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CAMBIOS EN EL PAISAJE SONORO MARINO DEBIDO AL RUIDO ANTRÓPICO

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ABSTRACT

We investigated the potential to use passive acoustics to access the impact of recreational boat mooring areas on ecologically sensitive habitats in the Western Mediterranean. Underwater sounds were recorded in mooring areas in Ibiza, Formentera and Tabarca Island harbours and compared with recordings in the Tabarca Marine Protected Area (TMPA). The number of fish calls/min,an estimated percent of time that different vocal pattern fish and the percent of boat noise occupancy were measured. Although fish sounds were much more prevalent at the TMPA site than the mooring sites, no strong relationship between boat noise and fish sounds was found. However, there was some support for the hypothesis that calls may have been masked during the summer. Our study demonstrates the critical need for research on the impact of acoustic noise “hot spots” such as recreational mooring areas on marine and freshwater soundscapes.

RESUMEN

Se ha investigado el potencial de utilizar la acústica pasiva para evaluar el impacto en las áreas de amarre de embarcaciones recreativas en hábitats ecológicamente sensibles en el Mediterráneo occidental. Los sonidos submarinos se registraron en áreas de amarre en los puertos de Ibiza, Formentera y Isla Tabarca y se han comparado con grabaciones en el Área Protegida Marina de Tabarca (TMPA). Se ha obtenido el número llamadas/min de los peces, un porcentaje estimado de tiempo, que diferentes peces de patrón vocal y el porcentaje de ocupación del ruido del barco. Aunque los sonidos de peces eran mucho más frecuentes en el sitio TMPA que los sitios de amarre, no se encontró una relación fuerte entre el ruido del barco y los sonidos de peces. Sin embargo, hay datos para apoyar la hipótesis de que las llamadas pueden haber sido enmascarados durante el verano. Nuestro estudio demuestra la necesidad crítica de la investigación sobre el impacto de los "puntos calientes" acústicos del ruido tales como áreas de amarre recreacionales en paisajes sonoros marinos y de agua dulce.

APPROACH

Anthropogenic noise is a growing threat to marine ecosystem inhabitants [1,2]](e.g., Andrew et al. 2002, Hildebrand 2005). The type of responses by marine organisms to noise effects range from small and temporary shifts in behaviour all the way to immediate death. Extreme underwater sounds, such as those produced by explosions (military activity, seismic surveys, constructions, etc.), research and military sonars or acoustic harassment devices, have been linked to conspicuous effects, including direct death and/or physical damage to fishes and sea turtles [3] and stranding and subsequent mortality of marine mammals [4]. Acoustic broadcasts used to disperse mammals away from aquaculture farms can also have unintended negative consequences on marine mammals and other organisms.
Lower levels of noise pollution can negatively affect marine organism in at least six ways:

1) Hearing capacity loss. This effect is more pronounced in fishes with anatomical adaptations to detect low sound levels [5,6,7] .
2) Putative distribution effects. There is some evidence of horizontal or vertical movements away from fishing vessels for Atlantic herring (Clupea harengus) and Atlantic cod (Gadus morhua) from the North Atlantic [8]. When exposed to vessel noise, captive tunas have been observed to change swimming direction, increase their vertical movements toward surface or bottom, and exhibit disruptions to their schooling behavior. However, to our knowledge there are no published studies that definitively link a rise in background noise to fish population density, changes in migration routes, or cessation of either feeding or spawning behaviours.
3) Fitness consequences. Stress is one of the ways that noise can affect fish physiology. The hypothalamo-pituitary-interrenal axis is stimulated by noises inducing secretion of the hormone cortisol, a glucocorticoid widely accepted to indicate the stress response of fishes [9] .Cortisol, breaks down stored lipids, which are transformed in glucose. Glucose levels may build up in the circulatory system or be quickly depleted if physical exertion also occurs during a behavioural response to the. High levels of cortisol have been linked with susceptibility to infection, [10], and decreased growth rates. The rise of heart rates is another common physiological consequence.
4) Masking of acoustic communication. Sound travels five times faster and attenuates less in water than in air, so it is an efficient way to broadcast important information rapidly and for long distances. For example, it is used in courtship calls, spawning or other social aggregations [11], and in agonistic interactions, [12]. However, these same underwater acoustic features increase signal overlap between biological sounds and anthropogenic noise and can result in significant reductions in communication distances. [13] calculated that a small boat passing an individual drum fish (Sciaena umbra) at a speed of 6 knots and a distance of 10m, dramatically reduces its capacity to detect conspecific sounds from 500 m to 10 m. They similarly found reductions of 10 m to 1 m in detection distances for Gobius cruentatus and Chromis chromis. In [14], Picciulin et al.found evidence that Sciena umbra was capable of increasing the acoustic drum rate of its call suggesting some scope for vocal compensation for noise effects.
5) Predator-prey interactions. Sound detection capacity is advantageous to locate prey or avoid predators [15]. The reduction of the signal to noise ratio by human actions decreases signal detection by both predators and prey and therefore has been suggested to be a significant potential impact on the soundscape [16,17] .
6) Putative larval disorientation. Reef sound is an orientation cue to reef settlement by Decapodae, fishes [18] (Tolimieri et al. 2000) and oyster larvae [19]. Anthropogenic sounds could thus disrupt settlement.

The Mediterranean coast is visited by millions of tourists each year, peaking in the summer months, when water transportation, fishing and recreation activities that involve boating increases dramatically. One important consequence of the tourist industry in the region is that it

targets the most pristine and ecologically sensitive habitats. Boat mooring, and recreational boating activities, therefore, likely dramatically increase anthropogenic noise in the most ecologically sensitive locations during the peak tourist season. In addition, summer coincides with reproduction time for numerous Mediterranean fishes that use sound in some reproductive phase [20,21]. Despite the potential for a high risk of detrimental effects to the marine soundscape during peak tourist seasons, studies on the putative changes in the soundscape of sensitive marine habitats that serve as mooring areas have not been conducted to date in the Mediterranean, or to our knowledge anywhere in the world.

We hypothesized that the mooring areas will have an adverse impact on the biophonic component of the soundscape through increased noise, or other mechanisms, which will result in significant declines in the detectable biophonic components in mooring areas during the peak summer tourist season compared to the fall off-season. Potential mechanisms of mooring location impacts on biophonic components of the soundscape include:

1) Direct noise effects (e.g. masking of calls, inhibition of calls under noise stress, or avoidance of noisy area),
2) Reduction in occurrence of sound producing species due to physical disturbance or fishing activities associated with boating activities (anchorage, mooring buoys and chains, propeller scouring, wake affects, pollution, etc.). Thus, we conducted a preliminary study to examine the potential of mooring areas to negatively impact the natural soundscape by comparing three mooring area locations with a protected location, and later comparing seasonal changes between one mooring area and a protected area.

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