15. Ocean noise pollution

Yann Stéphan, Florent Le Courtois and G. Bazile Kinda

The marine environment is an excellent guide to sound waves, which can propagate over hundreds of kilometers, whereas light penetrates only a few meters. Many marine species exploit this property of the ocean to communicate, locate or spot their prey. Underwater noise pollution caused by human activities can endanger the health of ecosystems, whose scales of adaptation are not always as rapid as the changes undergone by our societies.

Sound diversity

A wide range of natural sounds is emitted in the marine environment, for example, by geophysical phenomena. To this geophysical chorus must be added the biological chorus generated by living organisms. Whales sing at low frequencies and these sounds can spread over several hundred kilometers. Dolphins whistle and 'sound' their surroundings with specific signals called 'echolocation clicks'. Other species emit sounds of all kinds, such as grunts or snaps. Many listen to their environment to communicate, detect prey or flee predators. Living organisms can also produce incidental sounds by moving and feeding.

Through their offshore activities, humans add their contribution to natural submarine soundscapes. The use of underwater sound sources has become widespread for seismic prospecting, the detection of objects, estimating fish stocks, measuring ocean depth, submarine communication... The lower the frequencies and the greater the power of the sound source, the greater the propagation distances. Moreover, many human activities are also noisy by nature. For example, vessels and powered vehicles are sources of noise that emit continuously over time mainly at low frequencies. Works at sea, such as those related to the development and exploitation of renewable marine energies, also generate noise in the marine environment.

The study of sounds

Sounds are defined by their duration, their frequencies and their level, the latter being expressed in logarithmic scale, the decibel (dB). Two sources with the same level of sound do not produce twice as much perceived noise; conversely, the arrival of a source in a quiet place can considerably increase the perceived noise.

Underwater acoustics provide two essential tools for understanding the risks of noise pollution in the marine environment. The first is the observation of the sounds in the environment by submarine microphones, called hydrophones. These instruments measure the underwater soundscapes, their temporal dynamics, their volume, and their frequency content (Fig. 1). They make it possible to compare the anthropic and natural components of the soundscapes in the same space of representation. However, considering the extent of maritime spaces and the propagation distances of sound waves, hydrophone observations can only provide sparse one-off observations. This is why the

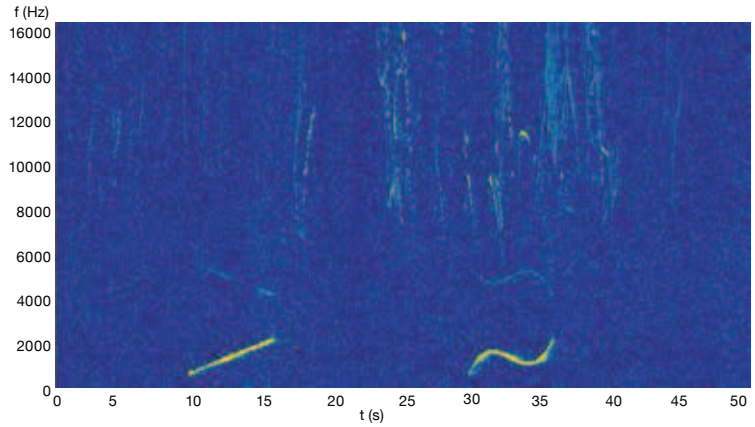

Fig. 1 – Example of time-frequency representation of a recording. The image makes it possible to estimate the signal frequency content as a function of time. The figure shows the whistles emitted by dolphins at high frequencies (above 8000 Hz) and signals emitted by the acoustic sources used in acoustic oceanography (under 2000 Hz). Source: Shom. ■

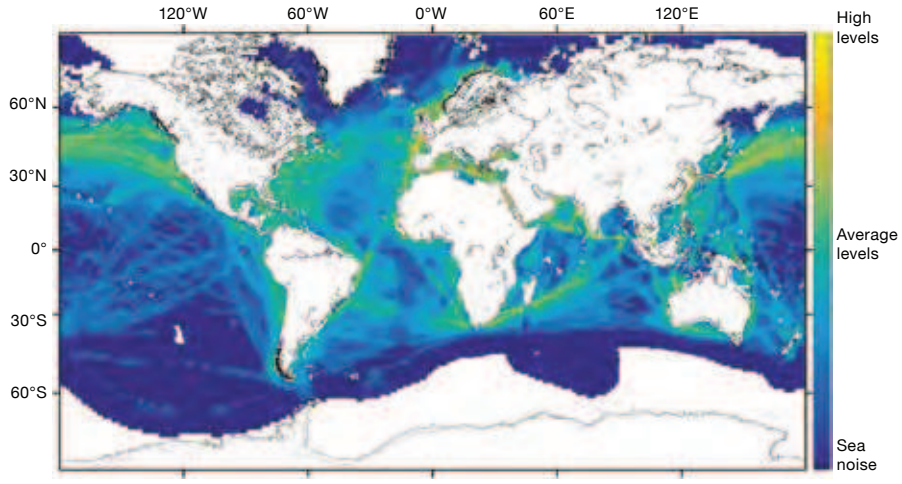

Fig. 2 – **Example of noise distribution of maritime traffic during the month of July 2012 for the one-third octave centered on 63 Hz.** The model is designed to estimate the sound levels produced by traffic and then propagate these levels at each point of the globe, in order to estimate the sound levels induced by traffic at different distances. Source: Shom and Lloyd's. ■

use of a second tool, spatial modeling, is essential. This enables noise levels to be estimated at the ocean basin scale (Fig. 2).

Too noisy an ocean?

Mass marine mammal strandings are a very strong ecological symbol, although the causes of such events are rarely precisely known. For beaked whales, more than 90% of mass strandings reported since the end of the 19th century took place after 1950; this period was marked by the development and intensification of the use of high-power sources, particularly in underwater warfare (sonars) and oil prospection (air guns). In particular, the linking of mass strandings with nearby naval exercises made it possible to formulate the first hypotheses of the traumatic impact of impulsive sources of human origin. The autopsy of animals stranded in the Canary Islands in September 2002, during an international military exercise, revealed lesions likely to be directly linked to decompression accidents, as well as acoustic trauma.

At the same time, the level of ambient noise is changing with the increase in maritime traffic. Several studies have compared the probability of stress in some whales caused by the noise of vessels. The risk of masking animal communications by boat noise is also an important issue. Changes in marine mammal vocalizations in terms of levels, durations or frequencies over several years of recordings were attributed to ambient anthropogenic noise.

A new environmental challenge

The effort of scientific research and the accumulation of knowledge have made it possible to publish increasingly urgent alerts on noise nuisance on marine life in general. These are beginning to be taken into account by environmental policies. In 2008, the European Community introduced underwater noise pollution into the Marine Policy Framework Directive. Implementation of nuisance risk management protocols, such as animal presence monitoring protocols, the soft start of sound emissions or acoustic damping have become common, encouraged and even regulated for certain uses. Other initiatives are also emerging, such as the incentive recently initiated by the Port of Vancouver in which quieter ships pay lower mooring costs.

The need to maintain anthropogenic noise at levels without risk to the health of marine ecosystems places human beings before the challenge of sound ecology: moving from the world of silence to that of harmony.

References

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