Underwater sounds of two marine protected areas in southern Brazilian waters

The collection of sounds that emanate from an environment is known as soundscape in scientific literature. Marine soundscape is based on sounds related to geophony (physical events, such as wind, precipitation, breaking waves, earthquakes), biophony (mammals, fish, crustaceans), and anthrophony (man-made events). The soundscape plays an important role for the dynamics and evolution of oceanic ecosystems. The soundscape of a particular environment can be strongly linked to the specific characteristics of the plane and its local fauna; this is especially significant for undersea environments. Marine organisms have an important relation with its acoustic surroundings, since they depend on sounds for communications, mating, hunting, avoiding predators and for navigation.

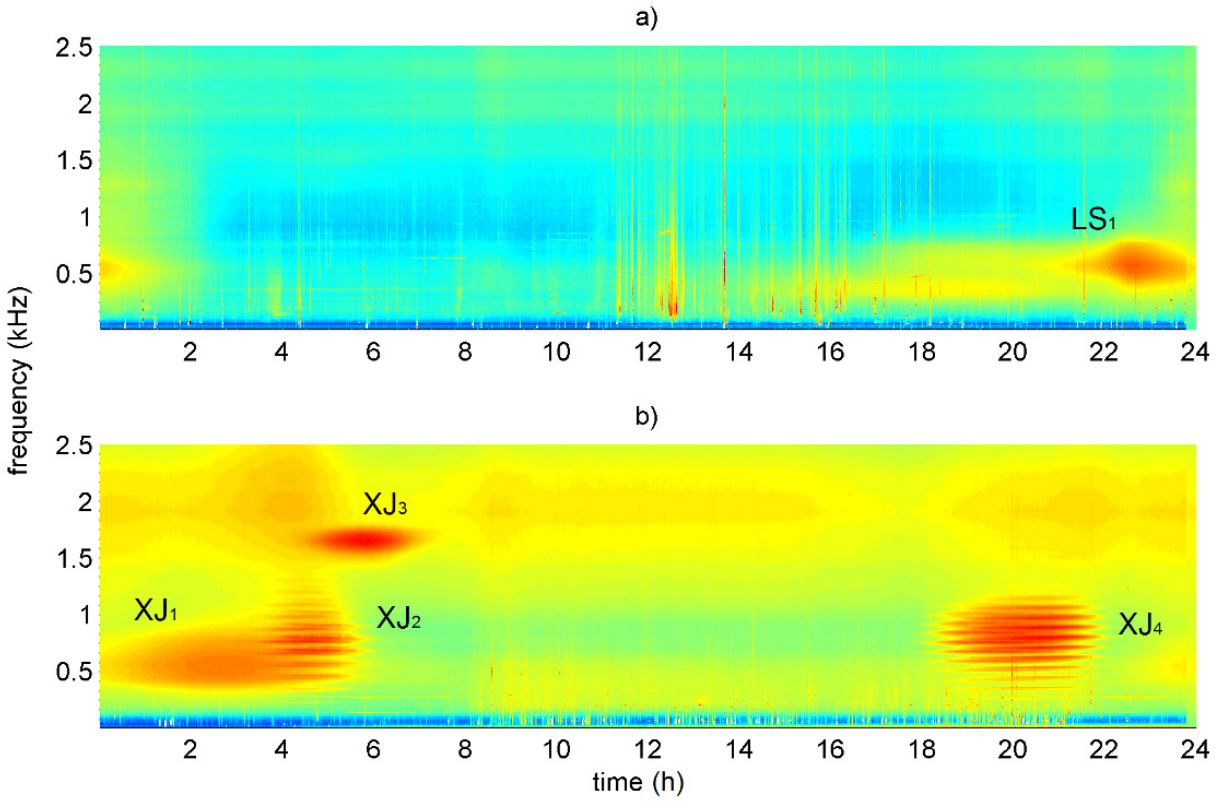

Fig. 1. 24-h mean spectrogram highlighting acoustic events with daily periodicities. For event naming, the letter indicates the site (LS for LSMSP and XJ for XJSP), and the suffix numerates the event for a specific location; a) LSMSP and b) XJSP.

Passive acoustic monitoring (PAM) is the tool commonly used to access terrestrial and aquatic

soundscapes. In contrast to active acoustic methods, passive ones do not generate any kind of sounds. Instead, PAM is based on "listening" (recording) the naturally occurrence of sounds to gather information of studied environments.

The present study exemplifies the uses of PAM to describe the soundscapes of the Laje de Santos Marine State Park (LSMSP) and the Xixová-Japuí State Park (XJSP). The LSMSP and XJSP are two protected areas located in the vicinity of Santos Bay, in the southwest of São Paulo State, Brazil. This region is recognized for having a great economic and ecological importance.

Major components of soundscape at both sites were originated by lasting acoustic events. The events showed well defined daily periodicities and exceeded background ambient noise for some hours every day, principally at dawn and dusk. The main acoustic event in LSMSP was a daily periodic event (LS_1) that occurs mostly between 21 h and 1 h. For the XJSP were observed four main daily periodic events (XJ_1, XJ_2, XJ_3 and XJ_4). The 24-h mean spectrogram (Fig. 1) highlights the characteristics of each event type, the estimated values of start and end for each event appear in Figure 2.

Event	Start	End
LS_1	21:00 h	01:00 h
XJ_1	00:00 h	05:00 h
XJ_2	03:00 h	06:00 h
XJ_3	04:00 h	07:30 h
XJ_4	18:00 h	22:00 h

Fig. 2. Estimated values of start and end for each acoustic event type

The origins of the events were not identified, but they are likely to be caused by fish chorus. In both protected areas, fishing activity is forbidden, so it is reasonable to suppose that these sites are favorable places to find fish shoals.

Sounds produced by fishes have been used by fishermen for centuries. One of the first references on fish sound production is actually from southern Brazil and came from a Charles Darwin’s correspondence. In 1867, Fritz Mueller communicated to Charles Darwin about the sound production of fishes in Santa Catharina. Nowadays is known that more than 700 species of fish produce sounds, many of which include commercially and recreationally managed species. Fish sounds are mostly produced in specific behavioral activities such as courtship and spawning,

aggression, disturbance, and feeding. In general, the most intense sounds are those associated with reproduction and often, as in other animals, only male produces sounds.

Traditional methods for research on fishes, although effective, are costly, and not necessarily practical for long periods of study. The temporal description of acoustic activity of fish shoals could be used as a pointer of reproductive behavior of fish. PAM brings to scientists the possibility to study soniferous (sound-making) marine animals for long periods of time, even in the absence of any visual information.

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Publication

Underwater soundscape of marine protected areas in the south Brazilian coast.
Sánchez-Gendriz I, Padovese LR
Mar Pollut Bull. 2016 Apr 15