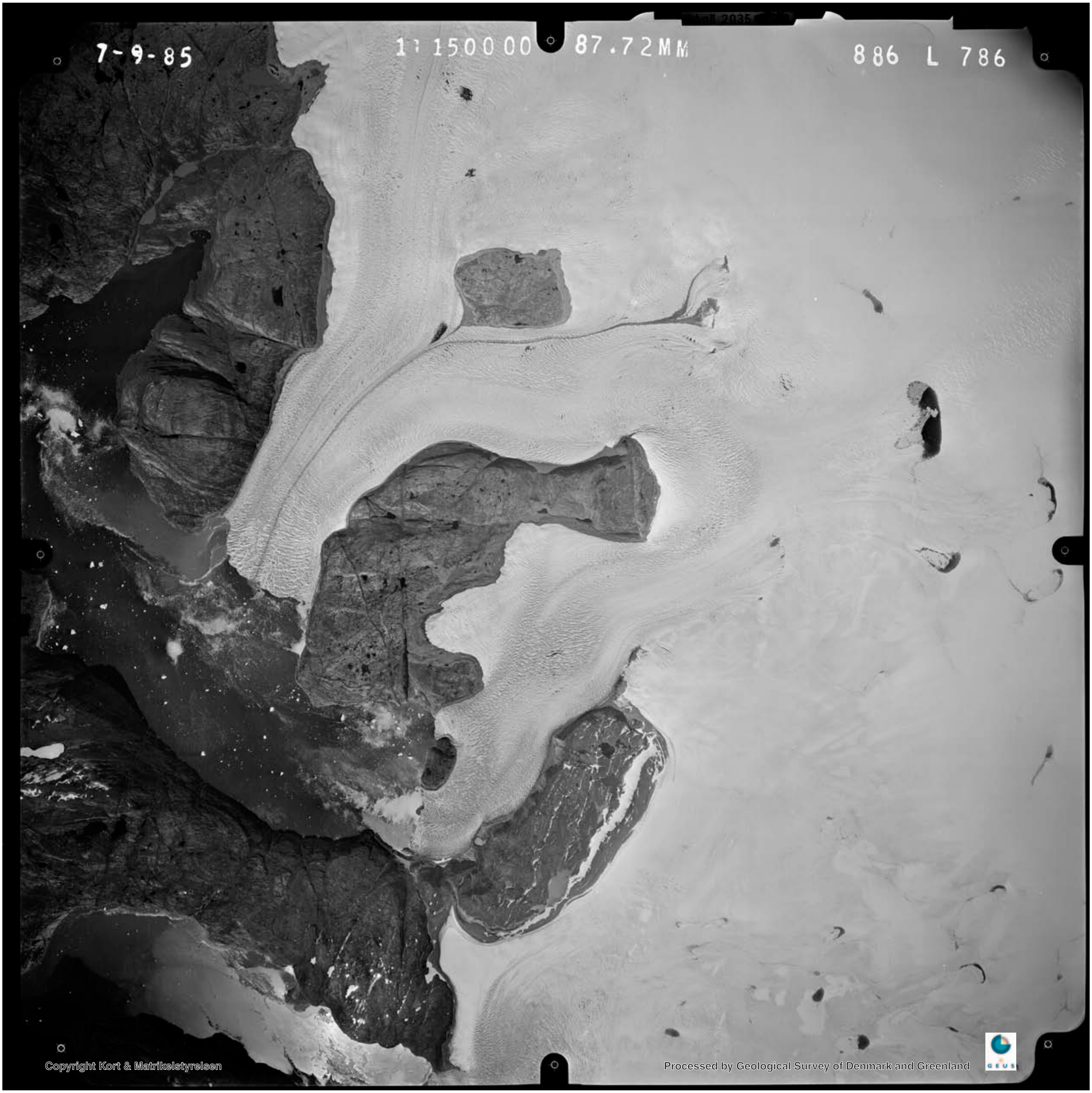

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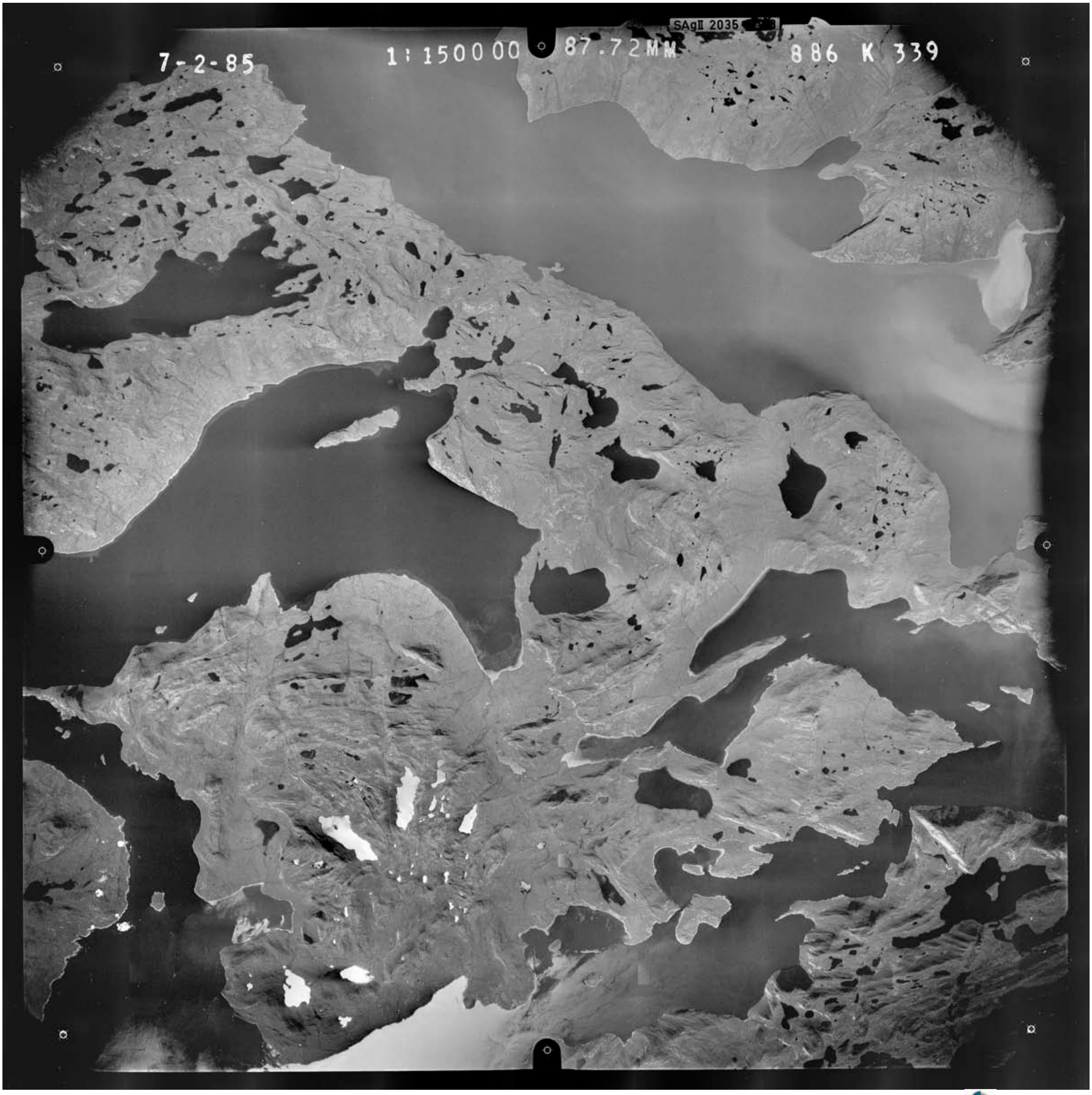

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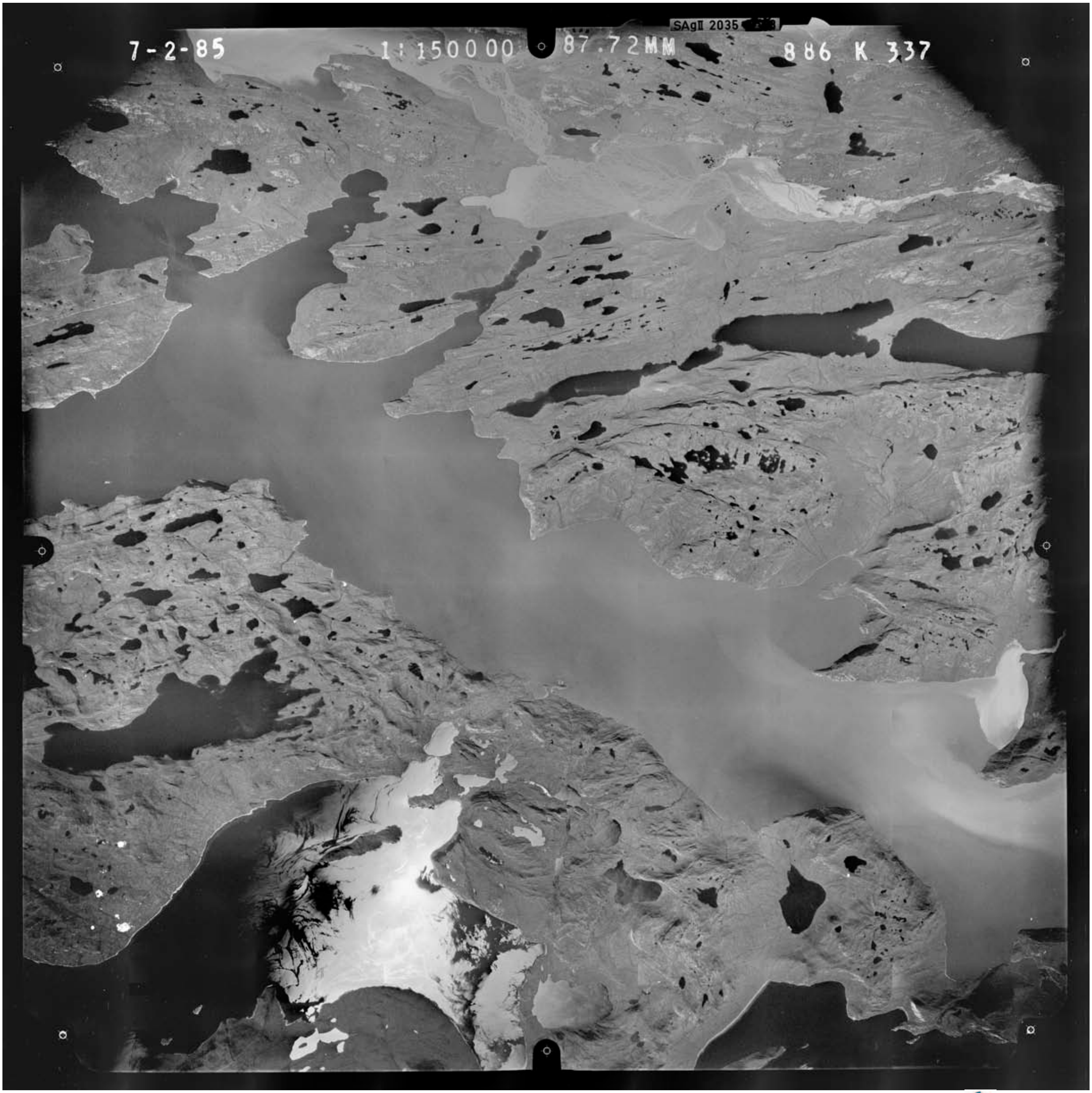

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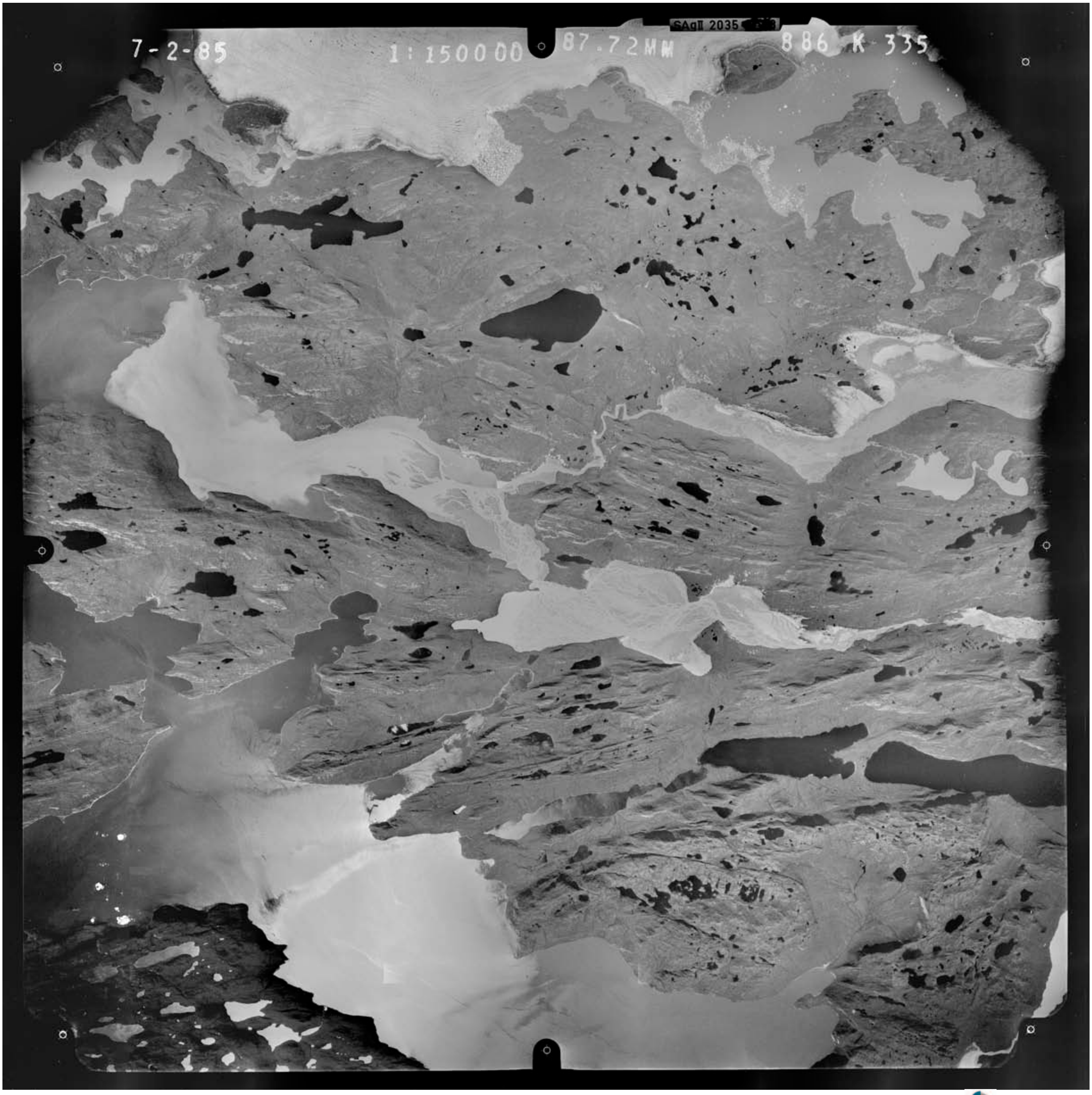

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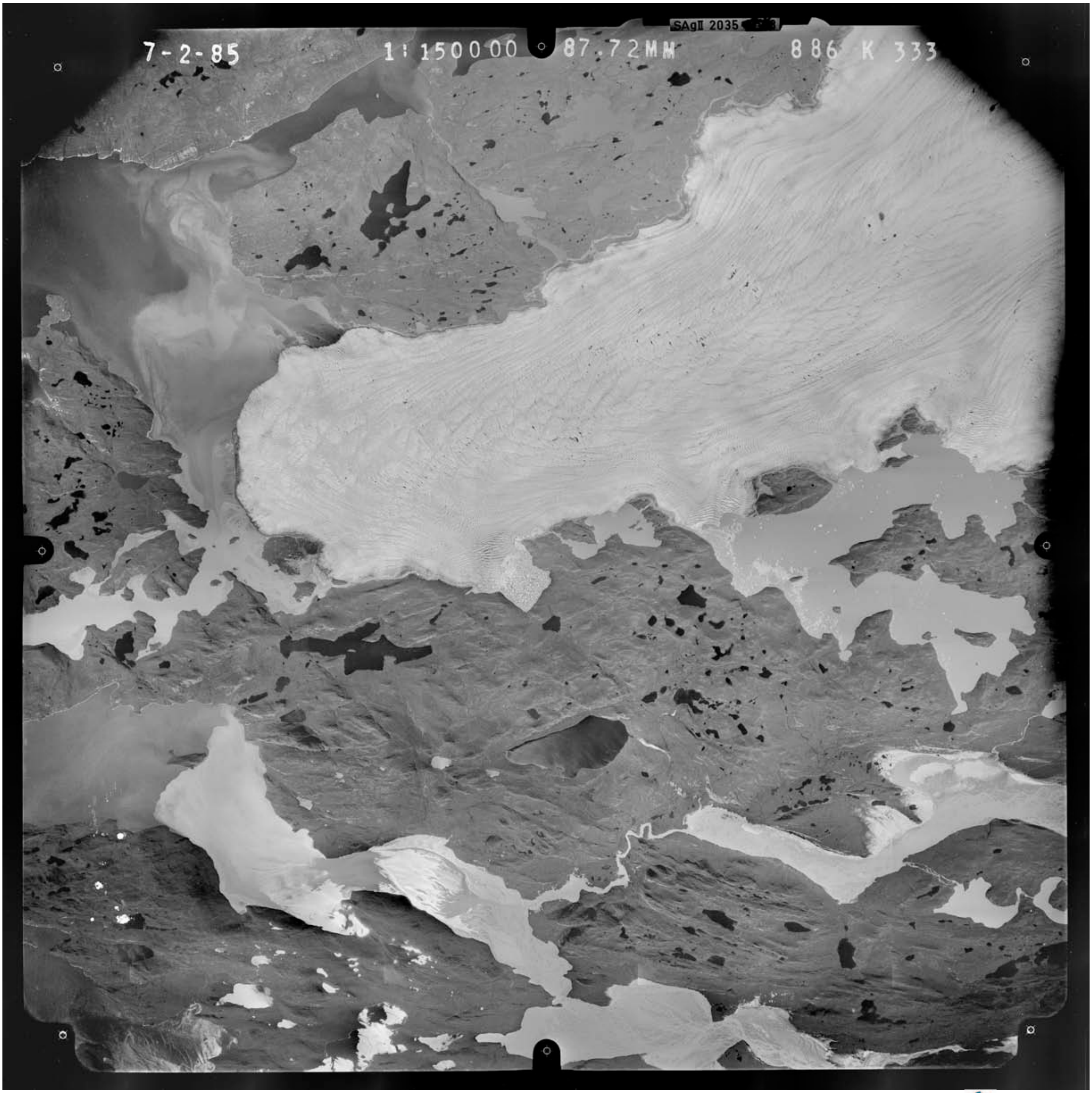

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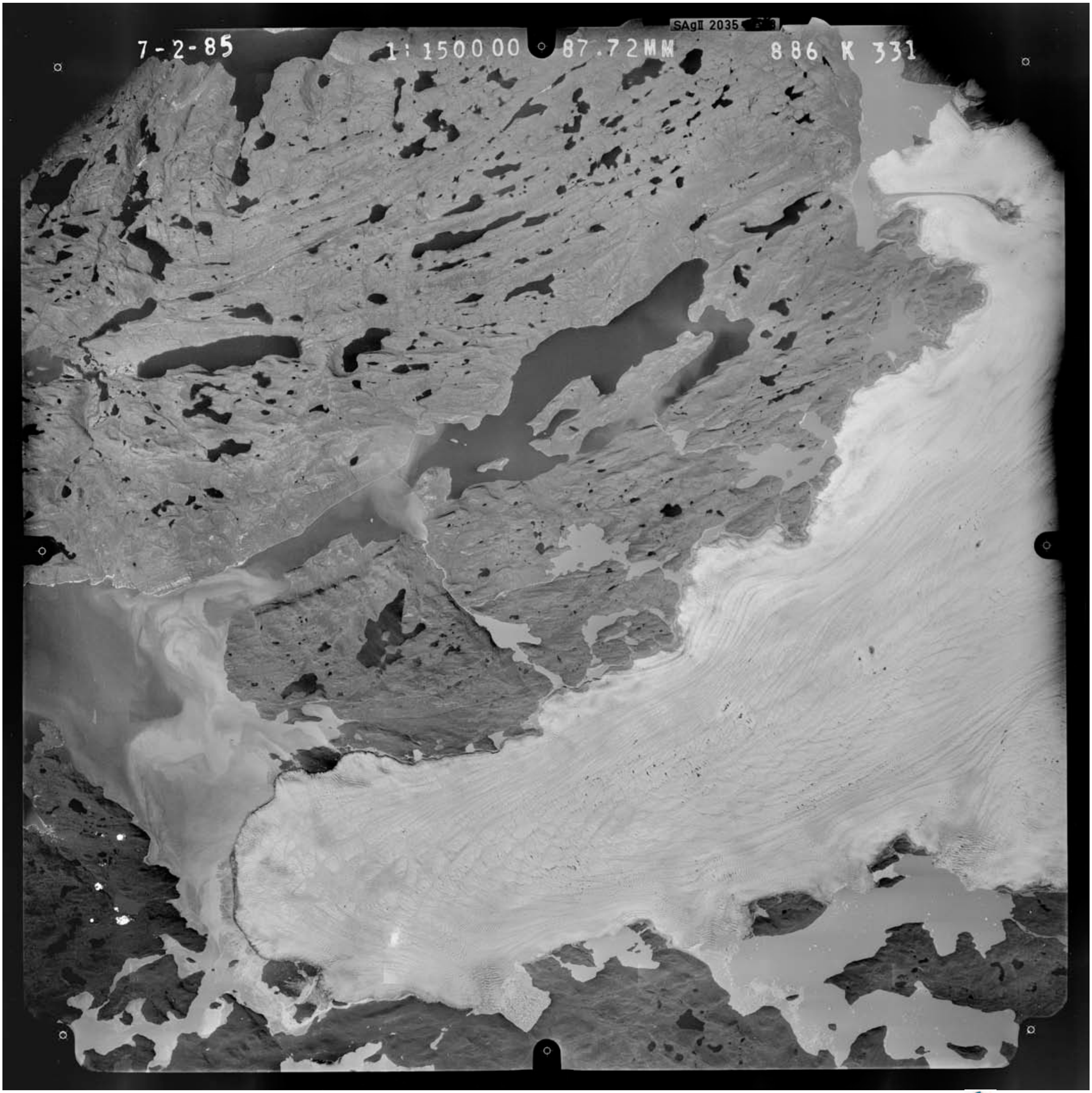

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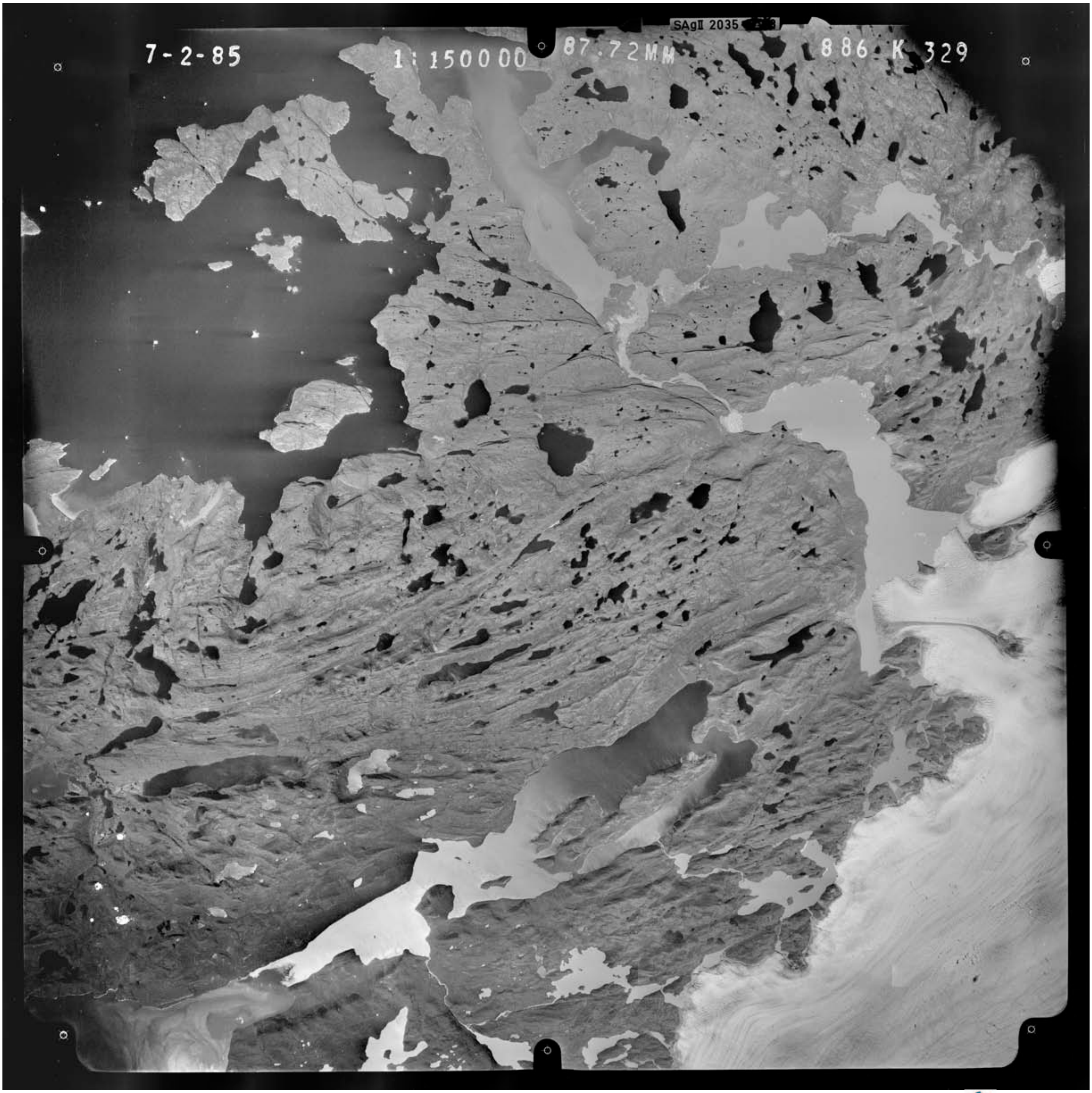

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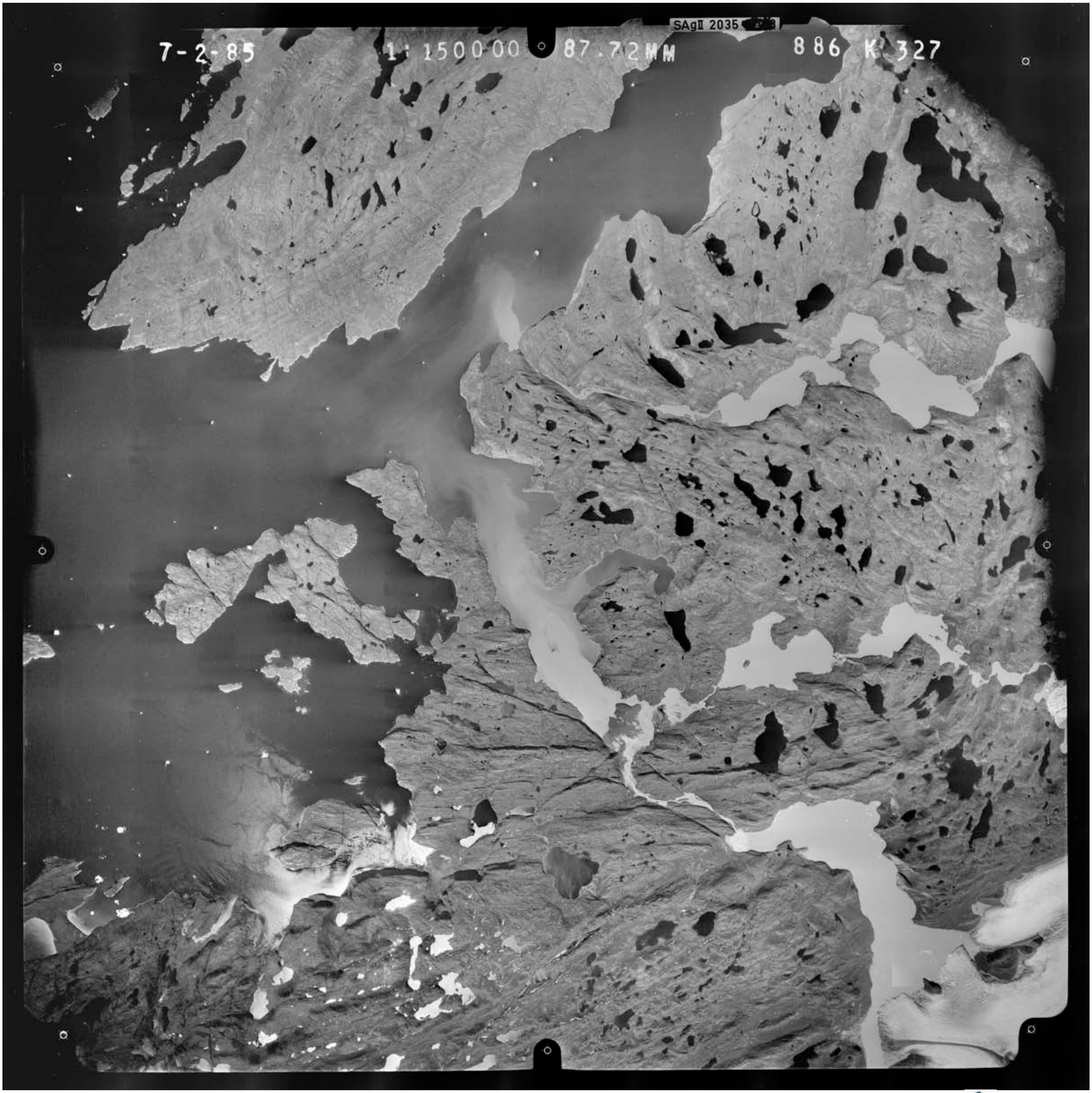

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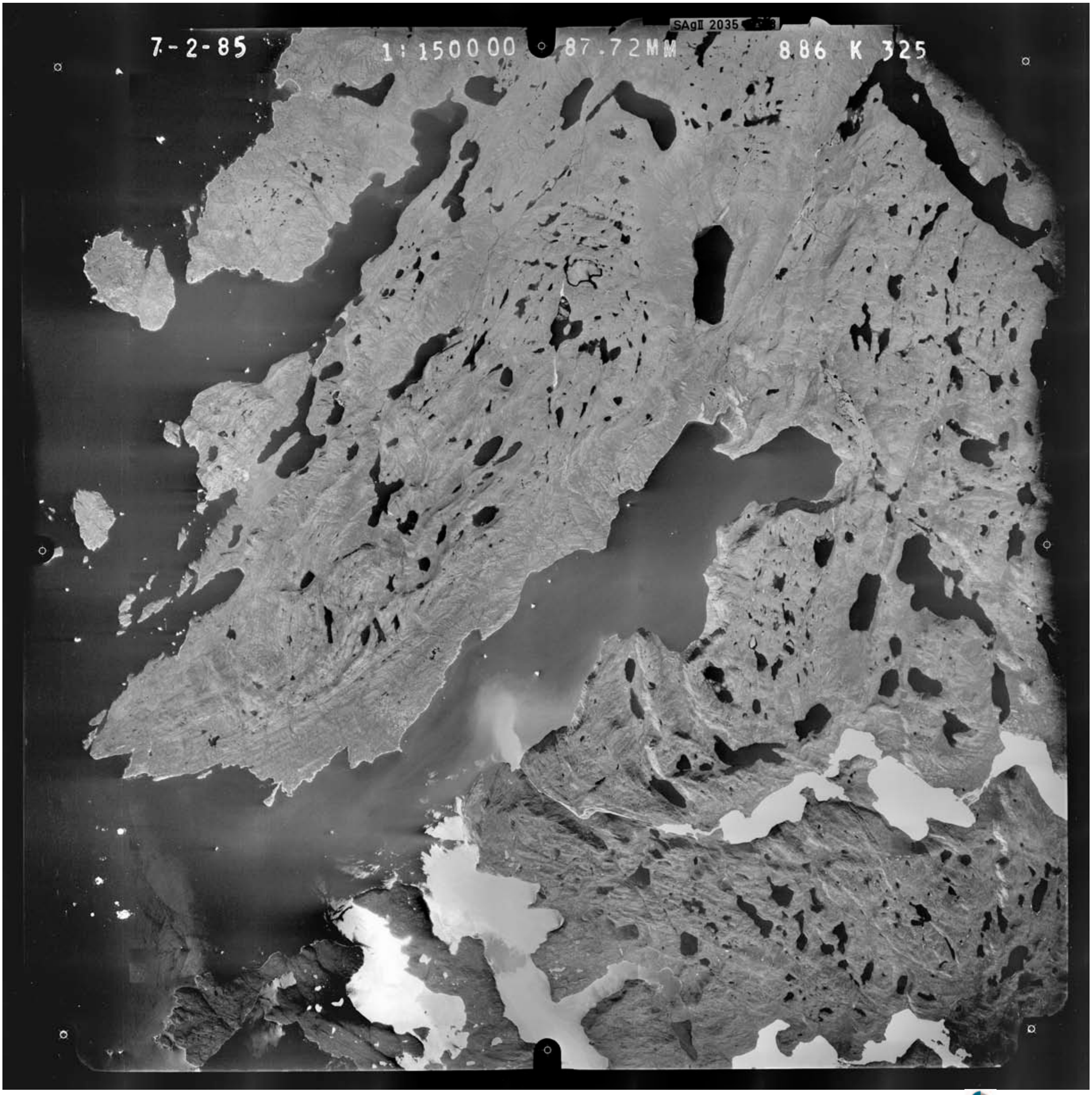

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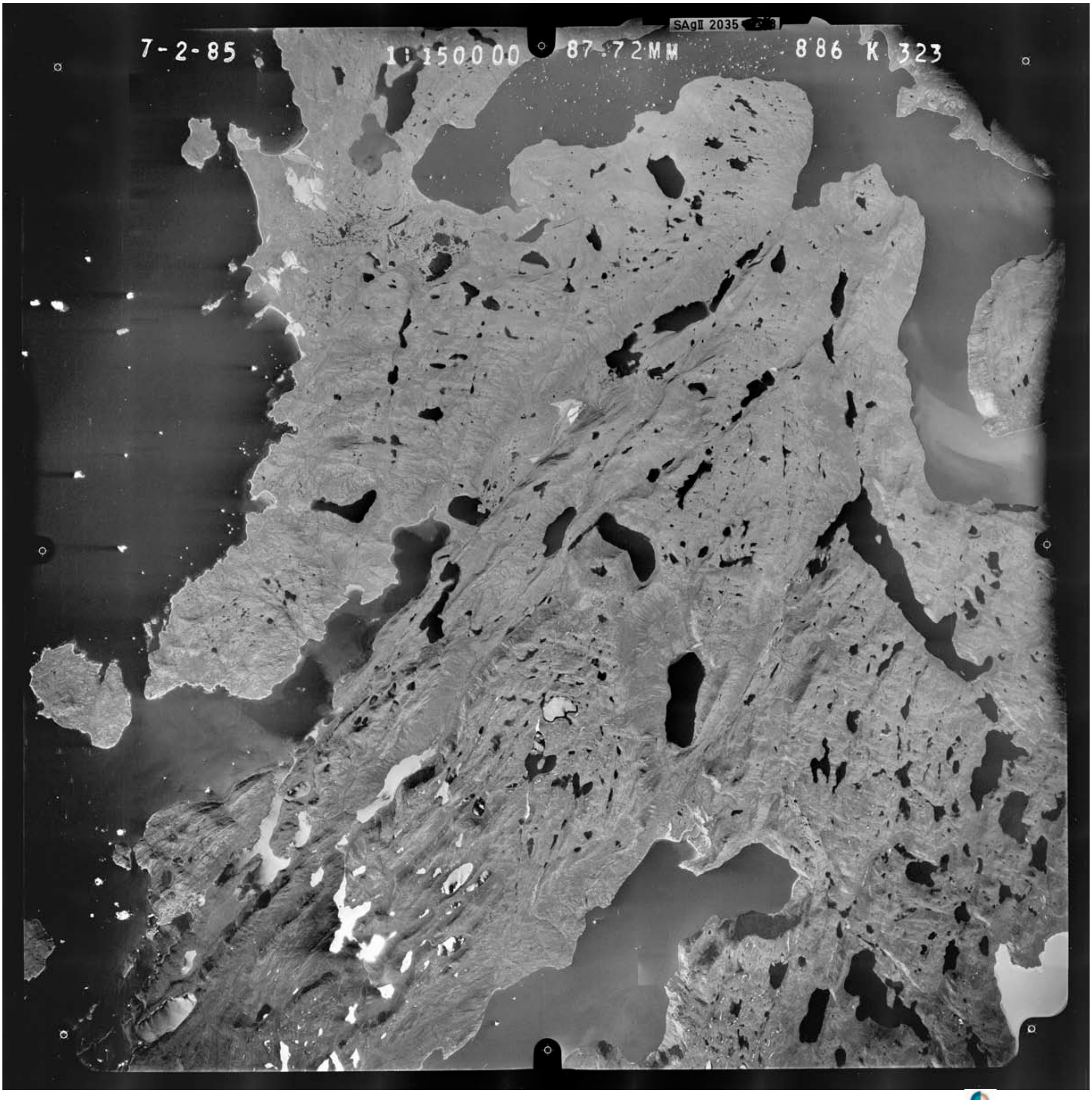

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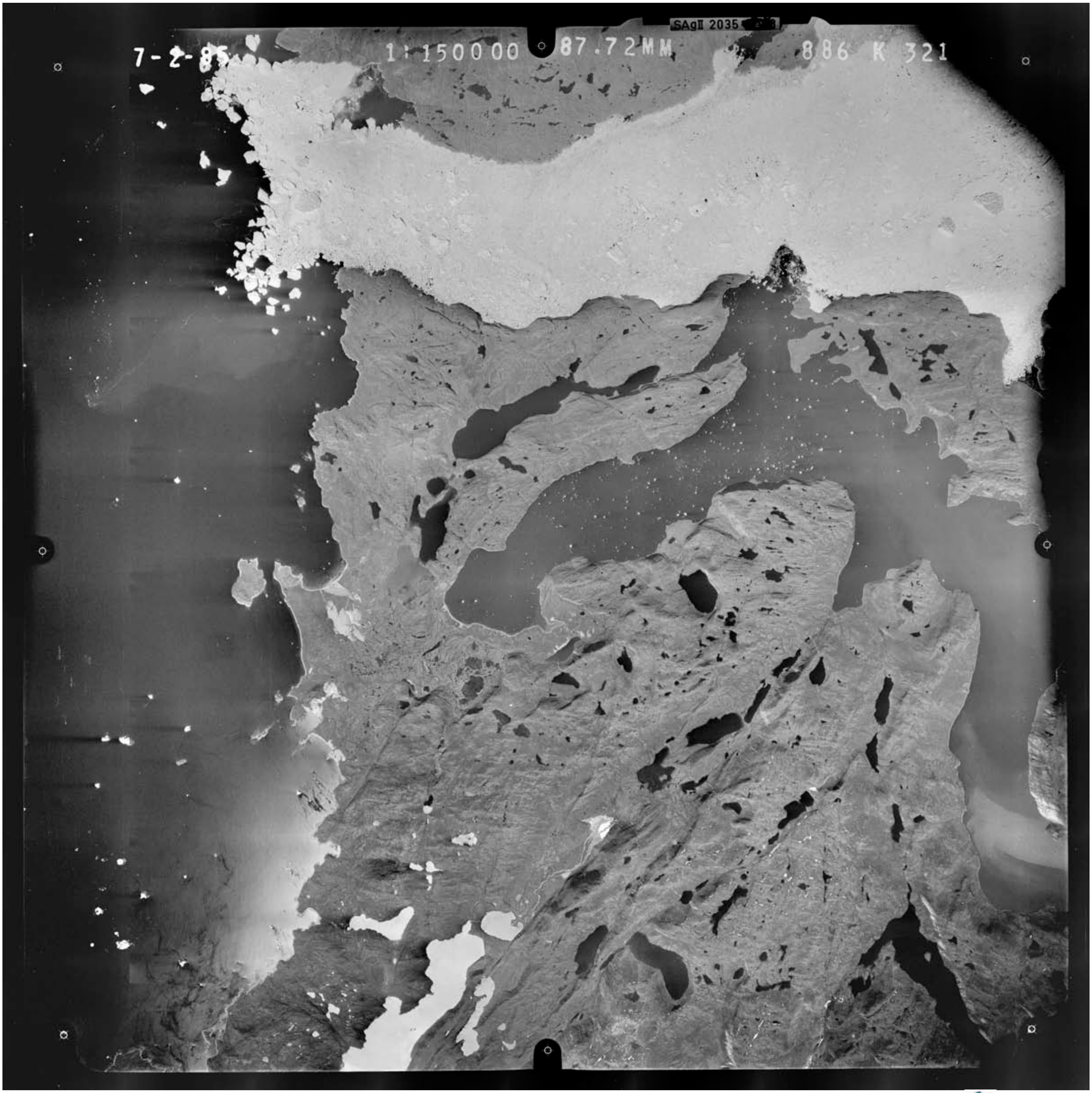

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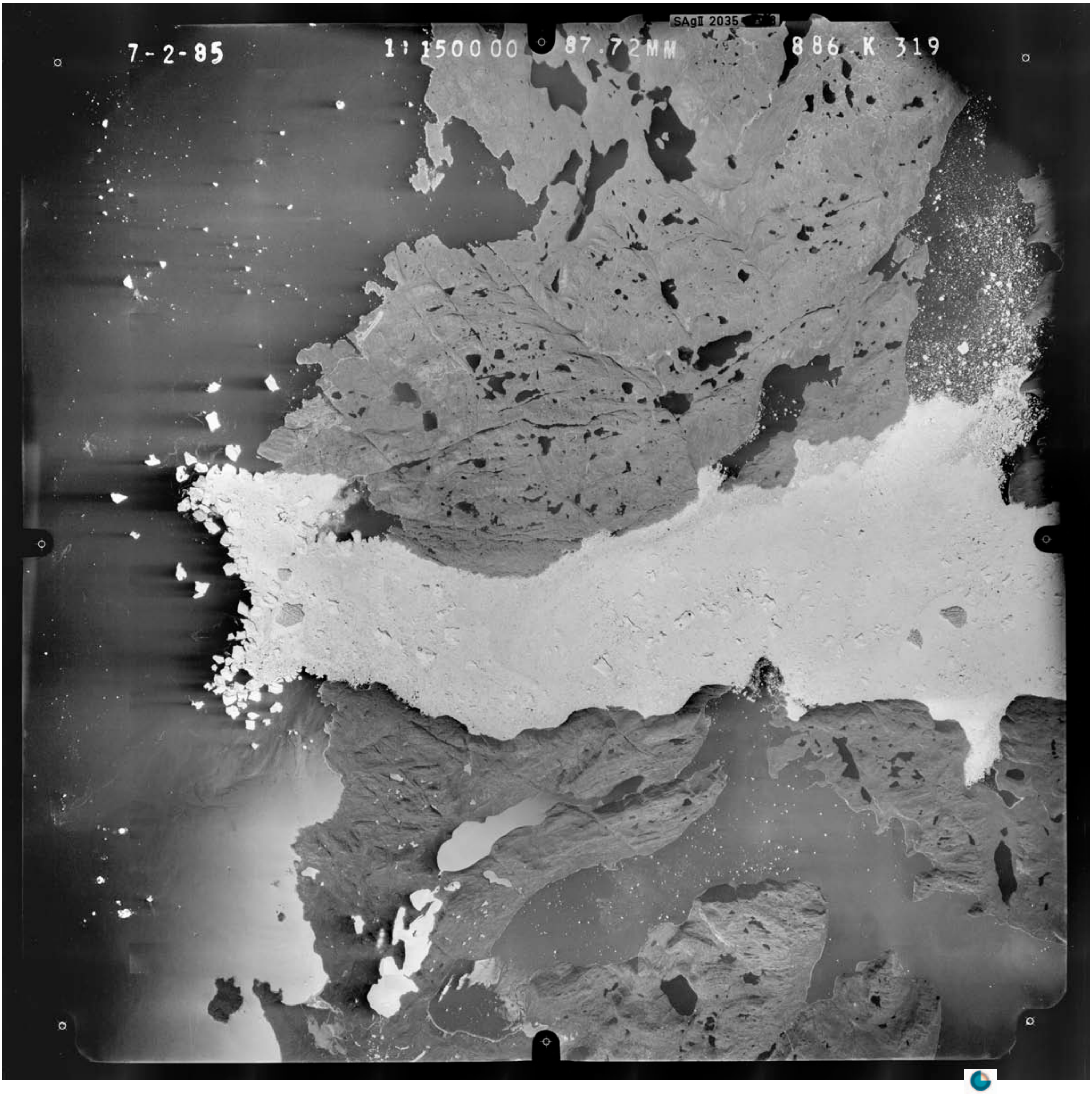

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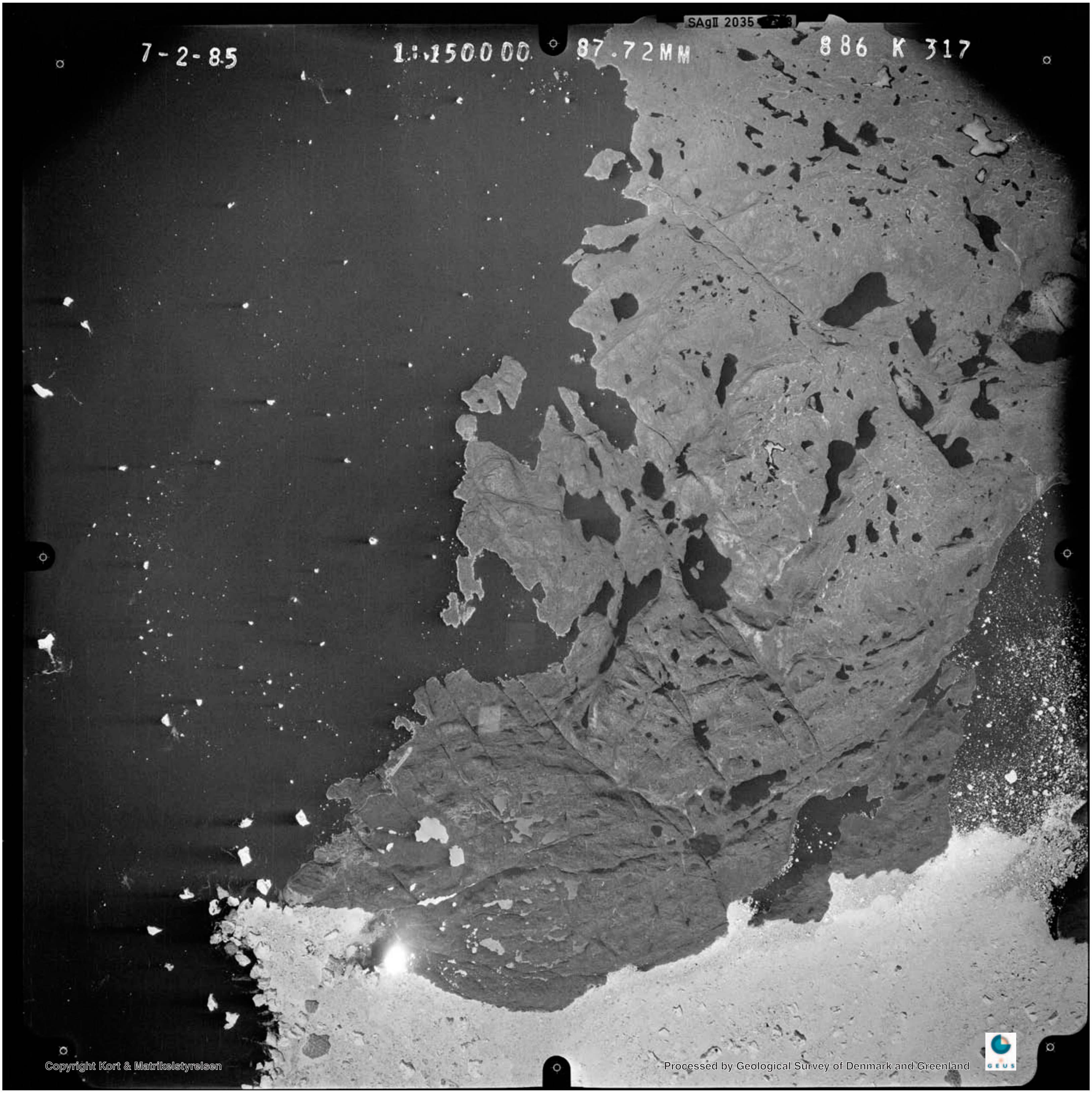

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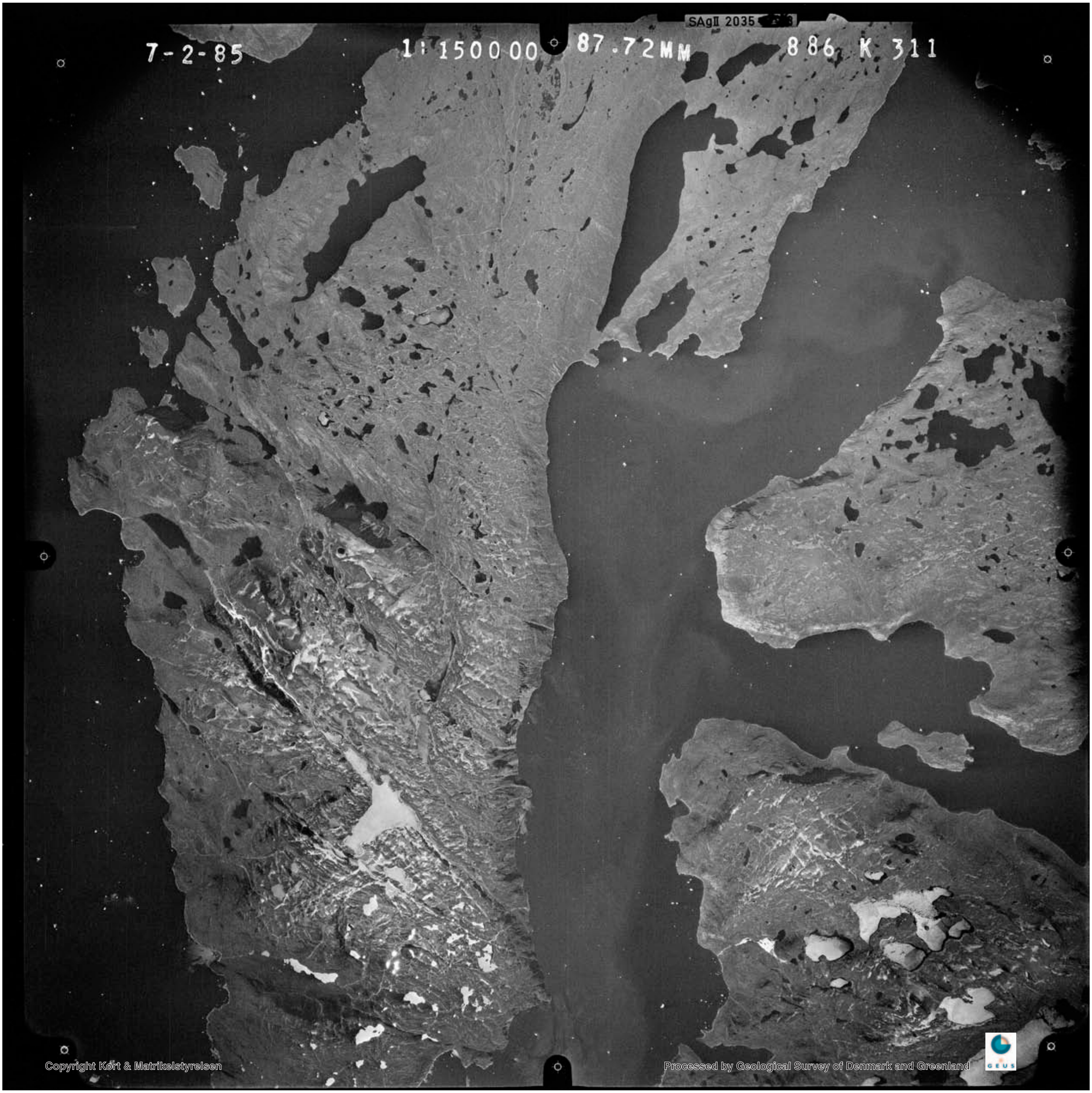

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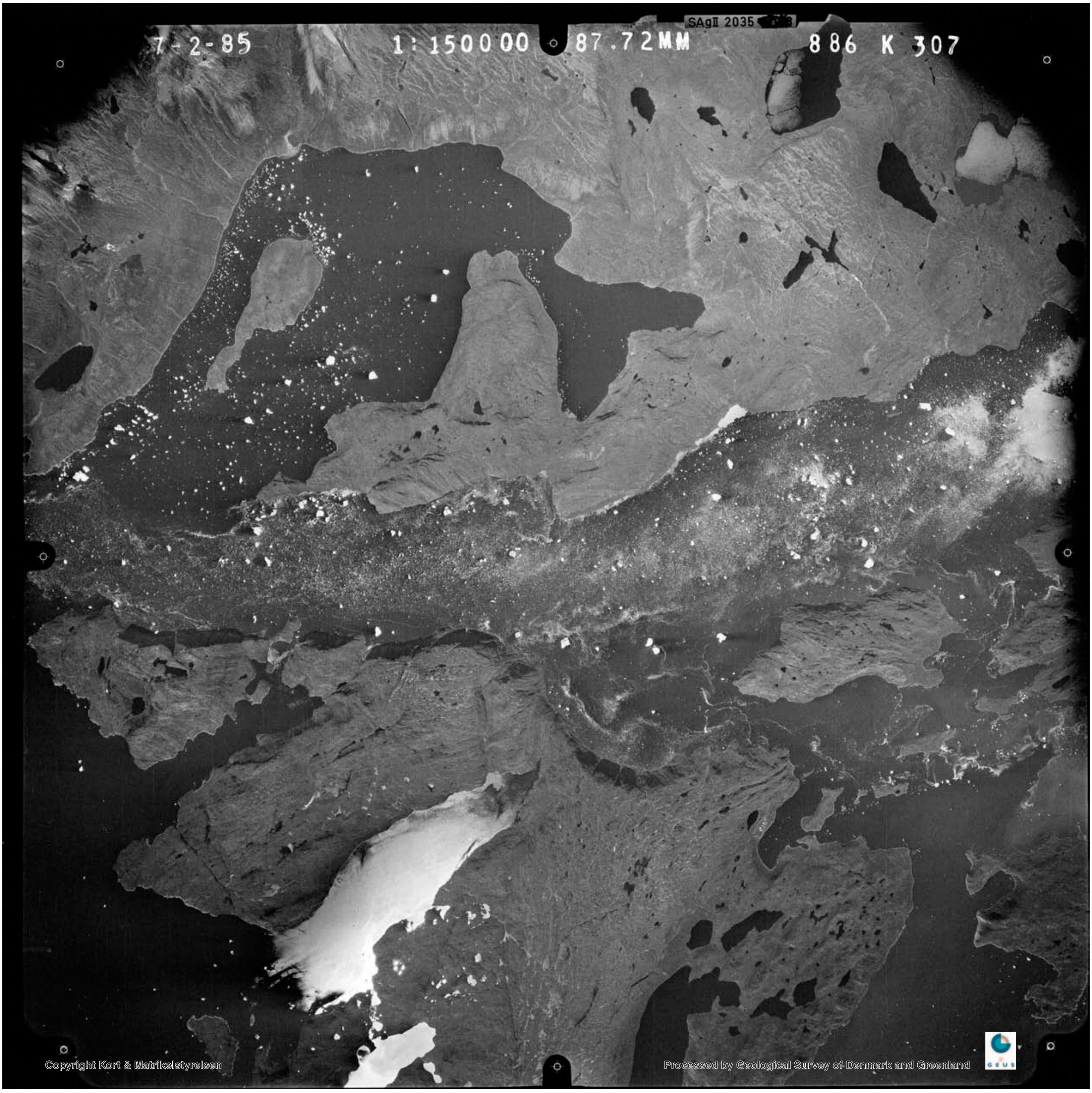

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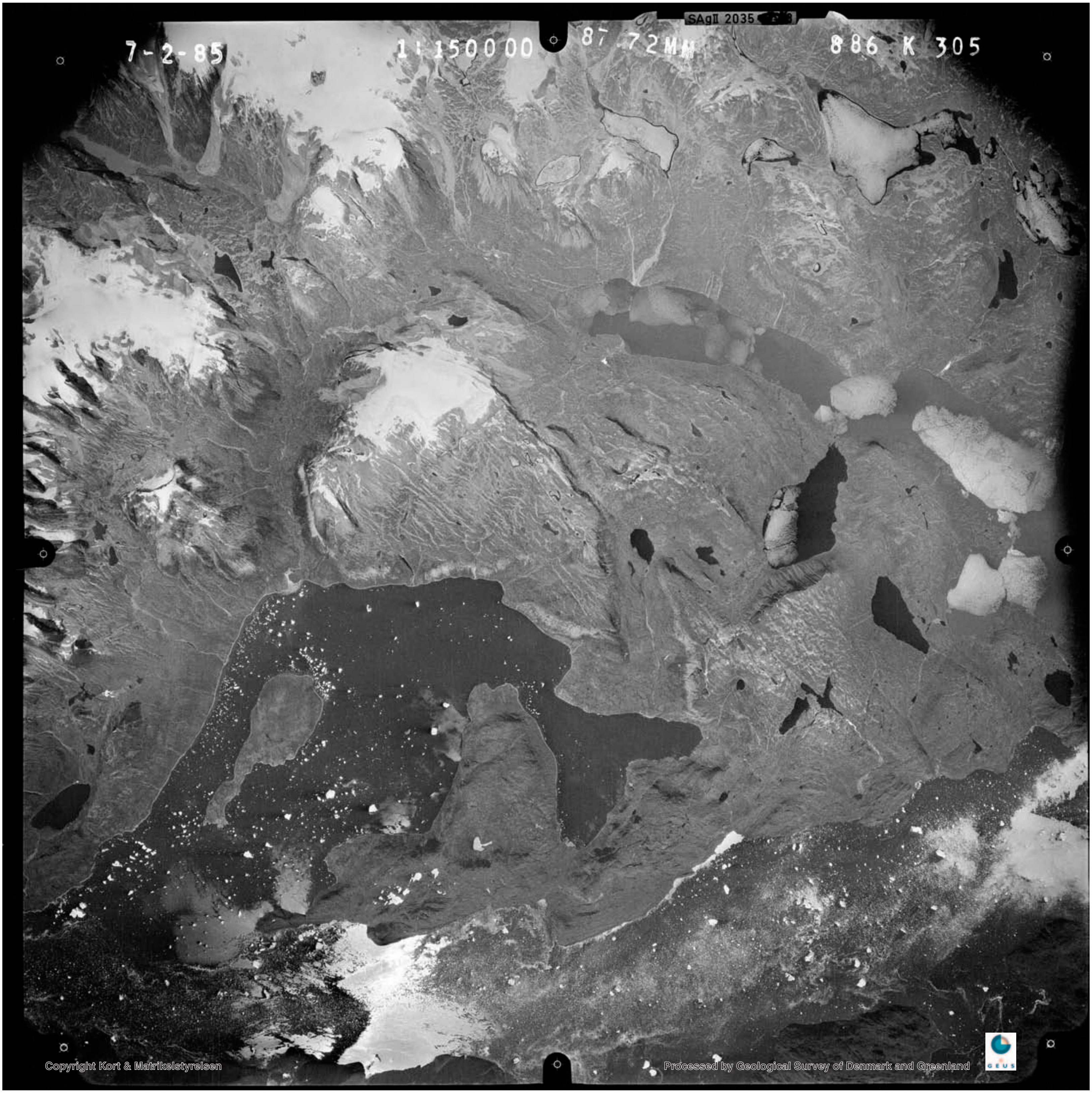

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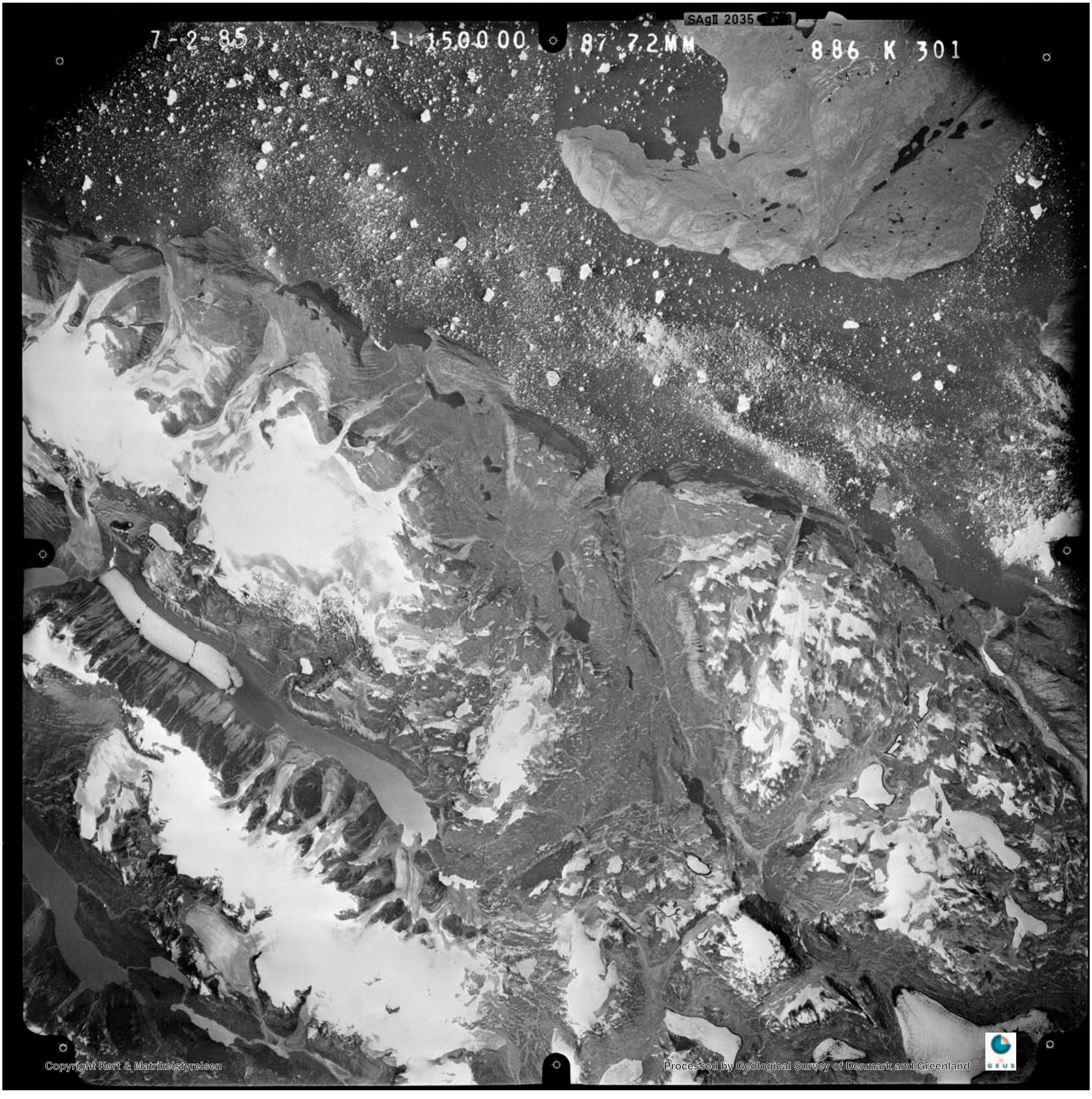

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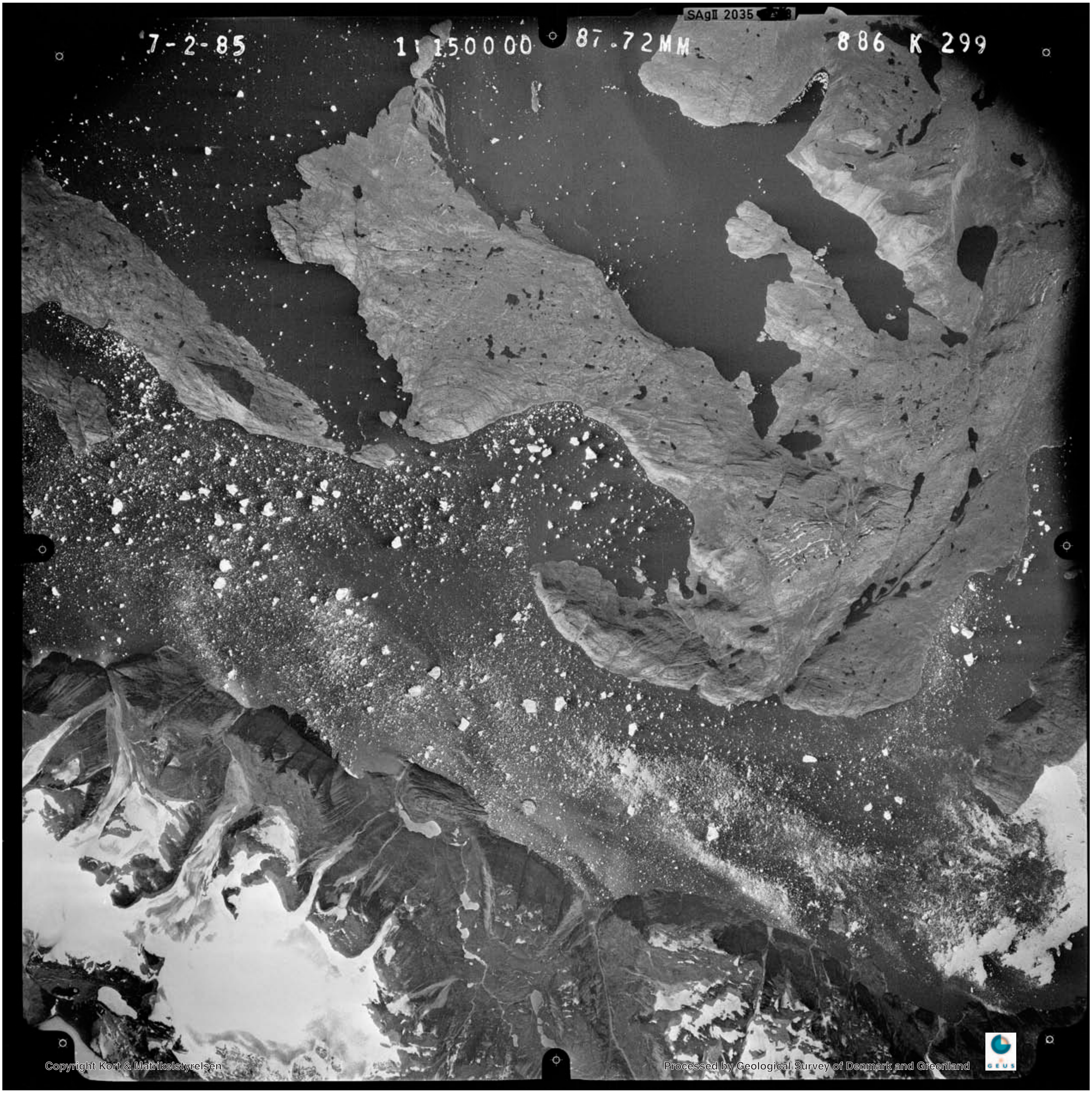

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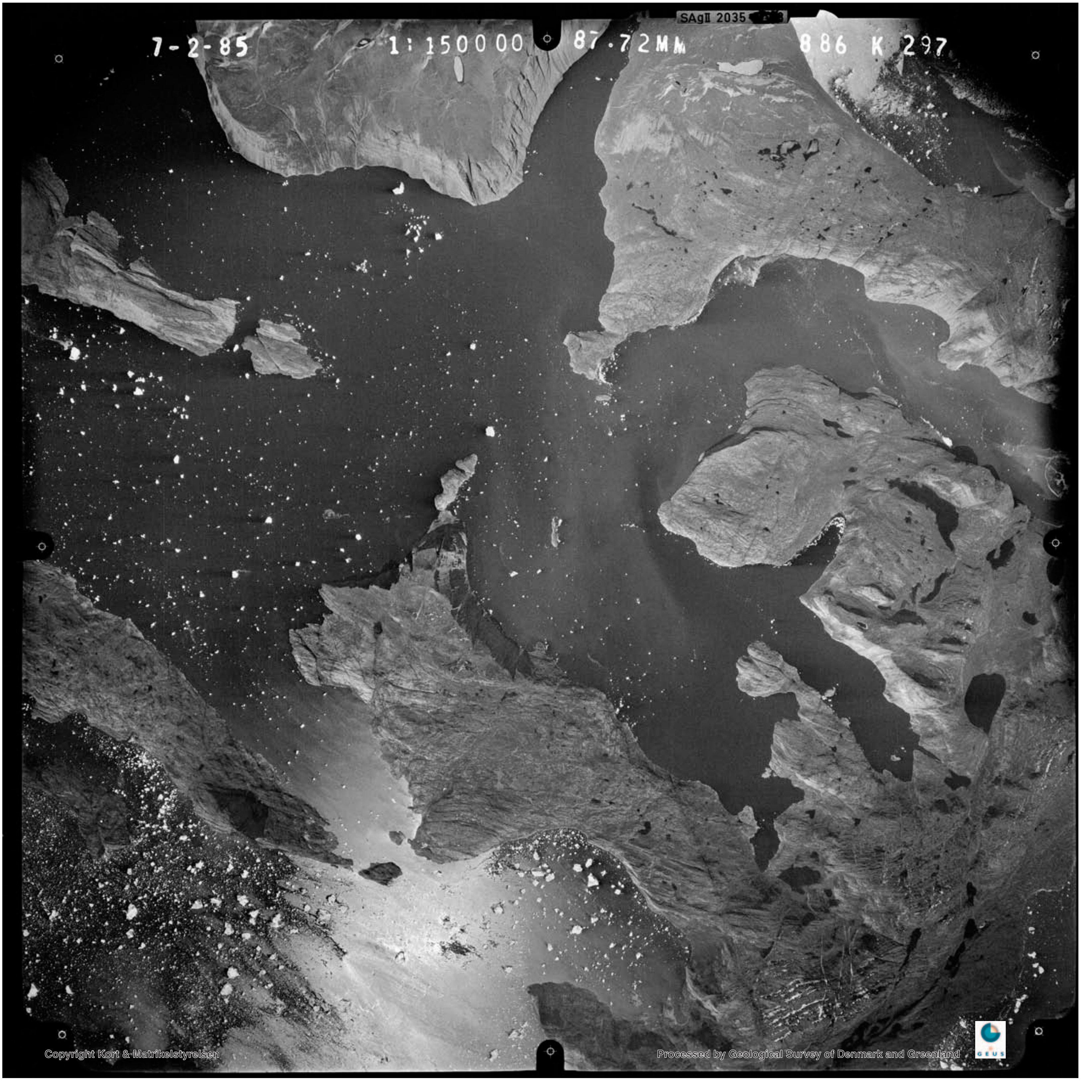

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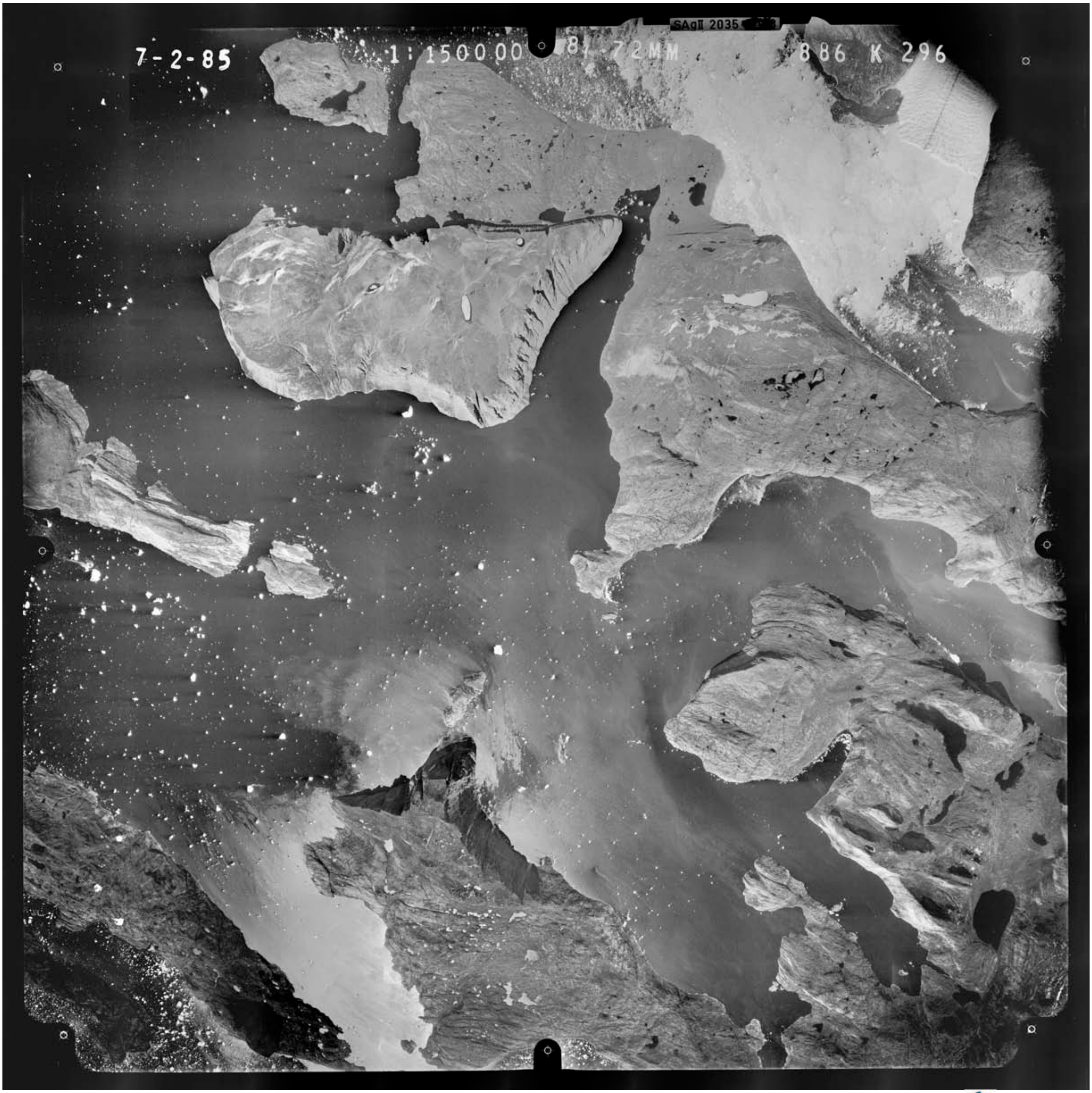

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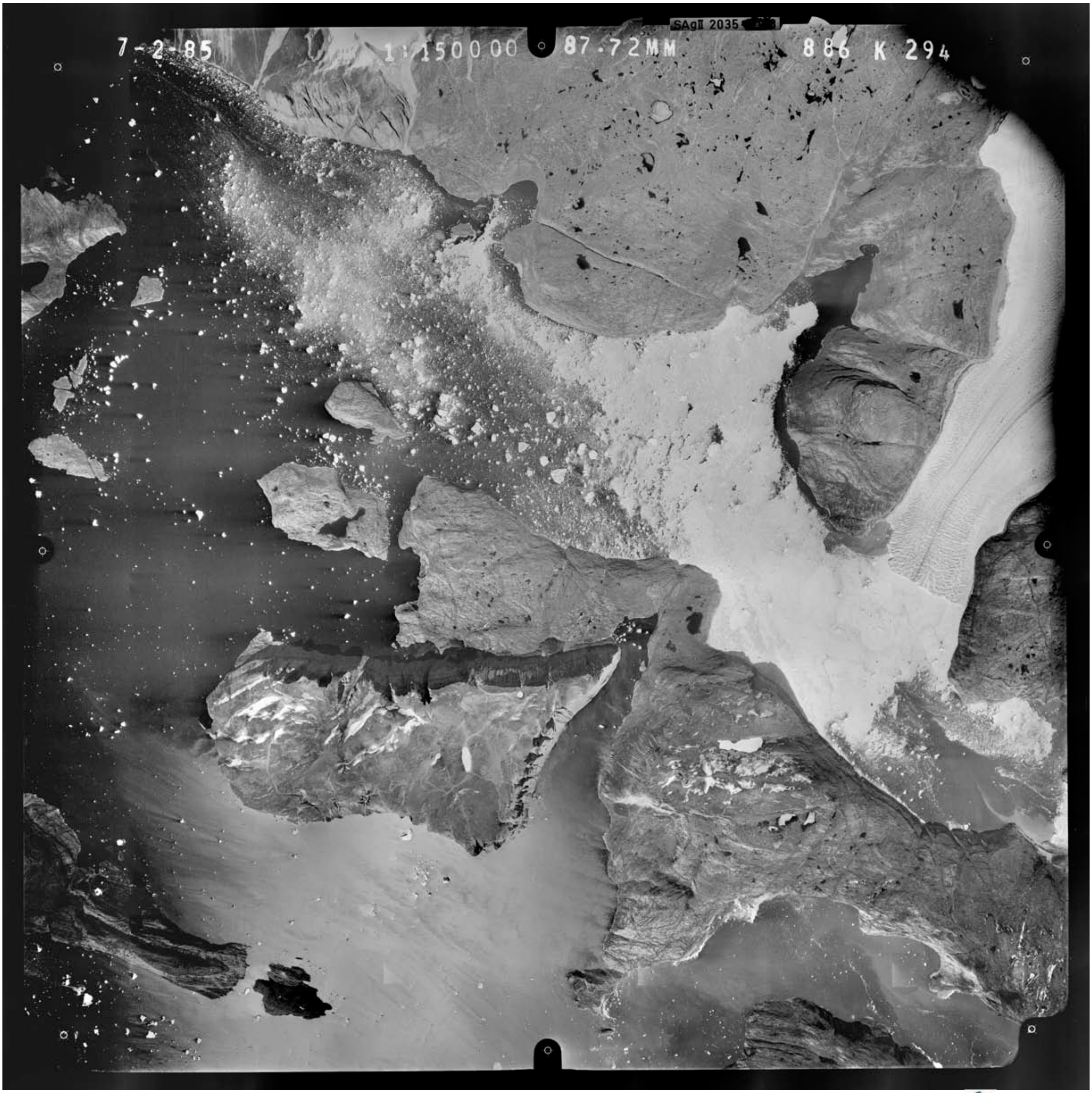

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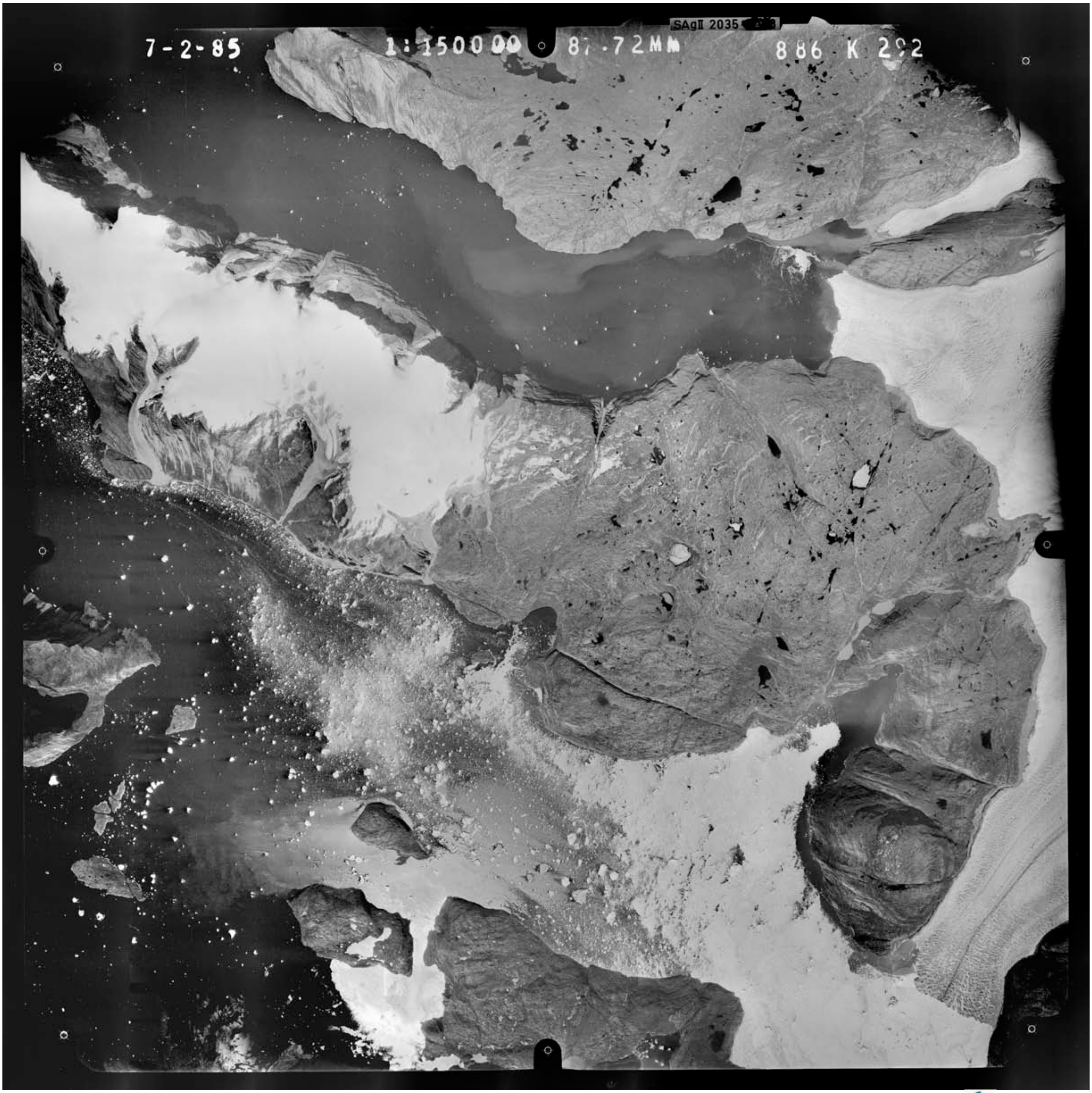

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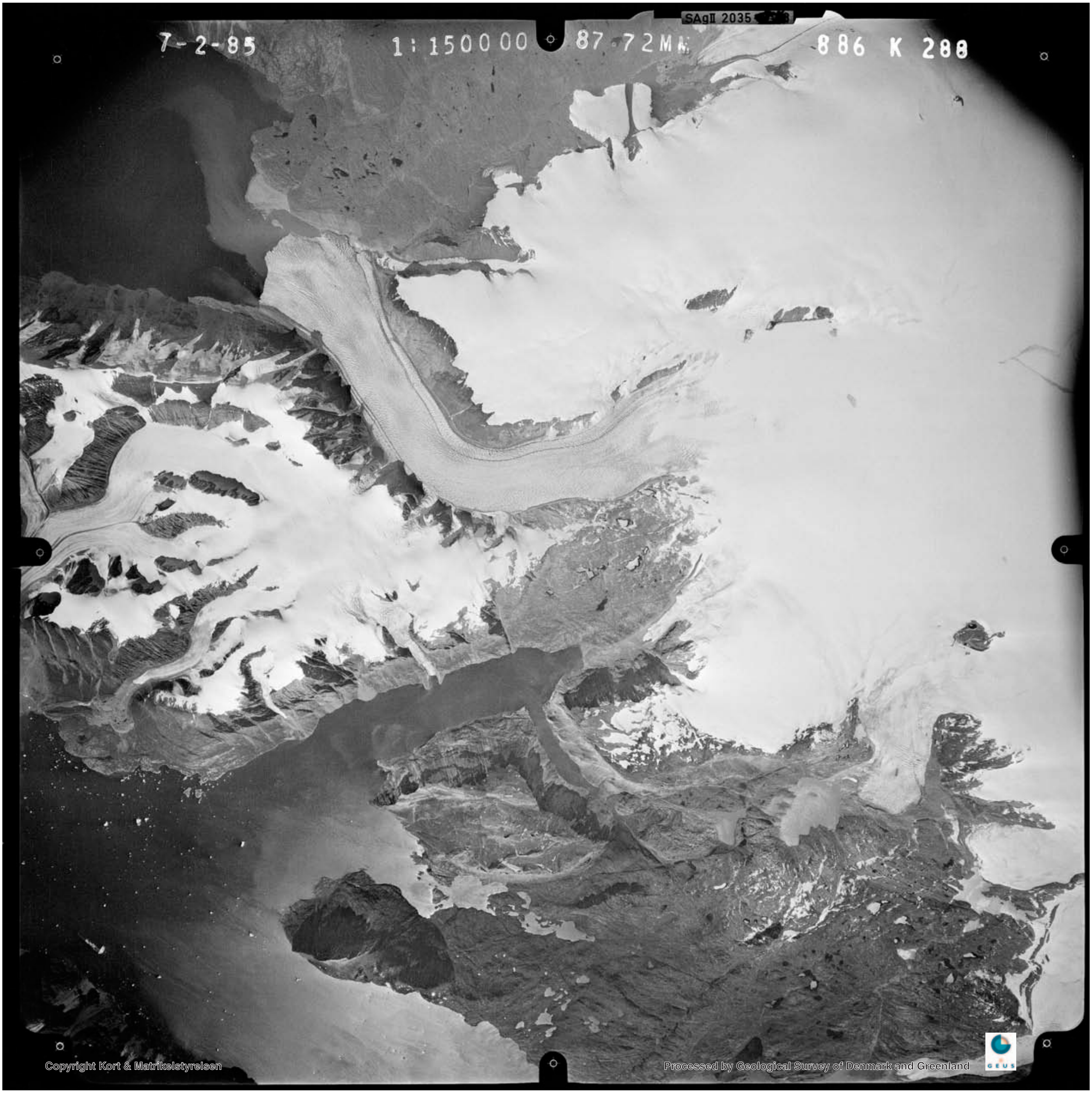

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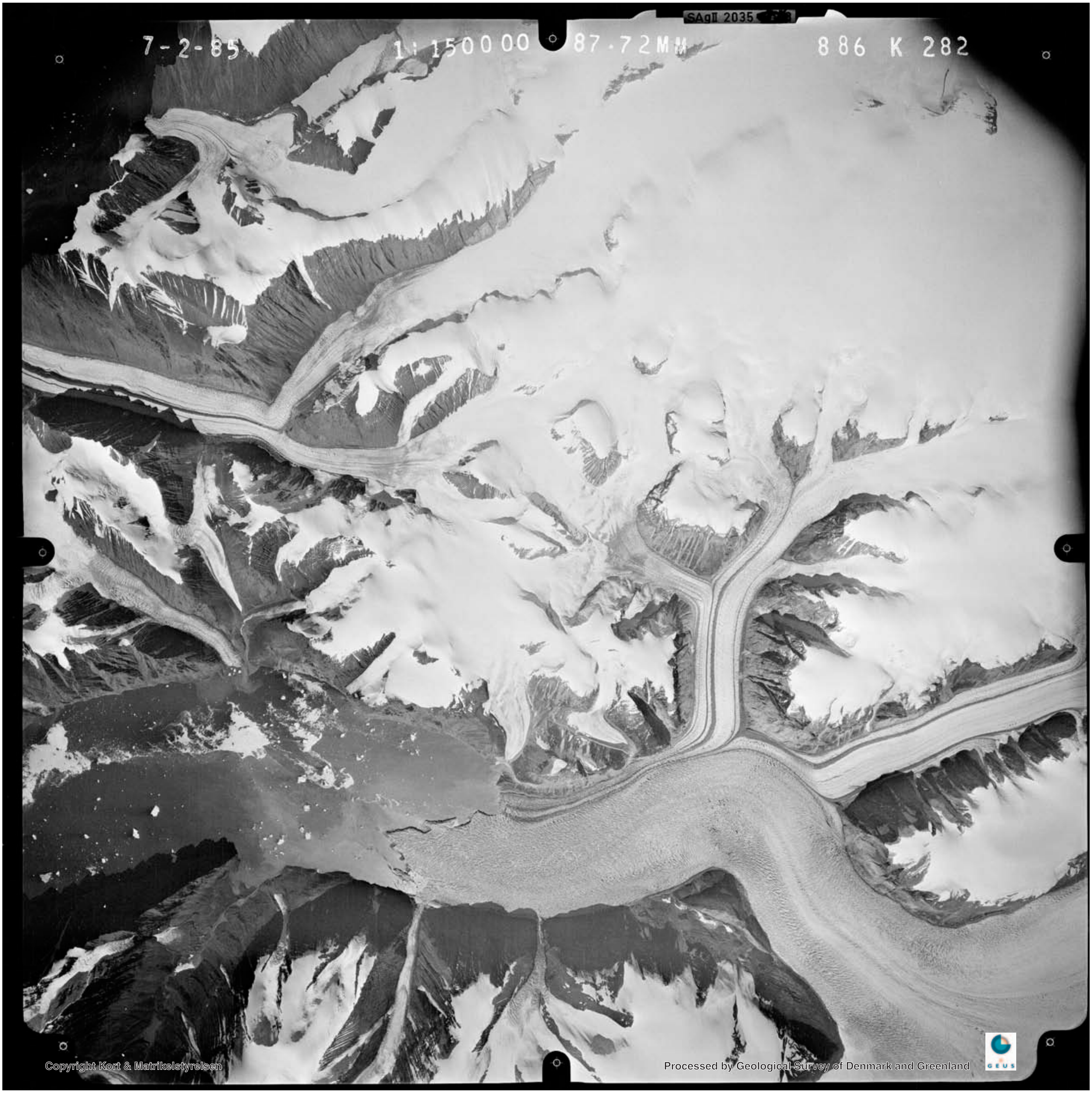

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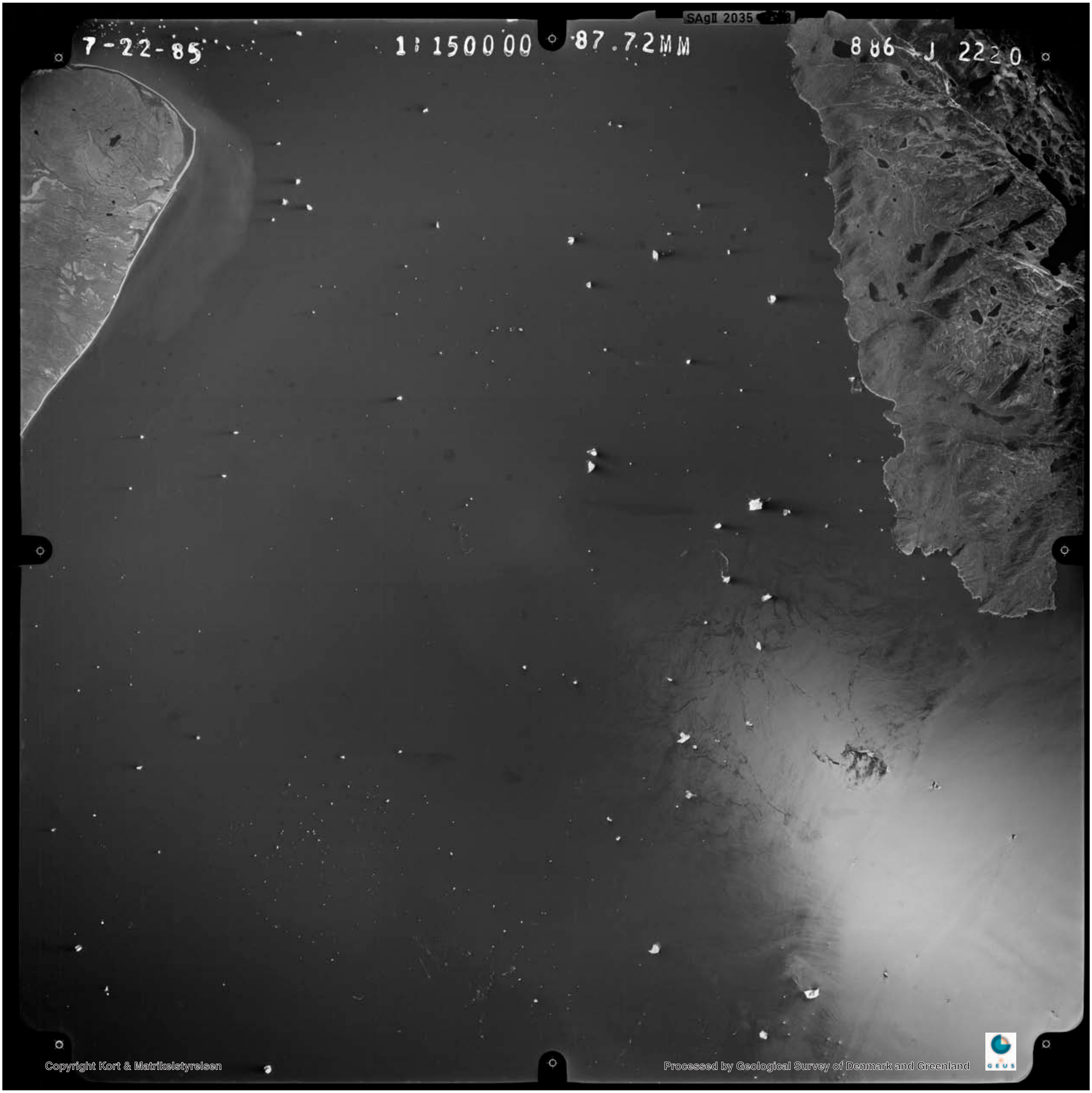

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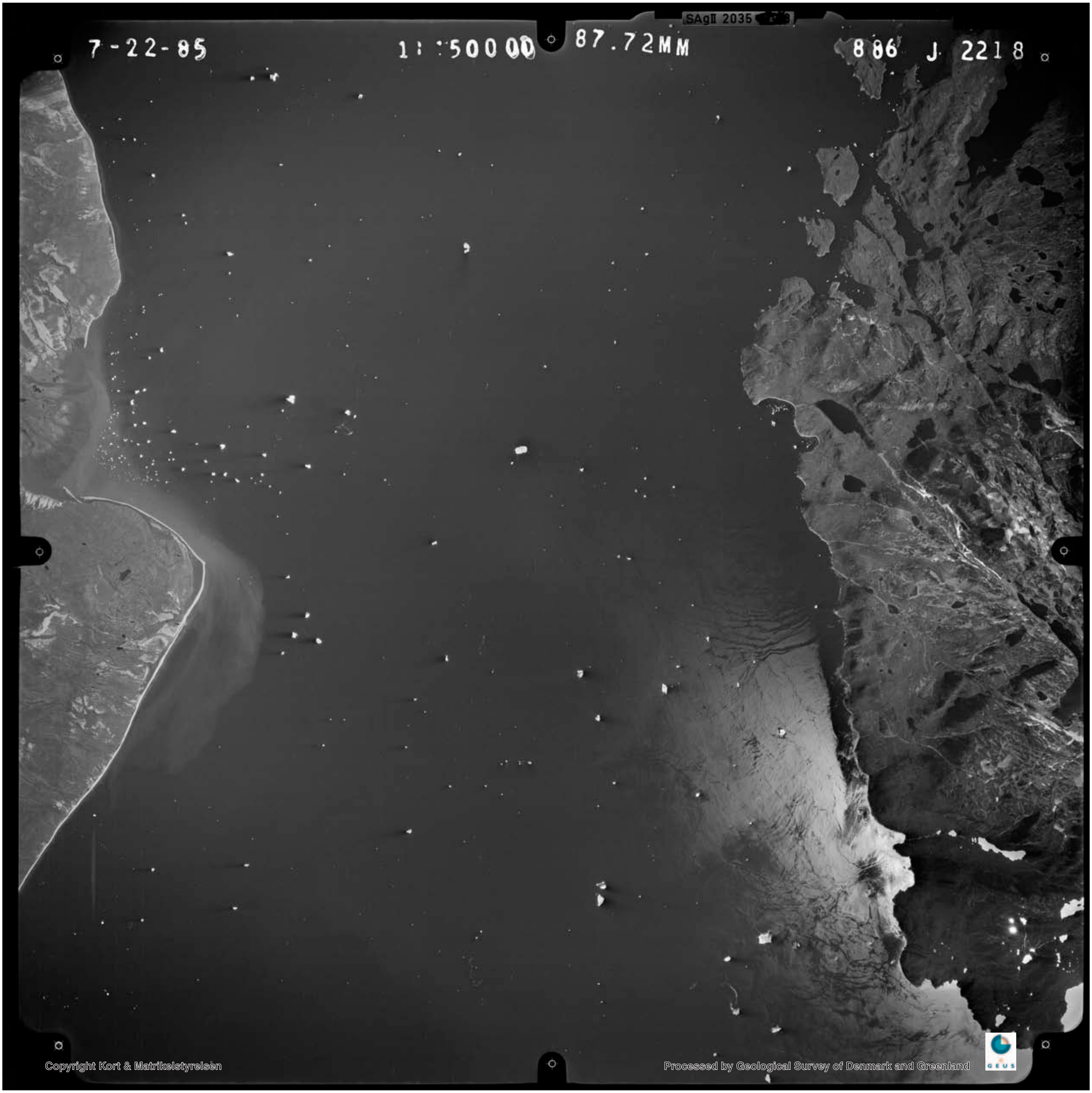

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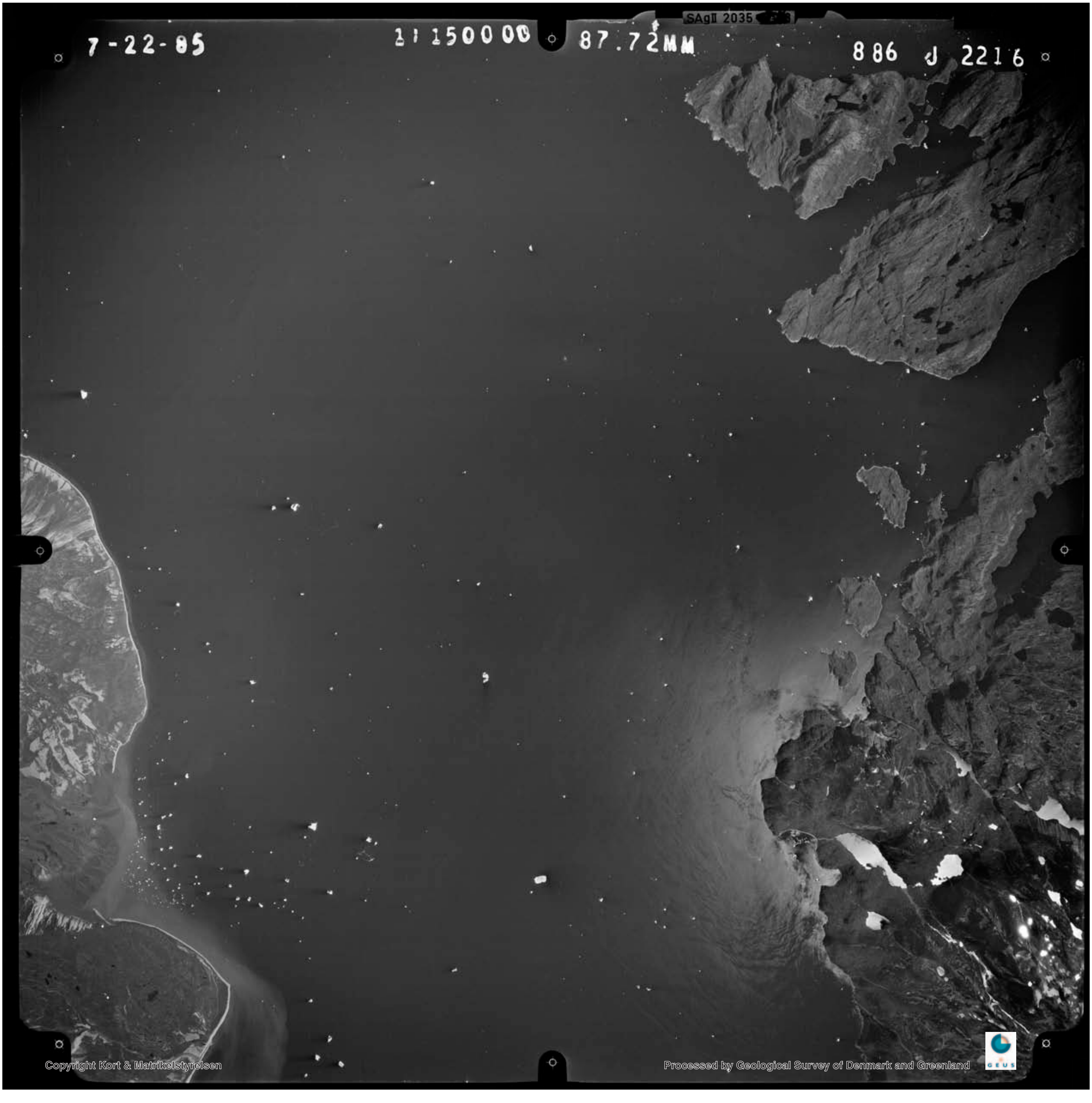

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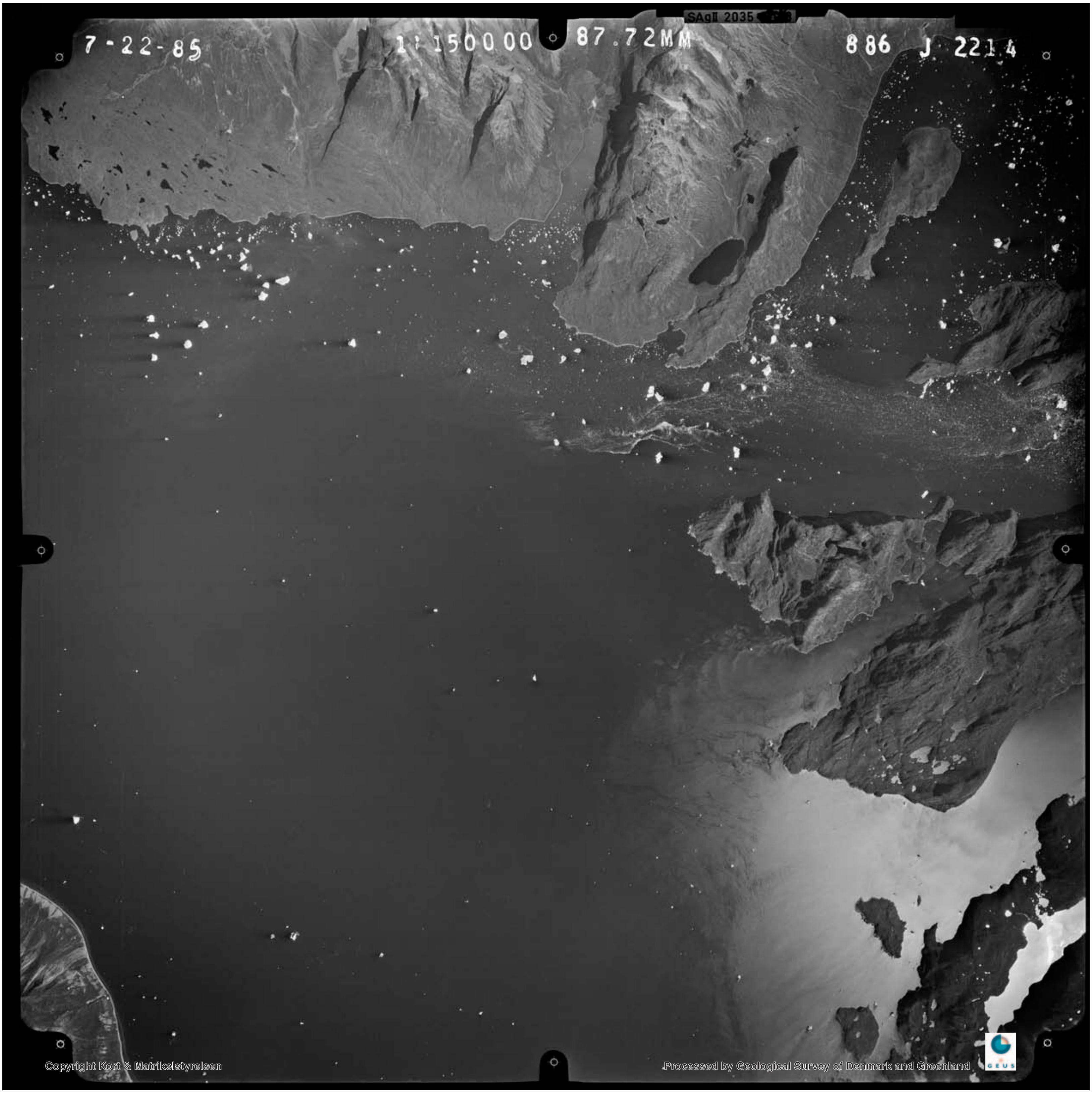

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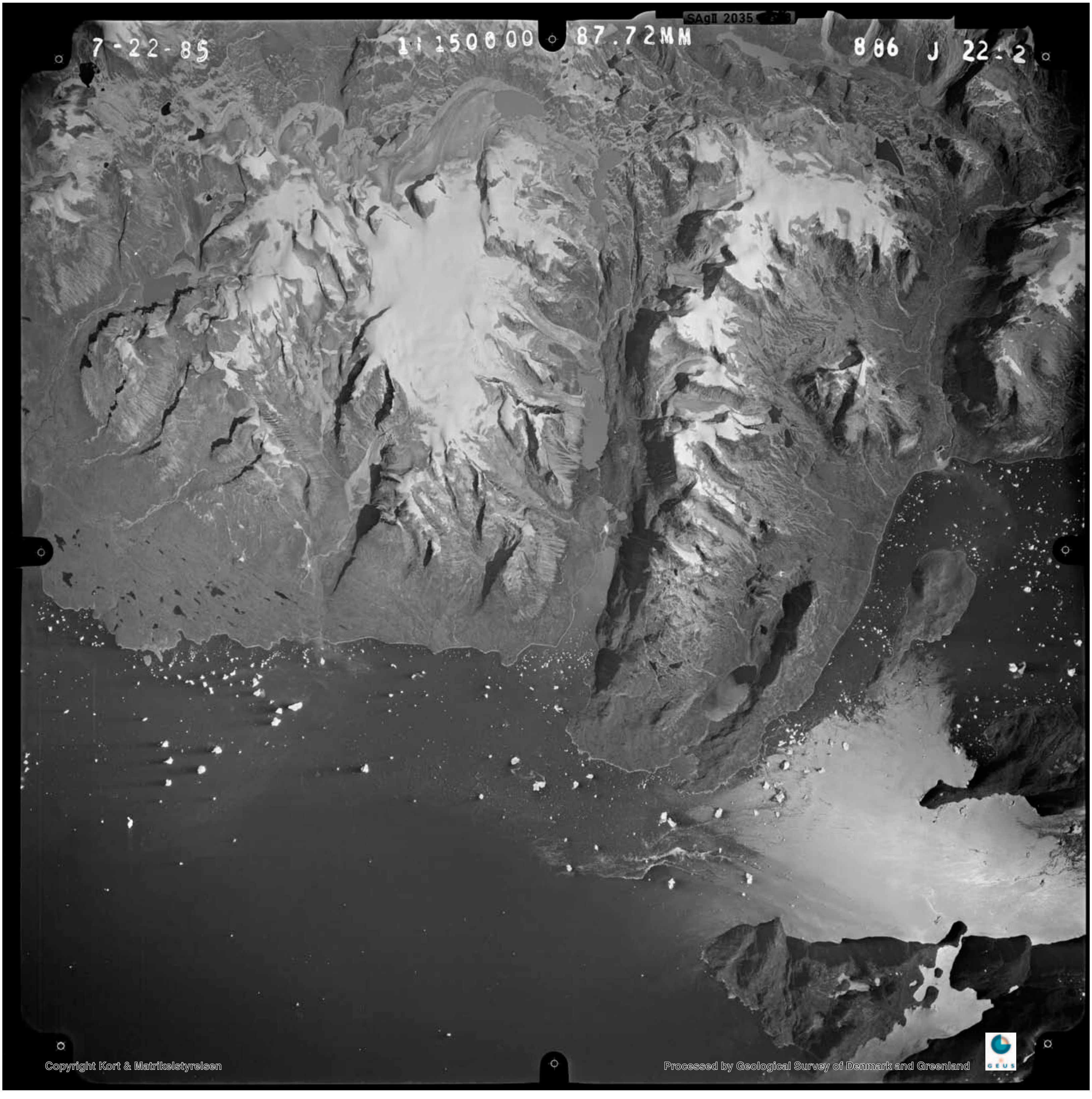

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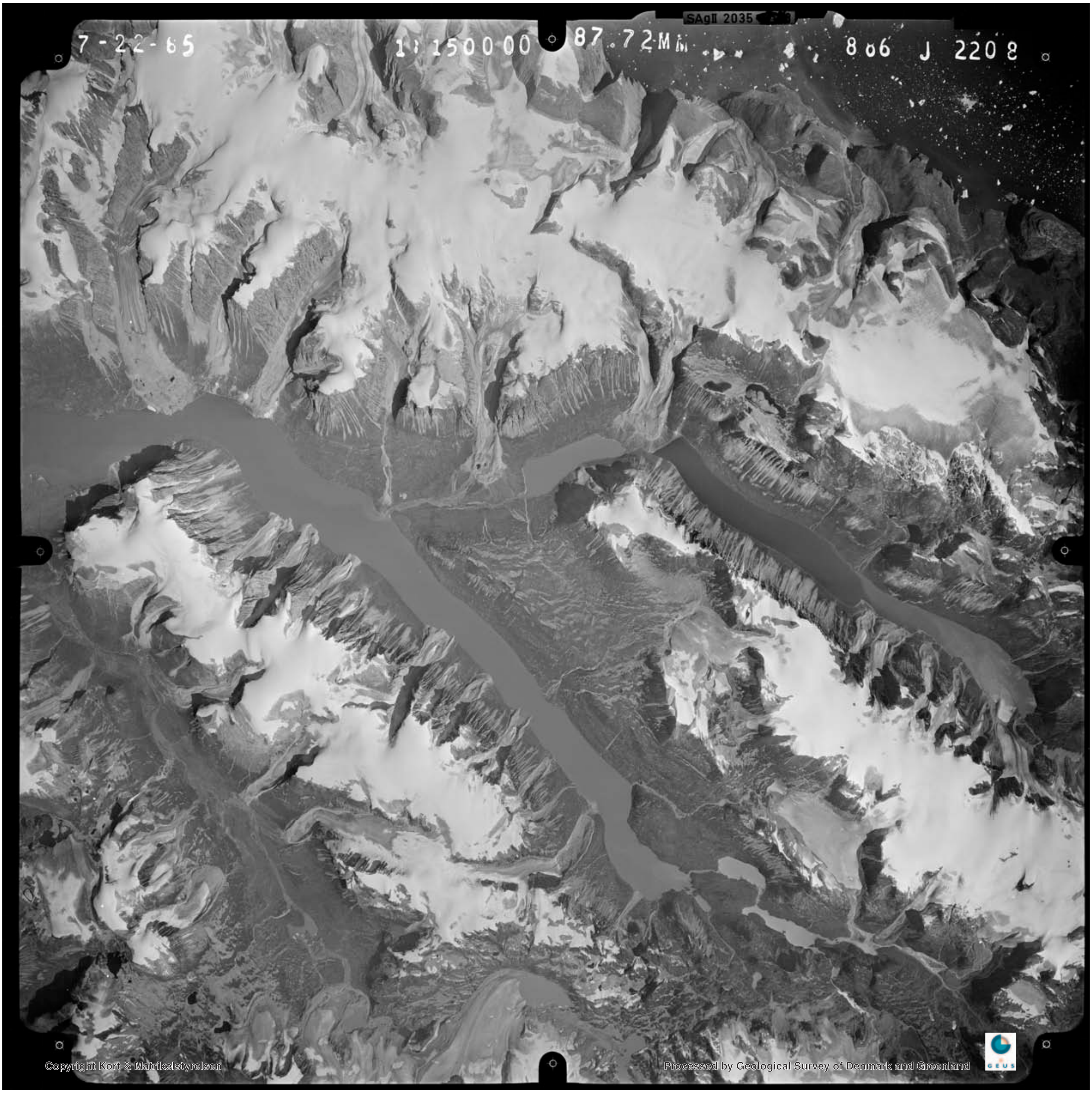

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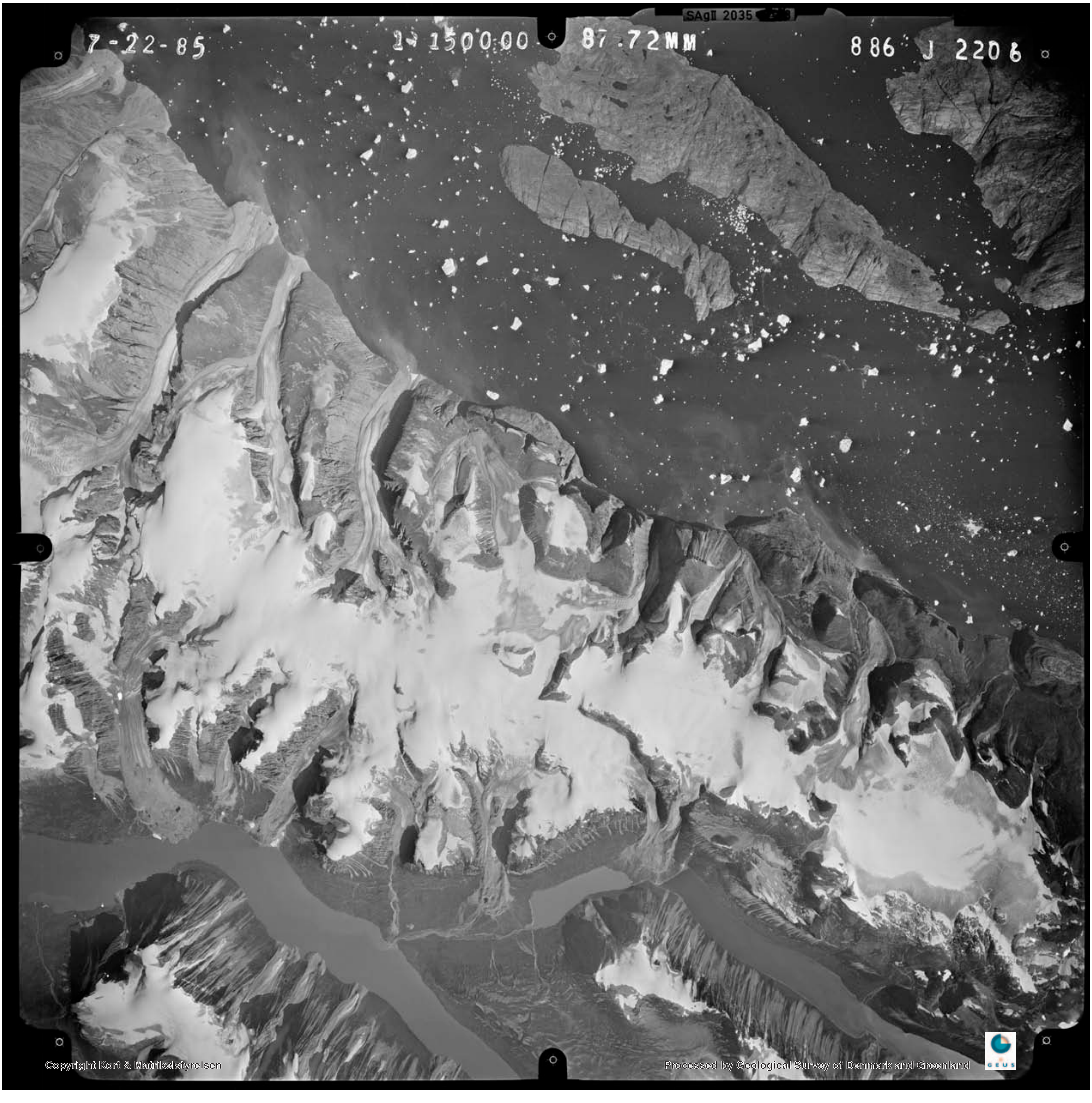

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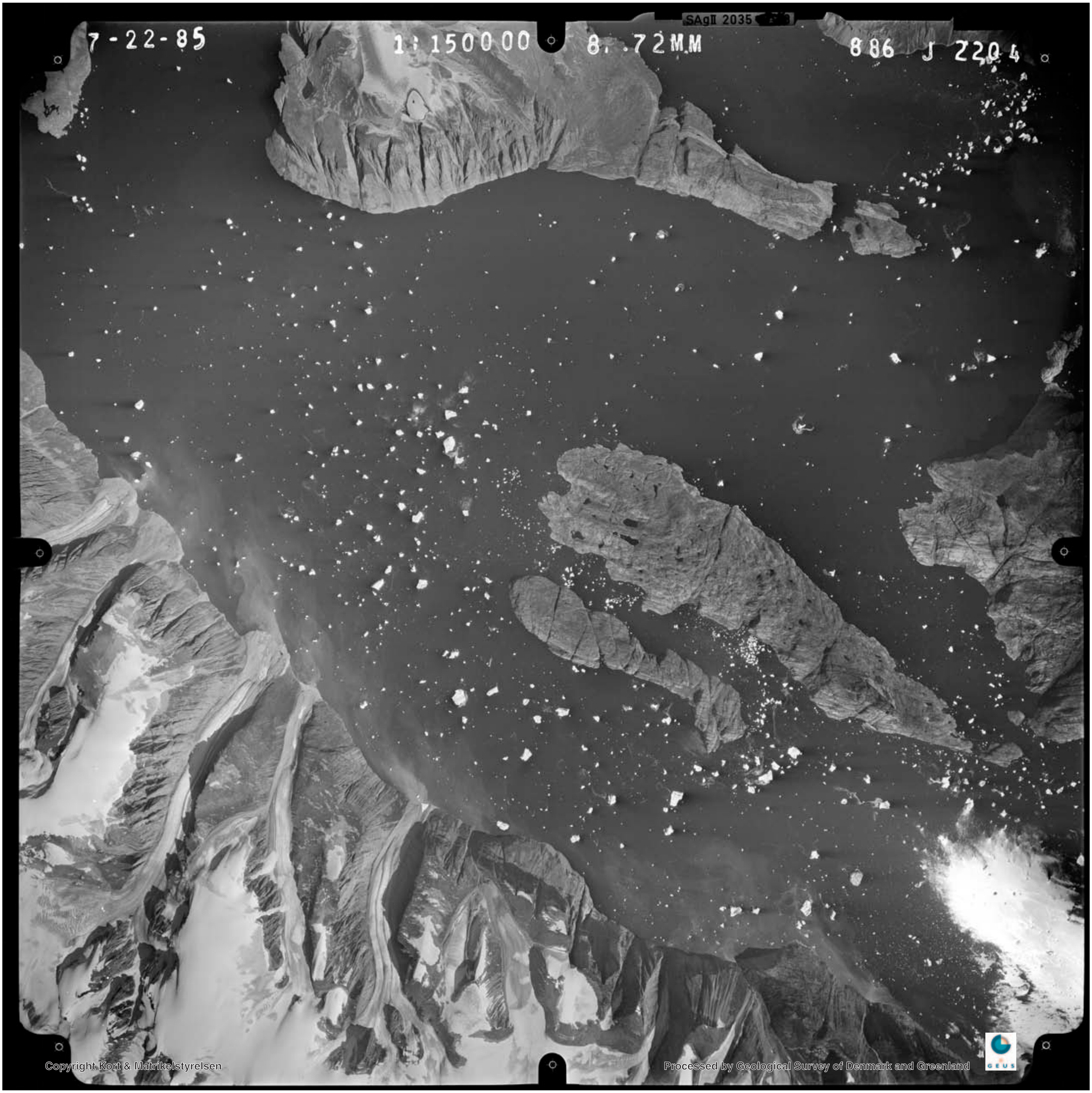

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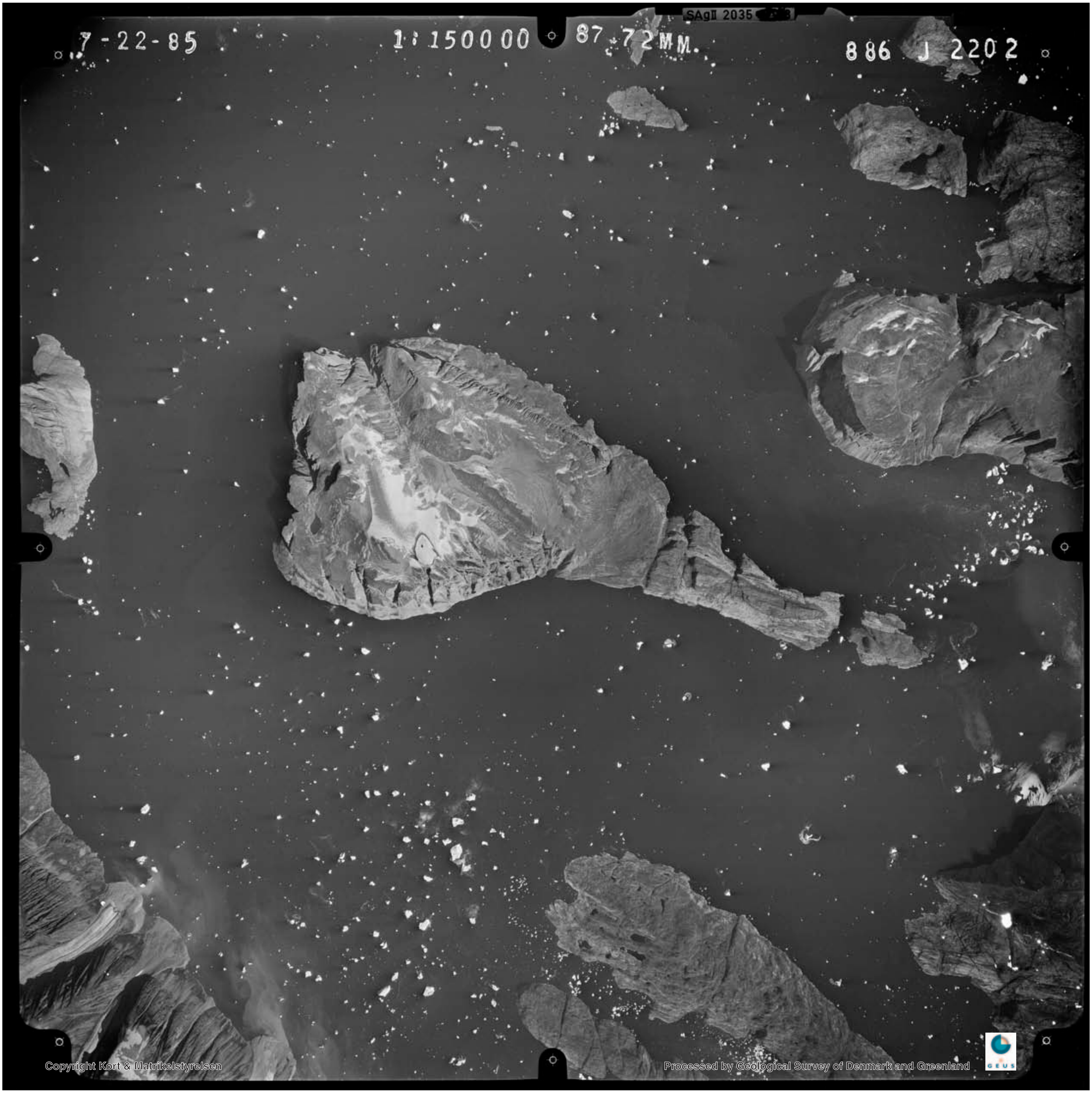

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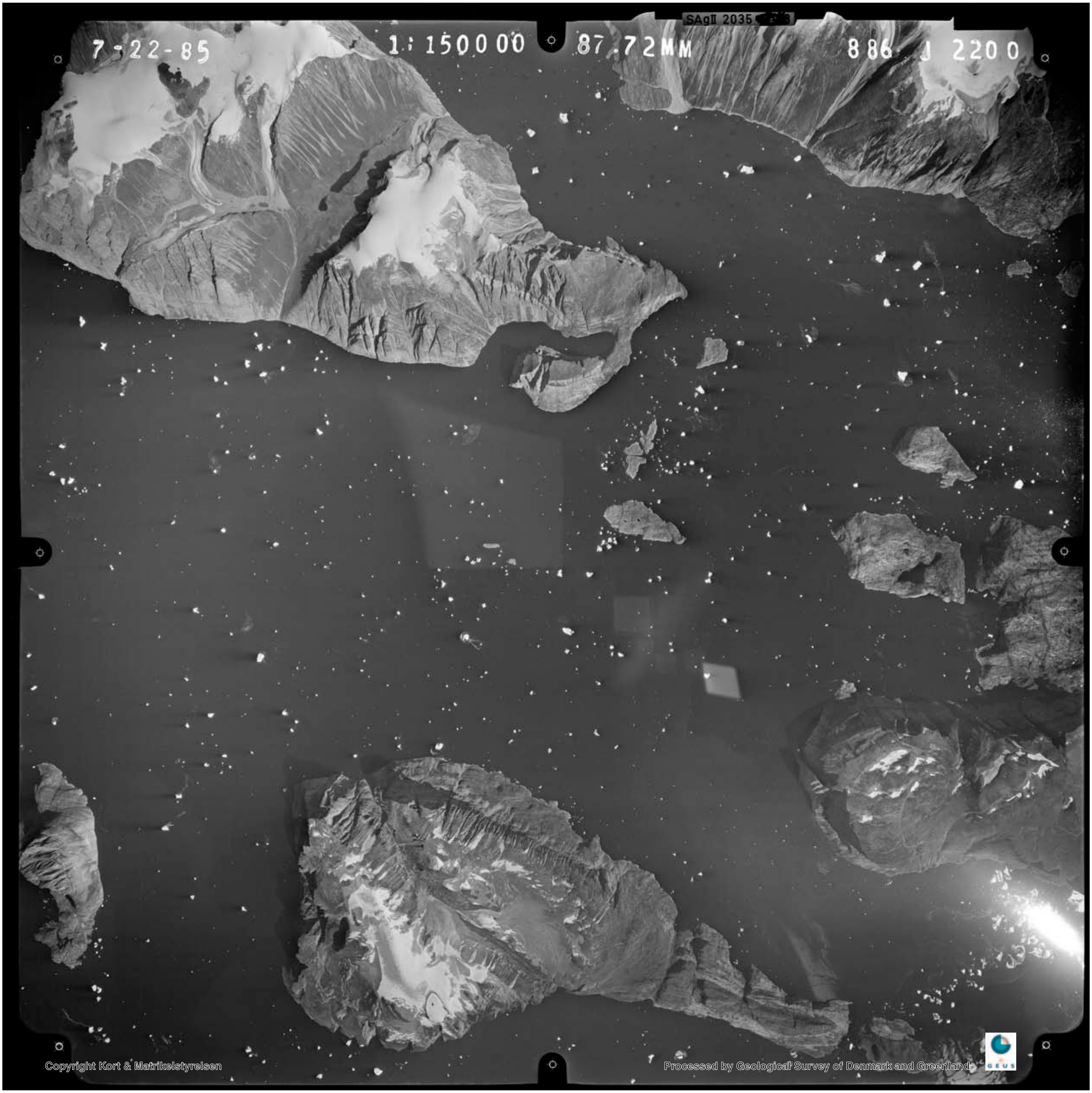

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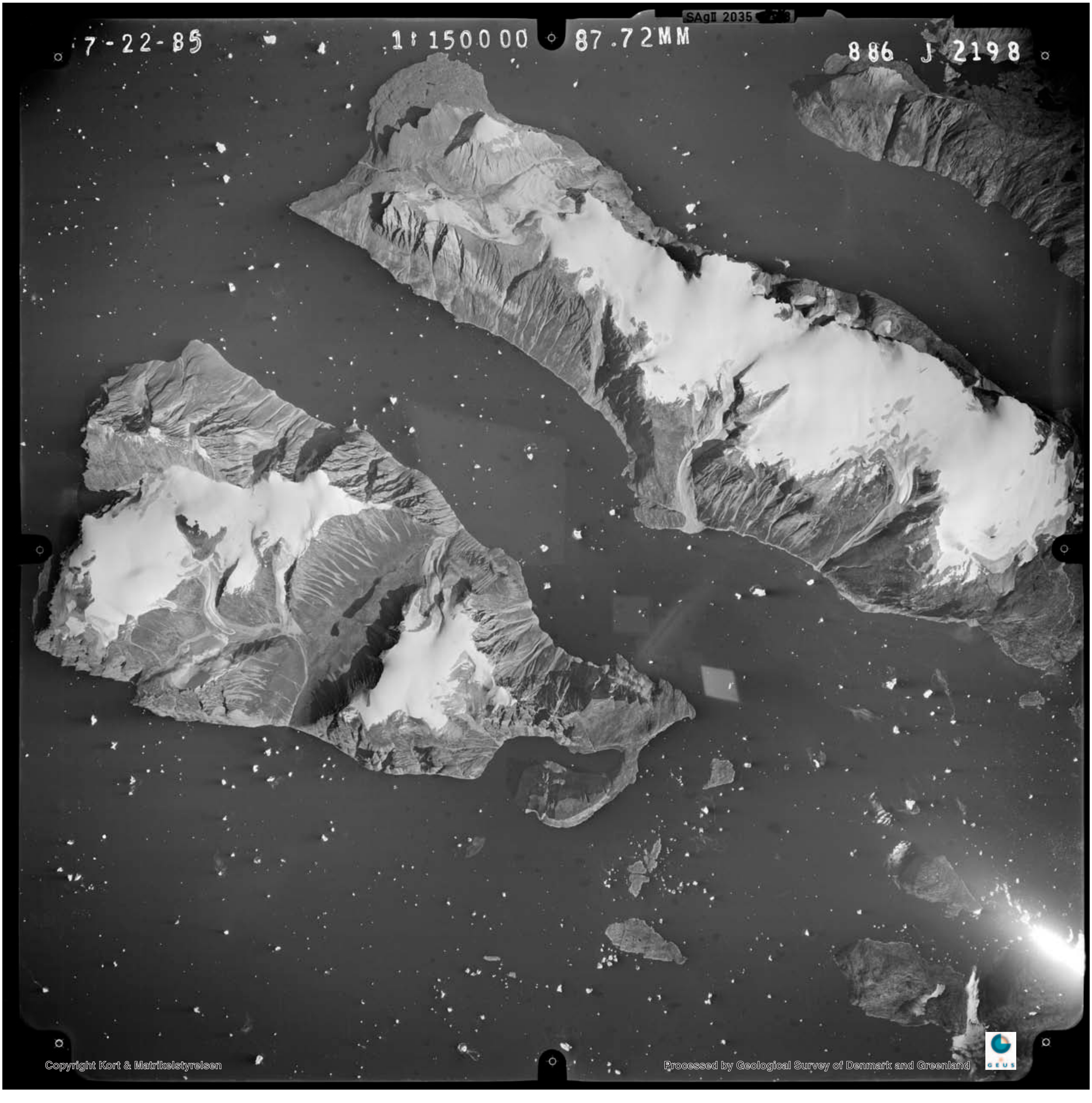

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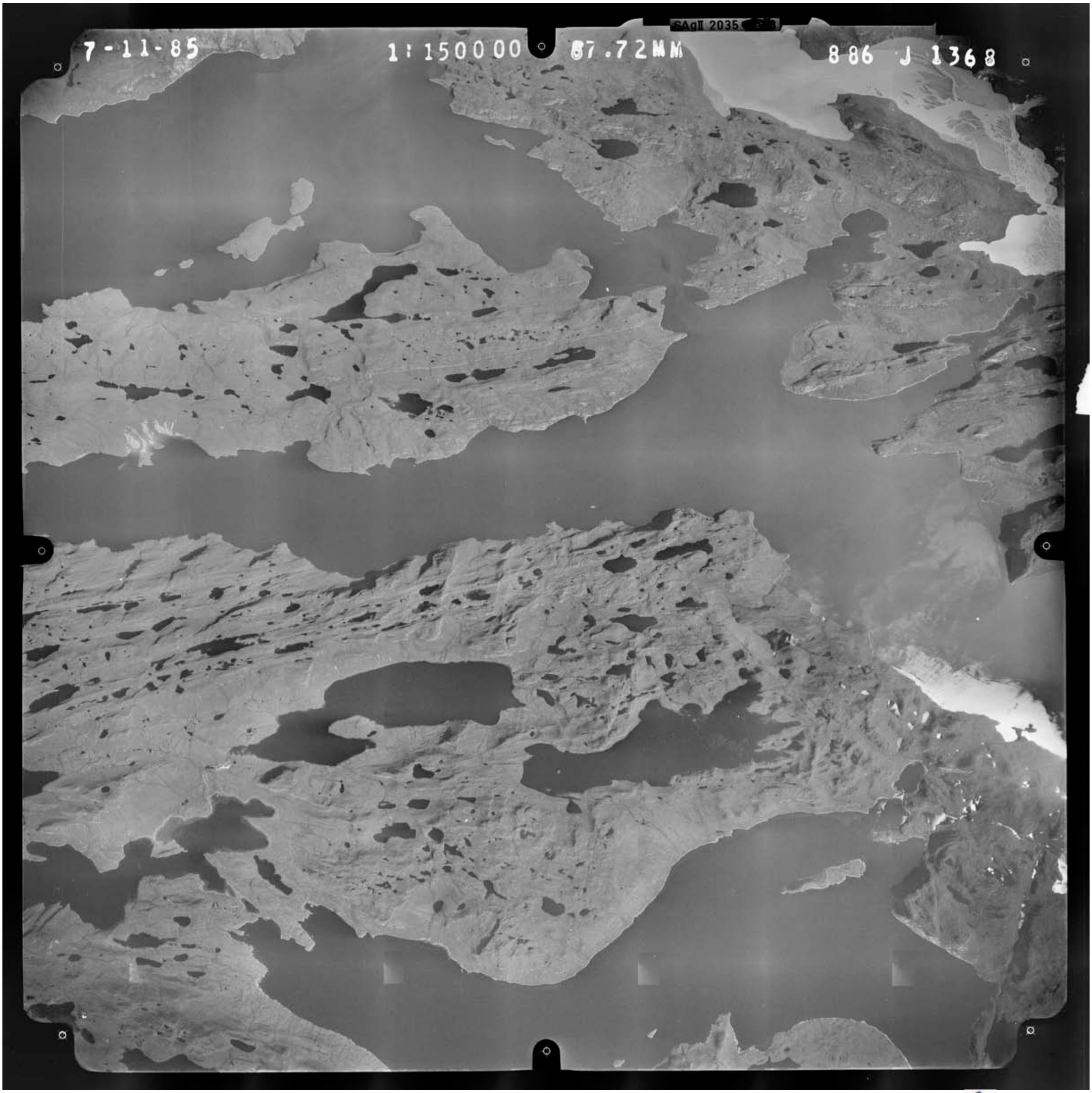

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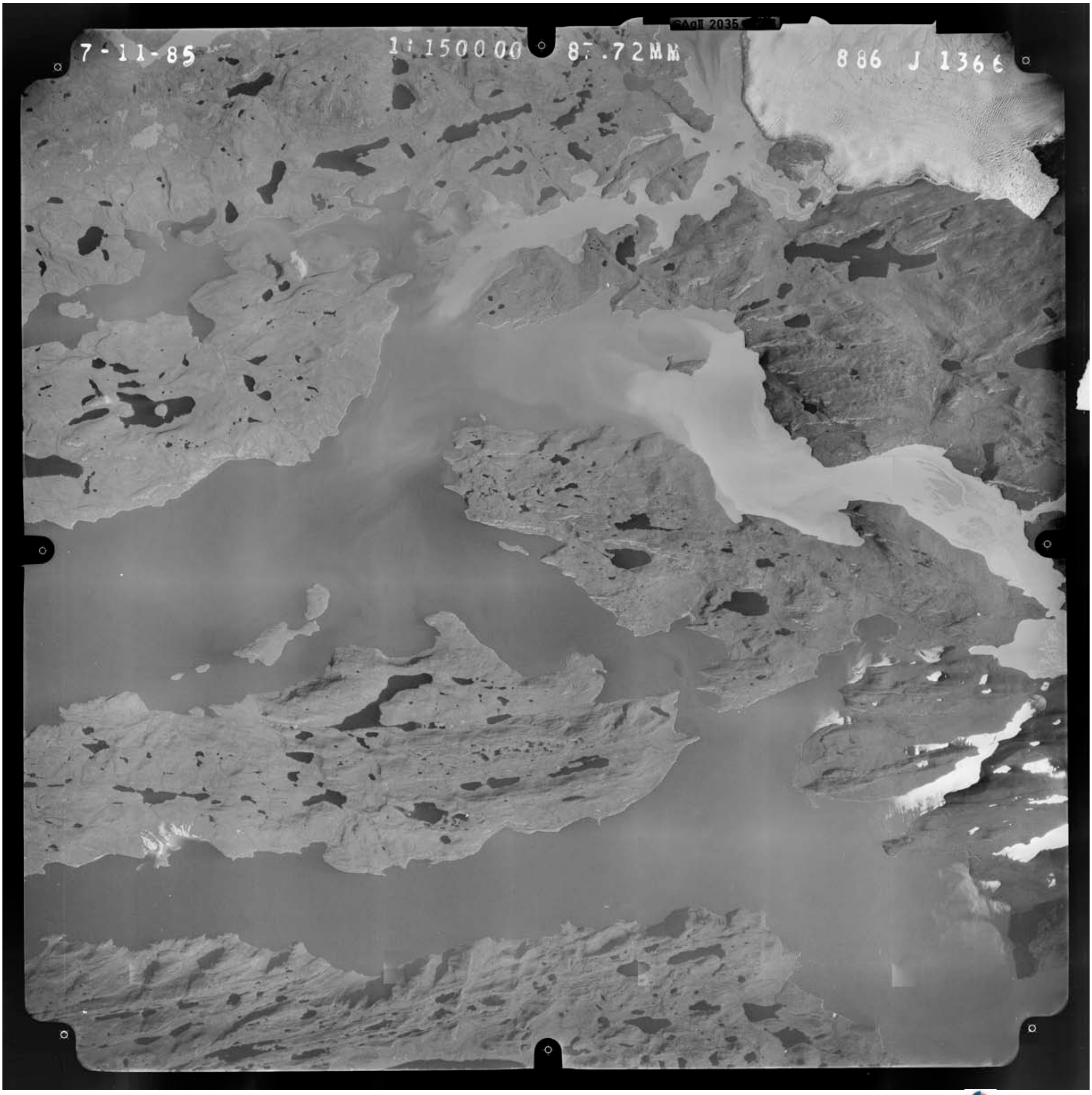

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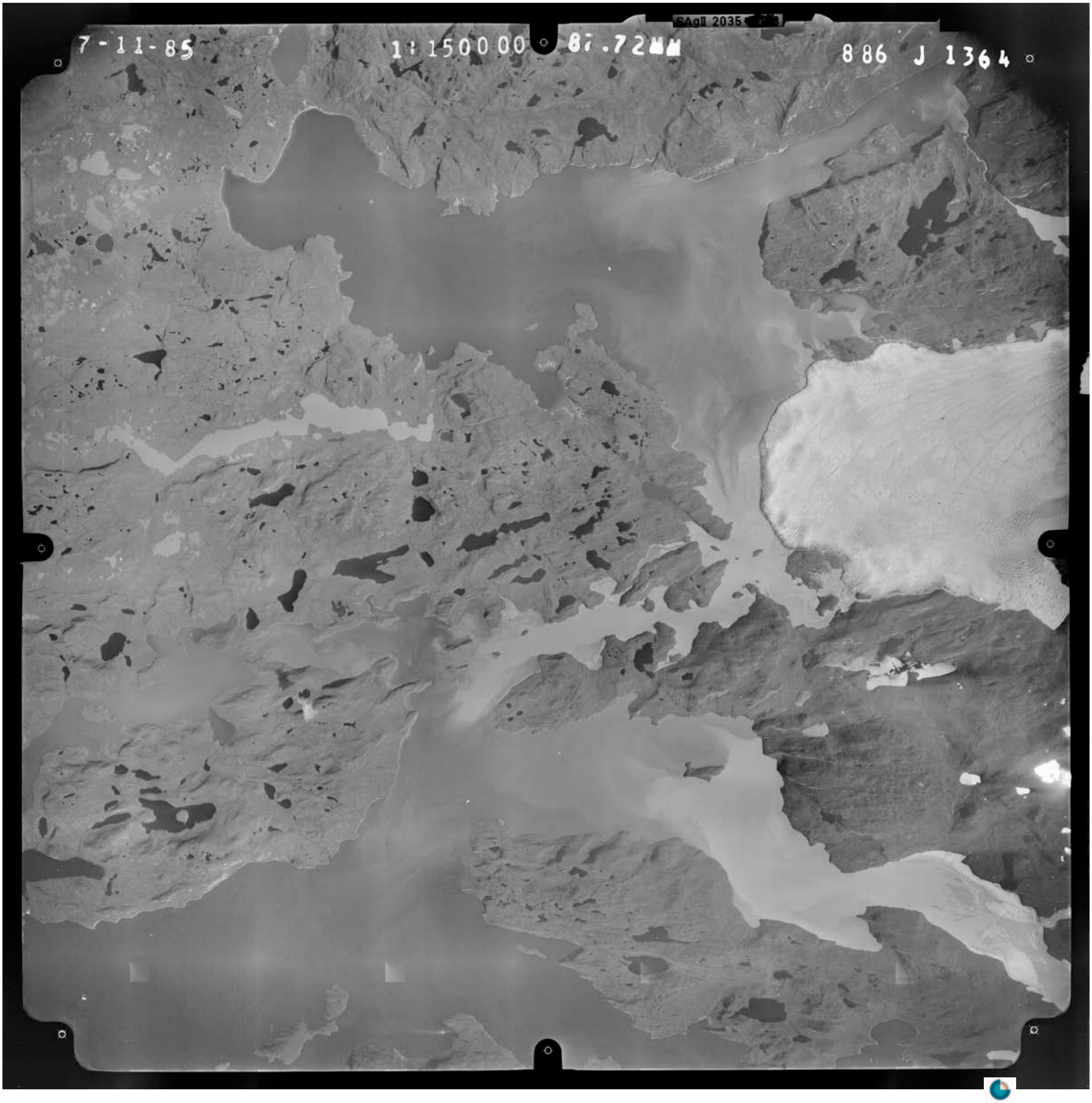

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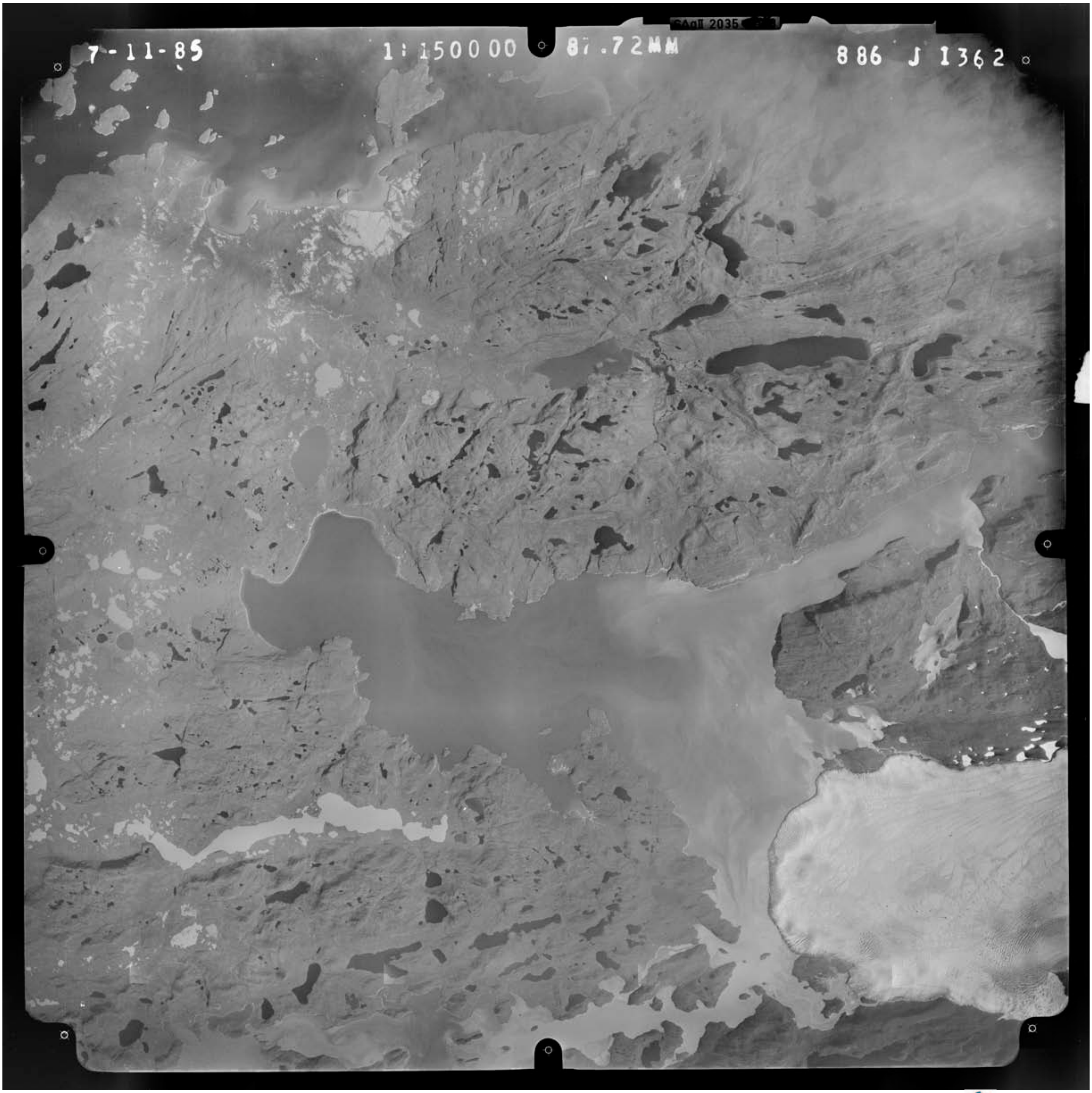

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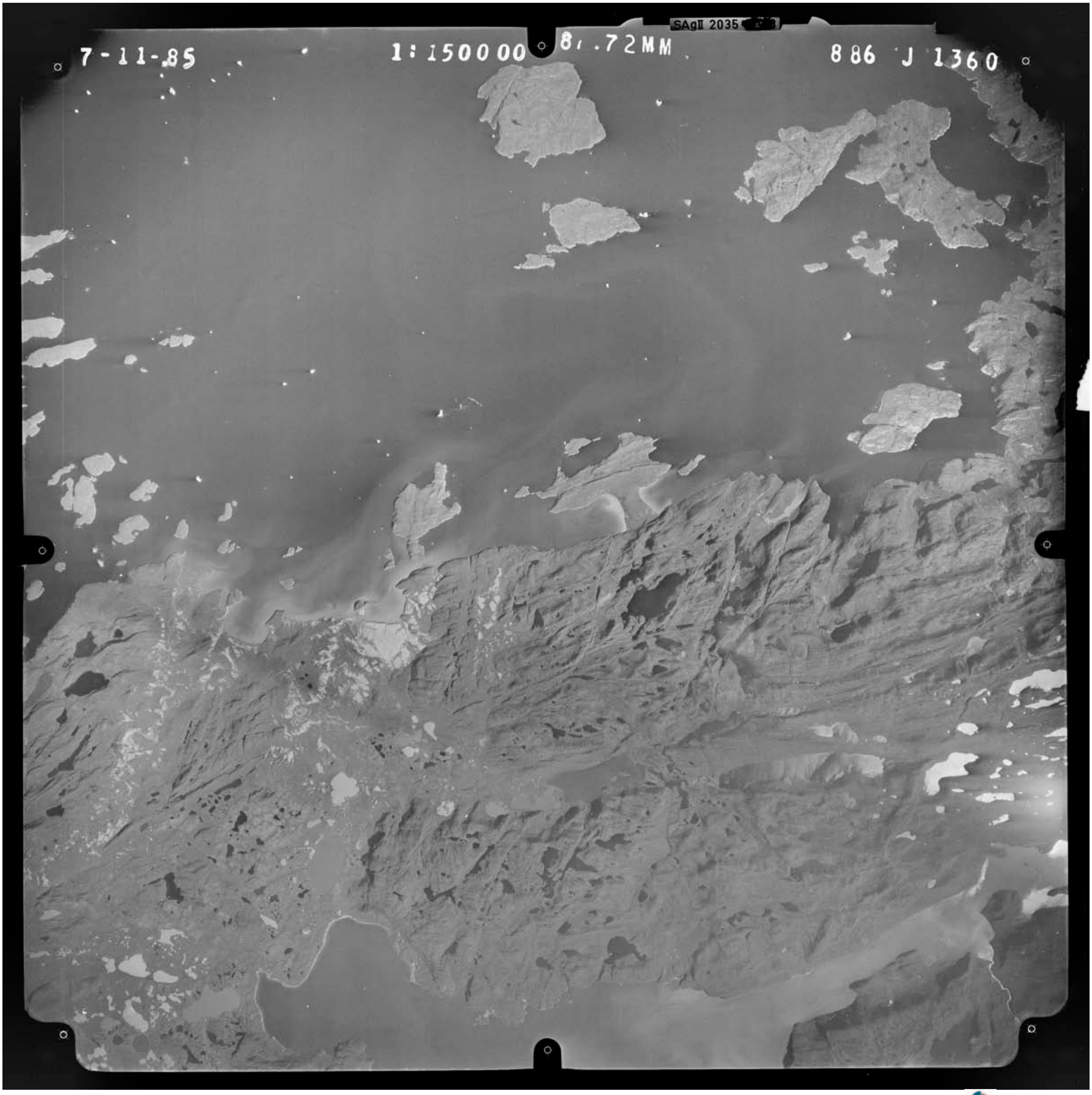

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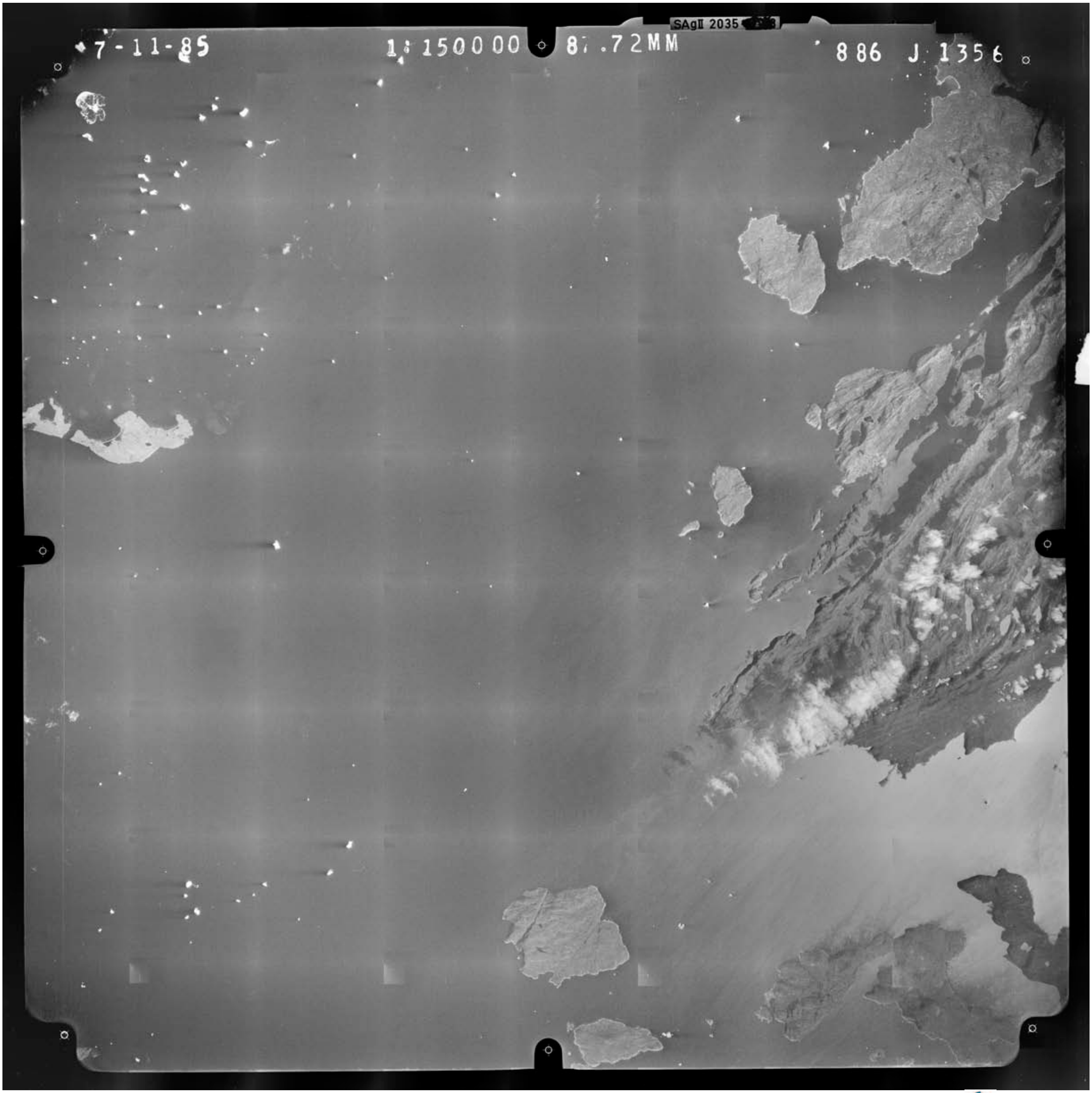

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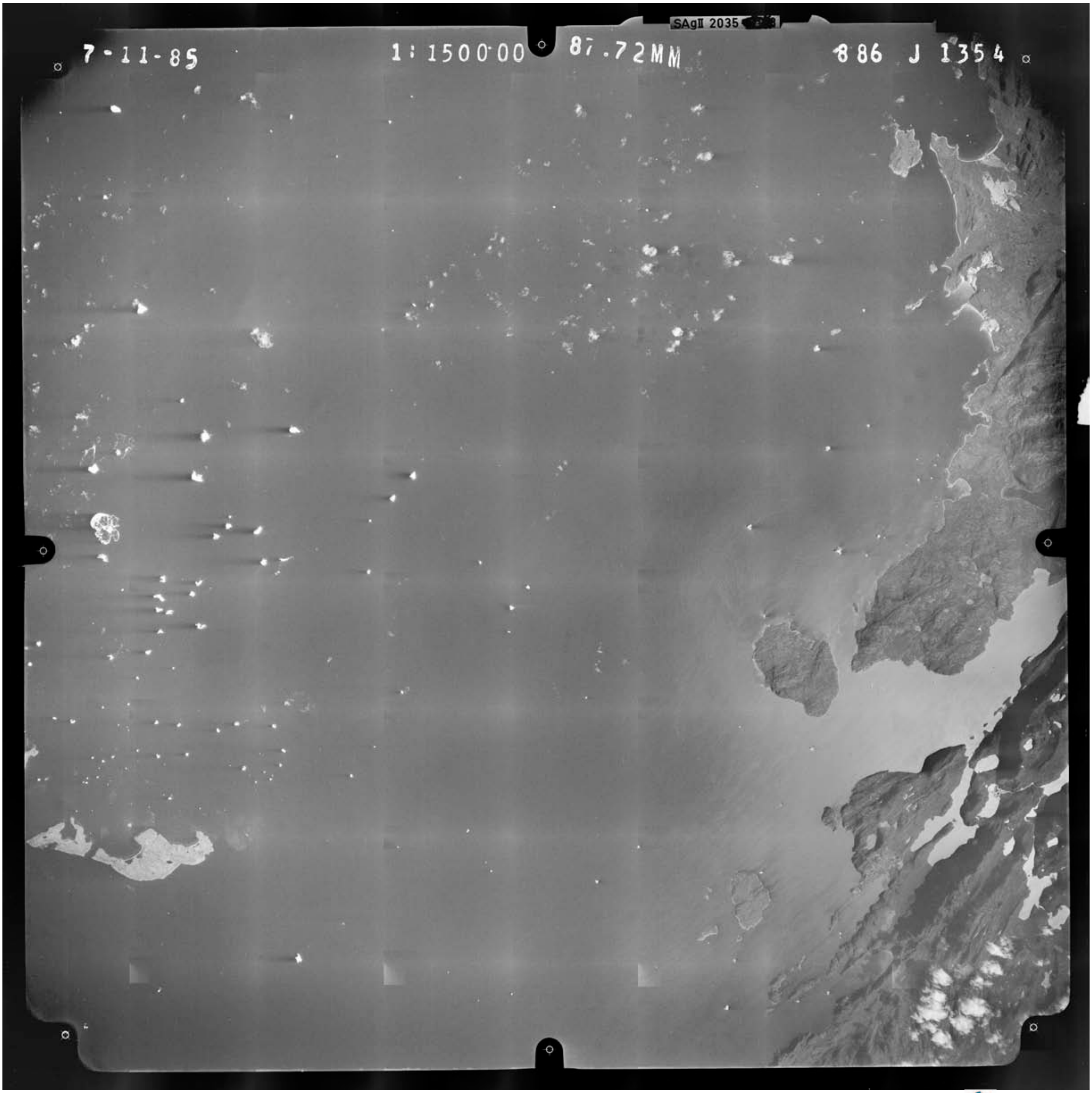

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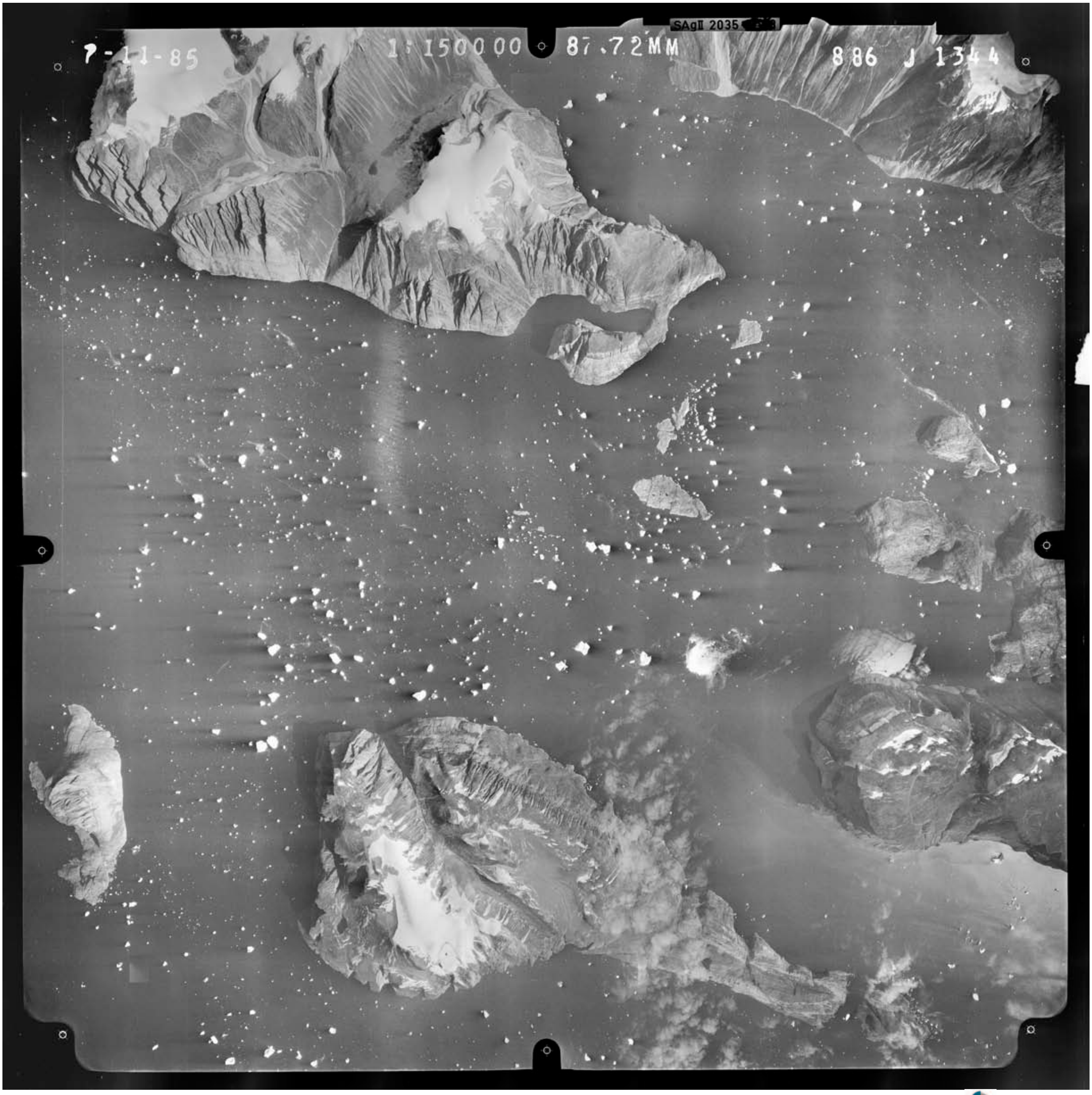

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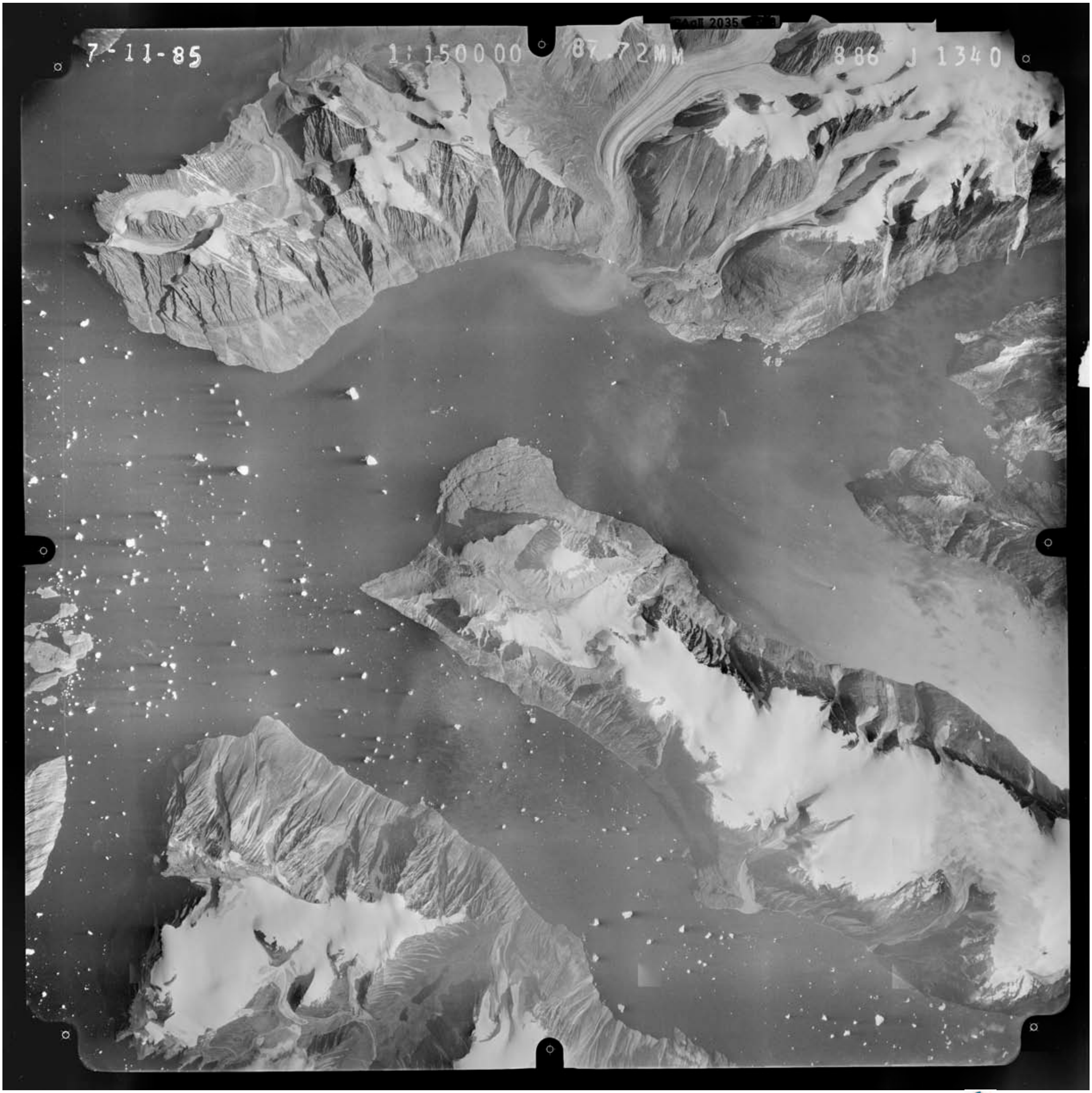

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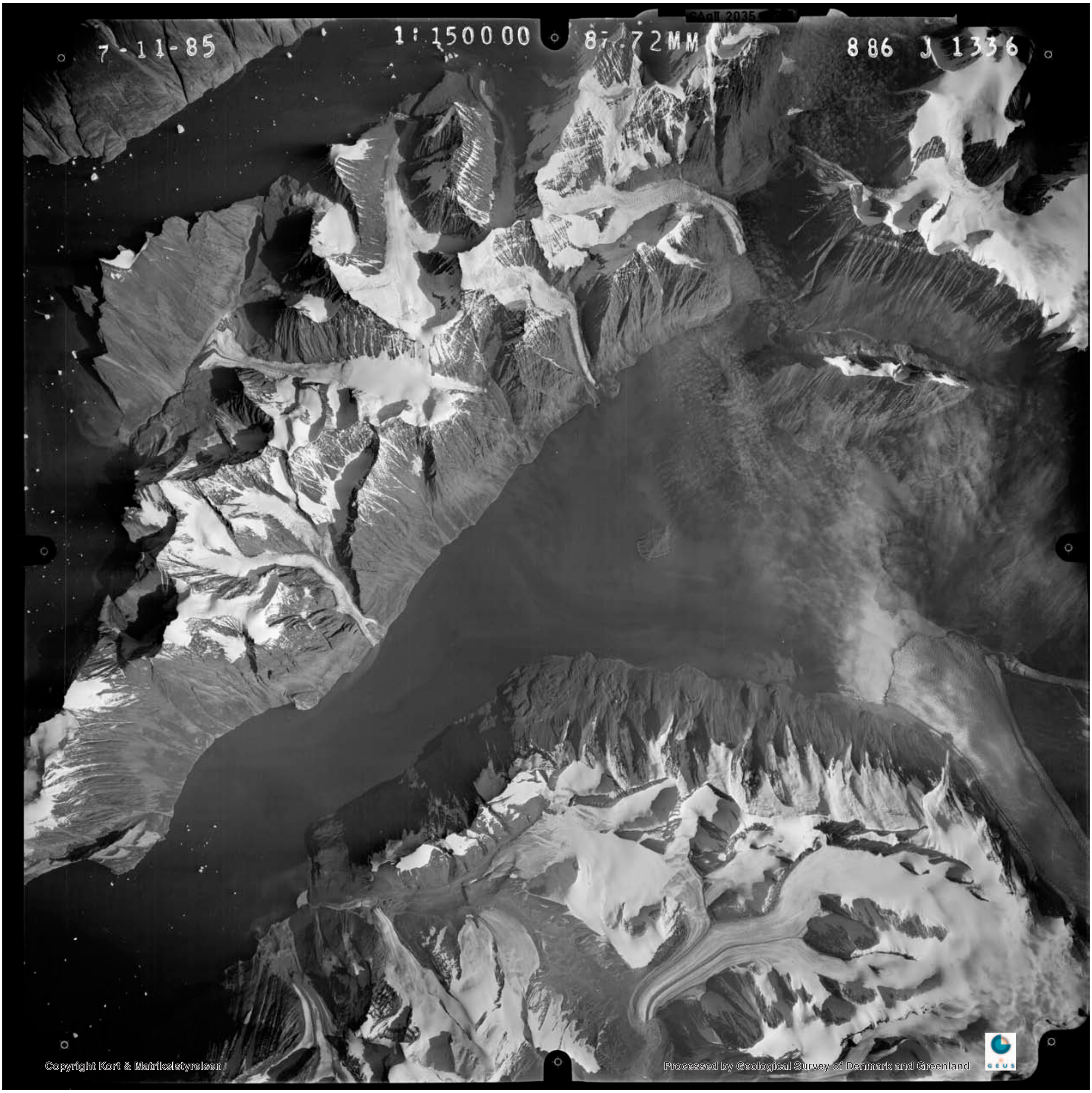

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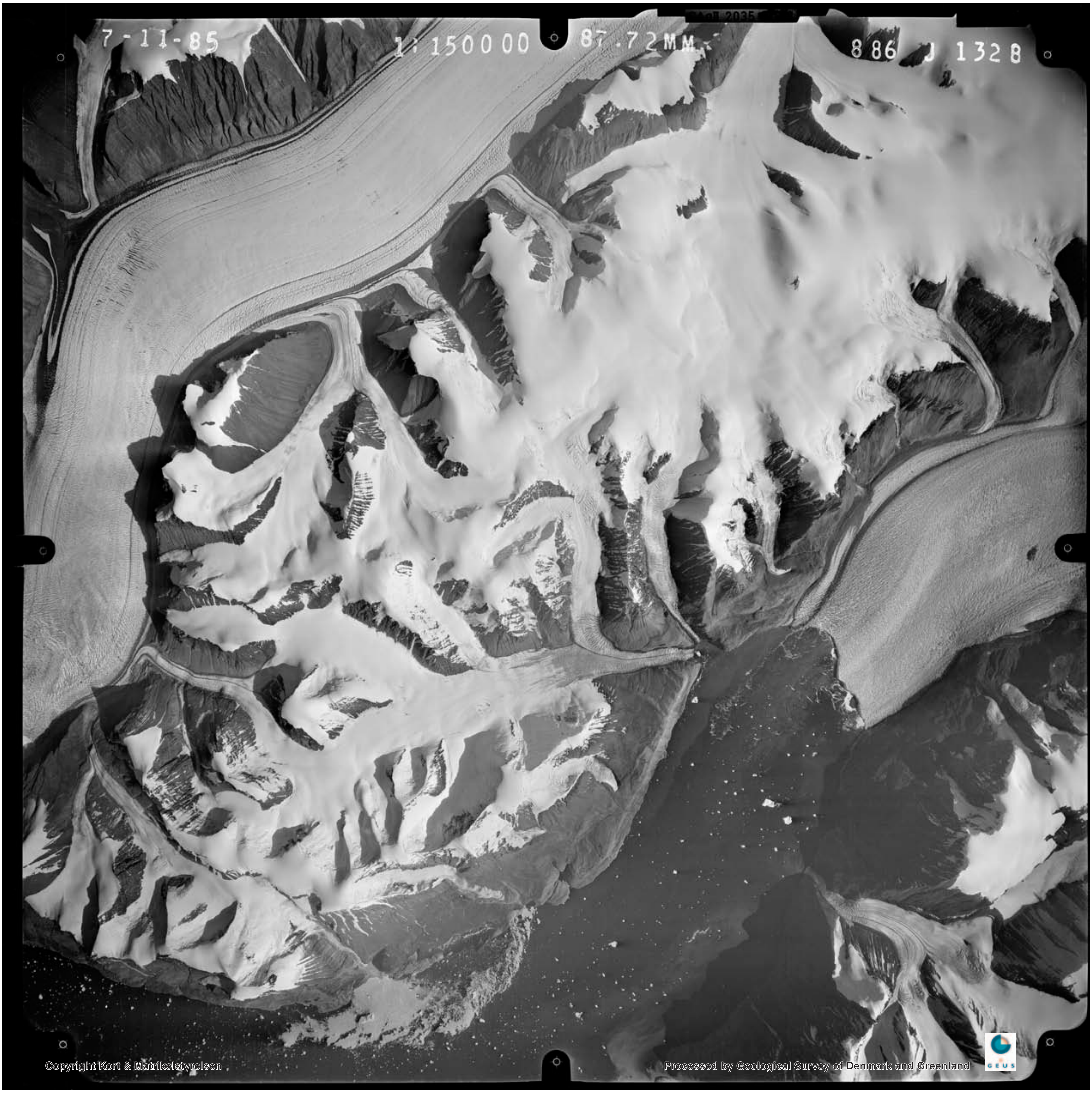

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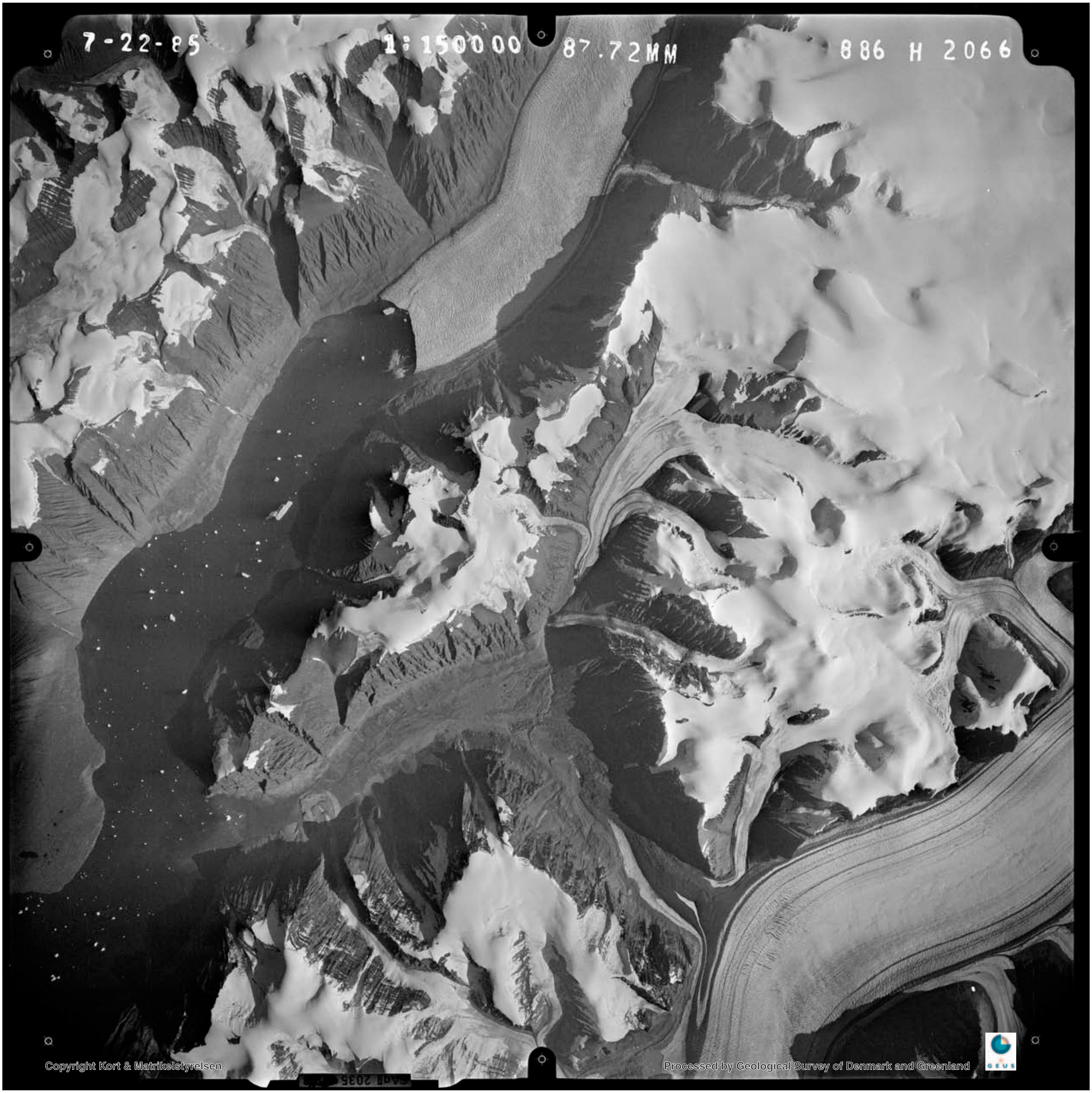

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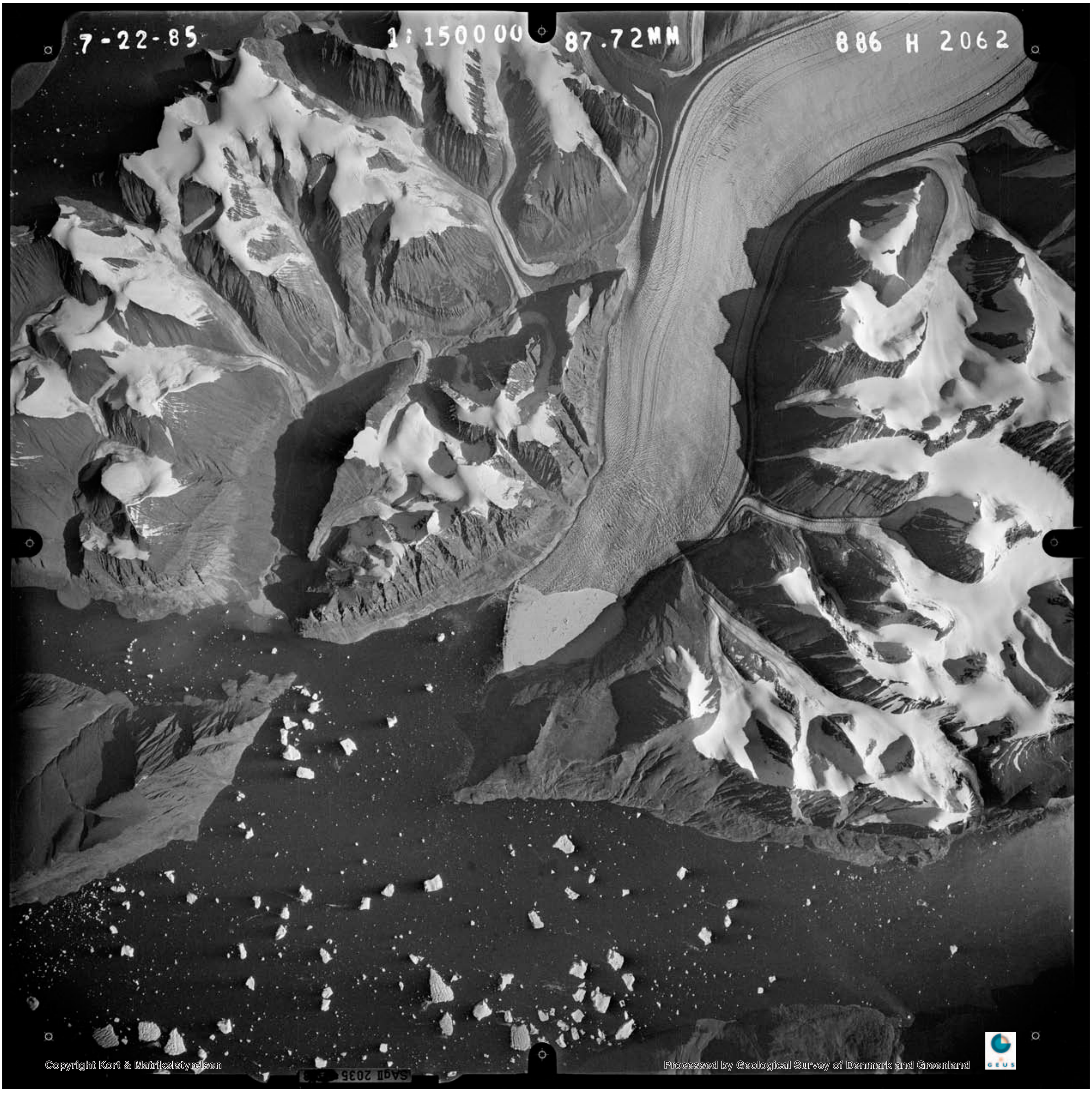

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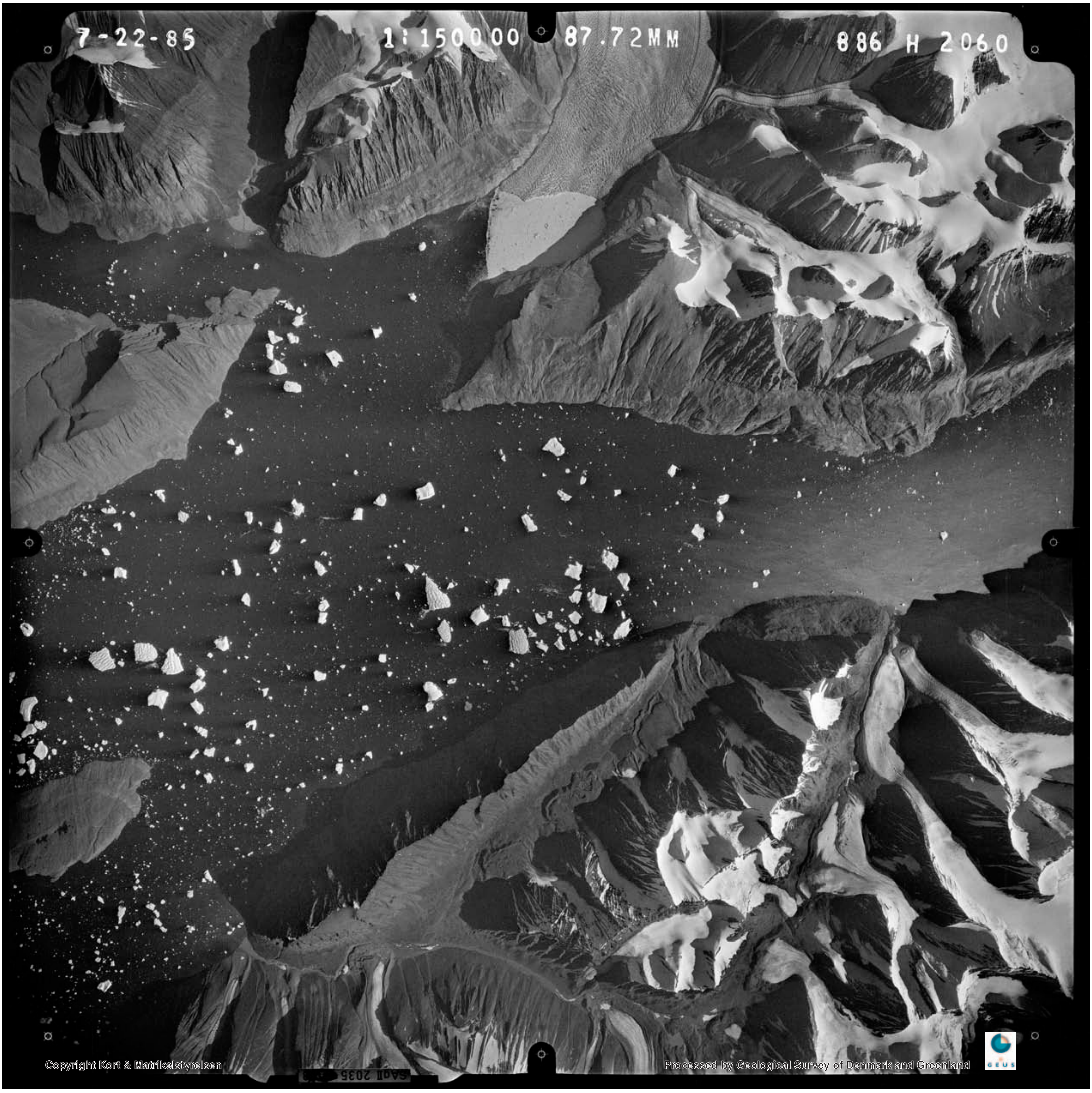

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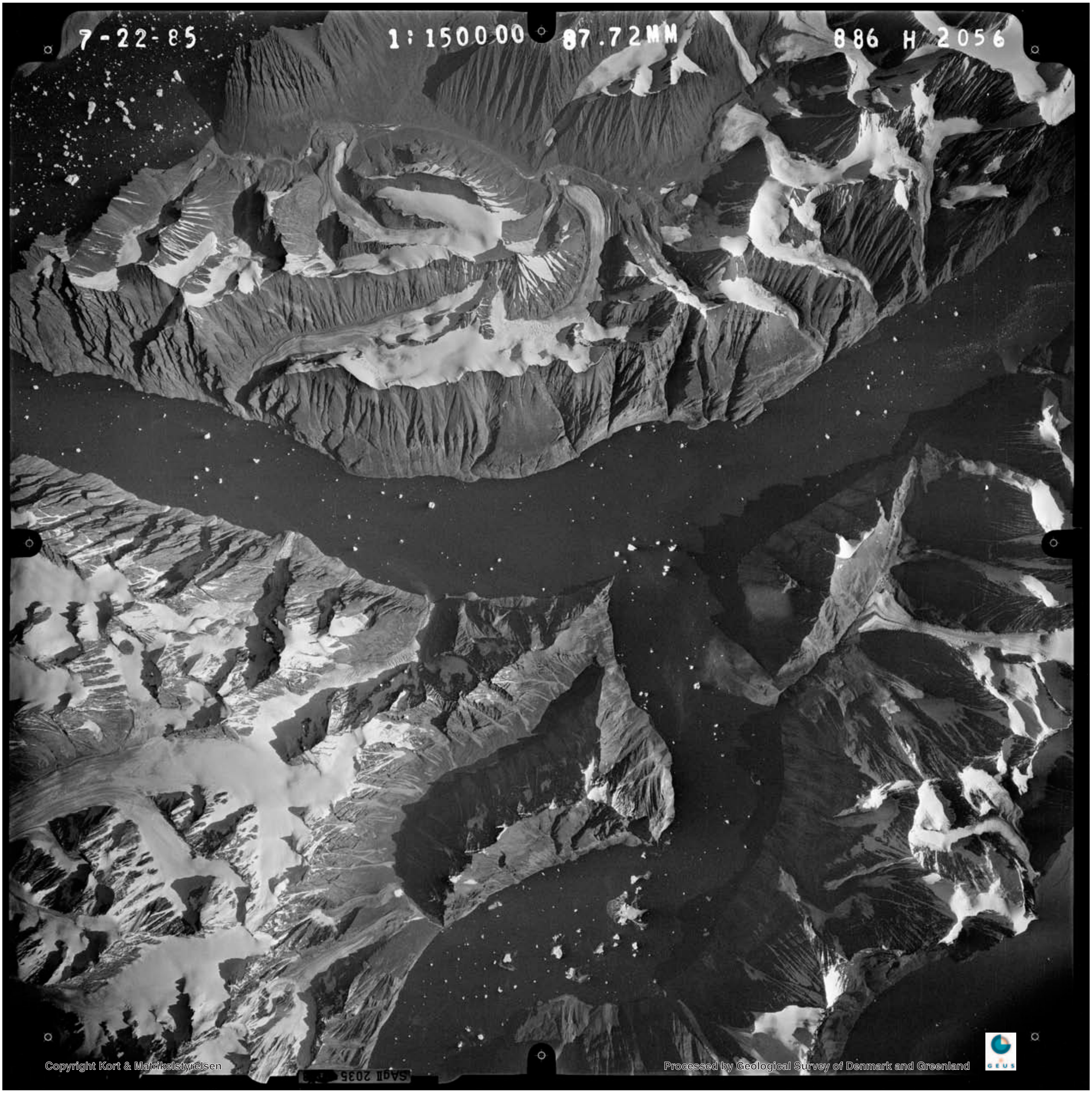

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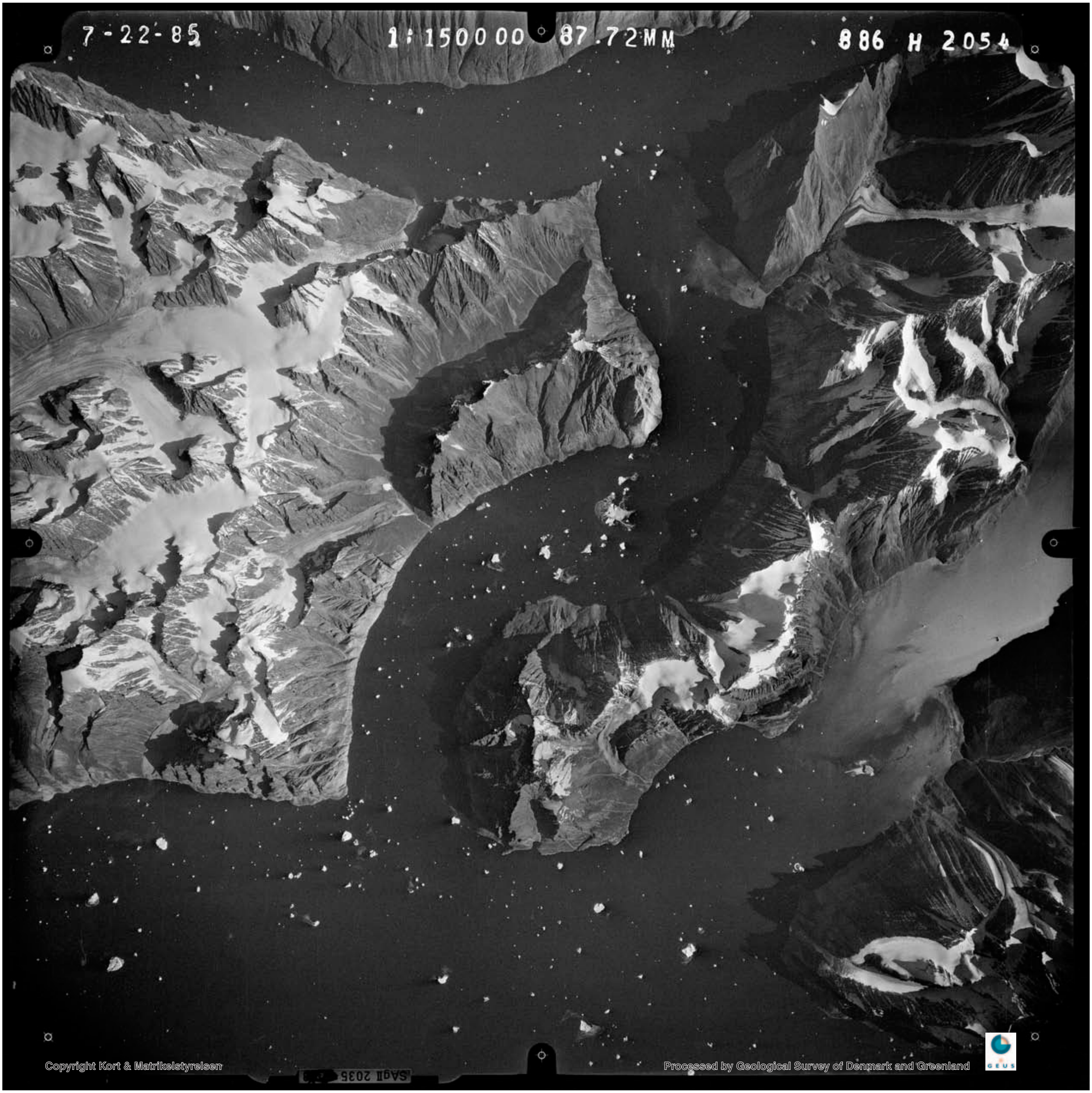

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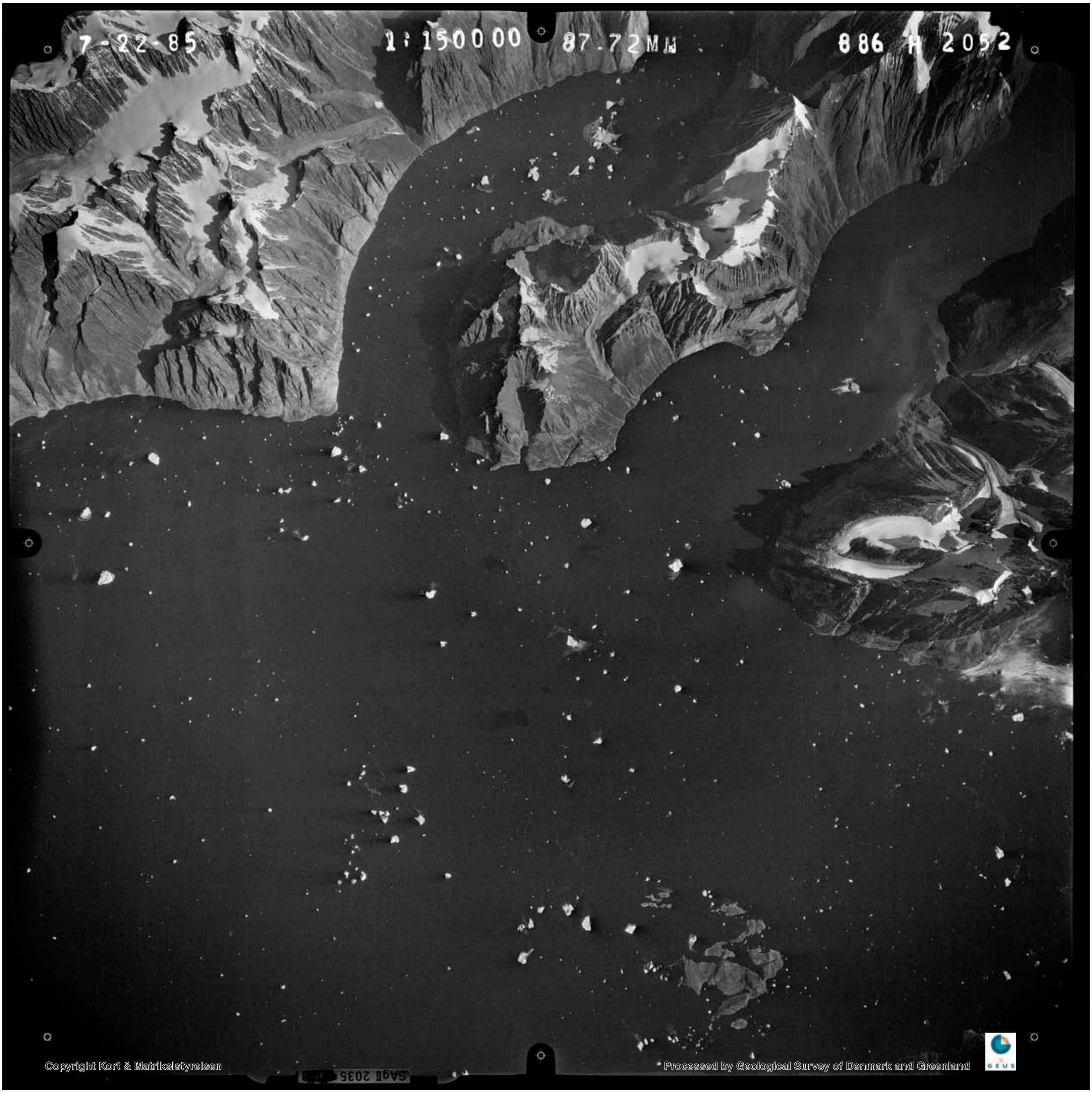

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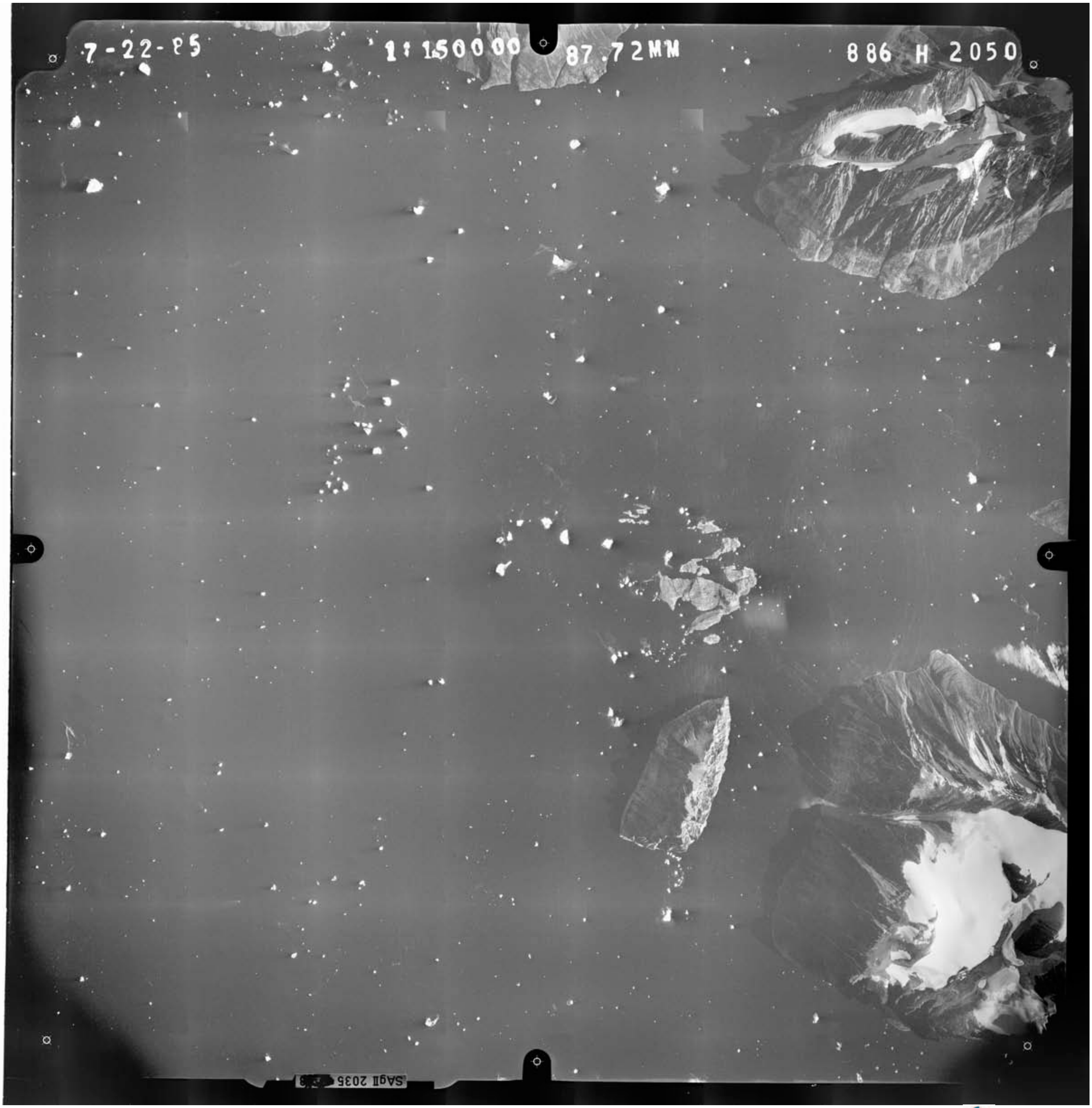

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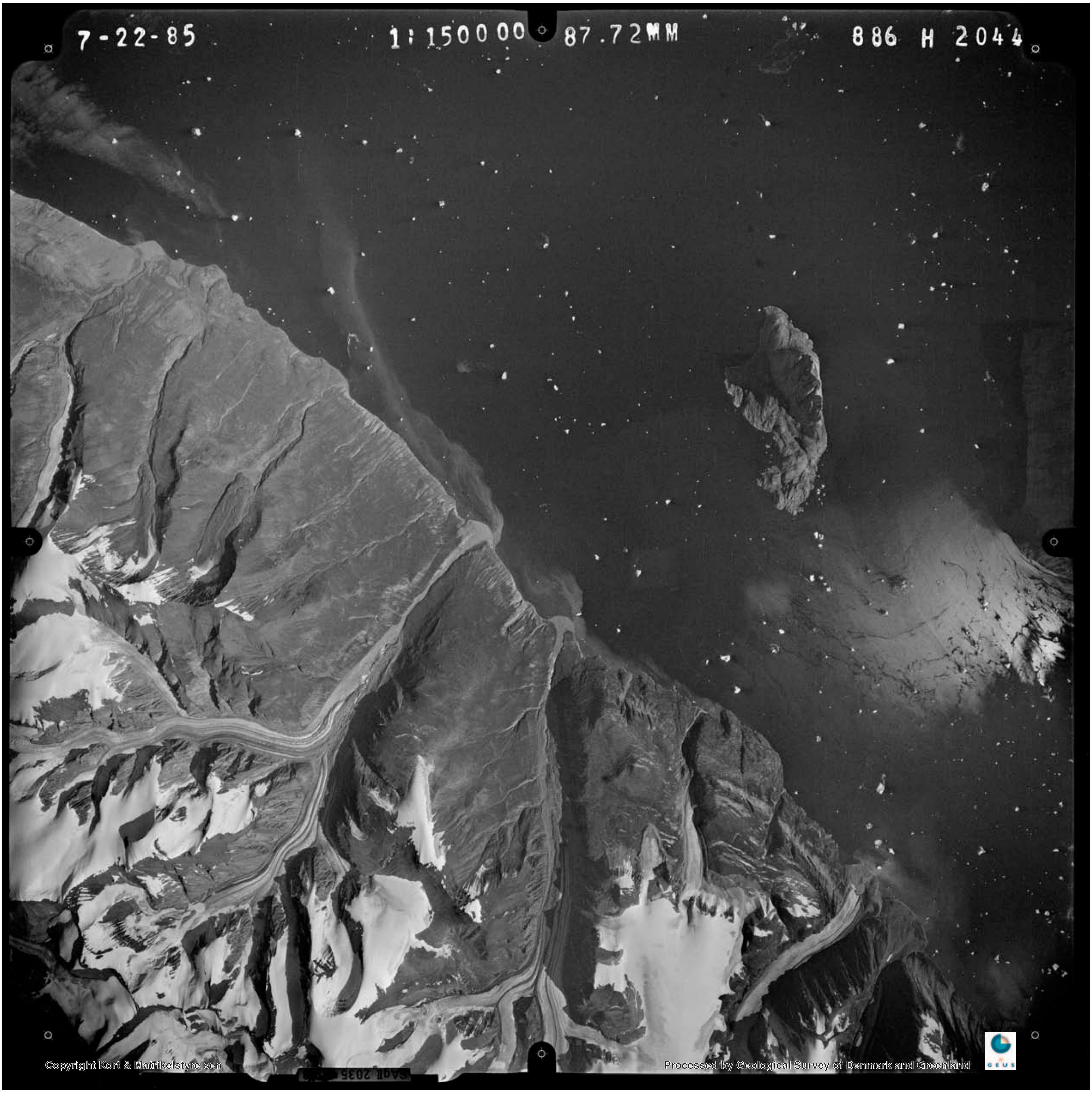

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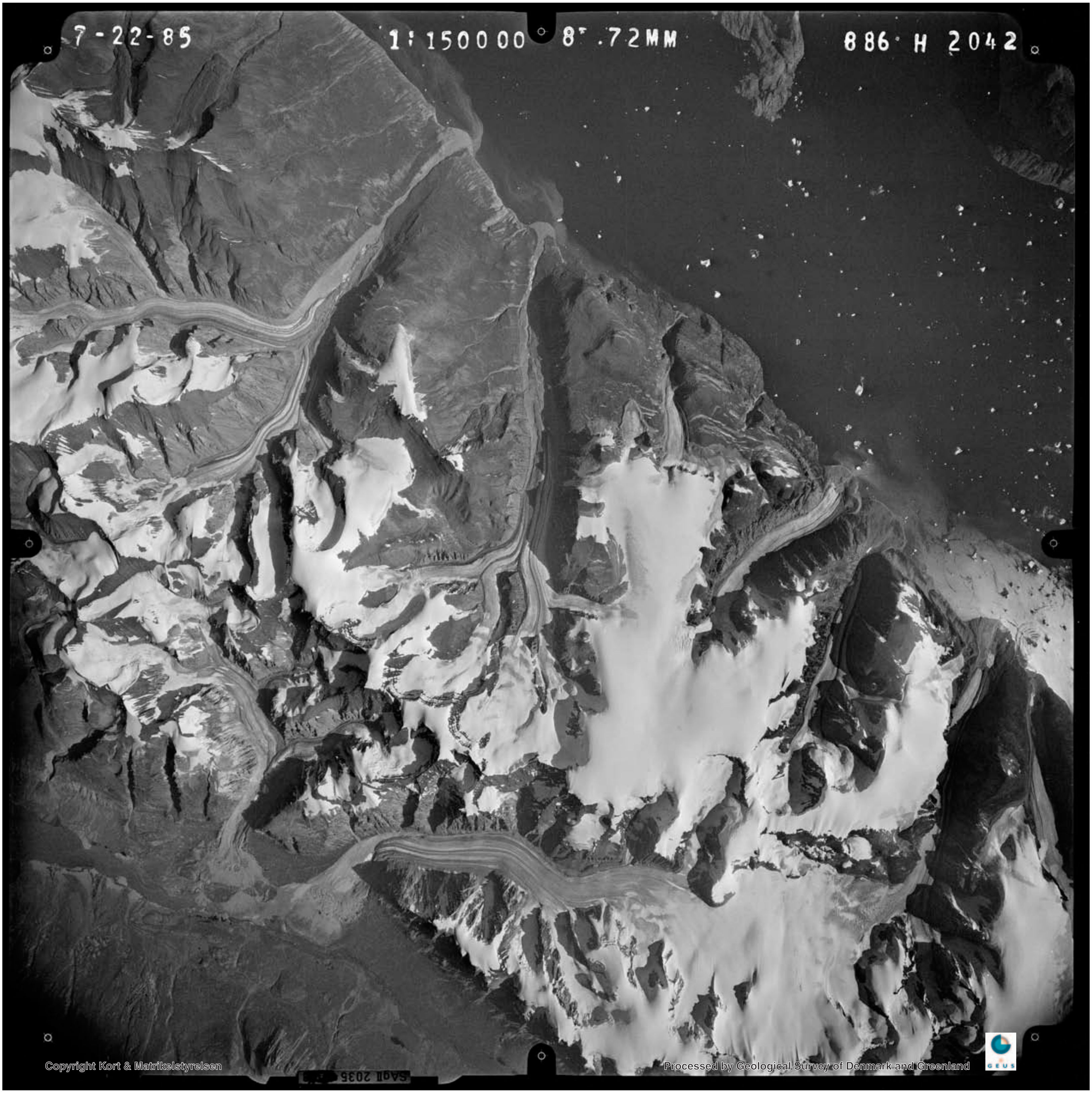

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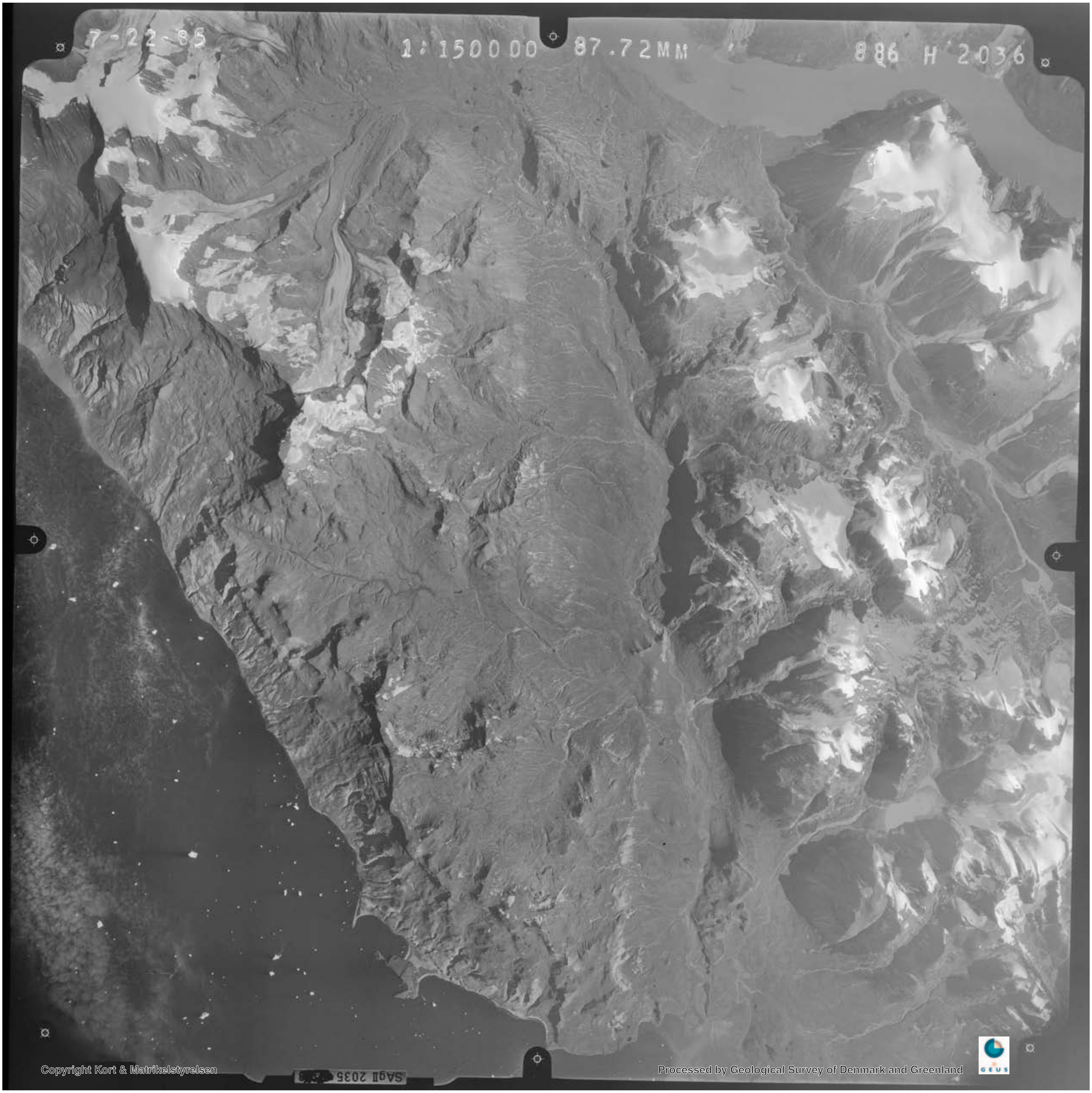

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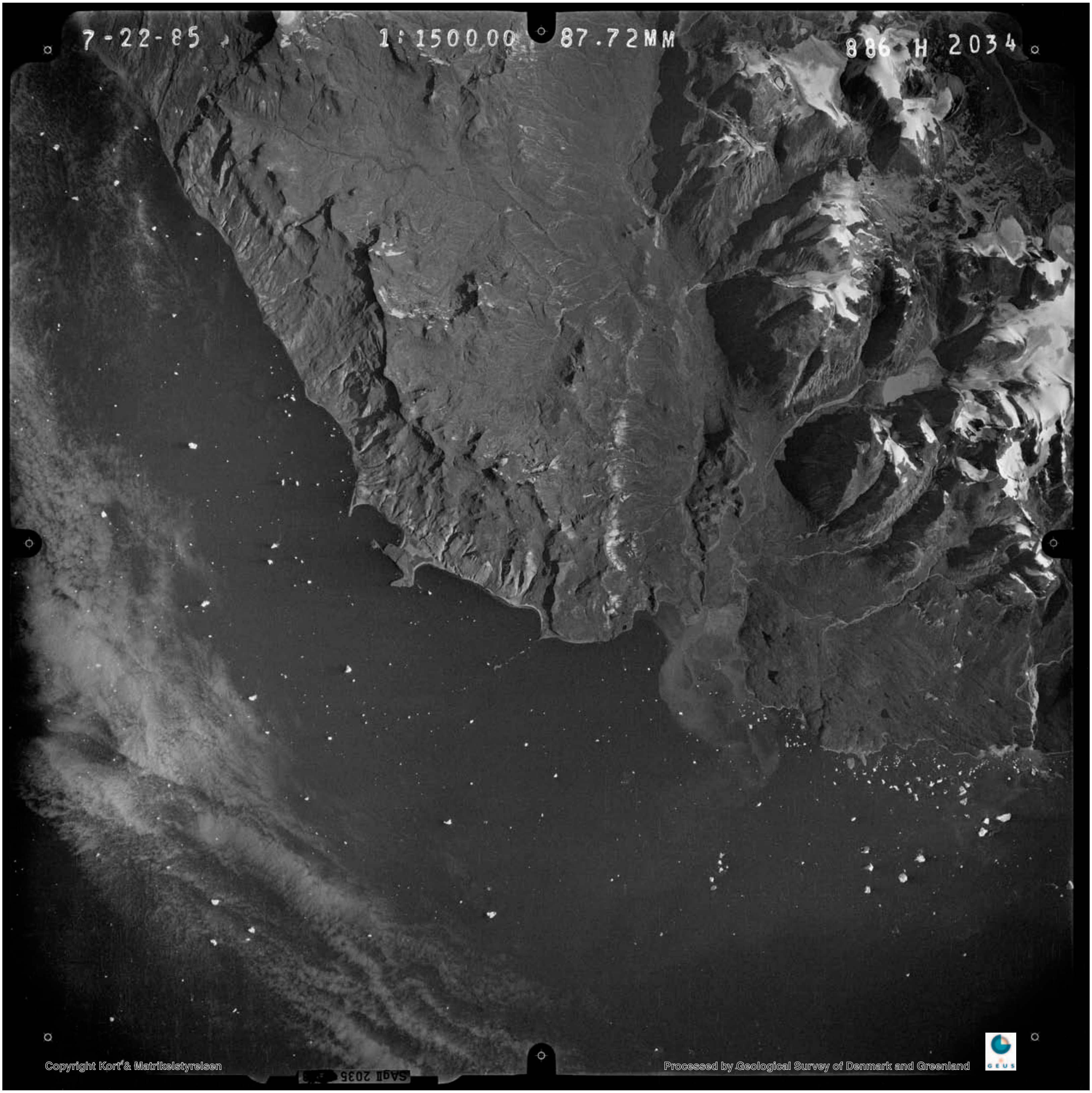

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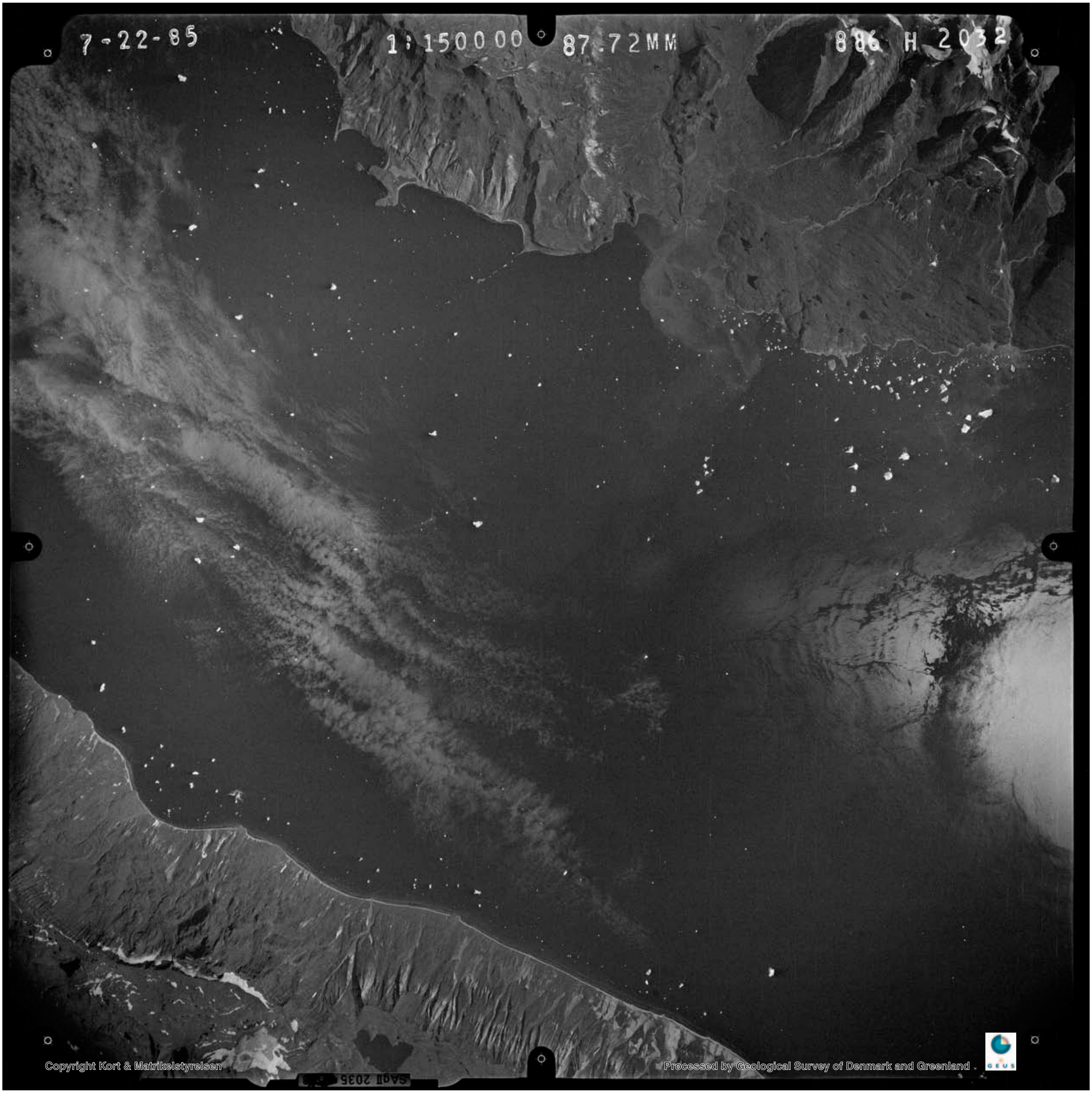

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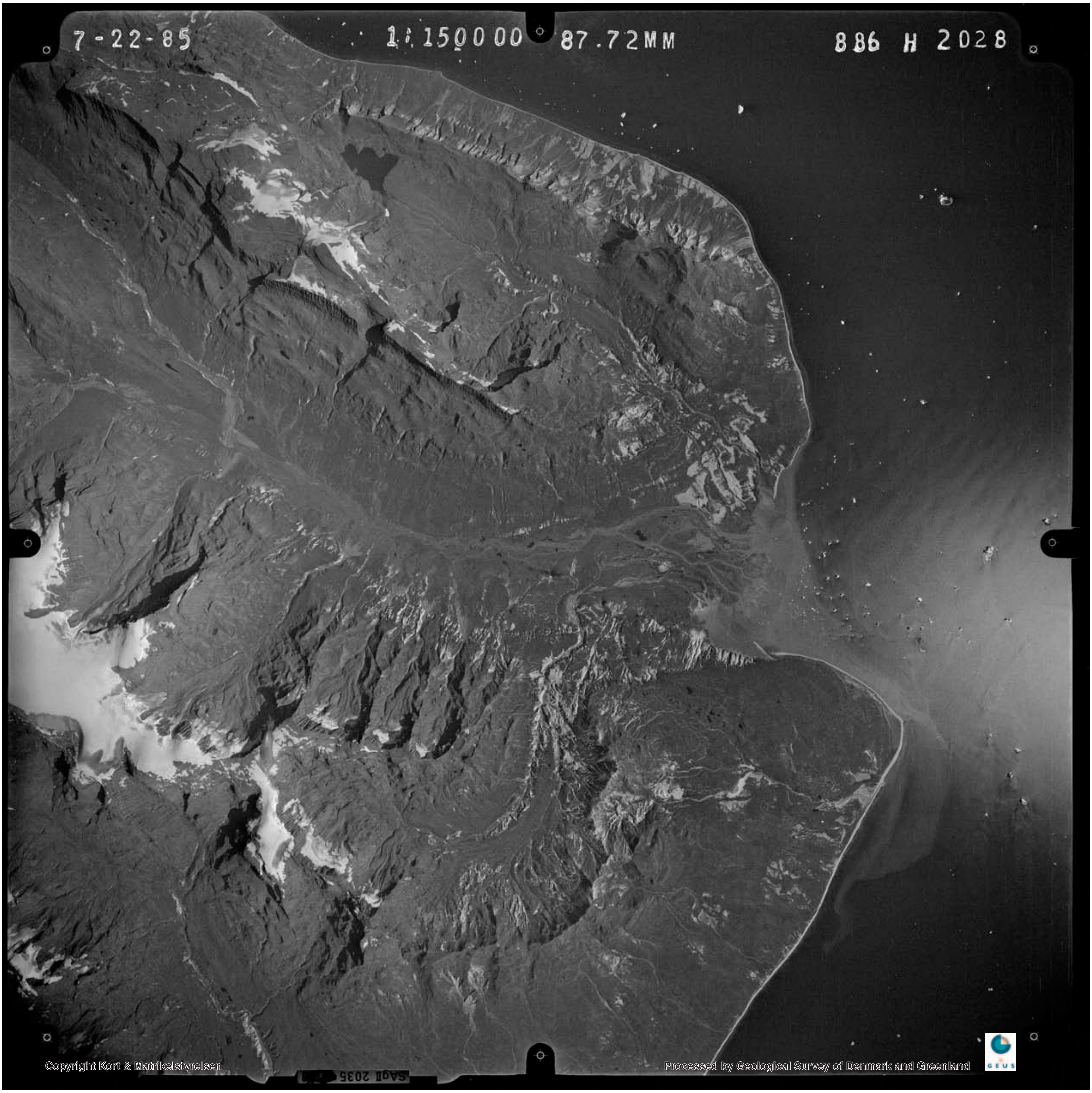

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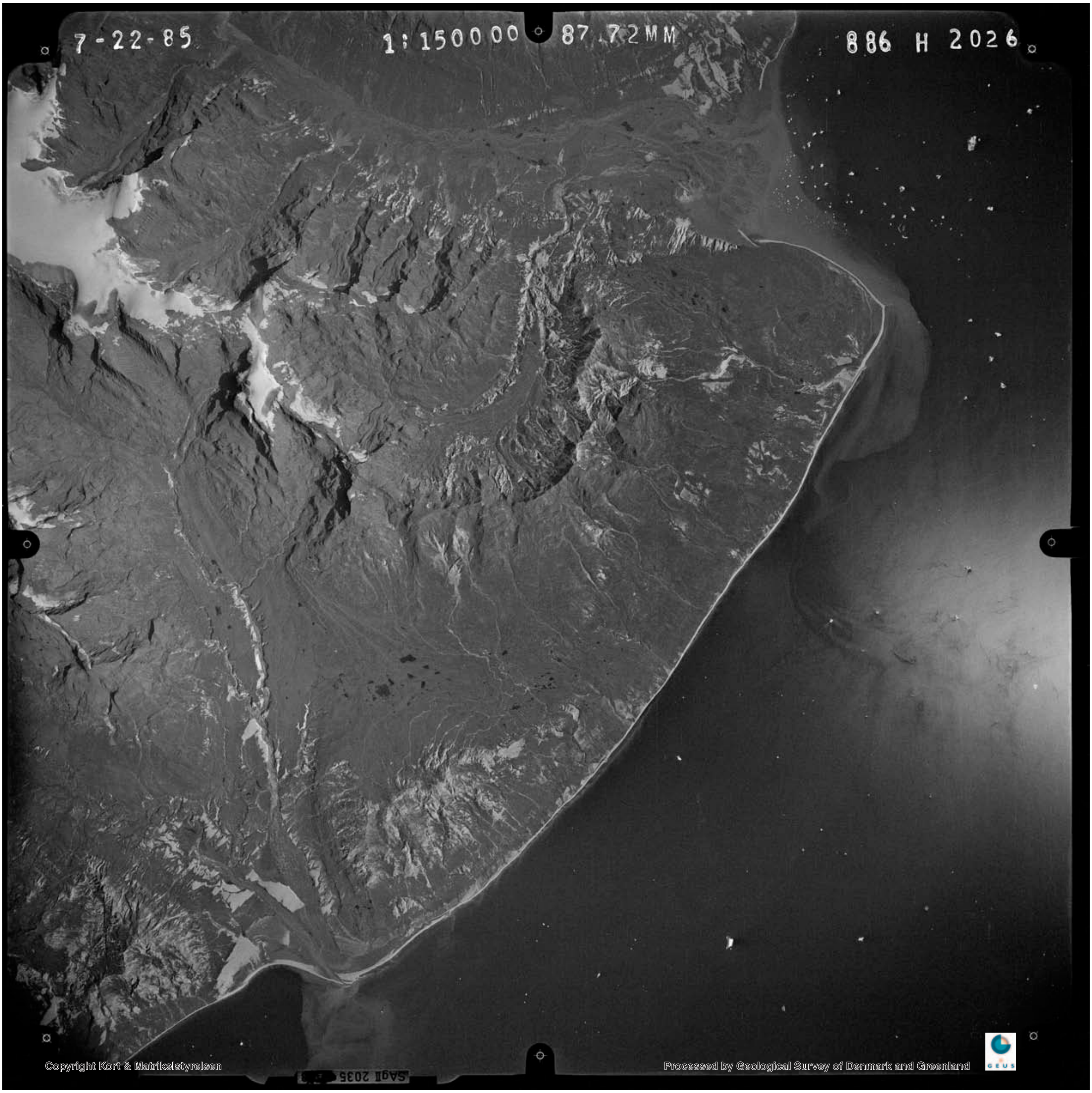

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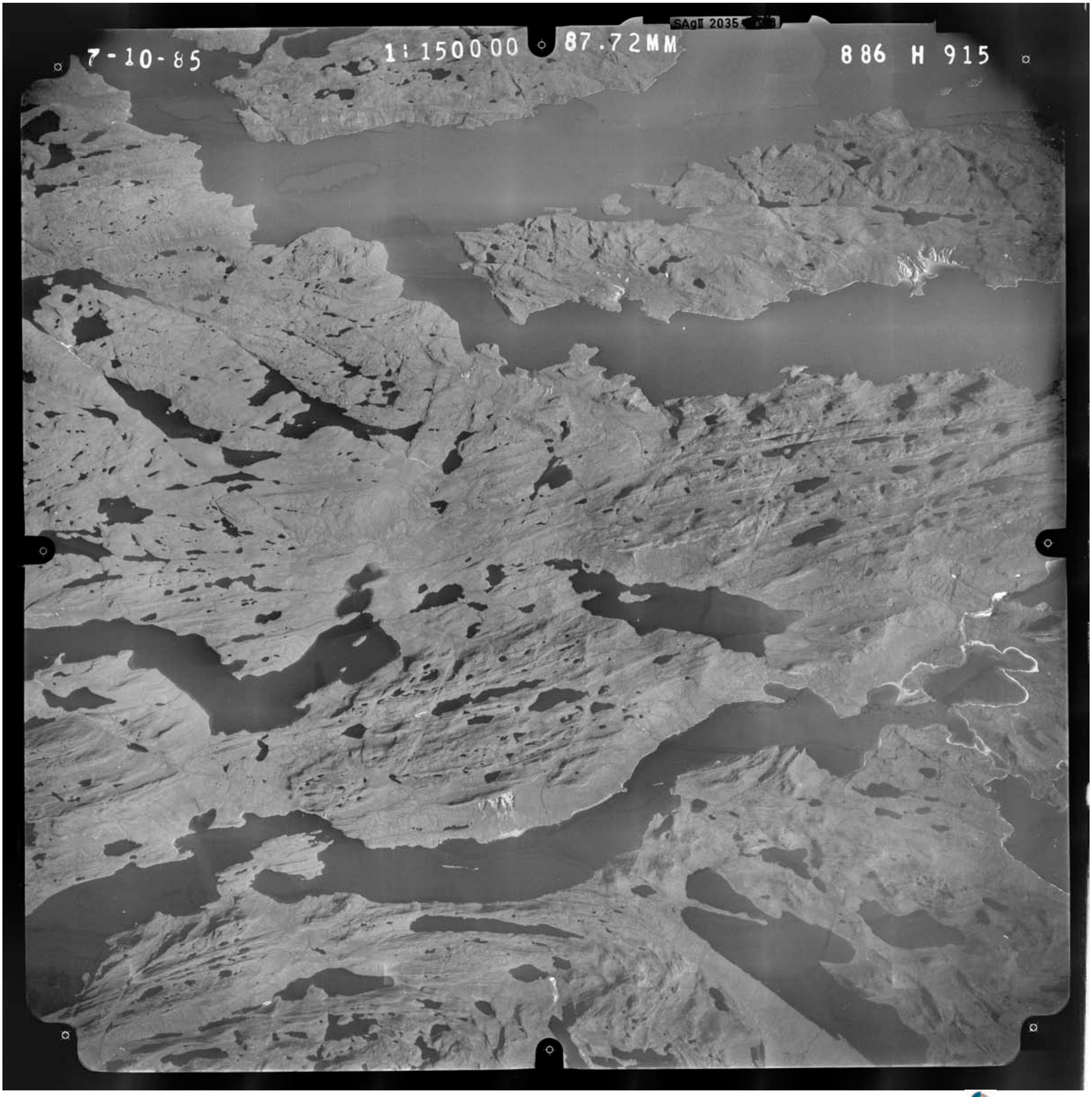

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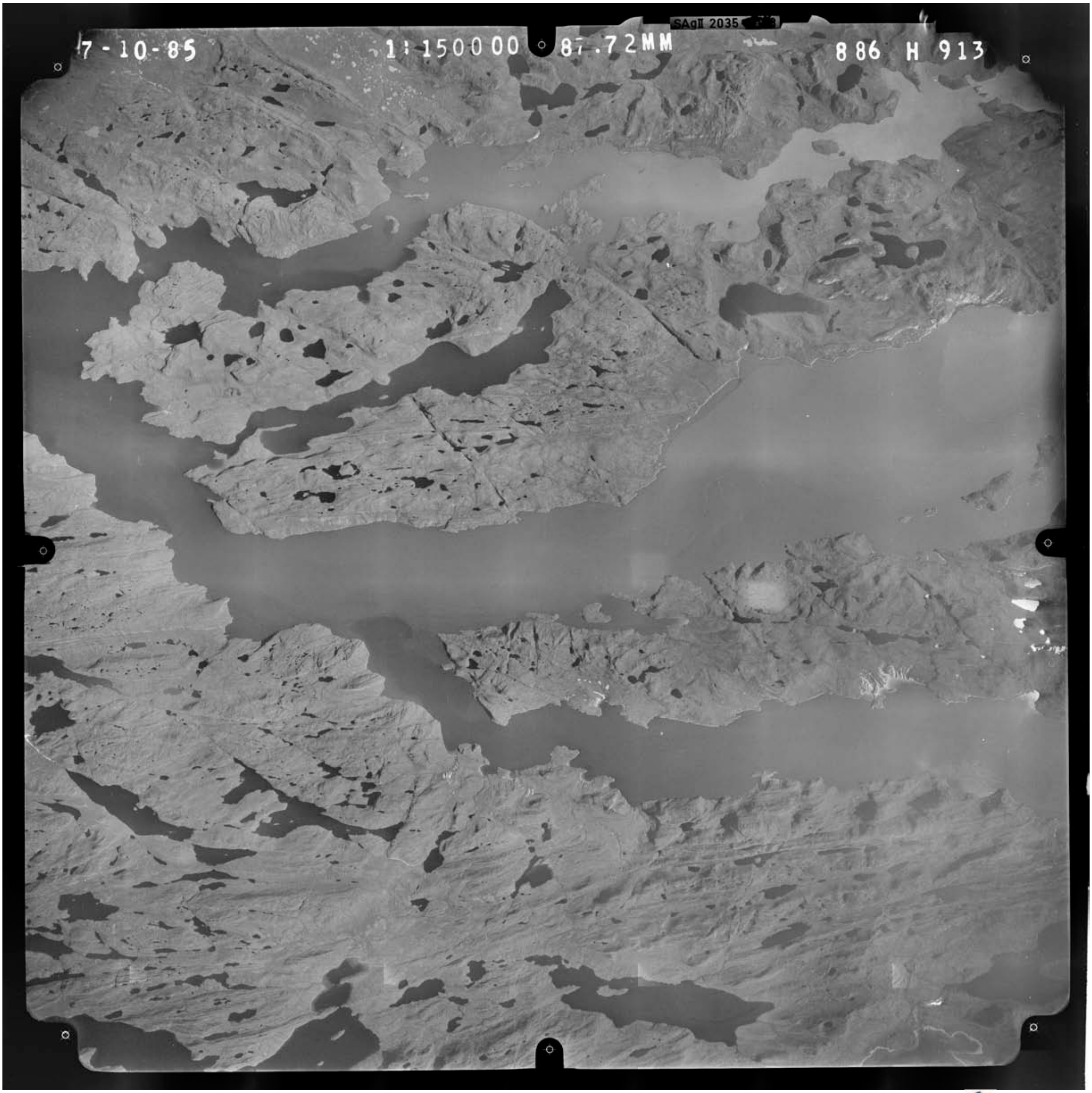

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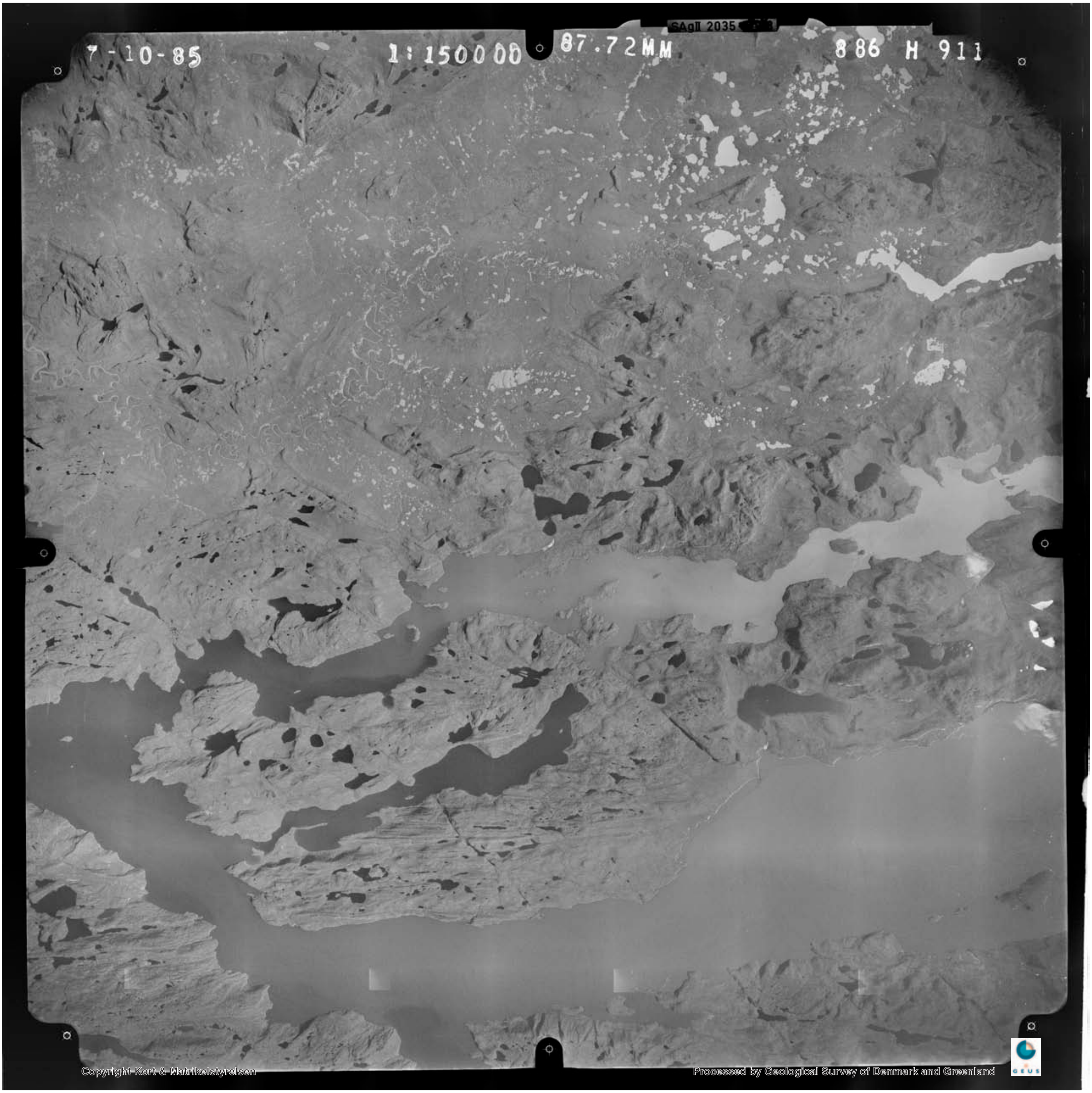

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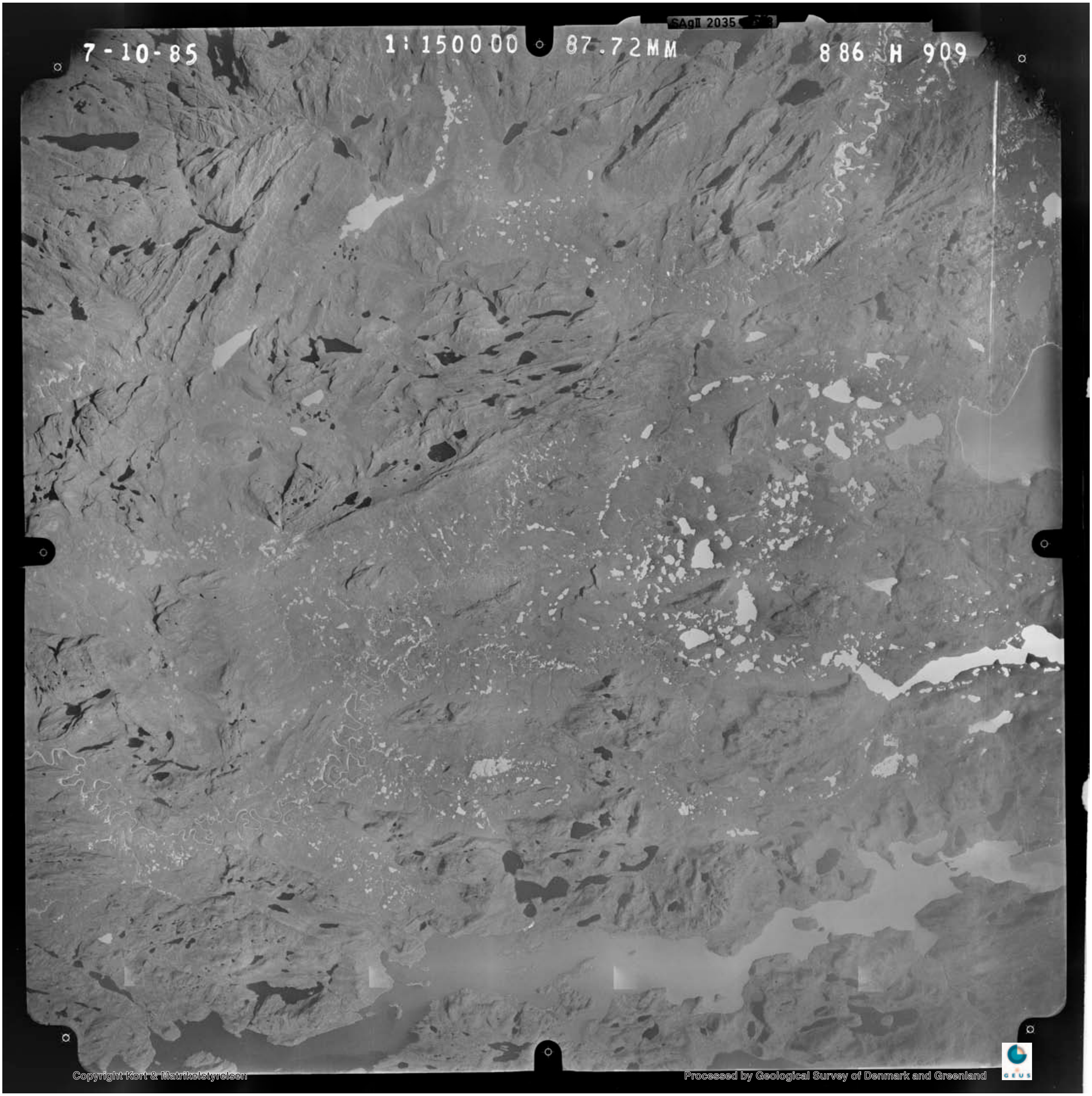

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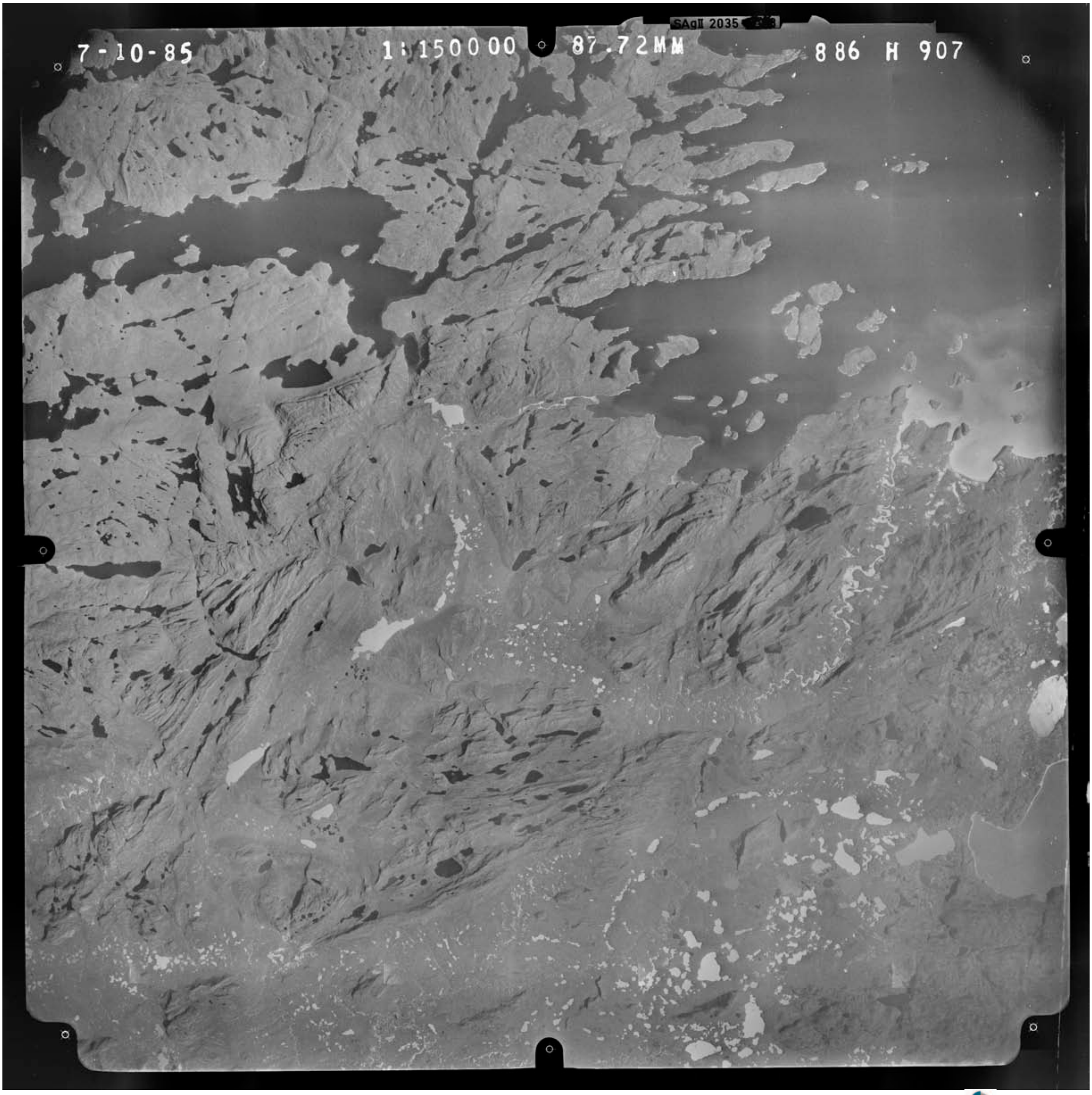

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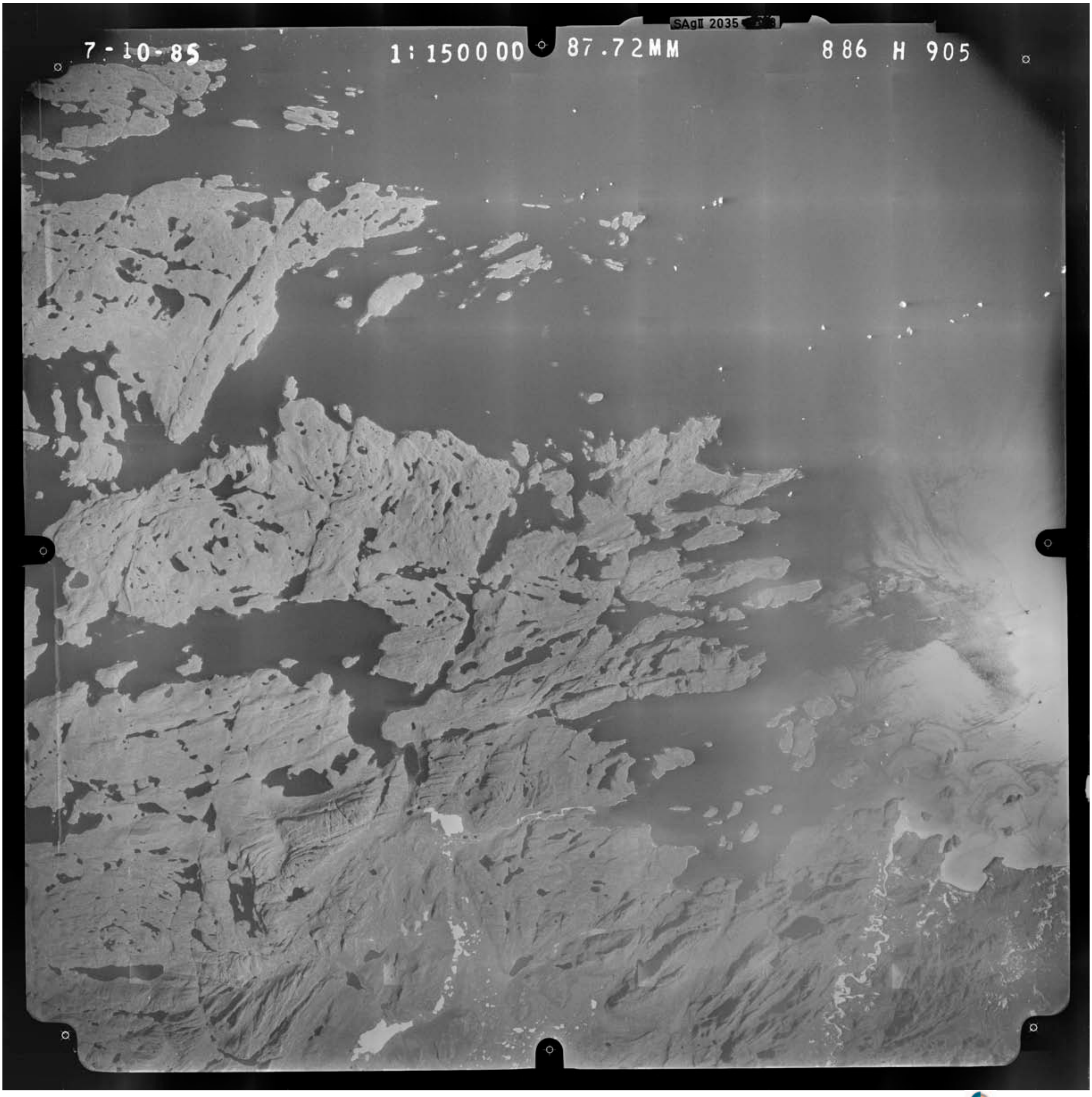

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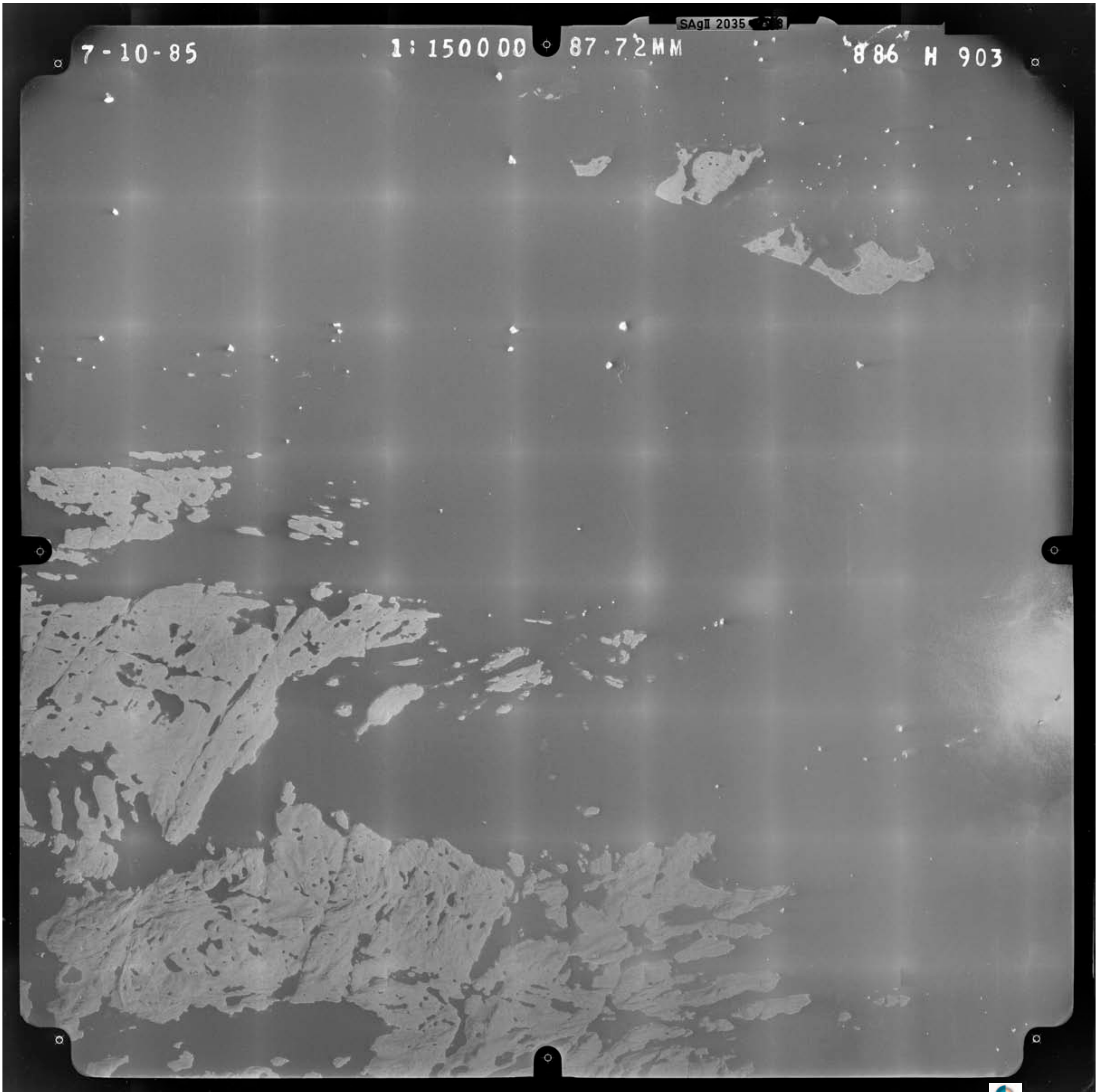

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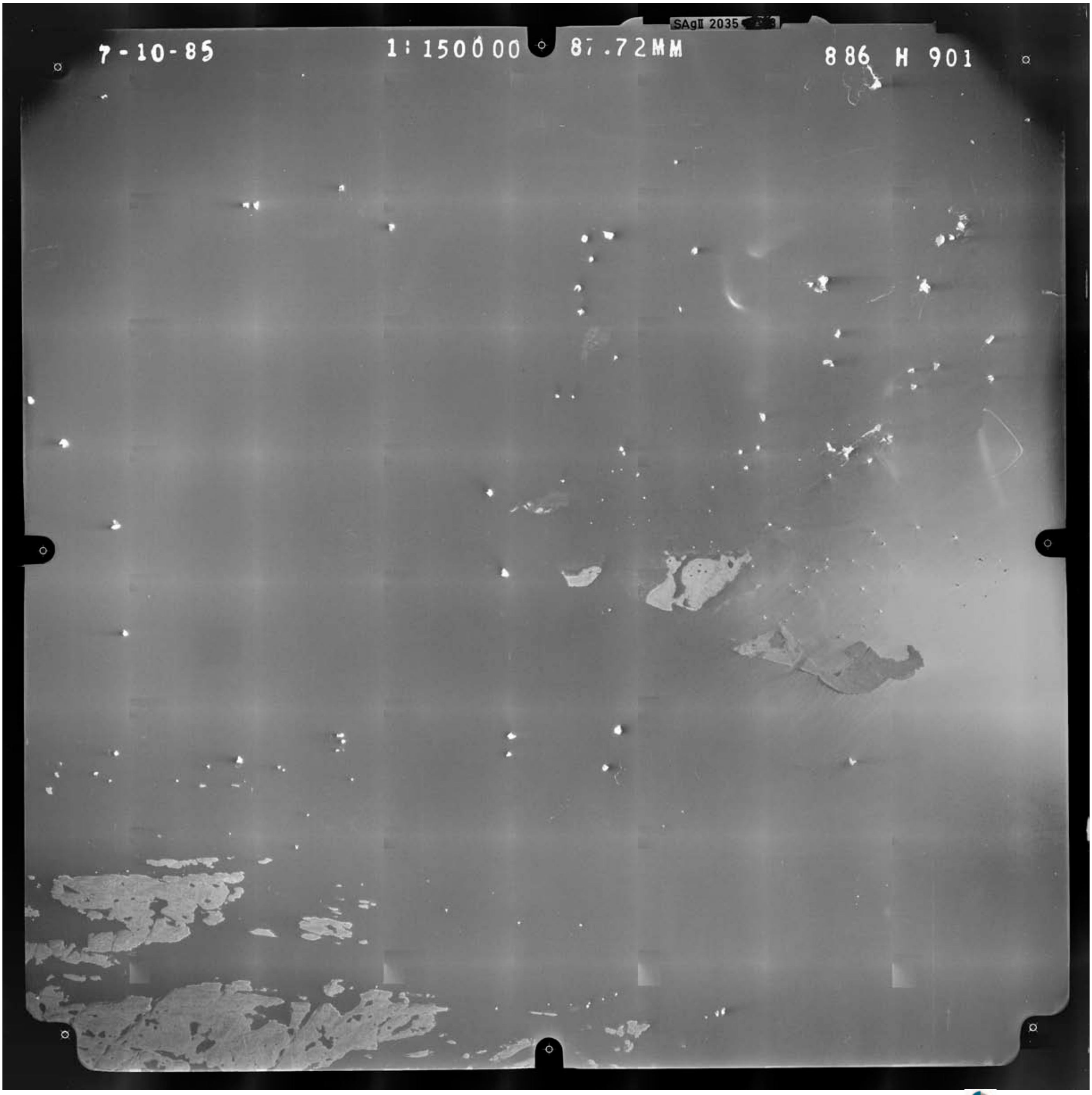

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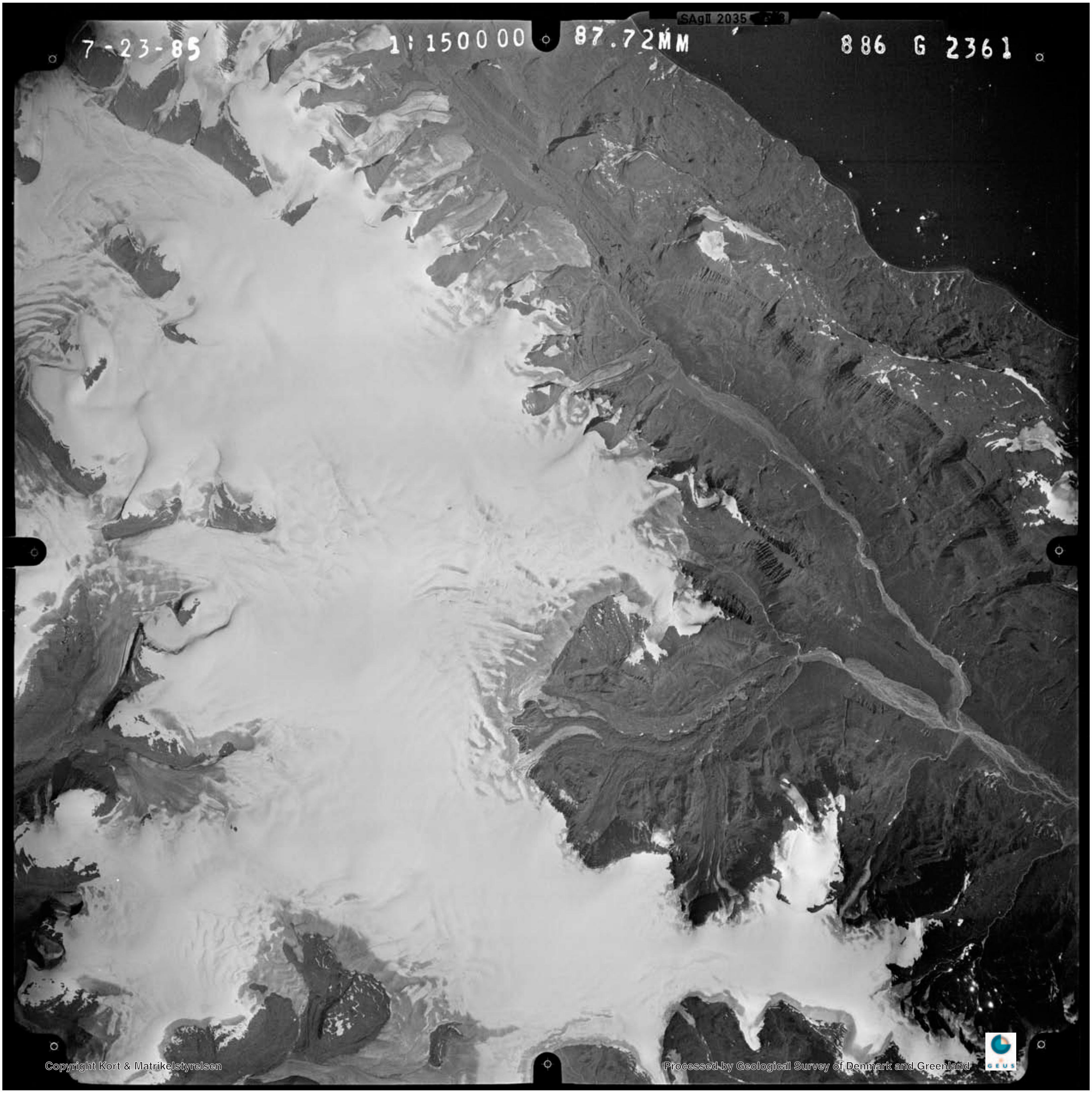

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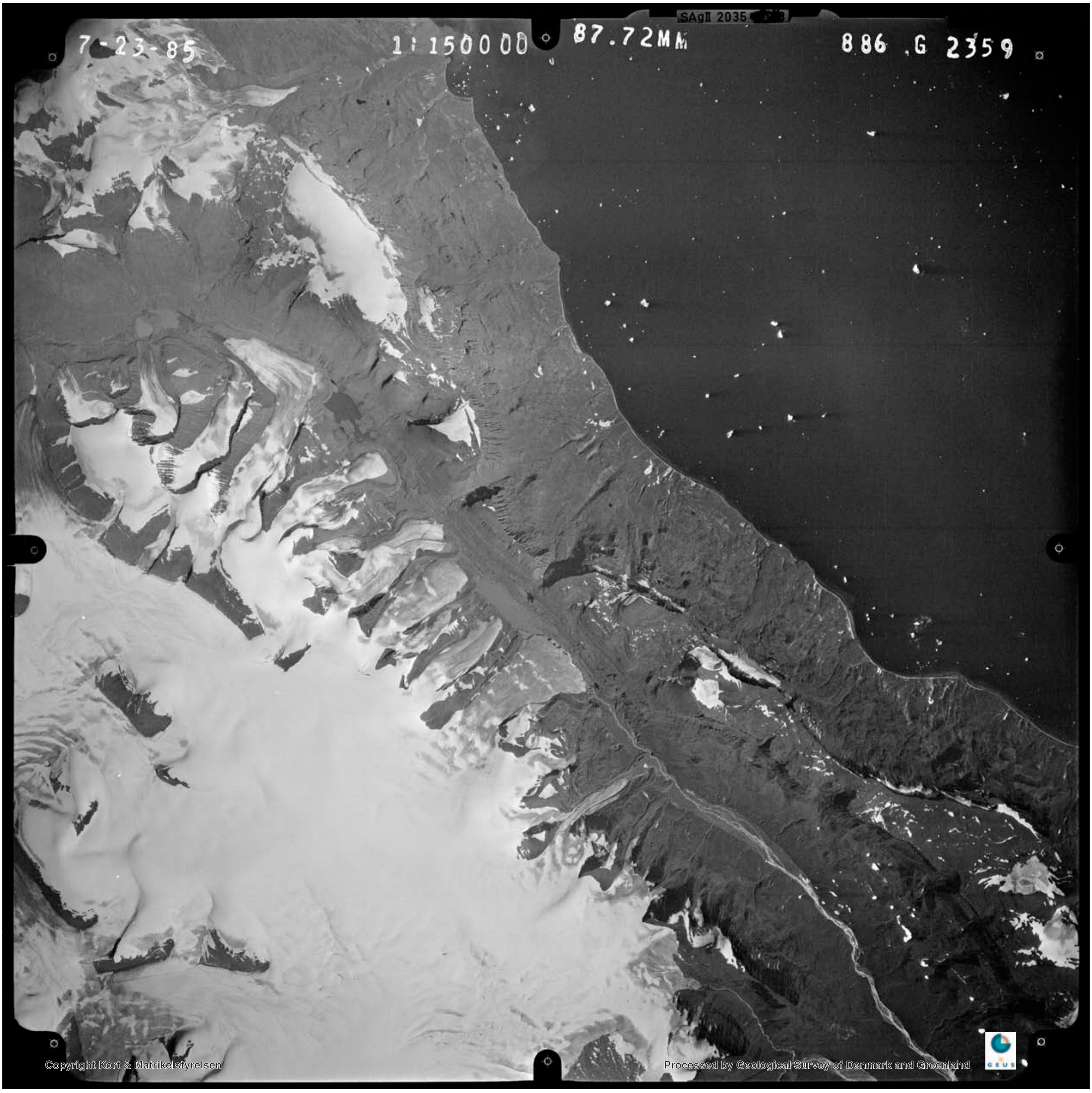

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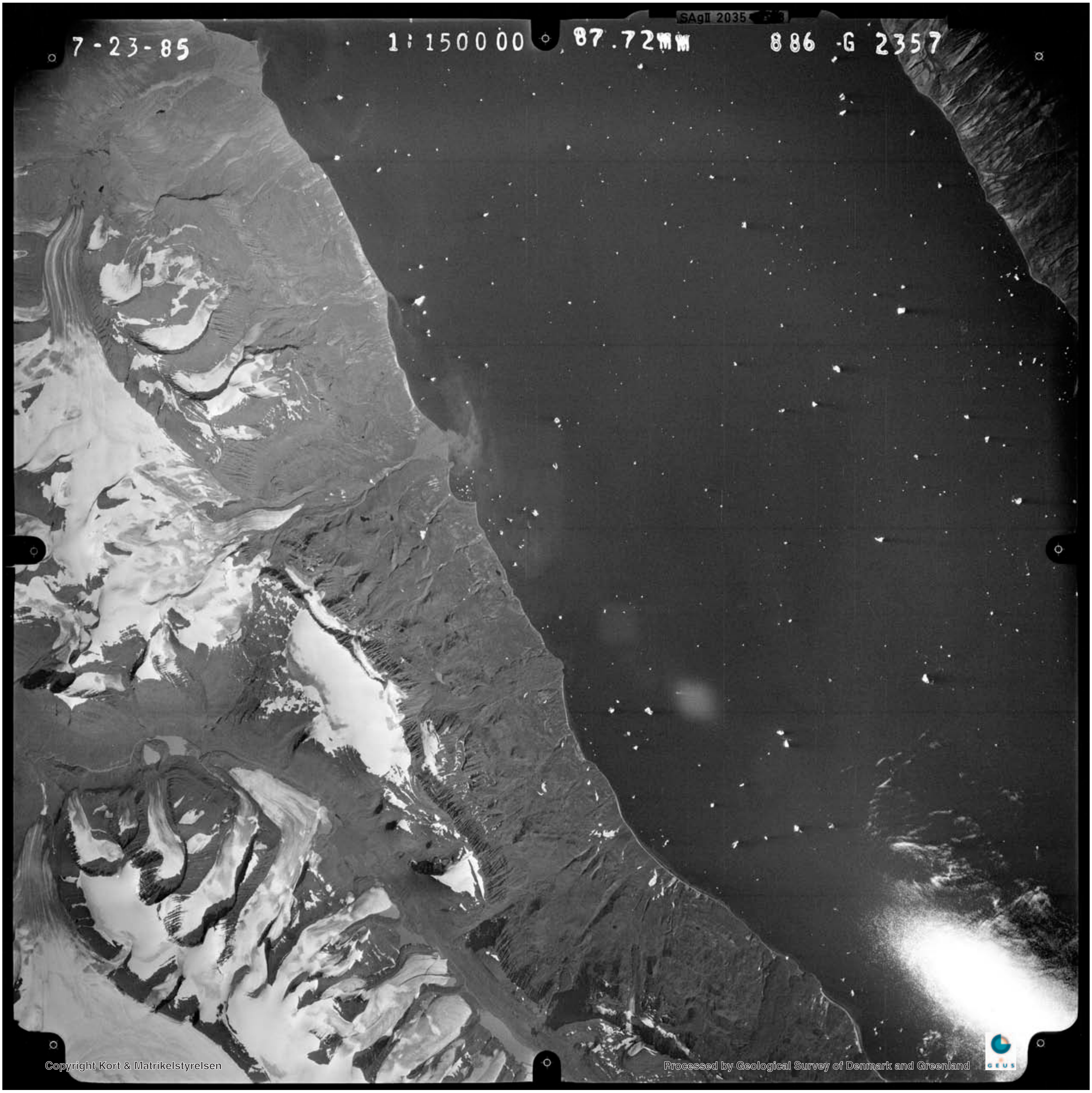

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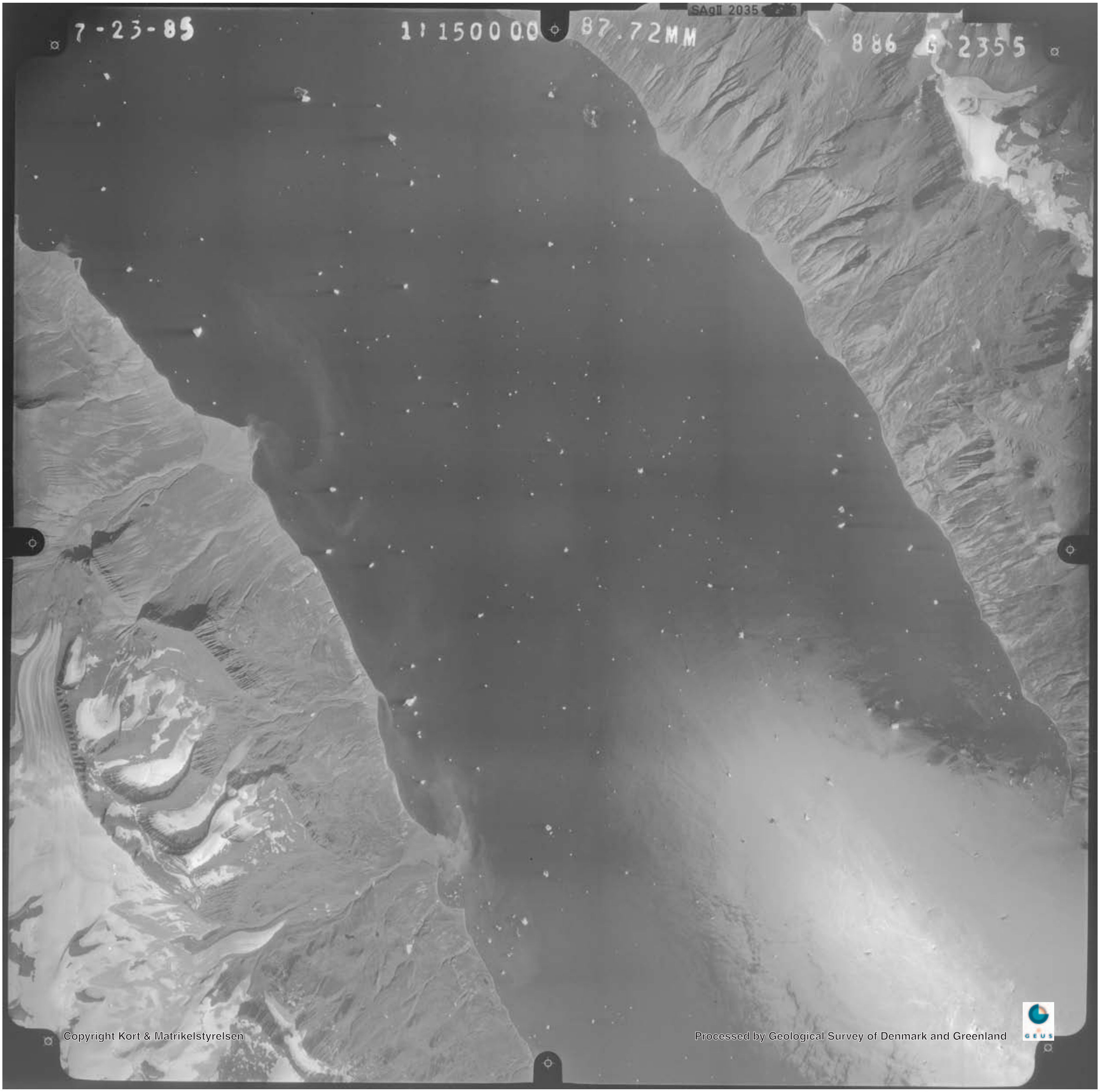

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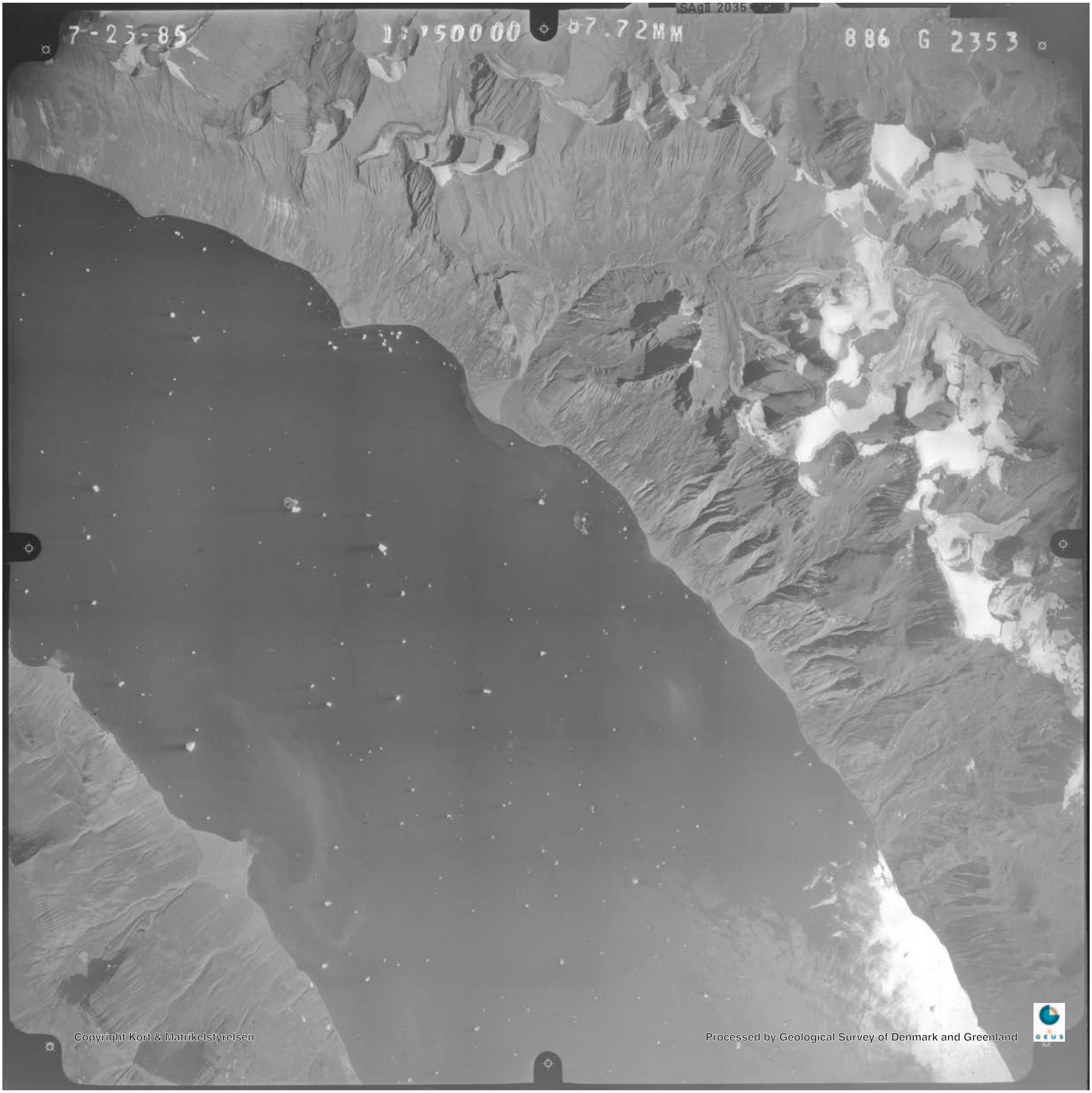

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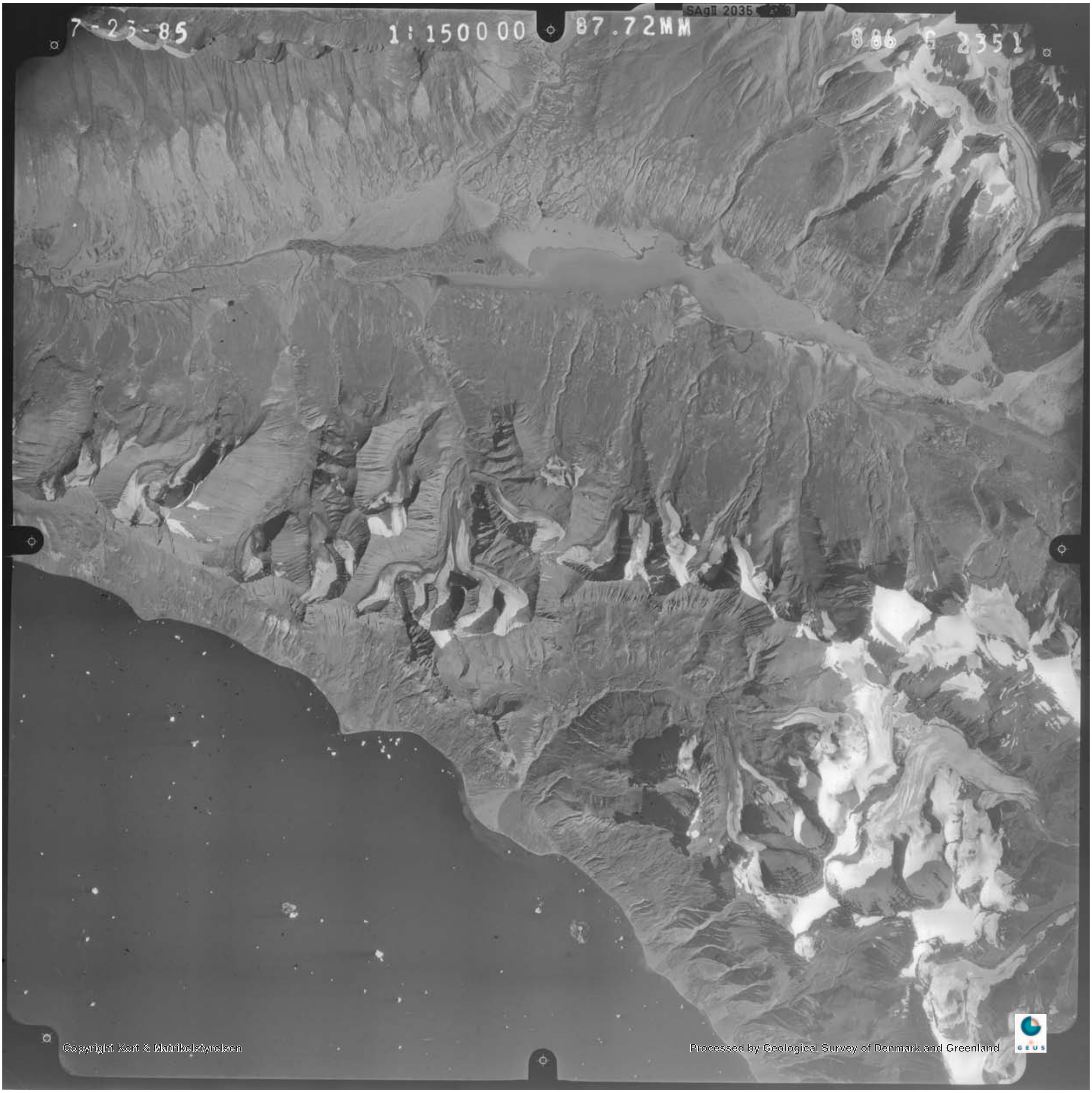

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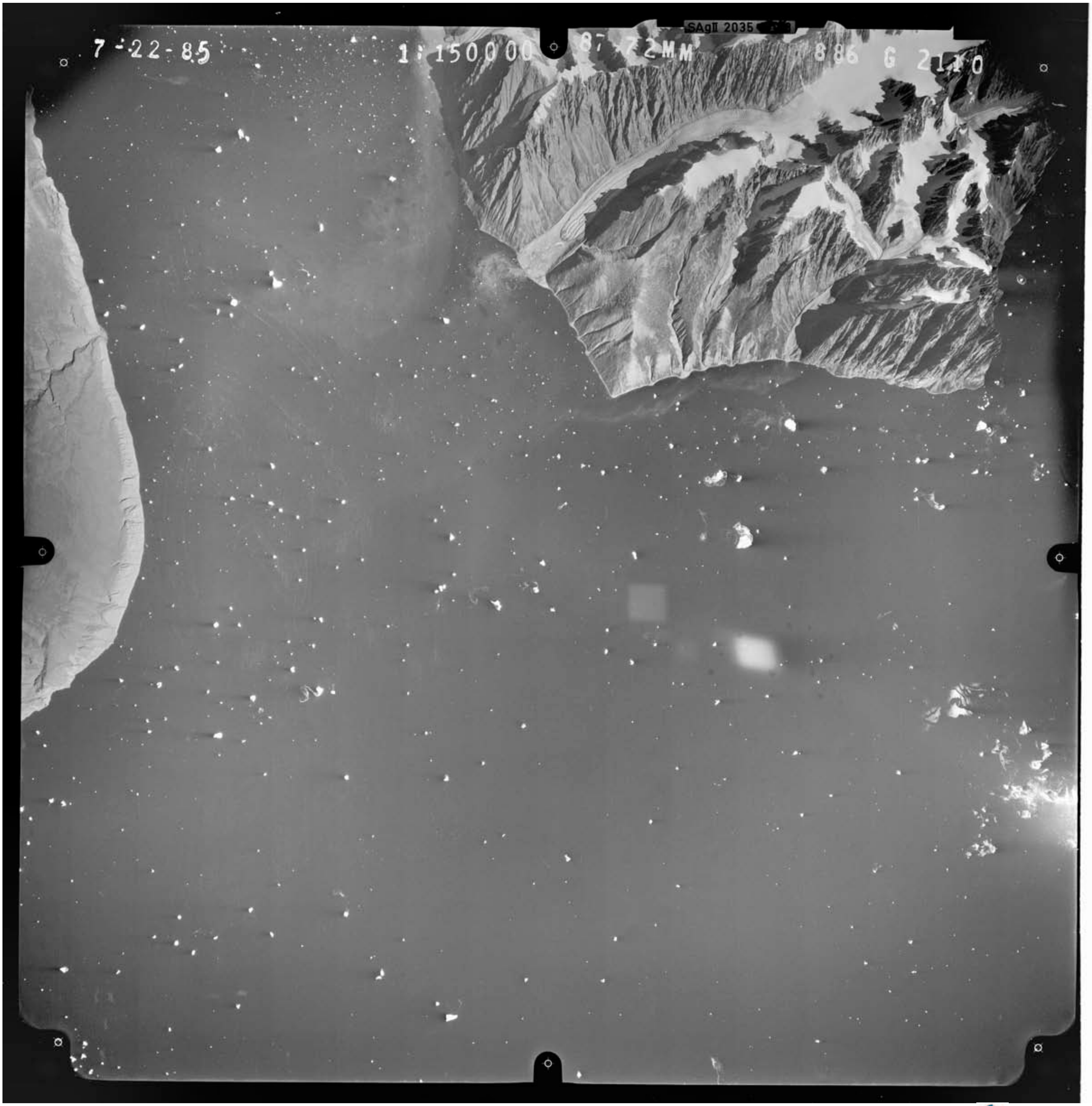

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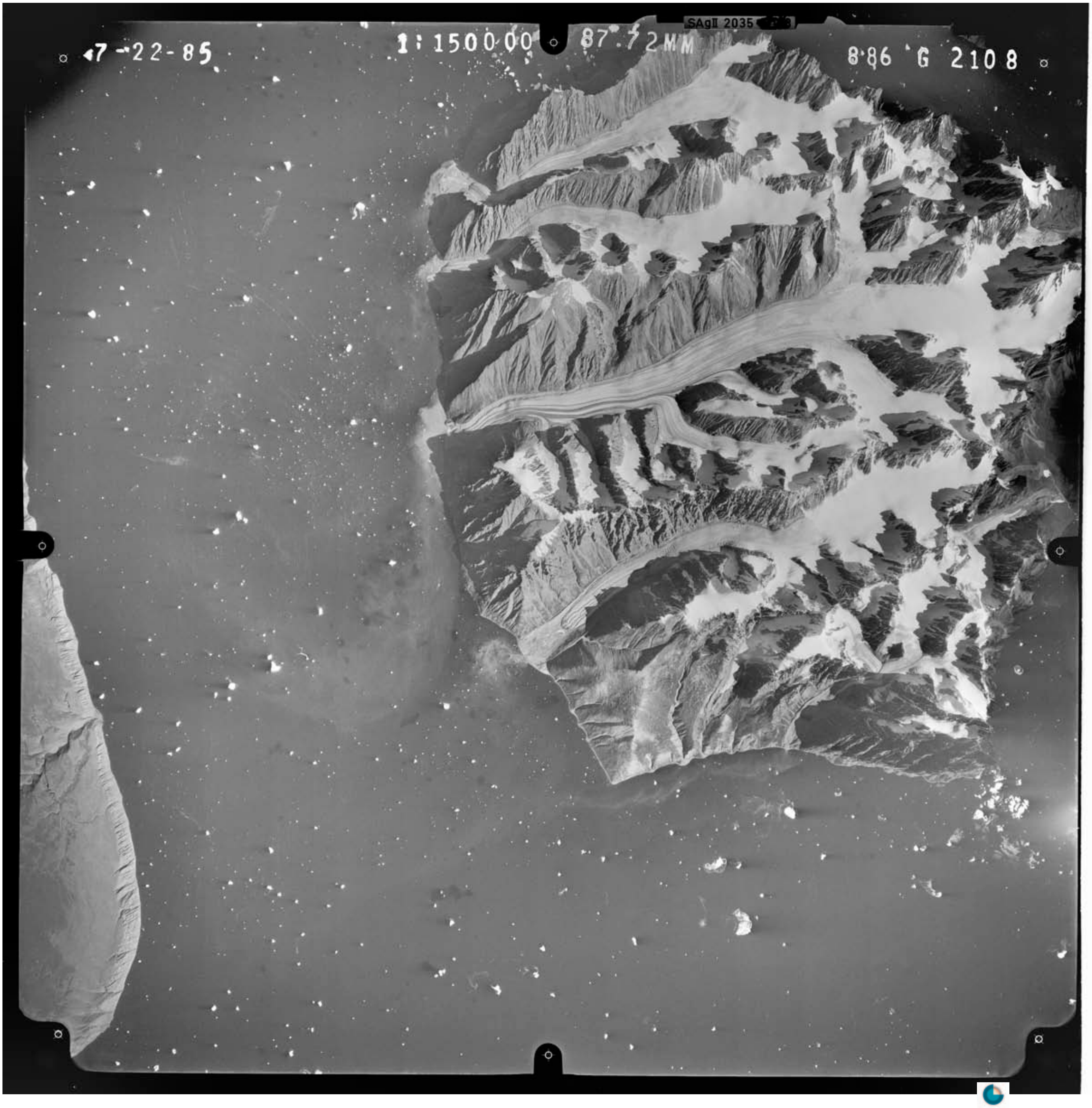

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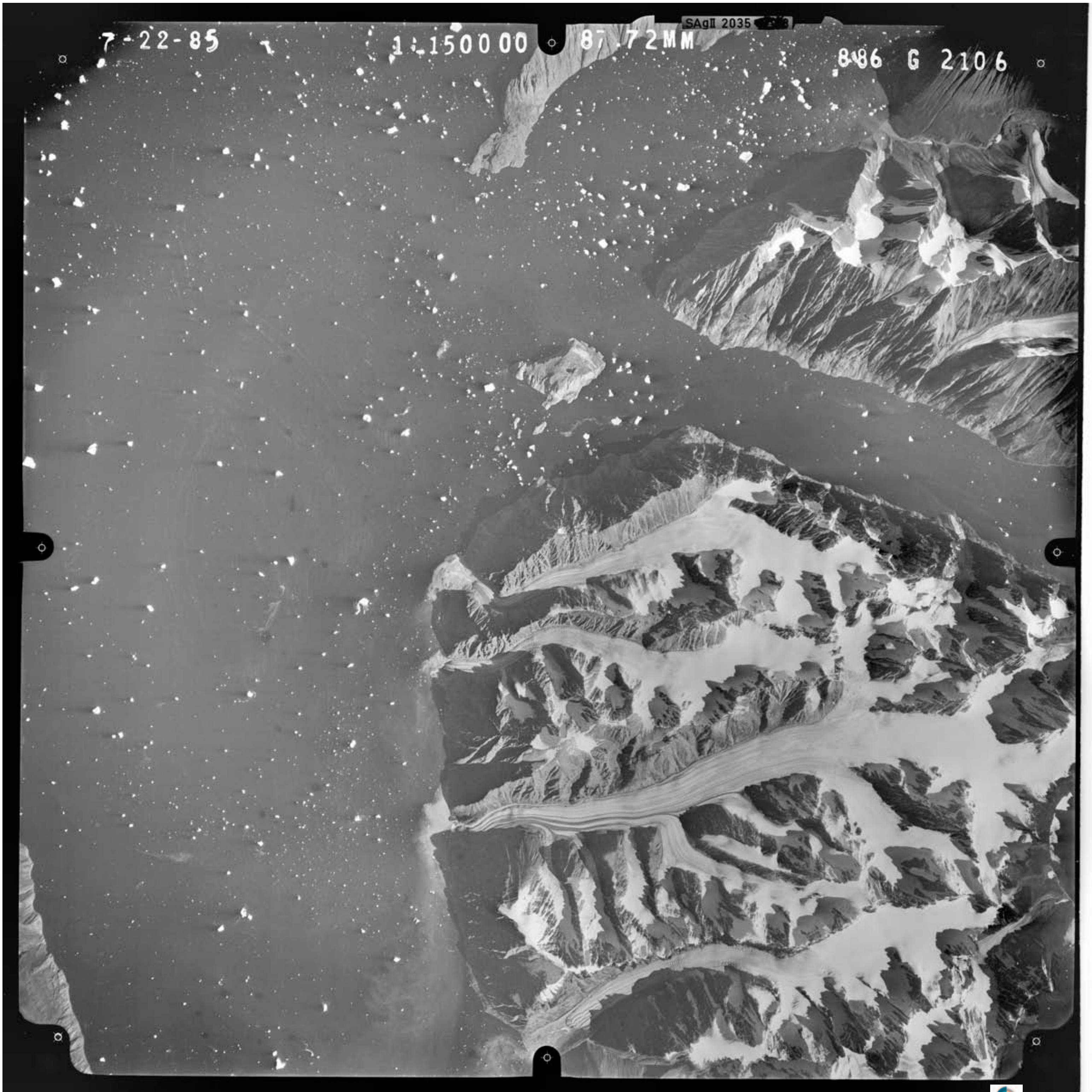

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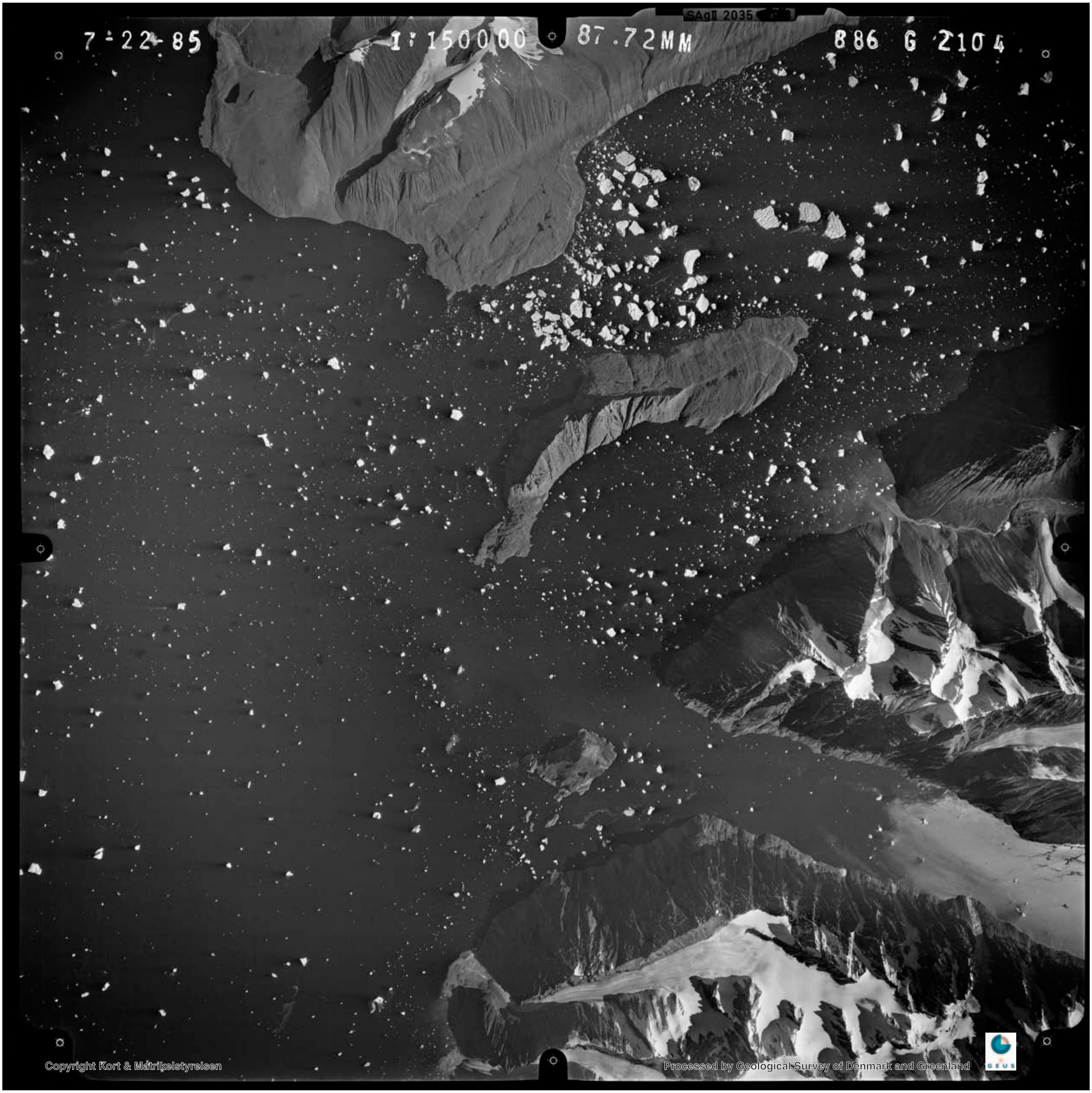

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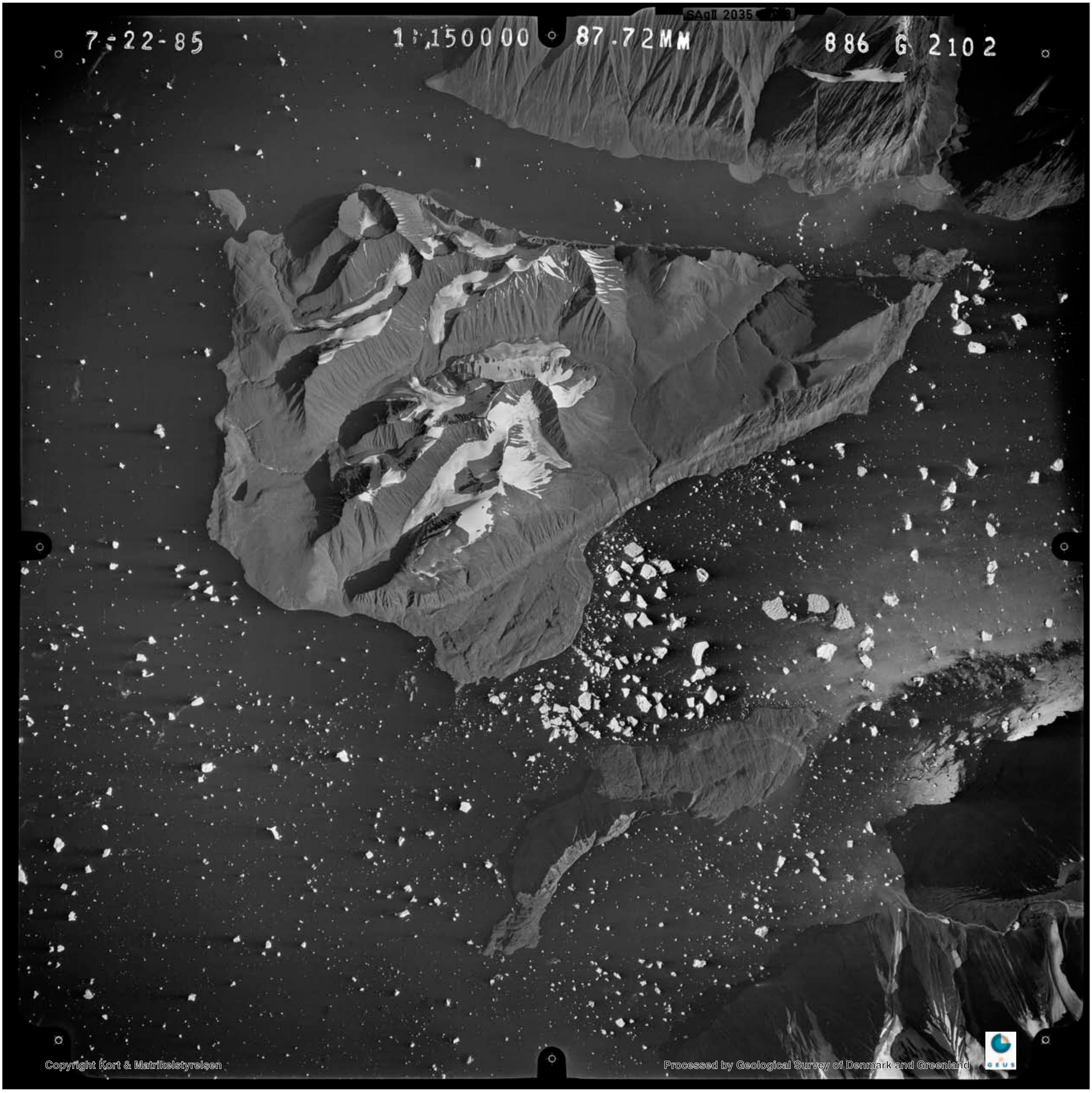

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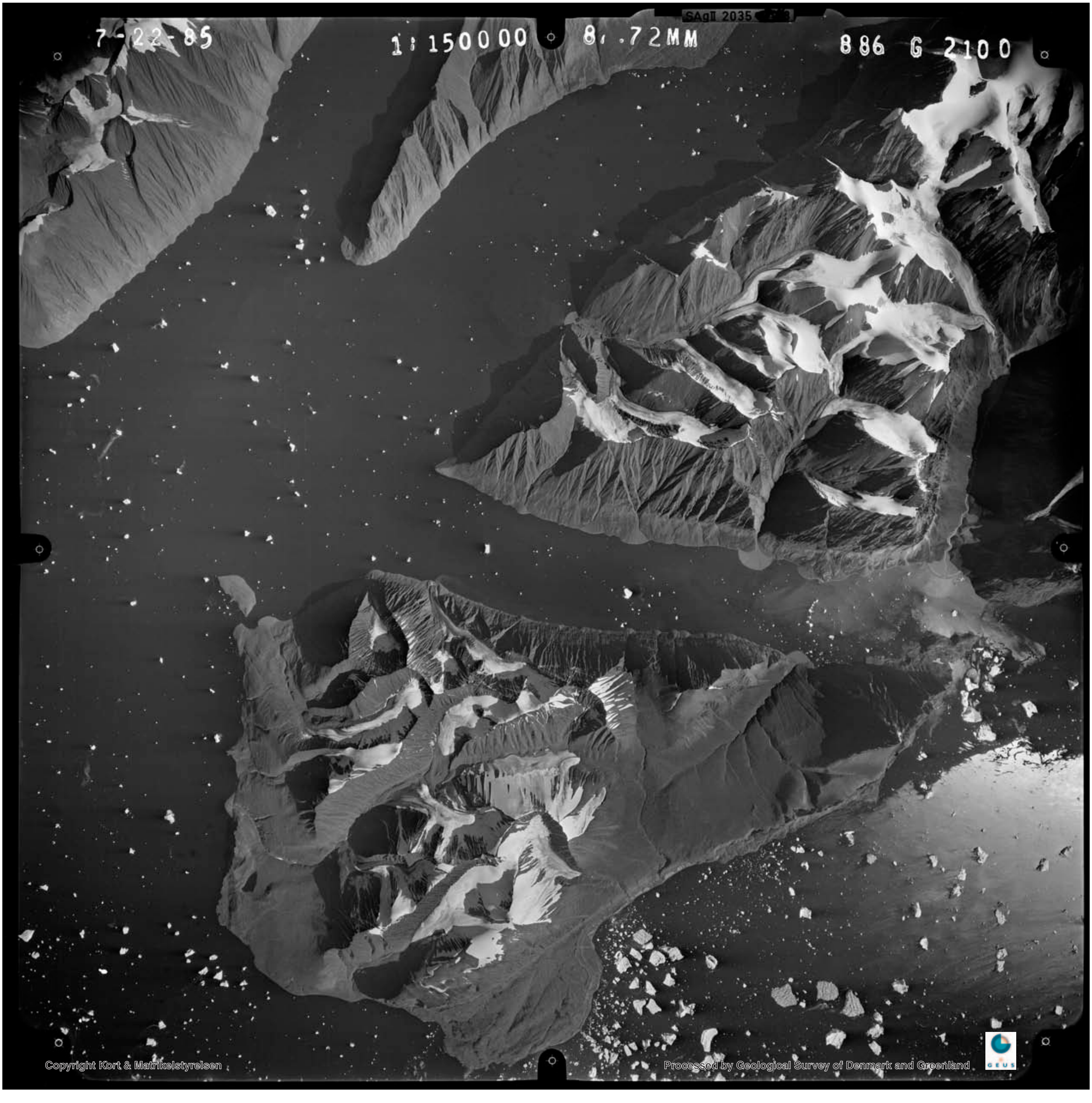

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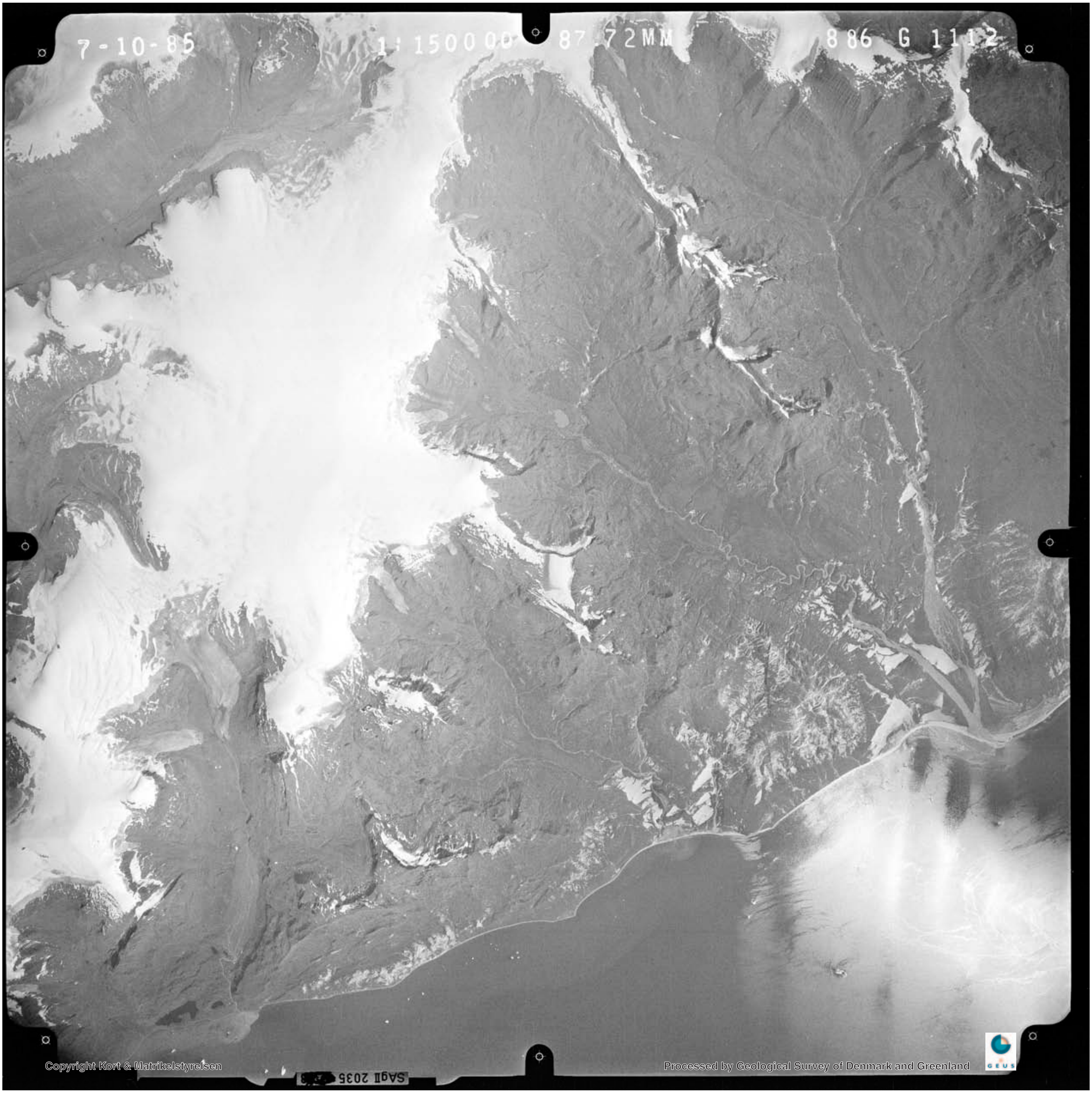

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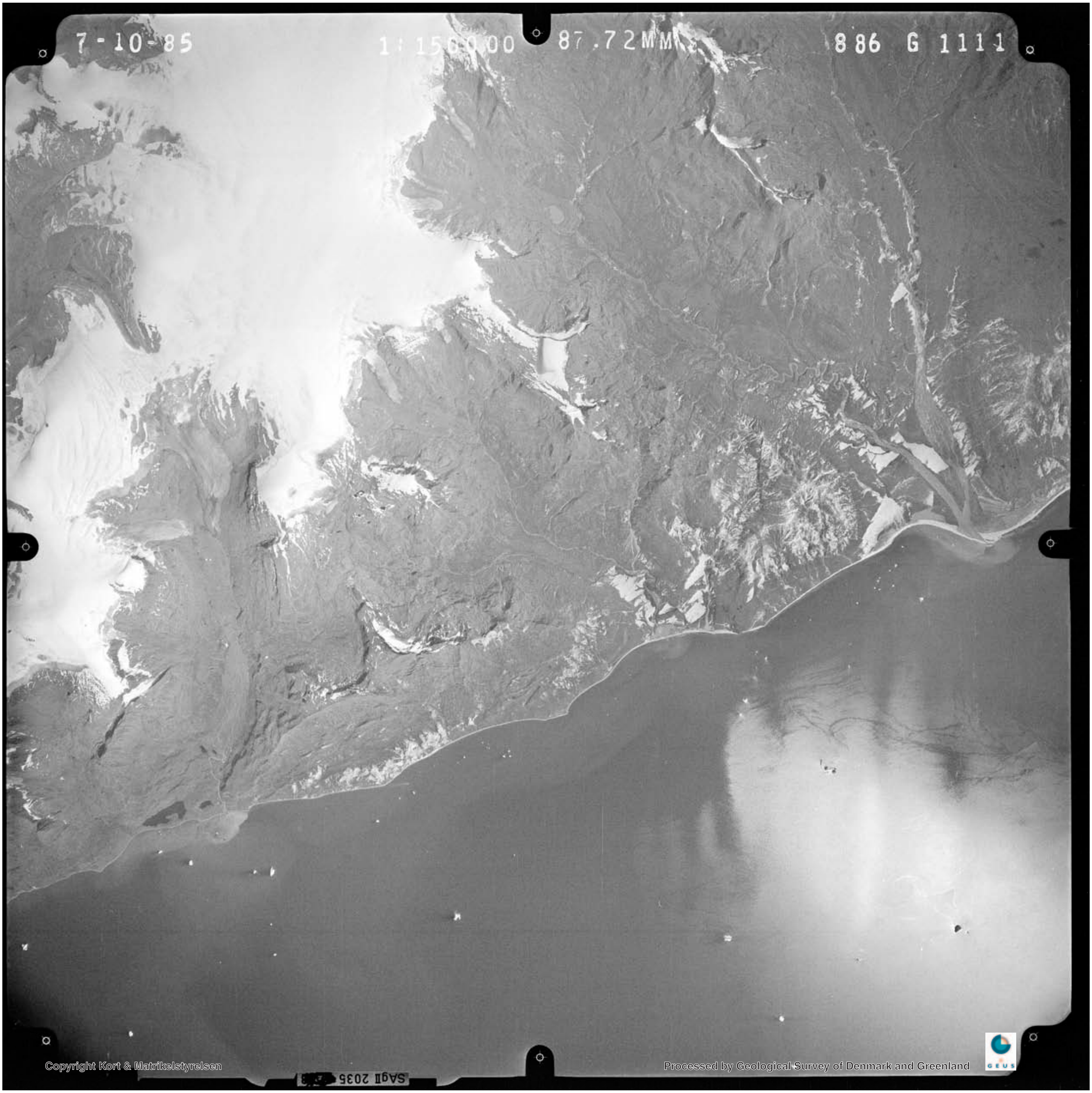

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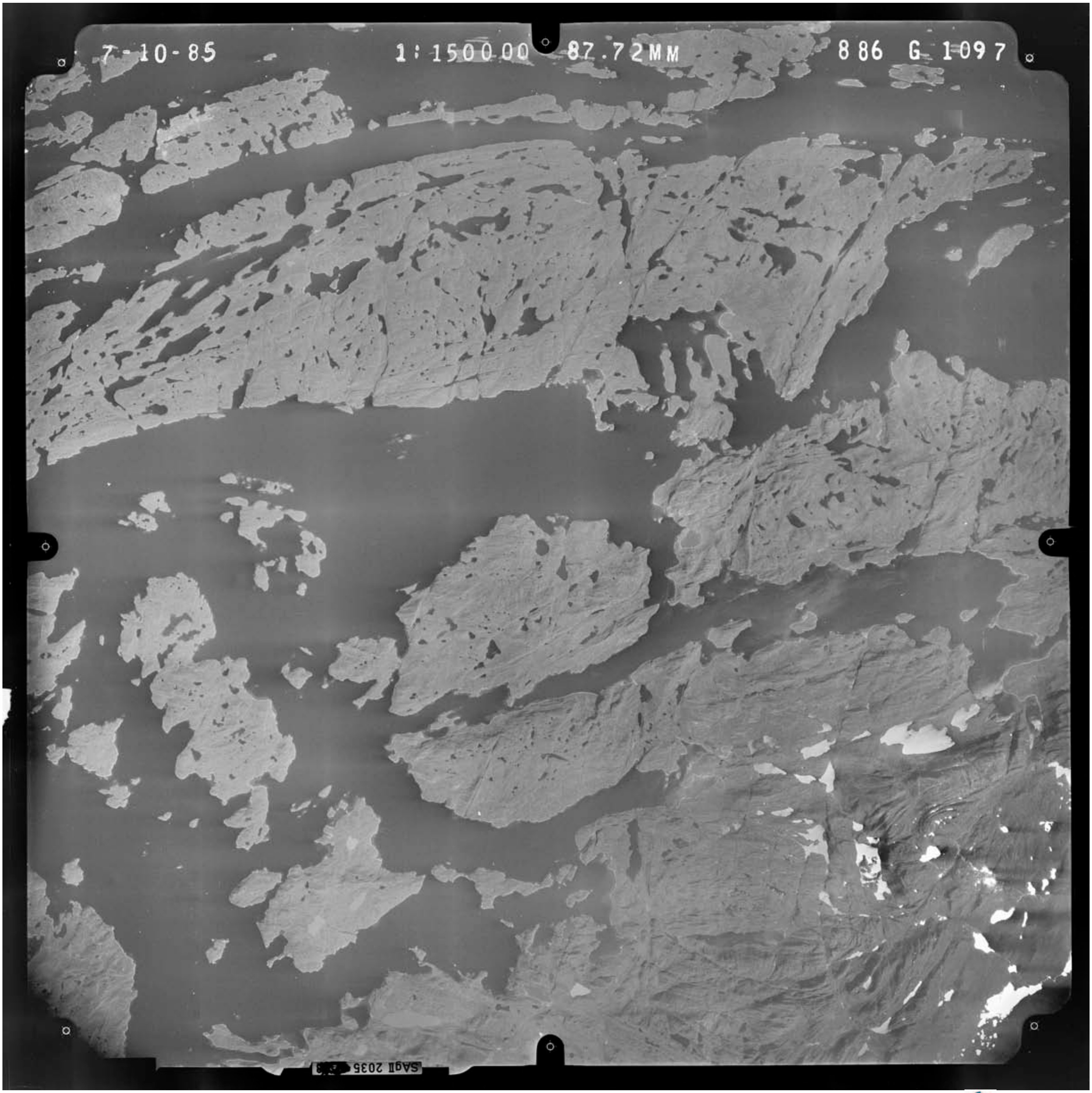

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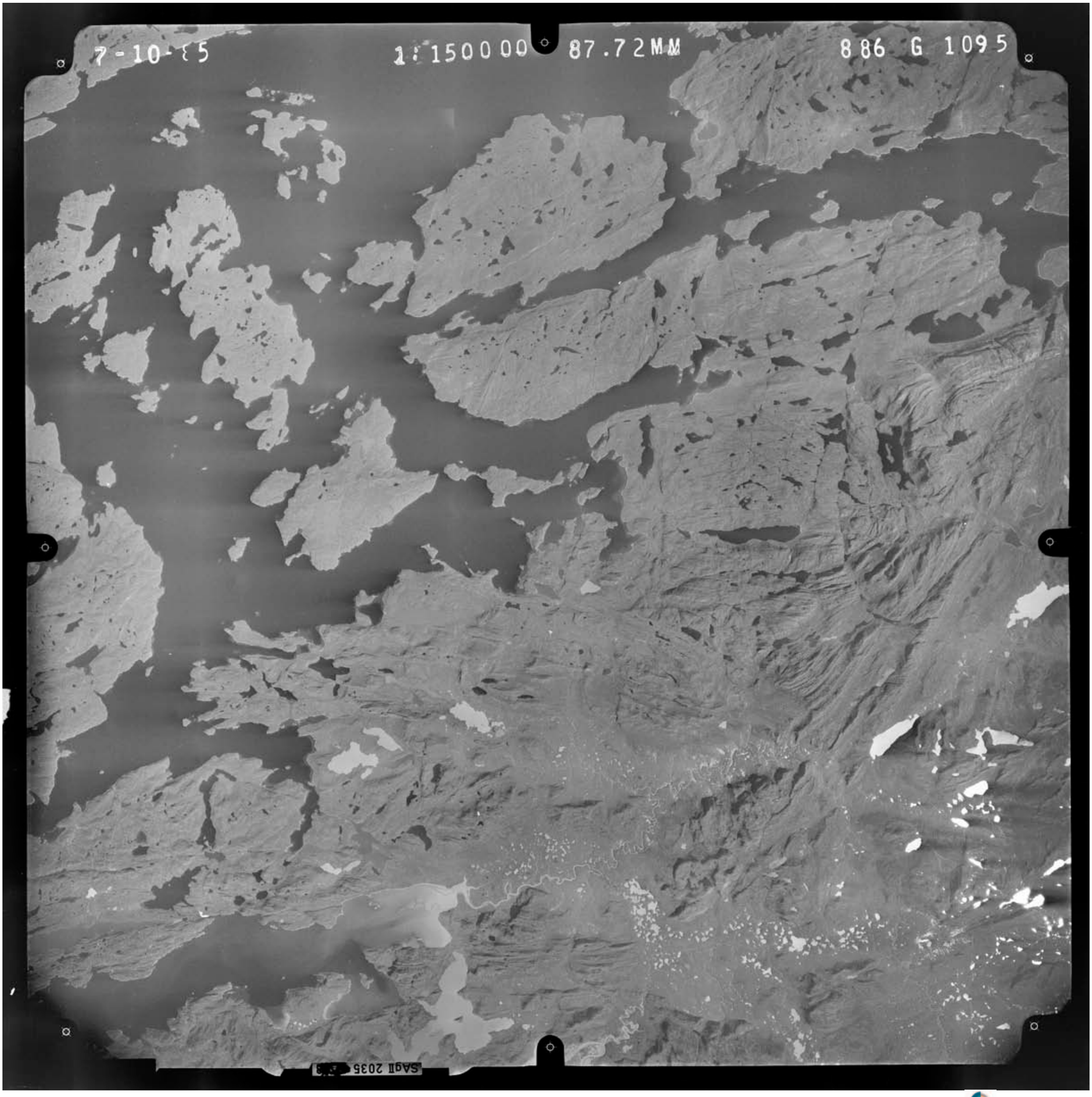

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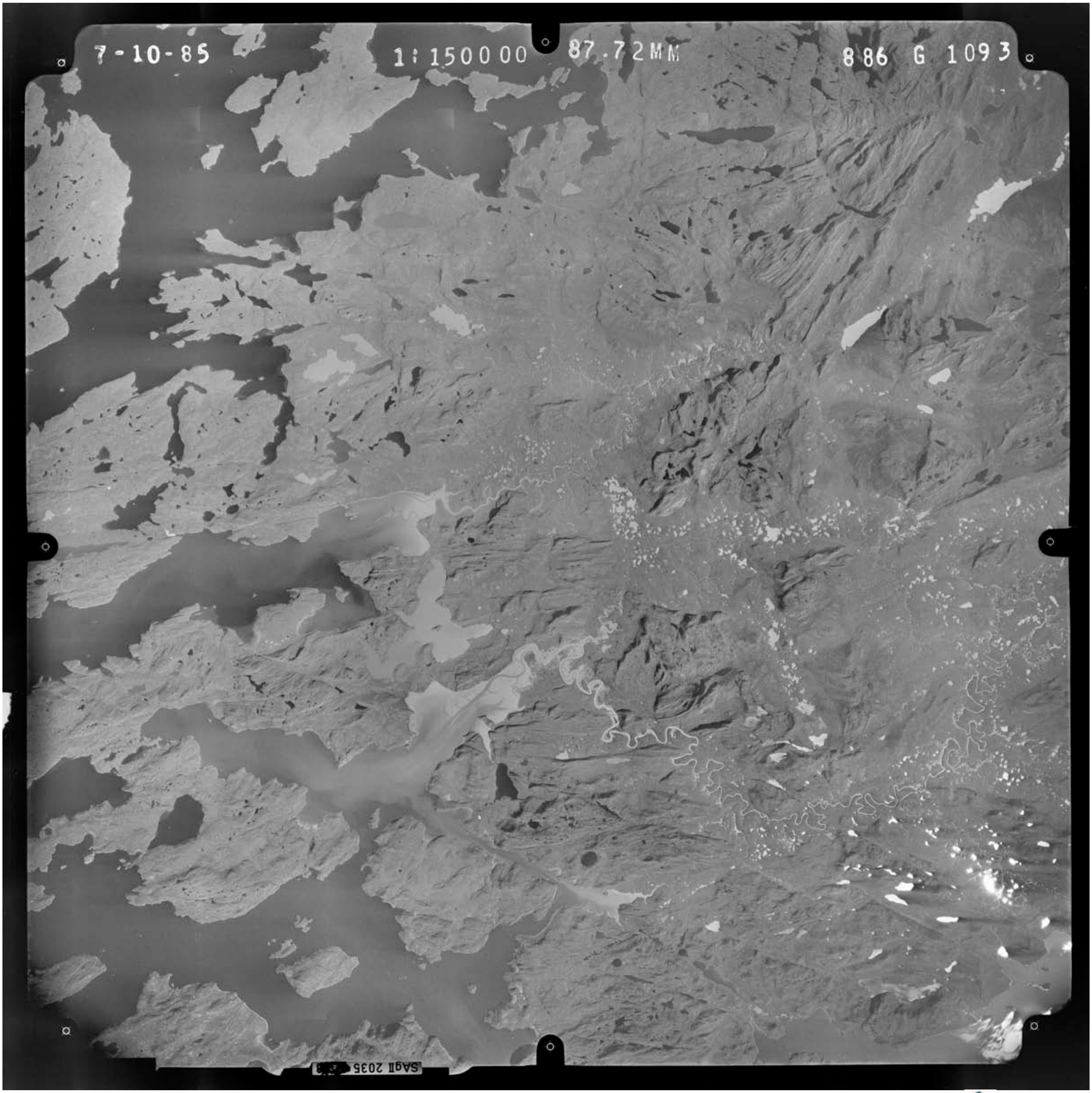

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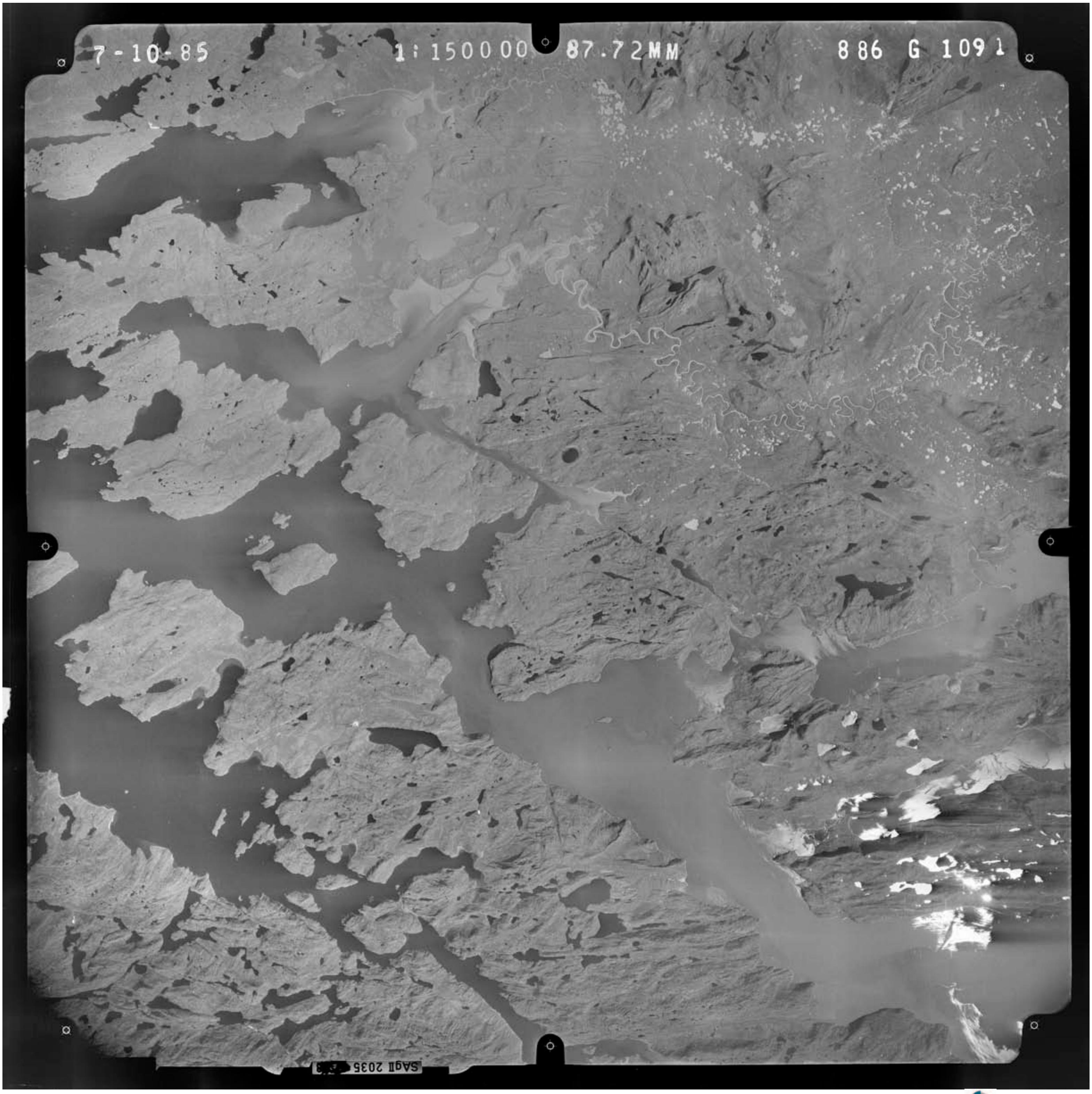

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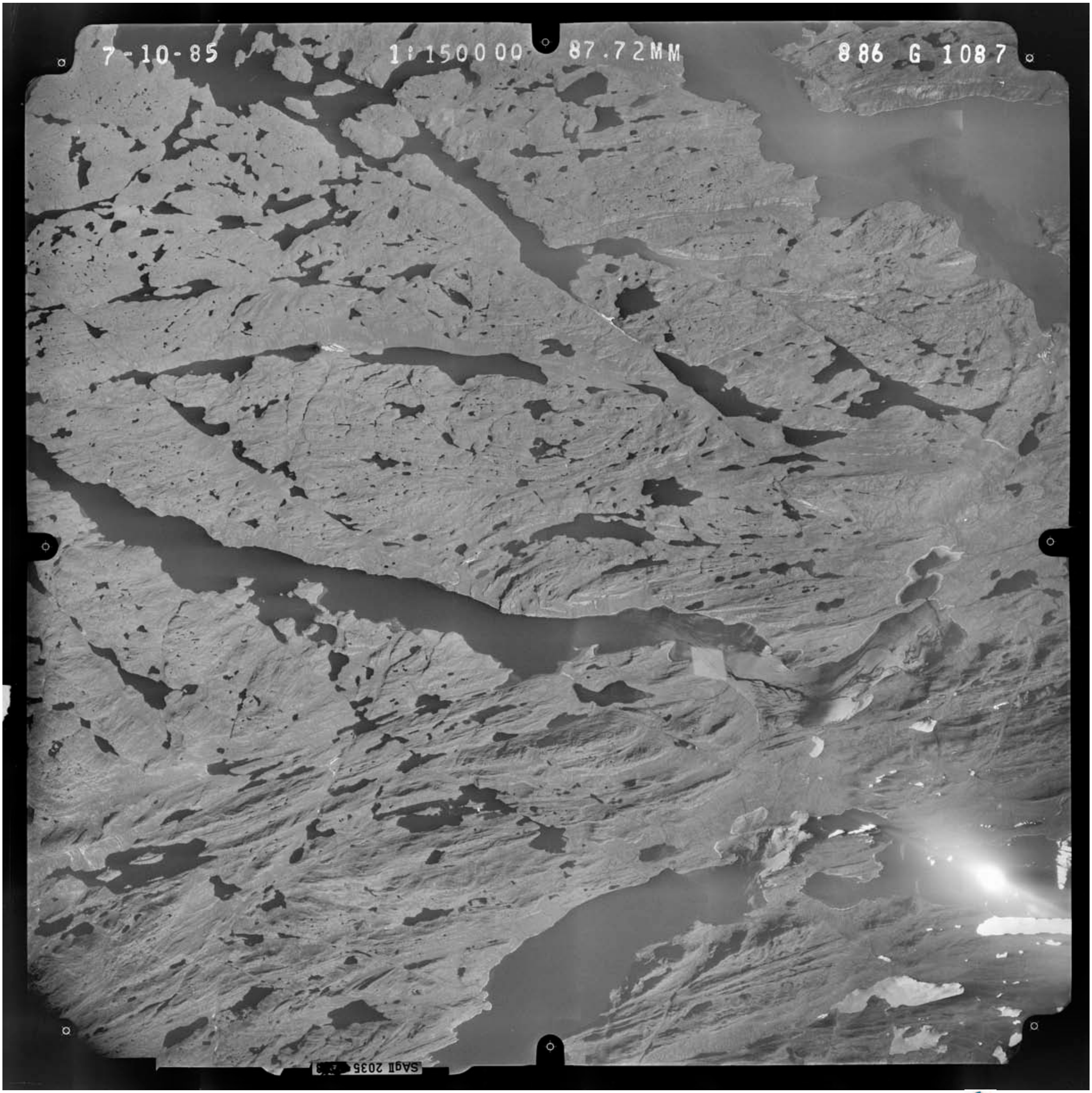

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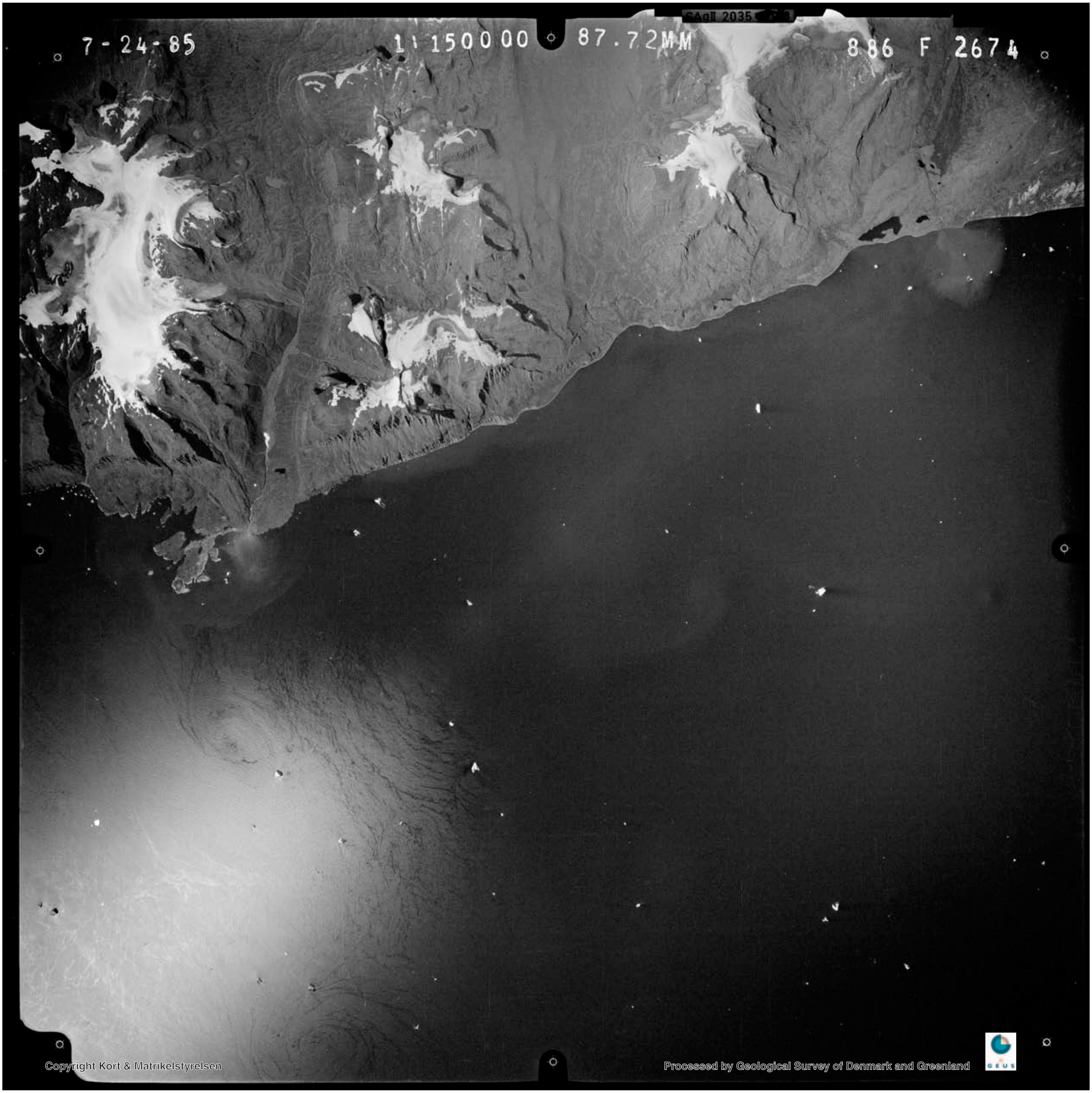

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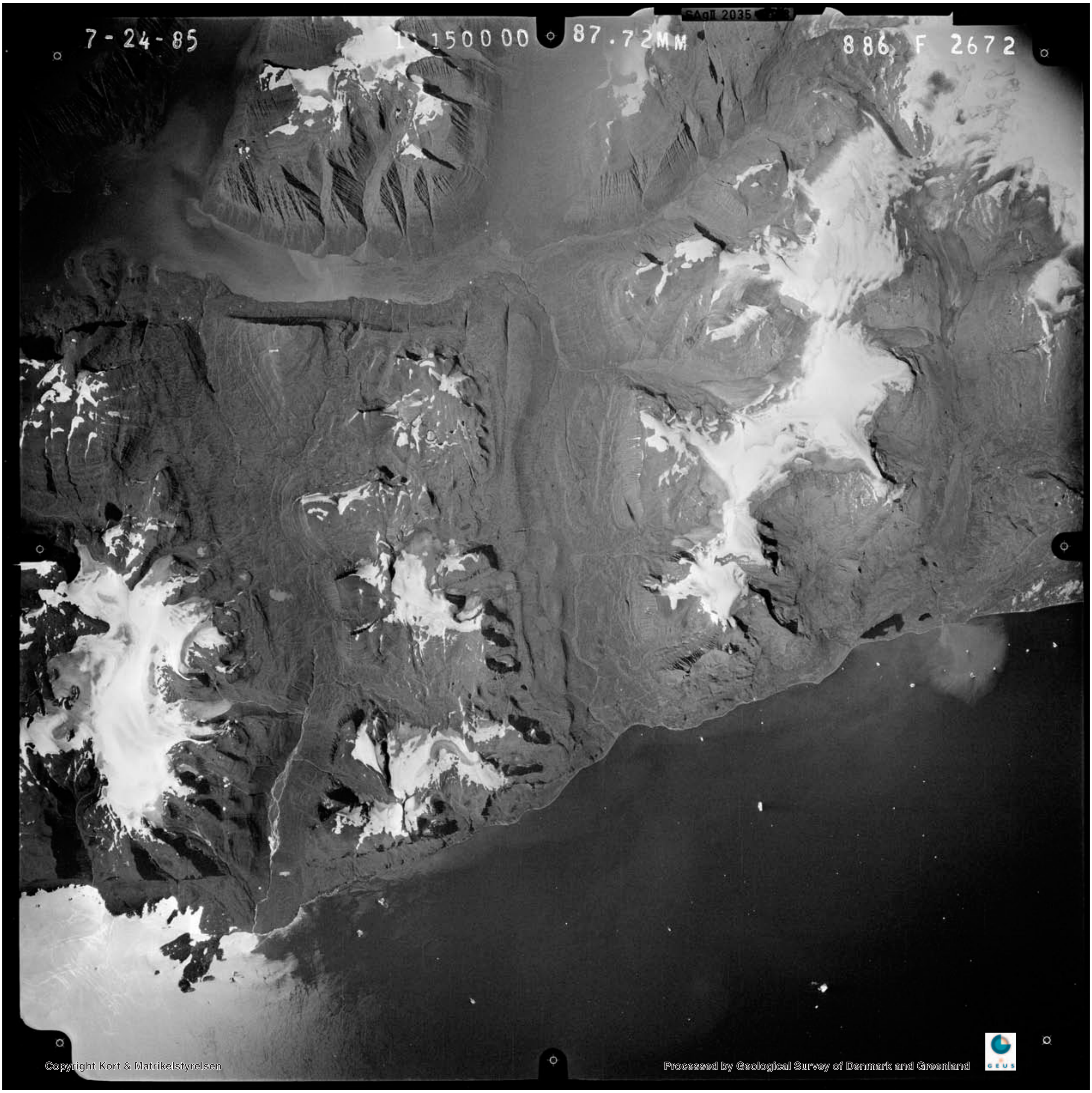

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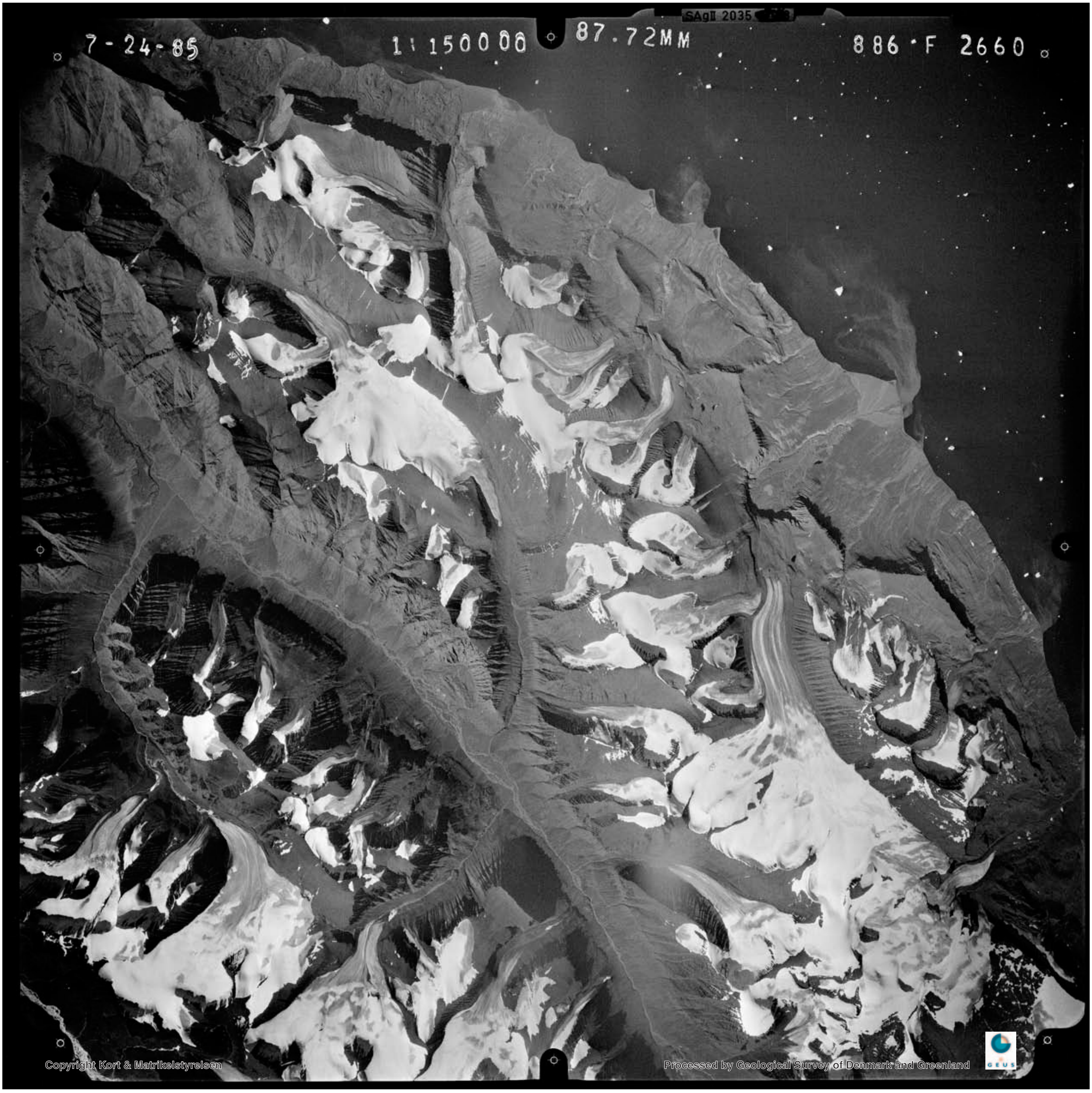

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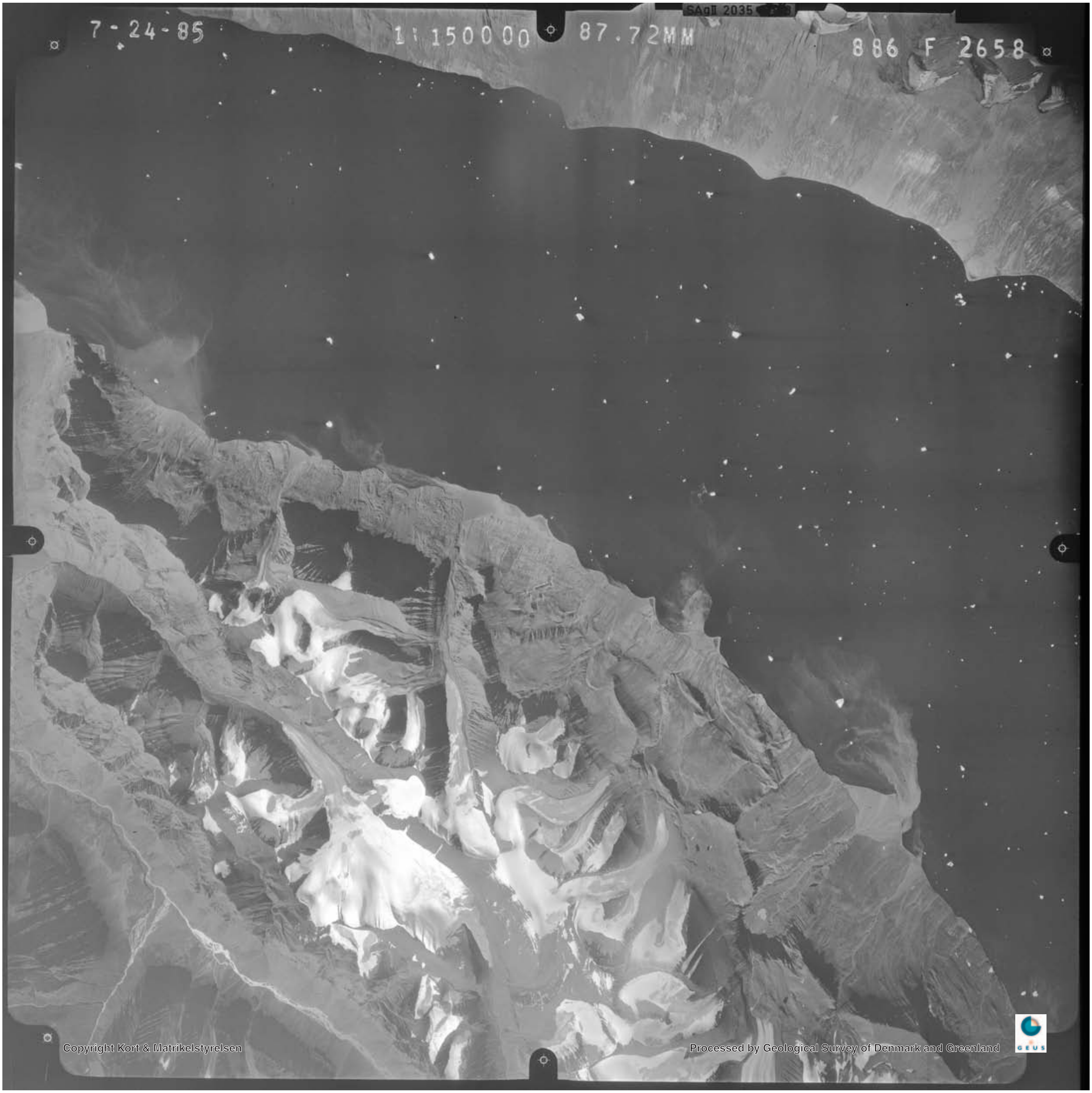

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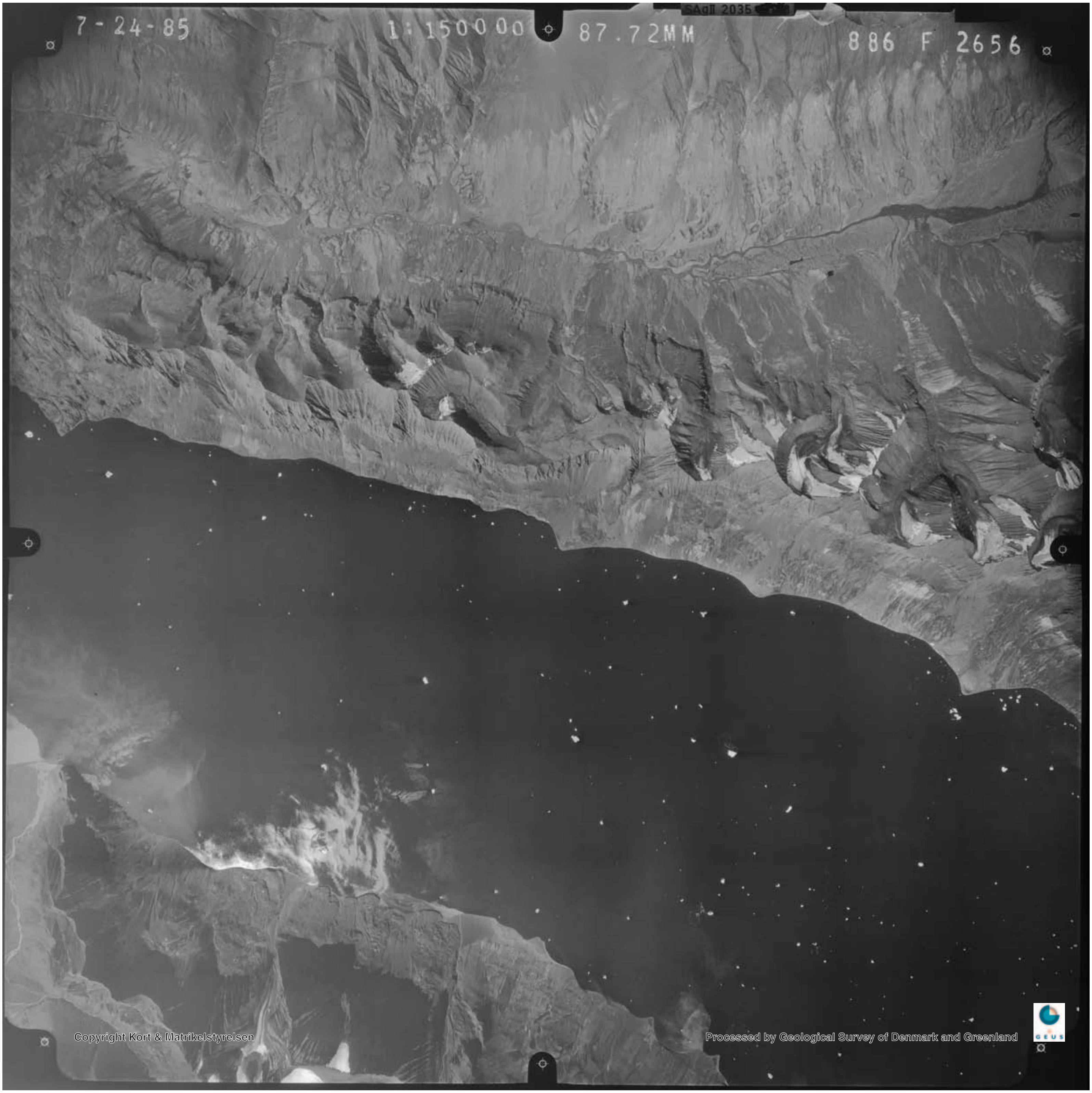

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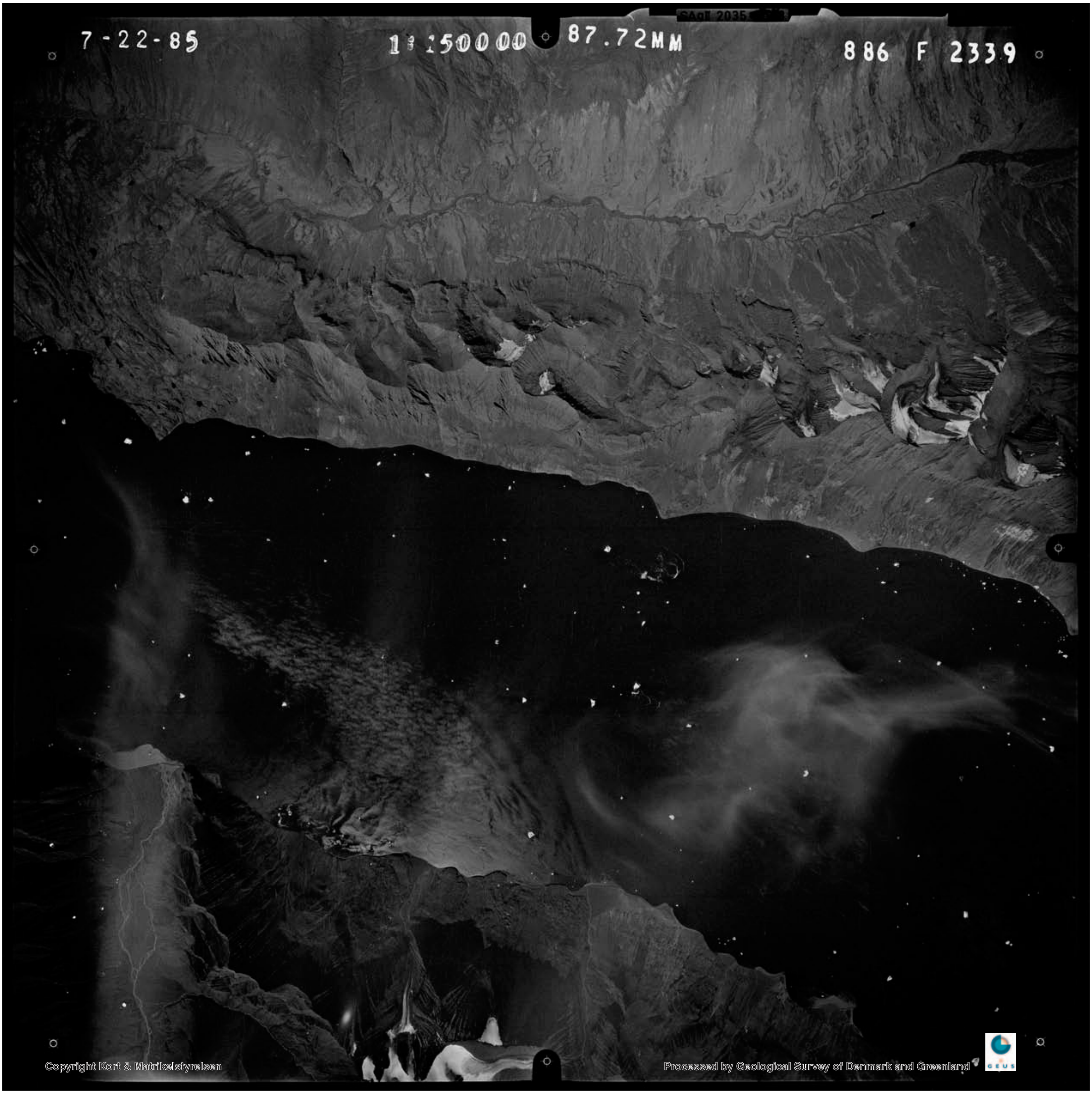

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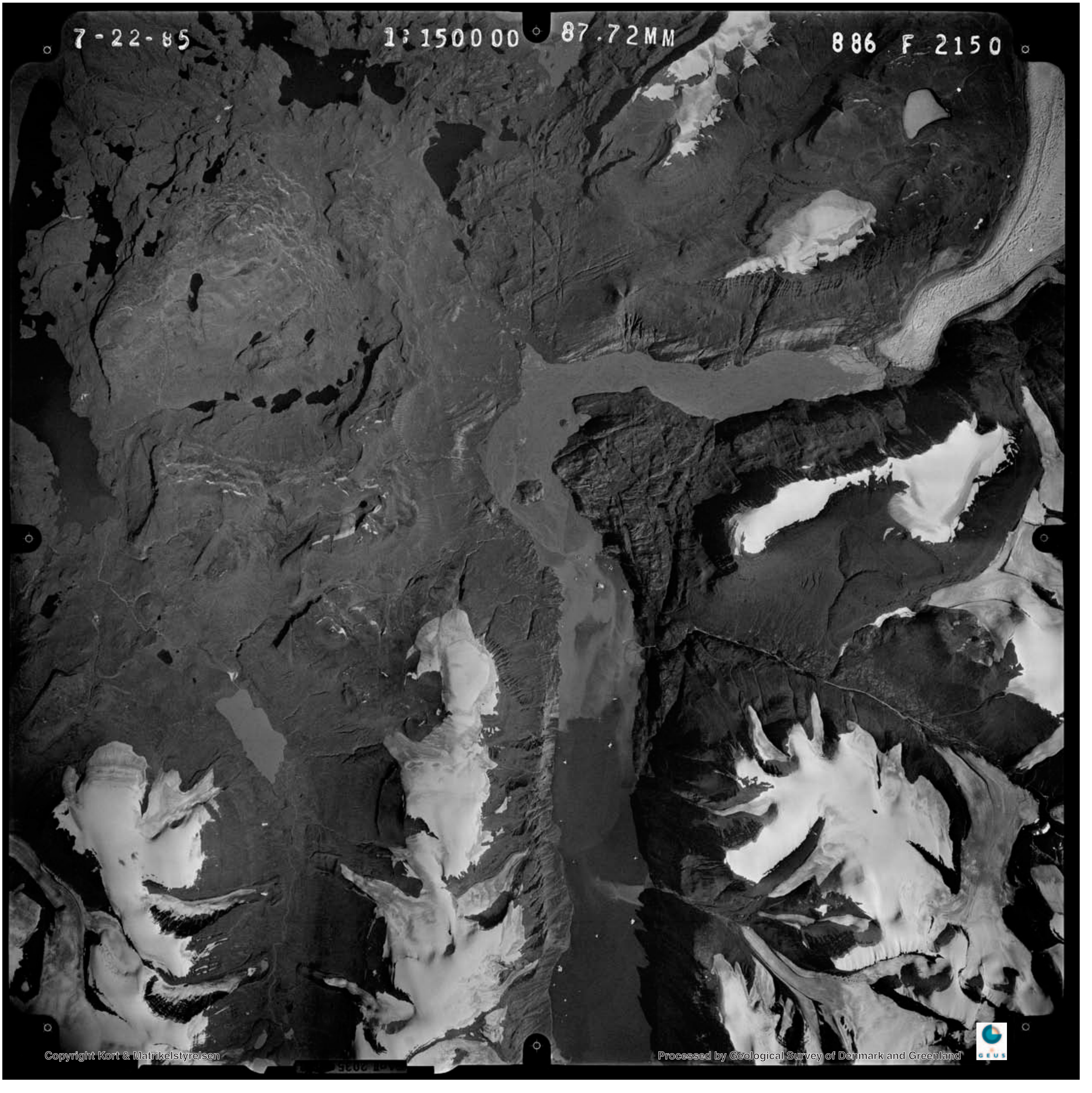

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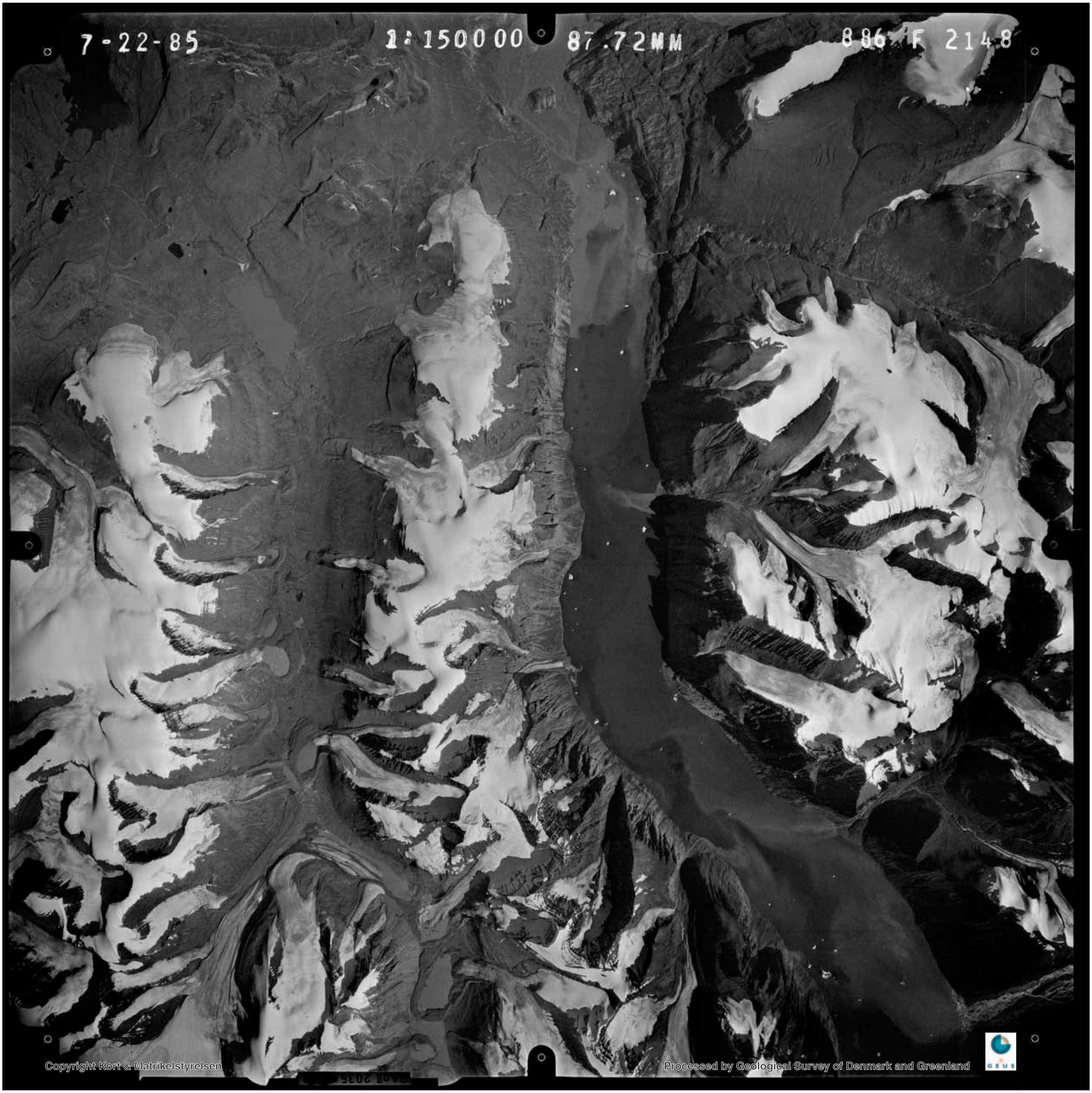

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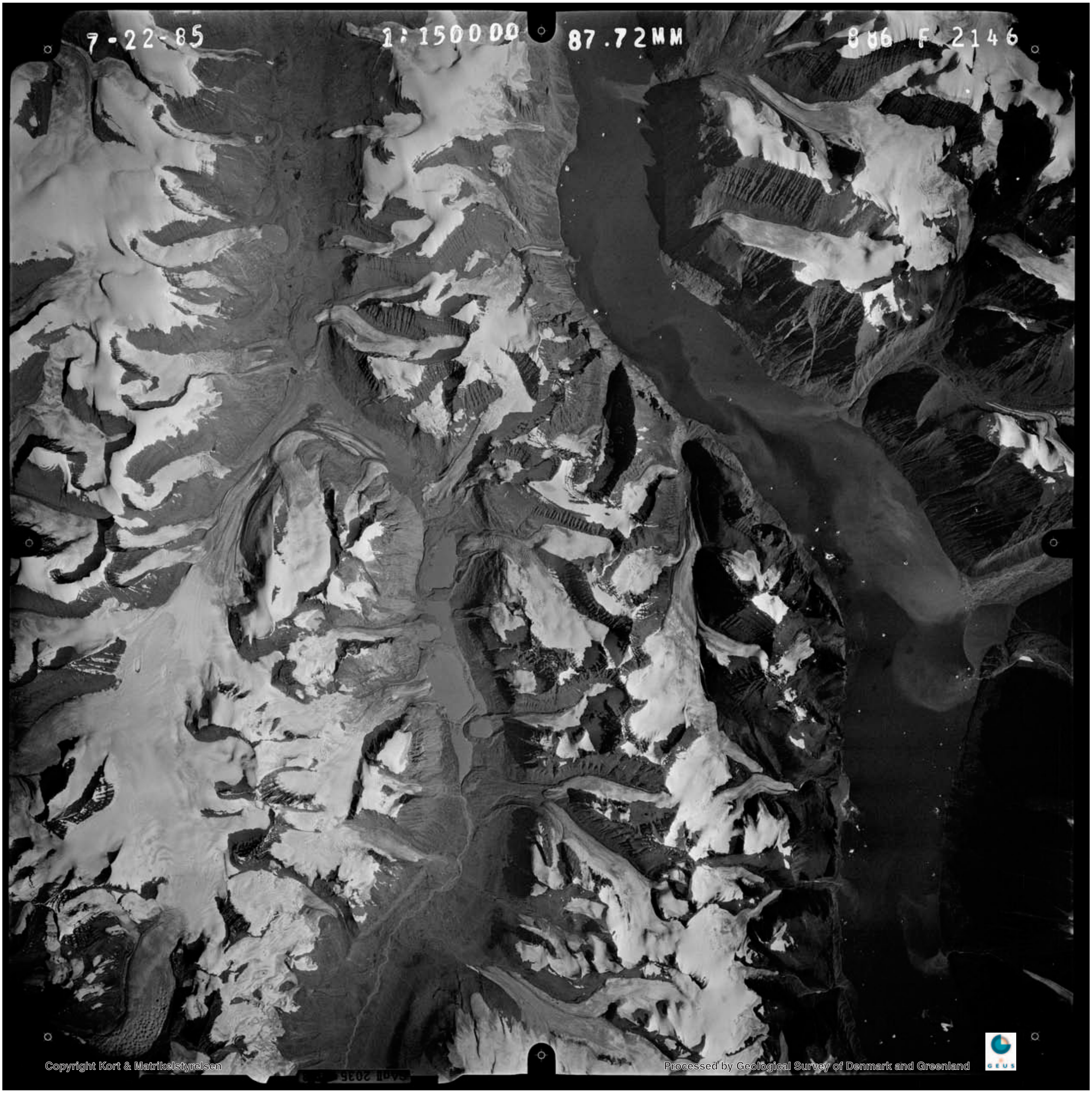

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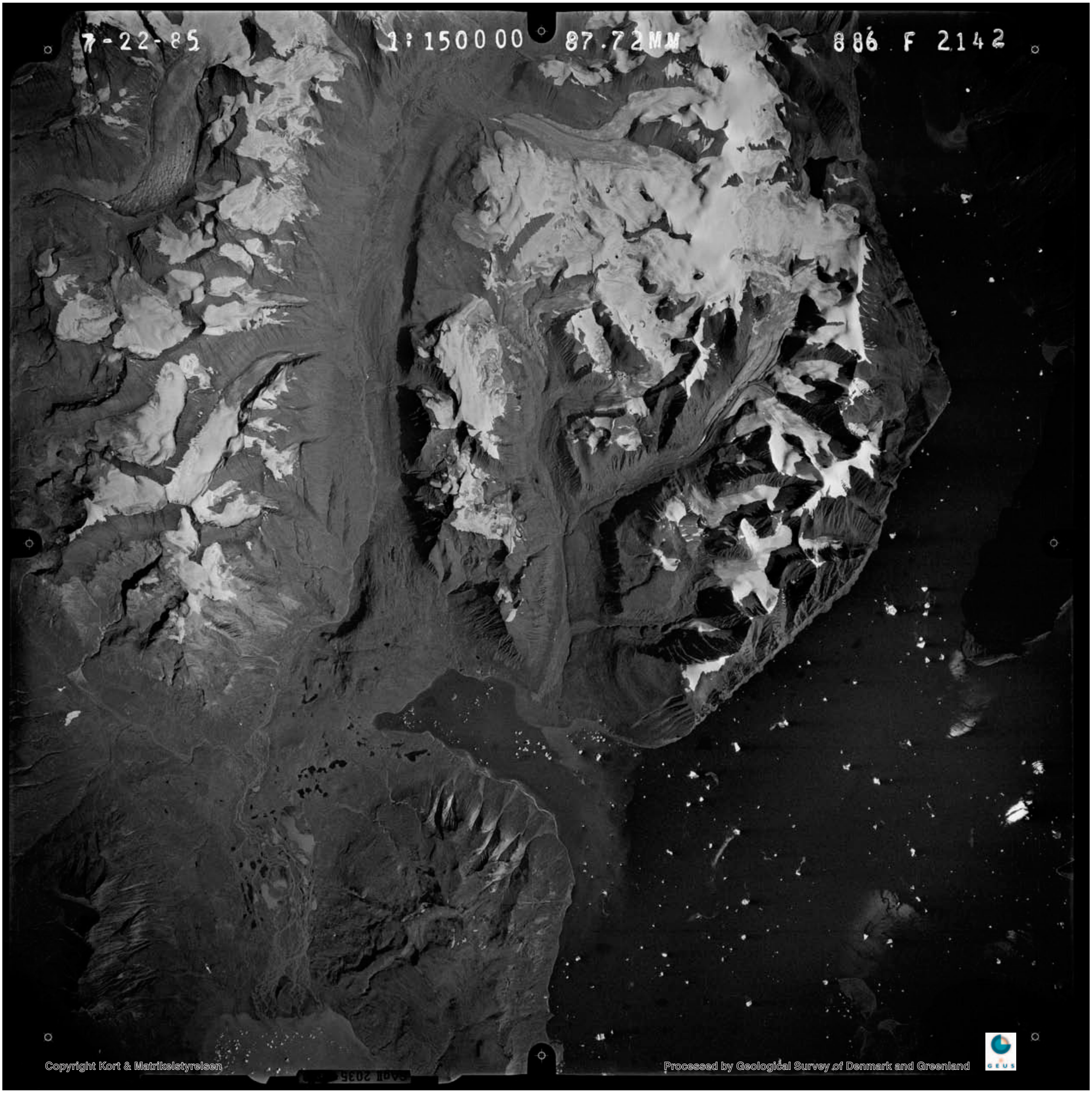

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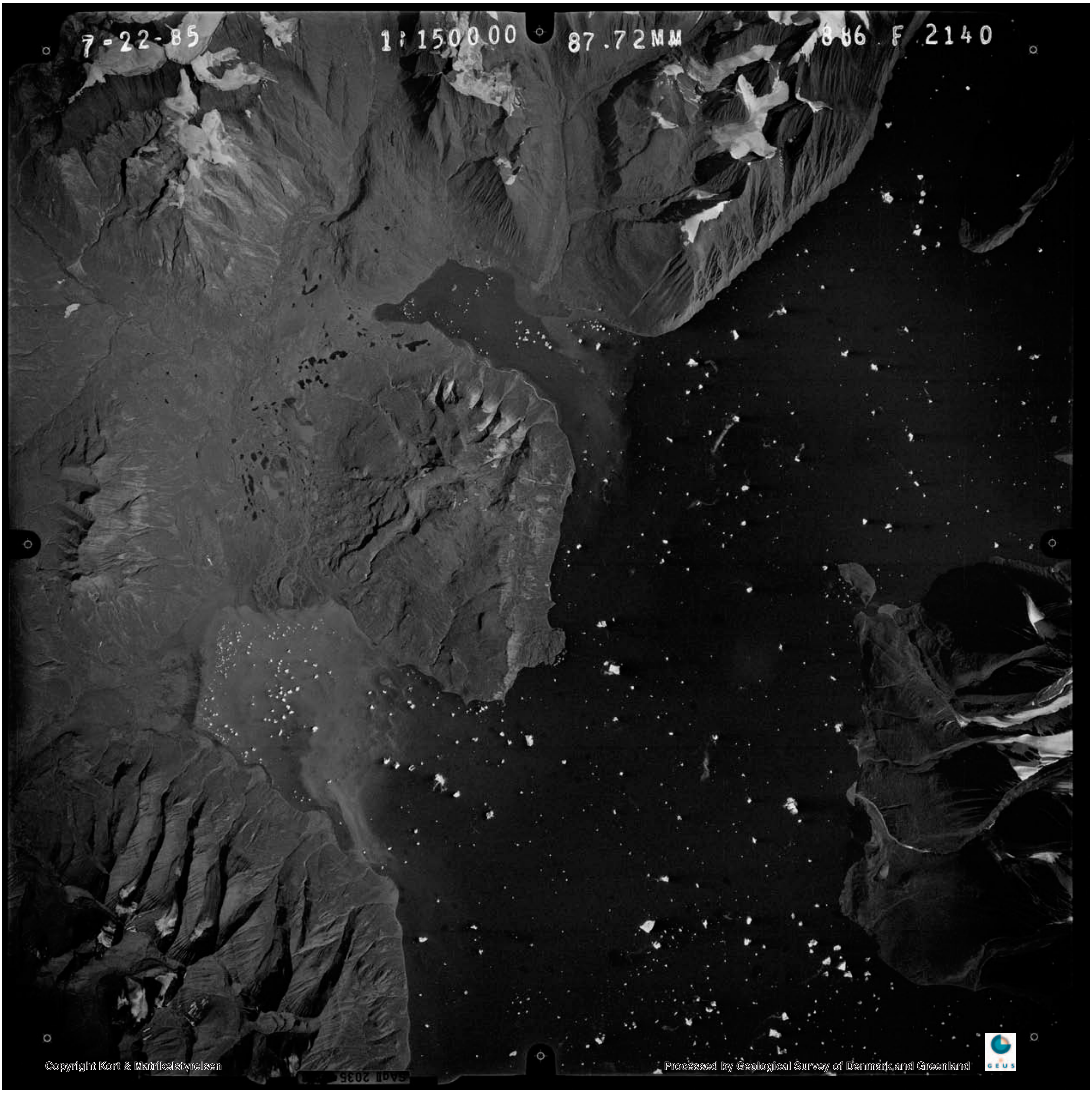

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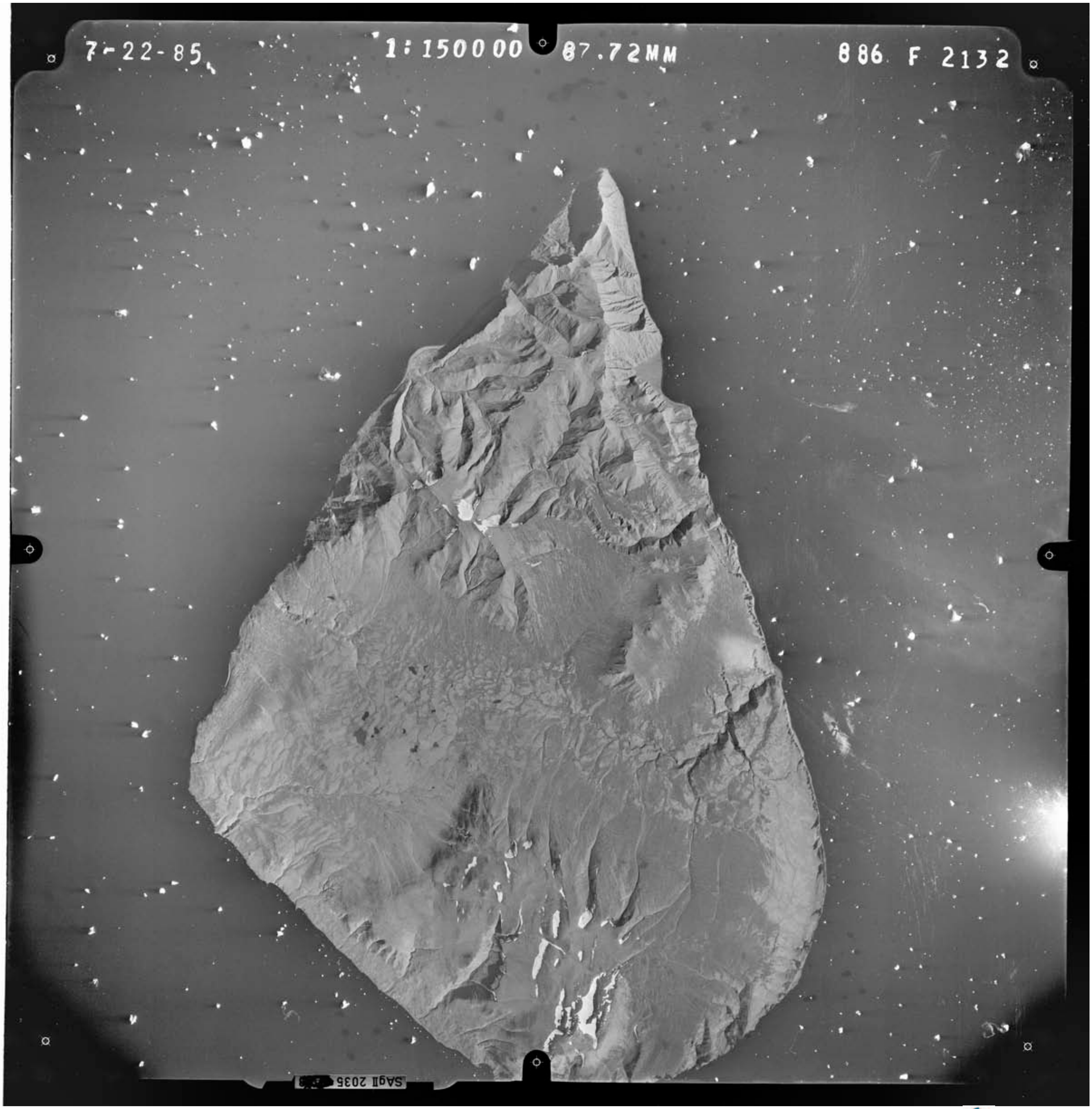

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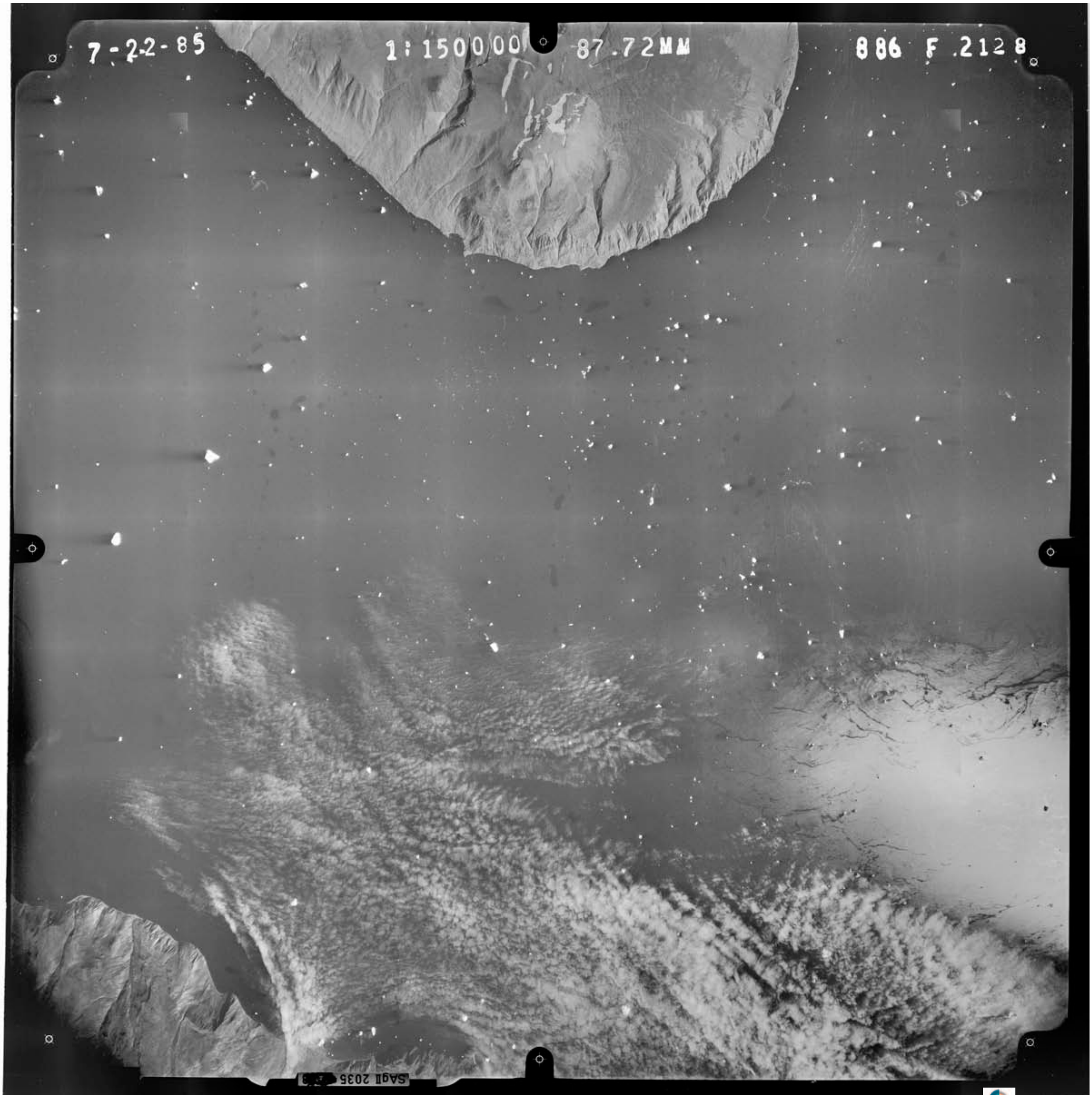

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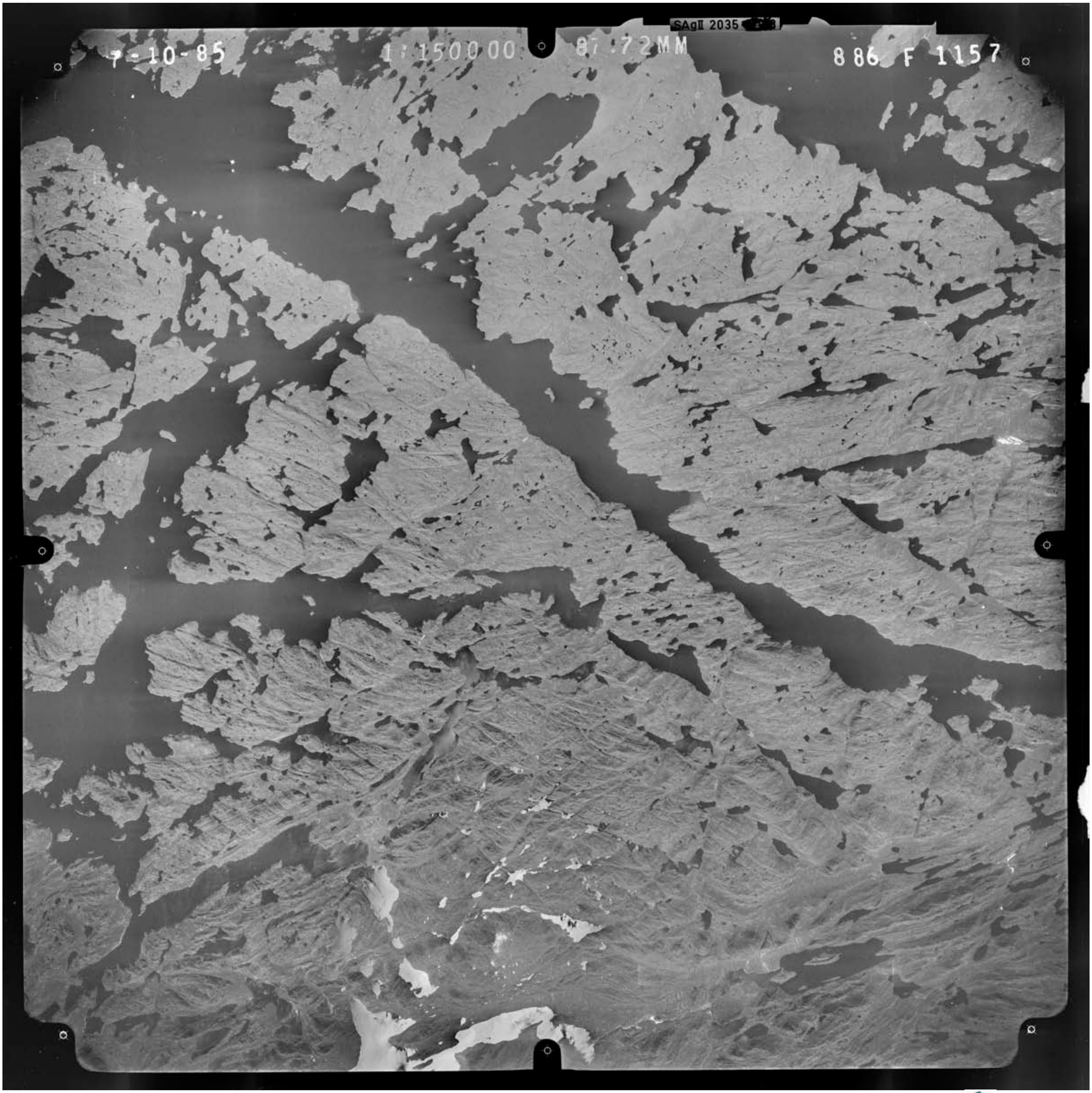

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

Contents

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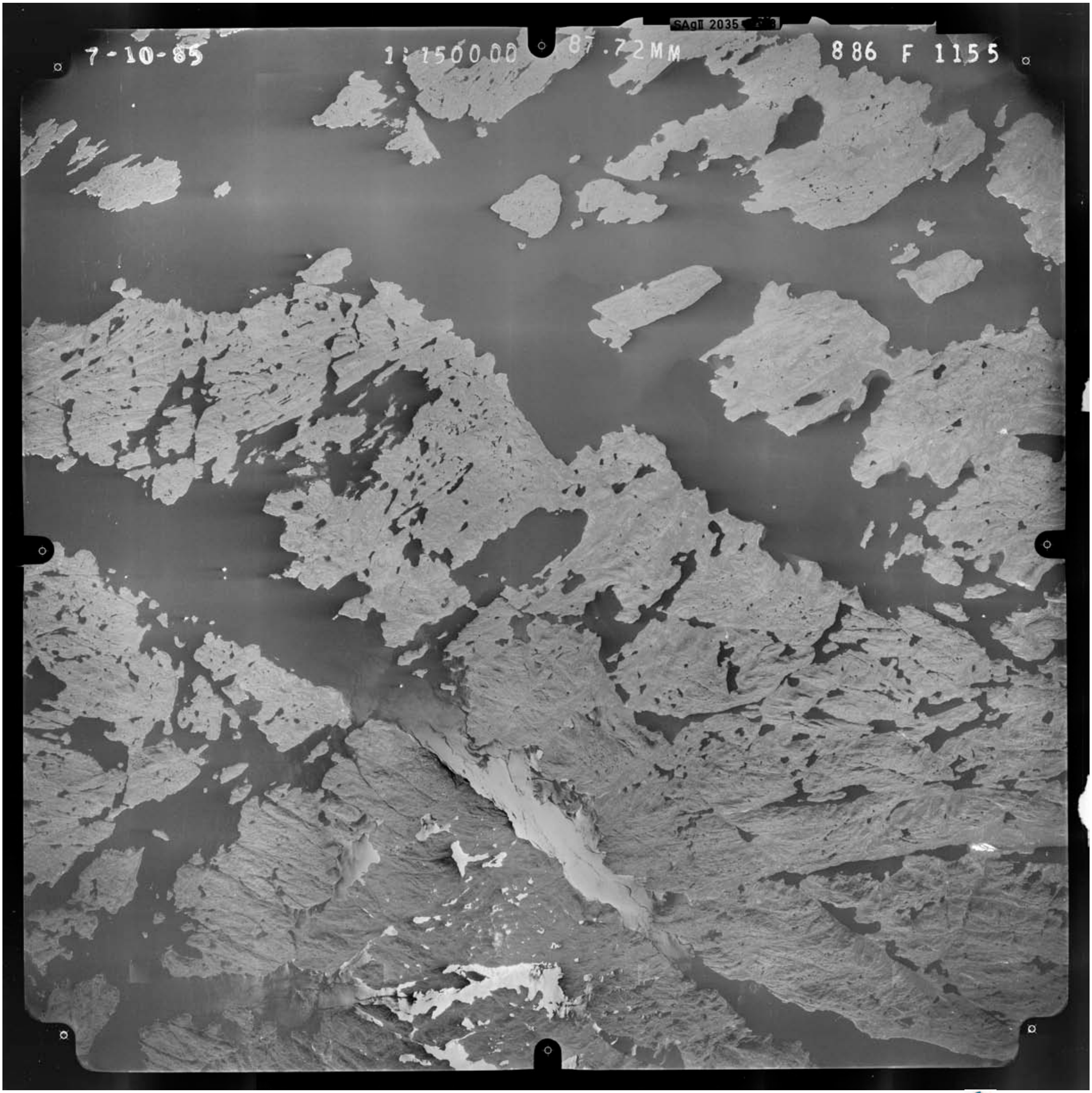
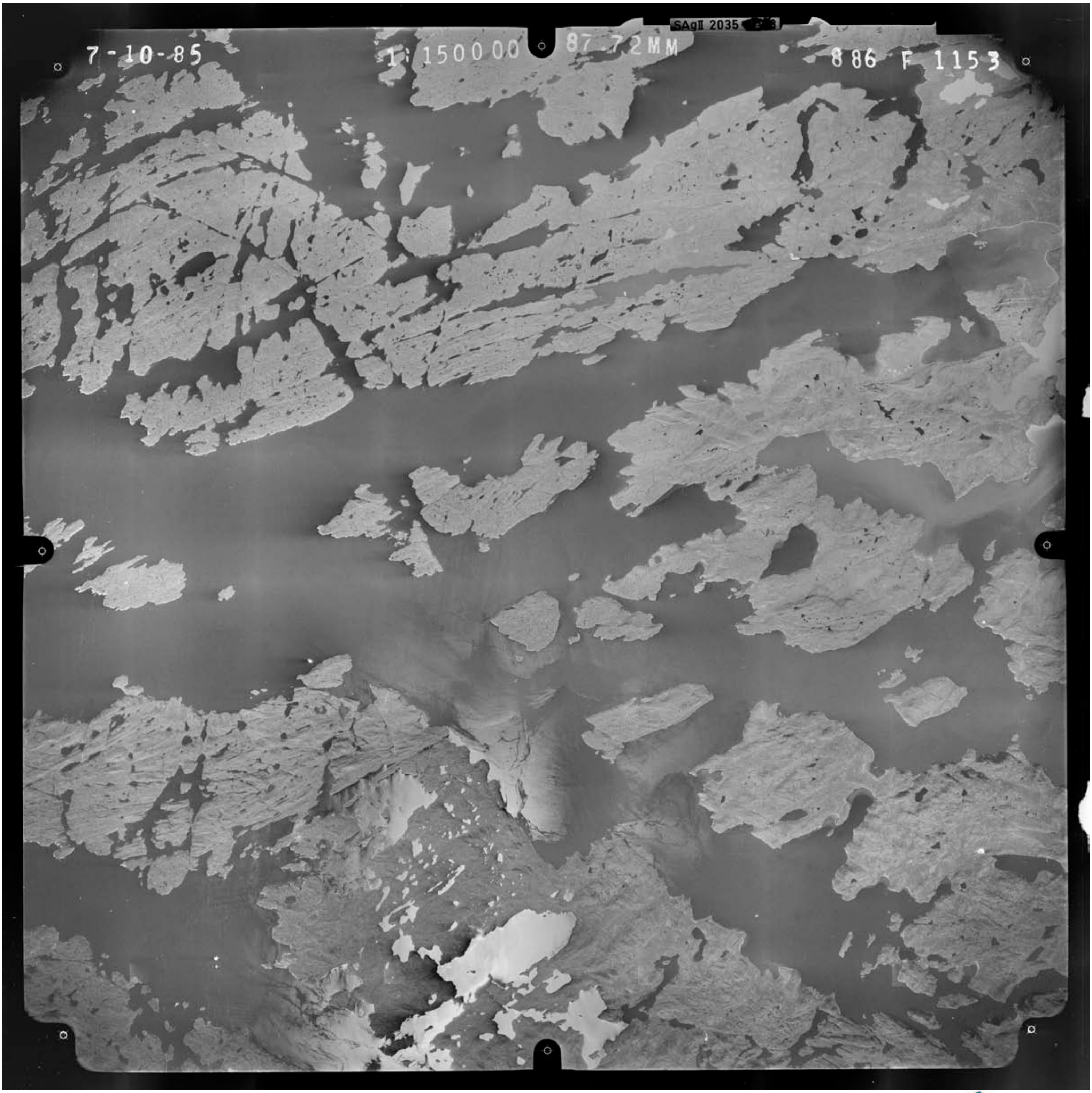


Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km



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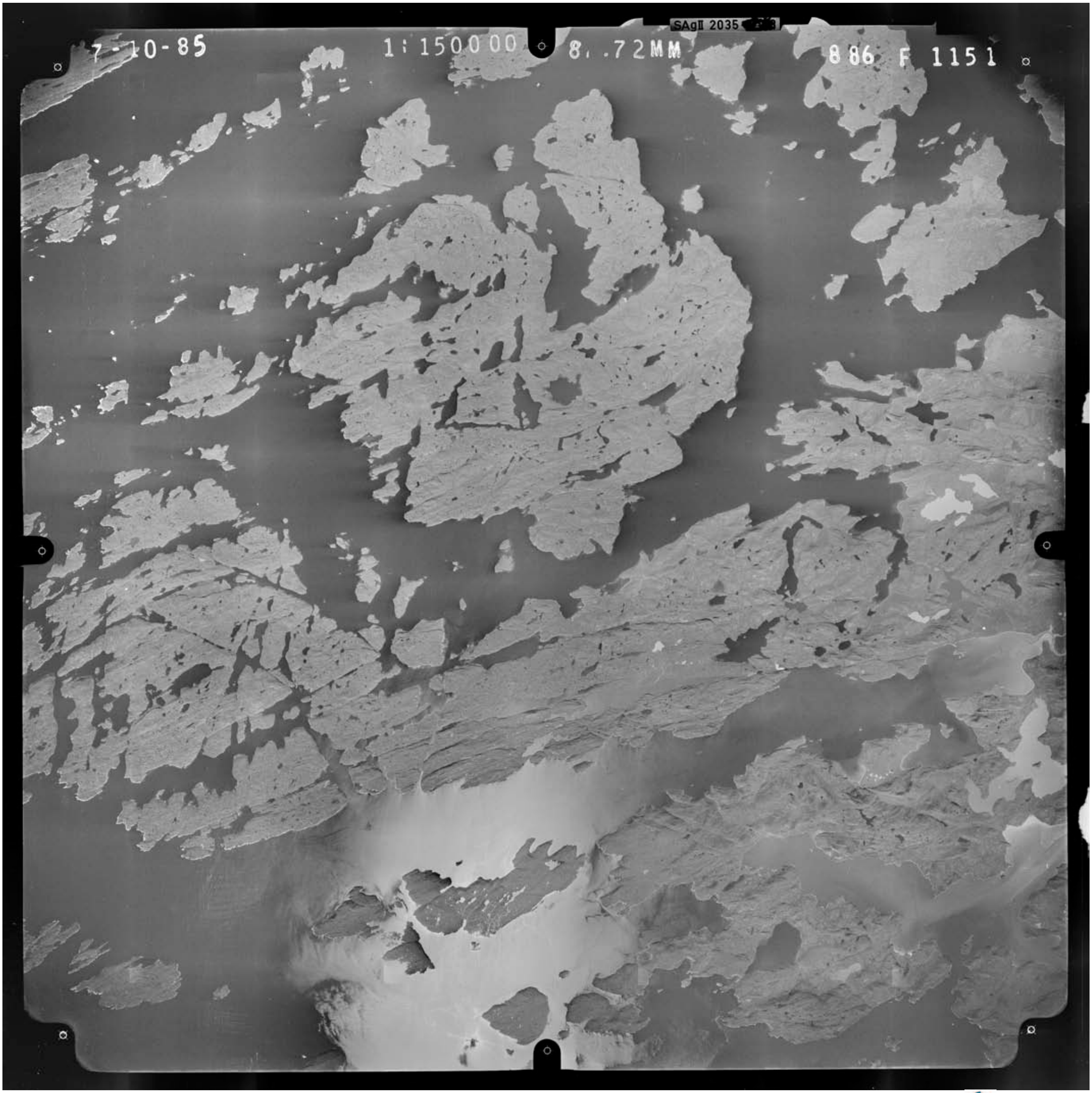
Approximate scale 0 2 4 6 8 10 km



Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

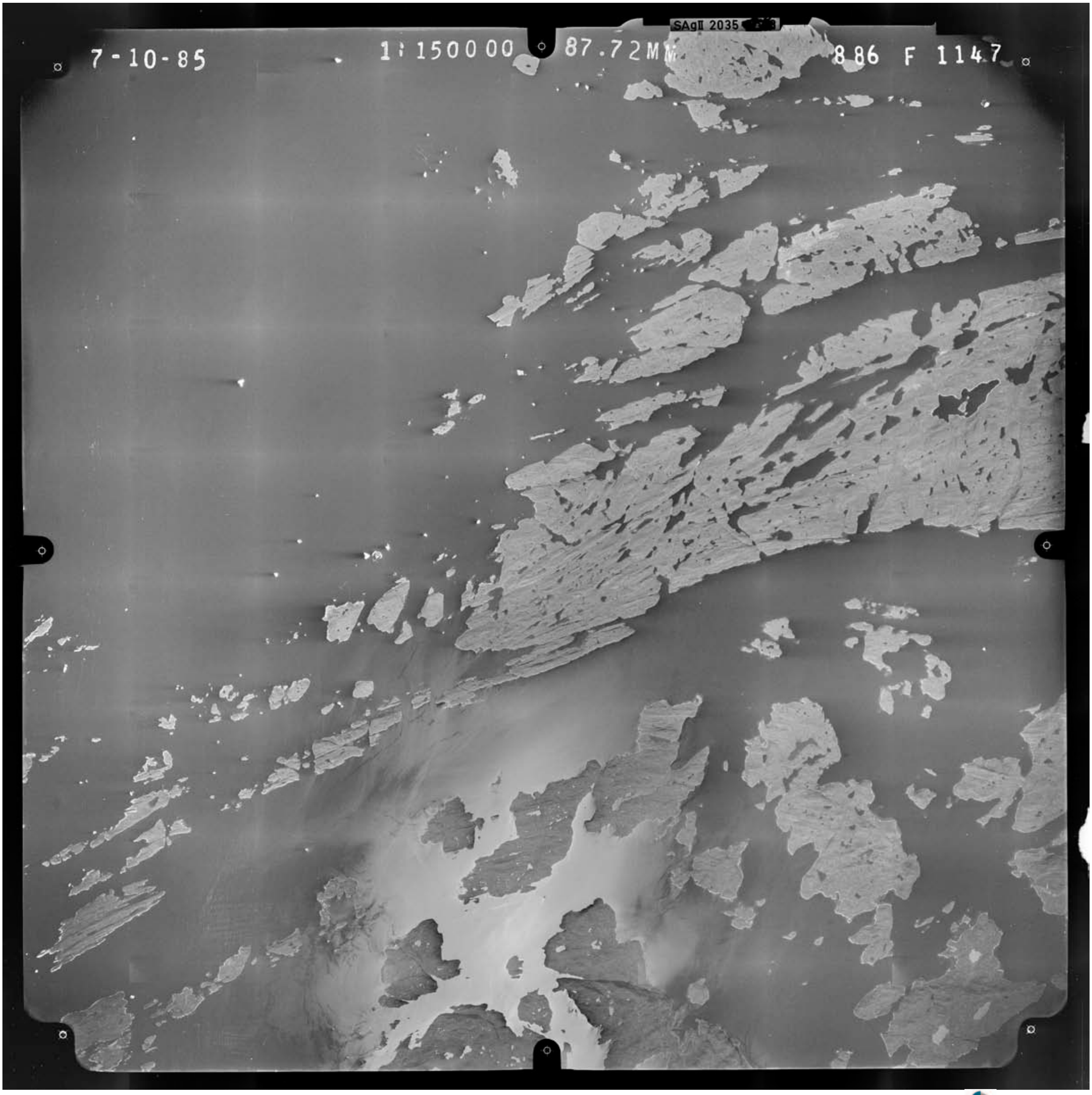
Contents
Airphoto Keymap

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

Contents

Airphoto Keymap



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Approximate scale 0 2 4 6 8 10 km

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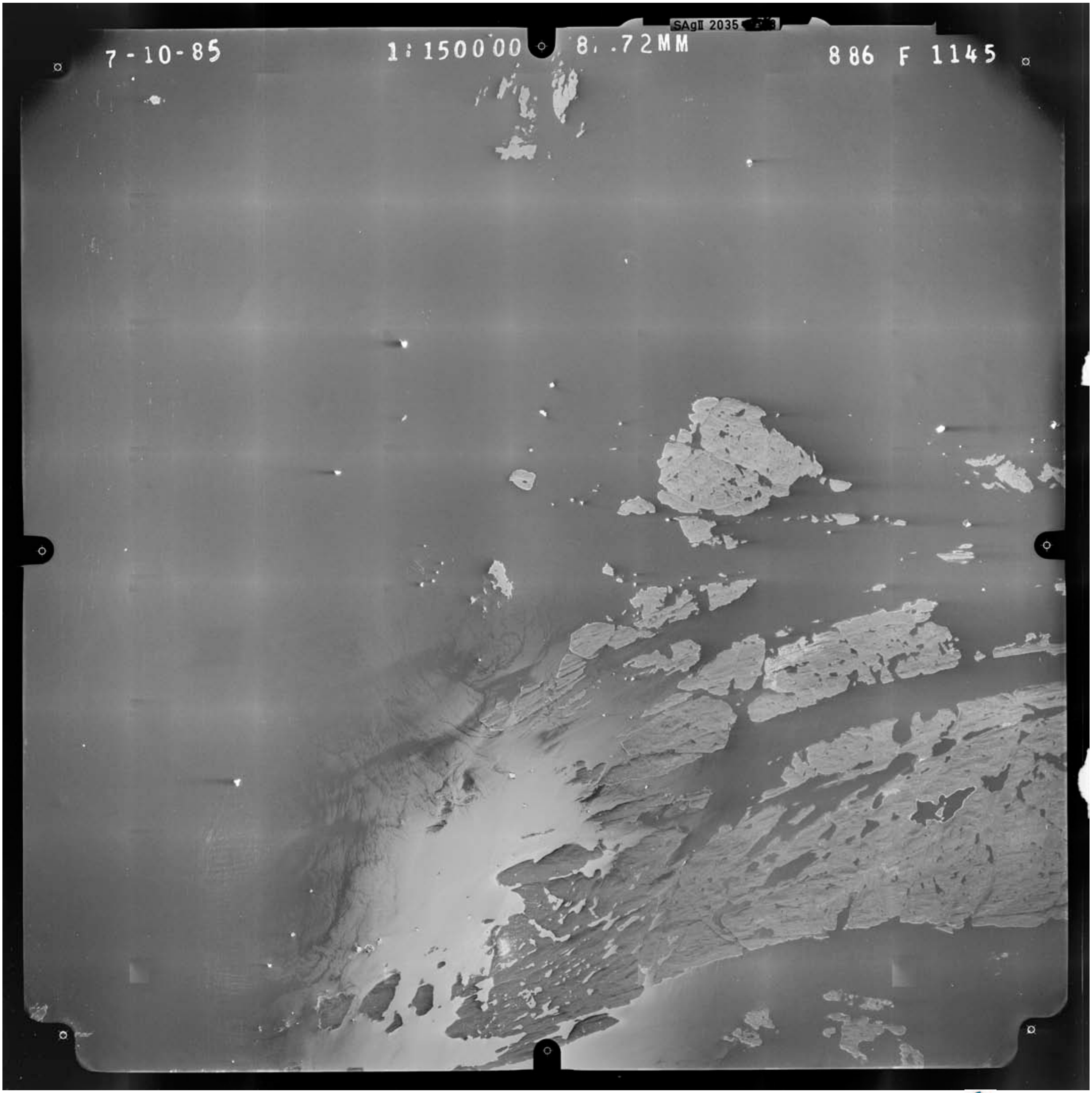

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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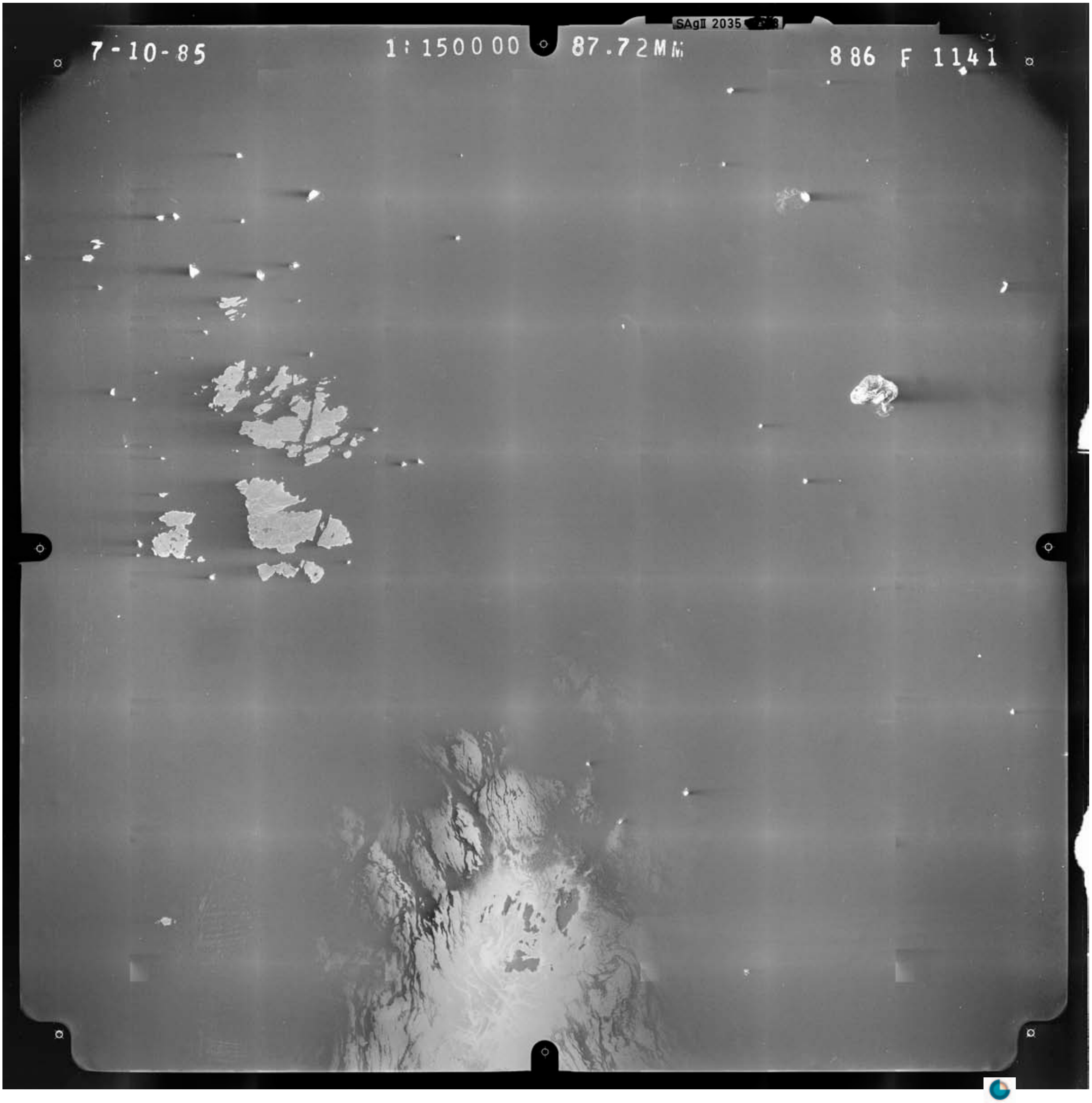
Airphoto Keymap

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km



Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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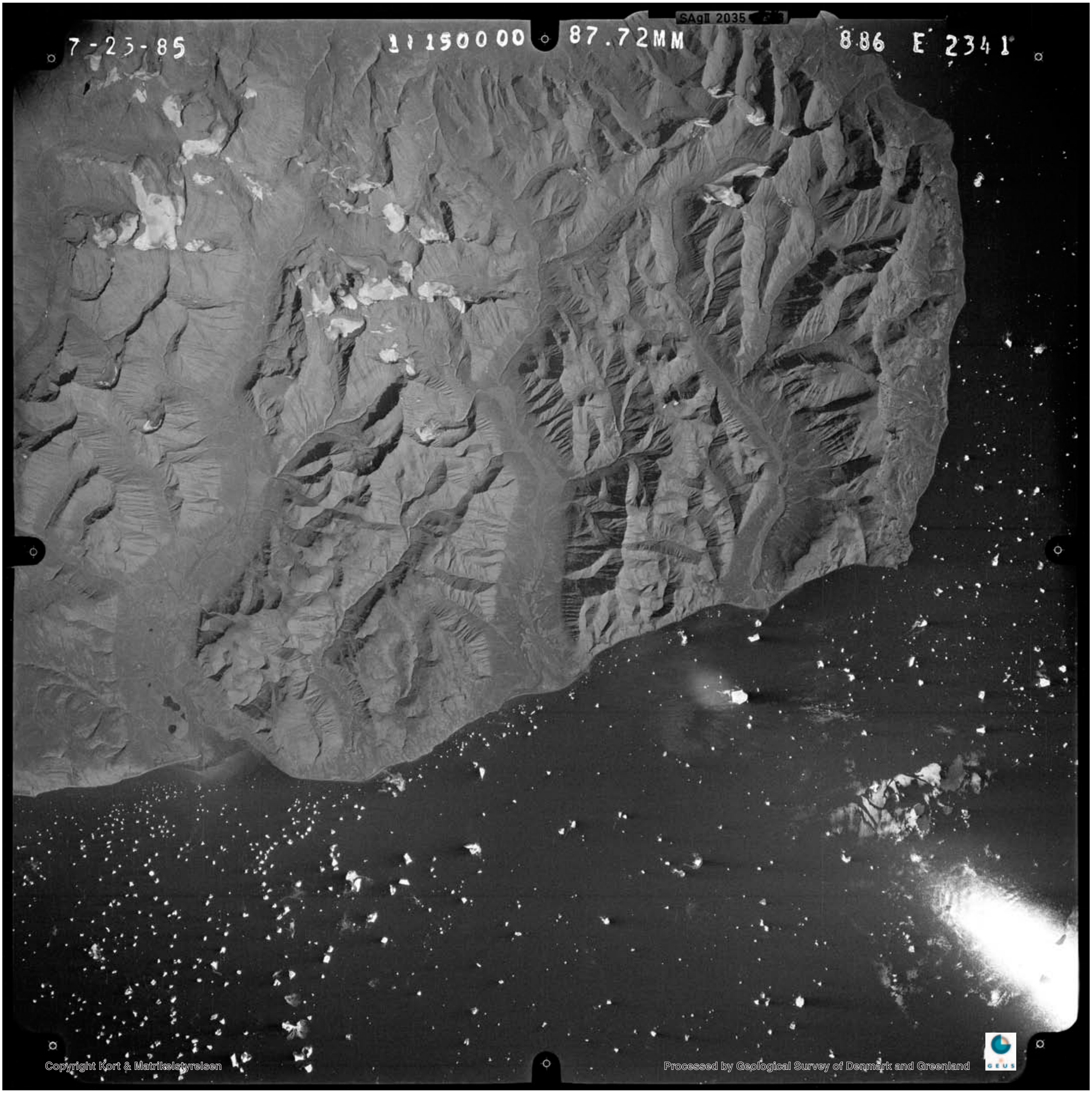
Approximate scale 0 2 4 6 8 10 km



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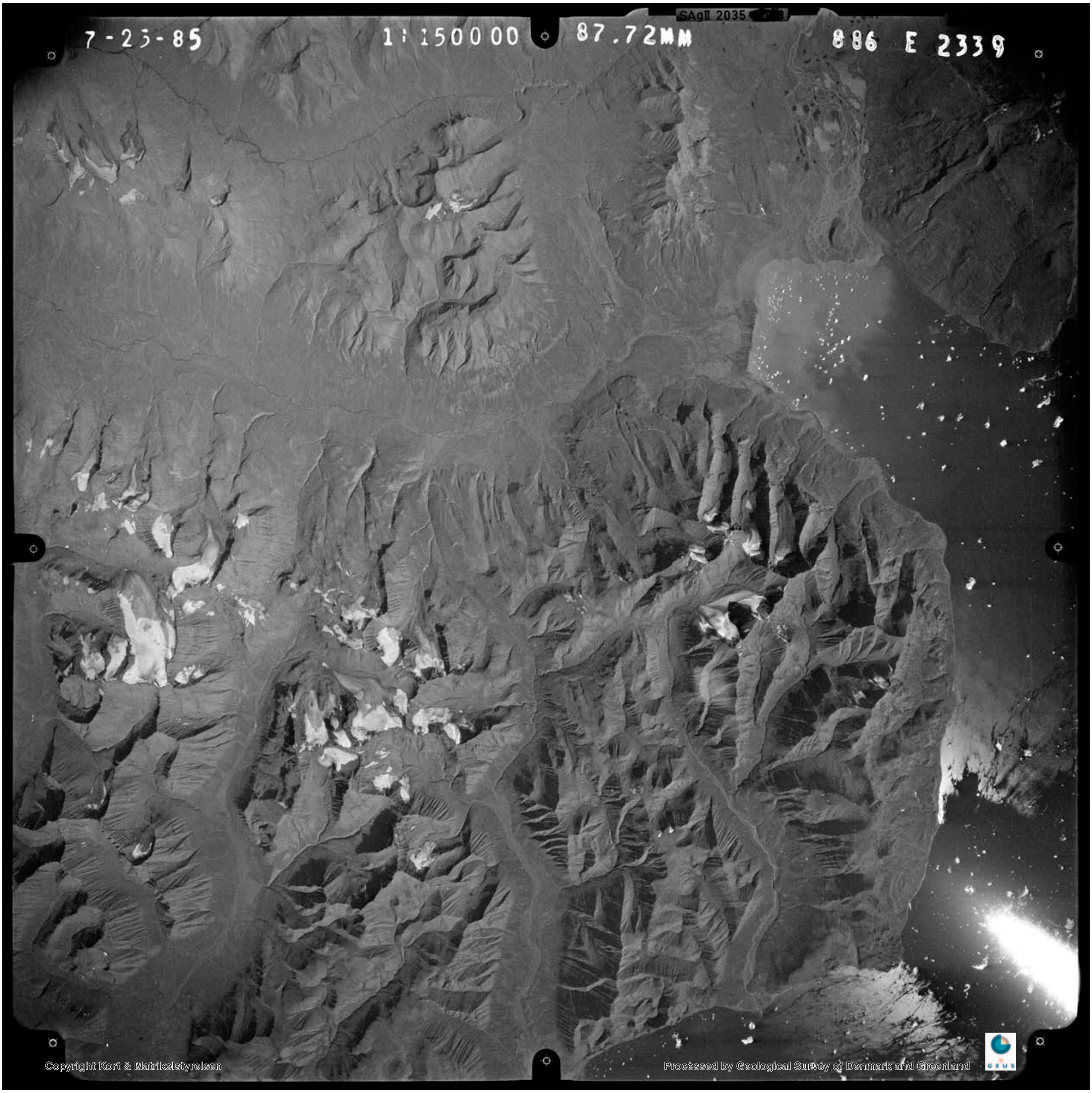

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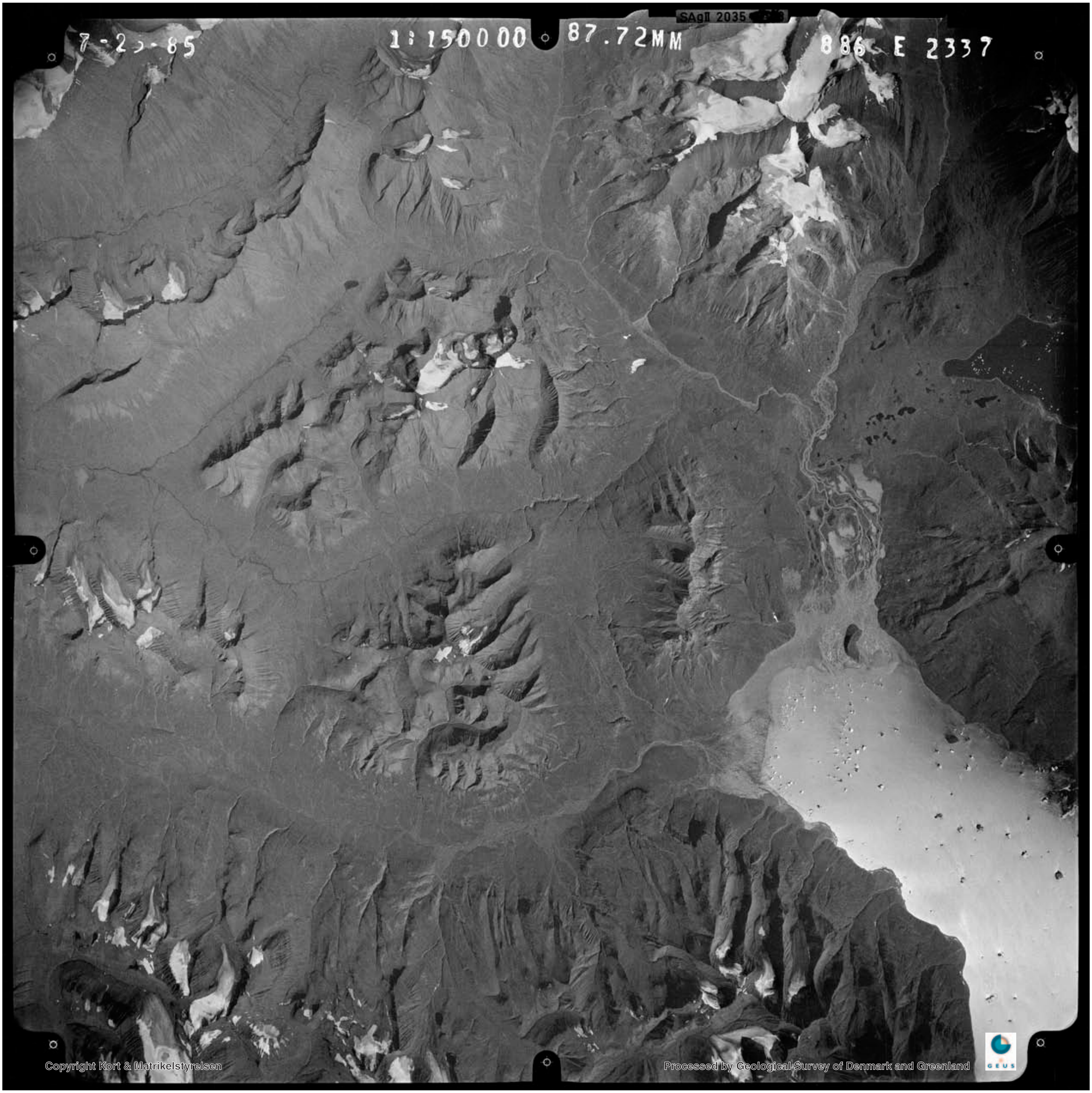

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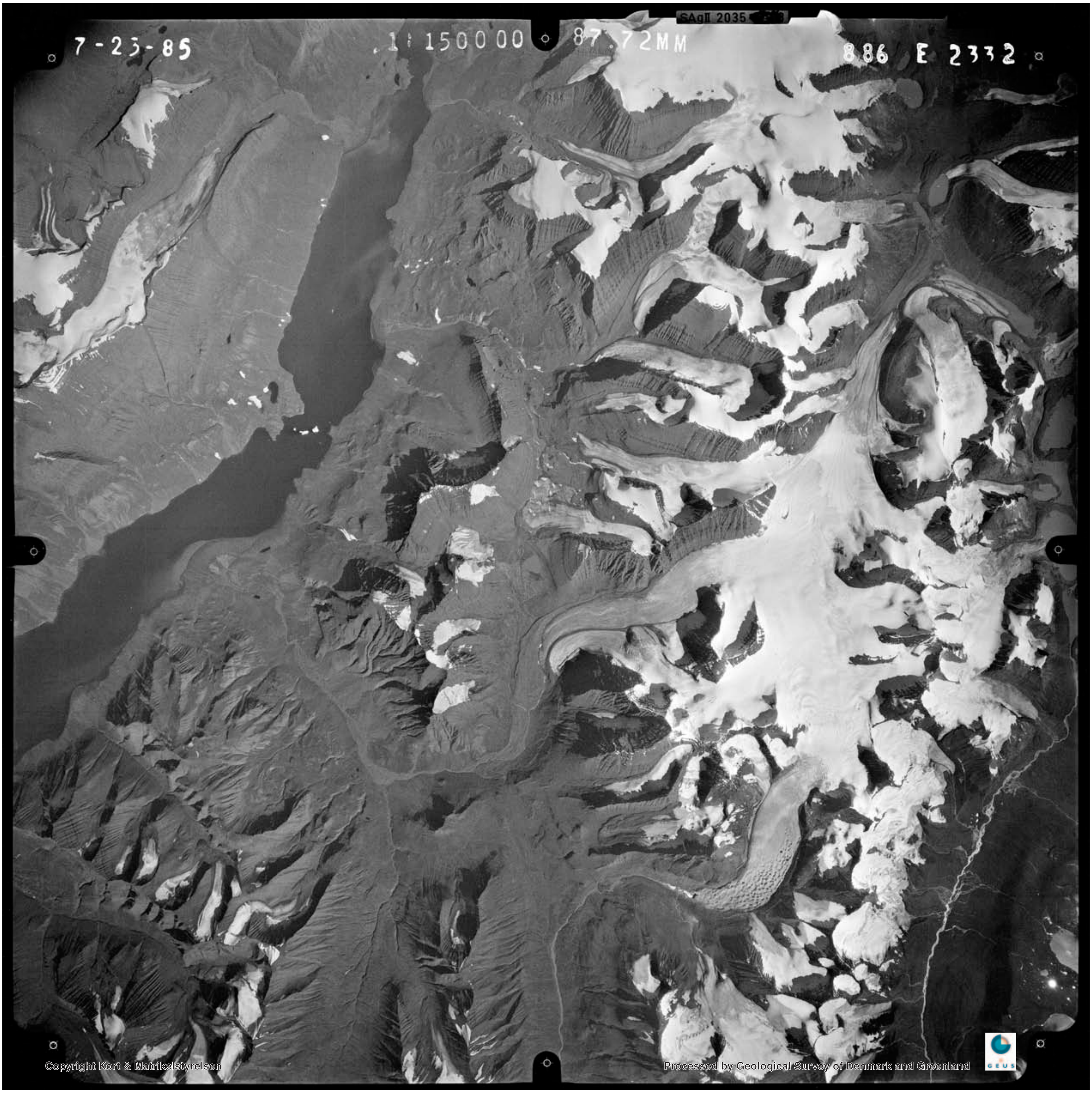

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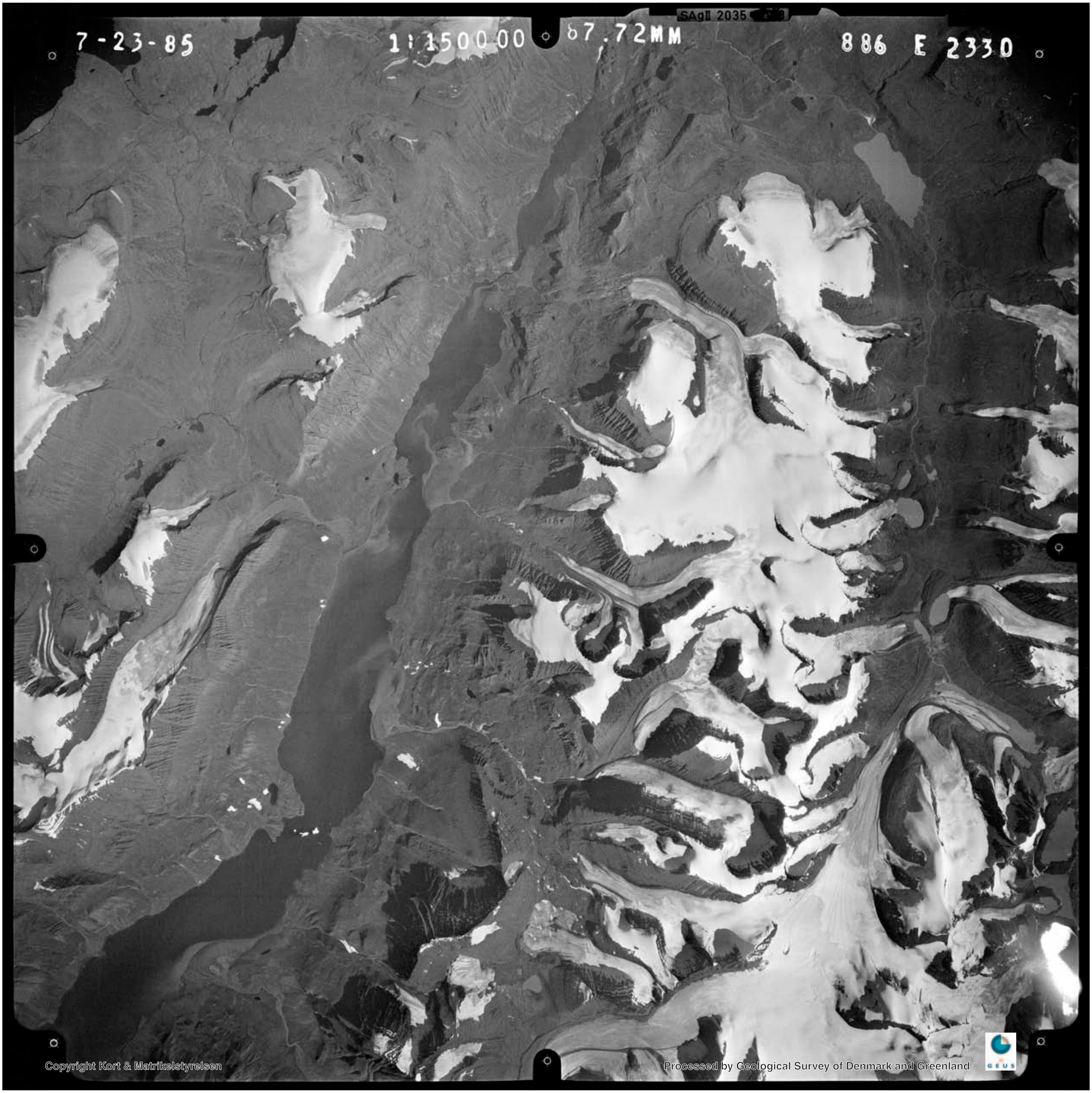

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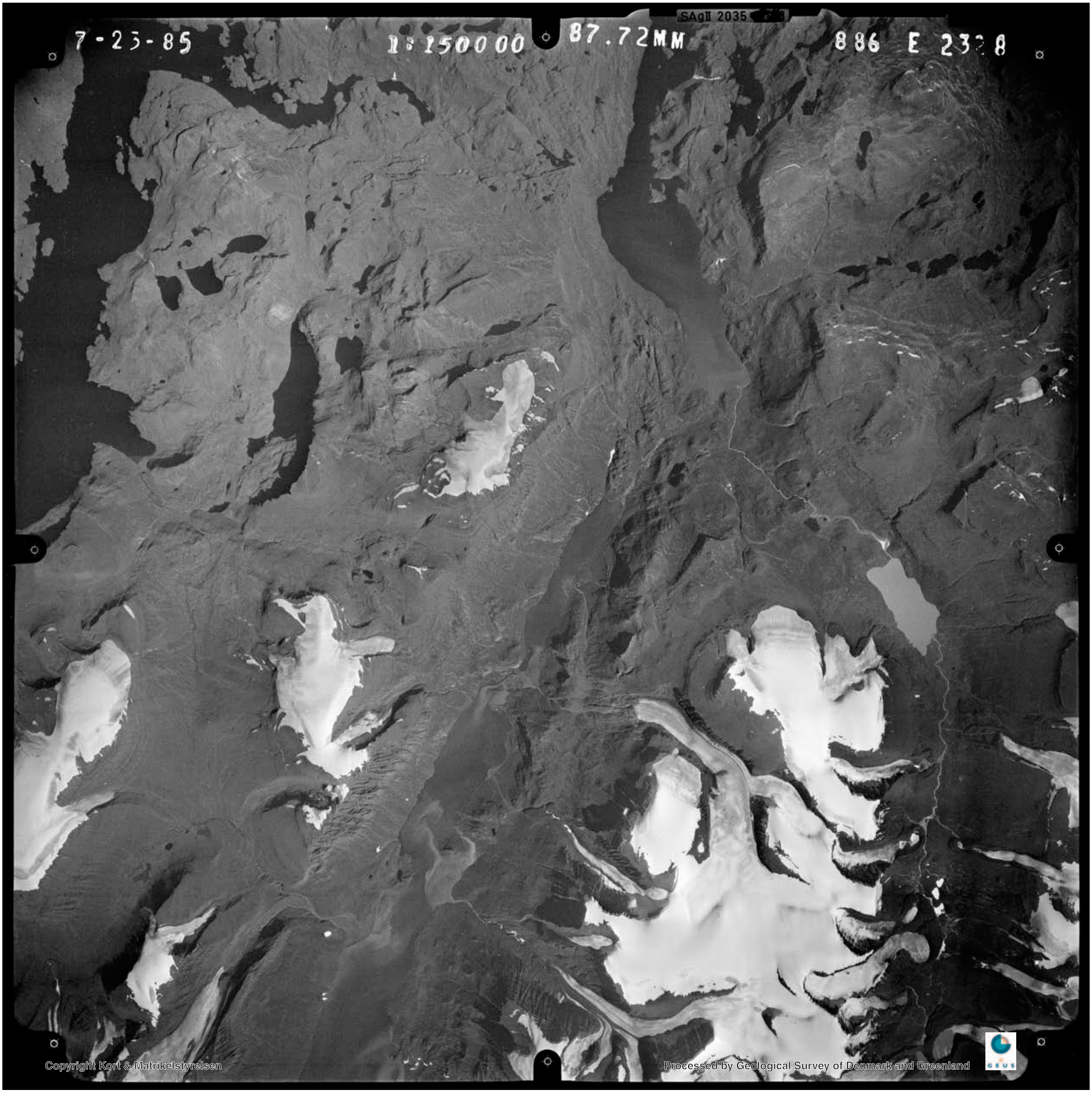

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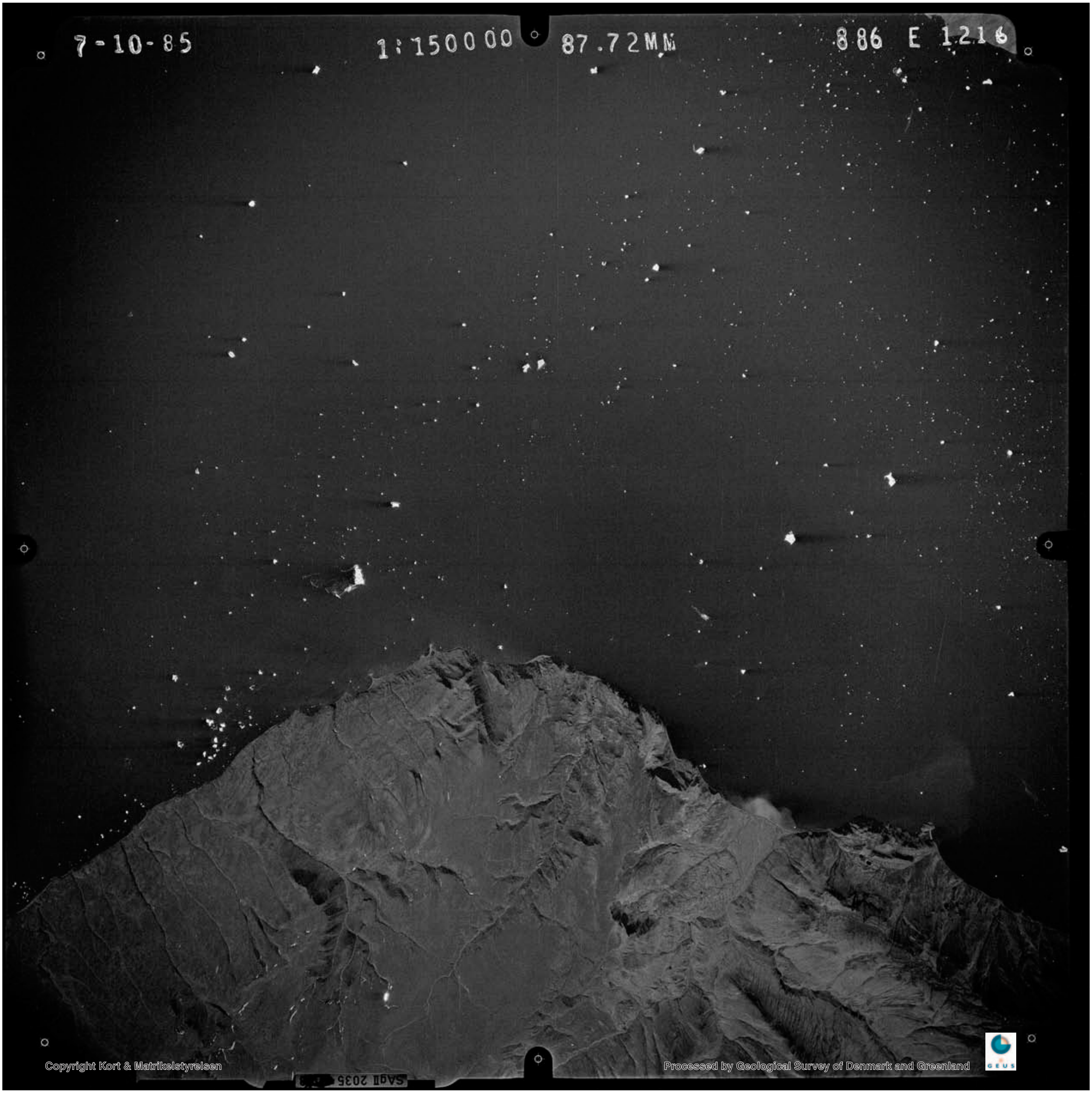

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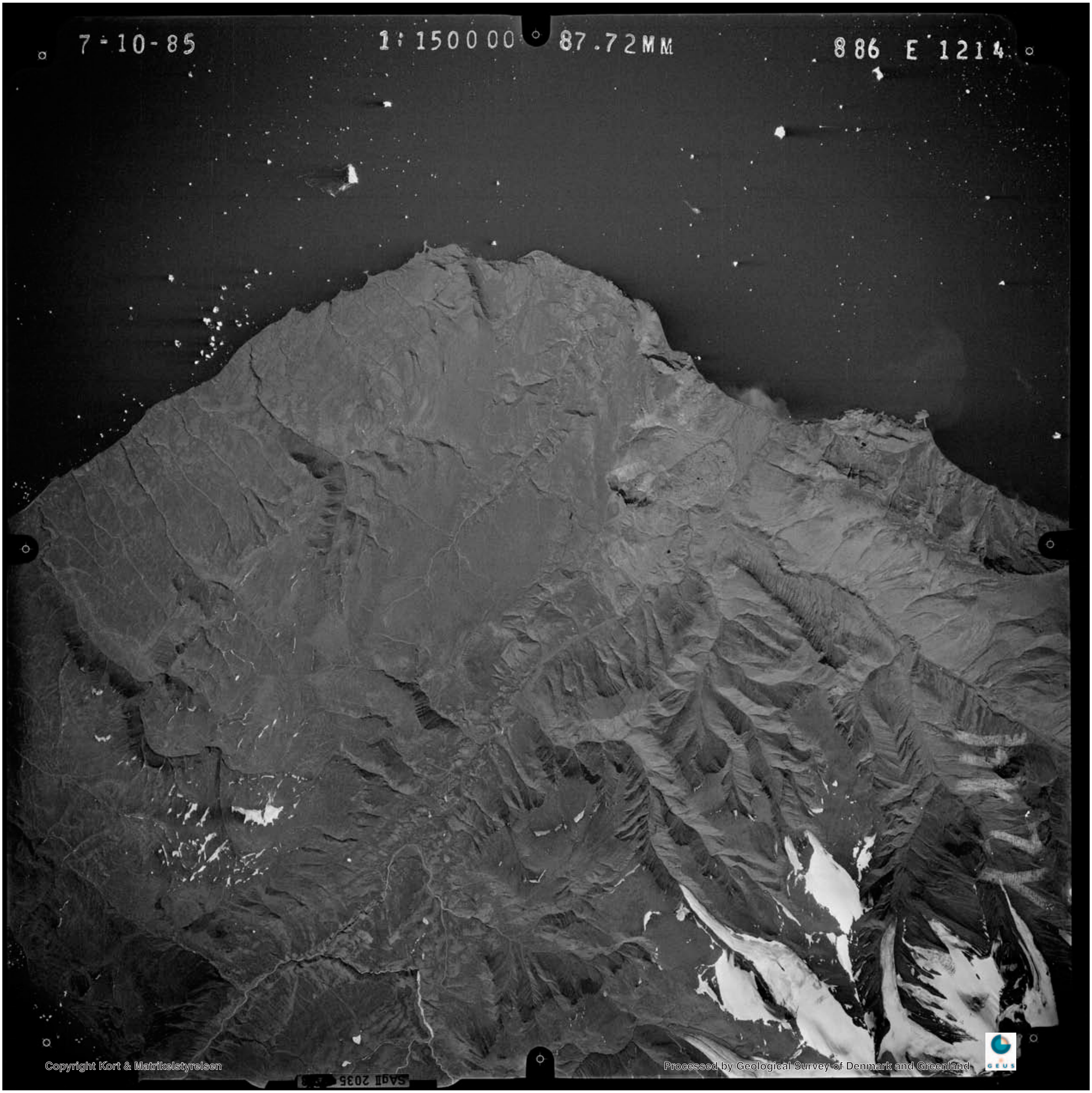

Approximate scale 0 2 4 6 8 10 km

Contents

Airphoto Keymap

Approximate scale 0 2 4 6 8 10 km

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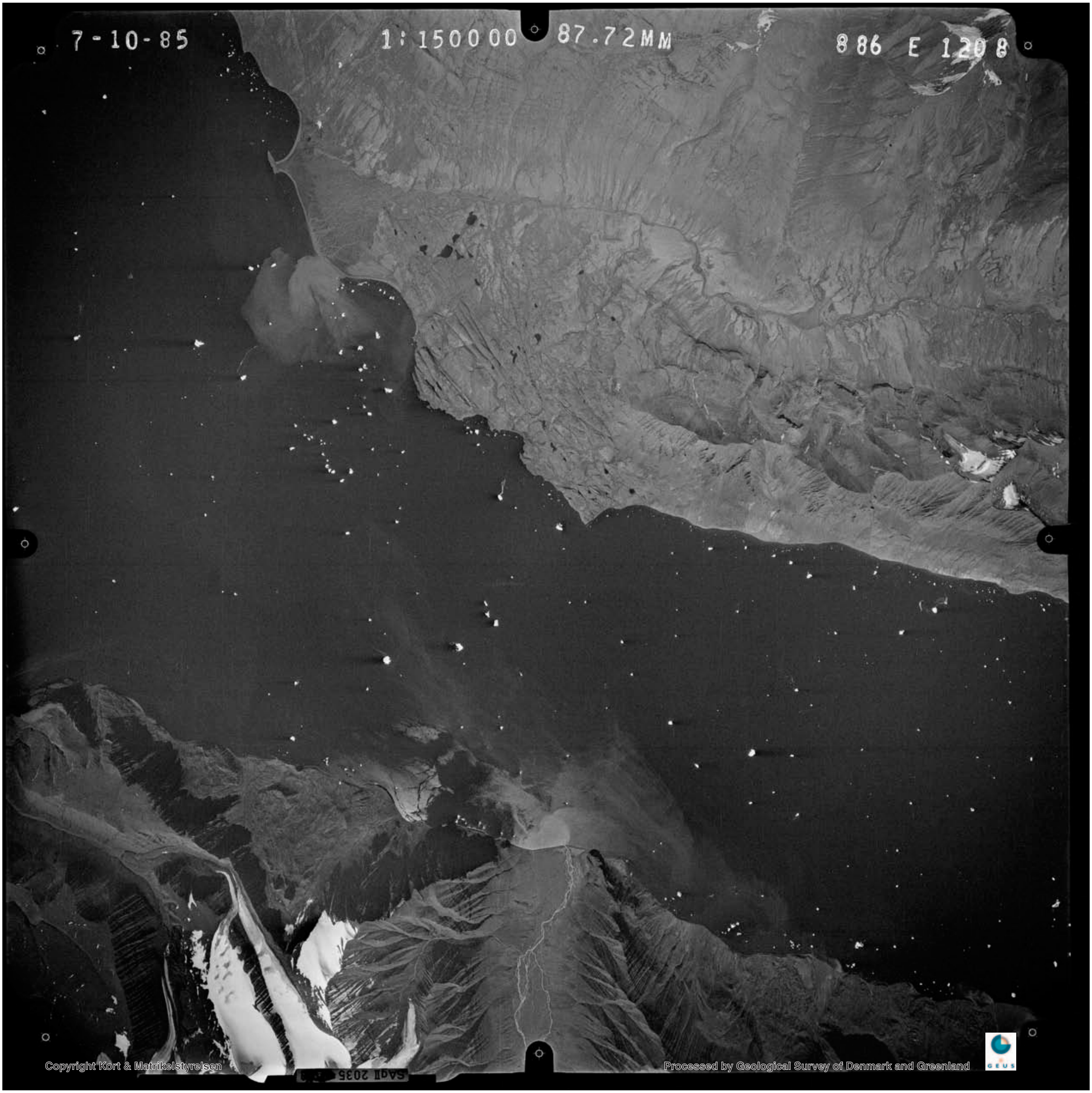
Airphoto Keymap

Approximate scale 0 2 4 6 8 10 km



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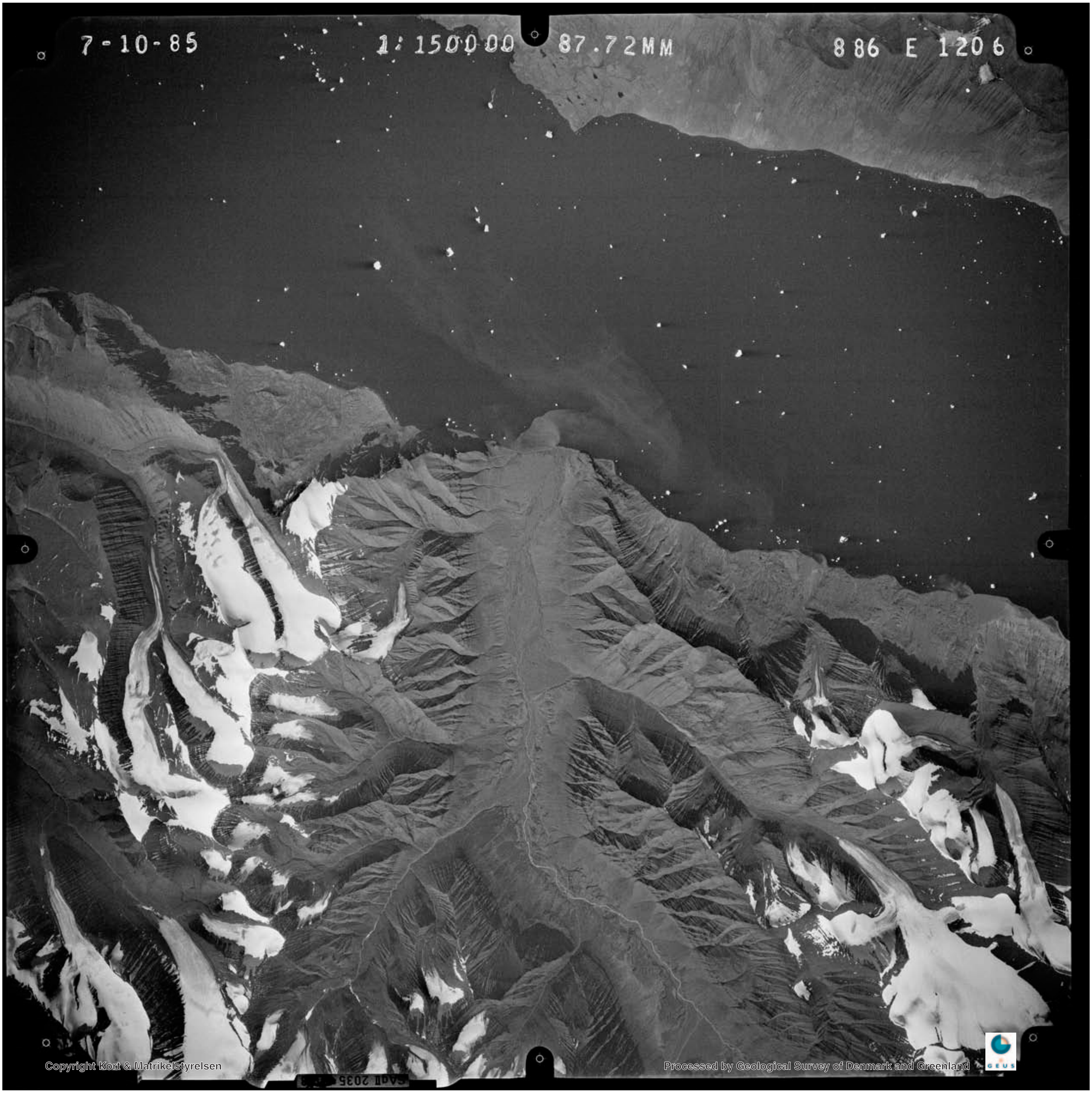

Approximate scale 0 2 4 6 8 10 km

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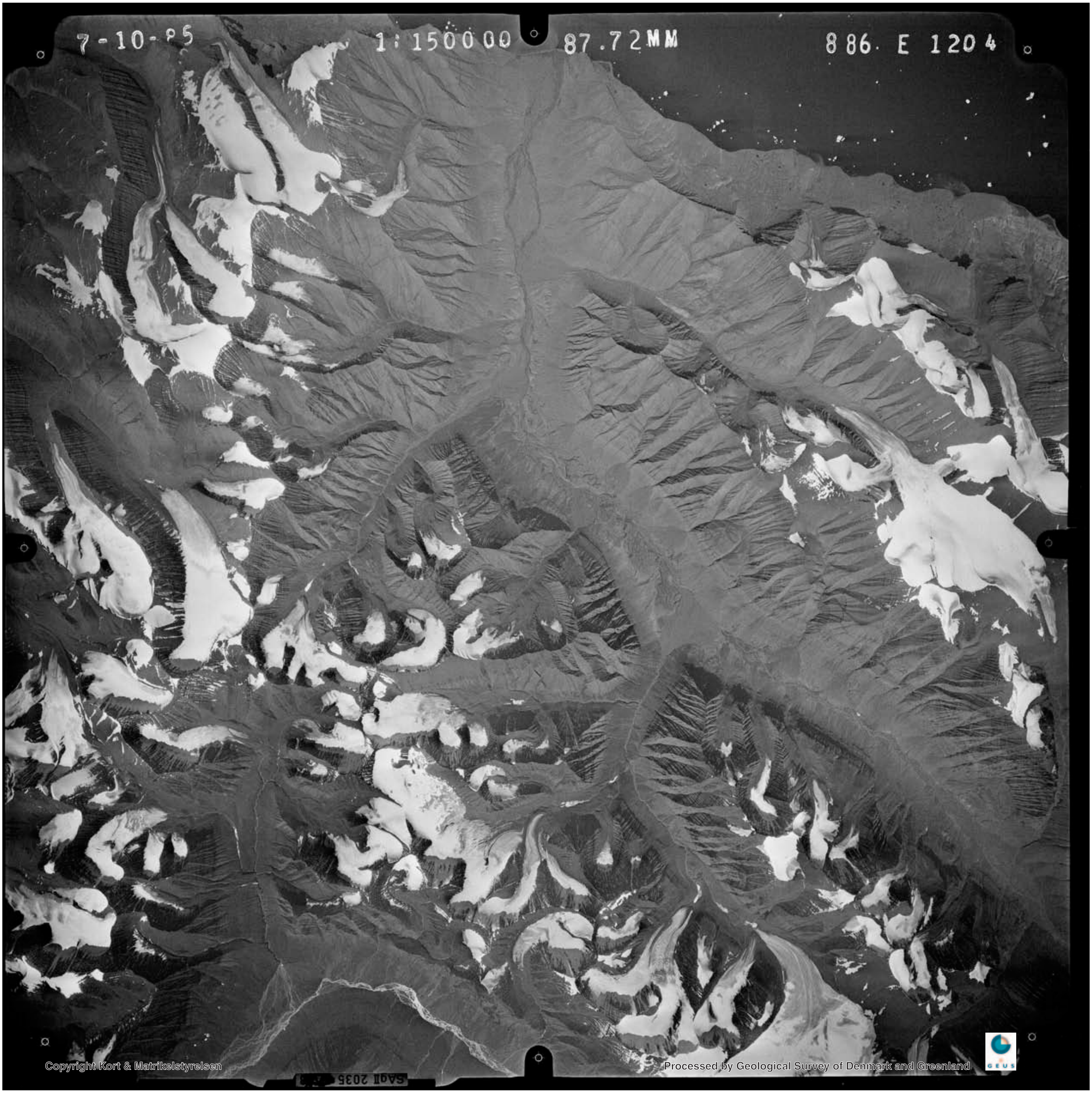

Approximate scale 0 2 4 6 8 10 km

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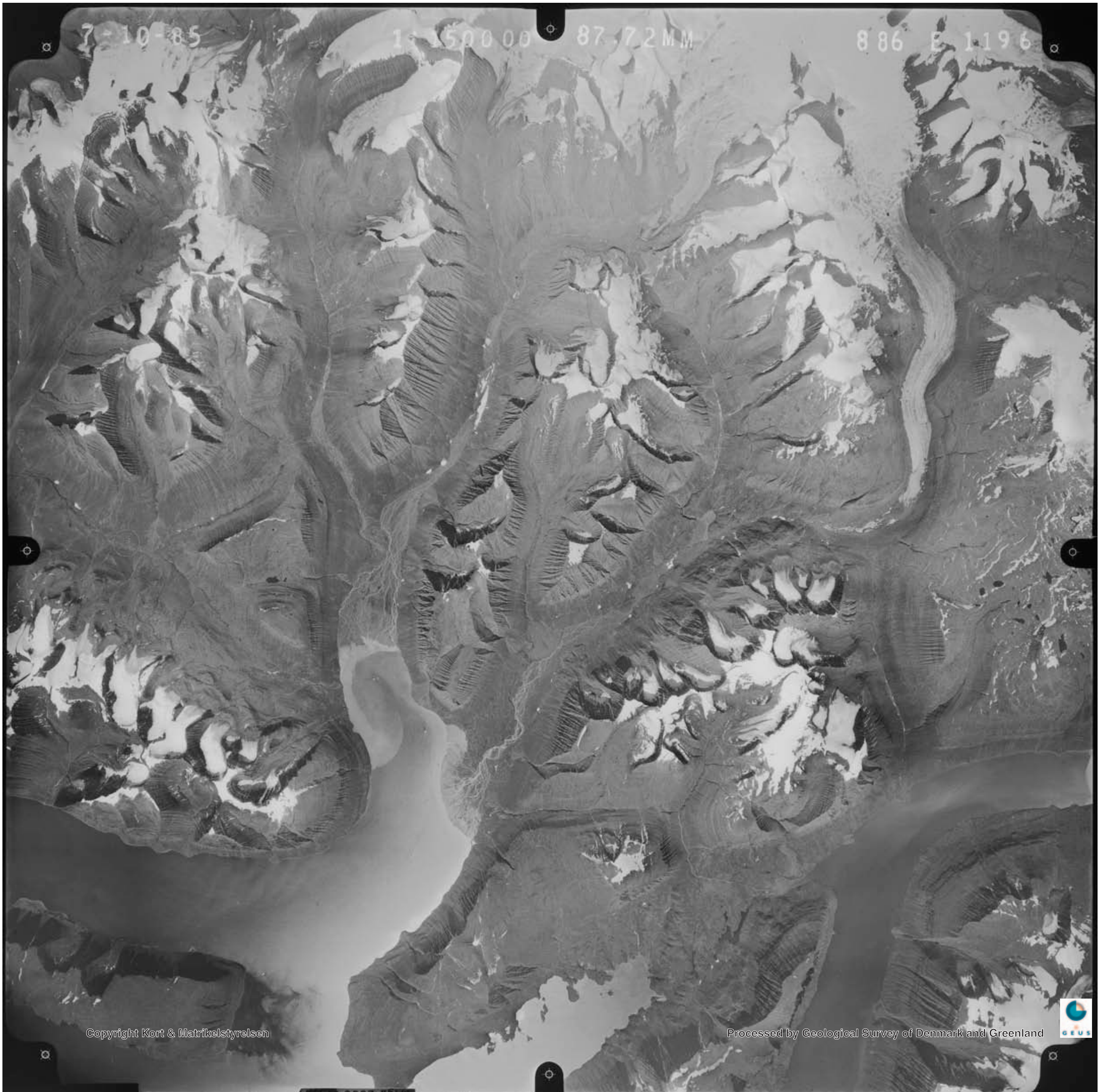

Approximate scale 0 2 4 6 8 10 km

Approximate scale 0 2 4 6 8 10 km

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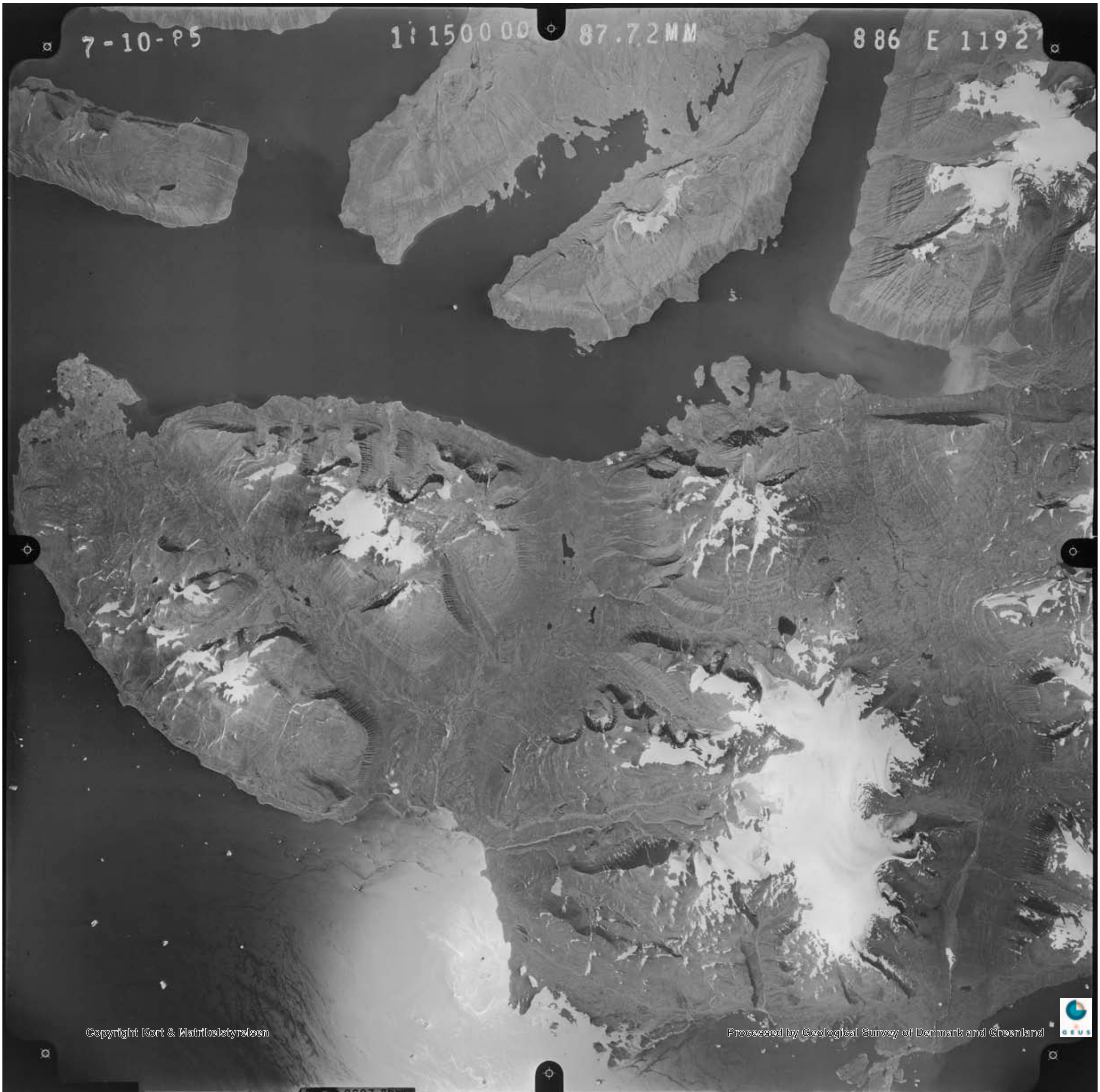

Approximate scale 0 2 4 6 8 10 km

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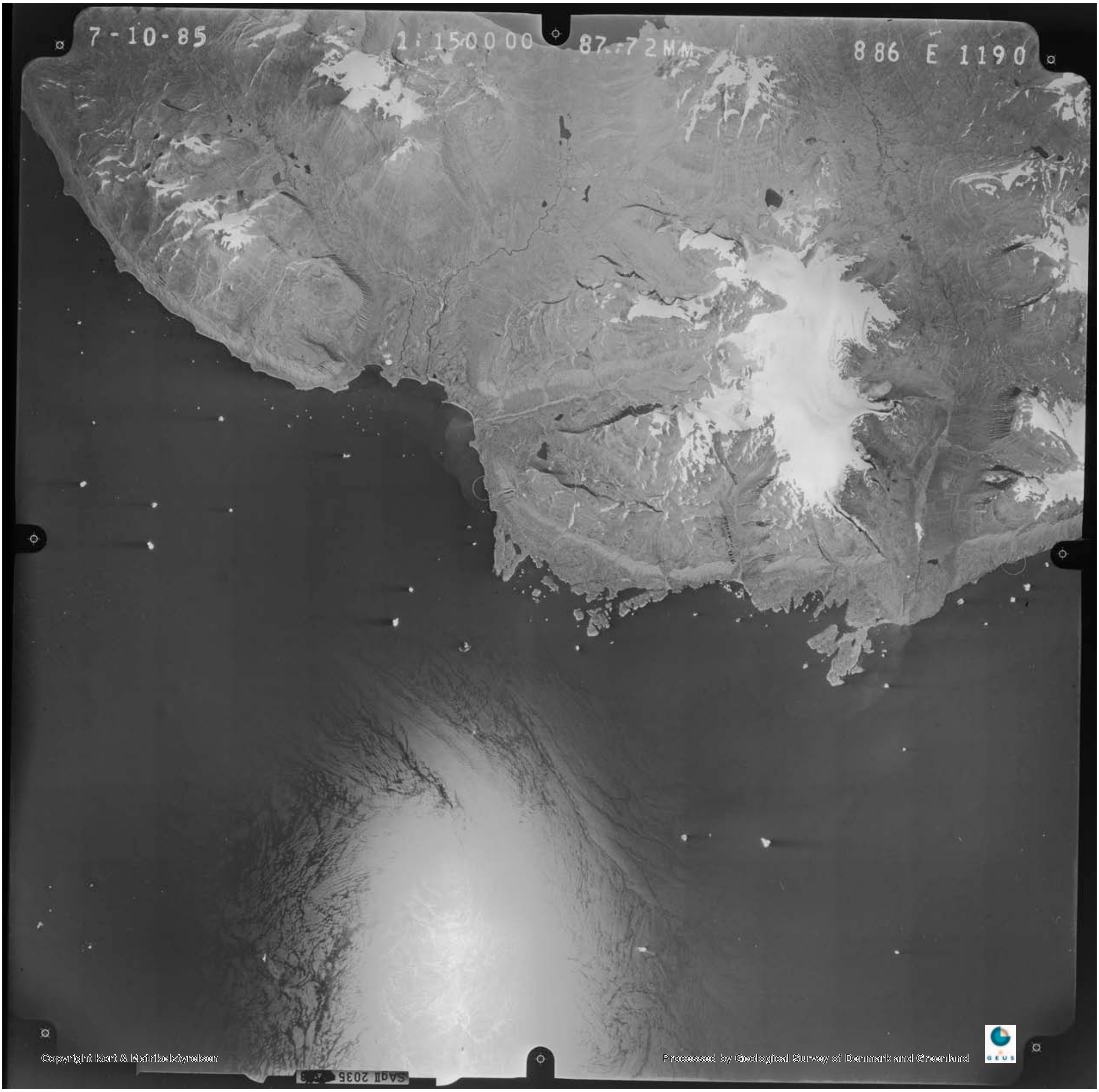

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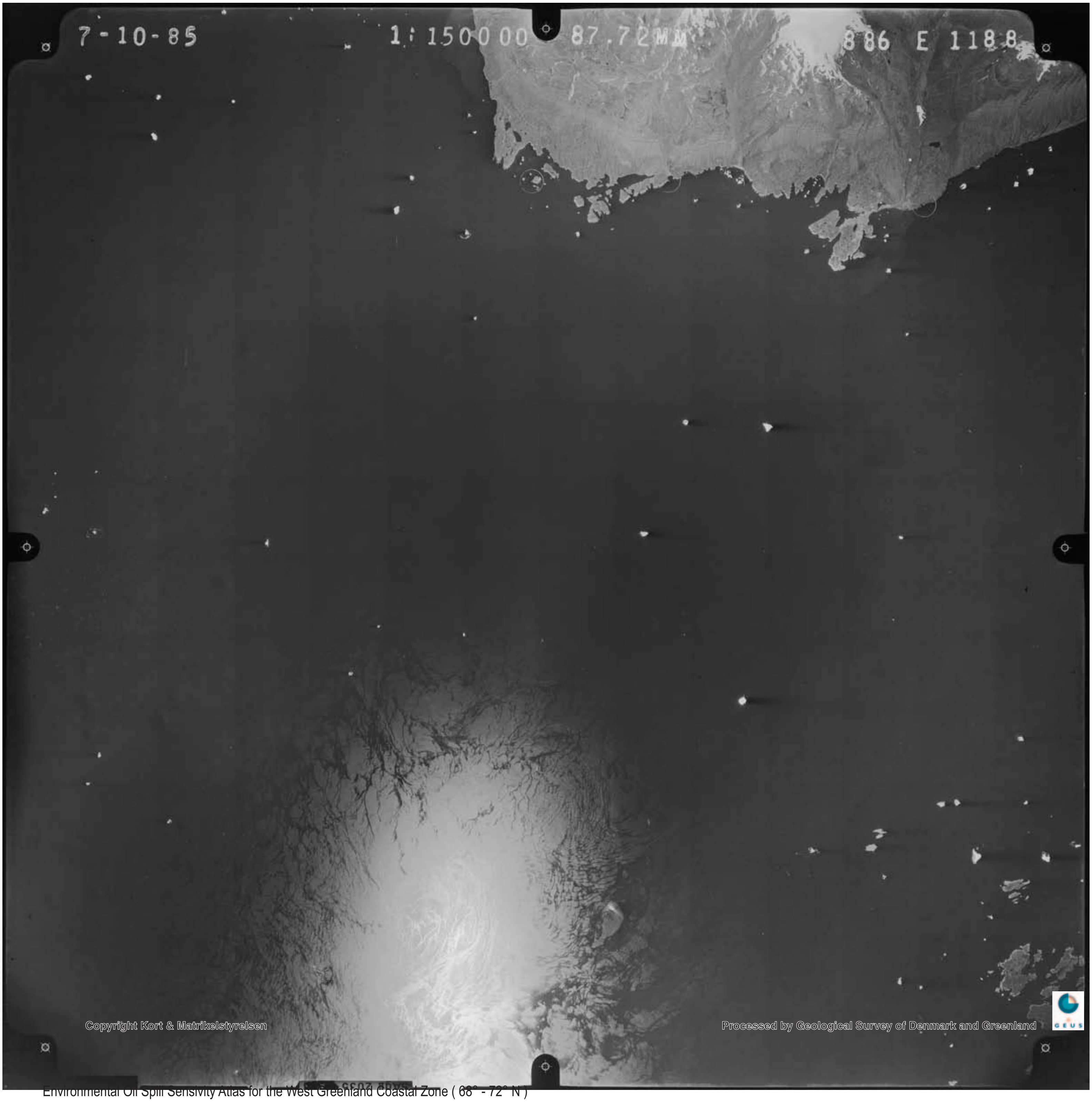

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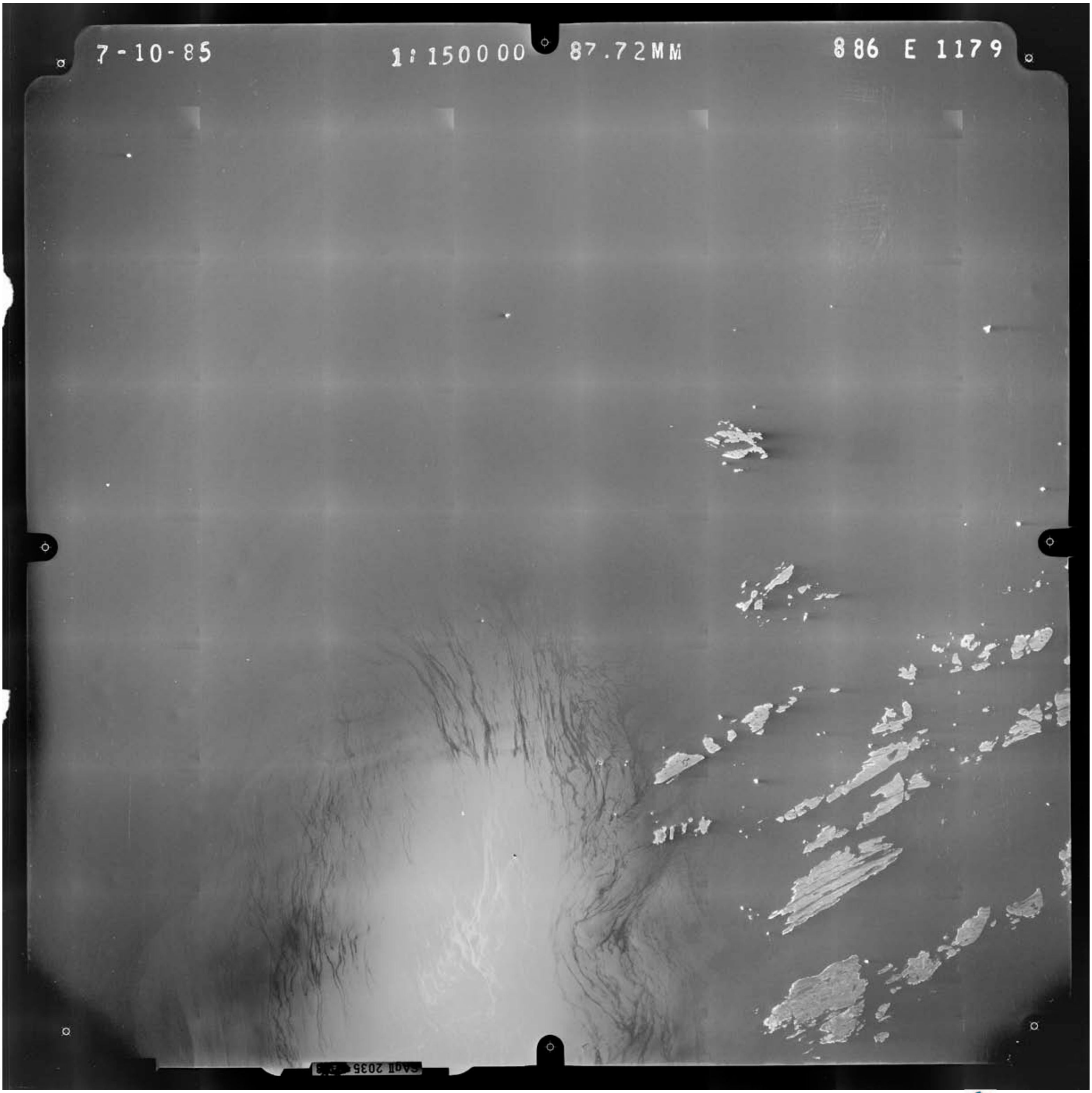

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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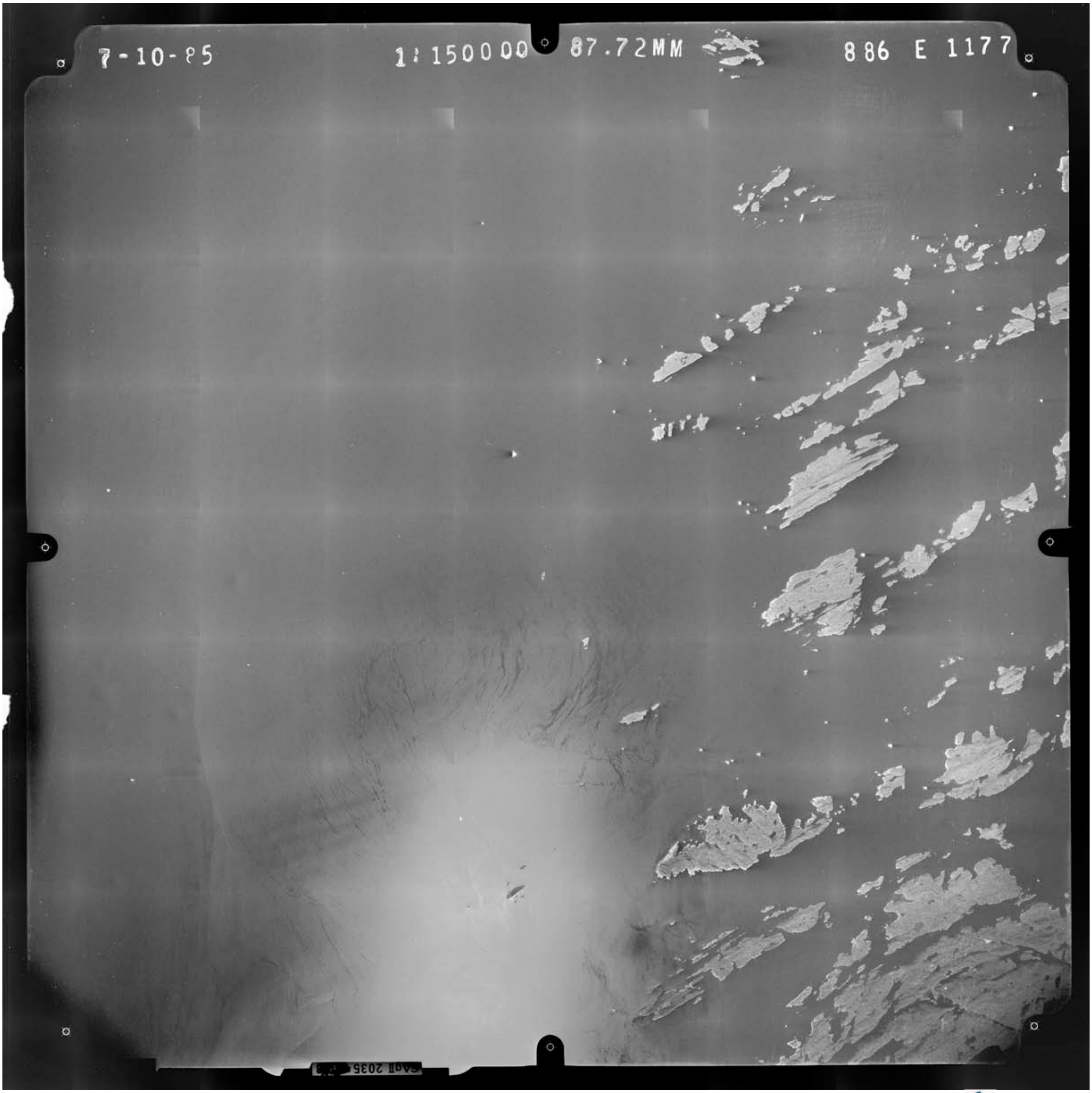

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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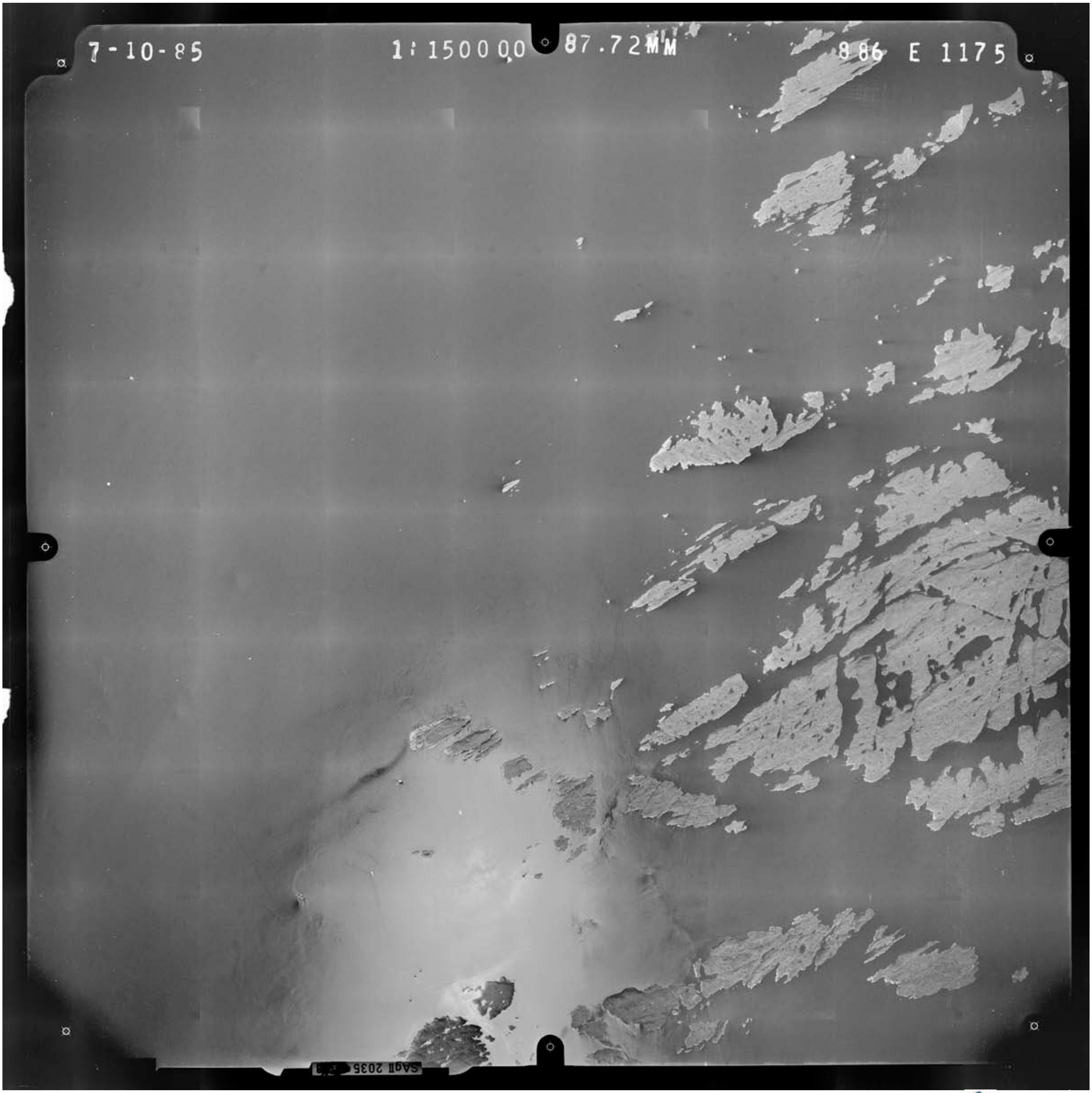

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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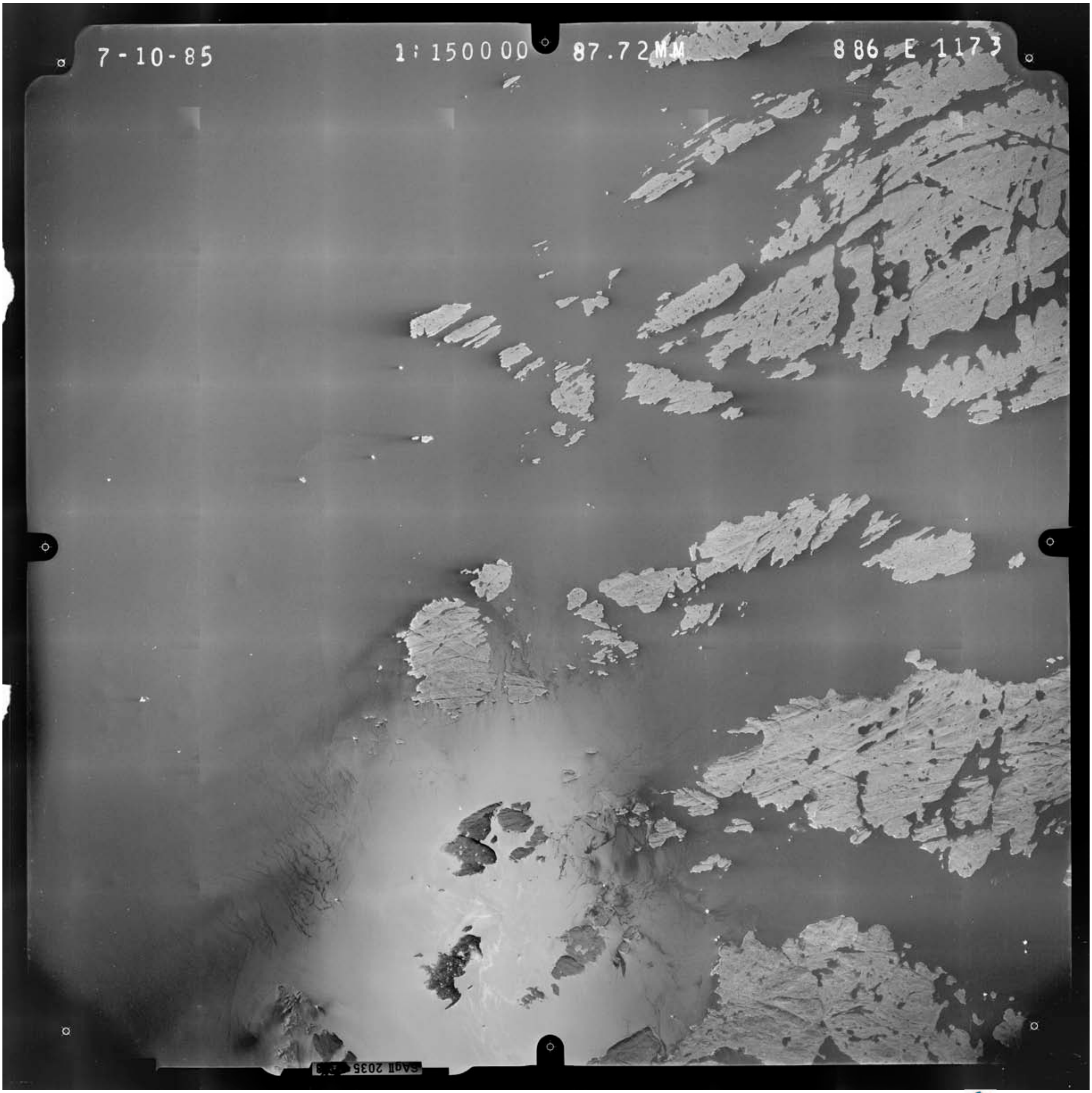
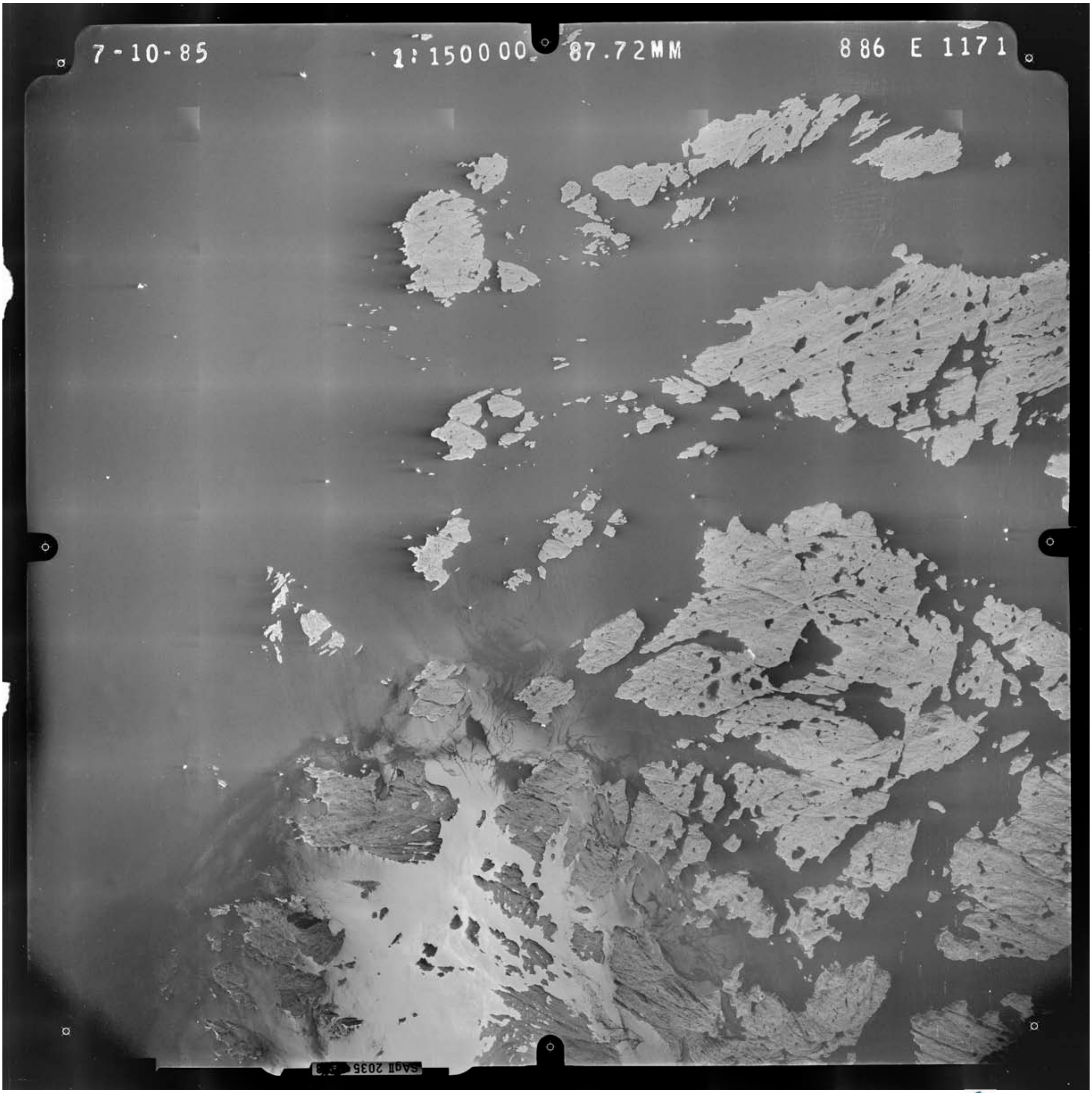


Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km



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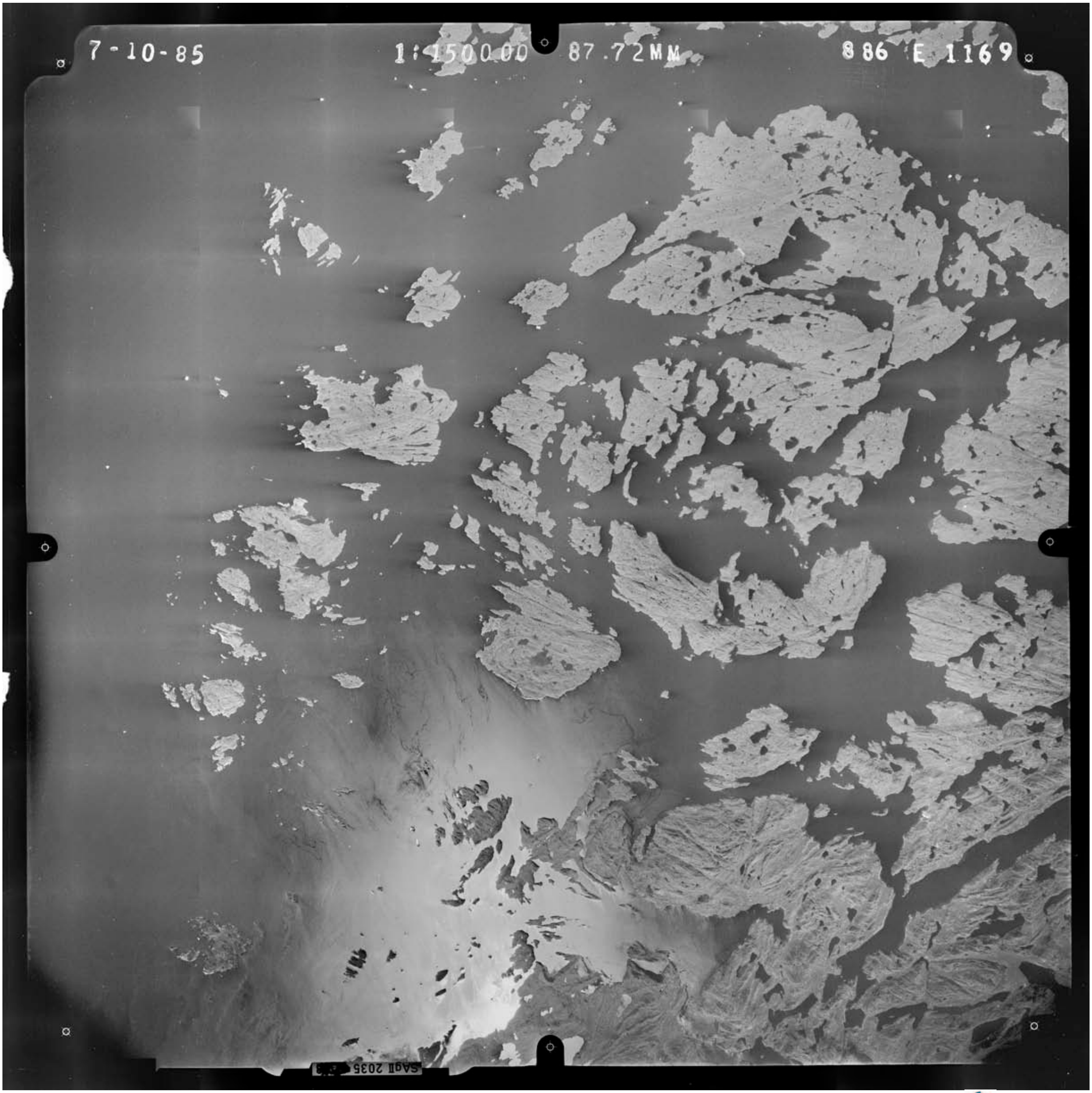

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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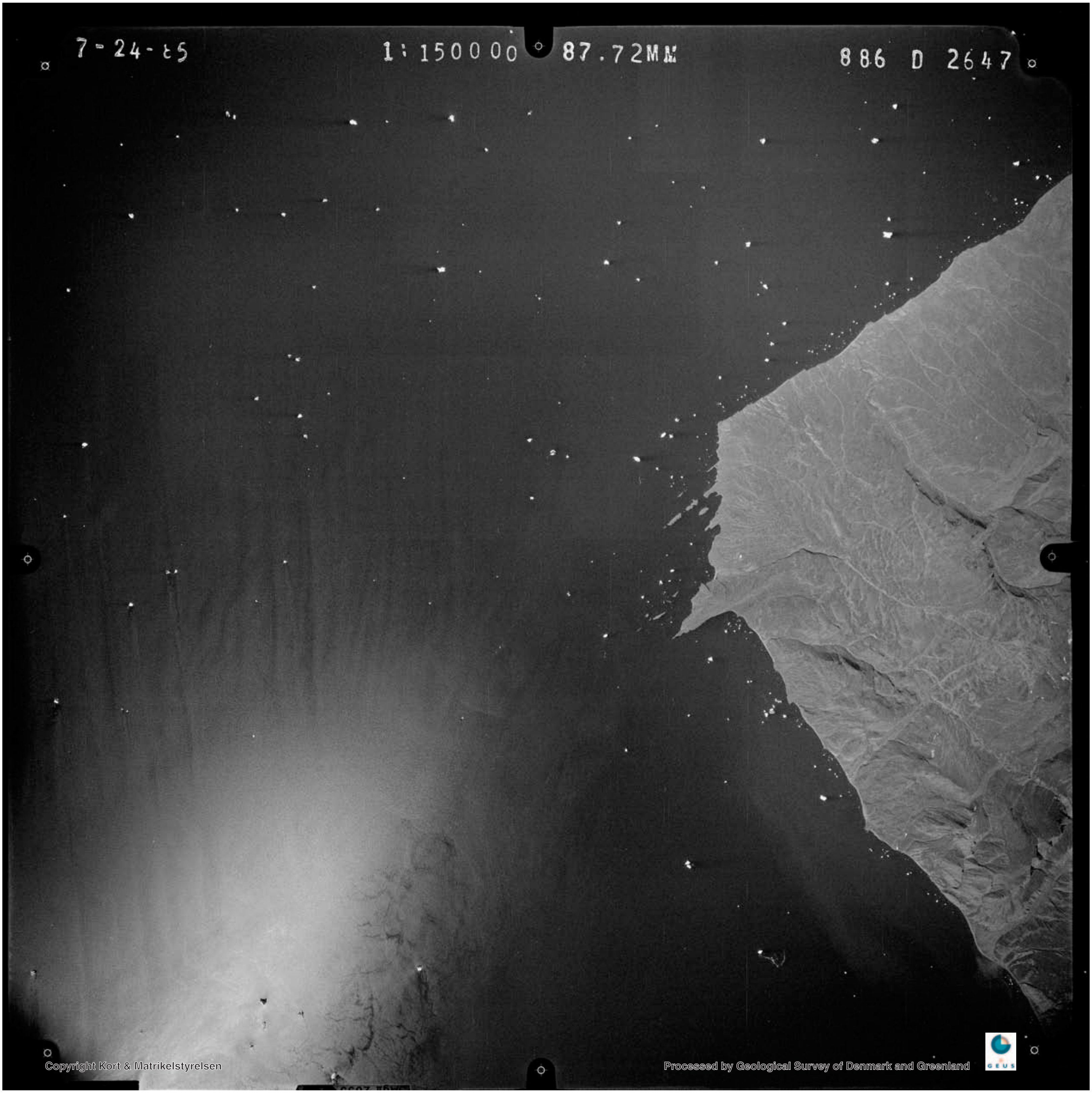

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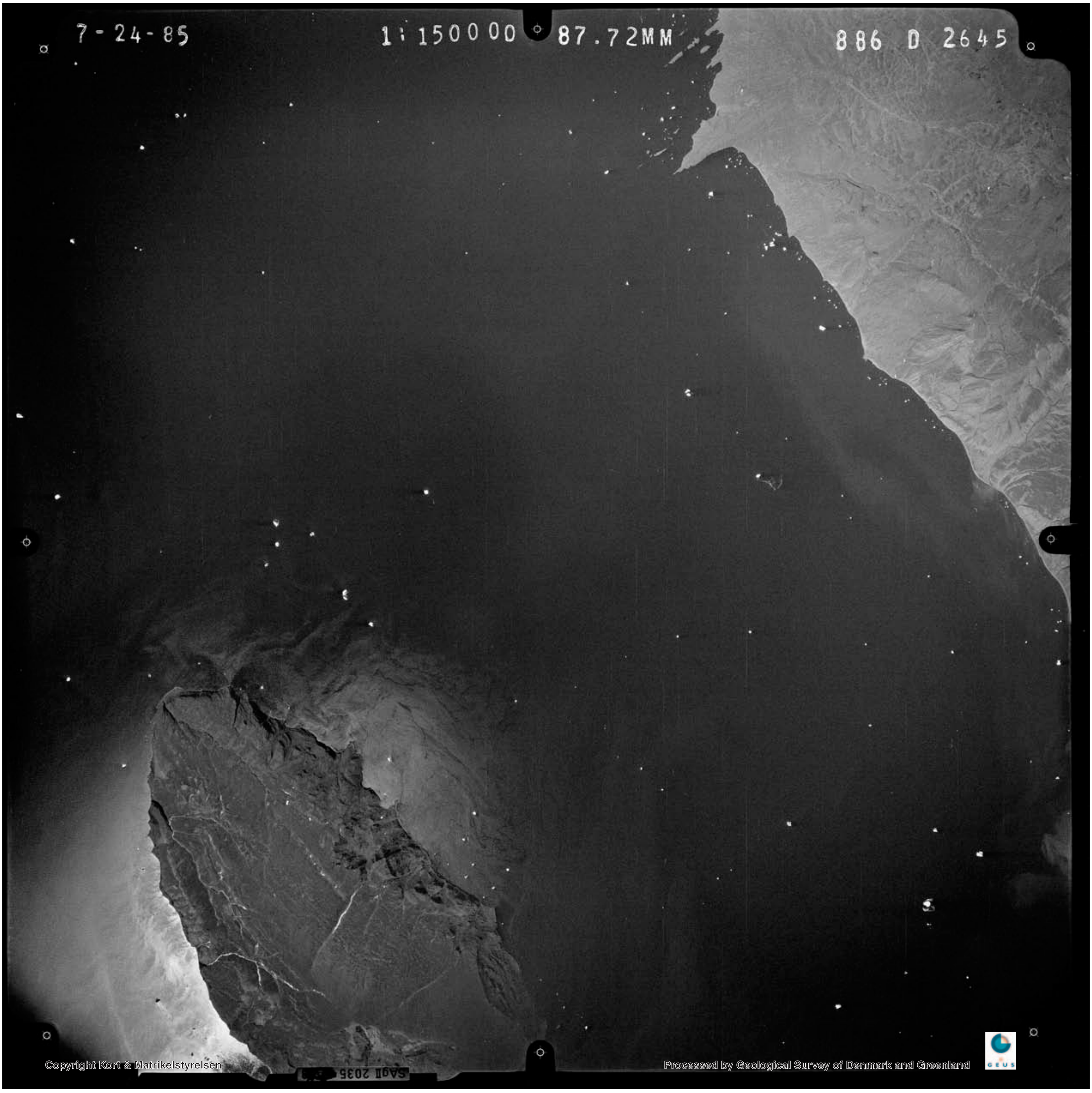

Approximate scale 0 2 4 6 8 10 km

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Airphoto Keymap

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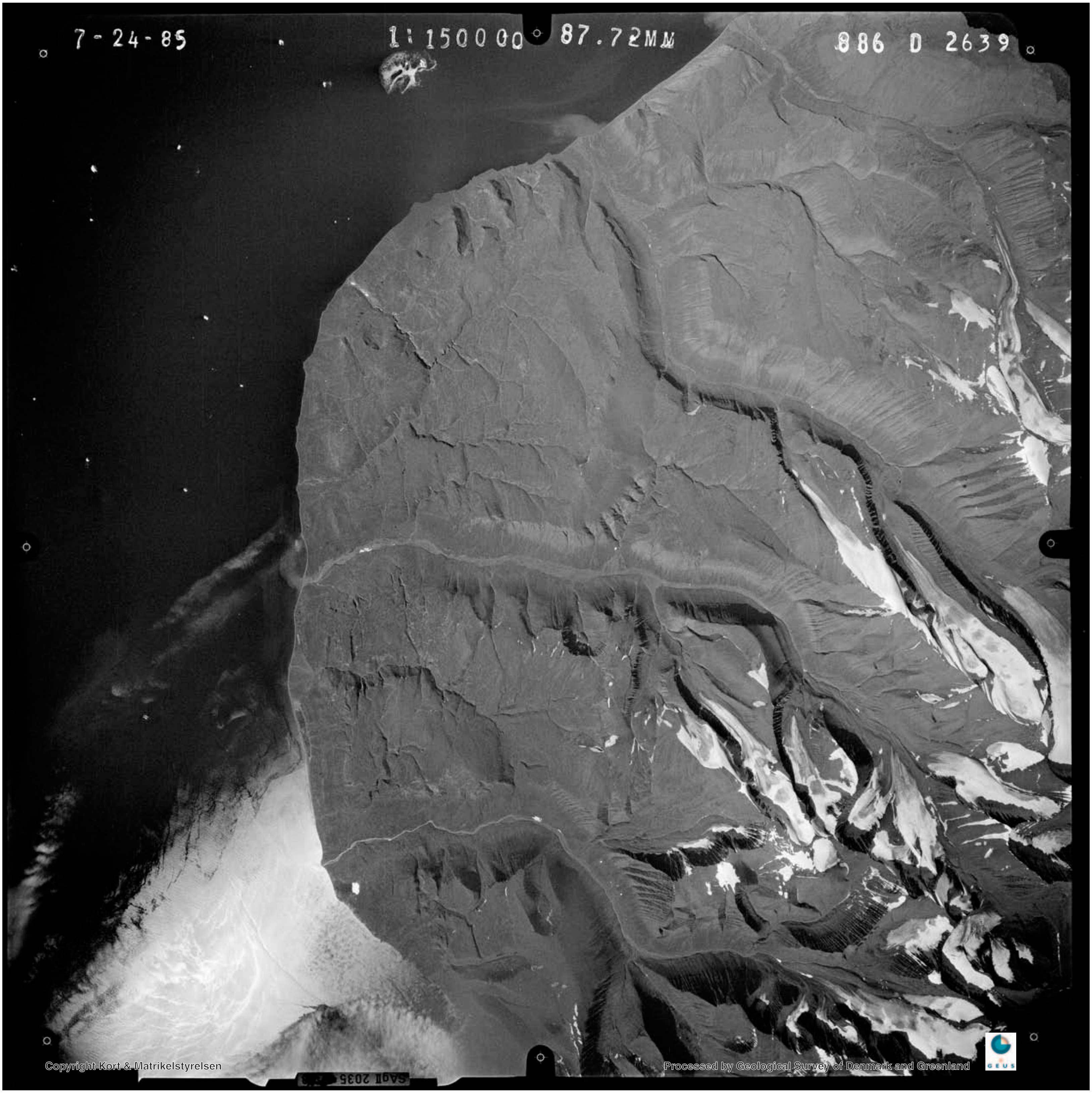

Approximate scale 0 2 4 6 8 10 km

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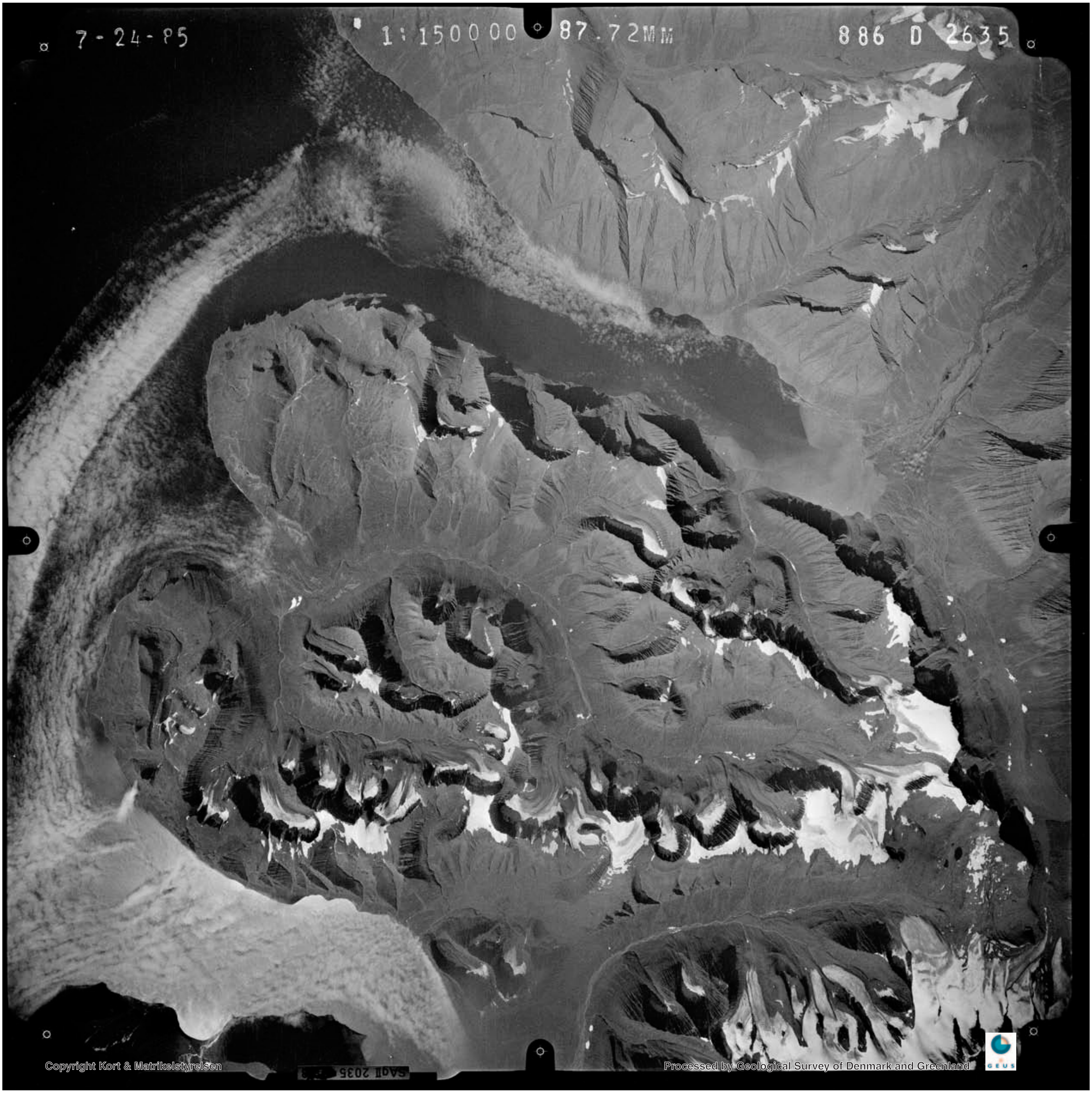

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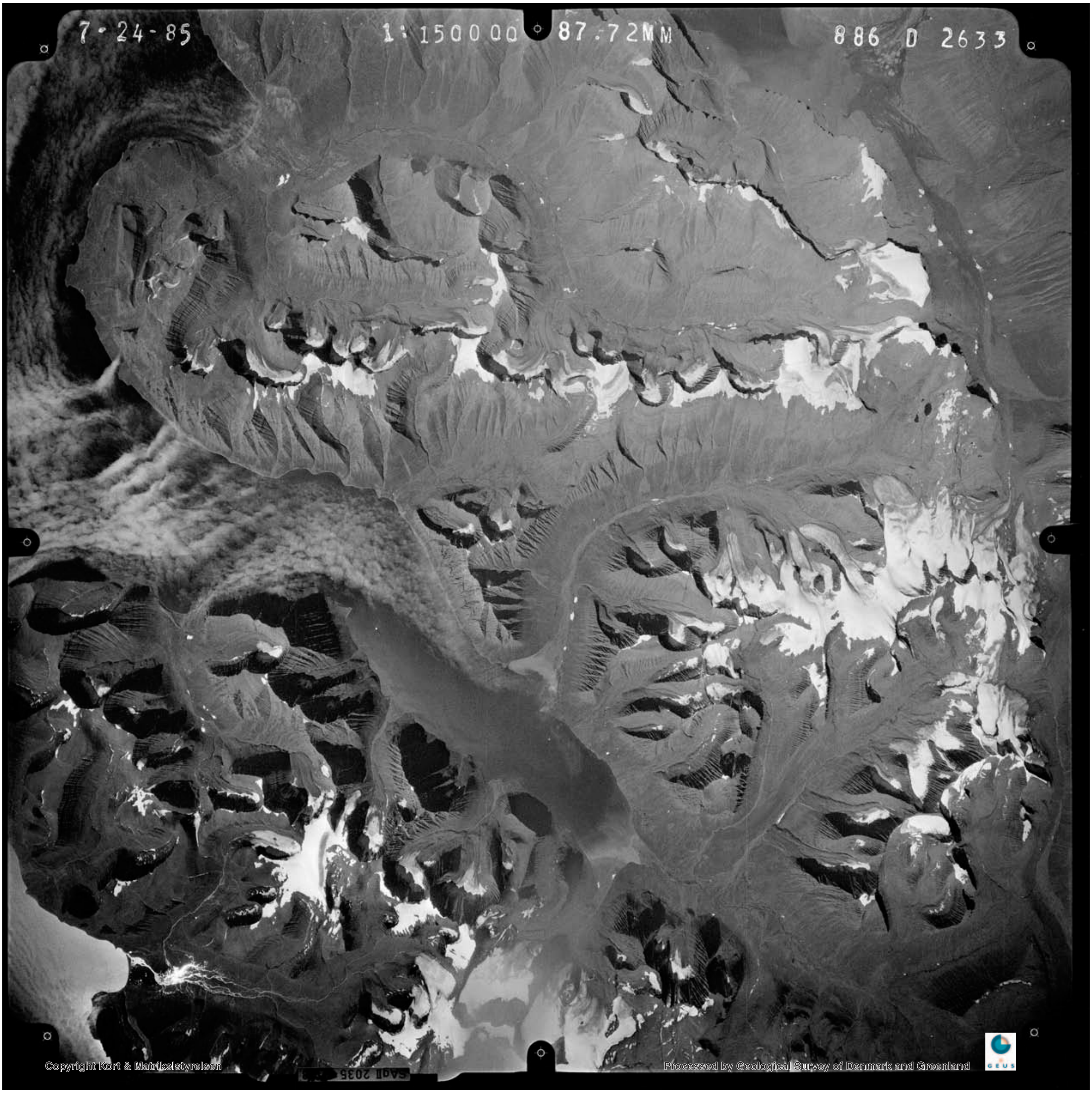

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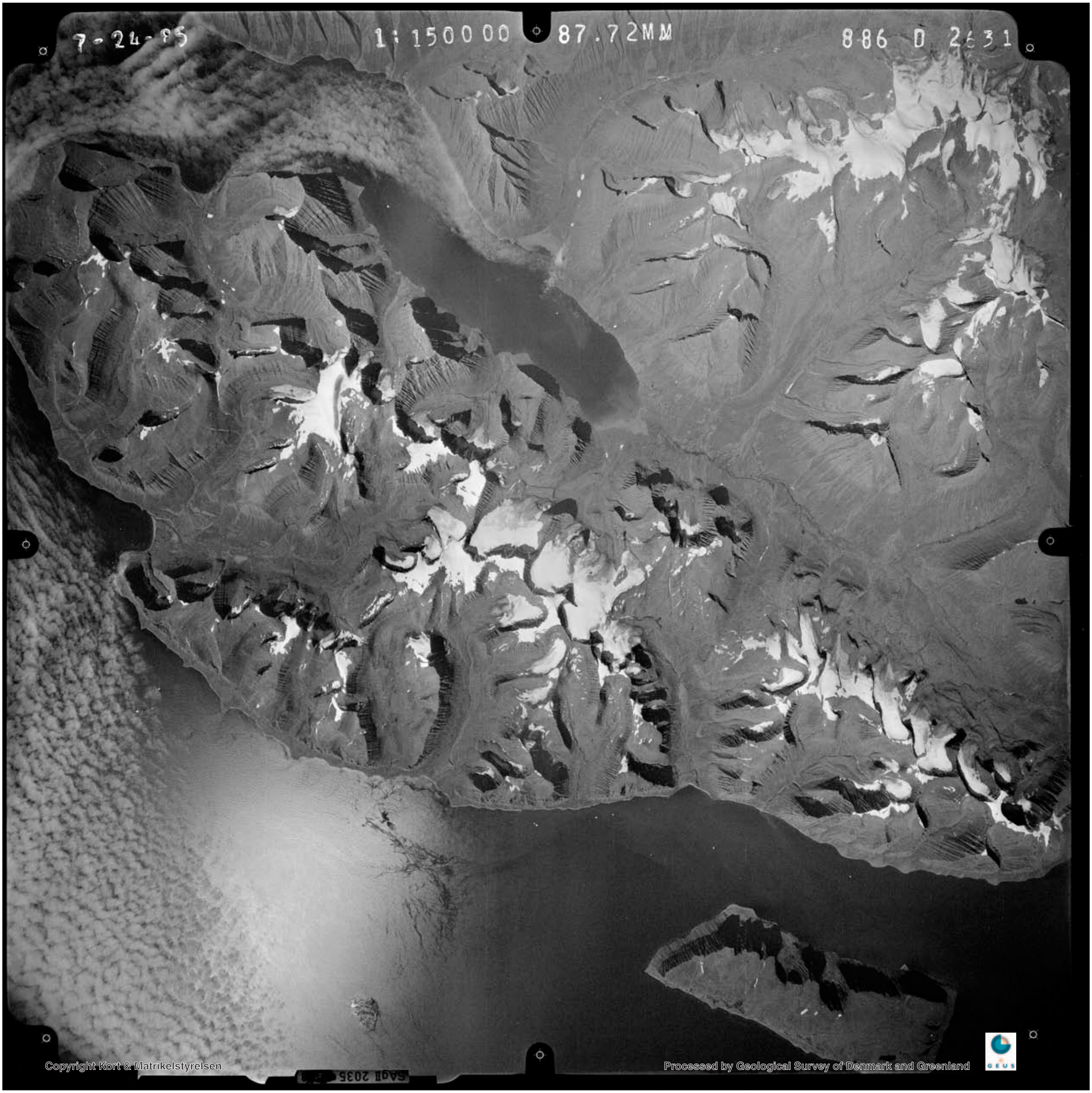

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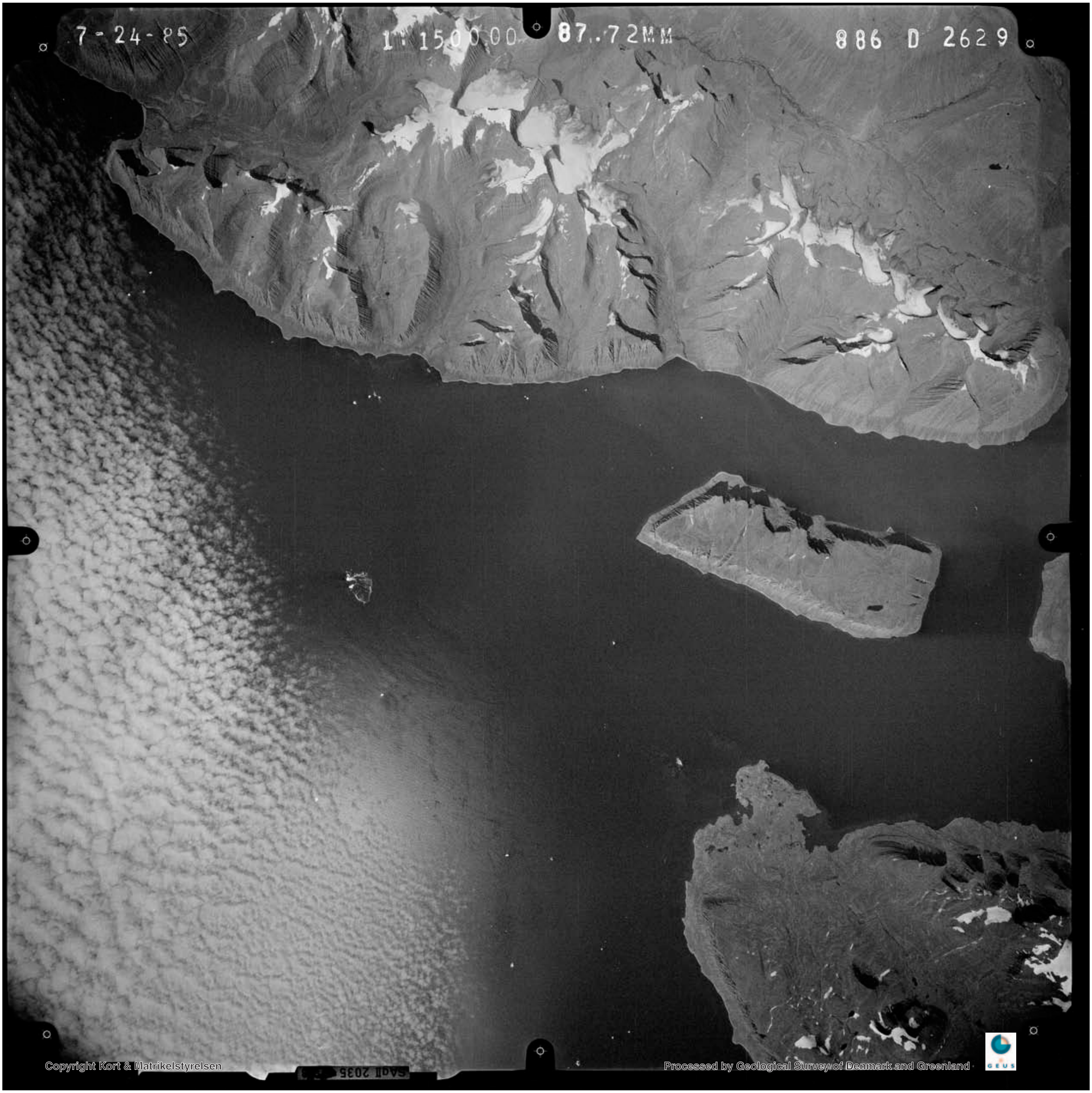

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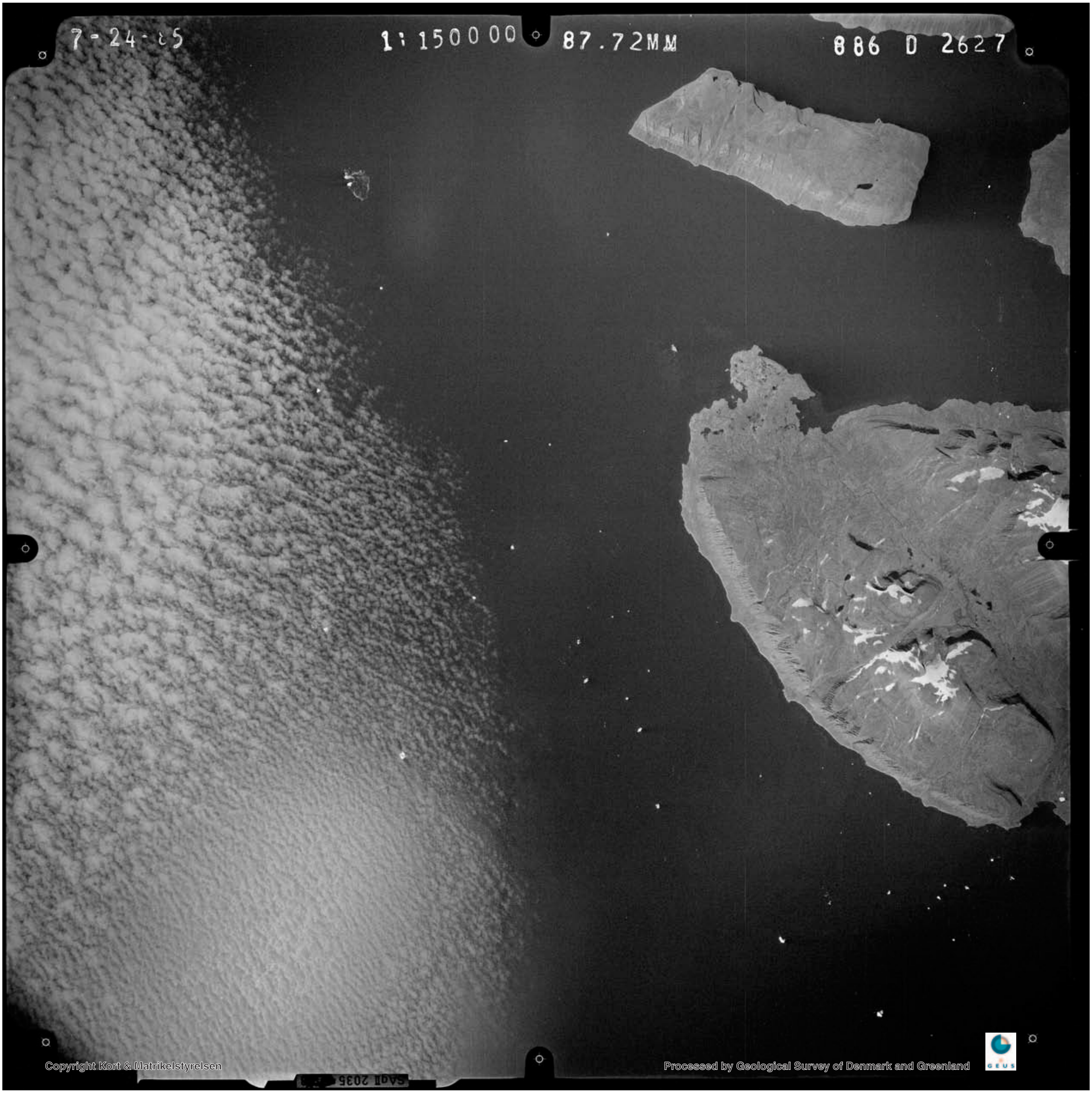

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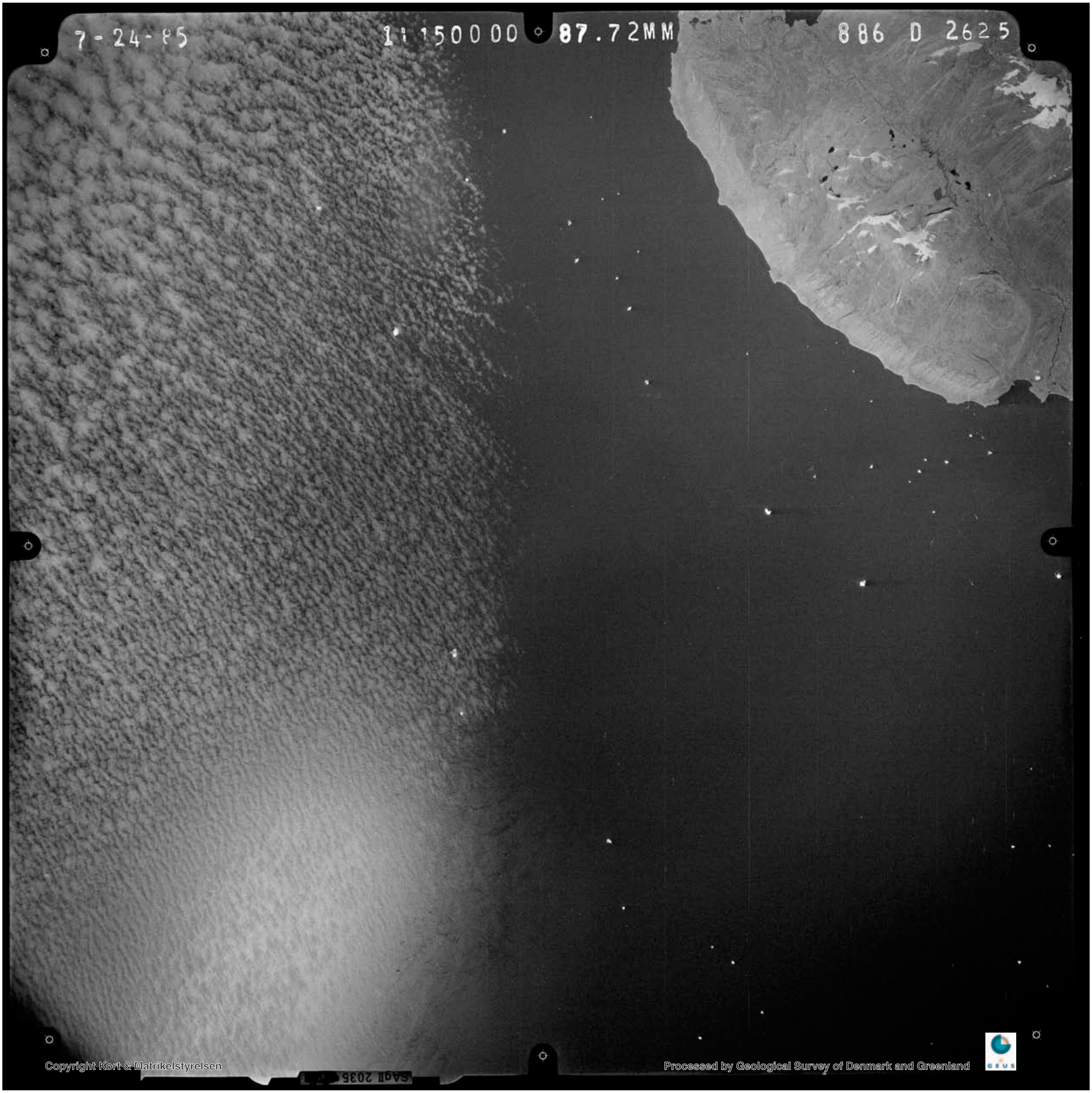

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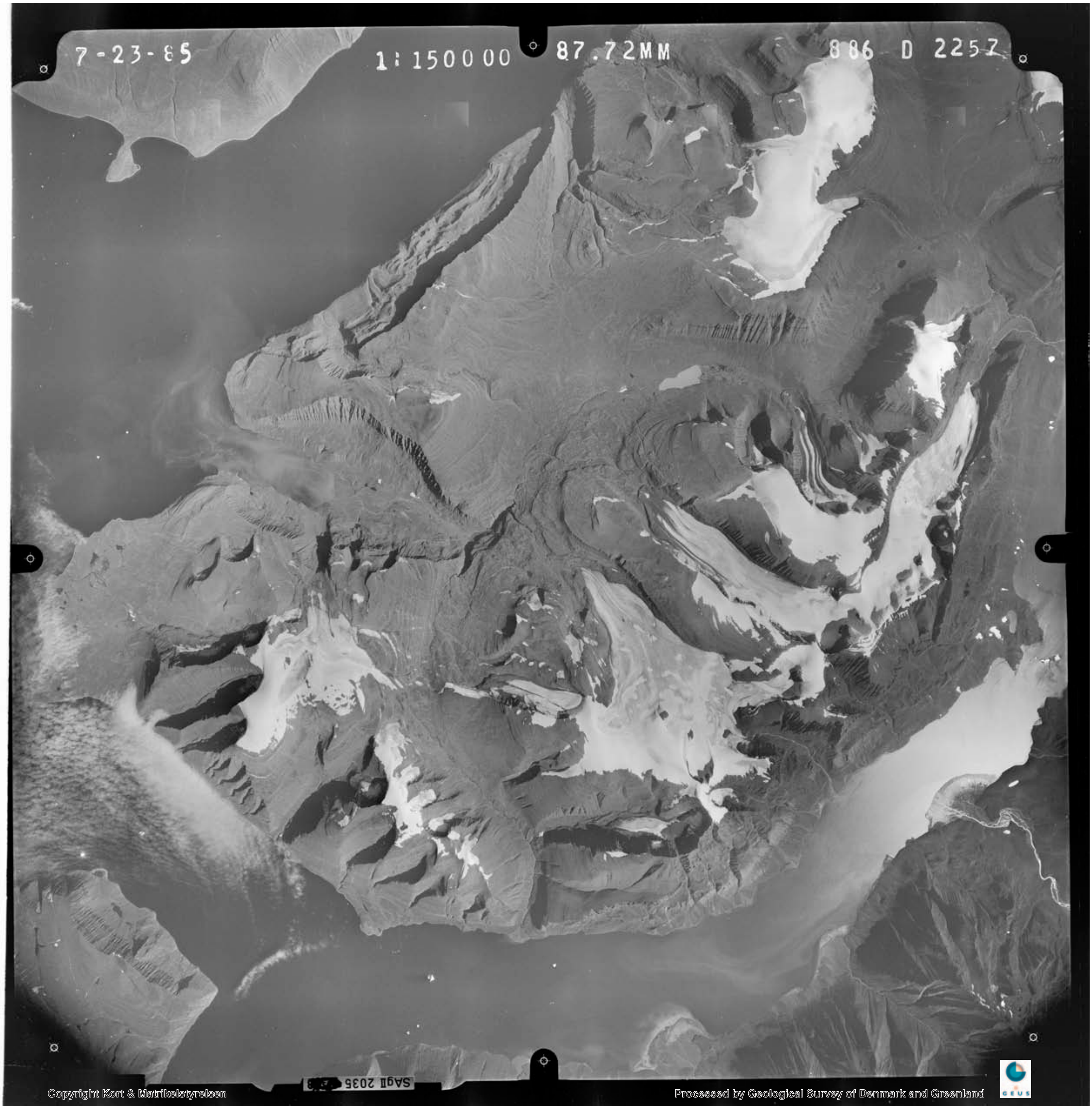

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Airphoto Keymap

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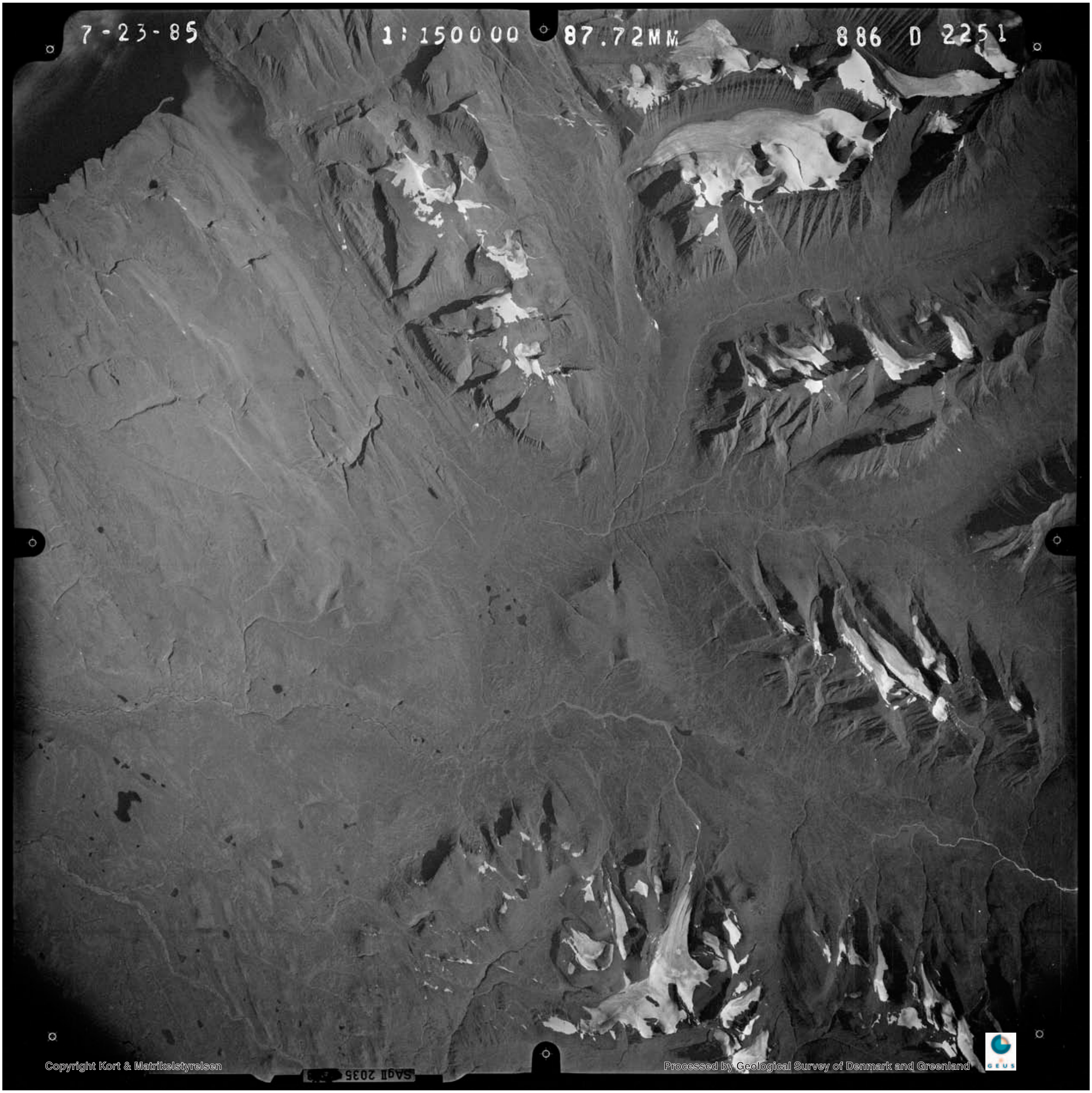

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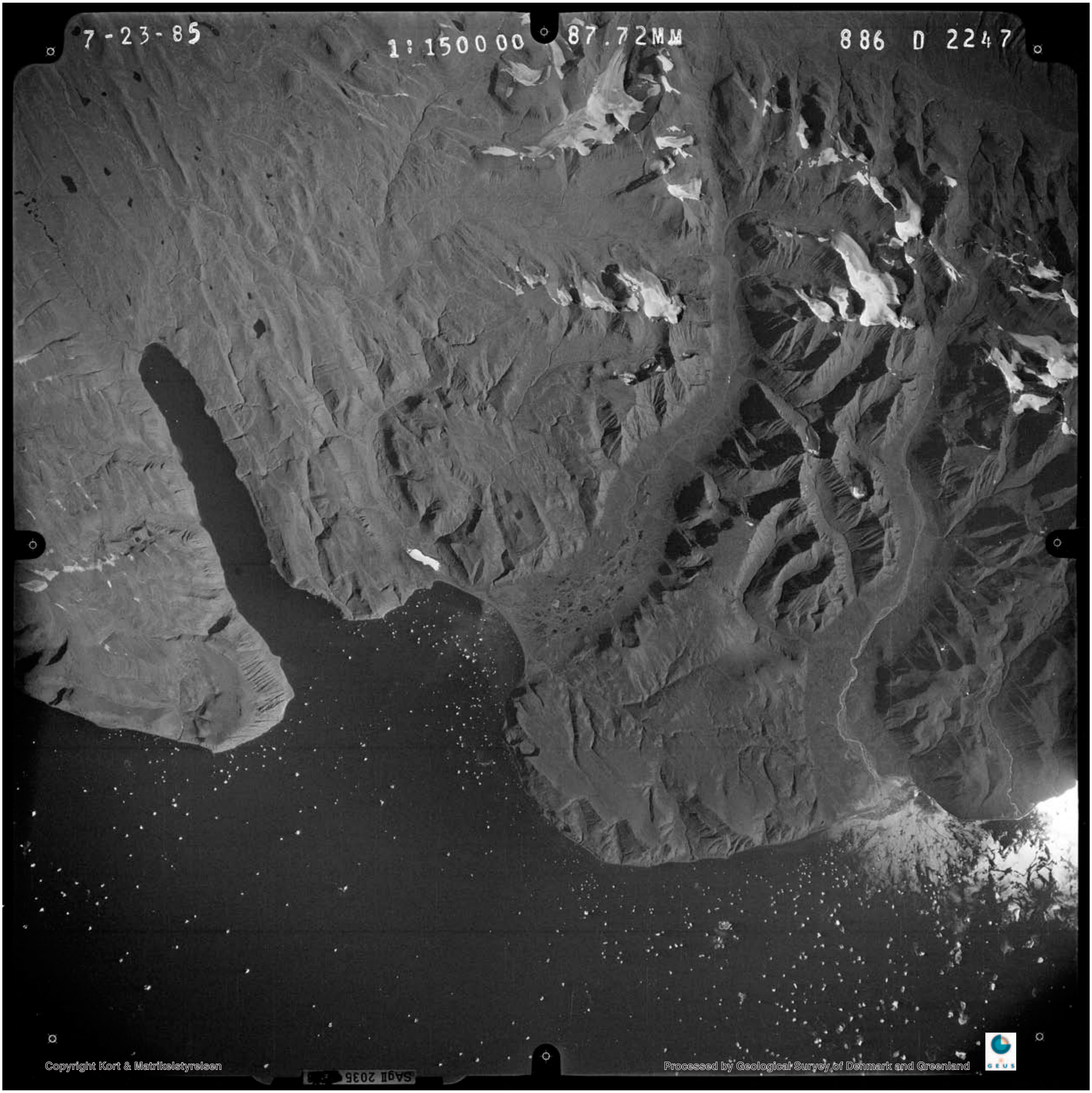

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Airphoto Keymap

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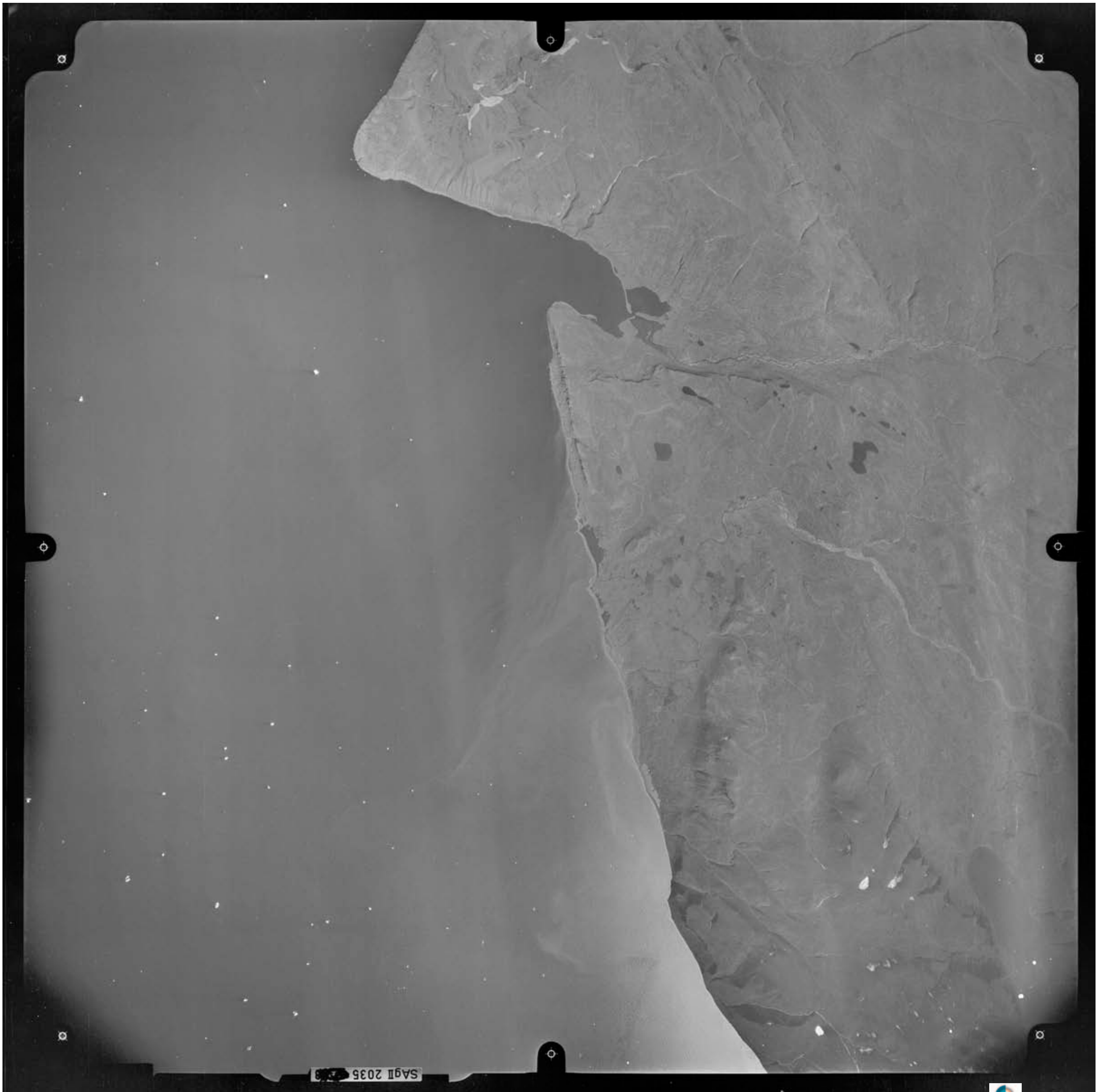


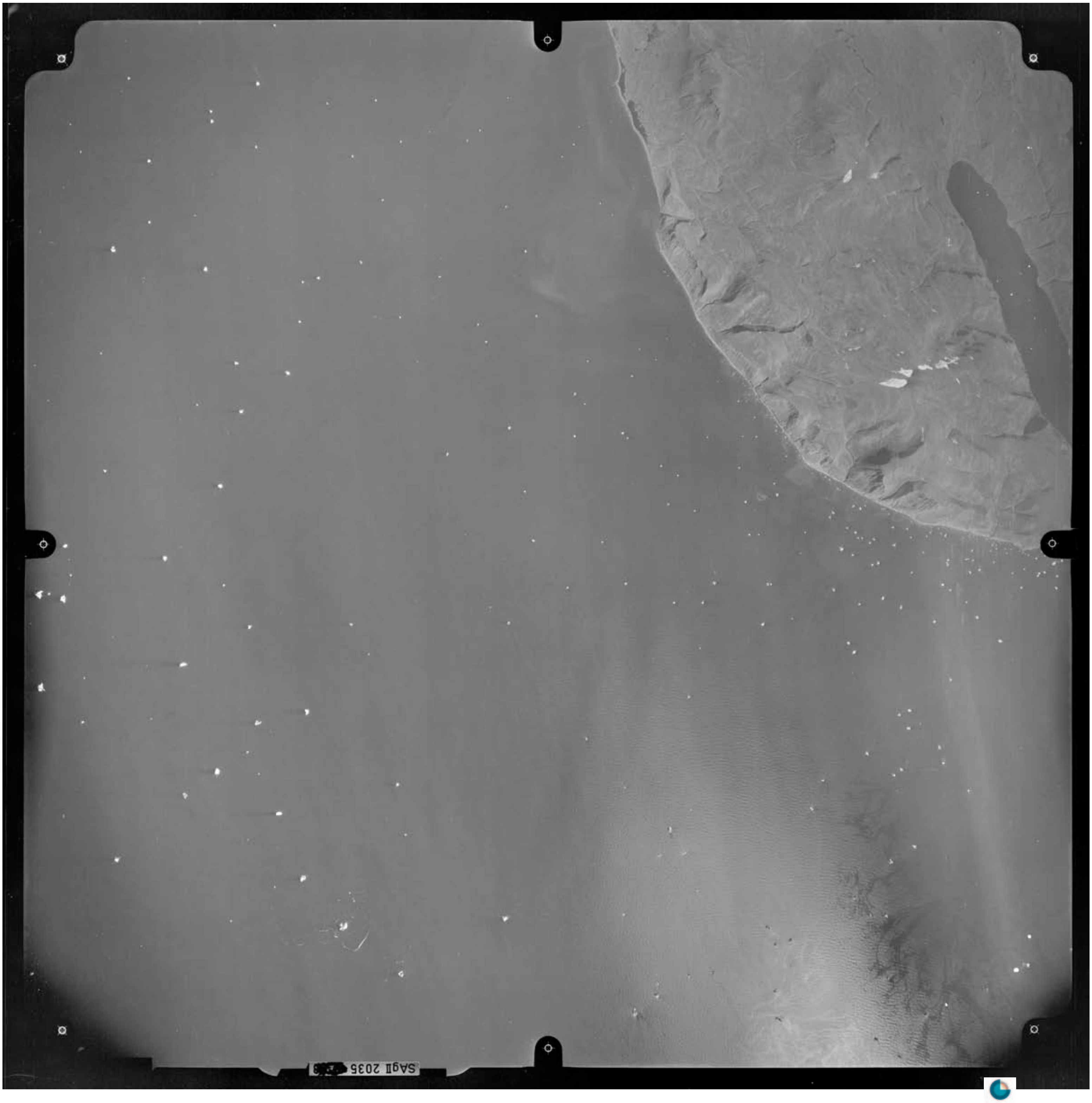
Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

Contents Airphoto Keymap

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km



Processed by Geological Survey of Denmark and Greenland

GEUS

Approximate scale 0 2 4 6 8 10 km

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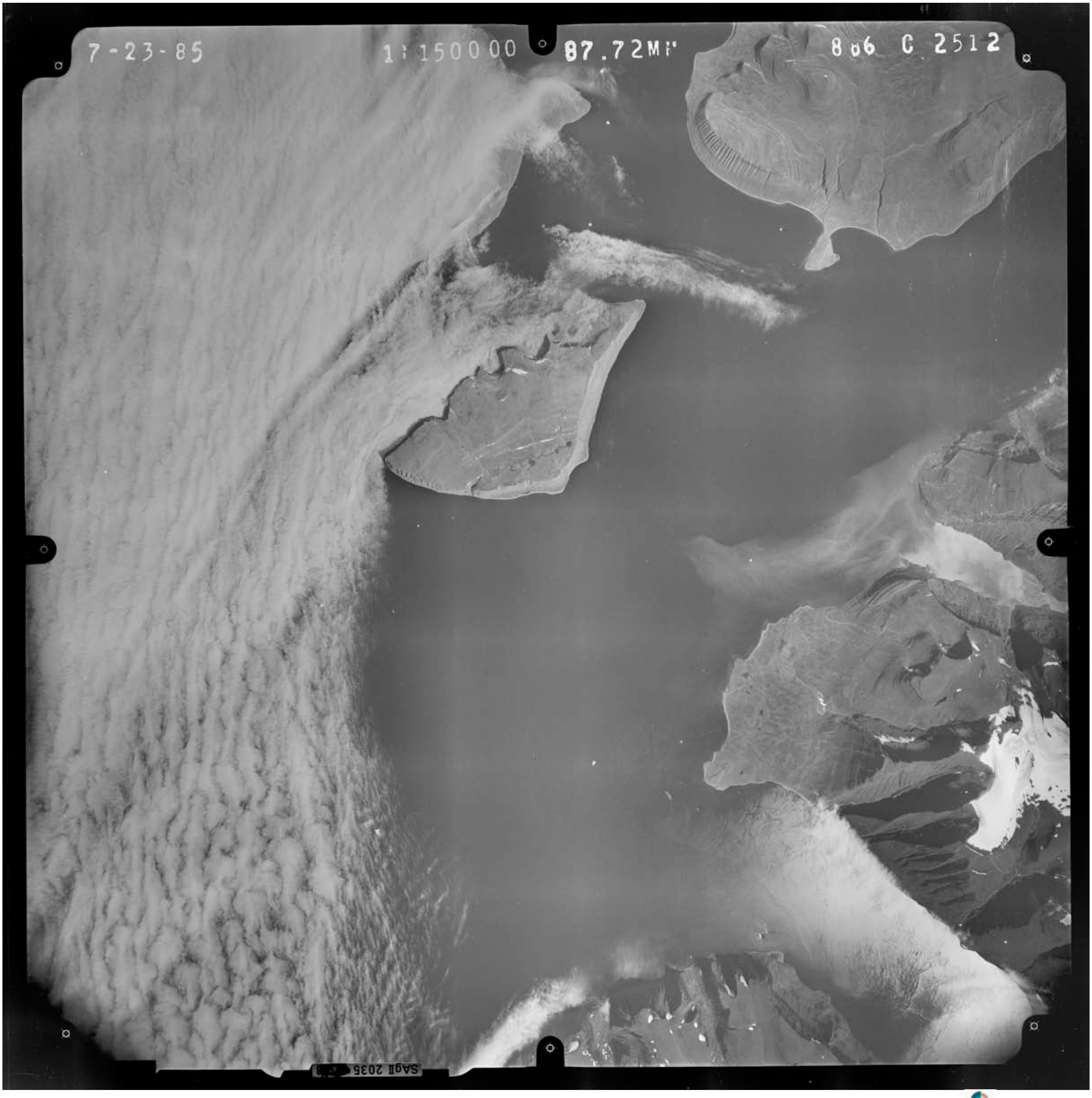

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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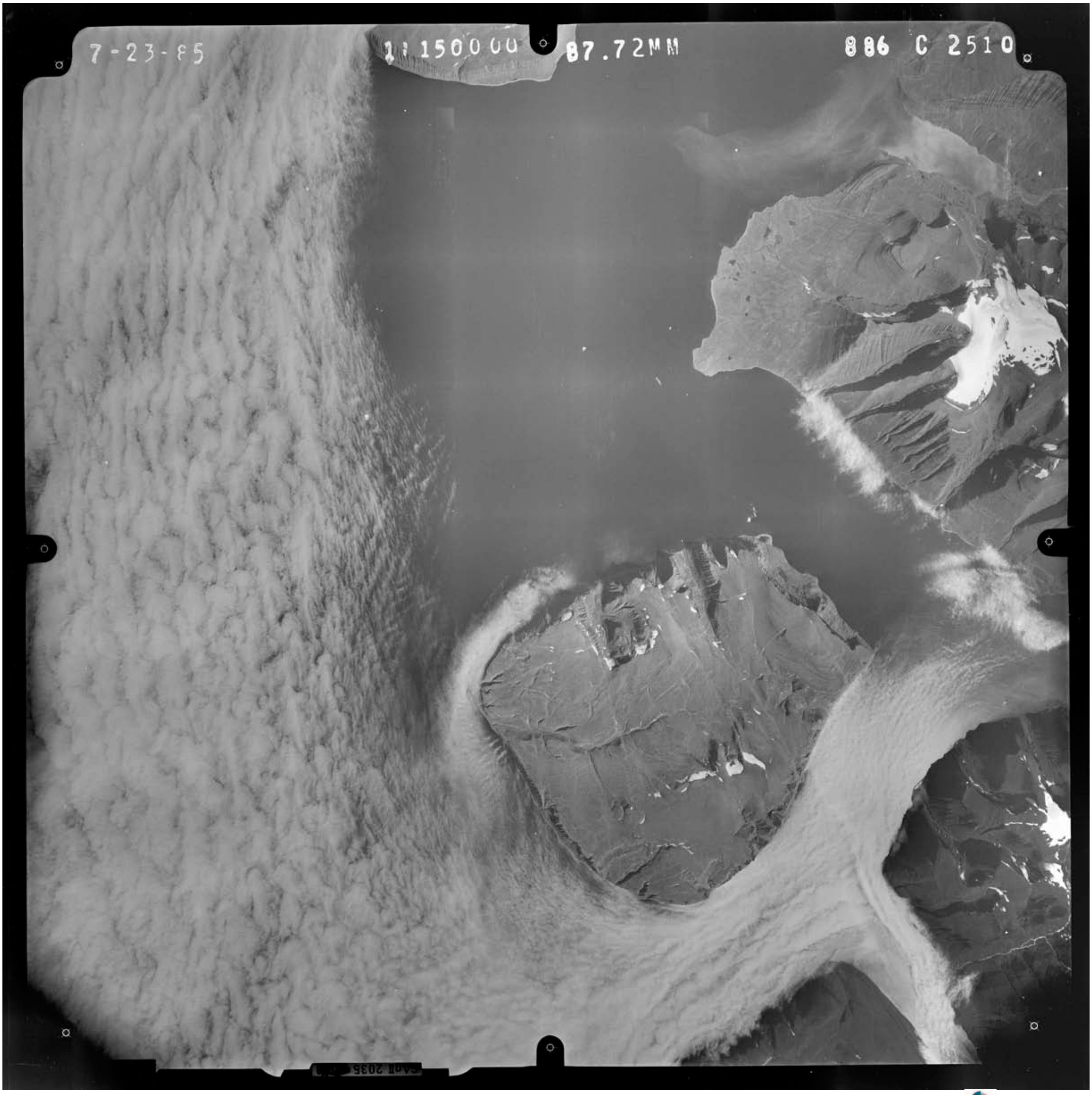

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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Airphoto Keymap

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

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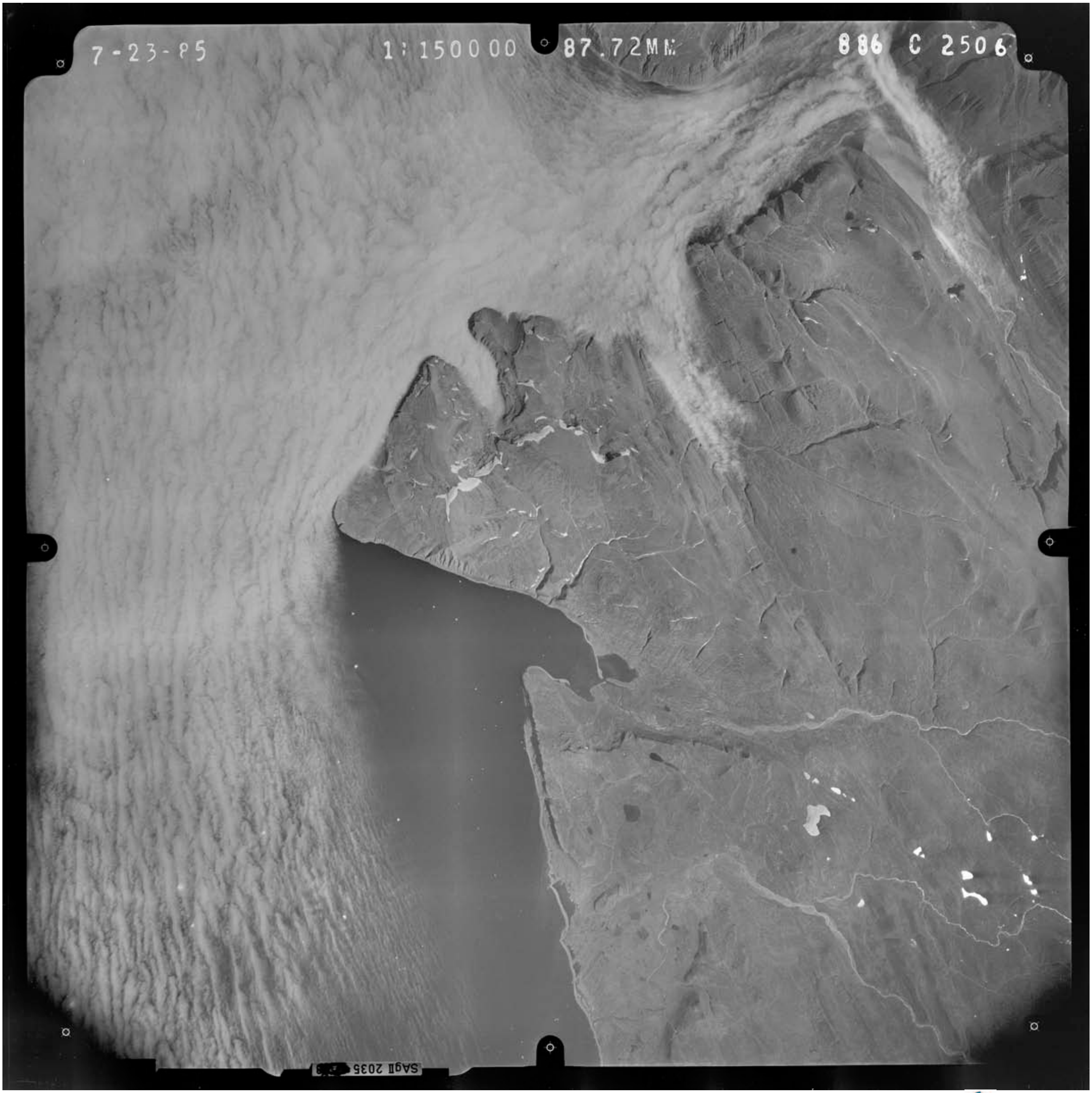

Processed by Geological Survey of Denmark and Greenland

Approximate scale 0 2 4 6 8 10 km

Approximate scale 0 2 4 6 8 10 km

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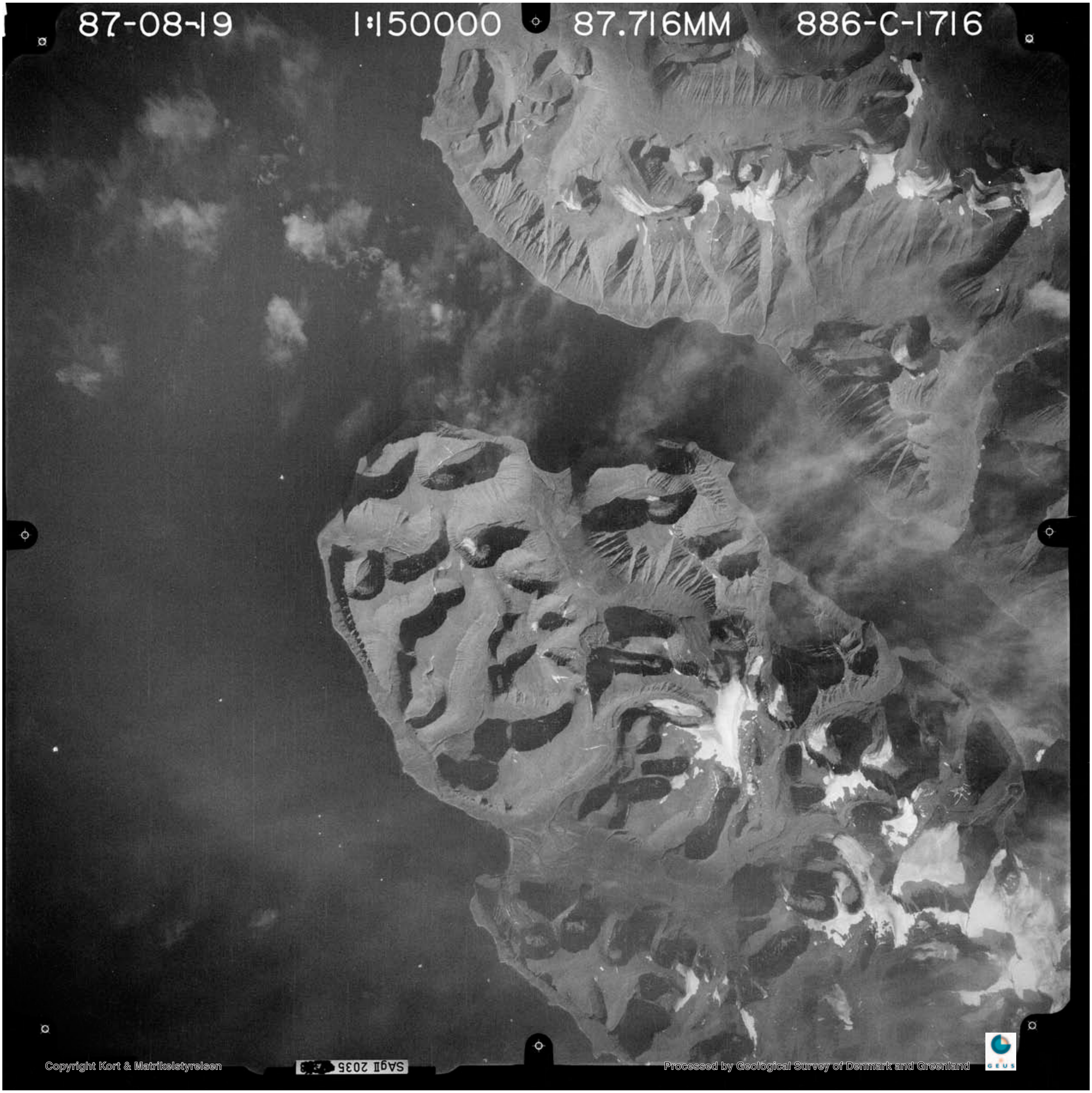

Approximate scale 0 2 4 6 8 10 km

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Airphoto Keymap

Approximate scale 0 2 4 6 8 10 km

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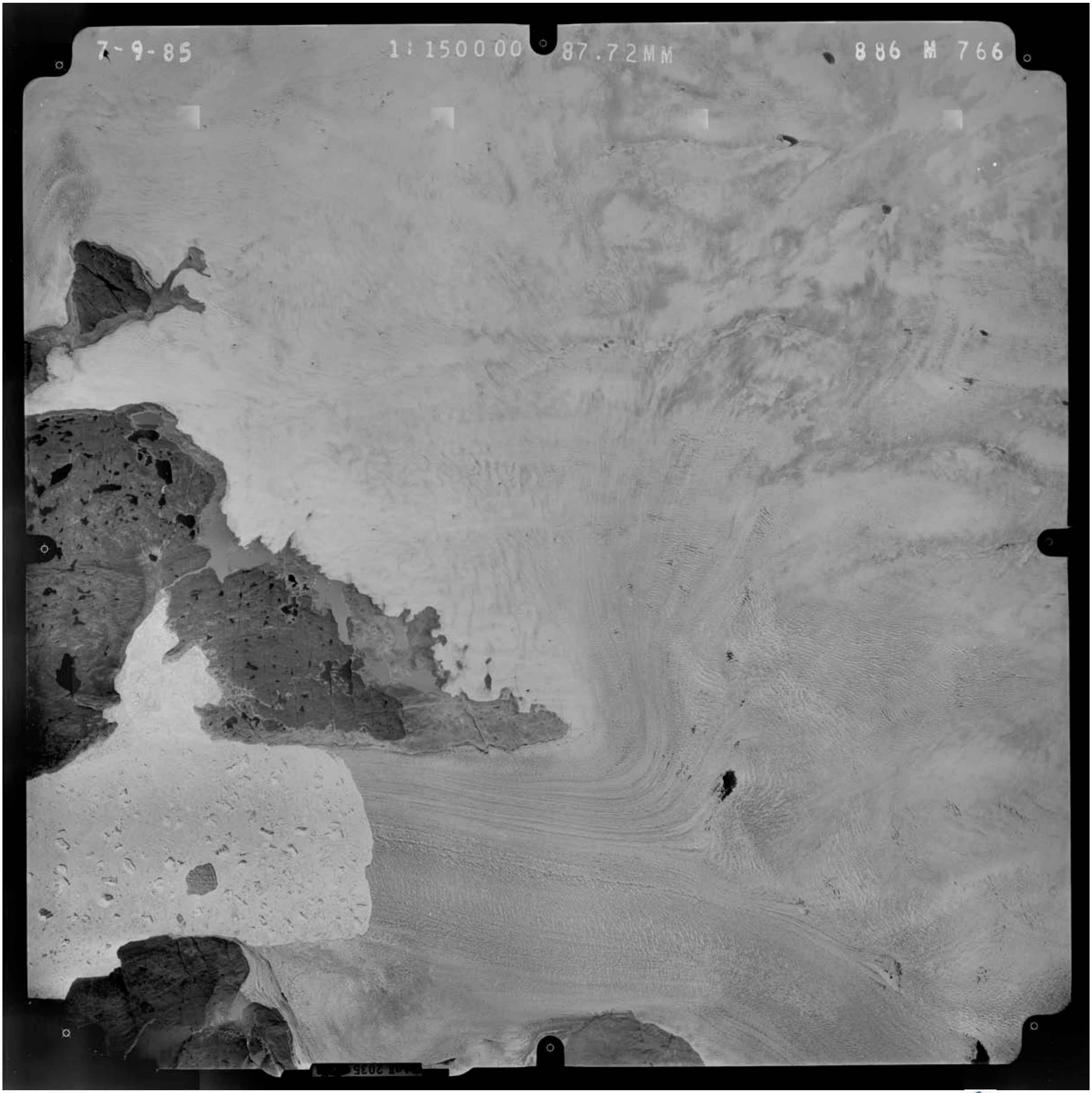
Airphoto Keymap



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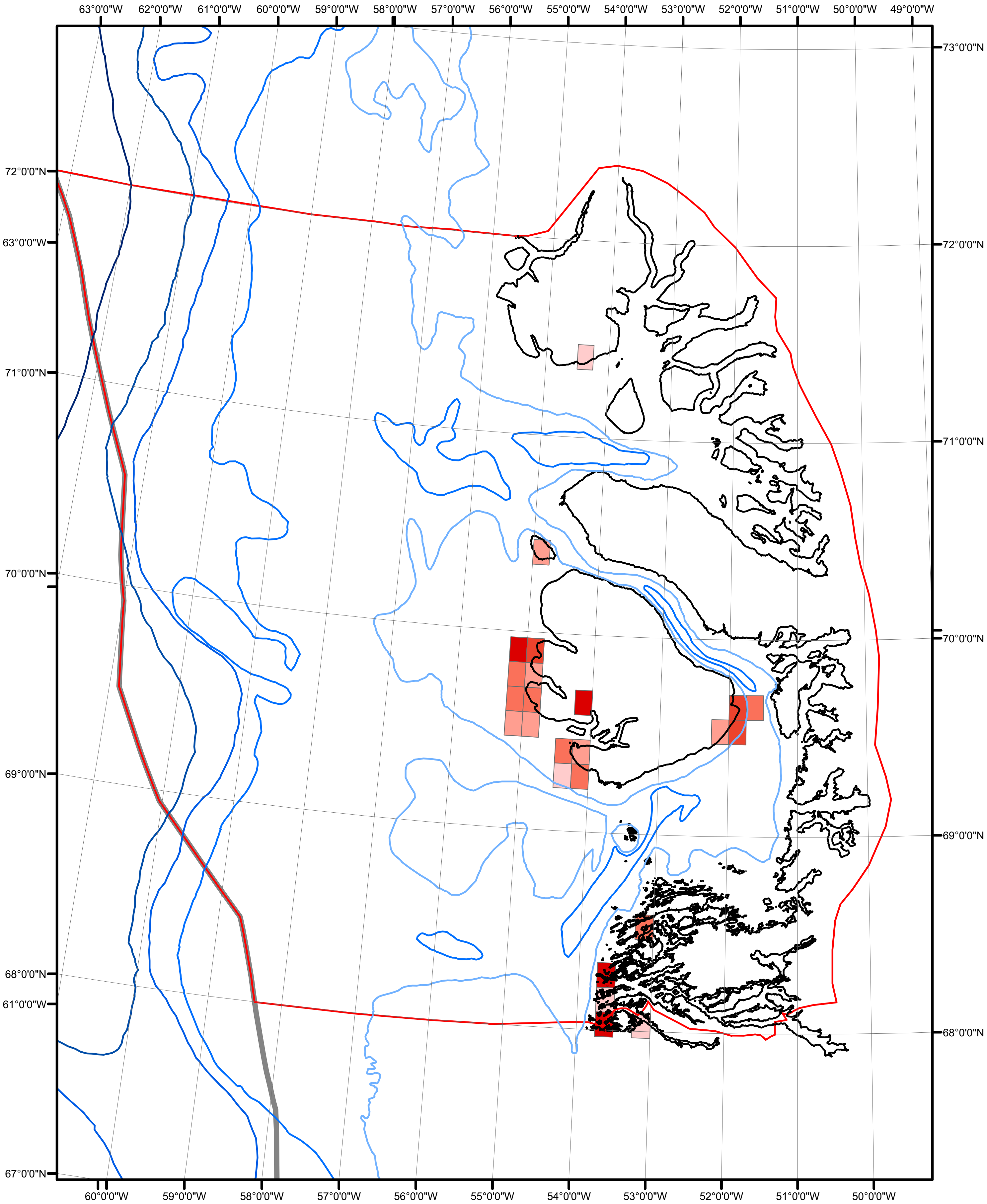


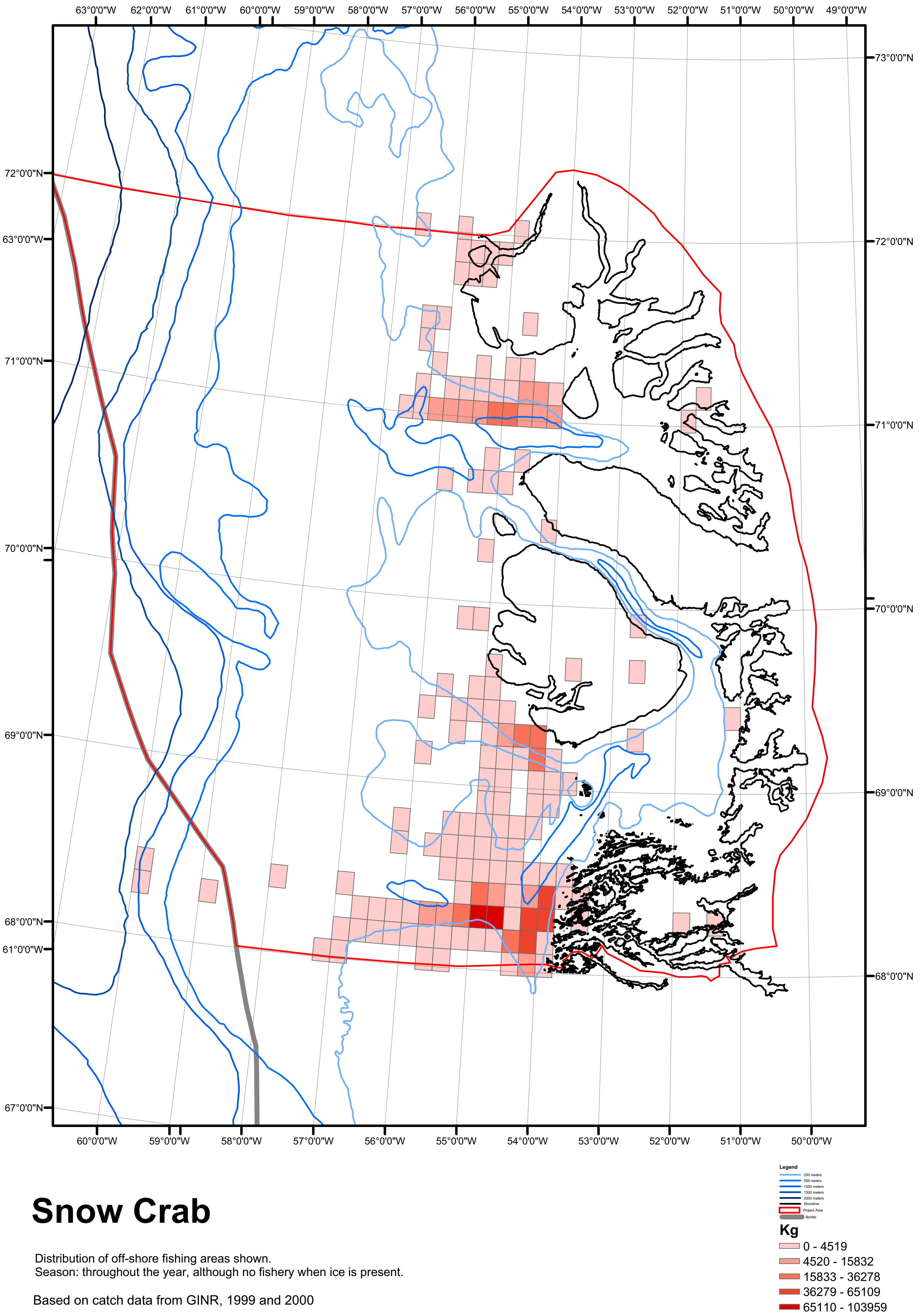
Legend
200 meters
500 meters
1000 meters
1500 meters
2000 meters
Shoreline
Project Area
Border

kg
0 - 800
801 - 2280
2281 - 3228
3229 - 4086
4087 - 4732

Scallops

Distribution of fishing areas.
Season: throughout the year, however, no fishery when ice is present.

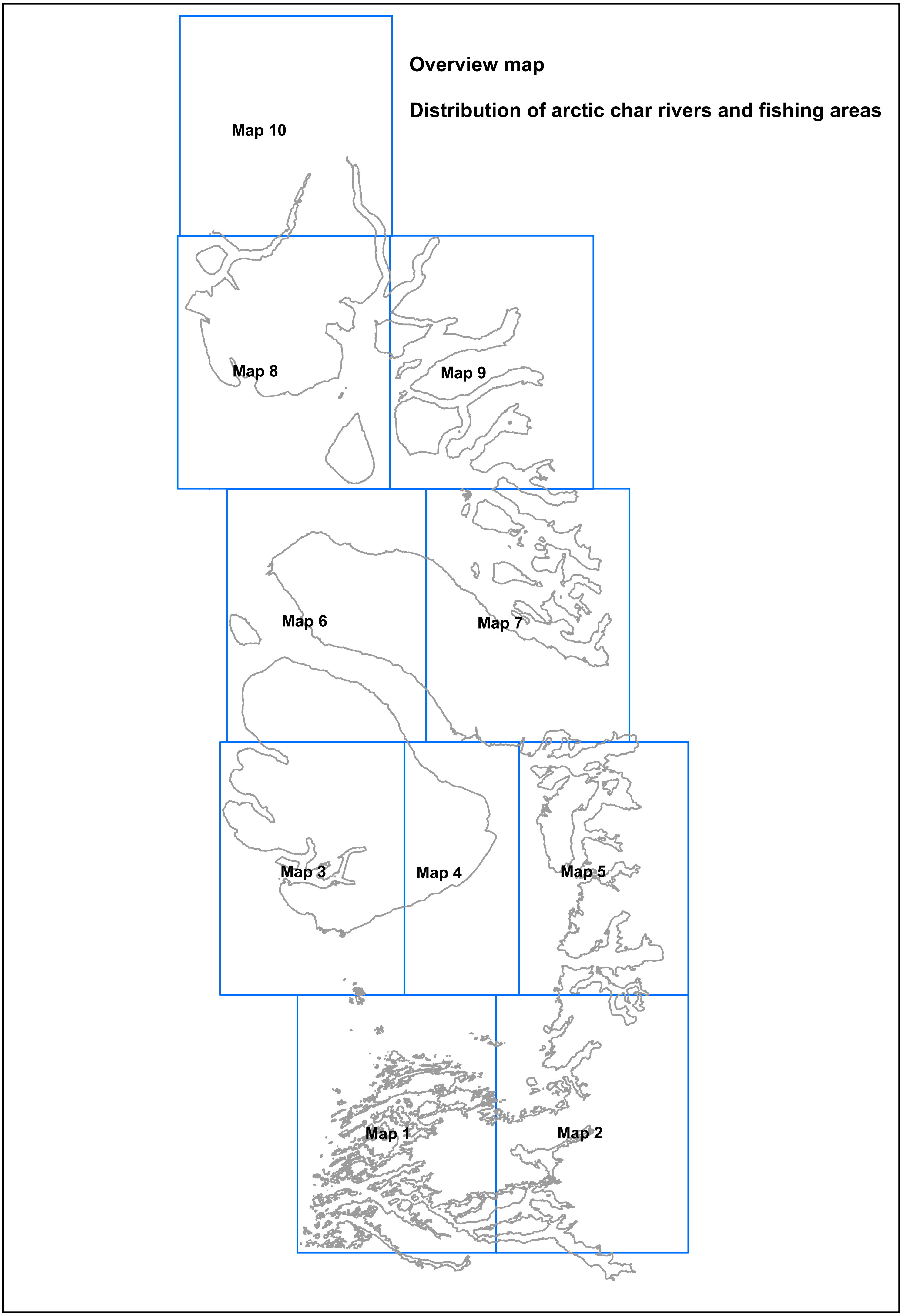
Based on catch data from GINR, 1999 and 2000



Snow Crab

Distribution of off-shore fishing areas shown.
Season: throughout the year, although no fishery when ice is present.

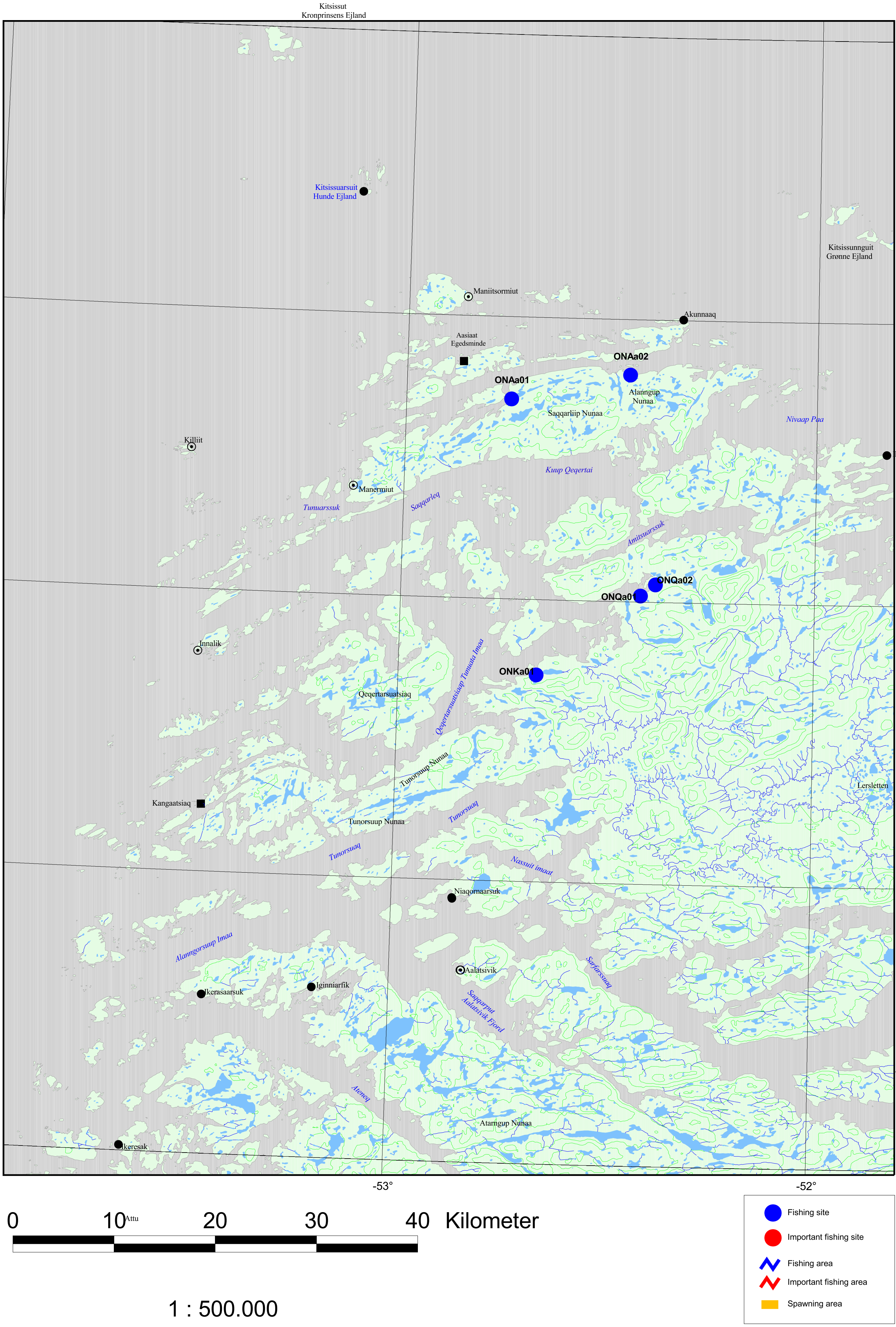
Based on catch data from GINR, 1999 and 2000



Overview map
Distribution of arctic char rivers and fishing areas
Map 10
Map 8
Map 9
Map 6
Map 7
Map 3
Map 4
Map 5
Map 1
Map 2

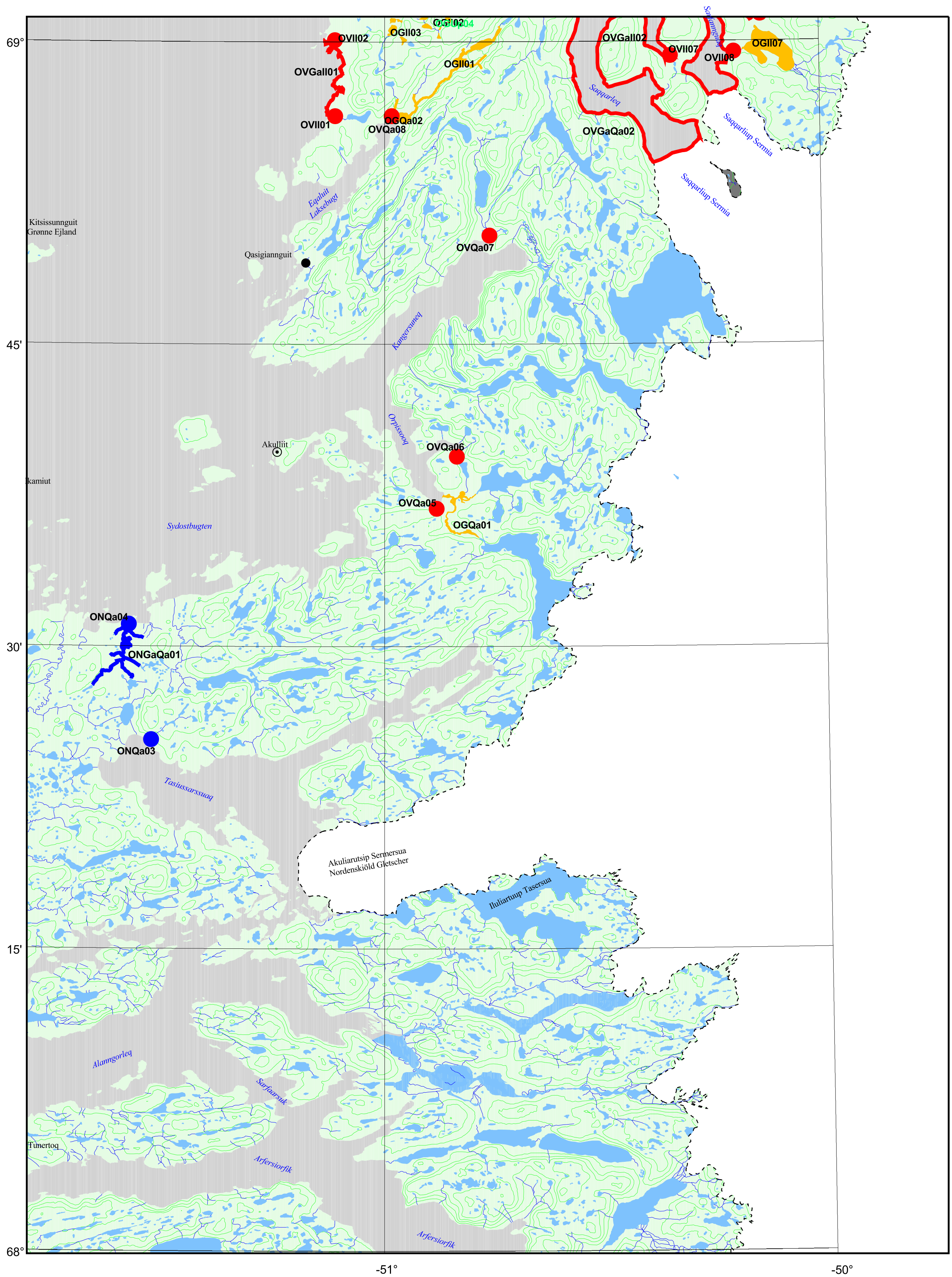
Map nr. 1

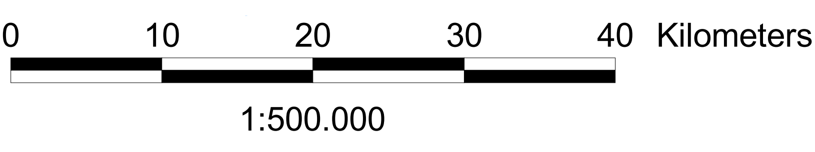
Distribution of spawning and fishing areas
Arctic Char

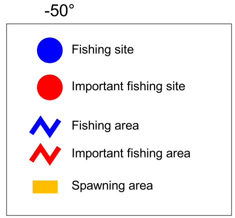


Map nr. 2

Distribution of spawning and fishing areas
Arctic Char

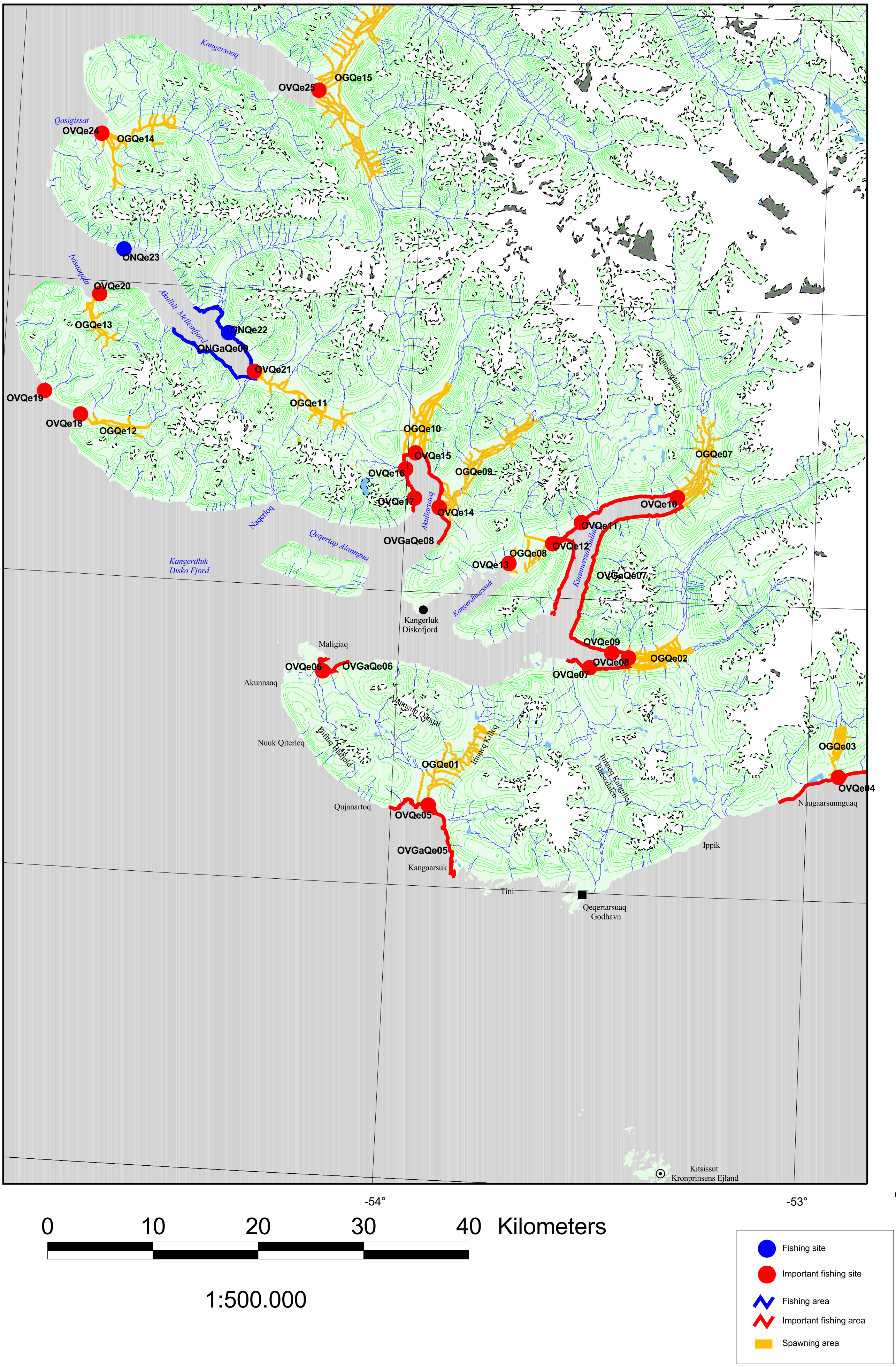






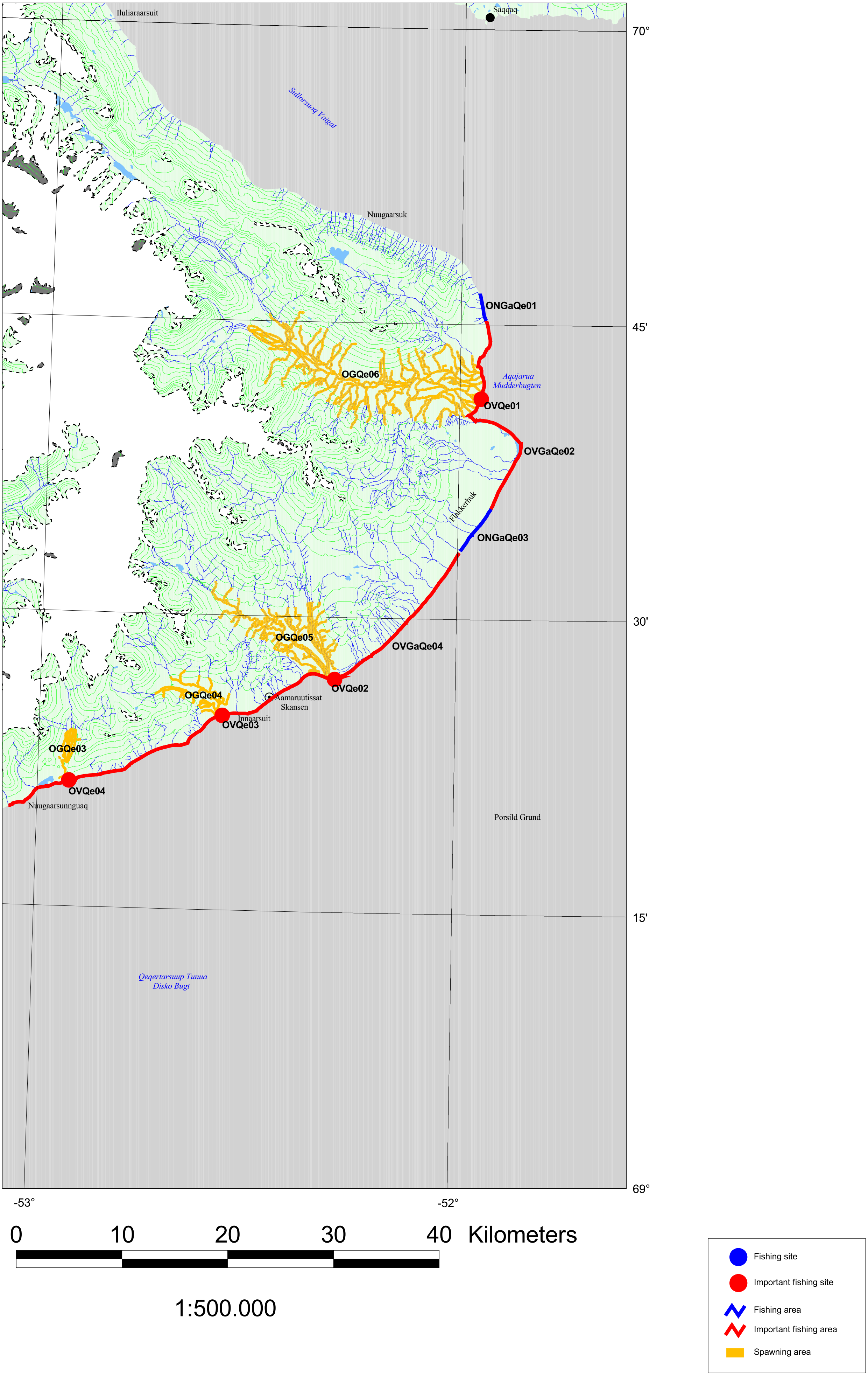
Map nr. 3

Distribution of spawning and fishing areas
Arctic Char



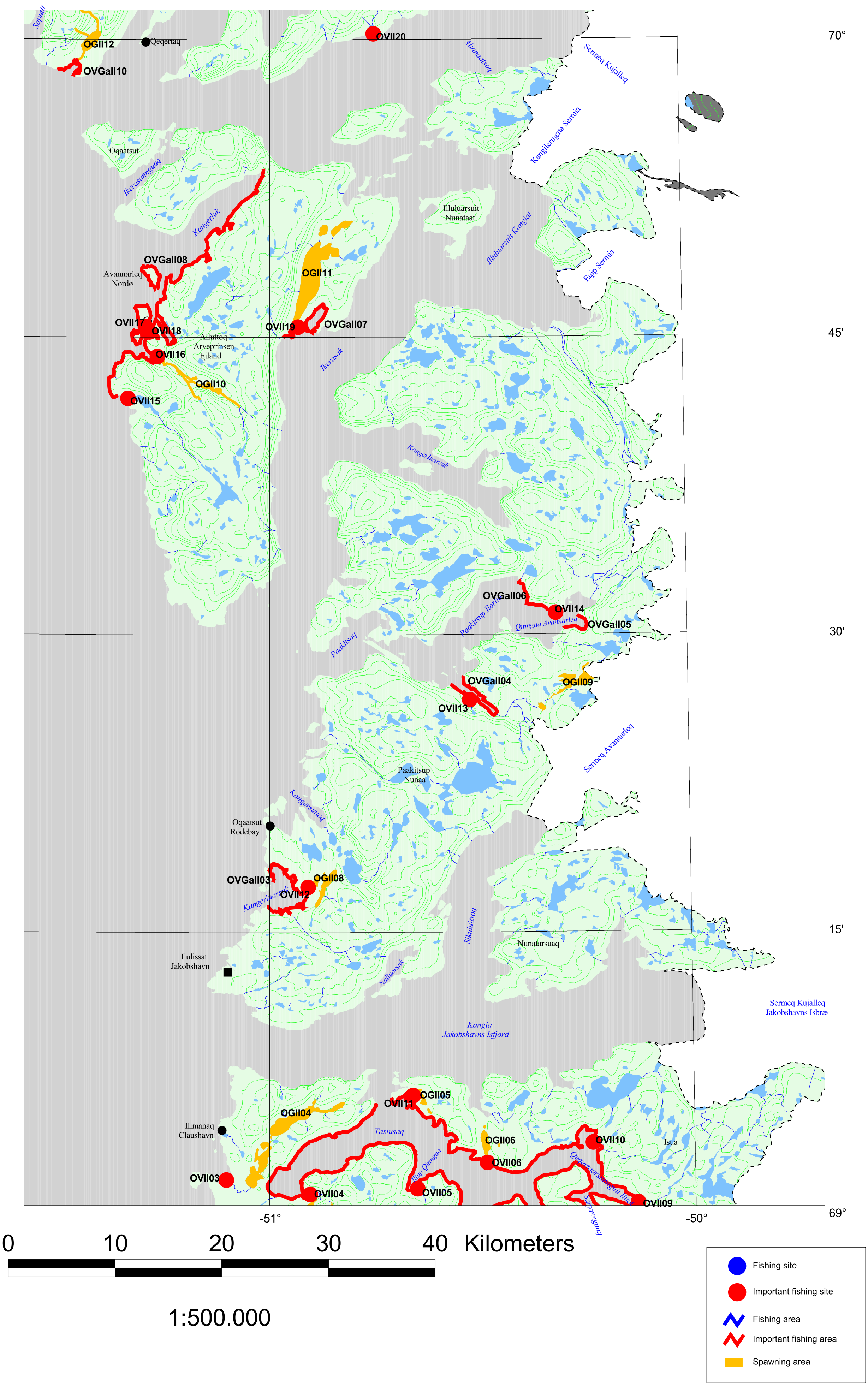
Map nr. 4

Distribution of spawning and fishing areas
Arctic Char



Map nr. 5

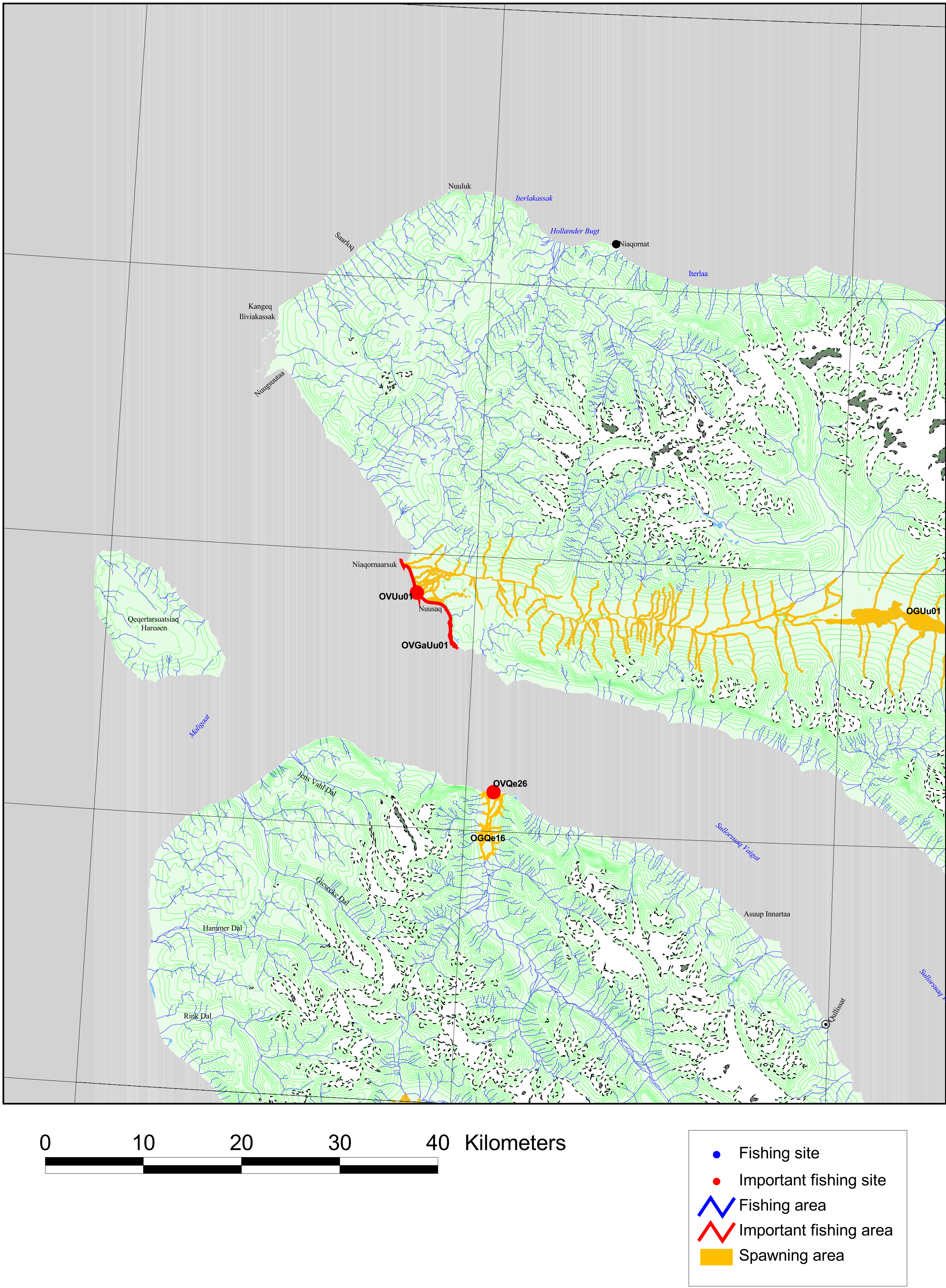
Distribution of spawning and fishing areas
Arctic Char



Map nr. 6

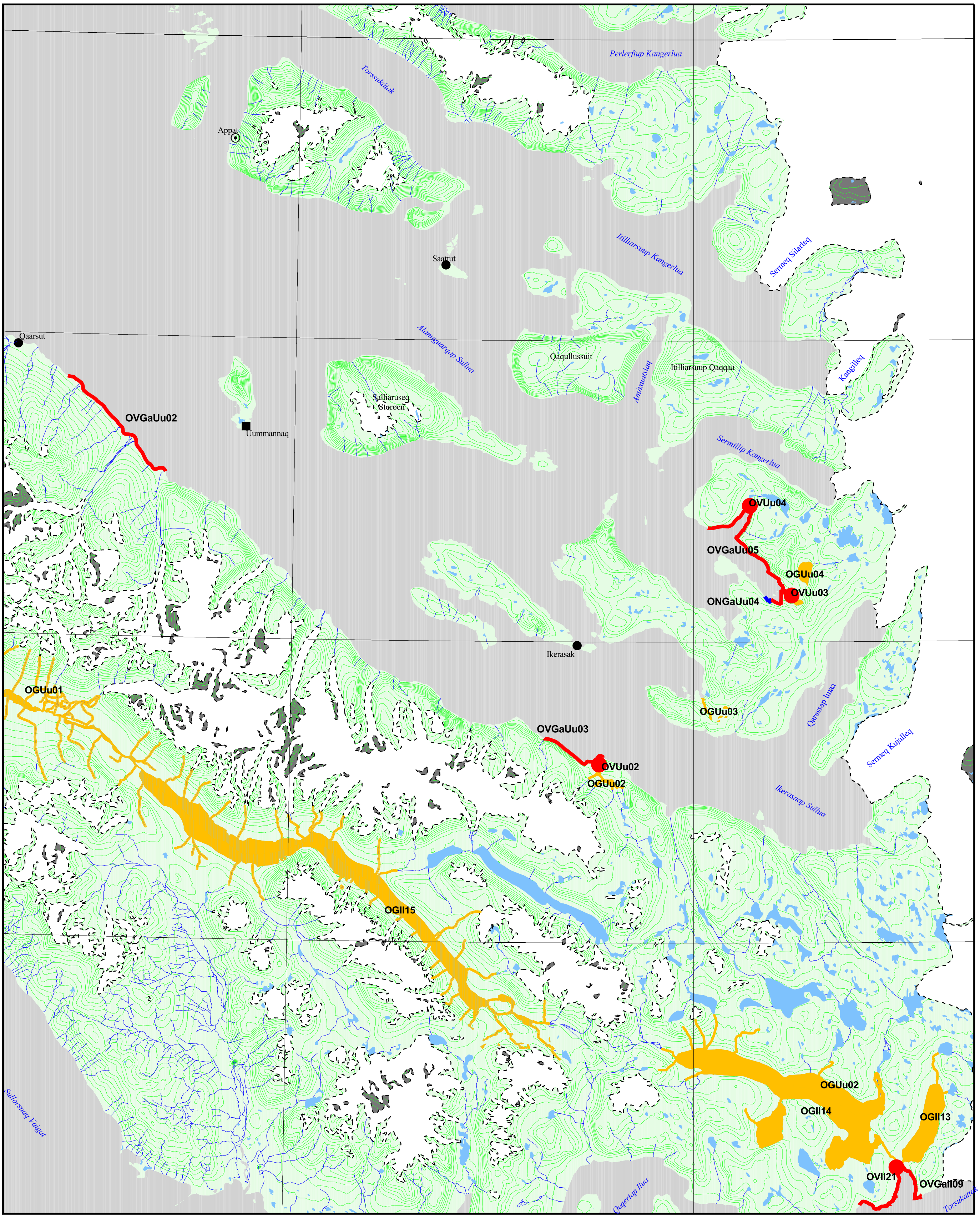
Distribution of spawning and fishing areas

Arctic Char



Map nr. 7

Distribution of spawning and fishing areas Arctic Char



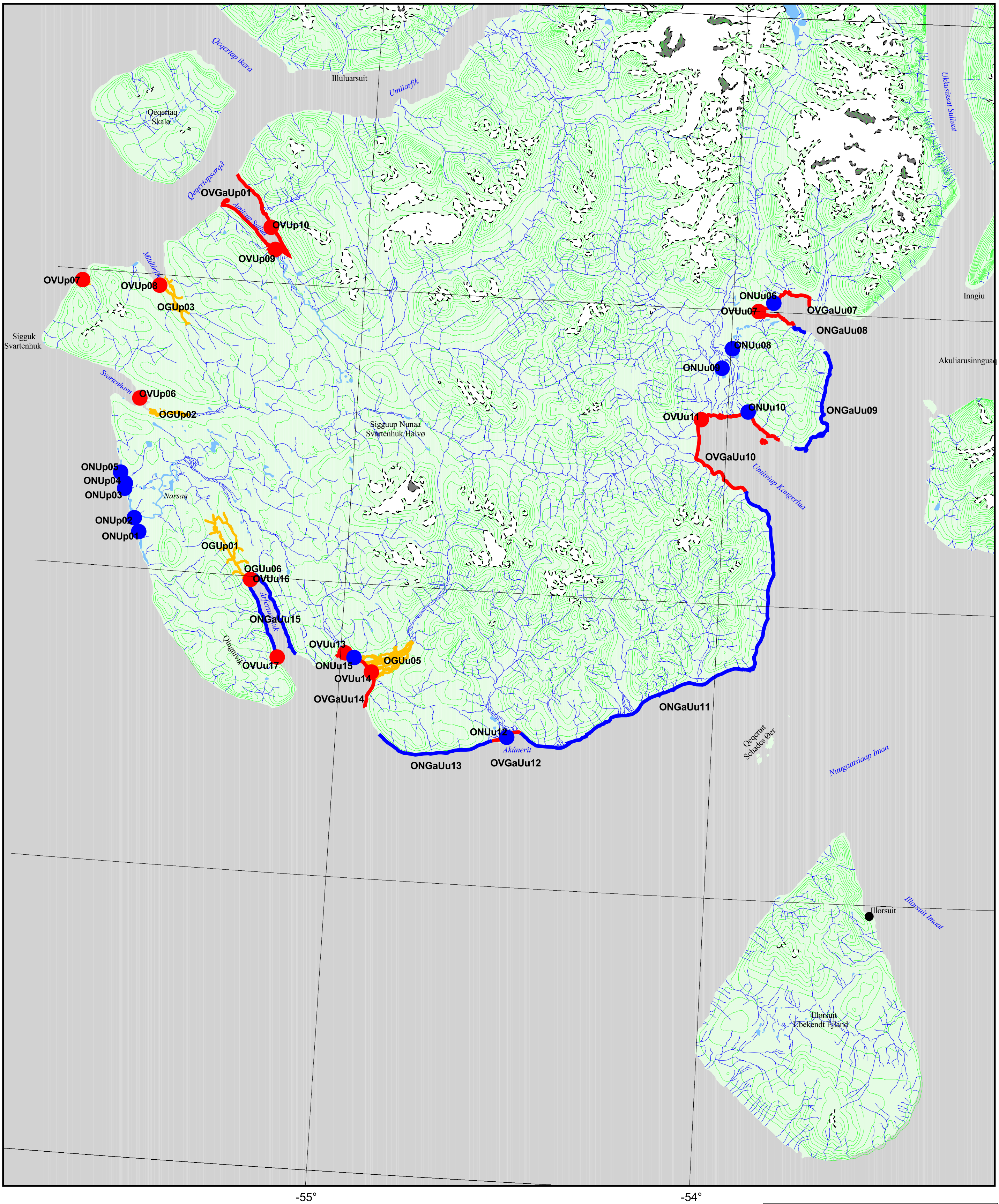
0 10 20 30 40 Kilometers

1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 8

Distribution of spawning and fishing areas
Arctic Char



0 10 20 30 40 Kilometers

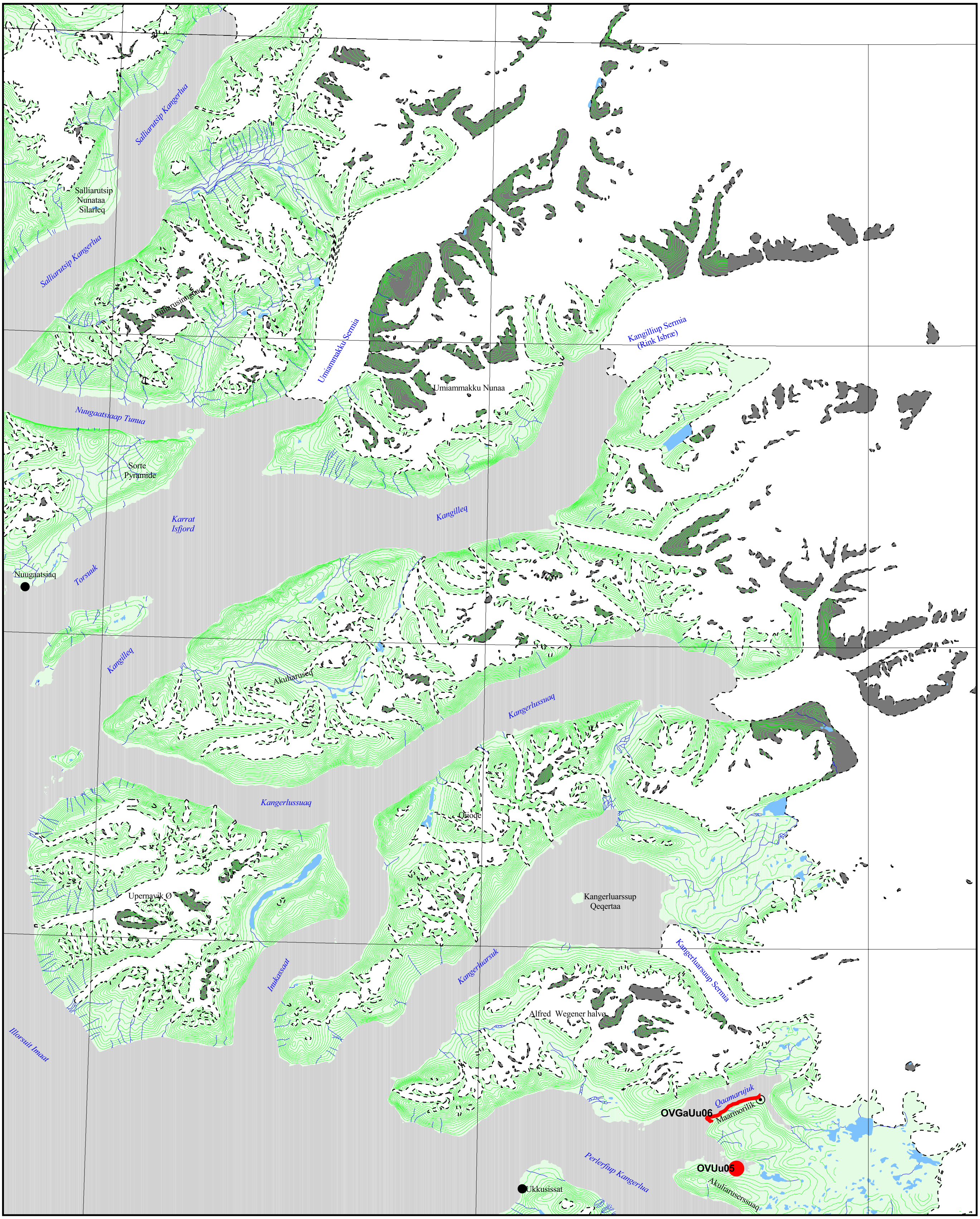
1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 9

Distribution of spawning and fishing areas

Arctic Char



0 10 20 30 40 Kilometers

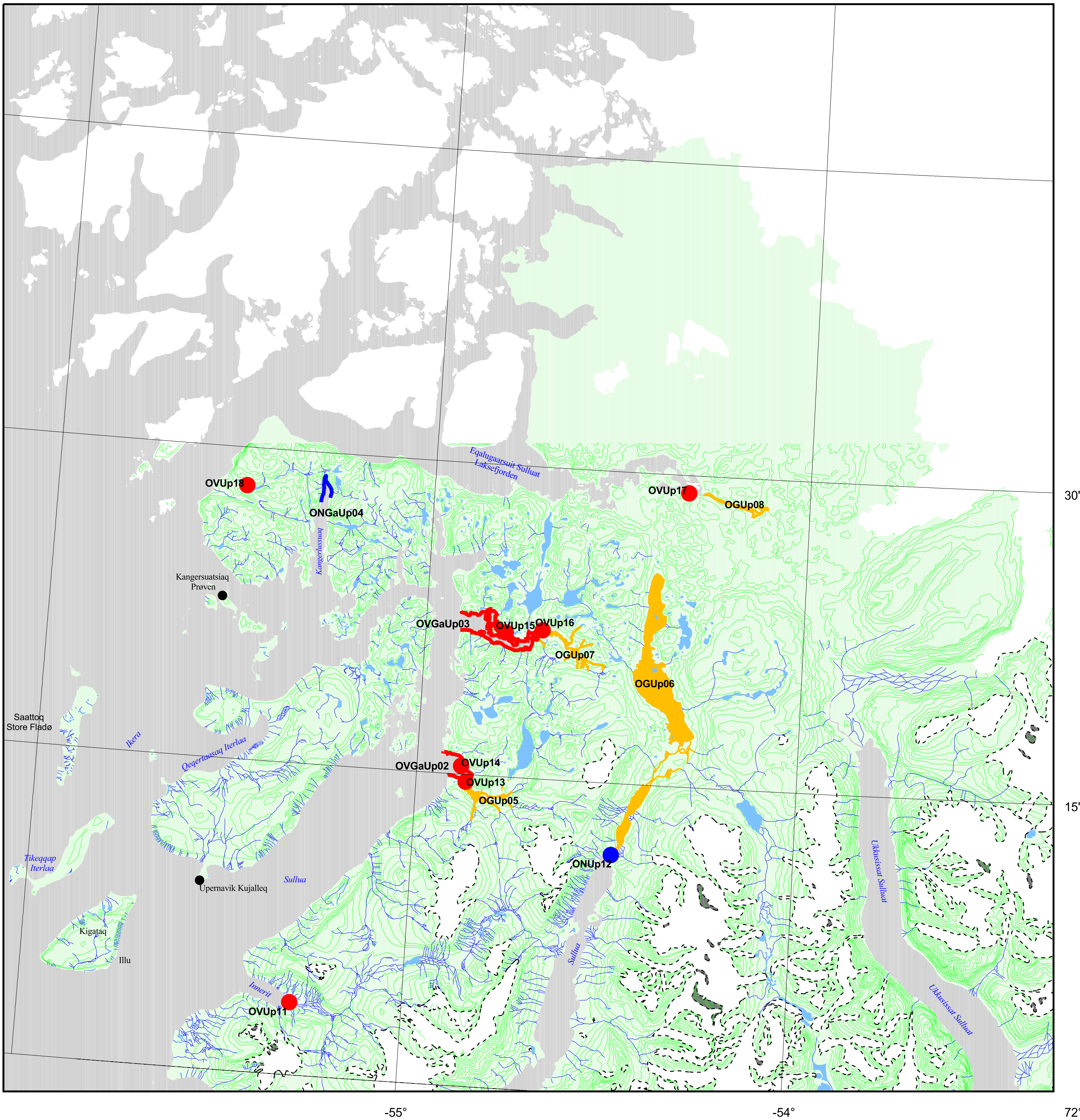
1:500.000

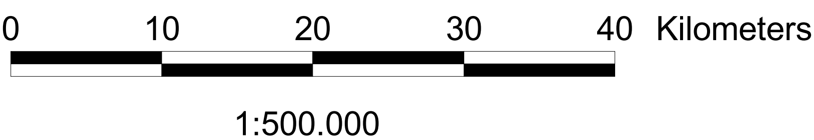
- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 10

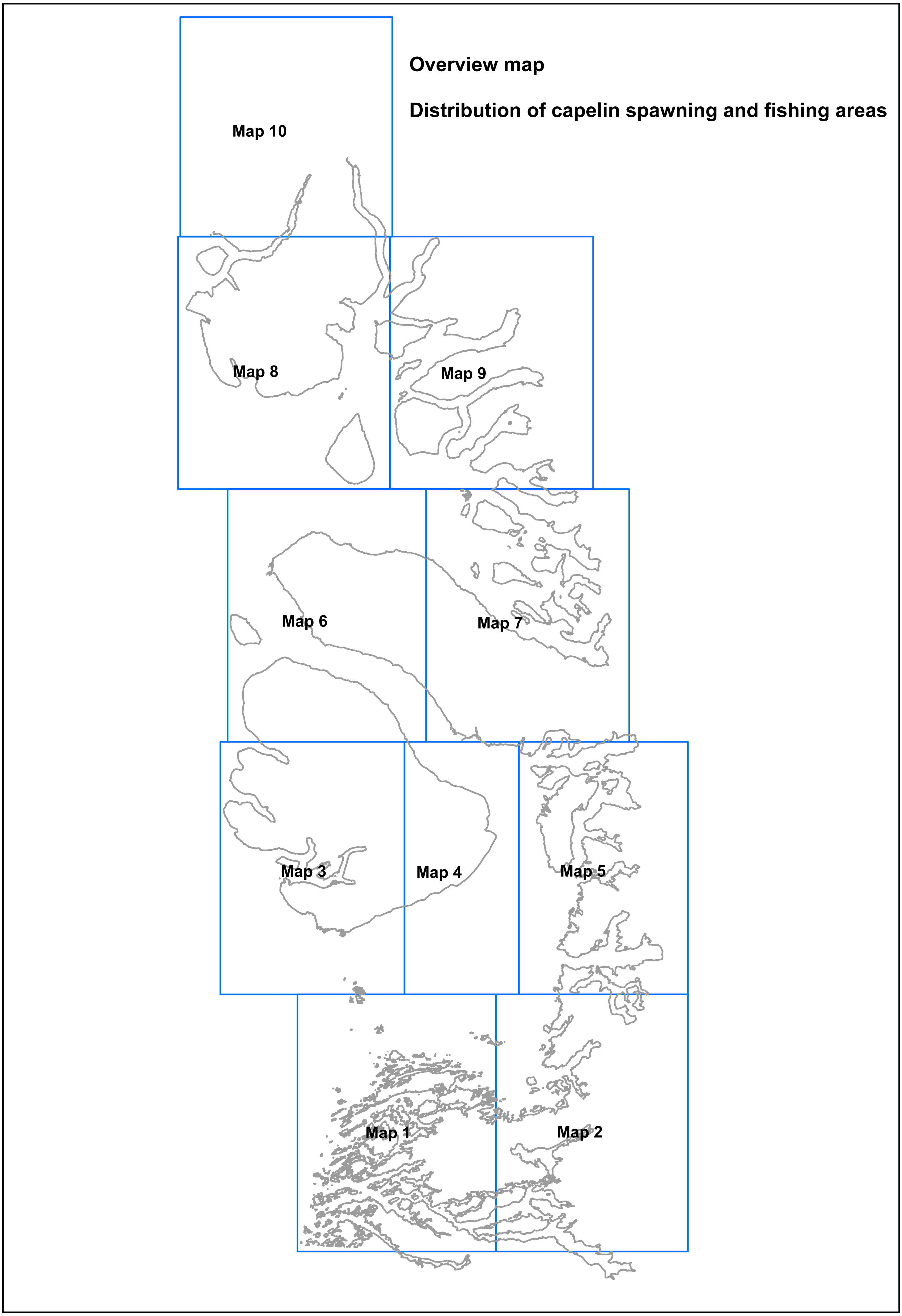
Distribution of spawning and fishing areas

Arctic Char





Fishing site
Important fishing site
Fishing area
Important fishing area
Spawning area

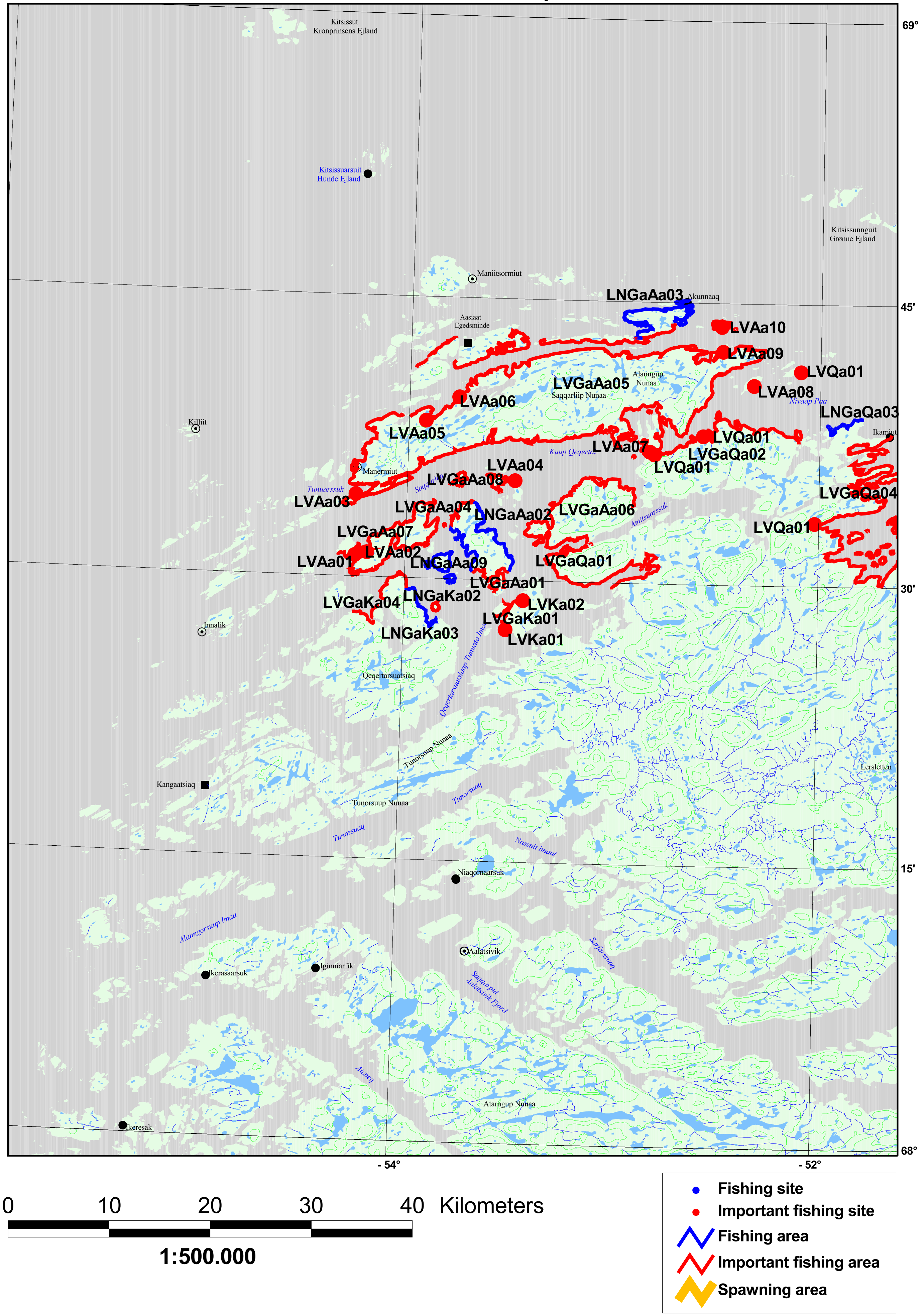


Overview map
Distribution of capelin spawning and fishing areas
Map 10
Map 8
Map 9
Map 6
Map 7
Map 3
Map 4
Map 5
Map 1
Map 2

Map nr. 1

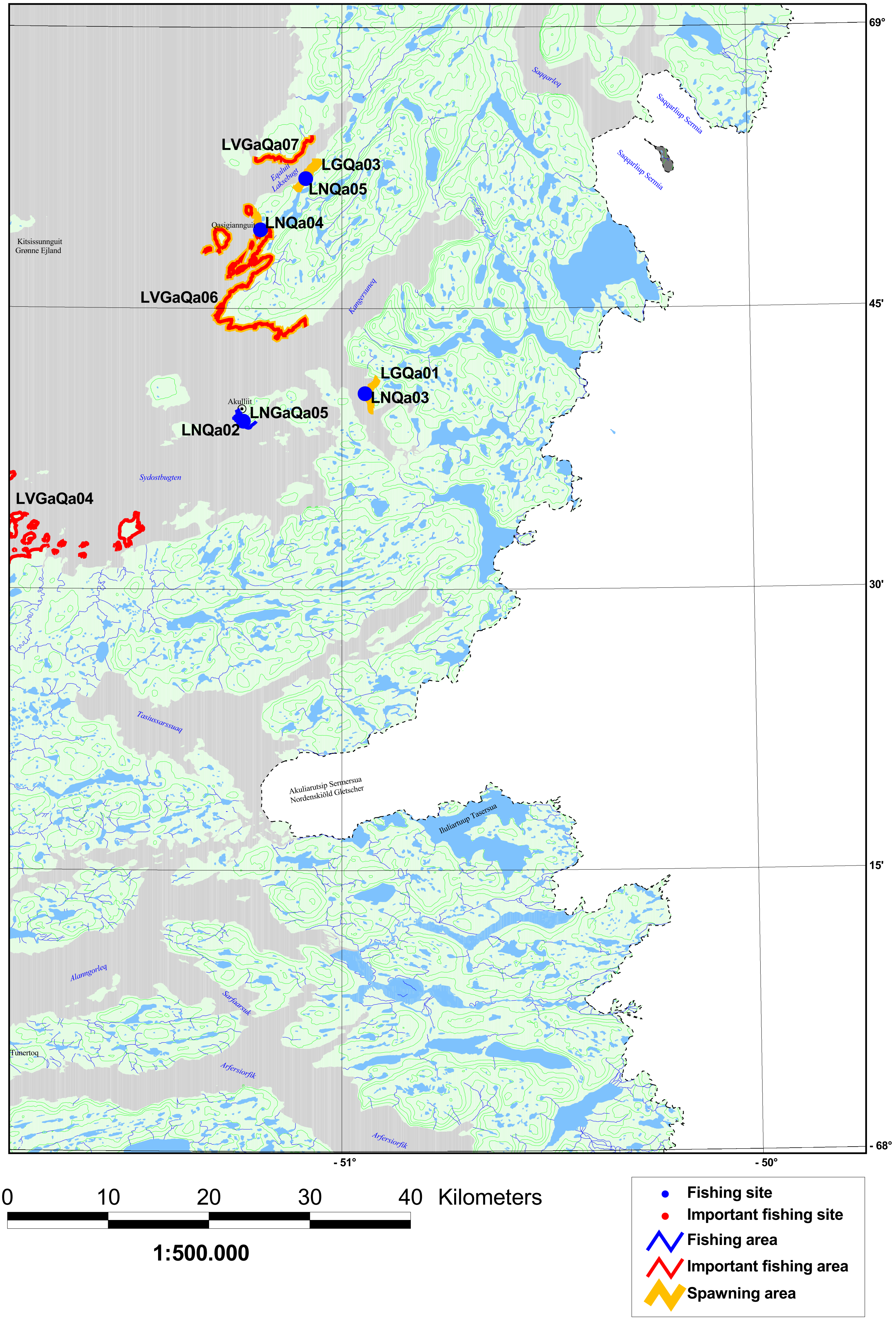
Distribution of spawning and fishing areas

Capelin



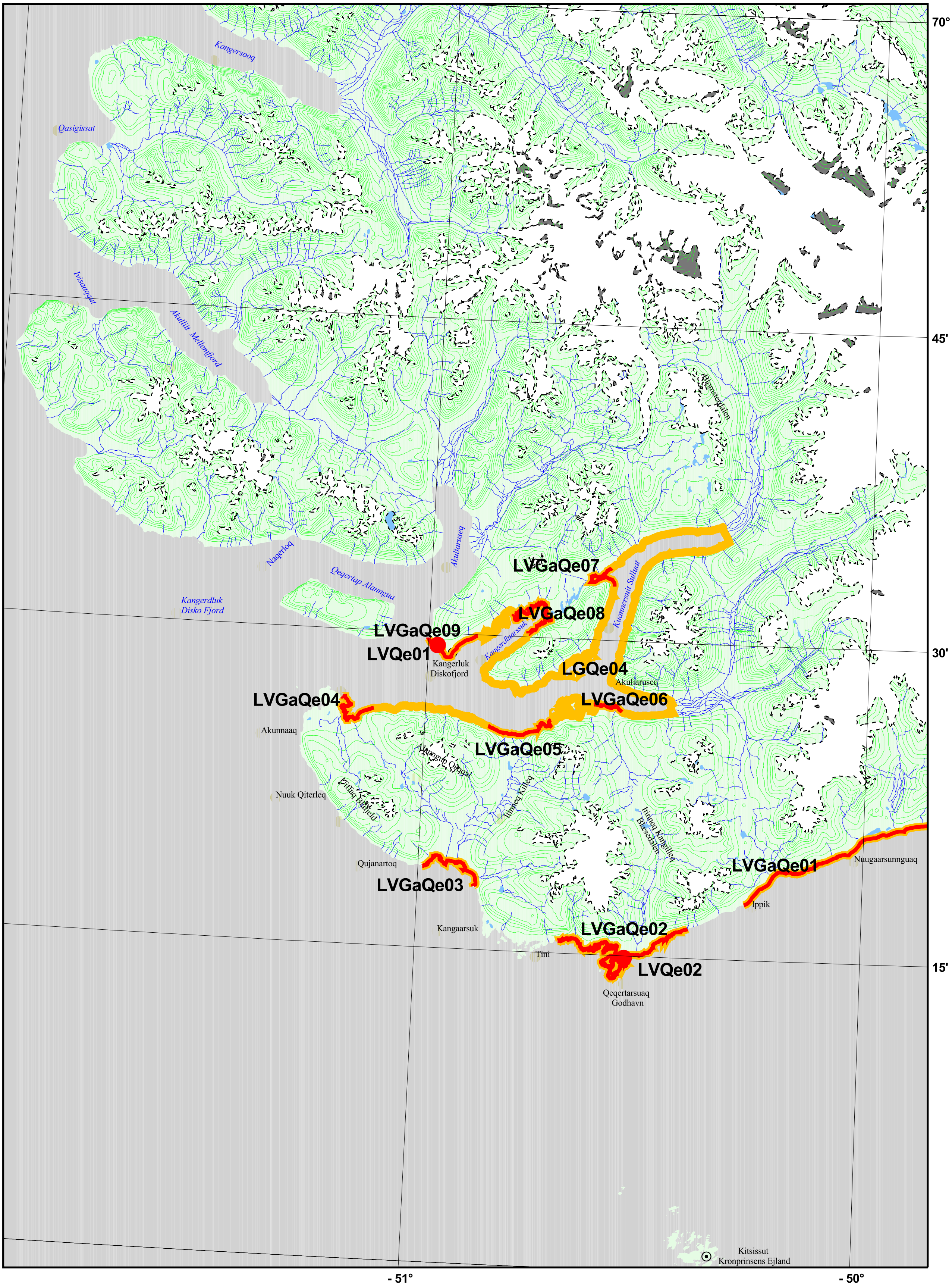
Map nr. 2

Distribution of spawning and fishing areas Capelin



Map nr. 3 **Distribution of spawning and fishing areas**

Capelin



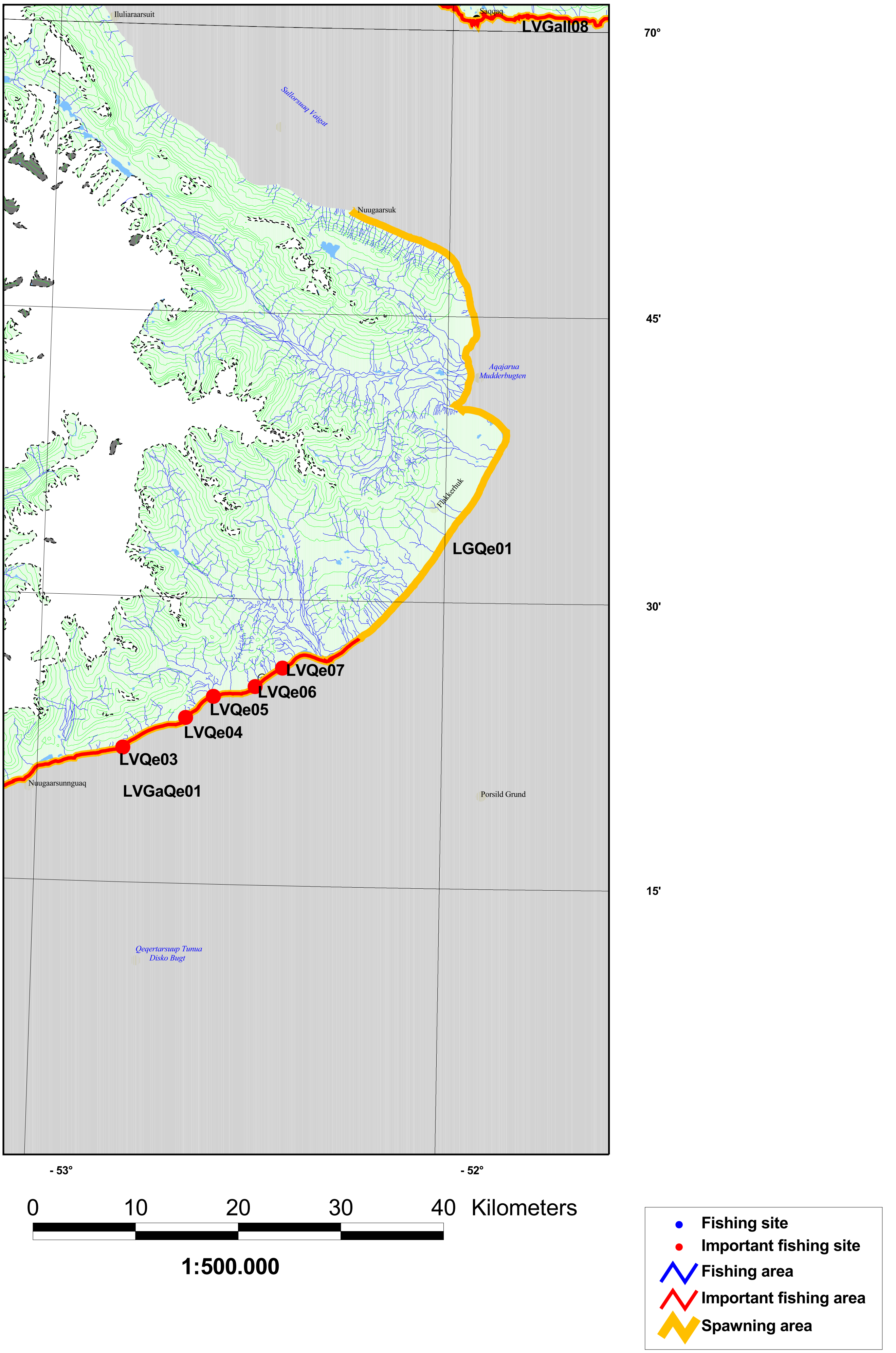
0 10 20 30 40 Kilometers

1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

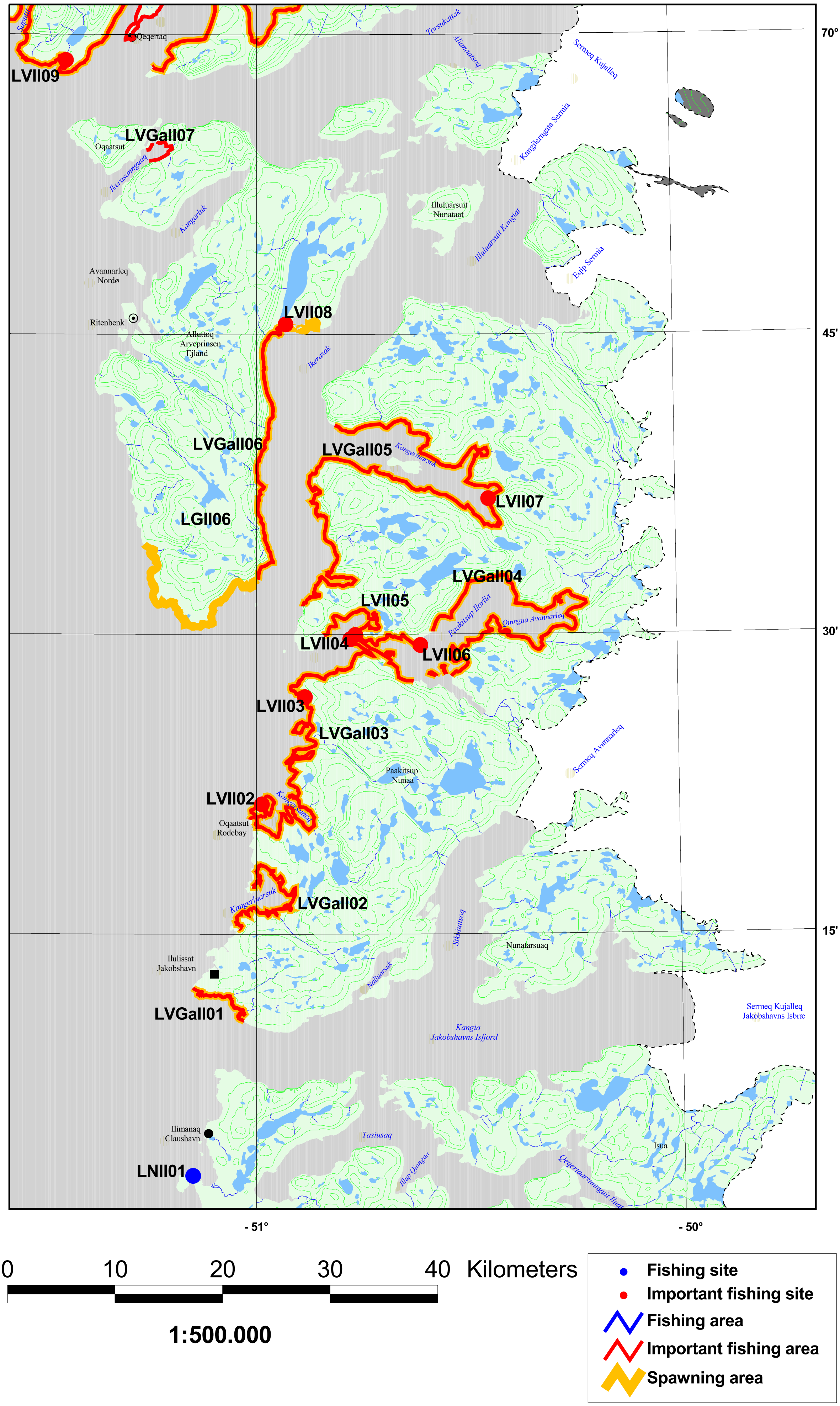
Map nr. 4

Distribution of spawning and fishing areas
Capelin



Map nr. 5

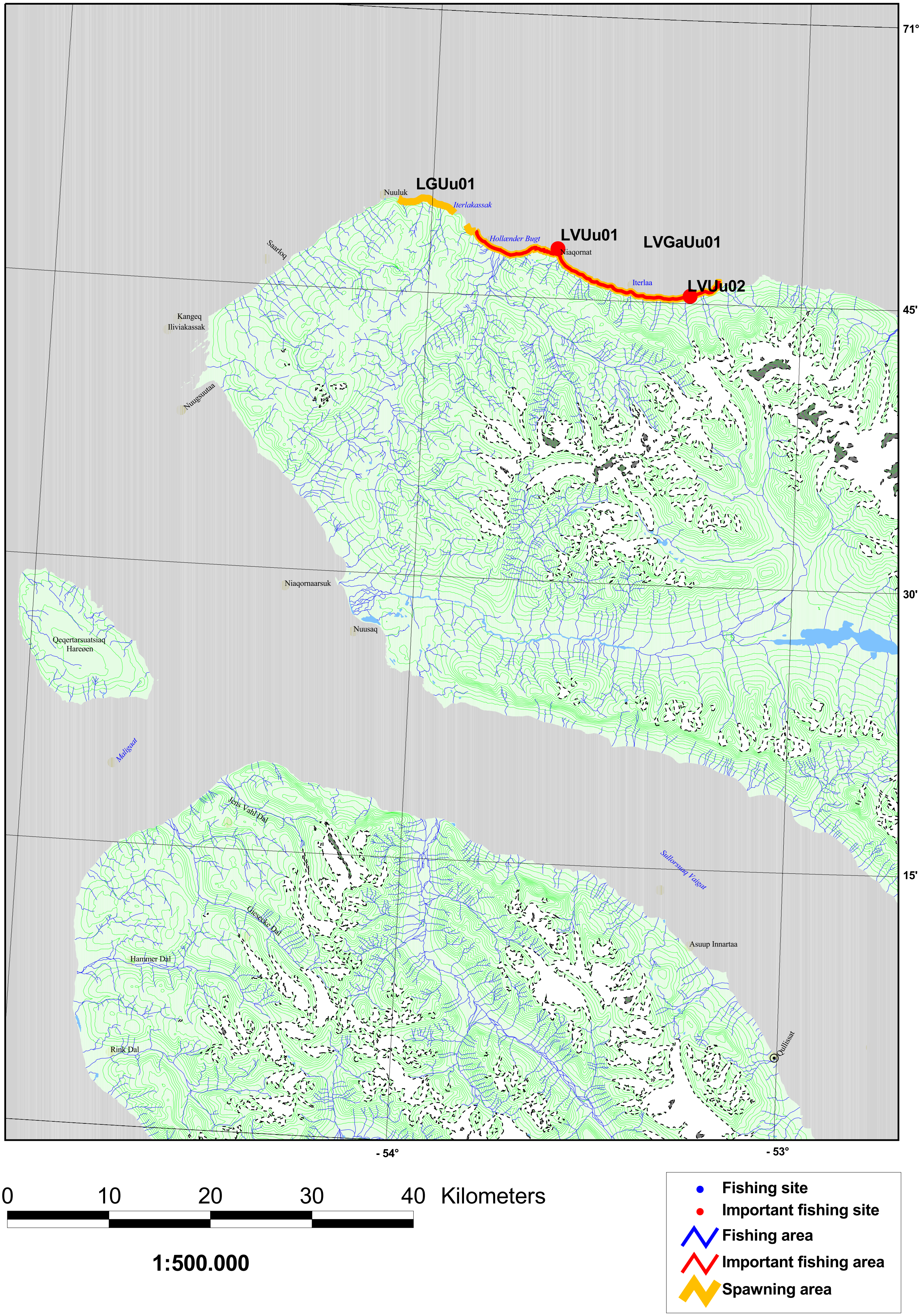
Distribution of spawning and fishing areas
Capelin



Map nr. 6

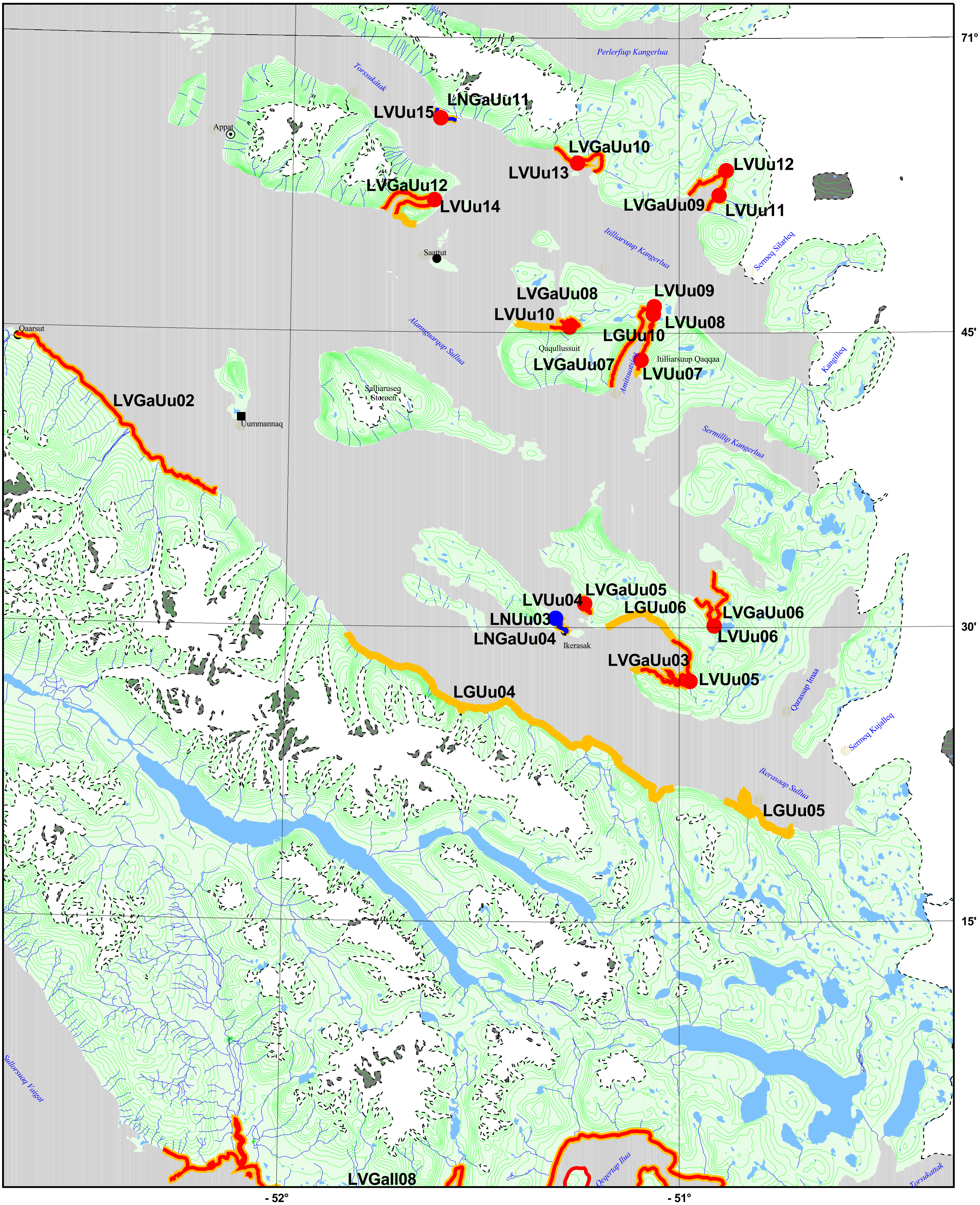
Distribution of spawning and fishing areas

Capelin



Map nr. 7

Distribution of spawning and fishing areas
Capelin



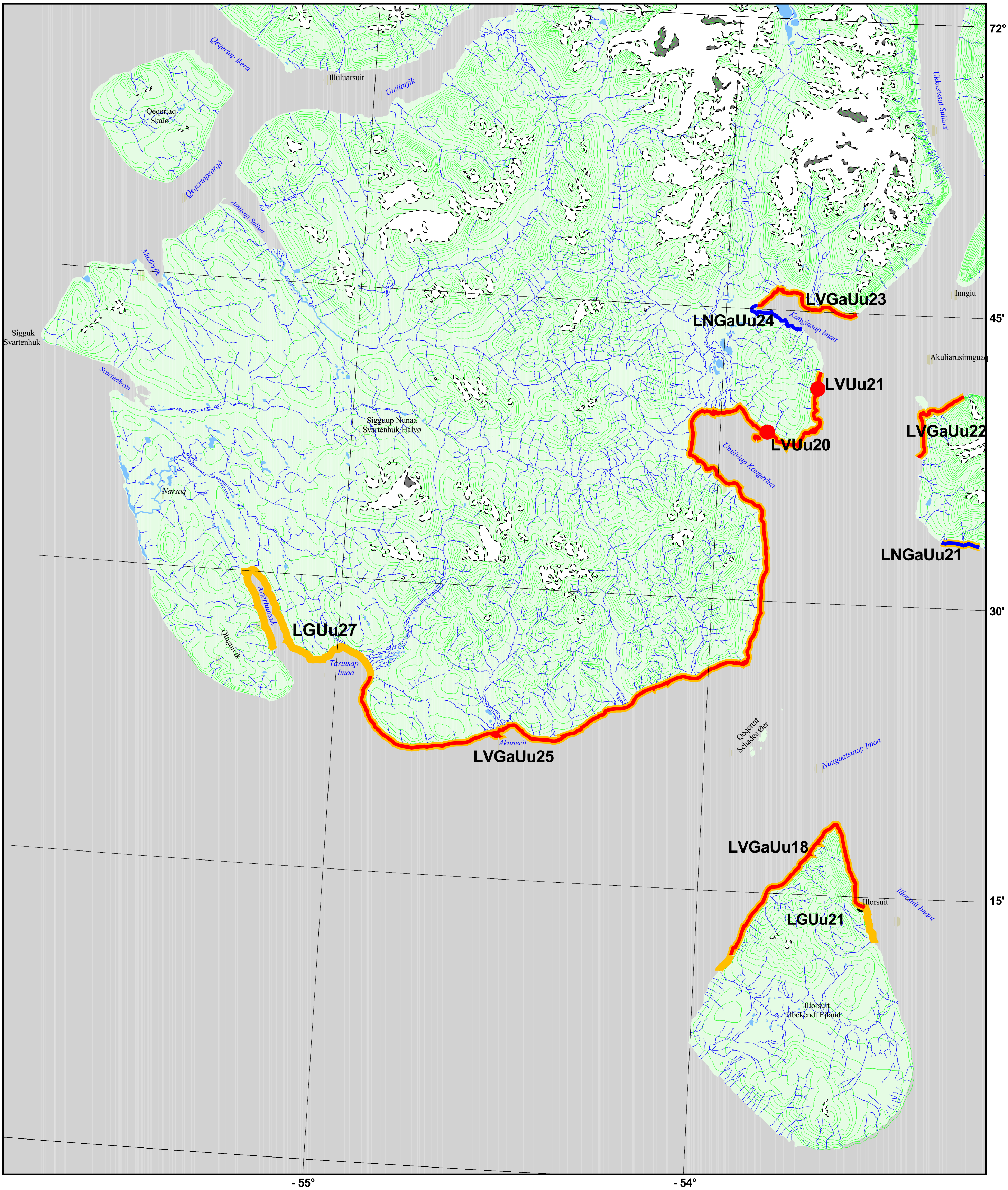
0 10 20 30 40 Kilometers

1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 8

Distribution of spawning and fishing areas
Capelin



0 10 20 30 40 Kilometers

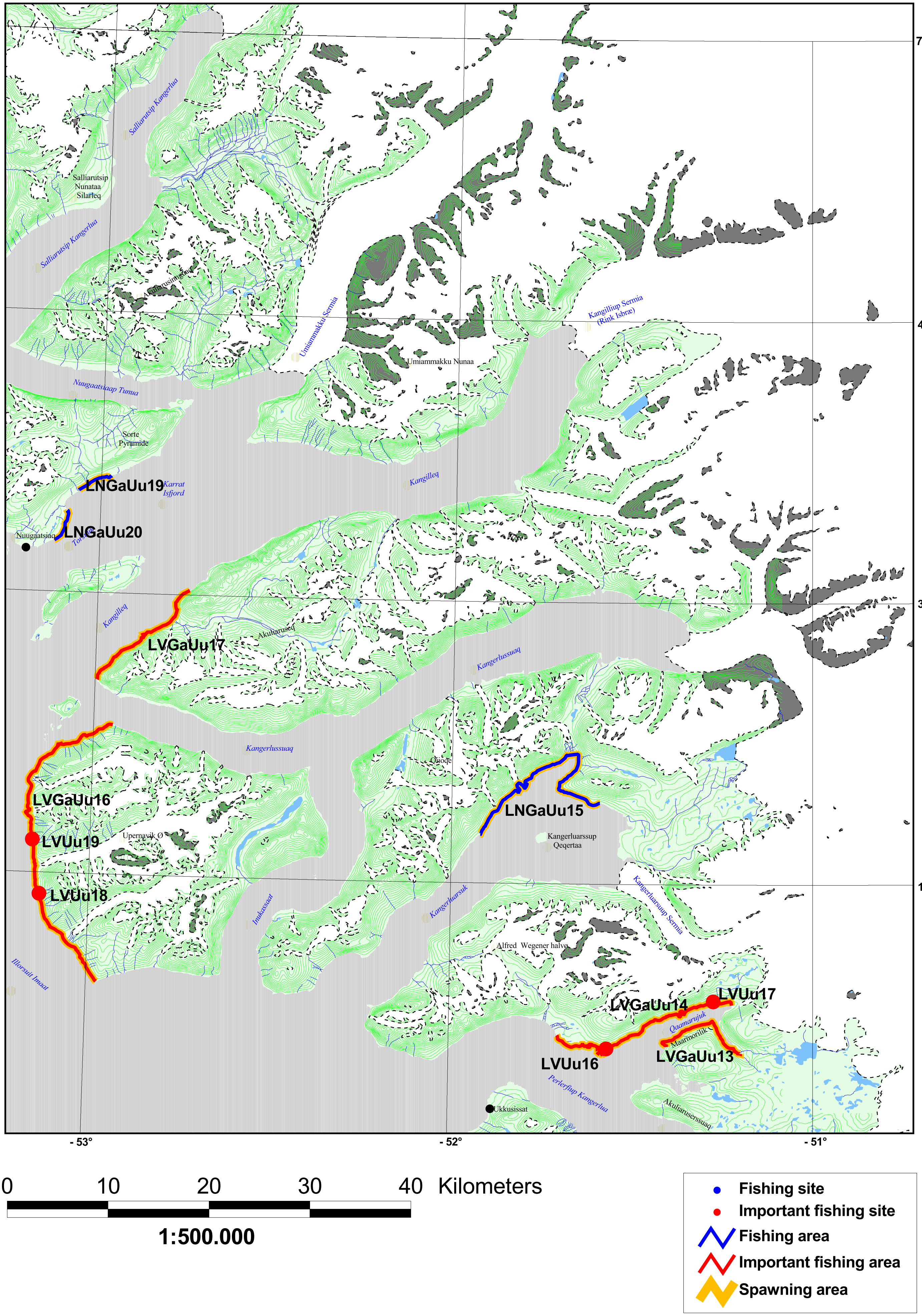
1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 9

Distribution of spawning and fishing areas

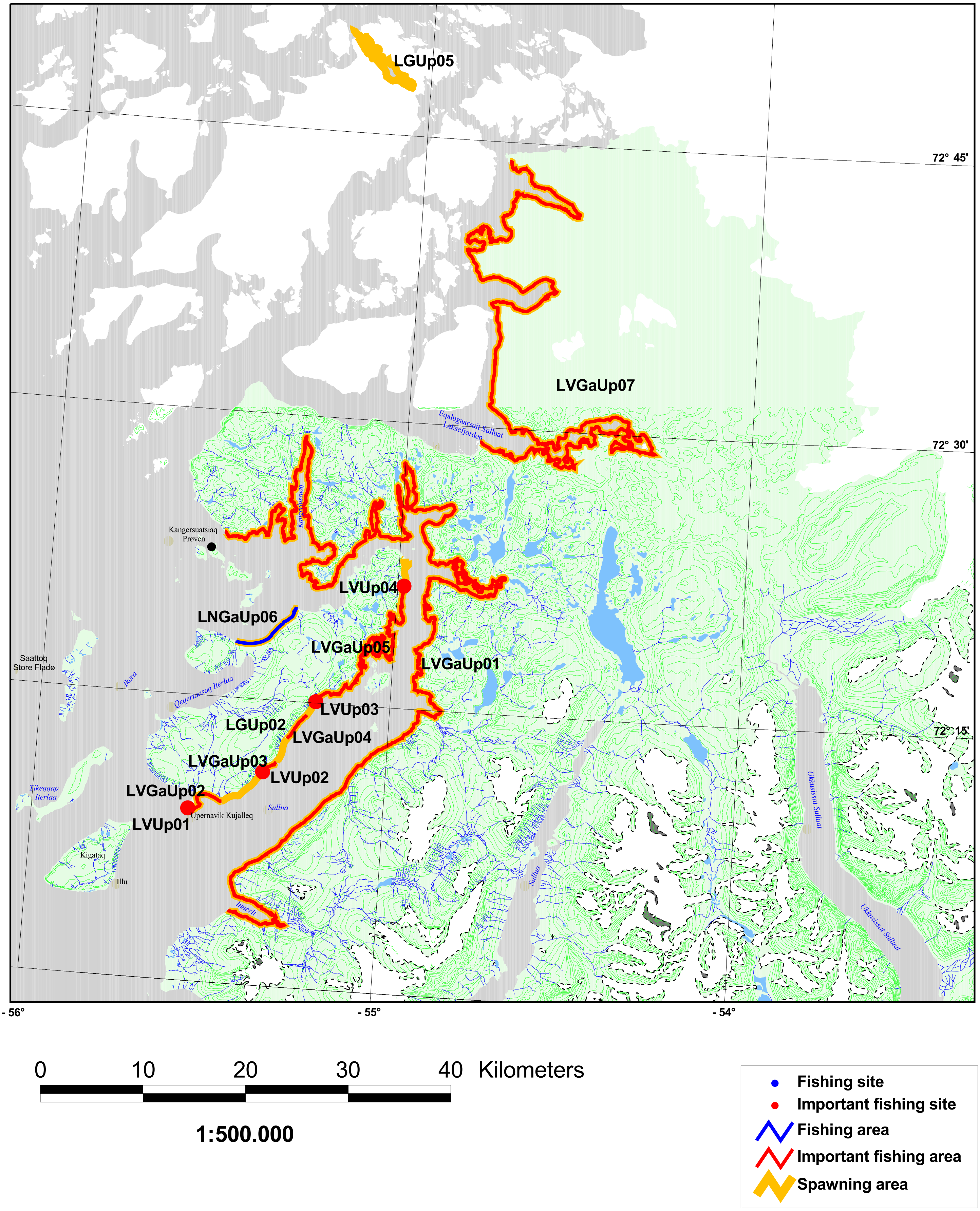
Capelin



Map nr. 10

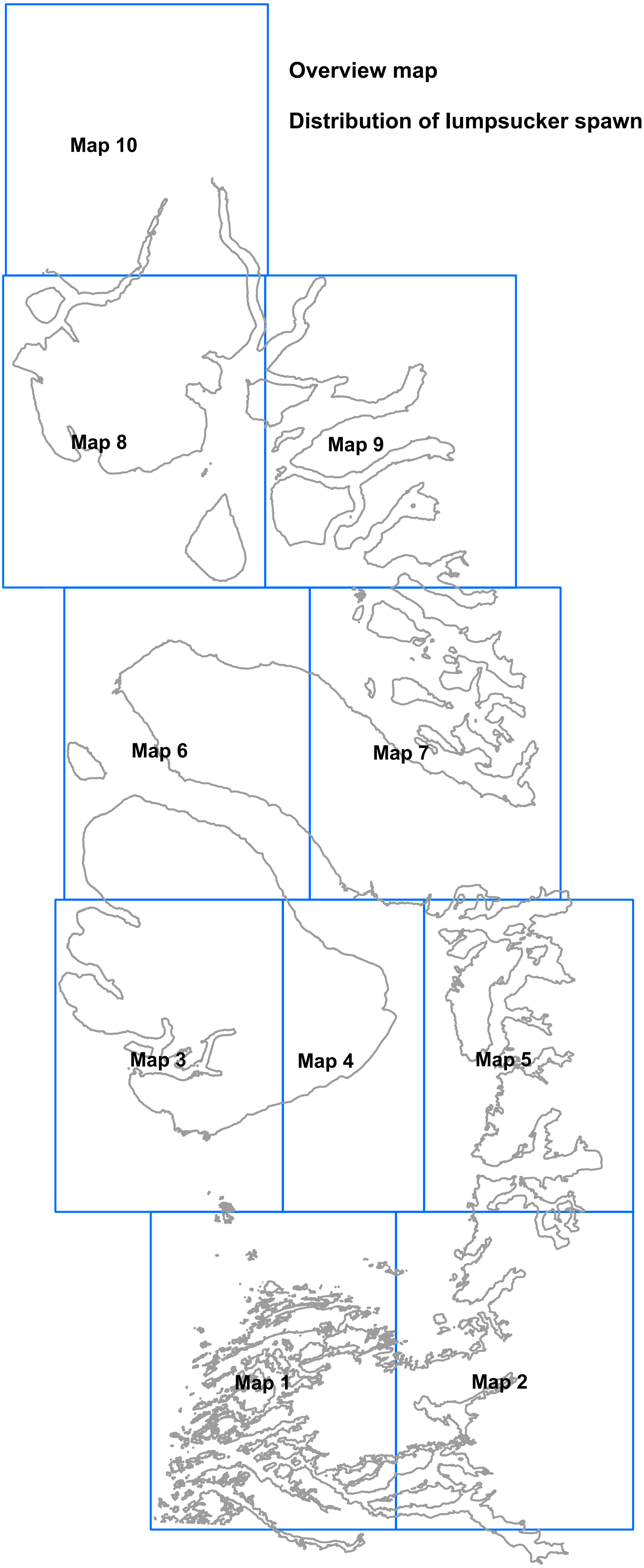
Distribution of spawning and fishing areas

Capelin



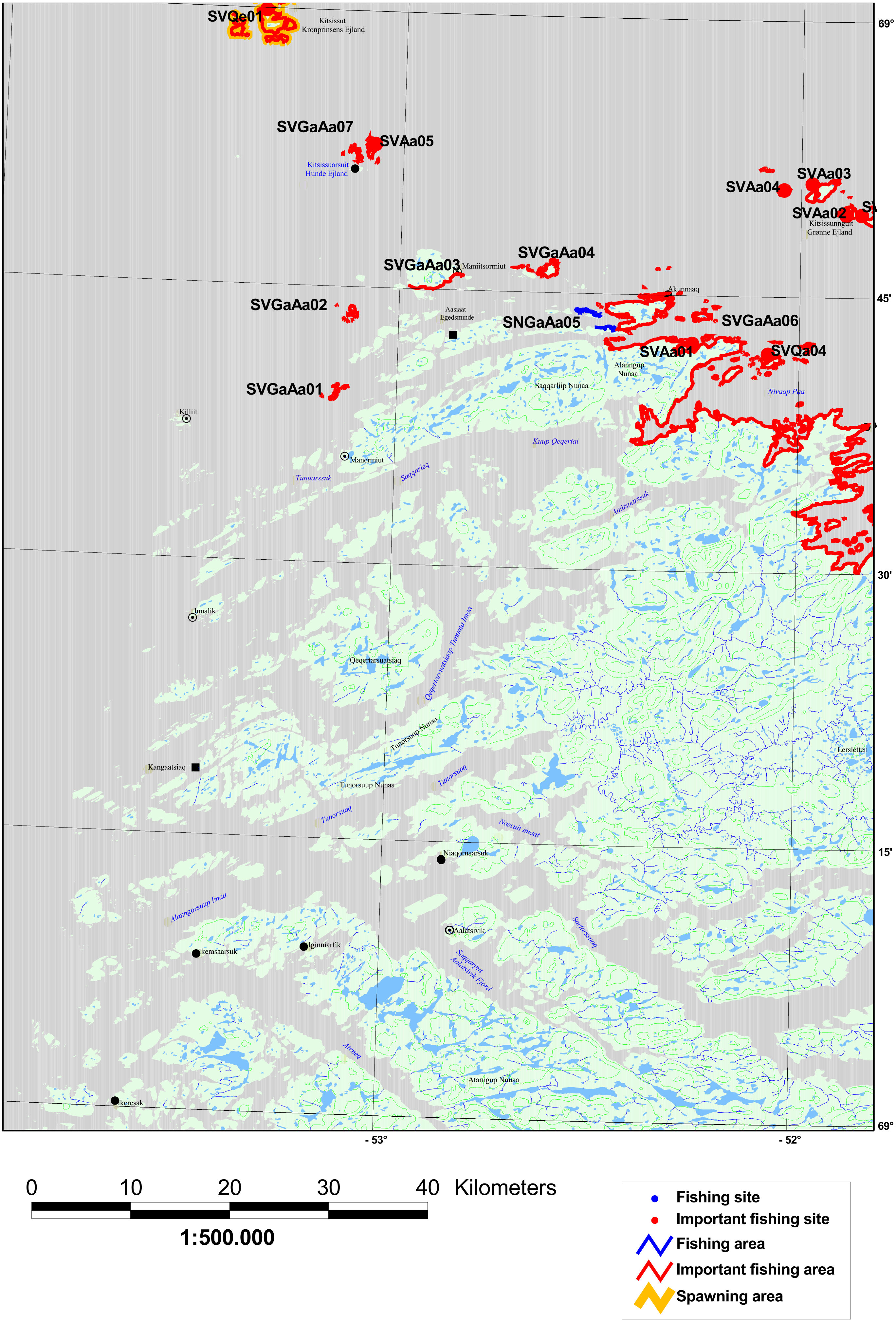
Overview map

Distribution of lumpsucker spawning and fishing areas



Map nr. 1

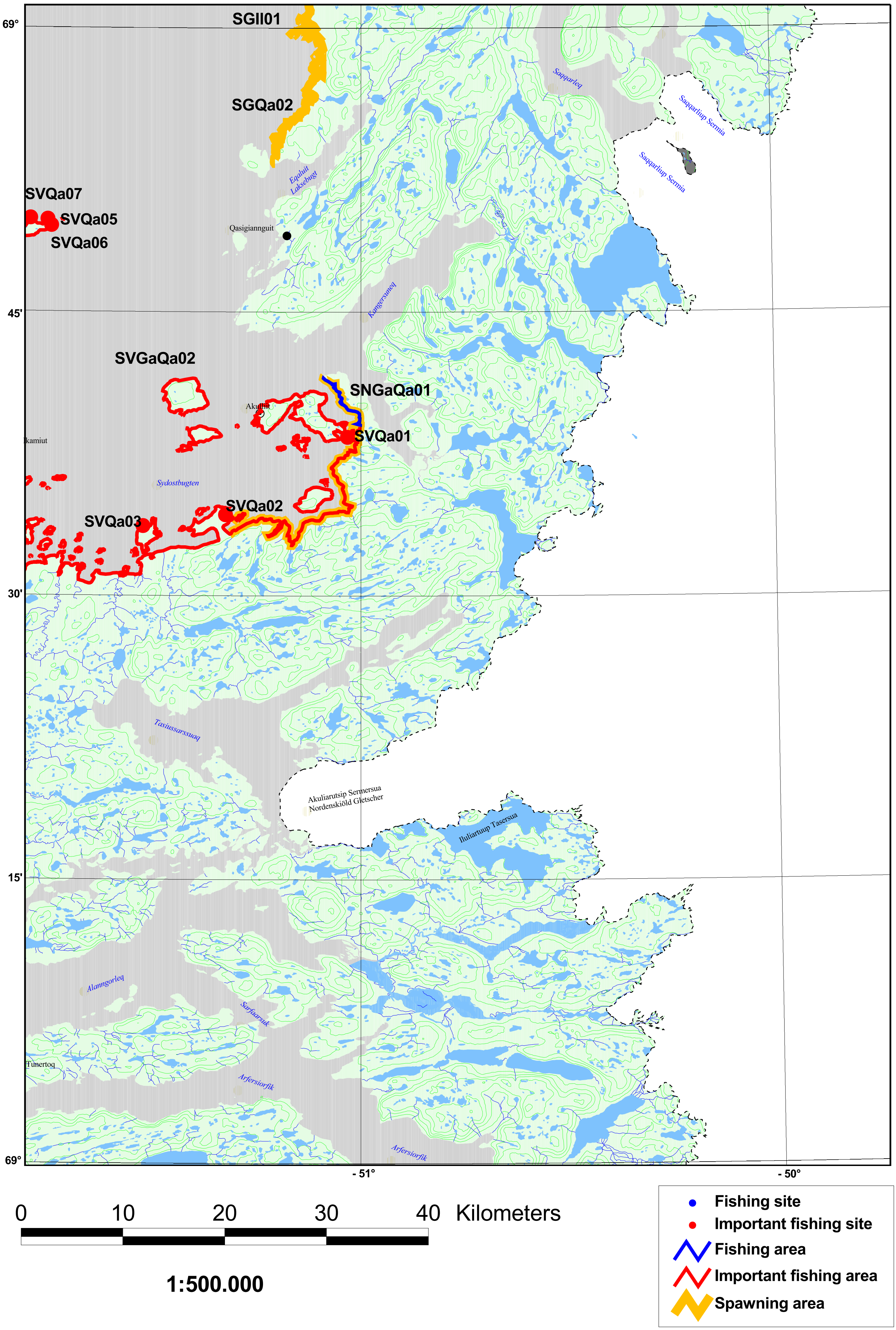
Distribution of spawning and fishing areas
Lumpsucker



Map nr. 2

Distribution of spawning and fishing areas

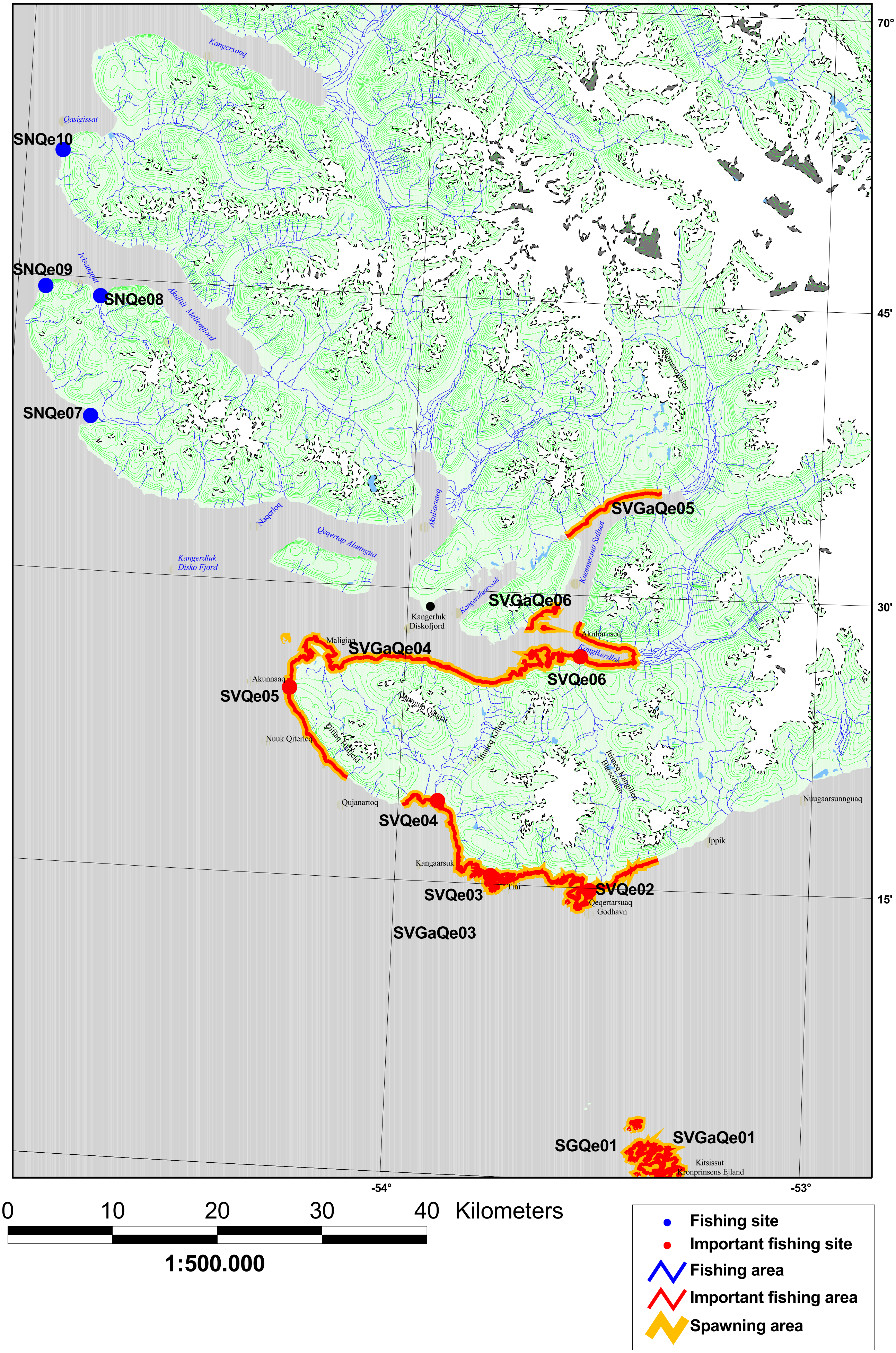
Lumpsucker



Map nr. 3

Distribution of spawning and fishing areas

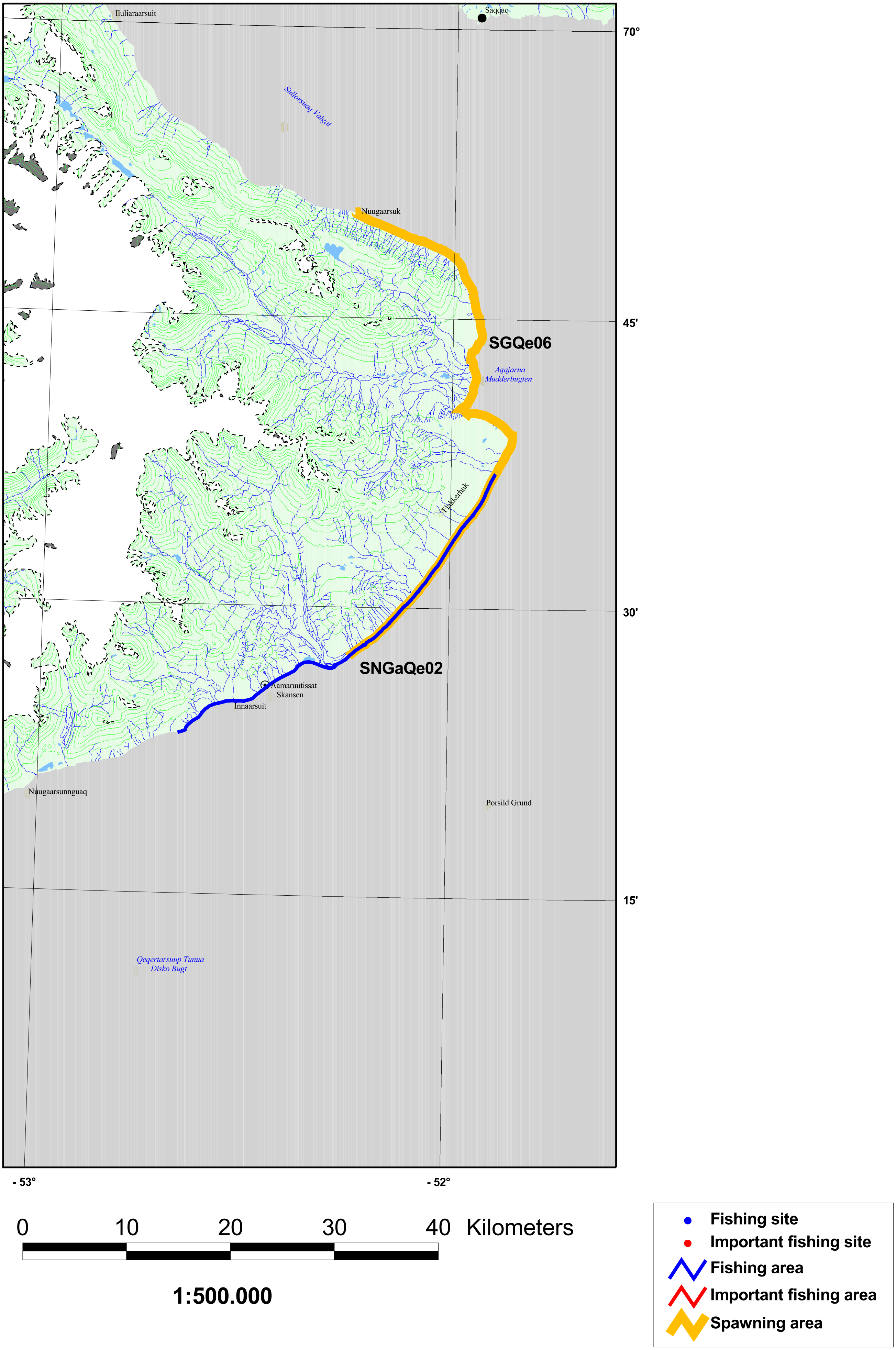
Lumpsucker



Map nr. 4

Distribution of spawning and fishing areas

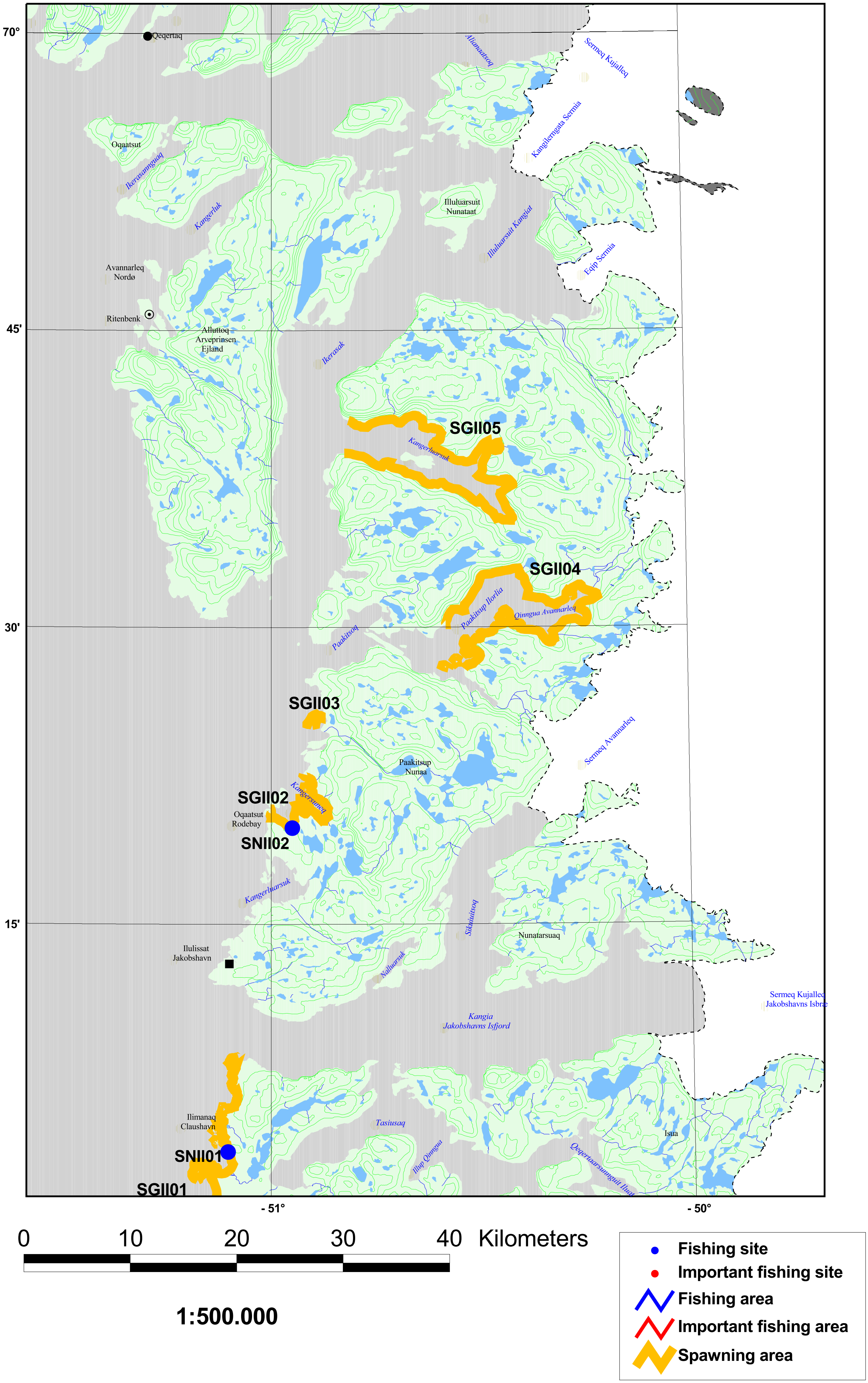
Lumpsucker



Map nr. 5

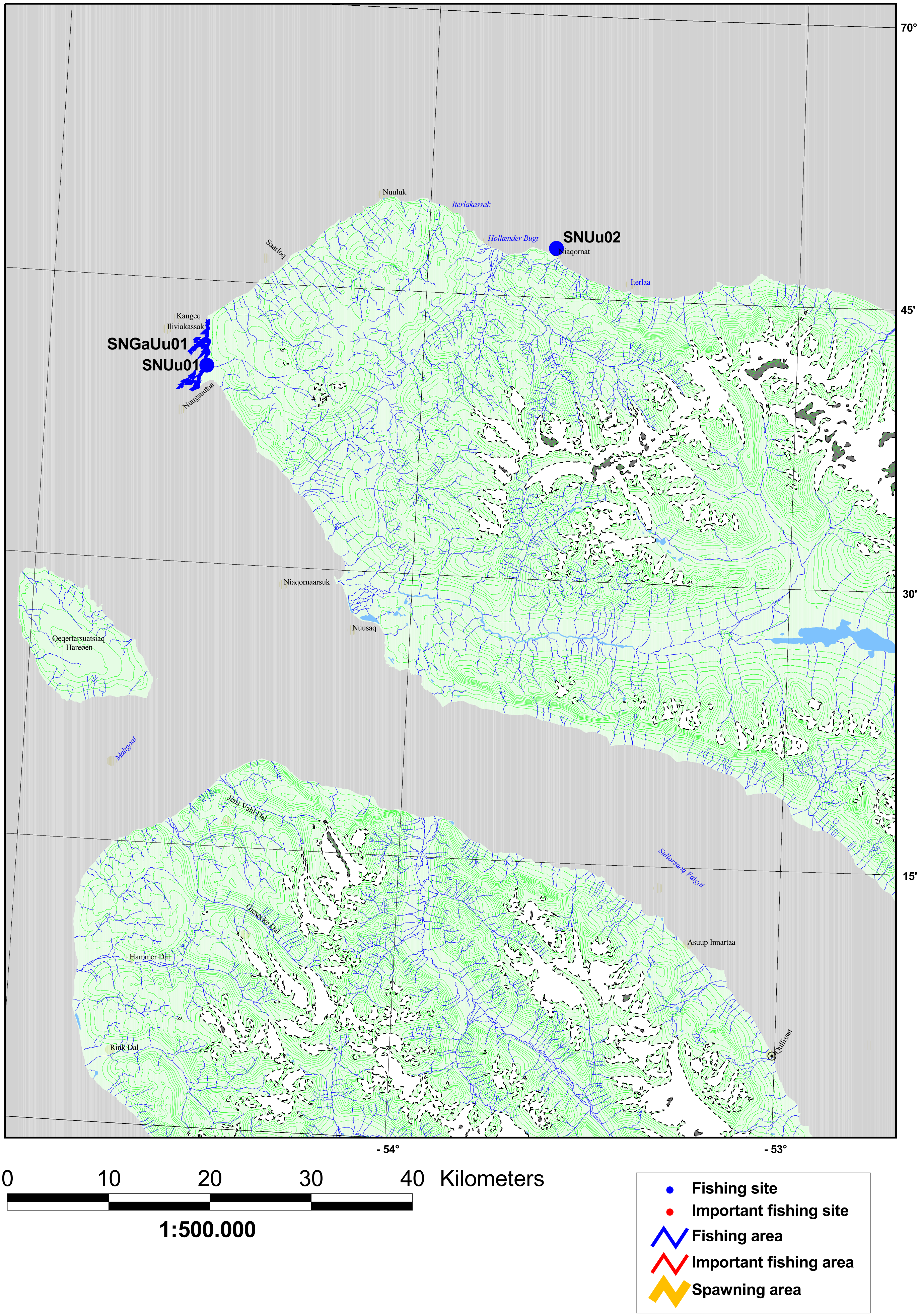
Distribution of spawning and fishing areas

Lumpsucker



Map nr. 6

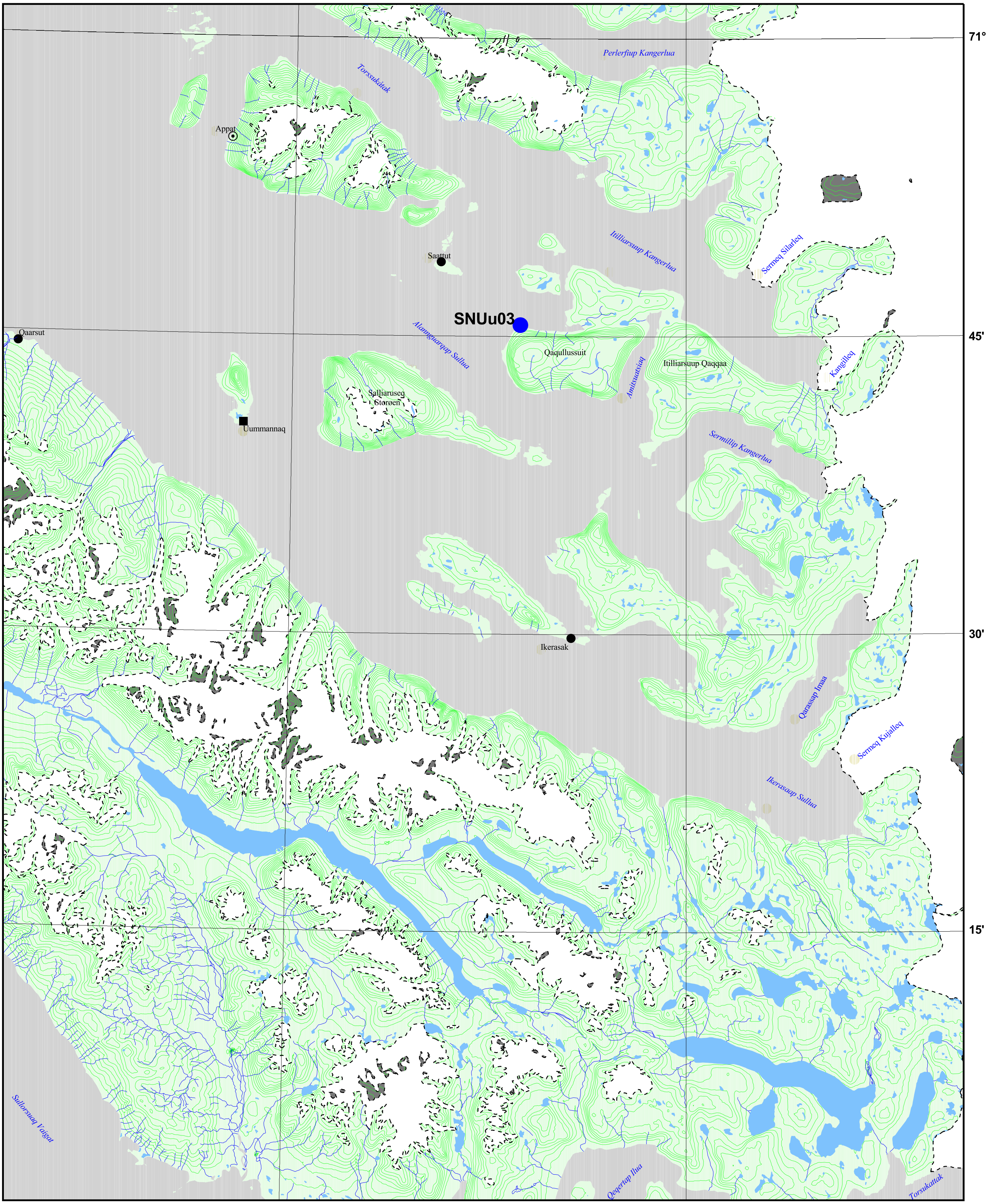
Distribution of spawning and fishing areas
Lumpsucker



Map nr. 7

Distribution of spawning and fishing areas

Lumpsucker



0 10 20 30 40 Kilometers

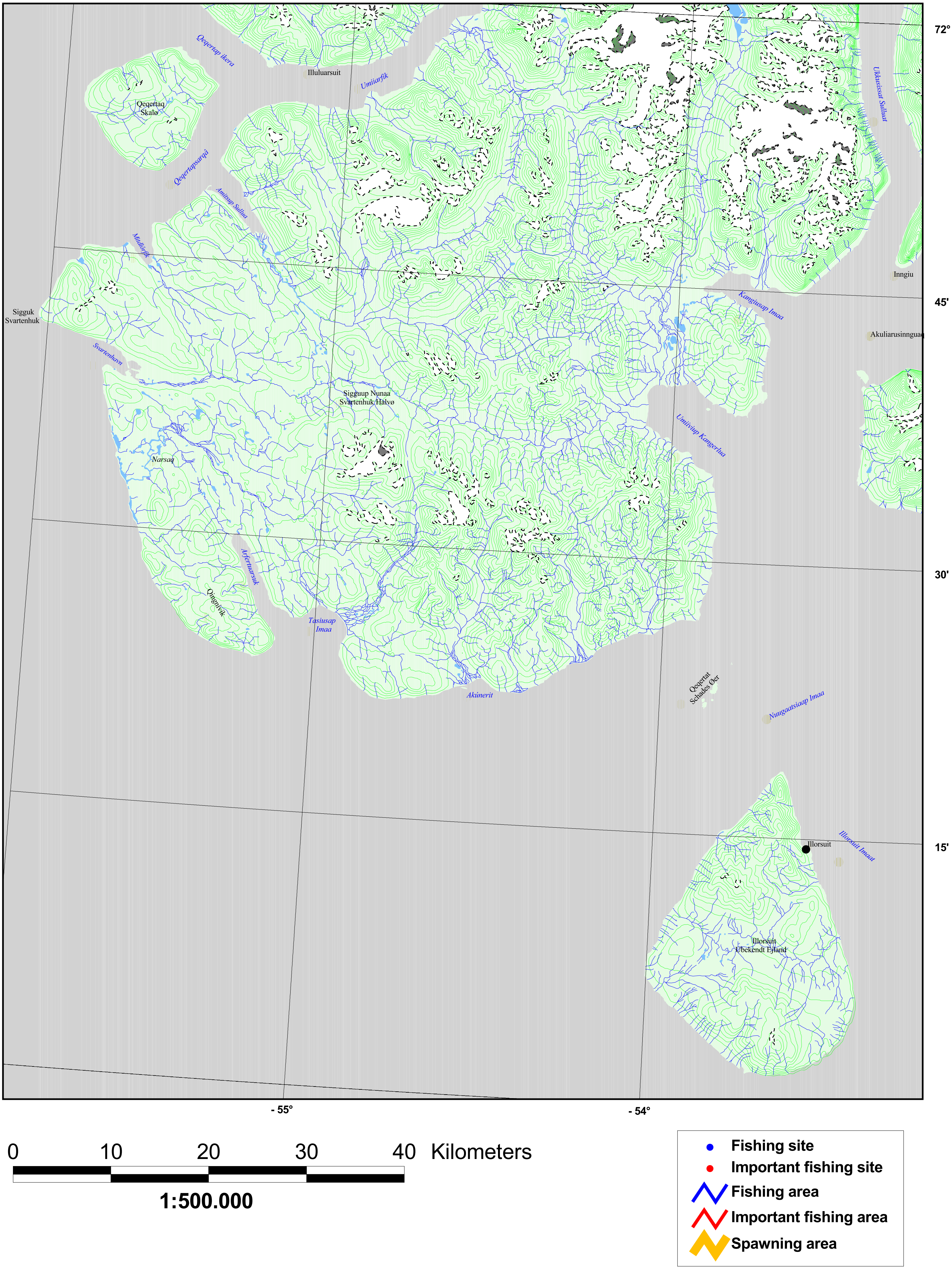
1:500.000

- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 8

Distribution of spawning and fishing areas

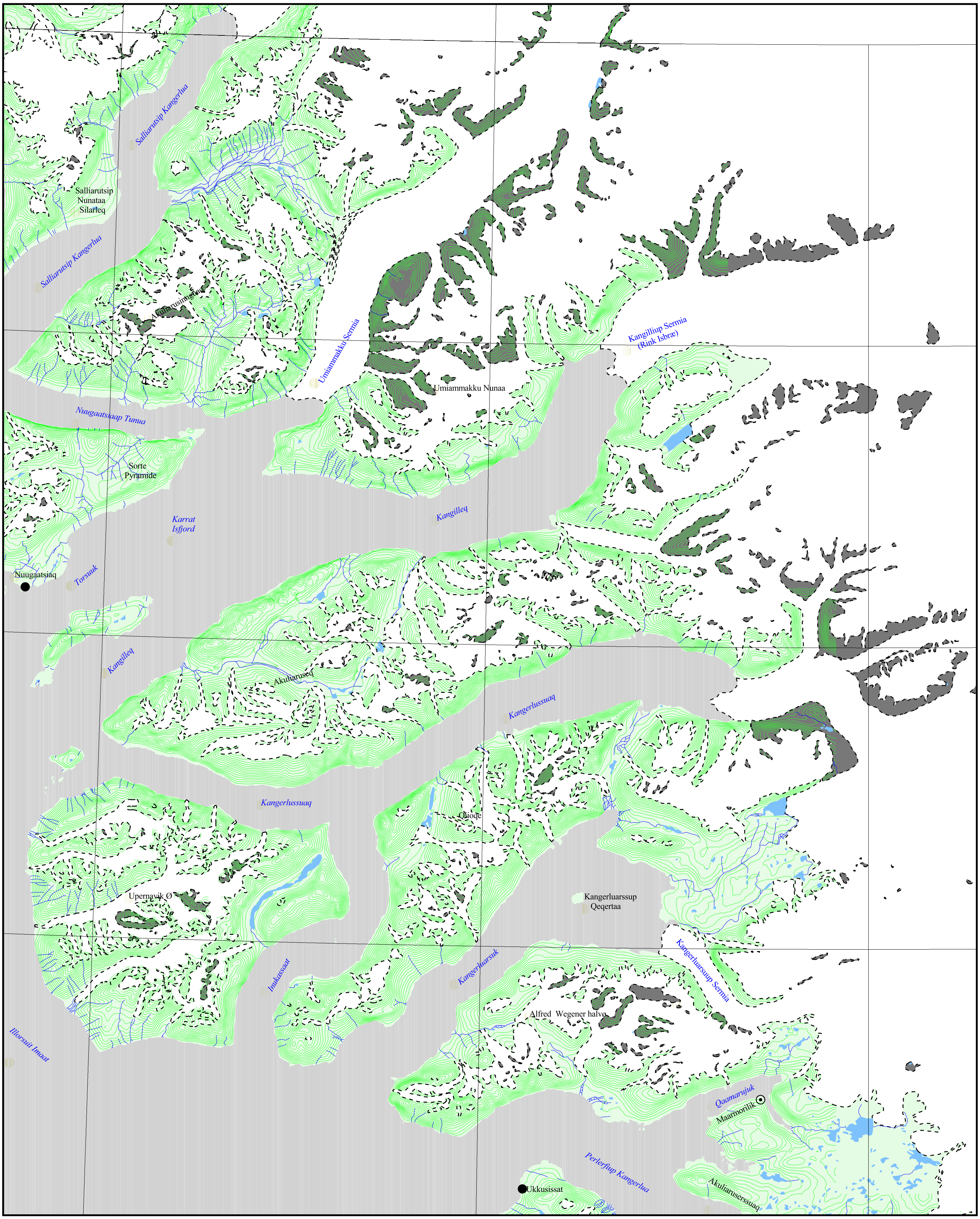
Lumpsucker



Map nr. 9

Distribution of spawning and fishing areas

Lumpsucker



0 10 20 30 40 Kilometers

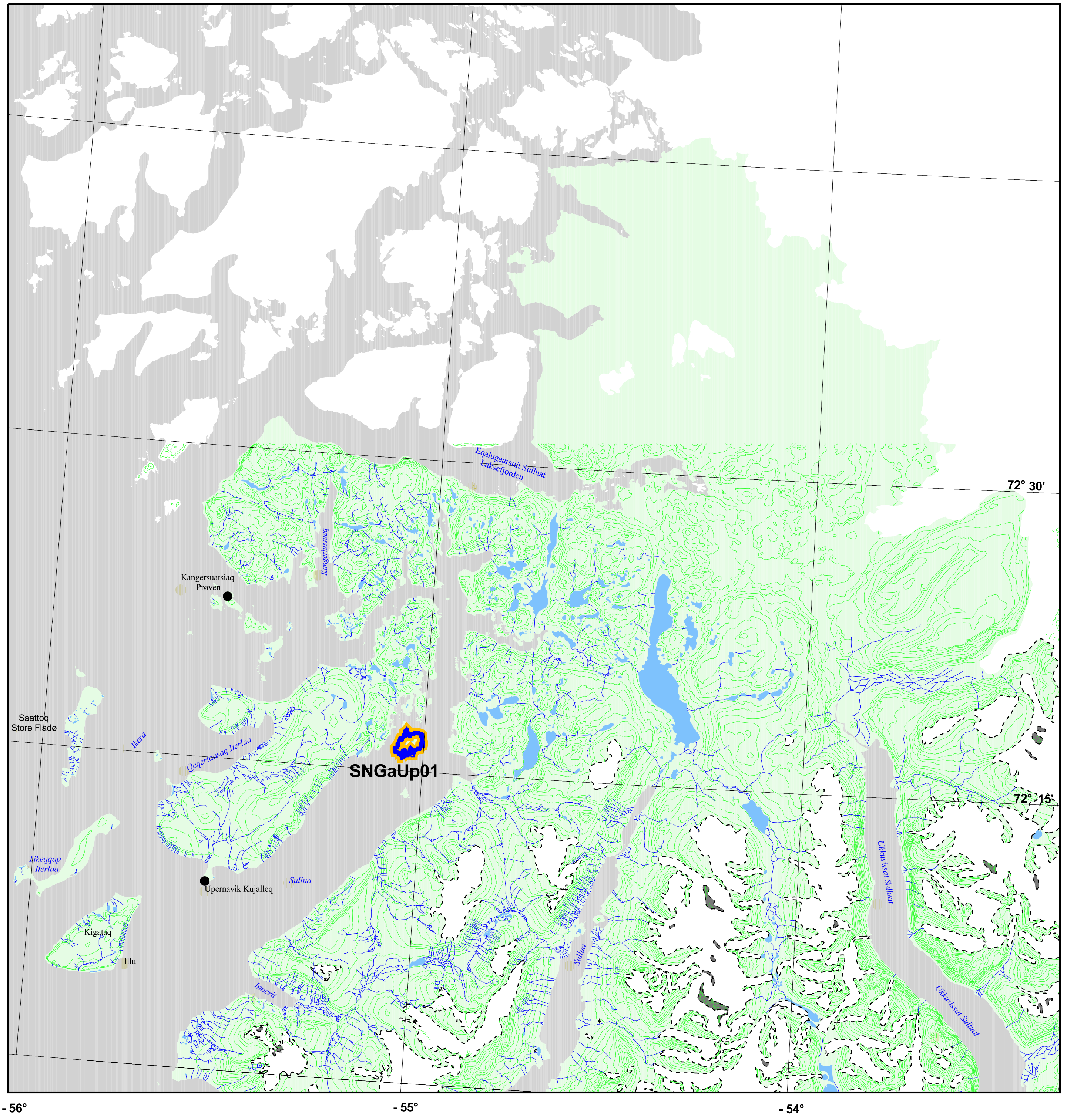
1:500.000

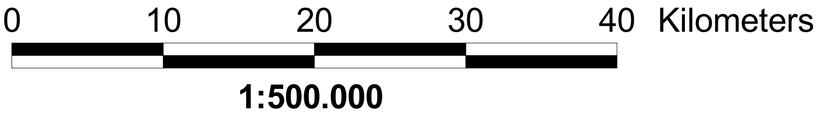
- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area

Map nr. 10

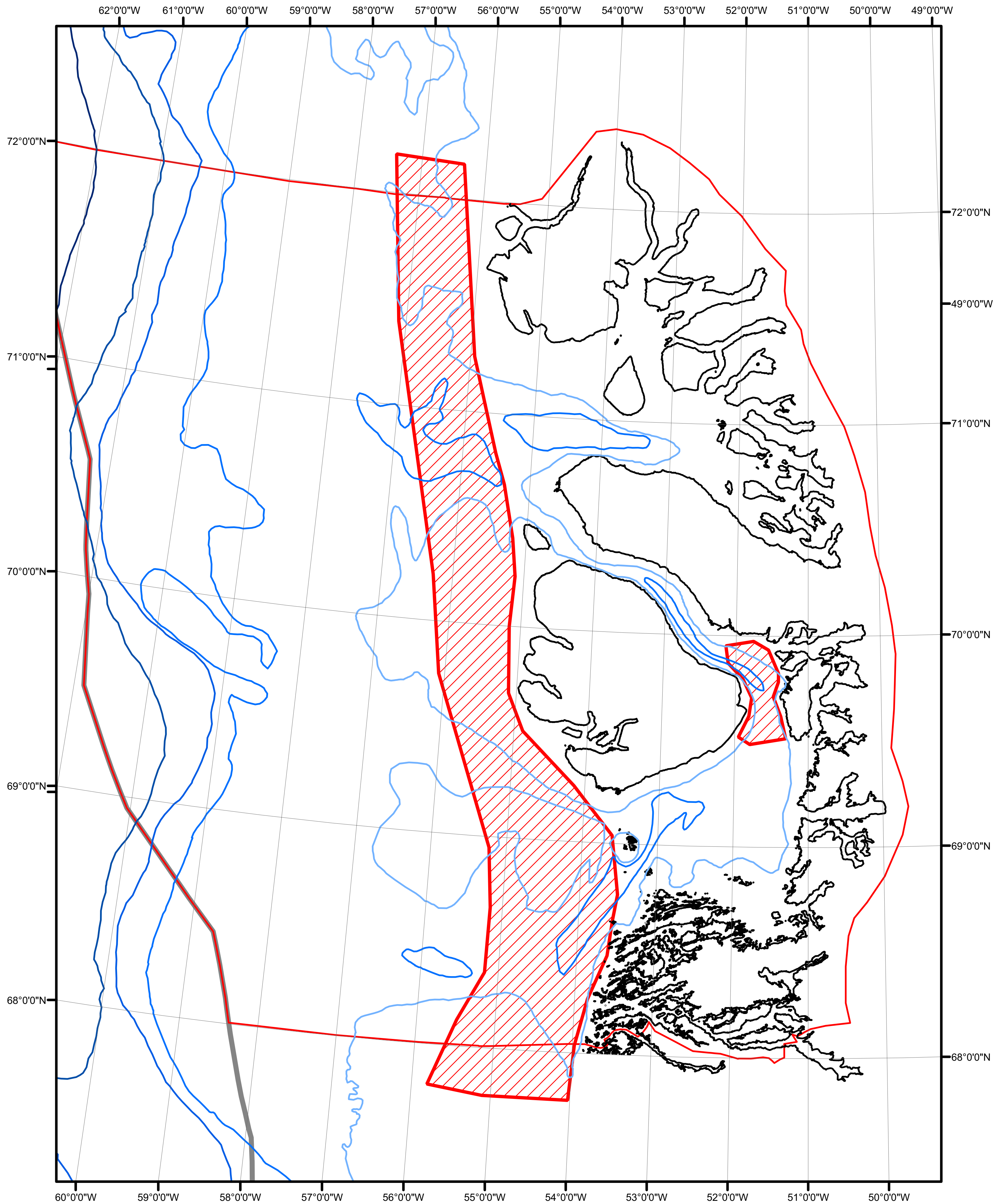
Distribution of spawning and fishing areas

Lumpsucker



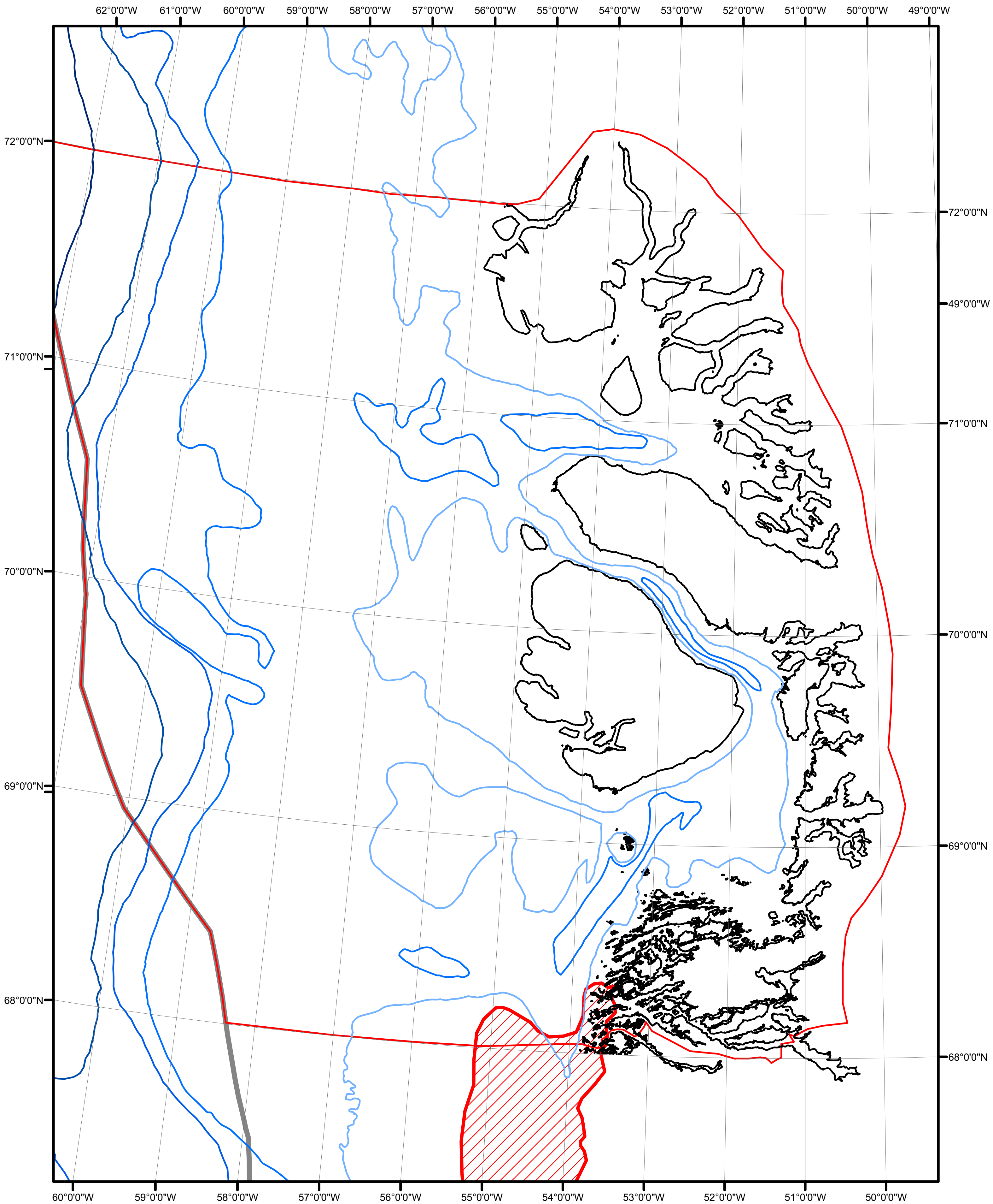


- Fishing site
- Important fishing site
- Fishing area
- Important fishing area
- Spawning area



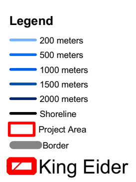
Seabird - spring

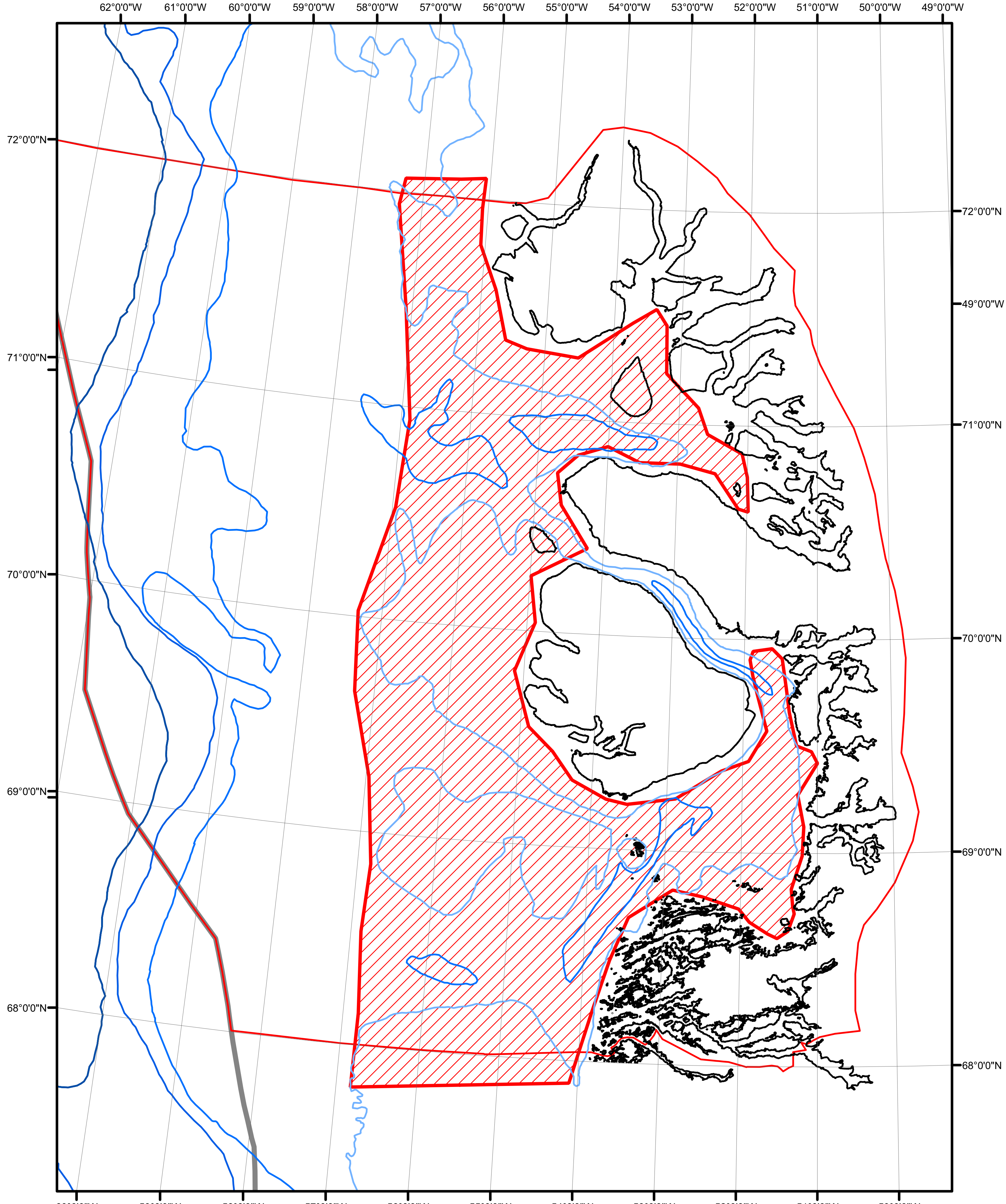
Seabirds off-shore distribution in spring.
In March to May seabirds will assemble in the open water area (along ice edges, in leads and cracks), which progressively moves towards north during spring.
It is mainly Brünnich's guillemots and eiders (both common and king), and gulls.
In autumn the distribution of these species (except king eider) is difficult to map as concentrations may occur anywhere on the banks or on the shelf breaks.



King Eider

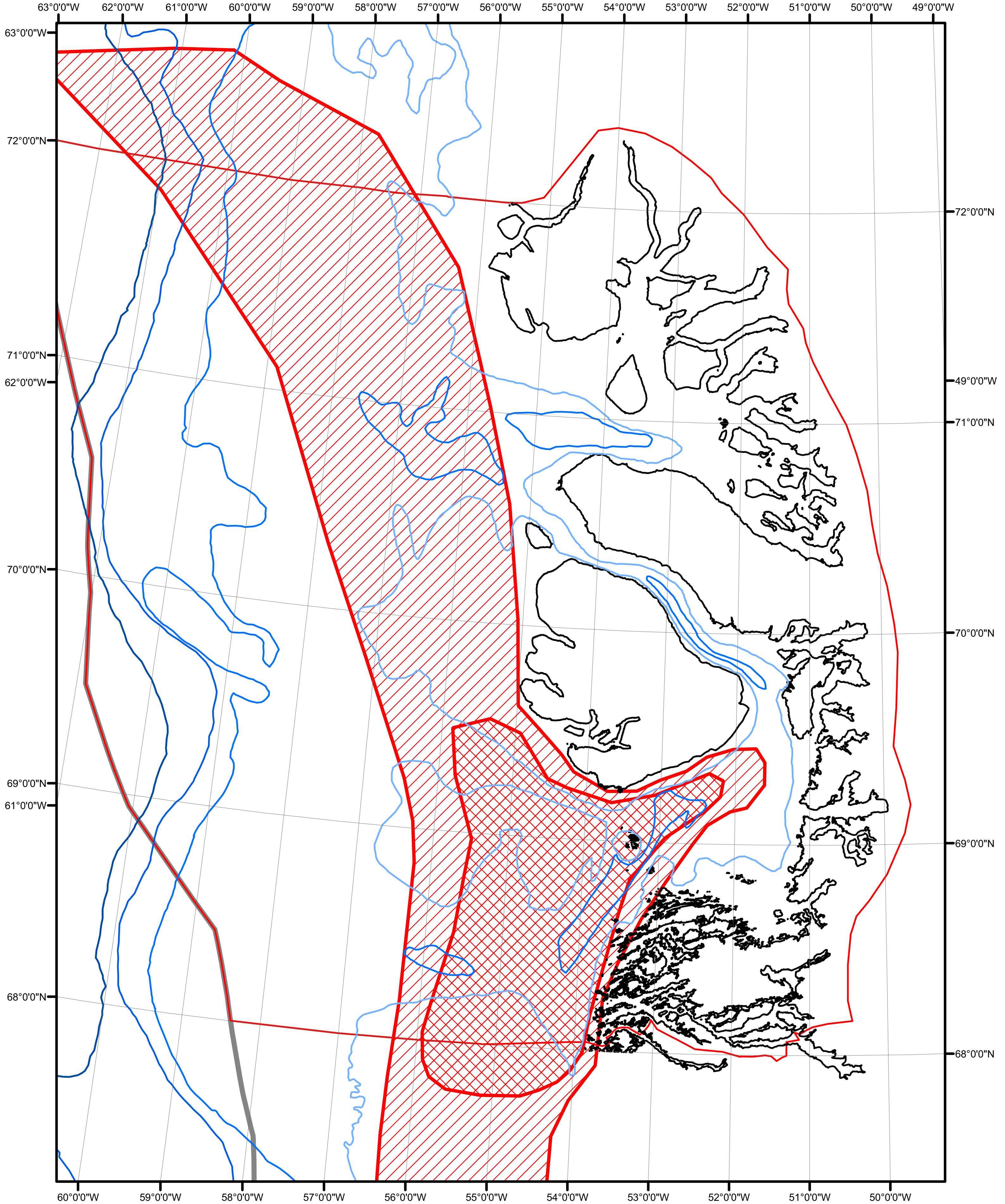
Important off-shore winter areas shown.
Season: October to May.





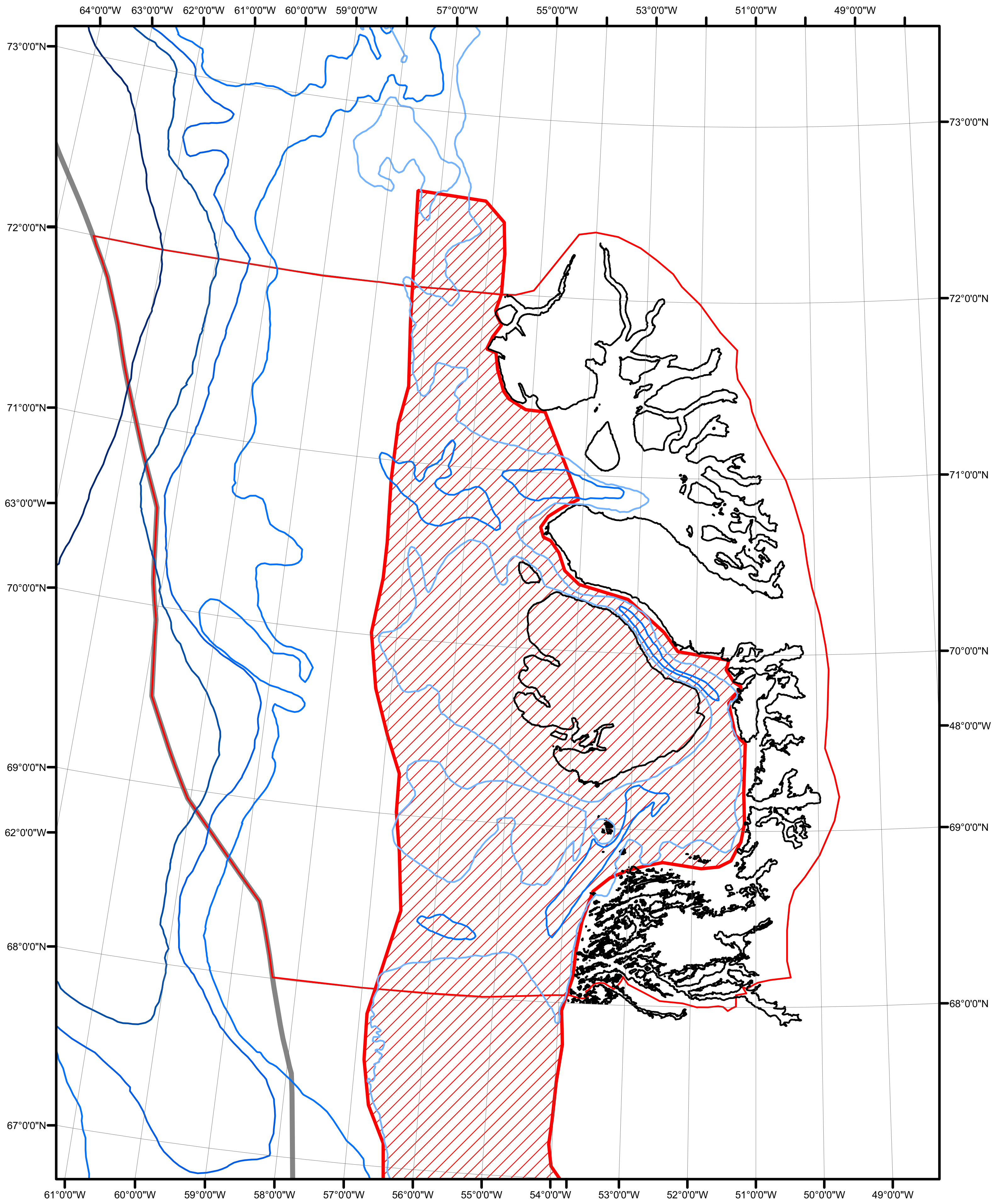
Large Baleen Whales

Off shore distribution: Minke, Fin and Humpback whales occur June to October.
Humpbacks venture rarely further north than Disko Bay (69º N).
It is not possible to give any information on specific concentrations areas or number of the whales occurring in the area.



Bowhead Whale

Main occurrence is within the shown area.
Bowheads are most frequent within the darker area.
Season: Dec. to May.

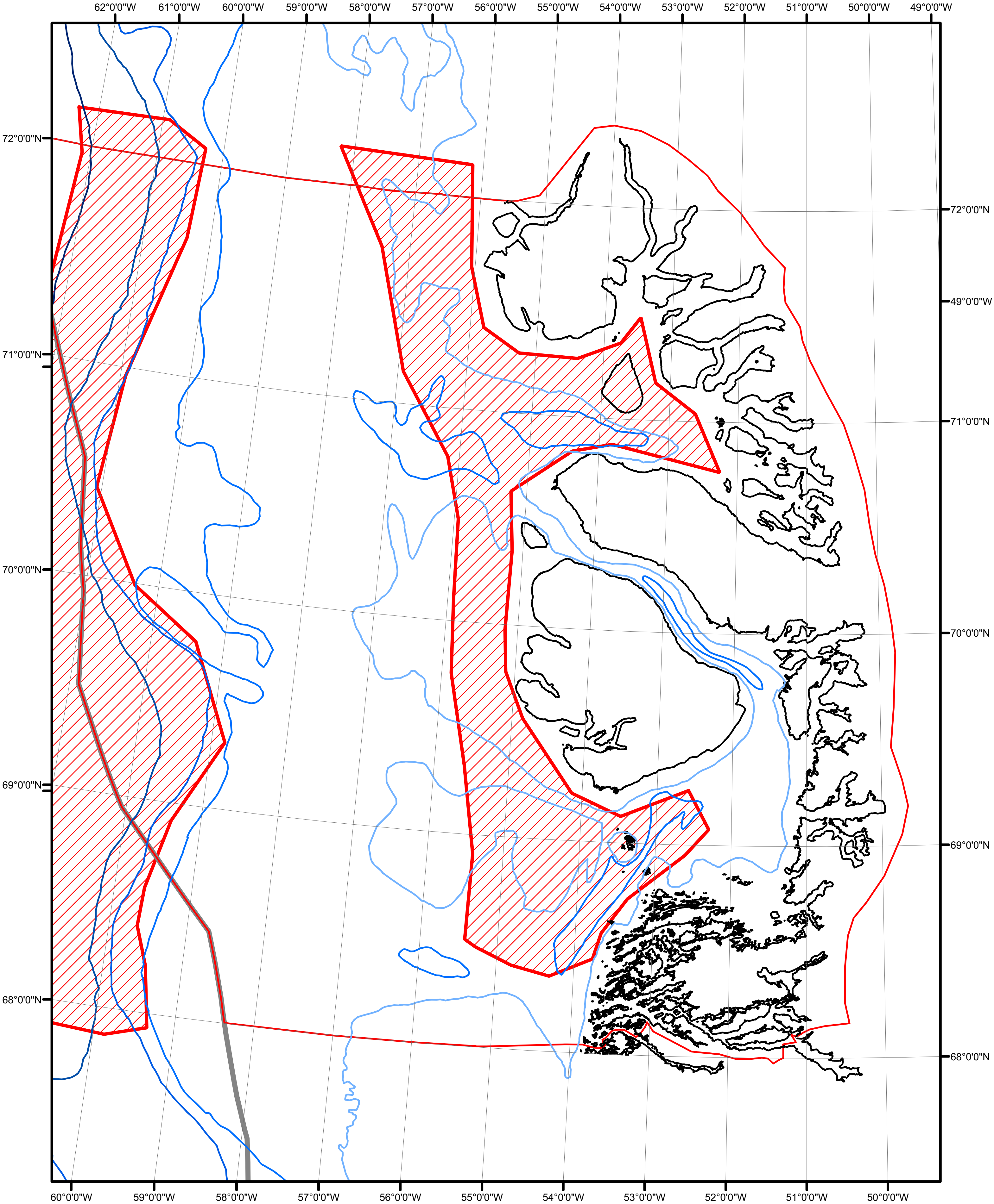


White whale

White whale (Beluga).
Main occurrence is within the depicted area.
Season October to May.

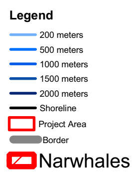
Legend

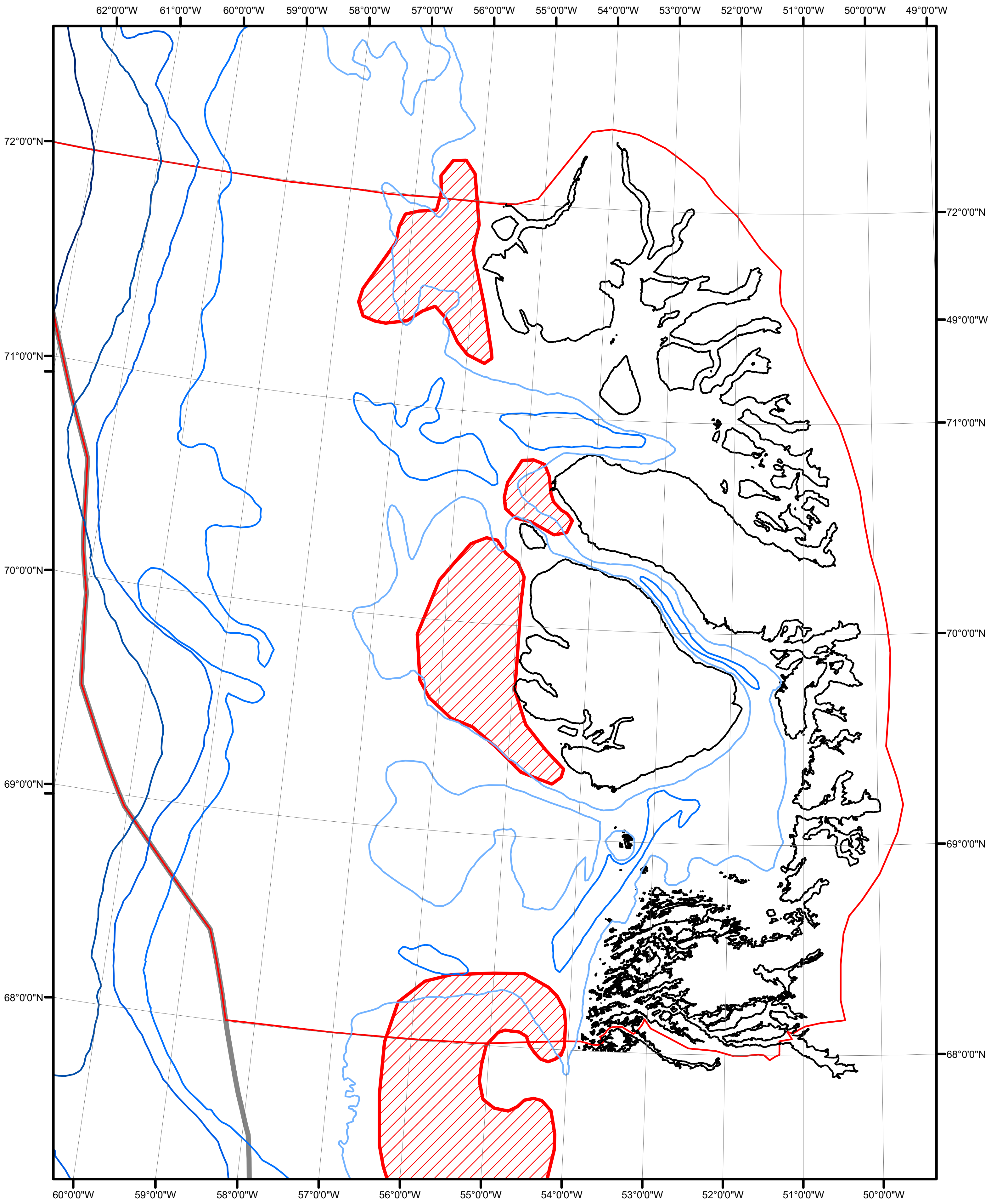
- 200 meters
- 500 meters
- 1000 meters
- 1500 meters
- 2000 meters
- Shoreline
- Project Area
- Border
- White Whales



Narwhales

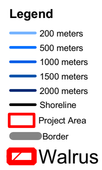
Main occurrence is within the shown areas.
Season: October to May.
Particularly important areas are Davis Strait at depth between 500 m and 1500 m.
The habitat is the dymanic drift ice, where cracks and leads are frequent.
Narwhals avoid the fast-ice areas.

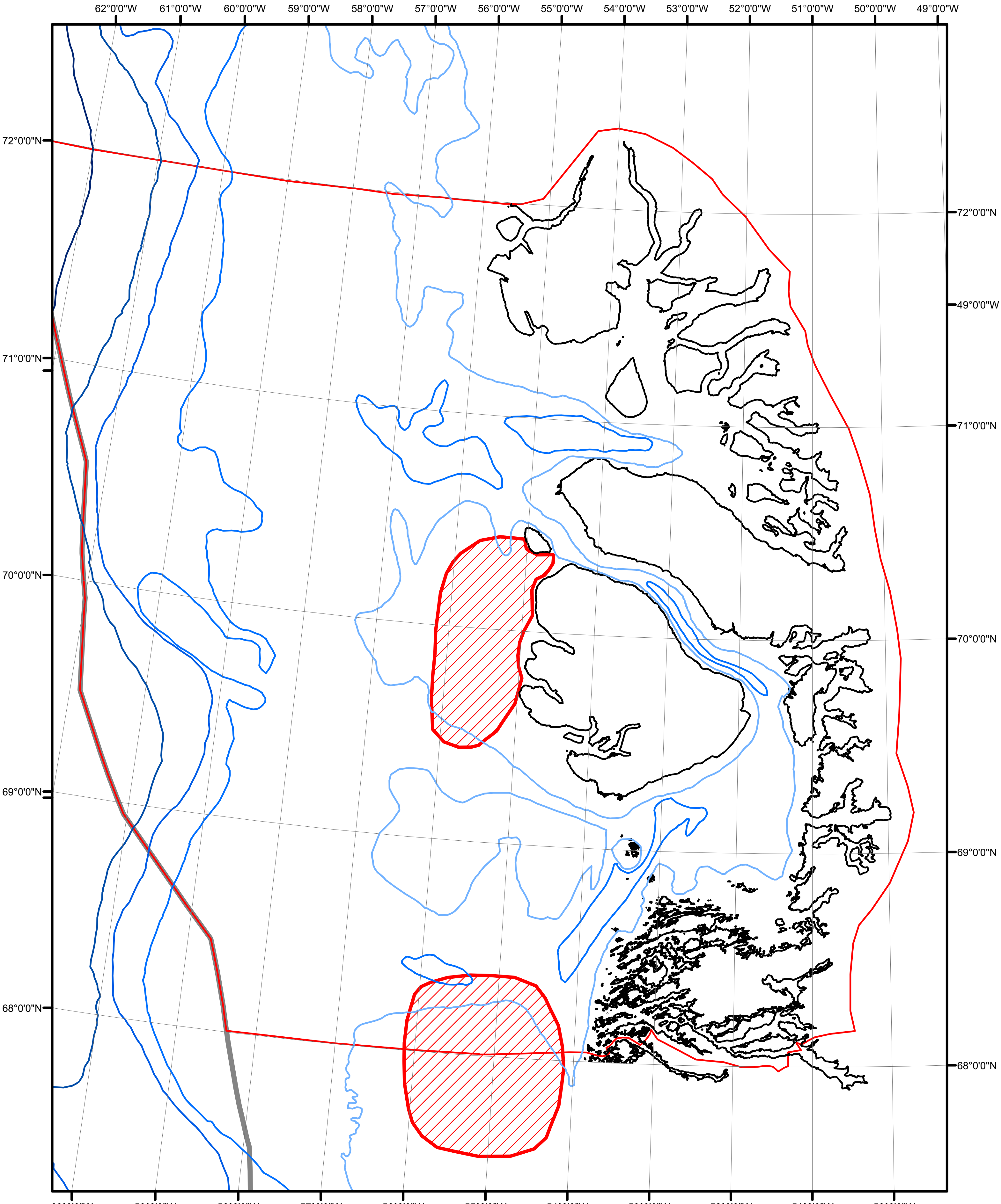




Walrus

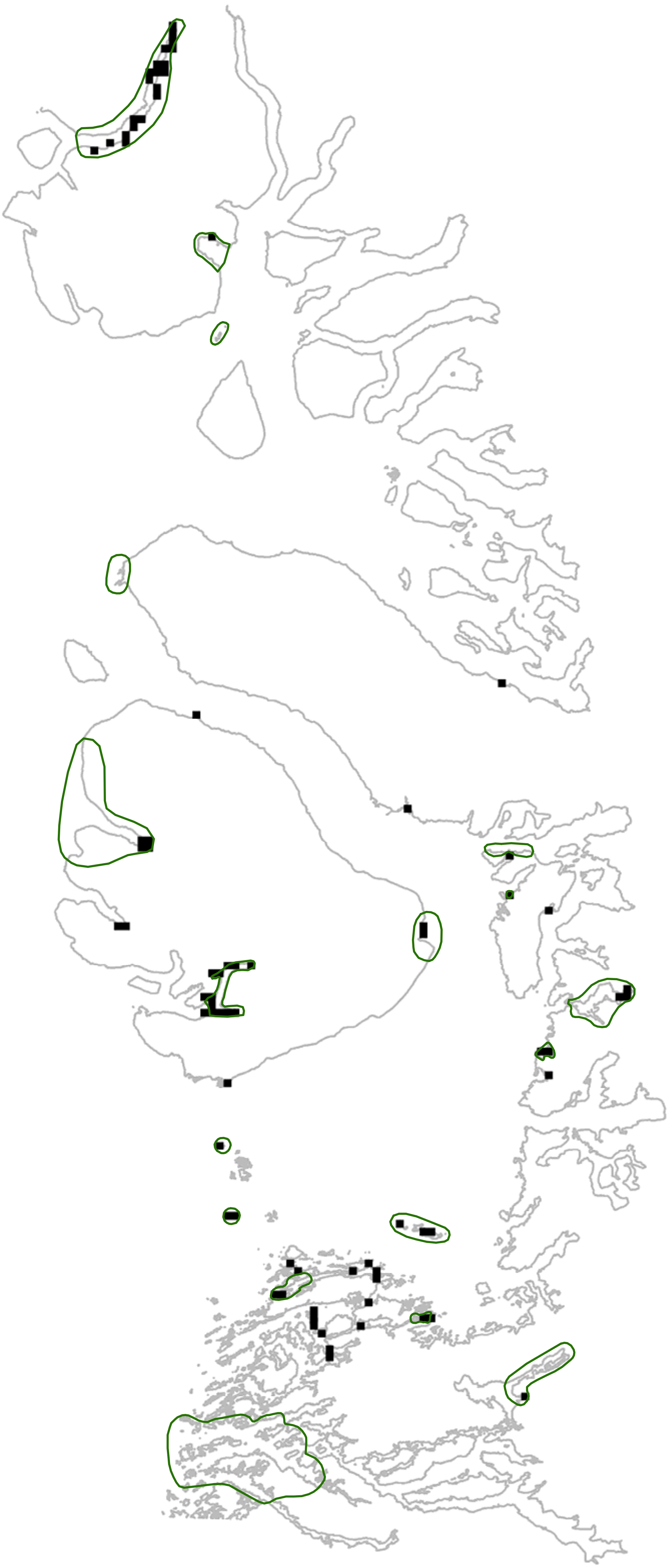
Important winter areas shown.
Season: February to May.





Bearded Seals

Important winter areas shown.
Season: November to May.



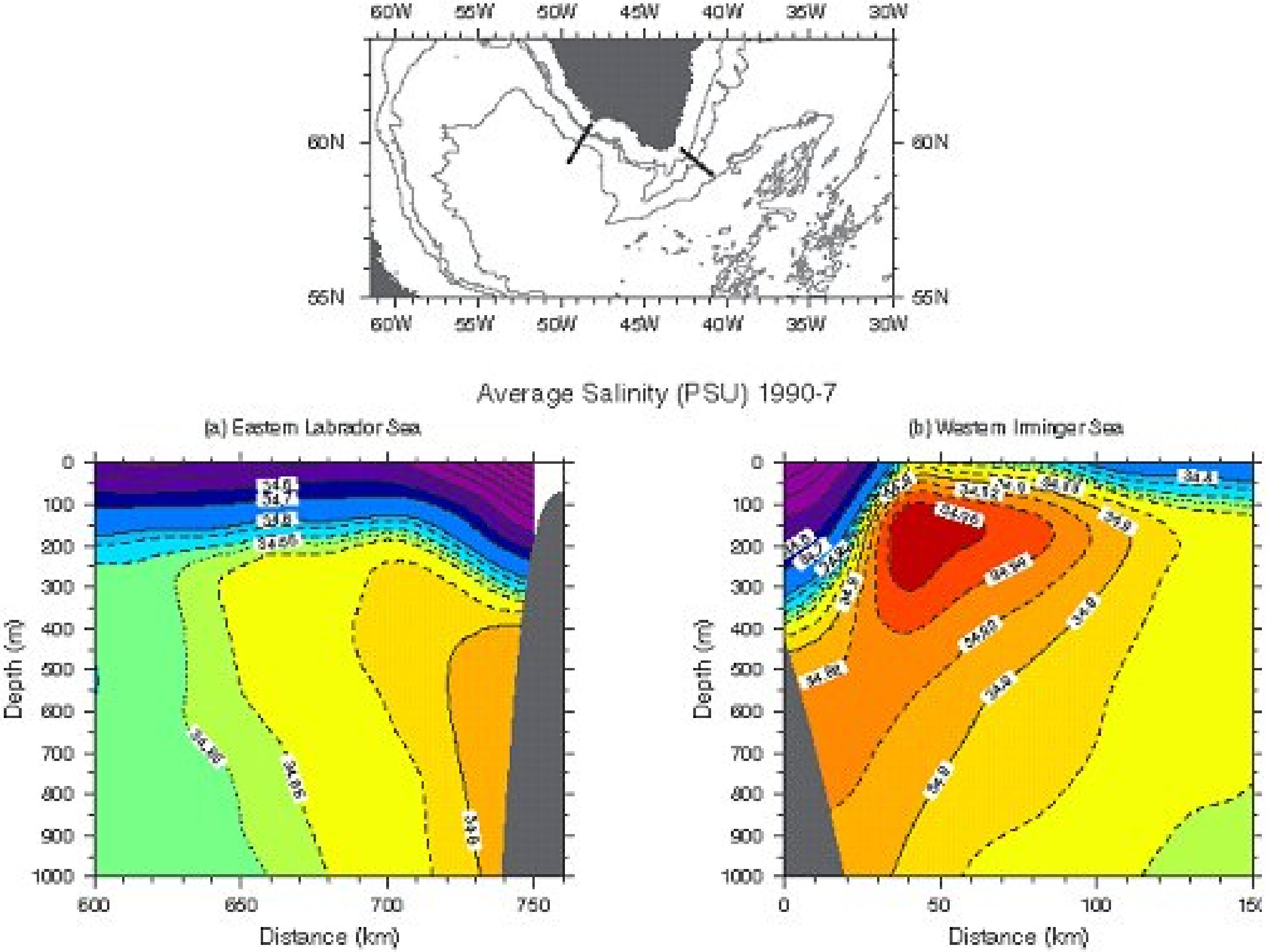
Selected Area

Classification

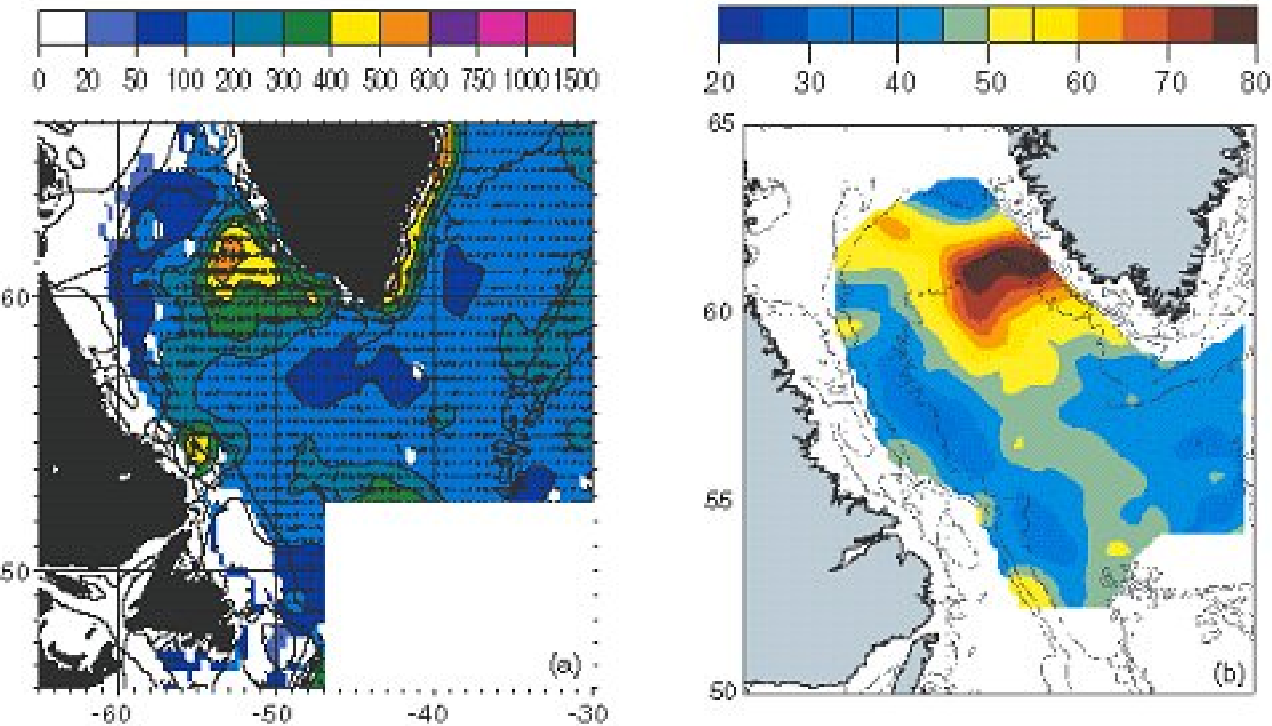
0 - 100 = 0
> 100 = 1

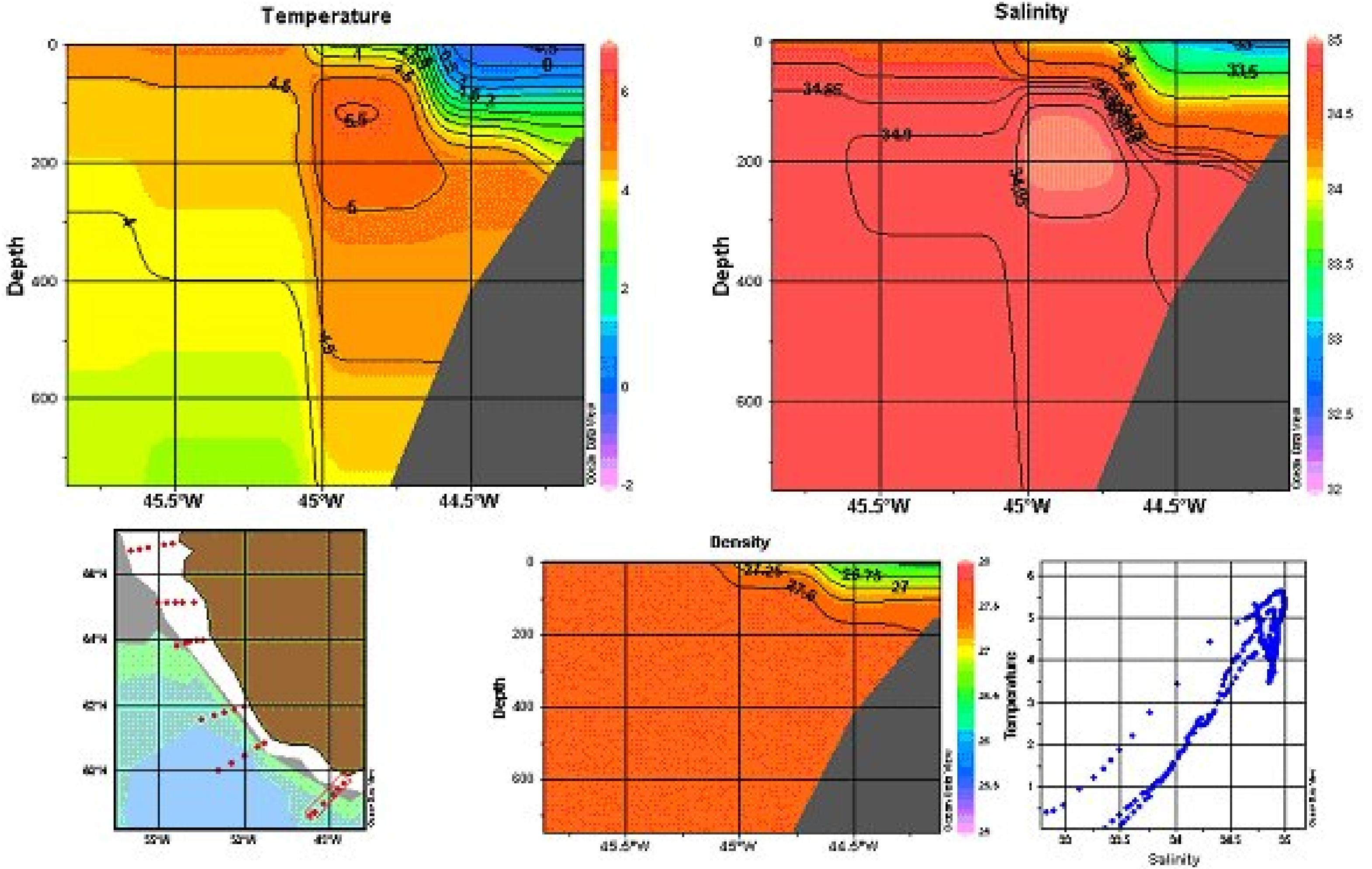
[Tourism + Bird colonies + Birds moulting + (Winter seabirds / 10) + Fish + Shellfish + Archaeology] x ORI

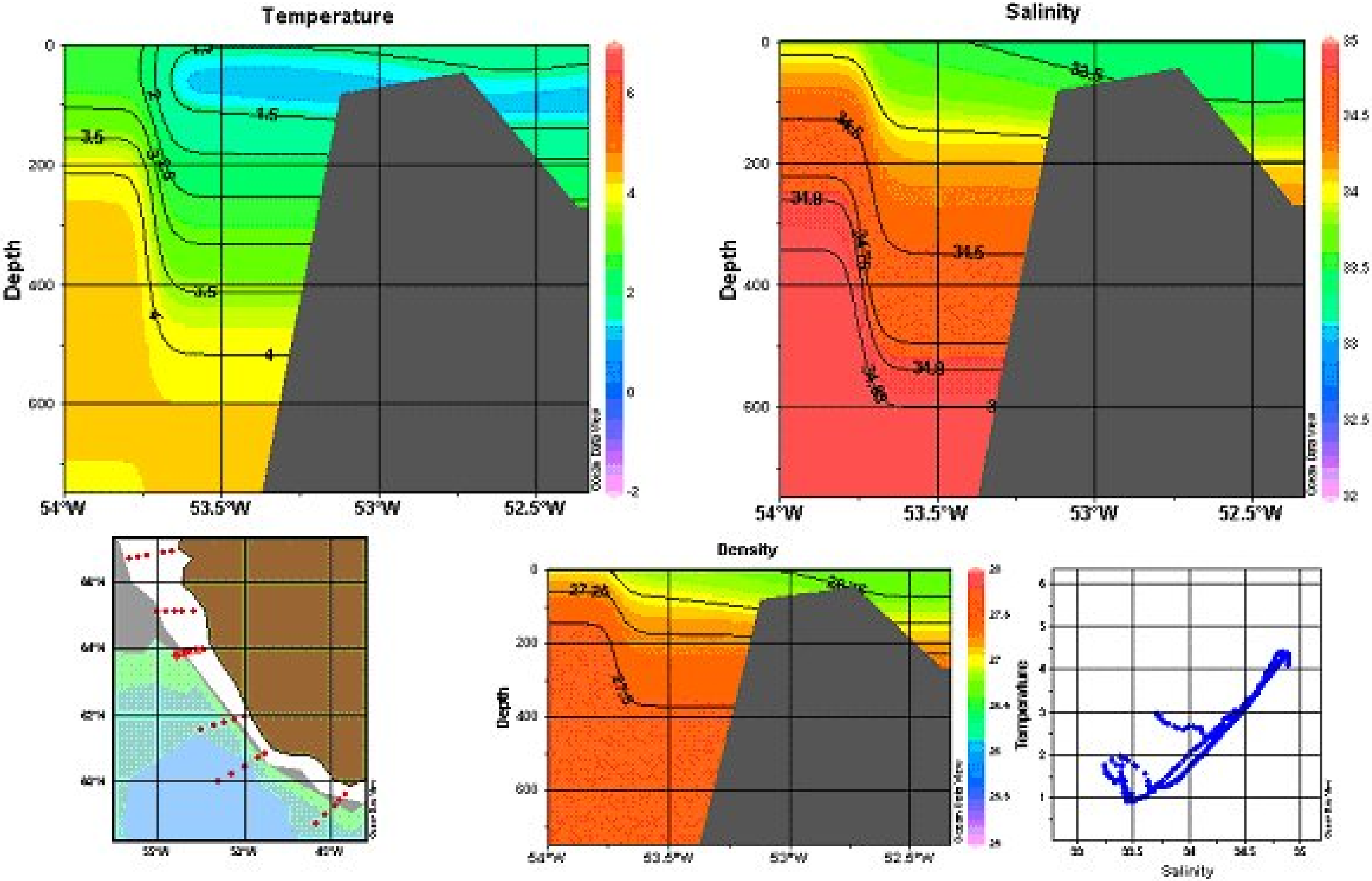

Selected Area
Classification
0 - 75 = 0
> 75 = 1
[Tourism + Birds moulting + (Winter seabirds / 10) + Fish + Shellfish] x ORI



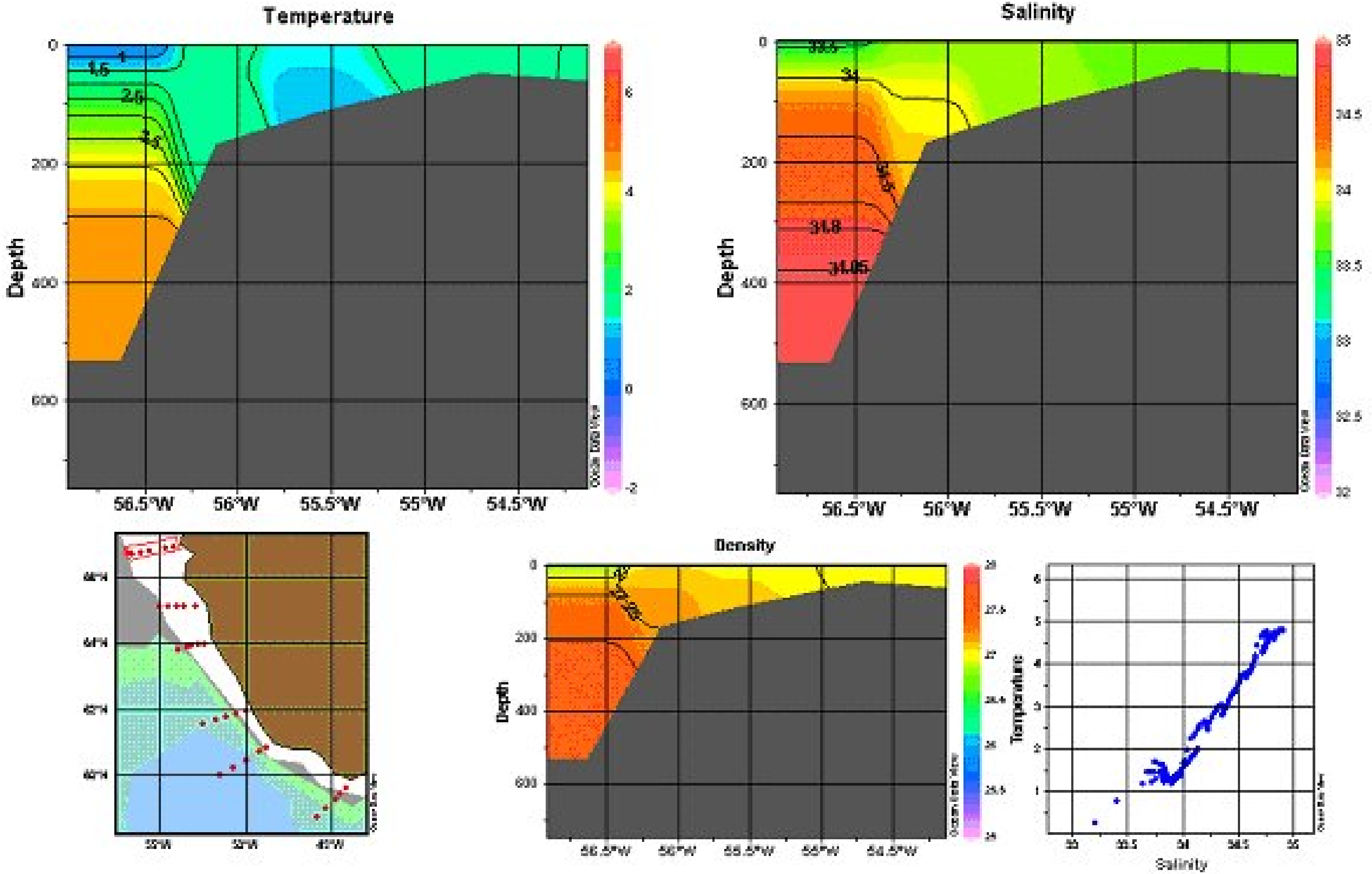
60W
55W
50W
45W
40W
35W
30W
60N
55N
Average Salinity (PSU) 1990-7
(a) Eastern Labrador Sea
(b) Western Irminger Sea
Depth (m)
Distance (km)
0
100
200
300
400
500
600
700
800
900
1000
600
650
700
750
50
150
34.7
34.8
34.9


0
20
50
100
200
300
400
500
600
750
1000
1500
60
50
-60
-50
-40
-30
(a)
20
30
40
50
60
70
80
65
60
55
50
(b)

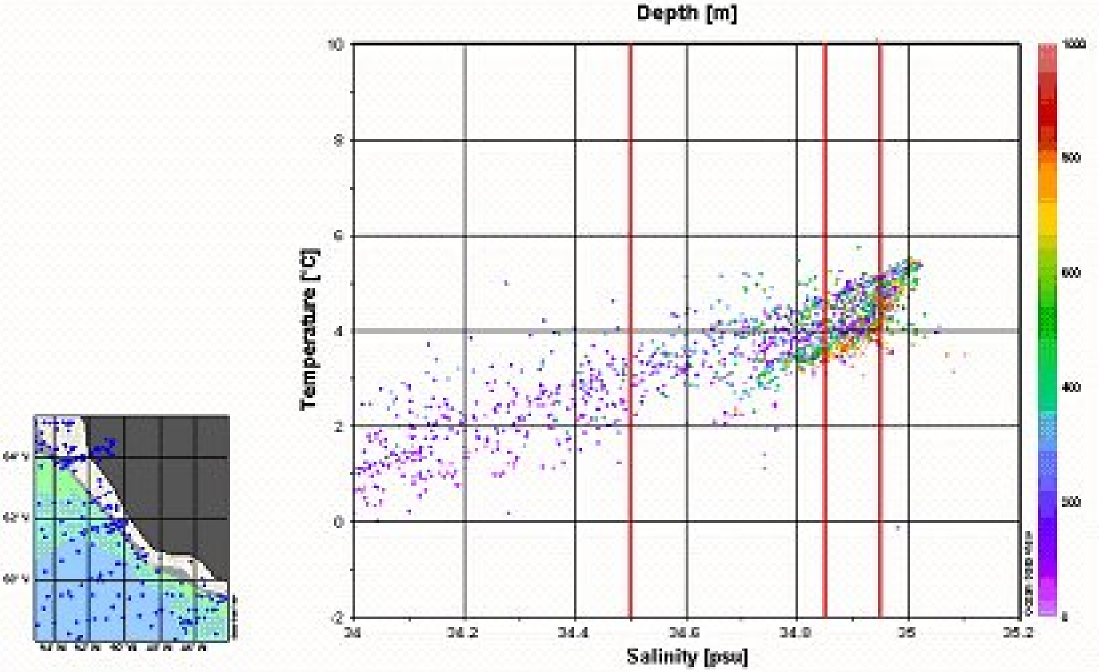

Temperature
Salinity
Density
Depth
45.5°W
45°W
44.5°W
Temperature
Salinity

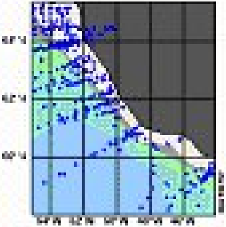


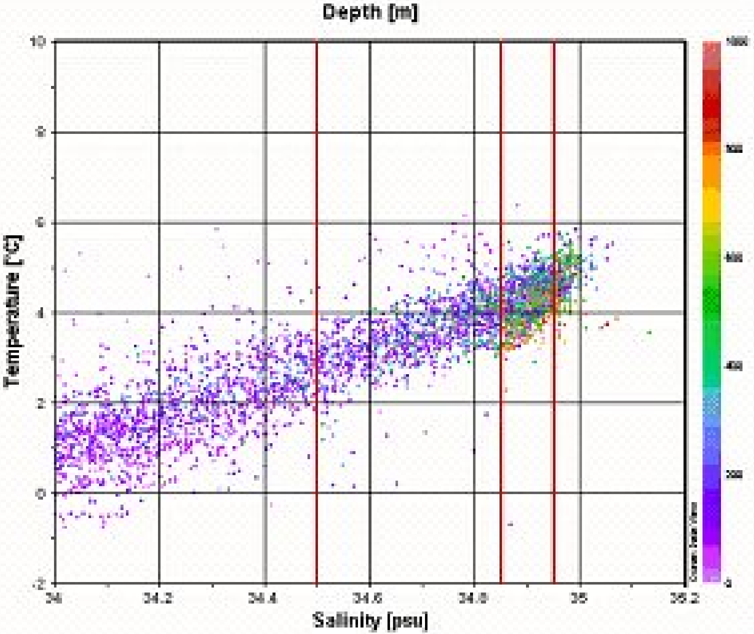
Temperature
Salinity
Density
Depth
Temperature
Salinity
54°W
53.5°W
53°W
52.5°W

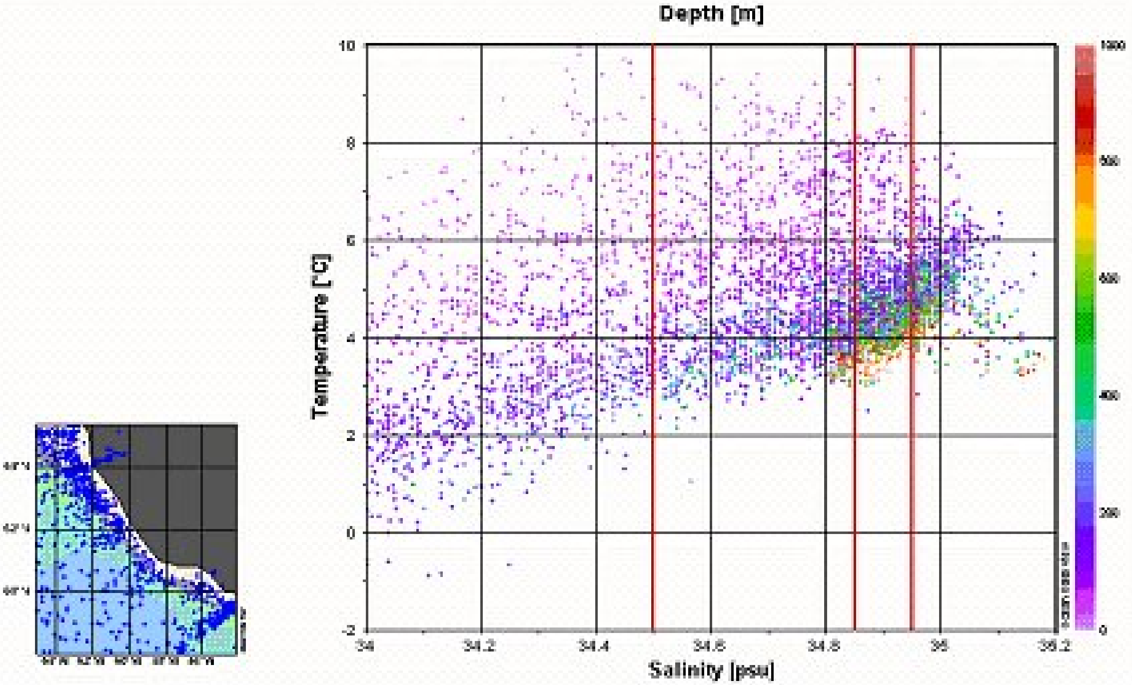


Temperature
Salinity
Density
Depth
0
200
400
600
56.5°W
56°W
55.5°W
55°W
54.5°W
1
1.5
2.5
34
34.5
34.8
Temperature
Salinity


Depth [m]
Temperature [°C]
Salinity [psu]
10
8
6
4
2
0
-2
34
34.2
34.4
34.6
34.8
35
35.2
1000
800
600
400
200
0




Depth [m]
Temperature [°C]
Salinity [psu]
10
8
6
4
2
0
-2
34
34.2
34.4
34.6
34.8
35
35.2


Depth [m]
Temperature [°C]
Salinity [psu]
10
8
6
4
2
0
-2
34
34.2
34.4
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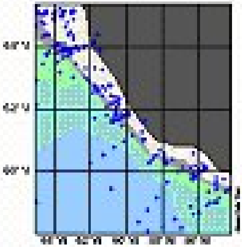
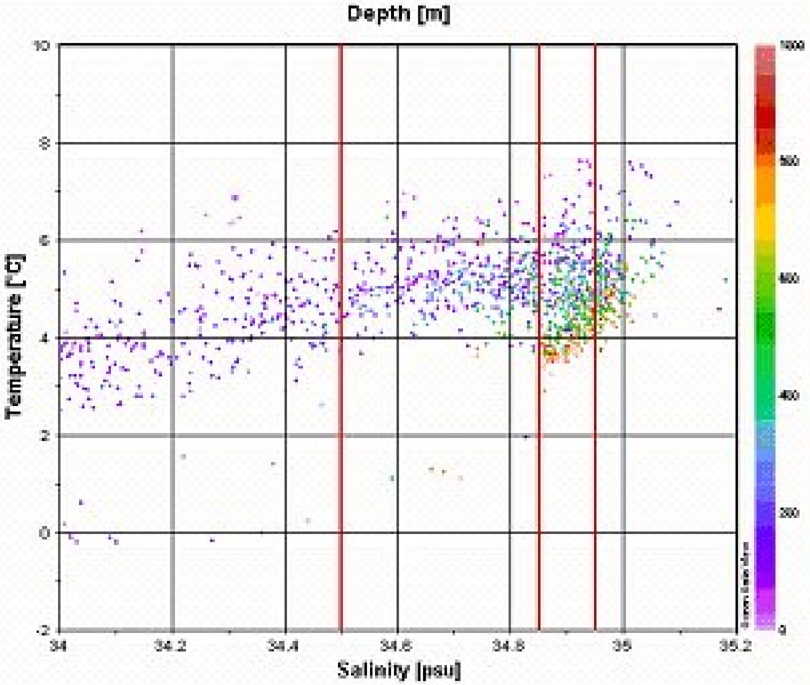
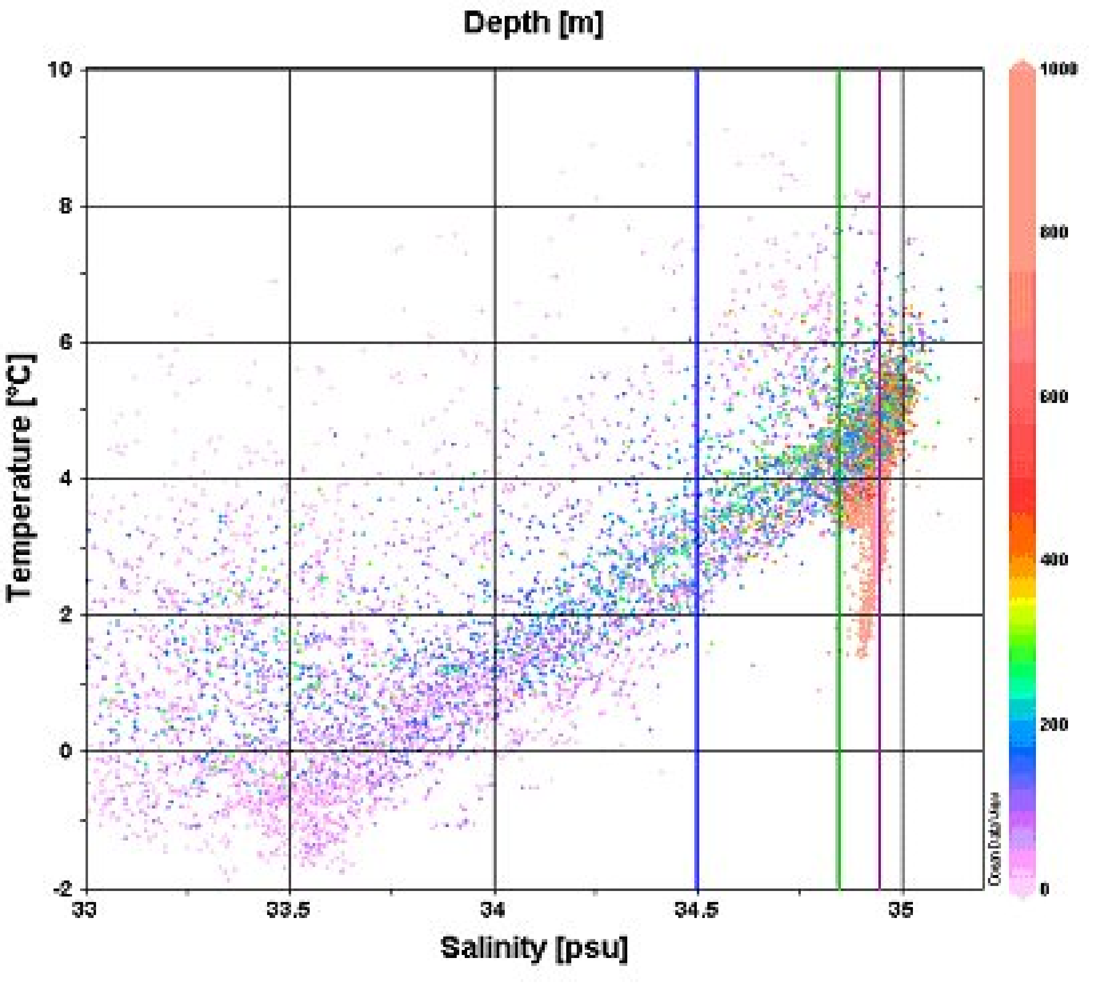
800
600
400
200
0

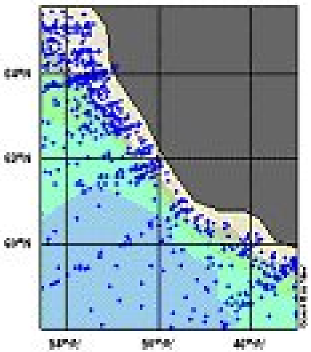


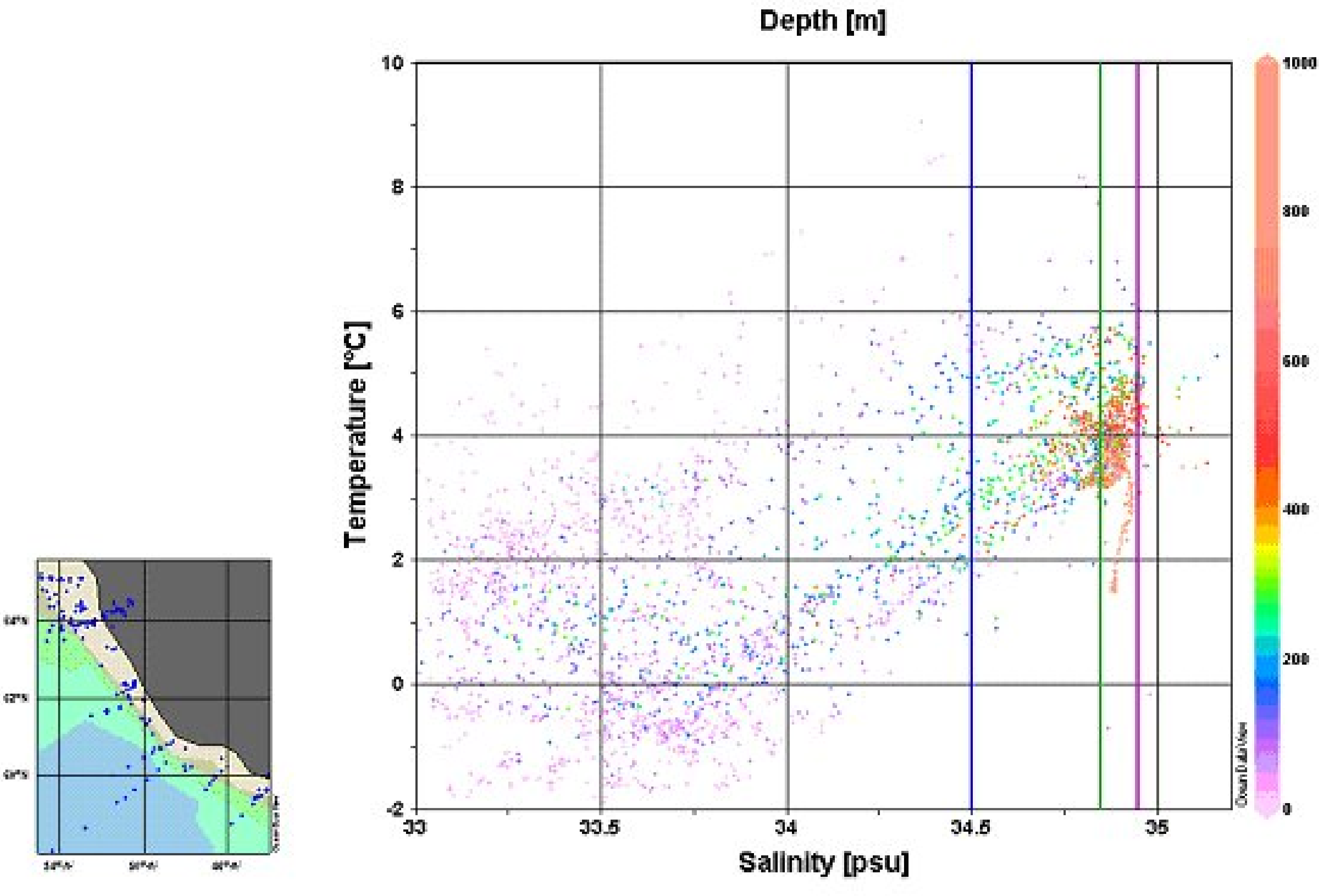


Depth [m]
Temperature [°C]
Salinity [psu]
10
8
6
4
2
0
-2
34
34.2
34.4
34.6
34.8
35
35.2
1000
800
600
400
200
0

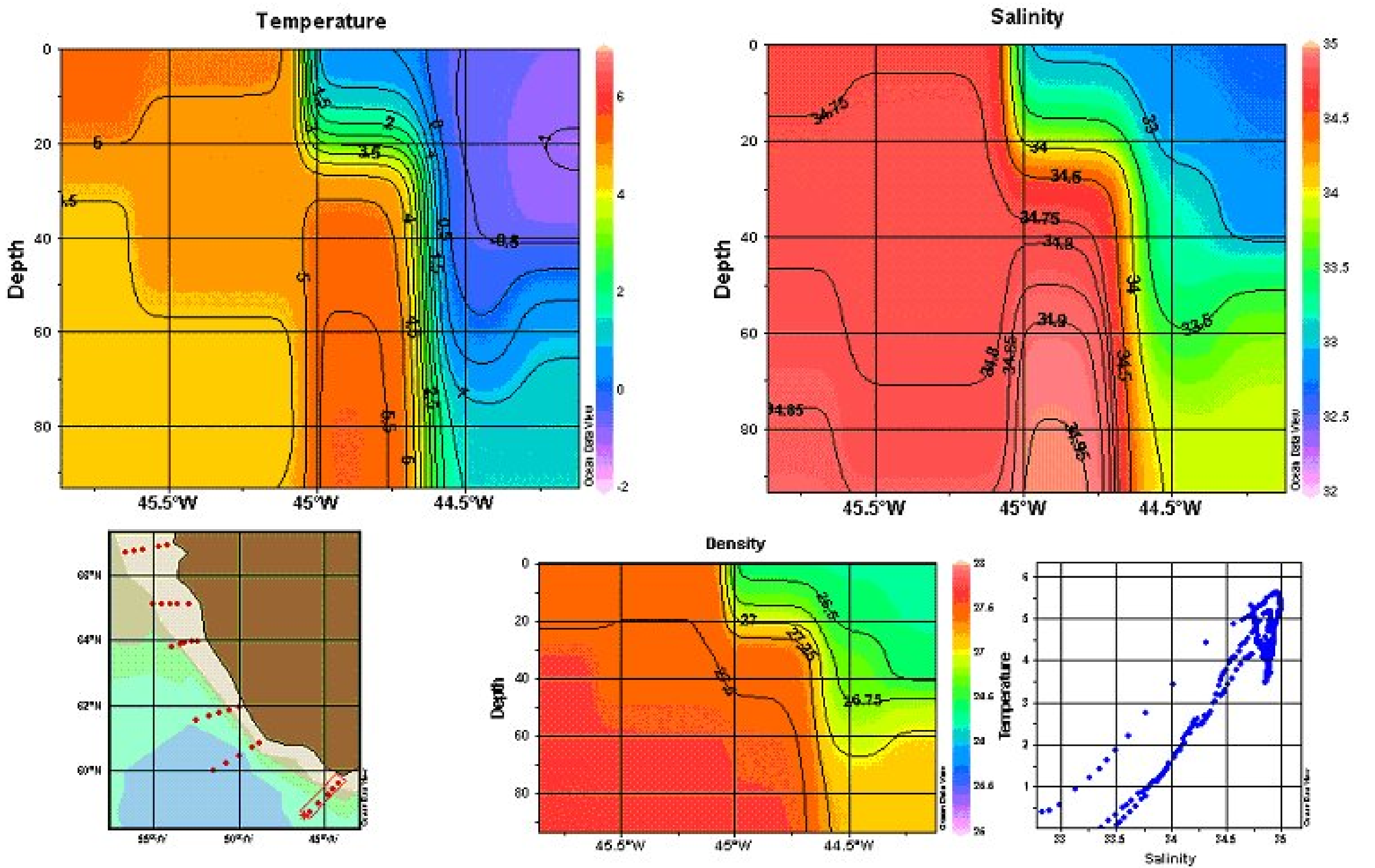


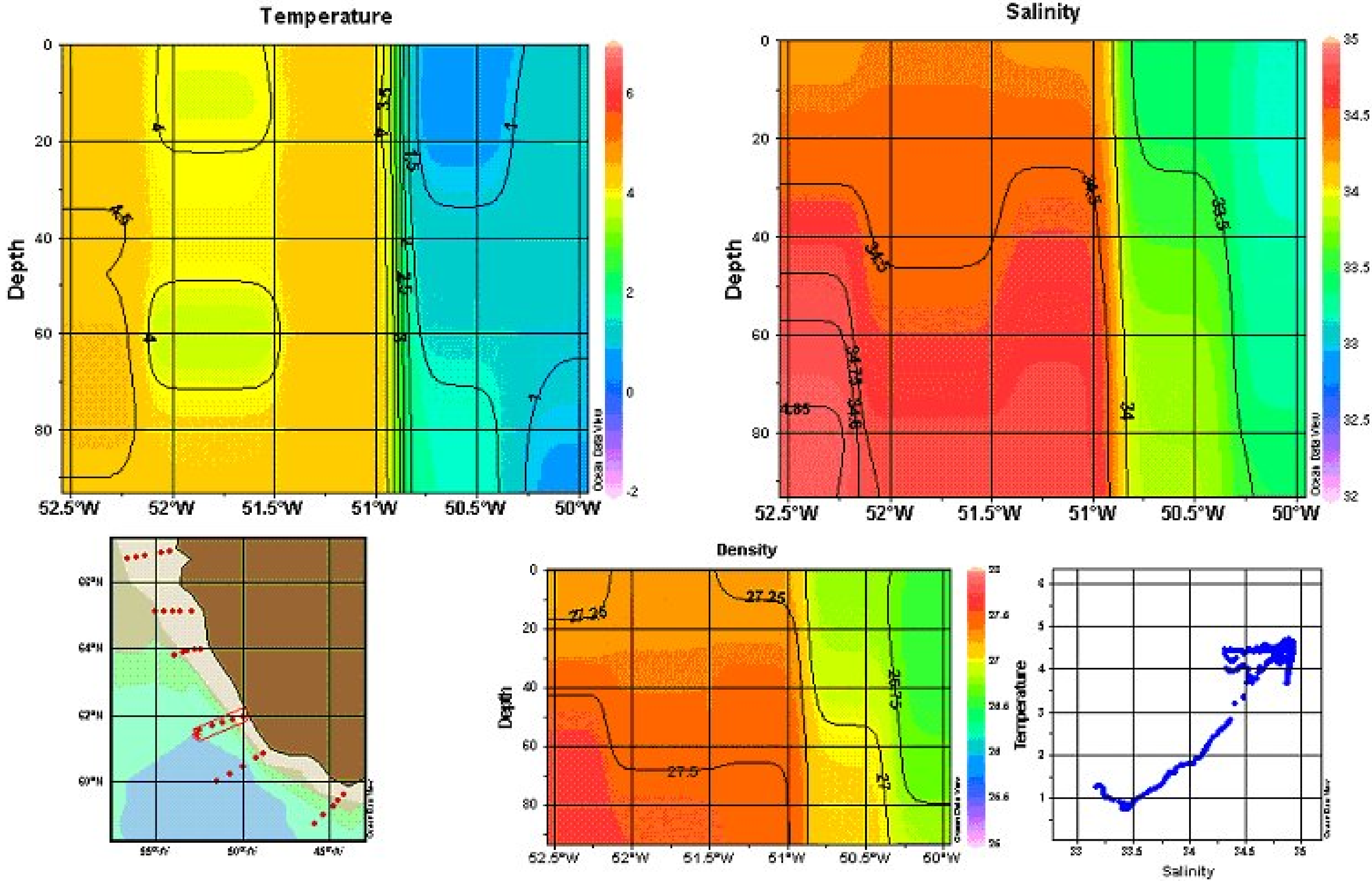
Depth [m]
10
8
6
4
2
0
-2
Temperature [°C]
33
33.5
34
34.5
35
Salinity [psu]
1000
800
600
400
200
0
Ocean Data View

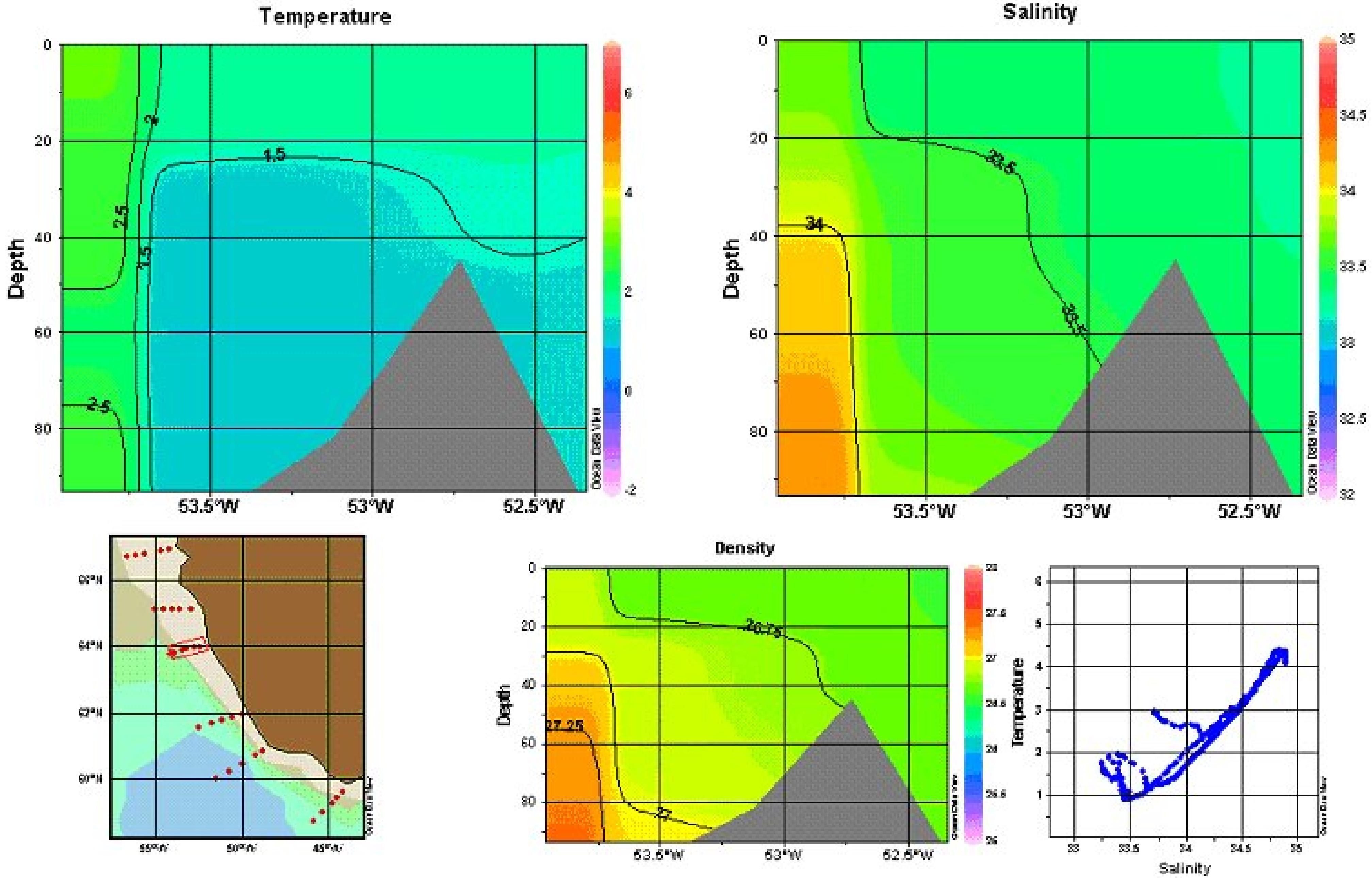


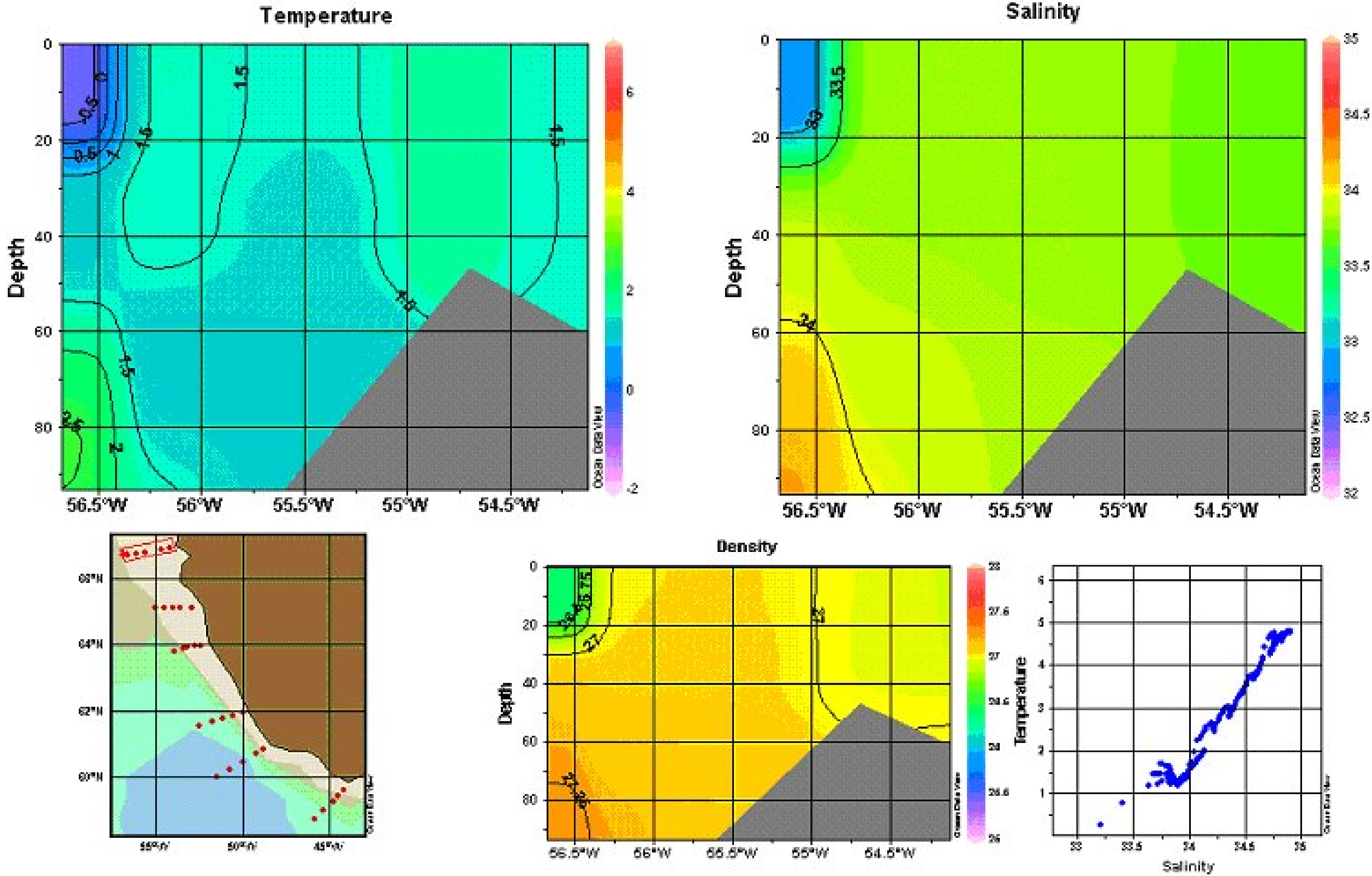


Depth [m]
Temperature [°C]
Salinity [psu]
10
8
6
4
2
0
-2
33
33.5
34
34.5
35
1000
800
600
400
200
0
Ocean Data View

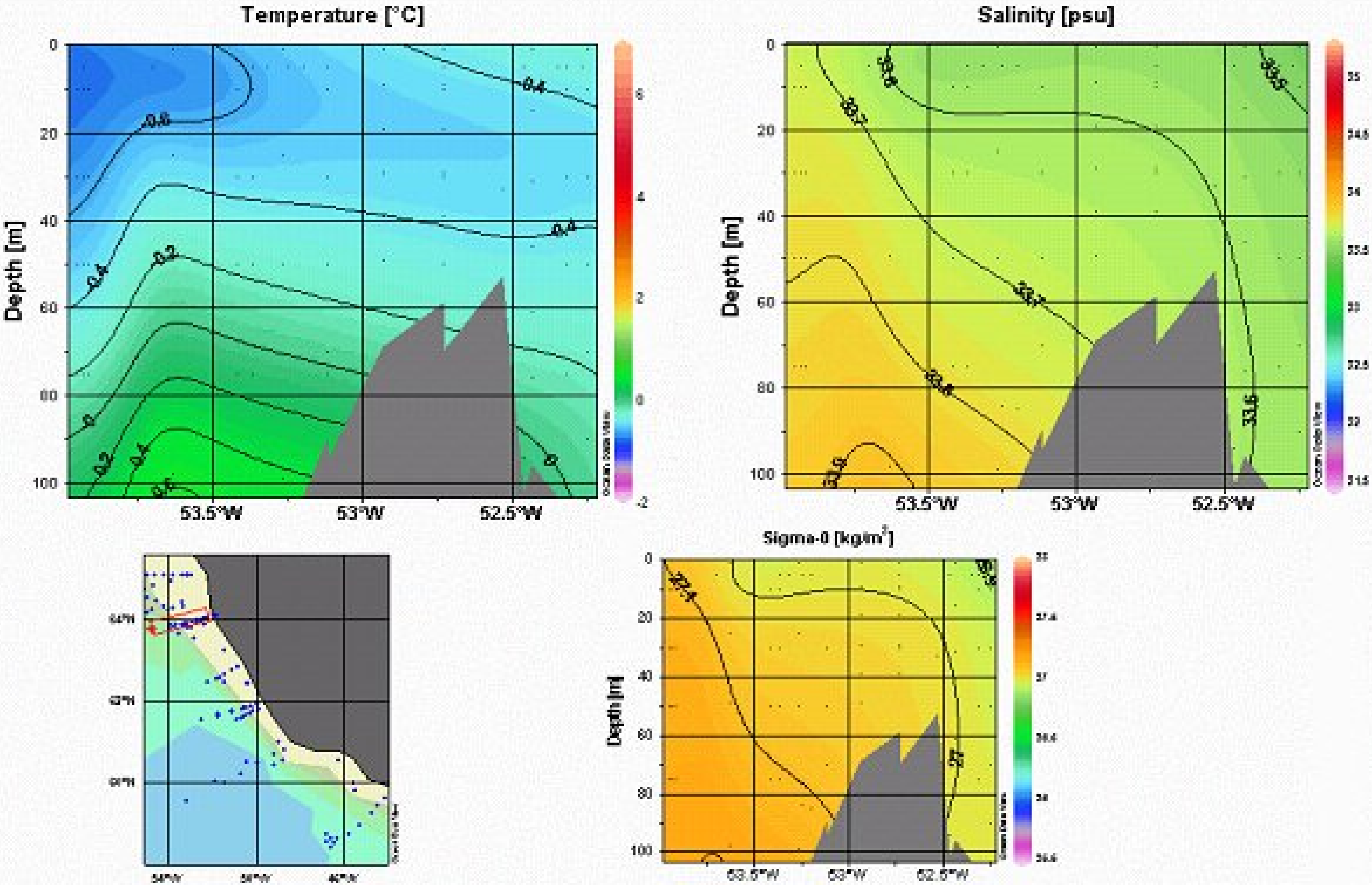

Temperature
Depth
45.5°W
45°W
44.5°W
Salinity
Depth
45.5°W
45°W
44.5°W
Density
Depth
45.5°W
45°W
44.5°W
Temperature
Salinity
Ocean Data View


Temperature
Salinity
Density
Depth
52.5°W
52°W
51.5°W
51°W
50.5°W
50°W
Salinity
Temperature
Ocean Data View

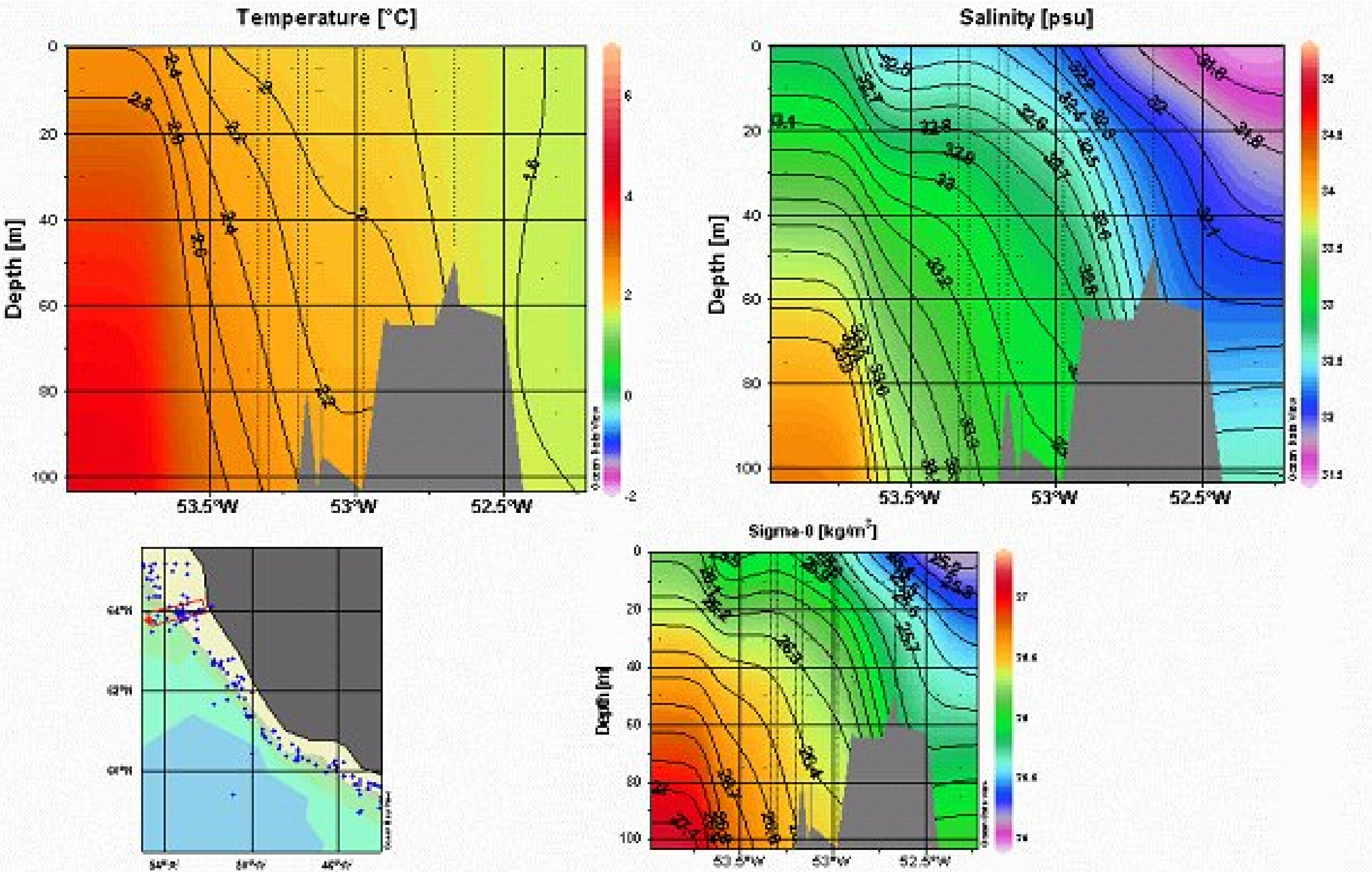

Temperature
Depth
53.5°W
53°W
52.5°W
Salinity
Depth
53.5°W
53°W
52.5°W
Density
Depth
53.5°W
53°W
52.5°W
Temperature
Salinity



Temperature
Salinity
Density
Depth
56.5°W
56°W
55.5°W
55°W
54.5°W
Temperature
Salinity
Ocean Data View



Temperature [°C]
Depth [m]
0
20
40
60
80
100
53.5°W
53°W
52.5°W
Salinity [psu]
Depth [m]
0
20
40
60
80
100
53.5°W
53°W
52.5°W
Sigma-0 [kg/m3]
Depth [m]
0
20
40
60
80
100
53.5°W
53°W
52.5°W



Temperature [°C]
Depth [m]
53.5°W
53°W
52.5°W
Salinity [psu]
Depth [m]
53.5°W
53°W
52.5°W
Sigma-0 [kg/m³]
Depth [m]
53.5°W
53°W
52.5°W

494 Environmental Oil Spill Sensitivity Atlas for the West Greenland Coastal Zone

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