



# The first study of ambient noise in Australia waters and how it influenced future work

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**Abstract** - The first study of ambient noise in waters near Australia was in the shallow Timor Sea in 1966. It was so different to what was expected from studies in other parts of the world that it changed our view of ambient noise and significantly influenced the design of the many Australian studies that followed over the years. The noise and the soundscape were dominated by biological sounds. Traffic noise was absent because of the poor propagation and scarcity of shipping, and low wind speeds during the periods of measurement ensured that wind-dependent noise was very low. Several quite unusual and aurally striking biological sounds were present throughout the recordings, later determined to be generated by fish. There were also biological choruses that reached levels 20 dB above background noise and just after dusk, before dawn and sometimes around midday. Were these features of ambient noise a peculiarity of the area were they more widespread? This paper summarises the results and places them in context with what was known at the time from Northern Hemisphere studies and how this influenced future ambient noise research.

## 1 INTRODUCTION

The first studies of ambient noise in Australian waters were conducted in the Timor Sea in 1966 by the Royal Australian Navy Experimental Laboratory (RANEL – later renamed the RAN Research Laboratory, RANRL). RANEL was established in 1956 initially to investigate the feasibility of detecting submarines by listening on hydrophone arrays (Hunter, 1996). The results of several sea experiments showed that acoustic detection of sound sources in the ocean depended critically on the acoustics of the environment such as the propagation and the ambient background noise. These in turn depended on the oceanographic conditions and the nature of the sea floor. Consequently, further sea experiments were planned to investigate the acoustic and oceanographic environment of the Indo-Pacific region around Australia. The first of these was in the Timor Sea in 1966 and some of the ambient noise results and how they influenced further research are discussed in this paper.

Prior to 1966, there had been a number of studies of ambient noise internationally. Many were conducted during the second world war and published in reports which were summarised by Knudsen, Alford and Emling (1948). They identified the main sources of ambient noise as shipping noise, sea surface noise including noise from breaking waves and precipitation, and biological noise, mainly snapping shrimps and fish sounds. The next major work was that by Wenz (1962) who provided a comprehensive analysis of ambient noise based on many studies and developed ambient noise prediction graphs in terms of the components of the noise. These graphs have become known as the “Wenz’s Curves” and have been used widely ever since. Although many sources of noise are included, the main prevailing components are *traffic noise* which Wenz defined as the background noise from many distant ships across an ocean basin, excluding the noise of any close ship that is detected individually, and *wind dependent noise* which is the noise from wind induced waves breaking at the sea surface. Traffic noise was predominant at frequencies below a few hundred hertz and wind dependent noise at higher frequencies. Although biological noise was known to contribute significantly to the noise, Wenz did not include biological noise in the curves because the wide variability and limited knowledge made it “difficult to generalise.”

## 2 THE TIMOR SEA STUDY

Hydrophones were laid on the sea floor north of Darwin and connected by a cable to shore on an island where they could be monitored continuously. Recordings were made on a portable reel to reel tape recorder, the only type of portable recorder available at the time. Some analysis was conducted at the site but most of the analysis was done later in the laboratory. This was well before digital systems were available, so all recording and analysis were analogue.

The results showed that the ambient noise was quite different from what was expected from Wenz (1962) and other studies in the northern hemisphere. The noise in the Timor Sea was dominated by biological noise, mainly sounds of fish and snapping shrimps, both sources providing continuous background noise that significantly exceeded Wenz's wind dependent noise for the low wind speeds observed during recordings. Noise levels at frequencies below about 200 Hz were so low that it was questionable whether this was traffic noise. Shipping was sparse in the area at the time and propagation loss high, and estimates of the contribution of the ship noise to the background noise showed that traffic noise would have been negligible. Noise at these frequencies was a combination of biological noise and wind dependent noise.

Several quite unusual and aurally striking biological sounds were present throughout the recordings. These were later identified as fish sounds and there were so many sounds that they provided a sustained background noise from around 100 Hz to 2 kHz. There had been sufficient studies of fish sounds by then to show that the individual biological sounds in the Timor Sea were almost certainly from fish. Even though none were identical to those from Northern Hemisphere studies, they were very similar in characteristics indicative of fish sounds. Initially, however, there was some discussion about whether these sounds were artefacts, possibly new sound sources used in the geophysical survey being conducted in the area at the time, and there were concerns that they may have been faults in the amplifiers in the inhouse equipment being used. The snapping shrimp noise was quite distinctive and similar in spectral shape to the spectra published by Knudsen, Alford and Emling (1948).

In addition to the sustained ambient noise, there were high level biological choruses that occurred for three or so hours at a time just after dusk, before dawn and sometimes around midday with levels rising to around 20 dB higher than the typical background noise. Interestingly, a spectrally similar chorus had been observed in New Zealand waters and attributed to sea urchins (Tait, R.I., reported by Fish, 1964).

The only significant non-biological noise was from the impact of rain during occasional tropical storms producing high levels of noise across the audio frequency band, and occasional noise from surf breaking on a beach less than 10 km from the hydrophones. The surf noise exceeded other sources of noise at frequencies below about 500 Hz.

These recordings also revealed a problem that continues to plague underwater acoustic measurements: low frequency non acoustic flow noise. Periodically throughout the recordings, noise at frequencies below about 200 increased by up to 60 dB at the spectral peak of about 20 Hz where the spectrum level reached 120 dB re  $1 \mu\text{Pa}^2/\text{Hz}$ . At the highest levels, a tapping sound like drumming was audible, caused by overload of the amplifier. It was found that the noise levels in the 25 Hz octave were highest midway between high and low tide when tidal flow was maximum and correlated with current measurements in the area. This is an area of high tidal flow and the maximum current of 1 m/s flowing past the cable used would have caused vortex shedding with a frequency of about 20 Hz.

A comprehensive analysis of the results was presented as a report (Cato, 1969) which may no longer be available. However, the results have also been published with the results of further studies in journal papers (Cato, 1976, 1978 and 1980).

### 3 THE SIGNIFICANCE OF THE TIMOR SEA STUDY

The ambient noise in the Timor Sea was so different to that expected from the ambient noise predictions and studies in the Northern Hemisphere that it changed our view of ambient noise. It significantly influenced the design of the many Australian studies that followed over the years. Was this ambient noise a peculiarity of the Timor Sea or was ambient noise in this part of the world different? This led to further studies of ambient noise in the Indian and Pacific Oceans in the Australian region. These showed that traffic noise was very variable depending on the shipping densities and propagation conditions in the area, with many areas having much lower traffic noise than in the high shipping areas of the Northern Hemisphere (Cato, 1976). They also showed that wind dependent noise is a significant component of ambient noise at frequencies below 200 Hz outside high shipping areas. The further studies also showed that evening choruses are a regular part of ambient noise, occurring almost everywhere the noise has been measured and so needed to be included in ambient noise prediction methods. The predominance of fish sounds, however, is unusual and this and the multiple choruses mean that the ambient noise (the background noise) and the soundscape (all sounds including the ambient noise and the individual fish sounds) of the Timor Sea are probably still as unusual today as they appeared almost 60 years ago.

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