



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Underwater noise emissions from a drillship in the Arctic



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ARTICLE INFO

Article history:

Available online 17 July 2014

Keywords:

Oil and gas exploration
 Marine mammals
 Noise pollution
 Greenland
 Transmission loss
 M-weighting

ABSTRACT

Wideband sound recordings were made of underwater noise emitted by an active drillship, *Stena Forth*, working in 484 m of water in Baffin Bay, western Greenland. The recordings were obtained at thirty and one-hundred meters depth. Noise was recorded during both drilling and maintenance work at ranges from 500 m to 38 km. The emitted noise levels were highest during maintenance work with estimated source levels up to 190 dB re 1 μ Pa (rms), while the source level during drilling was 184 dB re 1 μ Pa (rms). There were spectral peaks discernible from the background noise to ranges of at least 38 km from the drillship with the main energy below 3 kHz. M-weighted sound pressure levels were virtually identical to broadband levels for low-frequency cetaceans and about 5 dB lower for high-frequency cetaceans. Signals from the dynamic positioning system were clearly detectable at ranges up to two km from the drillship.

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1. Introduction

The combination of increasing oil prices and technological developments has increased the search for petroleum deposits in deep arctic waters. With the expected increase in industrial activities such as seismic surveys, drillings, vessel and helicopter traffic it is important to determine the underwater noise levels from the individual contributors in order to evaluate and if necessary, mitigate the effects on the surrounding environment.

Underwater noise emissions in polar waters are of particular interest due to the hydrographic conditions facilitating long distance transmission, the relatively pristine environment with little anthropogenic noise, and the generally high concentration of marine mammals. Marine mammals in particular are sensitive to noise because they depend critically on sound for communication, orientation and feeding. Their hearing system is therefore highly developed and sensitive. Effects of noise on marine mammals have been reviewed several times, most notably by Richardson et al. (1995), NRC (2003) and Southall et al. (2007). So far, most effort related to oil and gas extraction has been on effects of high intensity sounds from seismic surveys and only a few studies have looked at the actual and potential effects of noise from the drilling operations (Richardson et al., 1985, 1987, 1990; Blackwell et al., 2004). However, drilling operations and other activities associated with extraction of oil and gas take place in the same areas over extended

periods of time, typically decades. The cumulative impact of many installations in the same area and over extended time could well be significant and therefore calls for assessment.

Drillships are presumed to be the noisiest way of drilling in water, primarily because the hull has good coupling with the water and thus facilitates underwater sound radiation. Other types, such as jack-ups and semi-submersible rigs have most machinery well above the water line and therefore less noise is transmitted to the surrounding water.

Few studies have been published on the underwater noise emitted during oil drilling operations (Hall and Francine, 1991; Blackwell et al., 2004; Blackwell and Greene, 2006) and only two deal with the noise emitted from drillships (Greene, 1987; Richardson et al., 1990). Dr. Greene (Greene, 1987) measured noise from two drillships *Canmar Explorer I* and *II* and a drilling barge *Kulluk*. The drillships each had 13,000 ton displacement and were 115 m length overall. The noise from these drillships contained main energy at low frequencies, below 1–2 kHz and the sound pressure levels were 122–125 dB re 1 μ Pa (rms) at 170 m distance for *Canmar Explorer I* performing well logging (Well logging is the practice of making a detailed record (a *well log*) of the geologic formations penetrated by a borehole.) and about 134 dB re 1 μ Pa (rms) at 200 m distance for *Canmar Explorer II* during drilling. Measurements from the drilling barge *Kulluk*, yielded considerably higher sound pressure levels, around 143 dB re 1 μ Pa (rms) measured 1 km from the barge during drilling. The noise from the drillships was still above ambient at a distance of 10 km from the ships, the furthest distance at which recordings were made.

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Fig. 1. The drillship *Stena Forth*. The standby ship *Esvagt Connector* is visible in the background.

Modern drillships are considerably larger than the *Canmar Explorer* type and higher noise levels could be expected due to more powerful machinery on these ships. Furthermore, many drillings now take place in deeper waters, where sound propagation is drastically different from the situation of the Canadian Beaufort Sea, where the drillings took place at depths between 17 and

31 m below the sea surface (Greene, 1987; Richardson et al., 1990). Here we present sound recordings from the modern drillship *Stena Forth* during operation in the deep waters (484 m) of the Baffin Bay, West Greenland, 2010.

2. Materials and methods

2.1. Drillship and study area

Stena Forth (Fig. 1) is a double hulled drillship that was built in 2008. The ship is 228 m long, 42 m wide with a displacement of 96,000 Mt and equipped with six 5500 kW fixed pitch azimuth thrusters (Rolls Royce Aquamaster AQM UUC 455 L-Drive), sixteen drill motors and six 7430 kW diesel generators (Wartsilla/16V32). *Stena Forth* was positioned at 71°7'45"N 59°54'10"W in the Sigguk oil exploration block in Baffin Bay, located approx. 175 km west of Disko Island, West Greenland (Fig. 2). The depth to seabed at the site was 484 m.

2.2. Recording procedure and setup

No special actions were taken by *Stena Forth* during recordings. The recordings thus represent a random sample of the noise emitted by the drillship, and recordings were thus made during both active drilling and maintenance activities on the drillship.

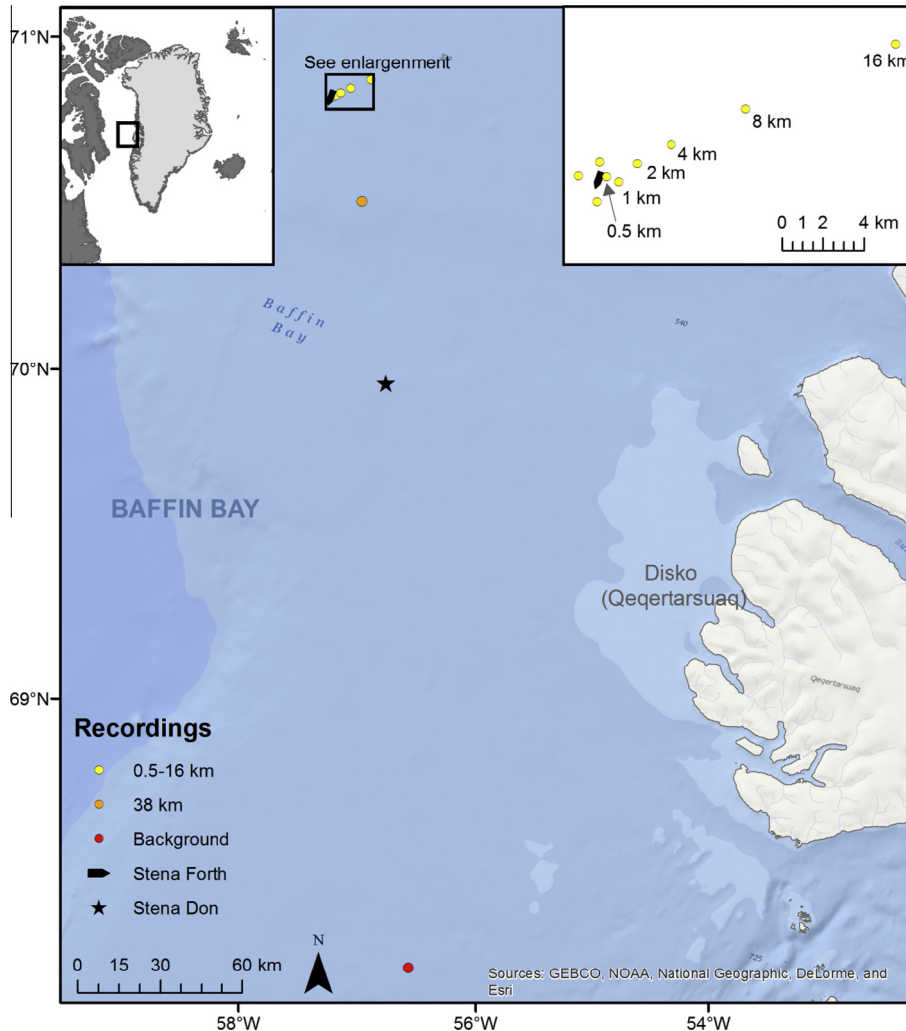


Fig. 2. West Greenland with the location of sound recordings, the drillship *Stena Forth* and the semi-submersible drill rig *Stena Don* indicated. The depth to seabed at the location of *Stena Forth* was 484 m. Map projection universal transverse Mercator, Zone 24N, WGS84.

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