# Research Note

# Acoustic Habitat Degradation in the IOR due to Shipping and its Management

**Maritime Research Centre, Pune**

**Devansh Sharma , Shridhar Prabhurman & Arnab Das**

## ❑ Background

Unlike other forms of energy (such as heat and light), in the ocean acoustic energy propagates efficiently, traveling fast and potentially over great distances especially at low frequencies. These characteristics of underwater sound have beneficial, as well as detrimental, effects for marine life. Many marine animals rely on sound for survival and depend on unique adaptations that enable them to communicate through clicks, whistles, moans, and wails. They use it in ***foraging*** for food, ***navigation by echolocation***, and understand their environment. They may both produce sounds and listen to the sounds around them.

***Sounds are particularly useful*** for communication because they can be used to convey a great deal of information quickly and over long distances. Changes in rate, pitch, and/or structure of sounds communicate different messages. Fishes and marine mammals use sound for communications associated with reproduction and territoriality. Some marine mammals also use sound for the ***maintenance of group structure*** communicating[1]. These large-scale changes in the acoustic environment are of particular concern for marine mammals [2]. There is growing evidence that marine mammals perceive anthropogenic noise sources as a form of risk, which is then integrated into their ecological landscape, affecting their decision-making processes.

**Underwater ocean ambient noise -**

Ambient noise is that part of the noise independent of the observation system and always present in some form in the sea. They have increased by ~ 15 dB in the past 50 years due to increased marine transportation, resource extraction, fishing, recreational activities, and other anthropogenic sources. It was noted that continuous anthropogenic noise in the ocean was primarily generated by shipping[3]. The Indian Ocean (IO) extends over 30% of the global ocean area. The Indian Ocean Region (IOR) has become strategically very important in the 21 st century with over 50% of the shipping traffic passing through and also the presence of naval fleet to protect their economic interest.[4]

**Impacts of Shipping Movements -**

Noise associated with shipping has the potential to cause disturbance to marine animals, including the marine mammals, fish, and birds designated under the Habitats Directive. From 200 Hz to 10 Hz shipping noise is dominant. The main source of noise from vessels is generated by the engine, which may travel via the atmosphere or be transmitted through the structure of the craft. The volume of sound generated and transmitted into the air or water will depend on the size, design, and location of the engine, and the craft's size and construction.

Commercial vessel engine noise, usually a low-frequency sound, may contribute to masking and habitat displacement. Intense low or mid-range sonar, used by the military and in seismic surveys for oil and gas exploration, as well as ocean floor mapping, can result in any or all of the effects listed below, as can pile driving and any type of explosion. Dredging, drilling and bottom-towed fishing gear all have impacts.

## ❑ Assessment of Degradation

Underwater Radiated Noise from commercial ships is generated during normal operation, most notably from propeller cavitation which is known to peak at 50–150 Hz but can extend up to 10 000 Hz.[5] An emerging concern in terms of increased shipping traffic and the increased potential for sound impacts and strikes. This industry trend should be particularly considered regarding marine mammals and noise because the routes involved in this emerging market are almost exclusively in nearshore environments. Accelerated loss of coastal and marine biodiversity components over the last few decades has been of great concern. The following documents are pivotal in this regard -

- NCPS Meeting (10th July 2018)[6] discussed threats posed to Marine Life in the Western Indian Ocean from Anthropogenic Ocean Noise and Shipping. They presented a graph of the spectrum of noise levels against frequency where they showed the interference of shipping noise with the frequency band used by a few marine species.
- Halliday, W. D. (2017)[7] in their work emphasized the impacts of shipping noise on marine species and represented sound levels affecting the behavior of marine mammals.
- W. John and Charles Greene (2013)[8] documented disturbance reaction to the various class of marine species, analyzed their responsiveness and audibility capabilities influenced by noise. In addition to that psychological stress, habituation and long term effects were also discussed.
- Peter L. Tyack [9], simulated the interference of shipping noise with the communication of marine mammals. Moreover, concerned about the Consequences to Individuals and Populations of Disturbance Responses
- Christine Erbe (2014) [10] illustrated the noise density hotspots, mapped marine mammal density in the Pacific region. They marked the areas where noise is high and animal density is high which can be identified in their risk maps, indicating where marine spatial planning efforts have the most impact.
- Peng, C. (2015)[11], this paper gives a brief overview of acoustic masking and physiological damage caused to the hearing system of marine mammals by anthropogenic noise. They validated this by studying different taxa being affected by anthropogenic noise.

❑ **Species Vulnerability -**

In marine fauna, moderate noise levels are known to provoke startle or avoidance responses in many taxa [20][21], and to increase metabolism and reduce growth and reproductive rates in brown shrimp (*Crangon crangon*)[22]. High noise levels have been reported to damage the auditory system of fish and cephalopods [21],[23] and cause hearing loss in dolphins[24]. In the wild, geophysical seismic surveys have been singled out as the cause for atypical mass strandings of giant squid (*Architeuthis dux*) with extensive tissue damages [20] while navy sonar has been implicated in the mass strandings of some whale species. [23],[22]

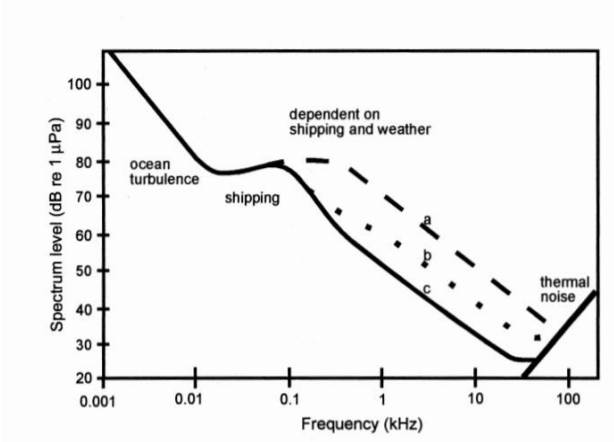


**Figure 1- Ambient spectrum level (1-200) Hz. [18]**

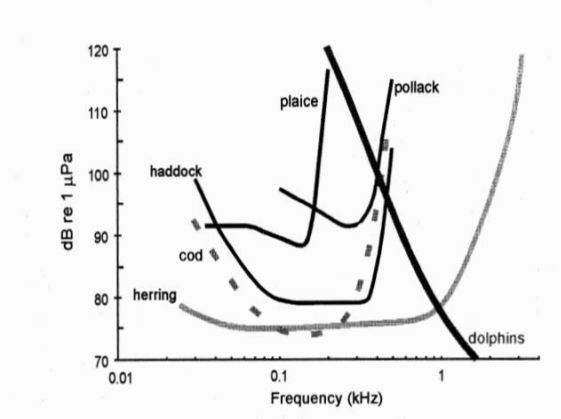


**Figure 2- Fish hearing threshold. [18]**

## ❑ Regulatory Framework And Management -

Territorial waters of the five IOC Countries span more than 5.5 millions sq km.[12] One -half of the world fleet owned by entities of Asia.[13] In the SOLAS regulations, there are rules set about noise on board of ships but no regulations are present for noise emissions to the surrounding area. The fact that ships mostly sail under foreign flags doesn't help to set noise limits either. Where ships owners and terminal owners are connected, authorities have more influence[14]The International Maritime Organization's (IMO) work in relation to noise, began with addressing the effects of noise on humans aboard ships in the early 1980s, through the adoption of a Code on noise levels on board ships by the Maritime Safety Committee (MSC) which has since been updated at regular intervals.[15]

- **Altered Shipping Routes-**
  A common step to reduce ship-strikes is to alter shipping routes in different areas or at different times when whale concentrations are high. Panigada (2006) [16] in his work showed Mediterranean fin whales at risk from fatal ship strikes.

- **Vessel Speed Restrictions-**
  Only a few areas are specified with vessel speed restriction area is currently endorsed by the IMO. Conn, P.B. (2013) [17] showed how can vessel speed restrictions can reduce the risk of mortality of whales in North Atlantic

- **Technical solutions -**
  Technical solutions are required to enhance environmental stewardship. Some experts consider the shipping industry as a leader in green technology and this industry has huge potential to adopt green technologies.

## ❑ Way Ahead

The development of best practice scenarios will require that governments, the shipping industry, and civil society work together. The urgent implementation of national and regional noise-limiting and ship-strike prevention guidelines is considered essential. Regional guidelines should be in keeping with current global best practice for IOR. These include those of CMS, the IMO, the IWC, CBD, IUCN, and the World Bank.

**Vessel Routing Density and Species Vulnerability Mapping** - Determine (via some direct measurements followed by modeling) how increases in vessel routing density or the development of new routes (particularly coastal) will contribute to local ambient noise levels. Species in the IOR can be mapped as per their prone to vulnerability and thus appropriate measures can be taken.

**Marine Traffic impact assessments** -Determine whether marine traffic impact assessments and risk-based methodologies offer opportunities to understand and potentially mitigate anthropogenic noise impacts on marine mammals.
Perform additional and more extensive controlled exposure experiments on behavioral reactions of marine animals to vessel noise. In other words, determine species-dependent dose/response relations for noise from various vessel classes. Conduct habituation/dishabituation experiments on both captive and free-ranging marine mammals.

**Underwater Acoustic monitoring** - Replicate local and regional underwater acoustic monitoring efforts in untested ocean areas as a means of more fully understanding variability in both natural and anthropogenic sources on daily, seasonal, and annual timescales.

**High traffic areas** (e.g., coastal regions and shipping routes) should be studied in regards to physiological and behavioral effects within marine animal populations. Further research could, in the long-term, elicit recommendations for potential changes to vessel routes based on affected areas. Specifically, stranded animals resident in high traffic areas should be investigated for evidence of permanent hearing loss that may be attributable to noise exposure.

## ❑ Conclusion -

Thus, underwater noise is clearly a serious issue for marine species, although the full scale of the problem is difficult to determine. Guidance in terms of implementing cost-effective quieting technologies rather than developing standards or regulations may be a more effective approach in engaging the shipping industry. A regulatory structure may be counter-productive to developing a collaborative working relationship between the industry, regulators, and scientists on this environmental issue. Major steps and guidelines need to be framed for IOR.

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