The characterisation of underwater noise at facilities holding marine mammals

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Abstract

A collaborative effort was undertaken to delineate underwater noise levels within holding enclosures at marine mammal facilities. Ambient noise levels were measured under normal operating conditions in the enclosures of 14 participating facilities. Facility habitats varied from ocean environments to fully enclosed pools. The means and standard errors of the noise pressure spectral densities measured across all pools were similar to those measured in natural coastal environments with relatively low presence of anthropogenic noise. Highest levels of noise in land-based pools were generally at frequencies < 2 kHz and primarily due to the operation of water treatment/filtration systems. Noise levels in land-based pools were comparable to or lower than semi-natural and natural systems at higher frequencies because of the presence of biological noise sources in these systems (eg snapping shrimp [Alpheus spp]). For odontocete enclosures, the whales themselves were often the greatest source of sound at frequencies where the whales have their best hearing (~40–100 kHz). The potential for facility ambient noise to acoustically mask odontocete communication signals and echolocation clicks appears to be low. In general, when noise was elevated it was at frequencies outside the typical frequency ranges of whistles and echolocation clicks, and where odontocetes have poor hearing sensitivity. Occasional noise issues were found; it is therefore recommended that facilities periodically assess enclosure noise conditions to optimise animal management and welfare.

Keywords: animal enclosures, animal welfare, bottlenose dolphin, California sea lion, marine mammals, noise

Introduction

The majority of marine mammals held at marine mammal display facilities include bottlenose dolphins (*Tursiops truncatus*) and sea lions (*Zalophus californianus* or *Otaria flavescens*). To a lesser extent, killer whales (*Orcinus orca*), belugas (*Delphinapterus leucas*), pilot whales (*Globicephala* spp), Commerson’s dolphins (*Cephalorhynchus commersonii*), harbour seals (*Phoca vitulina*), and sea otters (*Enhydra lutris*) are also held, along with a few other exotic species. Many of these marine mammals have excellent hearing sensitivity underwater and exhibit a greater frequency range of hearing than humans (eg Johnson 1967; Reichmuth et al 2013). Relatively little in the way of characterising the underwater acoustic environments of marine mammals under human care has been performed, yet these environments are potentially exposed to sounds that are inaudible in air (eg coupled through the enclosure walls) and inaudible to human caregivers (ie above the frequency range of human hearing but audible to many marine mammals). A lack of information on ambient noise within marine mammal facilities has led to speculation about the quality of the acoustic environments and the potential for sound to negatively impact marine mammals at these facilities. For example, some have speculated that marine mammal enclosures may be subject to high levels of noise from life support systems (LSS; eg water filtration and treatment) and other facility operations (Williamson et al 2011). Conversely, others have suggested that marine mammal facilities provide environments that are acoustically sterile and that animal acoustic behaviour becomes abnormal as a result (eg reductions in the production and amplitude of echolocation signals by odontocetes, such as dolphins and belugas; Rose et al 2009). The experience of chronic stress due to these opposing acoustic conditions has also been hypothesised (Williamson et al 2011). Little comprehensive reporting on the acoustics of marine mammal facilities exists. Scheifele and colleagues (2012a,b) recorded noise levels at the Georgia Aquarium in order to characterise the impact of LSS operations and in-air sound (eg music and sound effects) on underwater noise levels within the dolphin and beluga exhibits. They concluded that LSS operations contributed mostly to frequencies below 1,000 Hz, where dolphin hearing is relatively insensitive, and that the playback of soundtracks did