SHIPPING AND SEISMIC EXPLORATION CONTRIBUTORS TO NOISE IN THE NORTHERN NORWEGIAN SEA: TRENDS AND RECENT MEASUREMENTS

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1 INTRODUCTION

This paper presents a study of temporal and spatial distribution of maritime activities, including shipping, fishing, and seismic exploration in the northern Norwegian Sea. The study covers data from the period 2006-2009. Regional and seasonal variations in shipping and fishing activity and their correlations have been analyzed. Seismic exploration activity is treated as individual events, with example noise measurements presented. The work will be used in development of prediction models for ambient noise in the area.

2 MATERIALS AND METHODS

Information of ship traffic is extracted from databases of Automatic Identification System (AIS) messages, administered by the Norwegian Coastal Administration. Time and locations of seismic exploration surveys has been obtained from the Norwegian Petroleum Directorate (NPD). Ambient noise measurements have been conducted by FFI.

Analysis of ship traffic data was restricted to the northern Norwegian Sea and divided into three geographic regions: (a) north-west of Vesteraalen, (b) Lopphavet, and (c) north-west of Hammerfest. Ship traffic was divided into two categories: fishing vessels and other vessels (fishing and seismic exploration vessels excluded). Shipping density was defined as the number of ships registered within areas of size 1°/60 X 1°/60 during one day, averaged over a month, and normalized to area. Differences within each region, due to the factors month and location, were investigated using the Friedman two-way ANOVA on ranks test. For comparison between regions, mean cross section densities and cross section totals were calculated. Significant differences in activity, due to month, region and year, were searched for using three-way ANOVA. The number of seismic exploration vessels is relatively small compared to fishing and other vessels, thus seismic exploration is treated as individual events not by density.

Measurements of ambient noise were conducted at a location in the Norwegian Sea. A hydrophone was deployed on the seabed and attached via a cable to a digitizing and recording system in a surface buoy. Data analysis consisted of computing noise power spectral density from 30-second time intervals of data, then noise level cumulative distributions for ½-hour time periods.

3 RESULTS

Figure 1 presents mean cross section (region) density by vessel category, region and year. Mean cross section density of fishing vessels varied between 0.01 and 0.35, with yearly averages (each region separately) in the range 0.03-0.14. Mean cross section density of other vessels varied

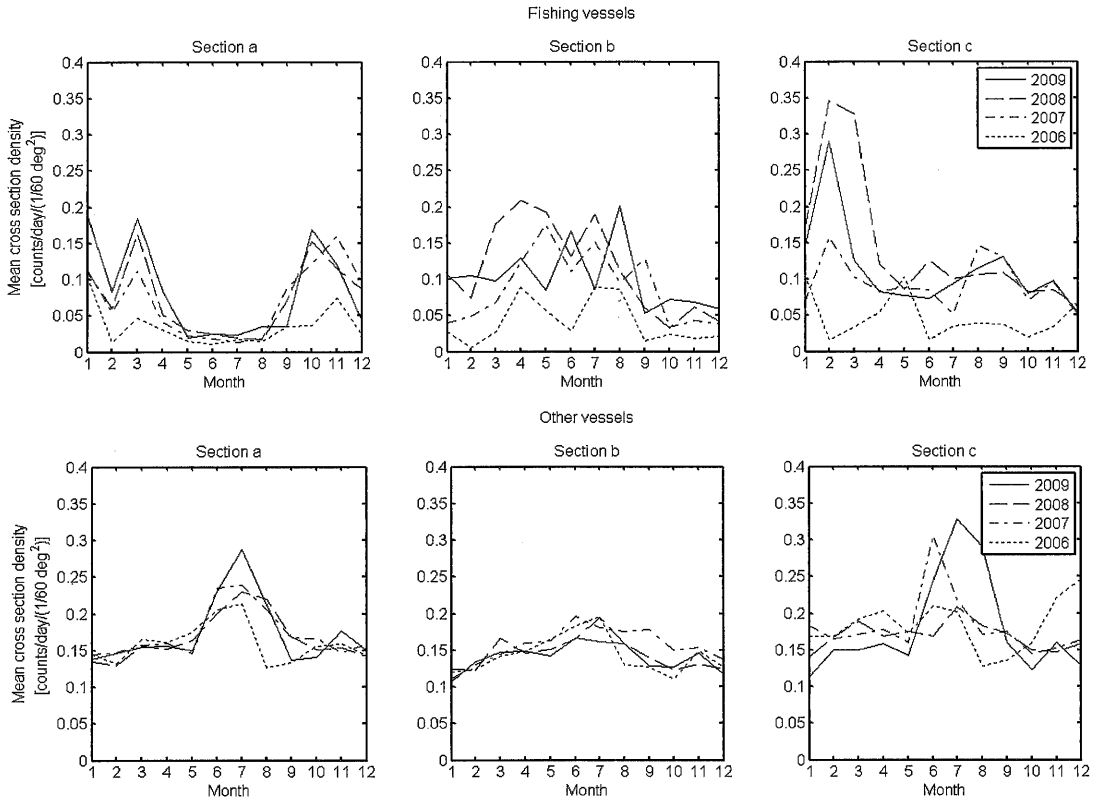

Figure 1 Mean cross section ship traffic densities for fishing vessels (upper panels) and other vessels (lower panels) for January through December of 2006–2009.

between 0.11 and 0.33, with yearly averages in the range 0.14-0.18. Significant differences were found in mean cross section densities of fishing vessels between the three regions. Significant differences were also found for other vessels. Analyzing the seasonal variations in the three regions as a total (combined), fishing activity was found to be significantly higher in March than in June, July, September and December. For other vessels, the total activity was significantly higher in June and July than September through May. Further, the AIS registered fishing vessel activity increased from the years 2006 and 2007 to 2008 and 2009. The AIS registered activity of other vessels did not change significantly during the years 2006 to 2009.

Figure 2 shows measured noise spectrum levels in presence of sèismic exploration activity. The symbols represent median noise levels with ten and ninety percentile level indicators, for each ½-hour time period over a total of 36 hours in the fall of 2009. Data is for the 1/3-octave frequency band at 63 Hz (corrected for bandwidth). Levels of up to 120 dB (re 1μPa²/Hz) can be observed, with a persistent median level above 90 dB. A 3D-seismic survey ship (3000 in^3 airgun array) operated in the area at ranges of 12 to 90 km during the period of measurement; range estimates (lower panel) are based on AIS data where available. Transitions between periods of high and low noise levels are assumed related to variations in operation of the seismic source.

4 DISCUSSION

Mean shipping density (fishing and other vessels) varies both with season and with region. Variations in the fishing vessel activity are mainly due to seasonal dependencies in the fishing of

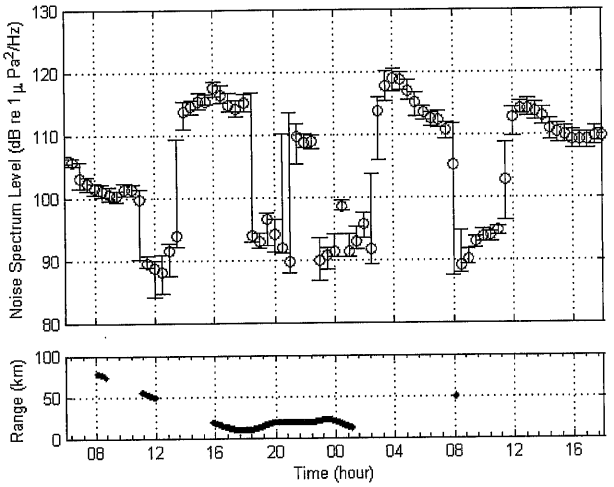

Figure 2 Noise spectrum level at 63 Hz measured in the Norwegian Sea over a 36-hour period when seismic surveying occurred. Each circle represents the median level for a ½-hour time period; bars indicate ten and ninety percentile levels. The lower panel shows range to a 3D-seismic survey ship.

herring and cod (1). The peak density of fishing vessel activity occurs in March and peak density of other vessel activity occurs in June-July.

Fishing vessels larger than 300 BT and longer than 45 m have since July 1st 2007 been required to have a class A AIS transponder (2). The trend of yearly increase in fishing vessel density may be due to an increasing percentage of large vessels with AIS transponders installed onboard. However, reports from other Norwegian Authorities show structural changes in the fishing fleet during the years 1998-2009, with a drastic reduction in the number of small vessels and a slight increase in the number of larger vessels (1). Changes in AIS registered fishing vessel density during 2006-2009 may be due to both factors.

In July 2007, the mandatory transport separation scheme off the coast of Norway from Vardø to Røst was introduced. Vessels above 5000 BT was from this date required to sail in these shipping lanes, changing the spatial distribution of vessels significantly. However, the mean density of other vessels in the three sectors analyzed did not change during the years 2006-2009.

Low frequency ambient noise levels depend on shipping density and ship parameters (3, 4). Further work, including correlation with measured data, is needed to investigate the relevance of shipping density separated by vessel category in predicting ambient noise levels in the region of interest.

5 REFERENCES

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