REPORTING OF IMPULSIVE NOISE SOURCES TO THE ICES NOISE REGISTER

Activities in Greenland EEZ 2014-18

Technical Report from DCE – Danish Centre for Environment and Energy No. 150 2019

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Data sheet

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Abstract:	This report represents Greenland's obligations to OSPAR to report to the ICES impulsive noise register. The report covers the years 2014-2019 for Greenland EEZ.

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Summary

Loud sources of impulsive noise with main energy below 10 kHz are to be reported to the ICES impulsive noise register, as part of Greenland's obligations towards OSPAR. The present report summarizes available information about relevant activities for Greenland in the period 2014-2018. Relevant activities are seismic surveys, underwater explosions, impact pile driving, sonars below 10 kHz and other loud, impulsive sources below 10 kHz.

Only information about seismic surveys were available and the level of details of the reported data was insufficient for submission to the ICES register. Thus, no data has so far been submitted. However, for three commercial seismic surveys it has been possible to provide estimates of the impulse-block-days, which could be attributed to these surveys. One impulse-block-day indicates that a source has been active on a particular day within a particular area. The spatial resolution of reporting is ICES statistical sub-rectangles (20' longitude x 10' latitude).

The extent of underreporting of other activities is discussed, including possible implications for future assessments of impact from underwater noise in OSPAR area I (Arctic Sea).

1. Introduction

This report presents the data available from Greenland for reporting to the ICES impulsive noise registry for the calendar years 2014-2018. This reporting is part of Greenland's obligations under OSPAR, including West Greenland. This report covers the indicator 11.1, impulsive noise of the EU Marine Strategy Framework Directive, agreed as an OSPAR common indicator.

The purpose of the report is to present the data in summary form, including comments that will not be passed on to the ICES registry. It thus serves as a background reference to the data to be submitted to the ICES registry. The ICES registry should be consulted directly for access to the data. No evaluation of the data has been performed, i.e. the possible effects of the reported activities on the environmental status of the Greenland waters have not been assessed.

2. Indicator 11.1 in Greenland Waters

Greenland has endorsed the OSPAR convention on emissions to the water, including underwater noise. OSPAR builds in this respect on the EU Marine Strategy Framework Directive, where Descriptor 11 deals with emission of energy, including underwater noise. Underwater noise was assessed by OSPAR in the 2017 intermediate assessment by means of an assessment of impulsive noise. Impulsive noise sources in this respect are defined by criterion D11C1 of the MSFD as a) below 10 kHz in frequency and b) have the possibility to detrimentally affect marine life. Further specification and details for reporting are provided by the guidance in Dekeling et al. (2014), which has been followed here to the extent possible. These guidelines operate with five different categories of impulsive noise sources: airgun arrays, explosions, impact pile drivers, sonars and other impulsive noise sources below 10 kHz. For the period 2014-2018, however, only activities involving airgun arrays are available and are reported.

2.1 Methods

Sources generating impulsive noise can be reported to the database in two formats: either exact position for each source, or by means of the so-called impulse-block days. An impulse-block day indicates that an impulsive source has been active within a particular geographical polygon on a specified date, but without further specifying the position. While the exact positions are well suited for stationary sources (pile driving, explosions etc.), the format of impulse-block days is better suited for moving sources, such as seismic surveys. The polygon grid relevant for east Greenland waters is the ICES statistical subrectangles (20' longitude x 10' latitude) (Dekeling et al., 2014). See also https://www.ices.dk/marine-data/maps/Pages/ICES-statistical-rectangles.aspx.

For each source (activity) there is a minimum amount of **required** information:

- Date of activity start in each polygon (ICES statistical subrectangle)
- Date of activity end in each polygon (ICES statistical subrectangle)[1]
- Source type ('Airgun array' for all activities reported here)
- Magnitude of impulsive noise, following classification by Dekeling et al. (2014). For airgun arrays this classification is as follows.

  Source factor (zero-to-peak level):

209-233 dB re 1 µPa m:	Very low
234-243 dB re 1 µPa m:	Low
244-253 dB re 1 µPa m:	Medium
> 253 dB re 1 µPa m:	High

- An additional Boolean variable ('Mitigation') relates only to impact pile driving and is therefore set to 'No' for all airgun activities.

Note 1: It is assumed that impulsive sounds were emitted on **all** days between start and stop. If there are breaks in the activity, each series of consecutively active days should be entered individually.

For each source (activity) a number of additional parameters can be specified:

- Source spectrum: Not yet defined
- Duty cycle: Fraction of the time sound is on (0-1);
- Start time of transmissions
- Duration of transmissions:
- Source depth;
- Platform speed.

The information regarding activities in Greenland 2014-2018 were not in a format compatible with the ICES register, as information about activities in individual polygons on individual dates were not reported, i.e. start and end dta/time were not submitted. Therefore impulse-block days were estimated differently than stipulated in Dekeling et al. 2014. This also means that the collected data in its current form cannot be submitted to the ICES register.

Impulse-block days were estimated with an Identity-function in ArcGIS 10.5.1, using the ICES Statistical Rectangles as reporting polygons The ICES Statistical Rectangles was obtained through the ICES web service (http://gis.ices.dk/sf/). The Seismic lines, provided by GEUS, was used as input features. Afterwards the length of each resulting new line segment was calculated. The resulting feature table could then be used to determine how many kilometers seismic data was produced in each grid cell, per year. The reported average seismic production per day as stated by the seismic company, was finally used to calculate the impulse-block days. Impulse-block days were calculated as total number of line segments per rectangle in a year. i.e. if a rectangle had multiple segments (meaning the ship passes through on several transect lines), each line segment counted as a block day. If two segments in the same rectangle were shot on the same day, this approach will overestimate the number of impulse-block days, whereas individual segments spanning more than one day within a rectangle (happens every night at midnight) will cause an underestimation of the number of impulse-block days.

2.2 Airgun arrays

Information about seismic surveys in Greenland EEZ was obtained from the permitting body: the Ministry of Mineral Resources and Labor.

Three commercial seismic surveys (TGS 2014, TGS 2015, TGS 2016) were conducted by moving sources covering larger areas (conventional 2D seismic surveys).

For all years:

Ship:	Akademik Shatskiy
Airgun:	The TGS NEG14 project array consisted of a tandem array of 2x8 guns (Bolt 1900/1500 LL) with maximum total volume of 3350 in^3, towed at a depth of 7 meters, separations of 6 meters. 1675 in^3 gun volume was used in difficult ice conditions.

Source array used on the Akademik Shatskiy consisted of 8 Bolt LL 1900 airguns made up in to 2 sub-arrays; each sub-array was configured as 2x2 gun clusters and 4 single guns per sub-array and was of the identical volume and operated at 2000 psi air pressure. This corresponds to a source level of app. 260 dB re 1 □Pa (peak-peak) @ 1 m, i.e. of ***High*** source level.

2.3 2014

Survey:
Begin 16th August 2014 at 11:35 UTC, Tromsø
End 17th October 2014 at 10:00 UTC, Tromsø

Production:
Begin 27th August 2014 at 23:03 UTC on line NEG1420560001A
End 14th October 2014 at 01:09 UTC on line NEG1410550A076A
Avg. prod: 112.80km / day

2.4 2015

Survey:
Begin 07th August 2015 at 11:35 UTC, Tromsø
End 17th October 2015 at 10:00 UTC, Kirkenes

Production:
Begin 11th August2015 at 11:38 UTC on line NEG1571030001A as sequence 001
End 13th October 2015 at 12:22 UTC on line NEG15-20550123A as sequence 123
Avg. prod: 118.80km / day

2.5 2016

Survey:
Begin 10th August 2016 at 12:12 UTC, Gydnya
End 15th September 2016 at 09:05 UTC, Kirkenes

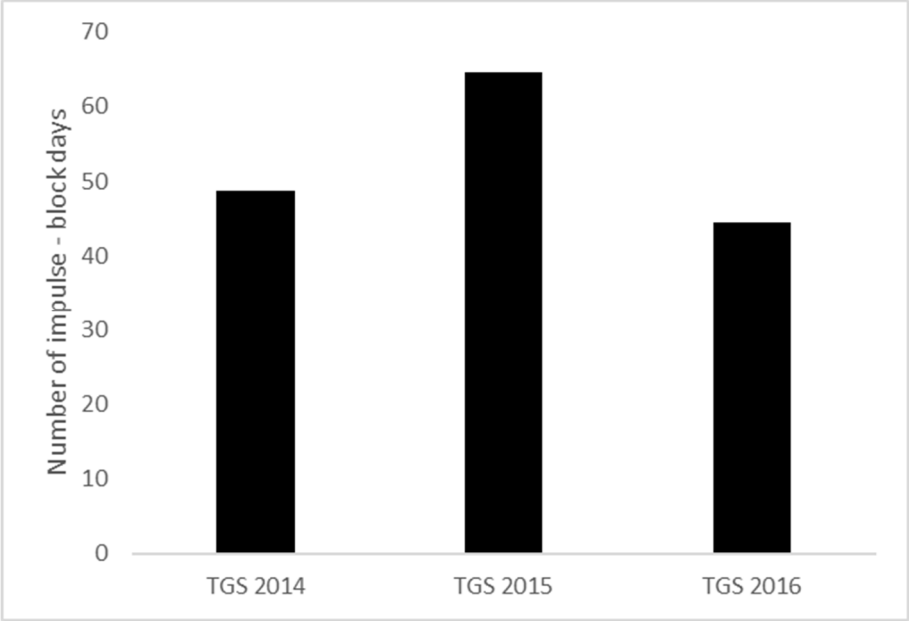
Production:
Begin 22nd August 2016 at 22:16 UTC on line NEG16-10670001A as sequence 001
End 10th September 2016 at 04:58 UTC on line NEG16-20545039A as sequence 039
Avg. prod: n.a. but likely similar to 2014 and 2015.

2.6 Overview of reported data

The total contribution of impulse-block days, estimated from line segments as described above, is illustrated in **Figure 1**.

The only contribution to reported impulse-block days in 2014-2018 was from seismic surveys with towed airgun arrays.

Figure 1. Overview of impulse-block days, i.e. number of days with airguns reported per ICES rectangle, in Greenland EEZ in the years 2014-2016. The data reported for 2017-2018.



2.7 Registered activities not reported to OSPAR

Three non-commercial seismic surveys were conducted in 2014-2018, however no reports were available from these surveys and they thus cannot be reported to the ICES register.

2017: A German scientific seismic survey was conducted in North East Greenland, the Greenland Sea, in the period 31st August to 4th October 2017 covering 2000 line km using a 50.4 L airgun array with an estimated source level of 259 dB re 1 µPa @ 1m (peak-peak). The purpose of the research was to study the geological evolution of the North Atlantic at the continental margins of north-east Greenland. No data was received following the completion of the survey.

2018: Between August 5th, 2018 and September 3rd, 2018 a German scientific seismic survey was conducted from the icebreaker R/V Polarstern. This survey collected 1500 line kilometers 2D seismic profiling data and 350 line km refraction seismic data NNE of Greenland and outsize 12 nM zone. The stated airgun array had a total volume of 2000 in^3 (32.8 L) operated with 2000 psi and an estimated source level of 244 dB re 1 µPa (zero-peak) @ 1m. The purpose of the research seismic survey was to study the evolution of the tectonic plates. No data was received following the completion of the cruise.

2017 & 2018: In the Scoresbysund Fjord a study was performed by the Greenland Institute of Natural Resources to study the effect of seismic surveys on narwhals.

As survey was conducted to study behavioural reactions of narwhals only a single airgun was used.

2017: Between 14th August to 20th August 300 line kilometers were collected in Gåsefjord and Ydrefjord from the Vessel Paamiut. A 210 in^3 GI-gun with 130 bar pressure and a source level of 232 dB re 1µPa @ 1 meter (zero-peak) was used.

2018: Between 24th August and 5th September 300 line kilometers were collected around Milne Land with the vessel Lauge Koch. A G-gun of 1040 in^3 was mostly used and a single line of 20 km was collected with a 210 in^3. The pressure of both airguns was of 130 bar and the source level was 232 and 243 dB re 1µPa @ 1 meter (zero-peak) of the small and the large airgun, respectively.

2.8 Possible underreporting

The registry relies on submission of accurate information from permit holders (seismic operators, offshore contractors, etc.) to permitting agencies under the Ministry of Mineral Resources and Labour following completion of the activities. The procedures for this reporting is under development and some underreporting is therefore currently unavoidable.

The reported figures for airguns are too low, due to the lack of data reported for the scientific / non-commercial seismic surveys. Also for the commercial surveys, the detail level of the reported data is not satisfactory and inadequate for submission to the ICES register.

There is no data available on impact pile driving and civil explosions, as these are not required reported in Greenland. However, most, if not all of these sources are likely to be located very close to the coast, in most cases in connection to harbours or settlements and impact thus likely to be restricted to coastal waters. The effect of such underreporting on subsequent assessments across the entire OSPAR region I is likely to be insignificant, because they are likely to be coastal and very few for Greenland. No information is available about military underwater explosions, but the extent of such is considered to be very low.

No sonar activities are reported for Greenland. Anti-submarine warfare (ASW) sonars (operating at frequencies <10 kHz) are very likely to have been used in Greenland in the reporting period, but no information is available on types and extent of use. The effect of this underreporting on the quality of future assessments is impossible to quantify without additional information, but could be significant.

No other impulsive sources have been reported for the reporting period. The primarily relevant sources for this category are considered to be various equipment for sub-bottom profiling, such as pingers, sparkers, boomers, as well as certain types of deep-sea bathymetric sonars. A permitting procedure for such surveys exists, but there is at present no requirement for reporting afterwards and no information is presently available about actual activities in this category in the reporting period. The severity of this underreporting thus cannot be assessed without additional information.

3. Reported activities

3.1 TGS2014

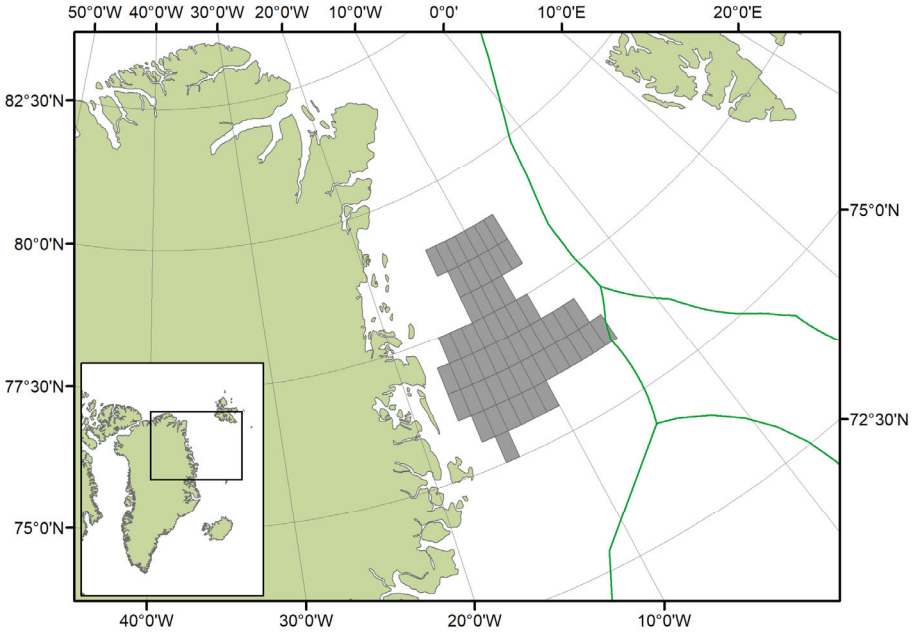


Figure 2. Seismic survey with air-gun array of magnitude high. Conducted between 27.8.2014 and 14.10.2014. The map is in UTM 24N, WGS84 projection.

Table 1. Summary of impulse-block days in 2014 for TGS2014.

ICES rectangle	Impulse-block days		
79D5	1	82E2	2
80D4	1	82E3	1
80D5	1	82E4	1
80D6	1	83D4	1
80D7	1	83D5	1
80D8	1	83D6	2
80D9	1	83D7	3
81D3	1	83D8	3
81D4	1	83D9	2
81D5	2	83E0	1
81D6	2	83E1	1
81D7	1	84D7	1
81D8	1	84D8	2
81D9	1	84D9	2
81E0	1	84E0	1
81E1	1	85D7	1
81E2	1	85D8	1
81E3	1	85D9	1
81E4	1	85E0	1
81E5	1	85E1	1
82D3	1	85E2	1
82D4	4	86D6	1
82D5	7	86D7	1
82D6	6	86D8	1
82D7	2	86D9	1
82D8	1	86E0	1
82D9	1	86E1	1
82E0	2	86E2	1
82E1	2		
		Grand total	**85**

3.2 TGS2015

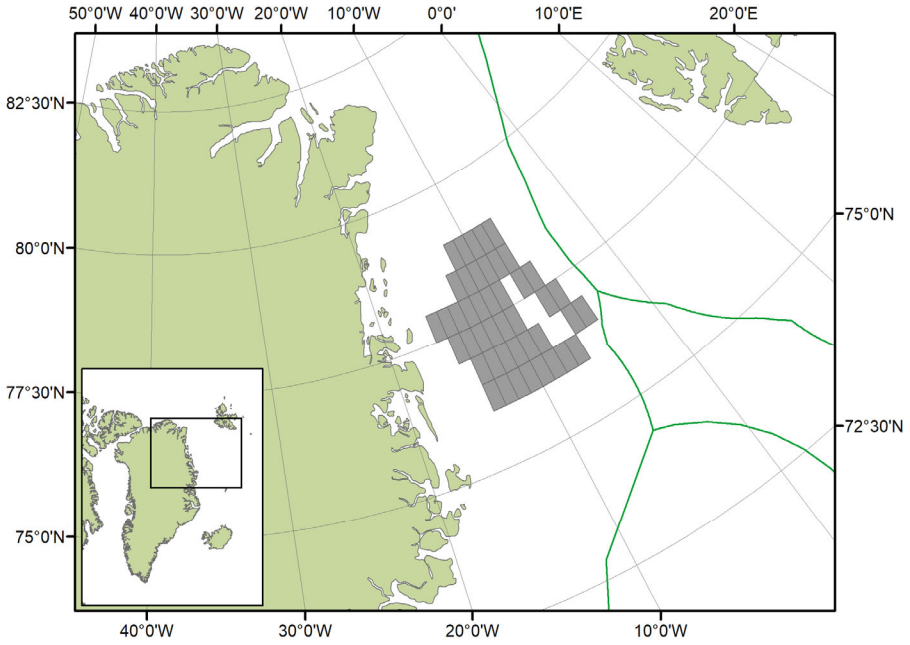


Figure 3. Seismic survey with air-gun array of magnitude high. Conducted between 11.8.2015 and 13.10.2015. The map is in UTM 24N, WGS84 projection.

Table 2. Summary of impulse-block days in 2015 for TGS2015.

ICES rectangle	Impulse-block days		
81D6	1	83E3	1
81D7	2	83E4	1
81D8	1	84D4	1
81D9	1	84D5	2
81E0	1	84D6	4
81E1	1	84D7	4
81E2	1	84D8	4
81E3	1	84D9	2
82D6	1	84E0	1
82D7	3	84E2	1
82D8	3	84E3	1
82D9	1	85D7	1
82E0	2	85D8	3
82E1	1	85D9	2
82E4	1	85E0	4
82E5	1	85E1	1
83D5	1	85E2	1
83D6	1	86D8	1
83D7	5	86D9	8
83D8	5	86E0	6
83D9	2	86E1	4
83E0	1	86E2	1
		Grand total	**91**

3.2.1 TGS2016

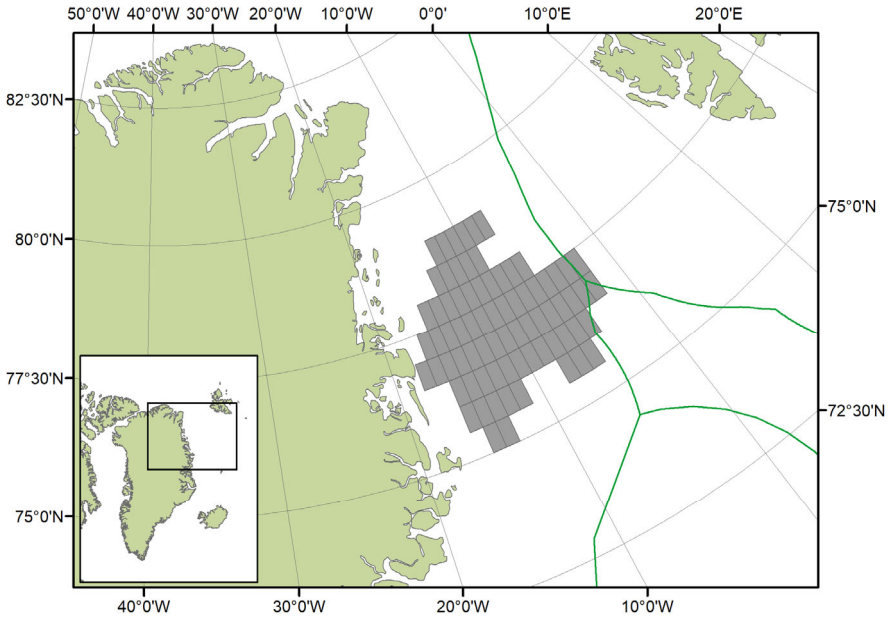


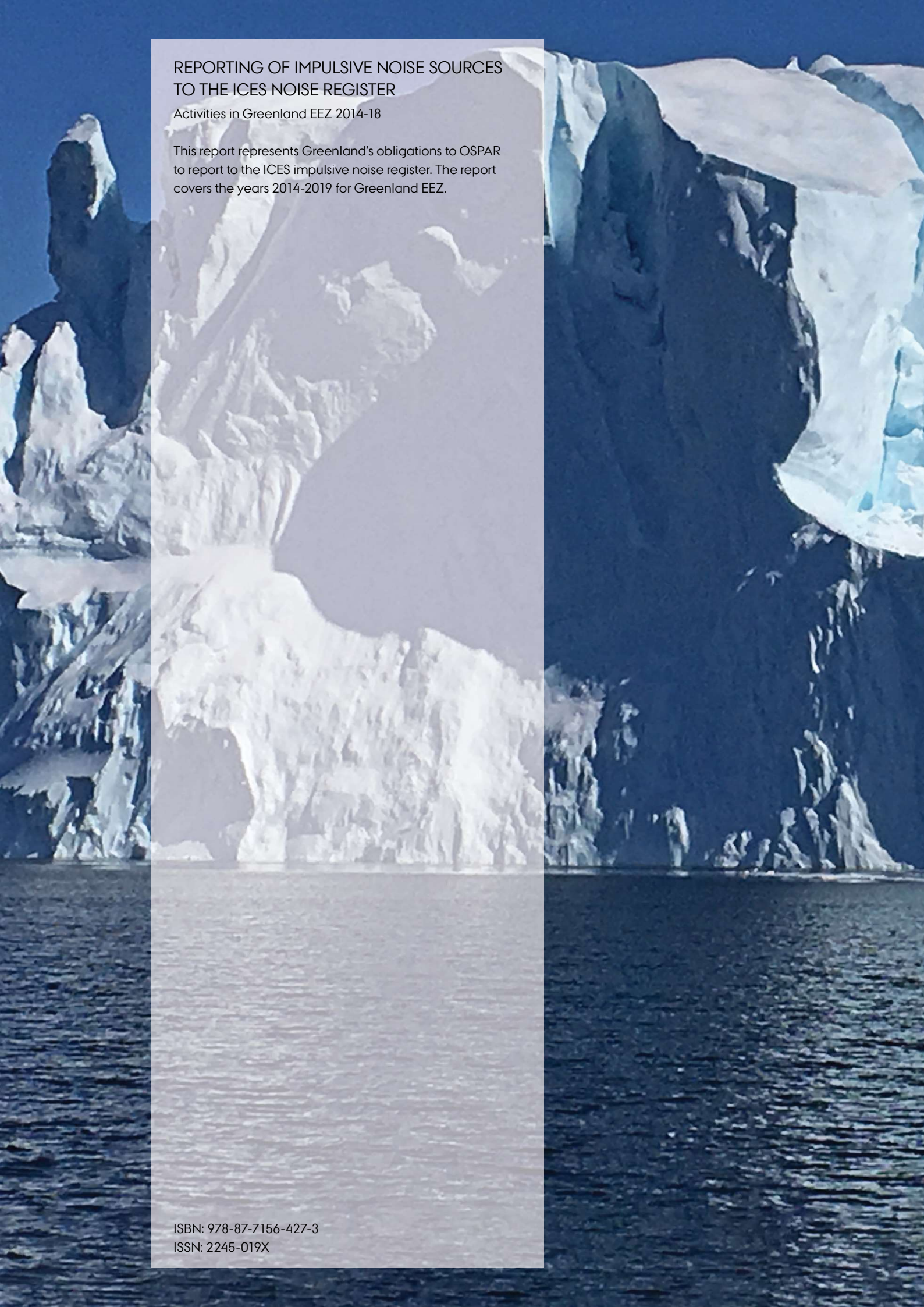
Figure 4. Seismic survey with air-gun array of magnitude high. Conducted between 22nd August to 22nd September 2016. The map is in UTM 24N, WGS84 projection.

Table 3. Summary of impulse-block days in 2016 for TGS2016.

ICES rectangle	Impulse-block days		
79D5	1	82E0	1
79D6	1	82E1	1
80D4	1	82E2	1
80D5	1	83D5	1
80D6	1	83D6	2
80D7	1	83D7	3
80D8	1	83D8	2
80E2	1	83D9	2
80E3	1	83E0	1
80E4	1	83E6	1
81D4	1	83E7	1
81D5	1	84D4	1
81D6	1	84D5	2
81D7	2	84D6	4
81D8	1	84D7	4
81D9	1	84D8	3
81E0	1	84D9	1
81E1	1	84E0	1
81E2	1	84E1	1
81E3	1	85D6	1
82D2	1	85D7	1
82D3	1	85D8	2
82D4	1	85D9	3
82D5	2	85E0	1
82D6	2	86D8	1
82D7	2	86D9	1
82D8	1	86E0	2
82D9	1	86E1	1
		Grand total	**78**

4. References

Dekeling, R.P.A., M.L. Tasker, A.J. Van der Graaf, M.A. Ainslie, M.H. Andersson, M. André, J.F. Borsani, K. Brensing, M. Castellote, D. Cronin, J. Dalen, T. Folegot, R. Leaper, J. Pajala, P. Redman, S.P. Robinson, P. Sigray, G. Sutton, F. Thomsen, S. Werner, D. Wittekind, and J.V. Young. 2014. Monitoring Guidance for Underwater Noise in European Seas, Part I: Executive Summary. In JRC Scientific and Policy reports. Publications Office of the European Union, Luxembourg.



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