



# Soundscapes and ambient noise in the ocean

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## SUMMARY

Ambient noise in the ocean has been studied for around 80 years and many hundreds of papers have been published. It is called noise in the context of the operation of sonar, since it is the main noise against which sonar signals must be detected, even though it has included many studies from mechanisms of sound generation to the use of sound by marine animals. Generally ambient noise refers to the background noise from all sources, excluding sounds from individual identifiable sources. Recently, there has been increasing reference to soundscapes for what appears to be much the same phenomenon. This has coincided with the development of interest by biologists in ambient noise, mainly in the context of the effects of noise on marine animals and their use of sound. Is soundscape simply a trendy new name for ambient noise or is it something different? Judging by what has been published on ocean soundscapes, it seems to be little more than a trendy new name. However, the term soundscapes has been widely used for much longer in many diverse applications from music, to architecture to terrestrial ecology and covers more than just ambient noise. This paper examines the wider use of the term soundscapes in other applications. It considers how these compare with ambient noise in the ocean and how ocean soundscapes might be defined to be more than simply a trendy name for ambient noise as well as being consistent with usage in other areas. The concept of ambient noise as the background noise against which signals of interest must be detected means that ambient noise is both unwanted sound and a necessary component of the sonar equation. This applies equally to our sonars and to the use of sound by marine animals. Soundscape is a broader concept, including all sounds of the environment, including not just the ambient noise but also signals of individual sources, whether the signals of interest to the sonar operator or to a marine animal, or signals that interfere with the capability of the sonar or the animal to make use of sound. For the ocean context, probably the most useful analogy is with soundscapes in terrestrial ecology.

## 1 AMBIENT NOISE

The study of sounds in the ocean has traditionally been referred to as “ambient noise,” “sea noise” or “ambient sea noise” since it was first considered in terms of the background noise against which sonar signals have to be detected. In the many papers on ambient noise over the decades, the concept has somewhat broadened to a study of ocean sounds in general, their sources and their function. This has partly been to better predict ambient noise through better understanding its nature and occurrence but also as a study in its own right, and sometimes the term “ambient sounds” is used.

Probably the most useful and appropriate definition of ambient noise is that given by Urick (1983) as the noise from all sources excluding those that are close enough to be detected individually (on an omni-directional hydrophone) and noise from the recording system. For example, the general background noise from shipping (“traffic noise”: Wenz, 1962) is considered to be part of the ambient noise, but not the noise of an individual passing ship. The sounds of a fish chorus would be part of the ambient noise, but not the sounds of individual fish.

## 2 SOUNDSCAPES

The application of the term “soundscape” to underwater environments is relatively recent, but the concept of soundscapes has existed for decades. There are many definitions of soundscape and these cover such a vast range of concepts, from musical composition to the ambience of a restaurant, that the definition must be chosen suitable for the purpose. Some consider that, in the context of the sounds that an animal hears, the auditory perception of the animal is part of the concept of sound scape, and some see it in terms of a human subjective response to their sound environment. ISO 12913-1 defines a soundscape as the “acoustic environment as perceived or experienced and/or understood by a person or people, in context” and the “acoustic environment” as



“sound at the receiver from all sound sources as modified by the environment.” “Soundscape ecology” and “acoustic ecology” (Pijanowski, 2011) are applications to that have been used mainly in terrestrial ecology.

Brown (2014) provides a good discussion of soundscapes and their relationship to environmental noise in the context of human wellbeing, as well as providing examples of the many uses of the term “soundscapes”. The concept of “noise” as being the unwanted component of the sound field applies here as it does in the underwater context.

Generally, the concept of “soundscape” includes all sounds at a receiver and does not exclude those from individually detectable sources as is the case in the definition of ambient noise by Urick (1983). This is a clear and useful distinction. Ambient noise is a general background that does not depend on transitory nature of individually detectable sources but the sounds of these are essential components of the soundscape. A soundscape is, however, more than this, according to the various definitions available. It includes the information that the receiver (in this sense the sonar operator or the marine animal) gains about the environment through the received sound field. When applied to underwater sound, this information may be exploited by an animal or a sonar operator to provide an awareness of their surrounding environment, especially the presence of other sources, in an environment where most information over any distance comes acoustically. The soundscape could be considered to be the ambient plus the sounds from individually detectable sources and the information they contain.

### 3 DISCUSSION

There are therefore clear distinctions between ambient noise and soundscapes and the recent application of the term “soundscape” to describe ambient noise or ambient sounds seems inappropriate. By scientific precedent, the correct term is “ambient noise” or “ambient sounds.” Furthermore, there is considerable value in maintaining the distinction, particularly in the study of the use of sound by marine animals. The application of soundscape ecology to the terrestrial environment may be the most useful approach to follow for defining underwater soundscapes. A value of the concept of ambient noise is that it is inherently predictable over broad scales since it does not depend on the presence of local, individually detectable sources. This predictability has been used widely since the earliest studies for predicting sonar performance, examples being the Wenz curves (Wenz, 1962) or the Australian prediction methods (e.g. Cato, 1997) and will prove useful in studies of soundscapes.

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