# The Underwater Acoustic Noise Field On Sable Bank

**F. Desharnais, G.J. Heard, M.G. Hazen, I.A. Fraser**
Defence Research Establishment Atlantic
P.O. Box 1012, Dartmouth, Nova Scotia, Canada, B2Y 3Z7

## INTRODUCTION

The ambient noise levels on Sable Bank were investigated, in the vicinity of the oil drilling sites by Sable Island. The goal of the research was to better qualify the background noise levels of the area, in order to assess the impact of the noise arising from the development of the Sable Gas Project. The results presented here are based on historical measurements made at ten different locations on Sable and Banquereau Banks, during various conditions of sea state, and during all four seasons [1-6]. The measurements were made with a range of systems, from commercial sonobuoys to various research array systems.

## MEAN NOISE LEVELS

Figure 1 shows the ambient noise spectral data (one-third octave band) in the frequency range of 20-2500 Hz obtained from nine separate data sets [1-6]. Where sufficient data were available, error bars indicating the standard deviation have been included. Figure 2 shows the ambient noise levels at selected third-octave bands for 12 aircraft sorties carried out during the period December 1995 to December 1996 [1]. The year-long study that provided the data of Fig. 2 adds seasonal information to the data from Fig. 1.

The overall noise level in the 10-200 Hz band depends mostly on the number of ships in the area, on their respective source levels, and on propagation conditions. The eastern Canadian shelf is a region of particularly high shipping noise and this is clearly reflected in our data by noise levels in excess of 90 dB//1 μPa2/Hz in the neighbourhood of 50 Hz. These high levels also compare favourably to the high shipping density noise curves from Wenz [7]. The propagation conditions vary according to seabed properties (which in this case do not change), and on the profile of sound-speed as a function of depth (see seasonal variations below).

Above approximately 200 Hz, the noise levels are usually dominated by wind noise. The wind conditions varied greatly over the different data sets included in this report. The mean levels for frequencies above 300 Hz agree to within 5 dB with the levels published by Piggott [8]. Piggott's data set covered an entire year and a full range of wind speeds from light to 18 m/s. The largest differences between our data and Piggott's data are seen for the 316-Hz band at very low wind speed. At this frequency, shipping can influence the noise levels at low wind speeds. Shipping noise contamination is suspected in some of our data sets.

There is a large spread in the 20 Hz data in Figs. 1 and 2. This large variation is believed to be due to finback whales, which are audible in many of the recordings. Finback whales, typically found on the Scotian Shelf and Grand Banks, emit loud calls with centre frequencies near 20 Hz [9]. The noise level in this frequency band can increase by as much as 25 dB if finback whales are in the area.

The lowest noise levels seen in Fig. 2 are representative of the lowest levels that can be expected near Sable Island, at all frequencies. This statement is based on the conditions observed during the recording of these particular measurements: light winds, low sea state, and no shipping in a 100-km radius around the experimental site. The maximum levels are also representative of the highest levels that can be expected near Sable Island under normal conditions, except in the band 100-500 Hz where higher levels could be observed for extreme weather conditions. It should be noted that a nearby ship could produce even higher broadband noise levels, especially if it is large (e.g. a tanker) and very close.

## SEASONAL VARIATION

Three different factors can introduce a seasonal variation in the noise levels. At shipping frequencies, the main factor is the seasonal change in the sound-speed profile. In the summer months (mainly May to September), the warm layer near the sea surface redirects the energy from a source near the surface (such as a ship) towards the seabed, and the interaction with the seabed is increased. Therefore, propagation losses for shipping noise are higher in the summer, and the measured noise levels tend to be lower, especially for distant shipping.

The only data set that covers an entire year is that of Fig. 2. Figure 3 shows the third-octave band noise levels as a function of flight date from the data set of Fig. 2. The 20 and 1000 Hz levels show a reduction in noise level during the summer season. The seasonal dependence of the noise is weak at shipping frequencies, especially when compared with other sites on the Continental Shelf [1]. This difference is explained by the noise on Sable Bank from nearby sources, believed to be due to the oil drilling platform within approximately 50 km of the experimental site. (Note that we do not differentiate between the noise from the drilling platform itself and the noise from the shipping traffic that the drilling operation attracts.) The high standard deviations of the noise levels at shipping frequencies (not shown here) are indicative of the importance of nearby sources near Sable Island. The noise levels influenced by a nearby ship are expected to show more variation, and therefore higher standard deviations than the levels influenced by a distant ship. This was observed in the summer months for Sable Bank, when the higher propagation losses reduced the contribution from far-away ships.

Another factor that can induce a seasonal effect is the seasonal variation of the wind speed. Since the noise levels above 200 Hz are mainly dictated by wind speed (sea surface noise), a statistically significant change in wind speed will induce a change in the noise levels. Fig. 3 demonstrates lower noise levels in the summer season (particularly during August) at wind noise frequencies, and the measured winds (not shown here) were on average slightly lower in the summer time. It should be noted that as the wind speed in the North Atlantic is generally lower in the summer season, the seasonal wind speed effect reduces noise levels as does the summer warming effect discussed earlier. On average, the noise levels can be expected to be lower by 2-6 dB in the summer season, in the frequency band of 150-2000 Hz.

The third factor that can produce a seasonal effect is the presence of biological noise sources. We mentioned earlier the strong emissions from finback whales around 20 Hz. The 20-Hz band in Fig. 3

shows the greatest variation and this is attributed to the behaviour of finback whales. A one-year cycle is clearly evident in the data, with a noise level variation on the order of 25 dB from peak to trough. From this figure, the peak whale season is defined as fall (October) to mid-winter (January).

## CONCLUSIONS

We have shown here some of the ambient noise data previously analysed that are relevant to predicting the noise levels on the Sable Bank, in particular, in the area of the drilling operations near Sable Island. Mean, maximum, and minimum noise levels have been presented and should form a baseline for evaluating the importance of new noise sources on the Bank.

Data showing the seasonal variability of noise have been presented. Shipping traffic tends to increase during the summer, but surface warming and lower wind speeds result in generally lower levels of ambient noise during the summer. It is also noted that the variation of noise levels can increase during summer, as the importance of individual nearby ships is increased by the loss of energy from distant shipping through increased bottom absorption. Biological sources have also been shown to have a seasonal dependence and can, in the case of finback whales, lead to increases in the noise at 20 Hz in excess of 25 dB.

More information on the directionality of the noise field and the influence of shipping traffic will be presented during AWC 1999.


## ACKNOWLEDGMENTS

This work was funded in part by LGL Environmental Research Associates.


## REFERENCES


1 Hazen, M.G. and Desharnais, F. (1997) "The Eastern Canada Shallow Water Ambient Noise experiment", in Proceedings of Oceans '97 conference, Halifax, NS, 1, p. 471-476.

2 Bluy, O. (1975) Private communication.

3 Desharnais, F., MacDonald, B.R. and Mah, K.J. (1998) "Vertical noise coherence measurements in shallow water using Lagrangian drifters," J. Acoust. Soc. Am., 103(5), p. 2858.

4 Zakarauskas et al. (1984) Private communication.

5 Zakarauskas, P., Chapman, D.M.F. and Staal, P.R. (1990) "Underwater acoustic ambient noise levels on the Eastern Canada continental shelf," J. Acoust. Soc. Am. 87, p. 2064-2071.

6 Carr, S. (1998) "TTCP Trial RDS-1: Rapidly Deployable Systems - reduction, analysis, and reporting of non-acoustic data from DREA Sea-Test Q239," DREA Contractor's Report CR 98/421 parts 1 and 2, JASCO Research Ltd.

7 Wenz, G.M. (1962). "Acoustic ambient noise in the ocean: spectra and sources," J. Acoust. Soc. Am. 34, 1936-1956.

8 Piggott, C.L. (1964) "Ambient sea noise at low frequencies in shallow water of the Scotian Shelf," J. Acoust. Soc. Am. 36, p. 2152-2163.

9 Watkins, W.A., Tyack, P., Moore, K.E., and Bird, J.E. (1987) "The 20-Hz signals of fin-back whales (balaenoptera physalus)," J. Acoust. Soc. Am. 82, p. 1901-1912.


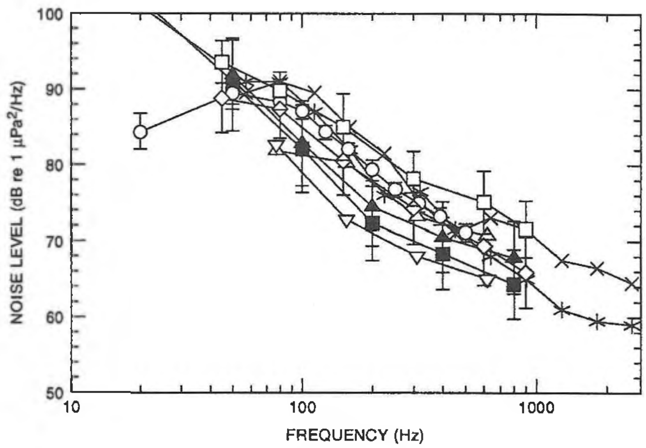


Figure 1. Ambient noise spectra obtained from 9 data sets on the Sable and Banquereau Banks.

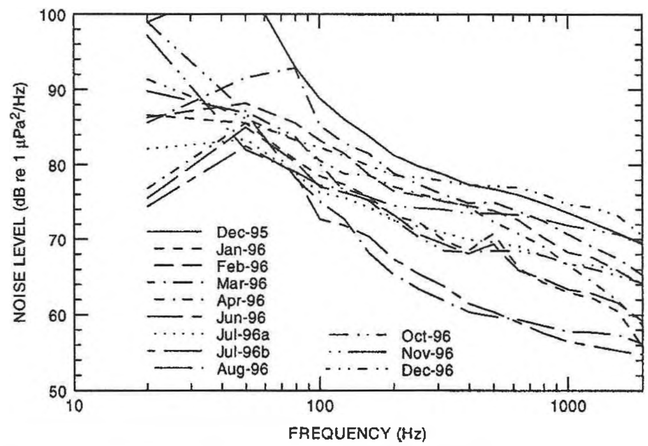


Figure 2. Ambient noise spectra obtained from [1].

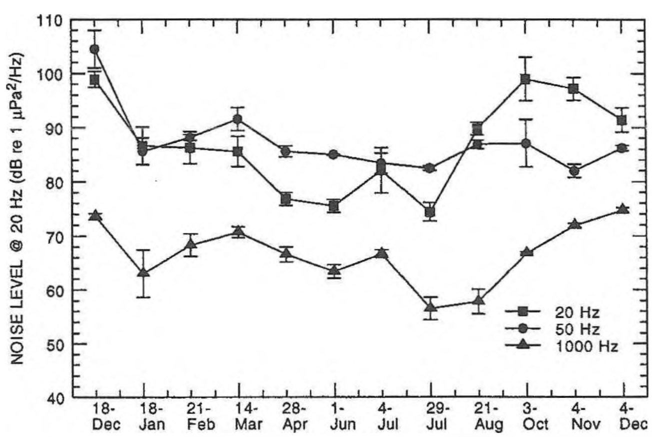


Figure 3. Ambient noise level-vs-time (1995-1996) at 20, 50 and 1000 Hz.