HEARING UNDER AMBIENT AND SHIP NOISE CONDITIONS: A CASE STUDY ON FISHES FROM A PROTECTED AREA IN THE ADRIATIC SEA

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1. Introduction

Anthropogenic noise emanating from ship and boat traffic causes growing concerns because it might hinder acoustic orientation and communication in vocalizing fish species. The Miramare Marine Natural Reserve is located in a coastal area of the Gulf of Trieste (North Adriatic Sea, Italy) characterized by considerable commercial and recreational boat traffic. Noise emanating from this source is an inevitable factor for fishes living in this reserve. The present work aims to understand to what degree ambient noise and recreational boat noises affect the auditory sensitivity and, subsequently, acoustic communication of two local vocal species, the damselfish *Chromis chromis* (Pomacentridae) and the drum *Sciaena umbra* (Sciaenidae).

2. Methods

The noise emission of a cabin cruiser, 8.5 meters in length with a 163 HP inboard diesel engine operating at its maximum speed (6 knots), was sampled inside the Reserve with a Pioneer DAT Recorder DC-88 (44.1 kHz) cabled with a Reson TC4032 hydrophone (sensitivity –170 dB re 1 V/µPa). The measuring distance was 10 m in a water depth of 10 m over an 18-m-deep muddy bottom. Ambient noise was recorded, and sound pressure levels were determined at the same site and depth.

Auditory sensitivity to tone bursts of various frequency was determined in the laboratory, either under quiet conditions or in the presence of each noise type previously recorded in the field utilizing the auditory-evoked potential (AEP) recording technique as described in Wysocki & Ladich (2005).

3. Results

The drum *S. umbra* possesses a broader hearing bandwidth and lower thresholds than the damselfish *C. chromis* under quiet laboratory noise conditions. In the presence of ambient noise, hearing in both species was only slightly masked, in particular at lower frequencies. In contrast, the auditory thresholds increased by approximately 35 dB in *S. umbra* and 20 dB in *C. chromis* in the presence of boat noise.

4. Discussion

As demonstrated for other fish species (Amoser & Ladich 2005; Lugli & Fine 2003; Scholz & Ladich 2006; Vasconcelos et al. 2007), the hearing abilities of the drum *S. umbra* and the damselfish *C. chromis* are well adapted to the local ambient noise environment. However, noise emanating from a cabin cruiser in the low-frequency range potentially worsens sound detection in both species. Masking occurred especially between 200 and 300 Hz, a frequency range where intraspecific acoustic communication takes place (Picciulin et al. 2002, this volume). In accord with our observation, Vasconcelos et al. (2007) showed that ferry boat noise decreases the ability to detect mating and agonistic sounds in the Lusitanian toadfish *Halobatrachus didactylus*. Thus, these two studies are the first ones to indicate that anthropogenic noise impacts acoustic communication in representatives from three nonrelated marine fish families inhabiting European coasts.

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6. References

Amoser, S., & Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *J. Exp. Biol.* **208**, 3533-3542.

Lugli, M., & Fine, M. L. (2003). Acoustic communication in two freshwater gobies: Ambient noise and short-range propagation in shallow streams. *J. Acoust. Soc. Am.* **114**, 512-521.

Picciulin M., Costantini, M., Hawkins, A. D., & Ferrero, E. A. (2002). Sound emissions of the Mediterranean damselfish *Chromis chromis* (Pomacentridae). *Bioacoustics* **12**, 236–238.

Scholz, K., & Ladich, F. (2006). Sound production, hearing and possible interception under ambient noise conditions in the topmouth minnow *Pseudorasbora parva*. *J. Fish Biol.* **69**, 892-906.

Vasconcelos, R. O., Amorim, M. C. P., & Ladich, F. (2007). Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish. *J. Exp. Biol*. **201**, 2104-2112.

Wysocki, L. E., & Ladich, F. (2005). Hearing in fishes under noise conditions. *J. Assoc. Res. Otolaryngol.* **6**, 28-36.