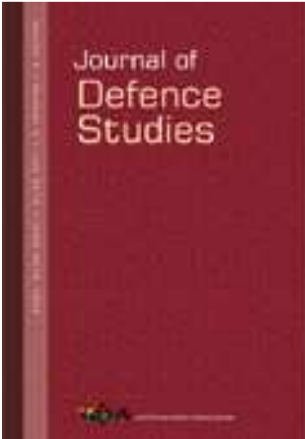


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Marine Eco-concern and Its Impact on the Indian Maritime Strategy

*Arnab Das**

Maritime strategic planning cannot be done in isolation of marine eco-concerns. Marine species are known to perceive the environment around them through acoustic signals, and depend on sound for numerous functions like foraging, communication and navigation. Noise as a pollutant has found scant reference in the United Nations Environmental Programme (UNEP) document of 1982—the United Nations Convention on the Laws of the Seas (UNCLOS). The International Maritime Organization (IMO) is yet to include noise as a pollutant in its 1978 MARPOL Convention. The enthusiasm for so-called economic growth and related activities in the absence of a regulatory framework encourages indiscriminate rise in such activities and the resultant increase in the anthropogenic noise, with disastrous impact on the acoustic habitat. A more inclusive maritime strategy is thus called for. In this article, the author presents a unique dimension for Indian maritime strategy.

INTRODUCTION

The continental outlook in our post-independence grand strategy has, for a long time, cost us a lot in terms of limited marine infrastructure and strategic thinking towards the maritime dimension.¹ However, in the recent past, there have been concerted efforts and initiatives to undo the sea-blind approach. The grand strategy approach recognizes

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the importance of the comprehensive maritime strategy as an instrument of economic and political growth for a maritime nation like India.² The numerous agencies of the government have initiated substantial measures to augment infrastructure and policy framework to encourage larger participation in the maritime domain.³ In keeping with this, on 16 October 2006, 'the Indian Navy declared it had established its first ever maritime strategy.'⁴

The heightened maritime activities of India are being watched closely and are creating some amount of unease among thinkers worldwide regarding her intentions: 'India has an expansive maritime strategy. Driven by great power aspirations and by strategic rivalry with China, India is expanding its naval capabilities and security relationships throughout the Indian Ocean Region.'⁵

Legitimate maritime growth is vital to our national interests and India will certainly carry forward its ongoing maritime activities with vigour and strategic prioritizing. While India wants to avoid a backlash to its increasing focus on the maritime domain, adding the marine eco-concern dimension into its maritime strategy will certainly provide it a geopolitical edge. Thus, India's efforts at taking leadership in the issue of marine eco-concern and coming up with a comprehensive regulatory framework and monitoring mechanism for noise pollution in the Indian Ocean Region (IOR) will certainly assuage some of the concerns of an aggressive intent in our maritime strategy.

Large-scale undersea exploration will continue and intensify in days to come, in order to be able to meet the requirements of the growing population and the corresponding economic growth momentum. However, unregulated maritime activities could have catastrophic impact as being manifested through frequent natural calamities the world over. A planned and regulated growth model will ensure sustained development and remain in sync with the globalized world order.

Environmental policy initiatives in the past, all over the world, have resulted in certain 'focusing events' that created significant public outcry and the political leadership had to submit to the growing public demand.⁶ However, the noise from marine platforms—categorized as diffuse pollution—that causes an overall increase in the background noise in the ocean is a slow process which has grown significantly over the last six decades.⁷ The marine species are known to use sound for biologically significant activities like foraging, navigation and communication, and the rising ambient noise is adversely affecting their well-being due to the

acoustic degradation of their habitat. The higher levels of ambient noise are masking their ability to perceive the environment around them and causing psycho-acoustic disorientation and resultant stress. The impact (masking of the marine species) of higher background noise in the oceans has been gradual, but it is highly catastrophic and irreversible. Such habitat degradation due to poor acoustic perception by these marine species could lead to a reduced or weak population.

Shipping noise is the single ubiquitous source of noise in the ocean. With the continuous increase in the shipping traffic, the radiated low-frequency noise from these platforms has much larger area of impact.⁸ Significant research findings are available today to substantiate the growing concern for the marine ecosystem.⁹ The present availability of research inputs and technology support does not augur well with the consistent ignorance that our policymakers pretend regarding this aspect. Urgent measures are required to avoid catastrophic degradation of the marine ecosystem.

There has been growing awareness regarding this concern the world over and numerous forums are conducting events to sensitize stakeholders. In the US, the National Oceanic and Atmospheric Administration (NOAA) conducted an international symposium in 2004 at Arlington, Virginia. The symposium was aimed at identifying the technology and policy gap to initiate regulatory measures. Subsequently, Okeanos—Foundation for the Sea organized an international workshop on ‘Shipping Noise and Marine Mammals’ at Hamburg, Germany, in 2008. Hamburg was seen to be the best location for this as Germany is a globally important supplier of ship equipment and the world’s fourth leading shipbuilding nation, with Hamburg being a capital of ship owners and operators (representing 36 per cent of the world’s container ship fleet). Hamburg is also home to Germanischer Lloyd, which classifies most of the world’s container ships. Numerous other forums worldwide have already organized such events to create significant public awareness to build up political pressure for such measures to come, and will do so in the future.

It suffices to say that there is growing awareness today and that regulations are in the process of being formulated and will soon get enforced globally.¹⁰ The IOR has very unique propagation characteristics and Indian maritime strategy has to be geared up to formulate specific regulatory framework and monitoring mechanism that is relevant to the tropical littoral conditions. Otherwise, our maritime industry will find it hard to compete with the global players in future.¹¹ This article

attempts to highlight the growing degradation of the marine ecosystem due to unregulated economic activities in the maritime domain. It further cautions regarding the global regulations being applied to the IOR in the future and the possible fallout.

MARITIME STRATEGY AND MARINE INDUSTRY

India's destiny has always been intricately linked to the sea, and events in history testify the same. Right from ancient to medieval and modern history, every era of intense maritime activity has been associated with economic prosperity and political stability. India, with its over 7,500 km long coastline, cannot ignore its maritime dimension while formulating its national strategy.¹² Yet, India has traditionally been considered as being sea blind.

However, in the twenty-first century, our grand strategy has been extremely sensitive to the maritime dimension and consequently, significant resource allocation and policy initiatives have taken place. The recently published book, *Grand Strategy for India: 2020 and Beyond*, emphasizes the maritime dimension of India's national strategy.¹³ The volume is the product of a four-day international conference on 'India's National Security Strategy', 20–23 December 2010, at the Institute for Defence Studies and Analyses (IDSA). The conference launched the IDSA National Strategy Project (INSP). The Ministry of Shipping (MoS) announced its first-ever comprehensive 'Maritime Agenda: 2010–2020' in January 2011.¹⁴ Thereon, the Planning Commission, on its part, constituted a working group for implementing the provisions of the MoS-charted maritime agenda in the Twelfth Plan (2012–17). The Ministry of Defence (MoD), on its part, constituted the joint Confederation of Indian Industries (CII) and Boston Consulting Group (BCG) committee and published a report in March 2012.¹⁵ This was a serious effort to revamp the domestic defence sector. The report analyses the growth potential of the warship production in India in line with the Twelfth Plan announced by the Planning Commission and the 'Maritime Agenda' (2010–2020) declared by the MoS.

MOD promulgated an Offset policy in 2005 as part of DPP-3, 2005, which aims at leveraging India's big ticket acquisition by bringing in FDI, fostering JV arrangements, sub contracting products and services, boosting exports, setting up MRO facility to bolster indigenous military industry capability. The scope of offsets which

was direct was extended to civil aerospace sector and homeland security products in DPP-4, 2011.¹⁶

The suitable amendment to the Defence Procurement Procedure (DPP), promulgated by the MoD, has facilitated participation of the private players in the rapidly growing warship-building industry in India. Significant infrastructure investments, both in the public as well as private sectors, are being seen in the shipbuilding industry. The majority of shipbuilding orders in India are from the MoD for the Indian Navy and Coast Guard. It is ironical how the regulated radiated noise, termed as acoustic stealth, has not been able to emerge as a priority area for the growing shipbuilding industry.¹⁷ The mature acoustic stealth standards that are being implemented in the warships have not been able to percolate to the commercial shipbuilding or even to Coast Guard platforms being designed and developed by the same shipyards. Indian Navy ships are designed and monitored by their in-house design directorate; however, the same technology and procedures are not provided for or implemented in commercial shipping by profit-conscious shipyards in the absence of regulatory obligations.

The rapid growth in marine infrastructure has coincided with heightened coastal activities in terms of dredging, piling, movement of marine crafts, underwater explosions, etc., thereby causing increased anthropogenic noise in these regions.¹⁸ The tropical littoral waters are known to be rich in biodiversity and the increased ambient noise levels are likely to have devastating impact on the marine ecosystem causing habitat degradation. It is well known that 90 per cent of the marine species globally inhabit the 7 per cent coastal regions, where the impact of anthropogenic noise is likely to be most dominant due to heightened human activities. The characteristics of the ambient noise sources need to be matched with the acoustic characteristics of the marine mammal hearing to ascertain the precise cause and effect in a specific region. The vulnerable species need to be identified and listed in Schedule 1 of the Indian Wildlife (Protection) Act, 1972. Figure 1 gives some indicative levels.¹⁹

The major concern in India is the lack of credible inputs on the extent of degradation of the acoustic habitat of the marine ecosystem. Conservation efforts in India have largely remained with marine biologists and study of underwater noise pertains to the acoustic signal processing domain. In the absence of multidisciplinary efforts, any stranding events in India have been attributed to reasons best understood by the marine biologists. The noise monitoring and acoustic study aspect has remained

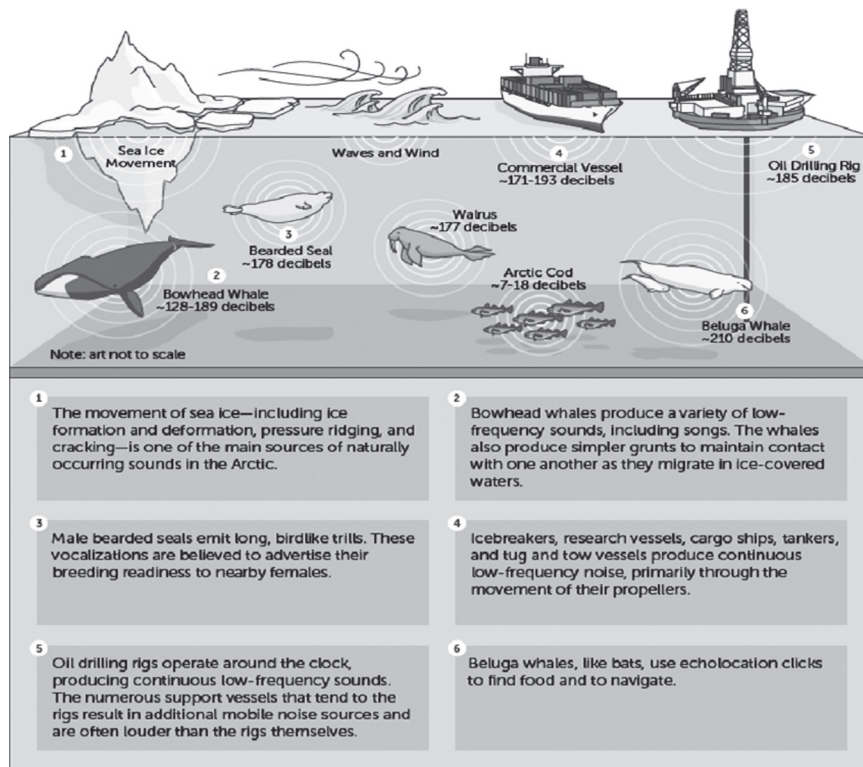


Figure 1 Typical Sound Sources in the Arctic Considered Highly Vulnerable Areas²⁰

unheard off and has never managed to surface in any marine conservation efforts. Role of academia and effective collaboration between policymakers and researchers has always been a weak area. Underwater technology has largely been limited in the Indian academic curriculum, and the lack of participation from the corporate sector and limited funds availability for credible research further adds to the bewilderment. Furthermore, the relative inaccessibility of the marine space for researchers and scientific community also makes the situation worse.

Globalization has completely changed the way we look at resources and particularly the maritime space. The phrase 'securing the commons', normally used for the security aspect, needs to be extended to the management of the marine ecosystem as well. The maritime commons beyond the exclusive economic zones (EEZs) of nations is a shared space not subject to any nation's sovereignty or control and, for that reason, all

states have an obligation to promote and enforce the public order necessary to prevent any degradation. 'Noise', due to its transborder nature, cannot be regulated by any nation alone and will require a broader framework with strong technological backing and enormous research inputs.²¹

India, with its geographical location and geopolitical setting in the IOR, has to play a leading role to retain its strategic position. The tropical littoral waters of the IOR present a very unique challenge in terms of underwater propagation of sound. Thus, the acoustic signals from the anthropogenic source, and even the marine mammals, undergo site-specific modification before being received by the marine mammal. The general assumptions of underwater sound behaviour do not hold good in these waters as reflected in suboptimal sonar performance.²² The detailed study of the noise pollution in the oceans and its impact on the marine ecosystem specific to the IOR is called for. The Indian maritime strategy needs to recognize the noise dimension and its impact on the marine ecosystem, and then work out its fallout on the numerous aspects of maritime resource management and strategic planning. The reputation of a proactive environmentally conscious maritime nation could provide significant advantage to our future trade relations, and also for political and economic considerations. Economic, political and technological dominance always provide a leverage for the maritime forces to play a more diplomatic and regulatory role rather than an aggressive role for military posturing.

UNDERWATER NOISE AND ITS IMPACT

Underwater noise or ambient noise in the ocean is caused by multiple sources, both natural as well as man-made (anthropogenic). Natural sources include wind noise, biological noise, seismic noise, among others, and the anthropogenic noise sources include noise as a result of human activities, including shipping, industrial activities, underwater explorations, sonars, etc. Sustained human activities in the maritime domain over the last few decades have ensured continuous rise in the ambient noise in the ocean. Measurement of acoustic signal for any sonar application, including biosonar for marine mammal hearing, is possible only if the received amplitude exceeds a minimal threshold determined by the receiver capability and the ambient noise. Increasing background noise could overwhelm the minimum detection threshold of the sonar receiver and limit its performance. Ambient noise is that part of the background noise that is an average level observed over a prolonged

duration. It does not take into account the momentary fluctuations due to transient sources. The ambient noise in the ocean has different sources and varies with location and frequency.²³

Natural sources include ocean turbulences and microseisms in the very low-frequency band from 0.1 Hz to 10 Hz. The next higher level is the wind-induced surface noise between 1 kHz and 30 kHz, which is very dominant. At very high frequencies above 100 kHz, thermal noise of water molecules begin to dominate. Even biological sound at varying frequency bands generated by numerous marine species inhabiting the ocean contributes to the overall ambient noise in the ocean.²⁴ The marine mammals adapt very well to the natural sources of ambient noise as these do not change significantly over short durations. However, it is the anthropogenic noise that is a real cause of concern.²⁵

The most dominant, man-made ambient noise source is distant shipping in the low-frequency band from 10 Hz to 1.5 kHz. Seismic explorations also use low-frequency sound (below 100 Hz) to probe deep into the seabed. Sound sources include air guns, vibroseis and explosives. Acoustic thermometry of ocean climate (ATOC) uses low-frequency sound to measure the global ocean temperature. Sonar transmissions vary from mid (1 kHz–25 kHz) to high (beyond 25 kHz) for both military and commercial applications.²⁶ Low-frequency analysis and ranging/recording (LOFAR) sonobuoys can also be used.

The propagation characteristics of the underwater ocean environment cause high attenuation of the signals at higher frequencies. Thus, the ambient noise spectrum levels decrease with increasing frequency from about 140 dB re 1 $\mu\text{Pa}^2/\text{Hz}$ at 1 Hz to about 30 dB re 1 $\mu\text{Pa}^2/\text{Hz}$ at 100 kHz. Lower attenuation in the low-frequency band translates to larger propagation ranges and thus, have a much wider impact undersea.²⁷ The low-frequency sound sources, like the distant shipping noise, have much bigger influence on the background noise. Figure 2 presents the detailed ambient noise spectrum in the deep oceans.²⁸

According to documented data, there are more than 90,000 ships of different types that are larger than 100 gross tonnes in the world and each introduces noise into the marine environment.²⁹ Commercial ships have been increasing in both number and size, and are producing ever-greater amounts of underwater noise as an incidental byproduct of their operation.³⁰ Based on deep-water studies in the north-eastern Pacific (see Figure 3), low-frequency background noise has approximately doubled (that is, an increase in power of 3 dB) in each of the past four decades.³¹

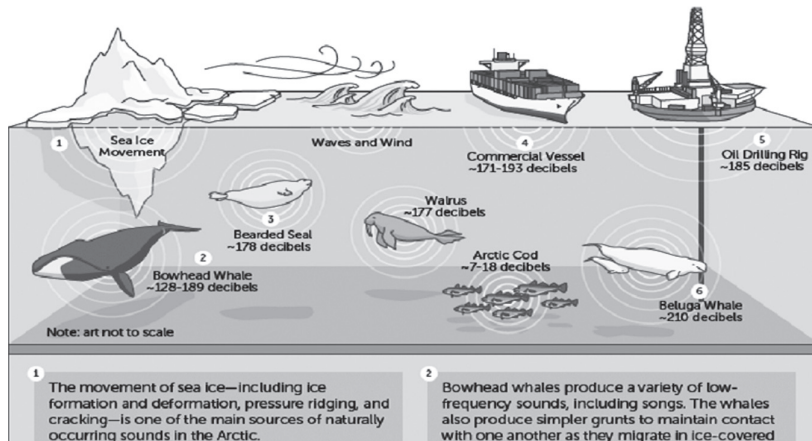


Figure 2 Ocean Ambient Noise for Frequencies between 10 Hz and 100 KHz

Source: Figure courtesy of J. Hildebrand, Scripps Institute of Oceanography/UCSD.³²

Note: This plot has the same form as the underwater noise curves developed by the US Navy in the 1960s, but it has been modified to reflect modern levels of shipping noise (shaded area), which exceed natural wind noise, even for higher sea states (numbered curves).

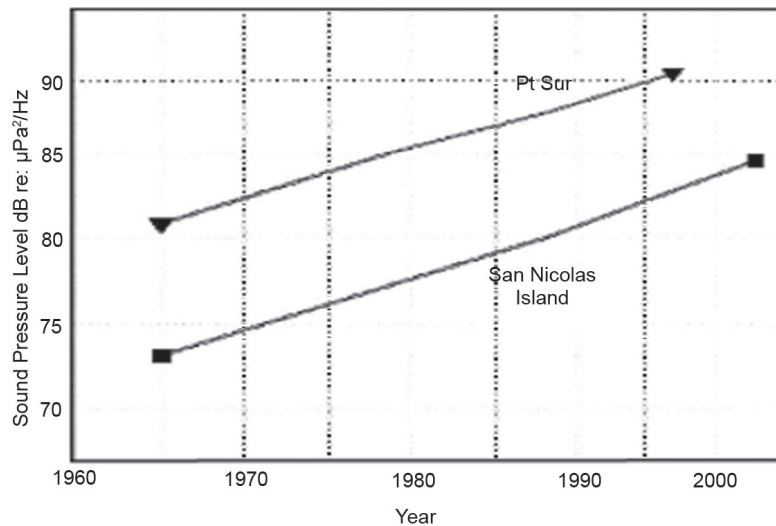


Figure 3 Ocean Ambient Noise Documented at Two Sites off California by Comparing US Navy Data from the 1960s with Recent Measurements³³

The well-distributed nature of shipping operation globally and the low-frequency characteristics of the spectrum further ensure that the impact is near universal. The near-continuous infrastructure development required to support the increasing shipping traffic is further increasing the ambient noise due to continuous activities in the coastal areas which are the prime habitats of these species.

The increased ambient noise in the ocean can potentially mask biologically significant sounds (that is, interfere with clear reception of signals of interest). Masking could disrupt breeding in marine species that use acoustic signals during mating and reproduction, and also disturb foraging in animals that use sound to detect prey. Also, noise can mask important environmental cues that these marine species use to navigate and sense their surroundings, including sounds that are used to detect predators.³⁴ Whale stranding, observed more frequently across various locations, is attributed to masking of the wave breaking on shore sound that disorients them, thereby leading to their stranding in large numbers. One question that may be asked by sceptics could be that the sound source and the marine hearing may not match to have any negative impact. Further, these species may adapt to the changes in the surroundings. Figure 4 presents spectral representation of various marine species and the shipping noise.

Some species adapt their communication signals to avoid being masked by ambient noise; however, the extent of such alterations is constrained behaviourally and environmentally. These adaptations also represent suboptimal behaviours as marine mammal communication systems evolve to maximize the ability for species to recognize biologically

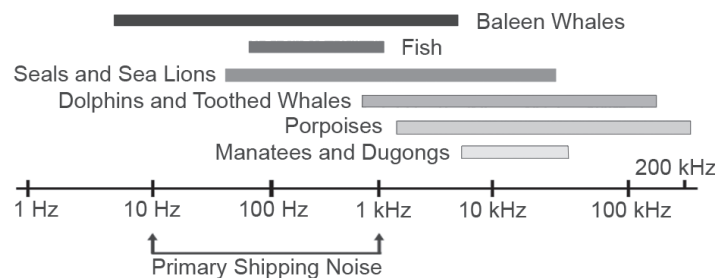


Figure 4 Frequency Relationships between Marine Animal Sounds and Sounds from Shipping

Source: Figure courtesy of B. Southall, National Marine Fisheries Service (NMFS)/NOAA.³⁵



Figure 5 Estimated Reduction in Baleen Whale Communication Range from (left) Prior to the Advent of Commercial Shipping to (right) the Expected Ranges of Today

Source: Figure courtesy of C.W. Clark, Cornell University.³⁶

meaningful sounds relative to the background noise. These alterations can be presumed to be a threat to survival and even reproductive success. The rapid rise in shipping over the last couple of decades may not have given enough time to some of these species to adapt to the noisier ocean. Figure 5 shows an example of predicted decreased communication ranges for baleen whales, owing to increase in ambient noise due to shipping. It may be added that hearing capabilities have been studied for 22 of the approximately 125 species of living marine mammals. Baleen whales are thought to be most sensitive to a range of low-frequency sounds (10–1,000 Hz).³⁷

FOCUSING EVENTS

Attempt at policy change has to be preceded by massive public pressure. This section attempts to highlight how issues of ocean noise and its effect have become a matter of international concern and have captured the attention of people both inside and outside of government. Conditions (such as noise pollution in the oceans) have been defined as problems through strategic use of focusing events. Focusing events, in turn, have been described as ‘key events that cause members of the public as well as elite decision makers to become aware of a potential policy failure.’³⁸

Non-government organizations (NGOs) have played a major role in shaping public opinions. In the US, the Natural Resources Defence Council (NRDC) has been one of the most active and vocal opponents of anthropogenic ocean noise. One of the NRDC’s significant contributions

to the noise pollution issue was the 1999 publication of a book entitled, *Sounding the Depths—Supertankers, Sonar and the Rise of Underwater Noise*. This book was one of the first to address underwater noise as a type of pollution. It focuses not only on experimental and military sonars but also on noise from shipping, oil exploration and other marine-related activities, and calls for the development of proactive policy to regulate underwater sound. The Humane Society of the US is one of world's largest animal protection organizations and has conducted major campaigns to protect marine mammals from noise pollution.³⁹

The Ship Shock Test

The controversy over ocean noise pollution is considered by some to have started in 1993 with US Navy's Ship Shock programme. Ship shock testing requires the detonation of underwater explosives at various distances from naval vessels to determine the strength of the hull and ship systems in stipulated battle conditions. The NRDC and others filed a suit to enjoin the navy from conducting the ship shock trials of the US AEGIS-class destroyer, the John Paul Jones. The court agreed that there was a failure to consider alternate sites for the testing in violation of the Marine Mammal Protection Act. Consequently, the navy was compelled to conduct surveys to determine an optimal area for the tests, carry out more stringent monitoring and prepare an environment impact statement (EIS) for the remaining trials after completion of the first test at a location recommended by the NRDC. The debate eventually carried over to submarine shock tests (the Seawolf) and tests in the Atlantic Ocean (the Winston S. Churchill) resulting in the consideration of not just explosions, but all sources of noise, as a threat to marine mammals.⁴⁰

Acoustic Thermometry of Ocean Climate (ATOC)

In the early 1990s, scientists at the Scripps Institute of Oceanography in San Diego developed acoustic thermometry, which used low-frequency signals to measure global warming. The plan involved the transmission of low-frequency sounds in the Indian Ocean and their detection by receivers thousands of kilometres (km) away. As sound travels faster in warmer water, they would be able to detect long-term changes in ocean temperatures and obtain valuable information about global warming. In February 1994, before the ATOC sonar could begin transmission, biologists at Dalhousie University launched an Internet discussion on their possible negative effects on marine mammals. Under public

pressure, senators publicly condemned the ATOC programme and some members of the US Congress threatened to slash the budget of the NOAA. The NRDC stepped in and lobbied vigorously to redirect resources to the study of sound on whales and other marine mammals. As a result, ATOC was delayed until a draft EIS (DEIS) was prepared. The consequent negotiations between Scripps and the NGOs resulted in the redistribution of funds for a major study on the effects of low-frequency sound on marine mammals.

Greek Whale Strandings and the North Atlantic Treaty Organization (NATO)

The benchmark international focusing event involving underwater sound took place in 1996. On 12 and 13 May, a number of Cuvier's beaked whales were stranded alive on a 38 km stretch of beach along the coast of the Kyparissiakos Gulf in Greece. At least seven animals died. At the time of that event, the NATO and the US Navy were conducting a joint international experiment using a high-powered, low-frequency sonar. In a correspondence to the journal *Nature* entitled 'Does Acoustic Testing Strand Whales?', A. Frantzis, a biologist at the University of Athens, linked the deaths of the whales to the use of sonar in the immediate area. His letter created a lot of controversy in the scientific community. Although scientists were not able to prove a link between the use of sonar and the whale deaths, the incident acted as a focusing event for the issue of unregulated underwater sound. Furthermore, the event underscored the regulatory challenges posed by the presence of a transboundary 'pollutant' in the international arena: the sonar was owned by the US government; the ship was owned by the 16 NATO nations; the experiment was carried out in Greek waters; and the ship flew a German flag. Determining who might regulate the use of the sonar in this scenario was problematic and the international implications were significant.⁴¹

Regardless of the outcome of these programmes just discussed and many more, these controversies provide a focal point for discussion and policy analysis with respect to underwater noise pollution. The NGOs, primarily the NRDC, clearly have been instrumental in bringing the issue of ocean noise to the attention of governments and international organizations such as NATO. In India, we need not wait for large-scale public protests to take a cue from focusing events elsewhere to initiate our own efforts towards formulating our own standards and regulations suited to the typical tropical littoral water of the IOR.⁴²

STATUS OF REGULATIONS

International management of ocean activities is of growing importance due to a greater reliance on marine resources and technological advances. Ocean management may be carried out unilaterally, bilaterally, regionally or globally. Unilateral measures and bilateral agreements are commonly used for coastal zone planning, fisheries management and pollution prevention. Internally, more than 200 agreements address ocean issues such as biodiversity, sustainable use of ocean resources, fisheries and pollution.

The 1982 United Nations Convention on Laws of the Sea (UNCLOS) provides the framework for addressing ocean noise pollution; however, precious little has been done under the United Nations banner to ensure that the ocean noise emission is regulated effectively. In 1985, the United Nations Environmental Programme (UNEP) published *Marine Mammals: Global Plan of Action*, which called for the international community to study the long-term threat of anthropogenic noise in the ocean. Specifically, the report noted:

[the] possibility that underwater noise from vessels and other human activities such as geological surveying by sonic techniques can constitute a form of noise pollution to which the cetaceans may be seriously sensitive on account of their dependence on acoustic processes for such purposes as communication and location of prey.

Numerous studies have been initiated by the UNEP; however, no clear regulatory framework has been proposed. In 1988, UNEP performed an evaluation of the global plan of action for marine mammals and it was found to be 'not...satisfactory'. This was attributed to changing government priorities, severe budget constraints, a lack of clear framework for action and insufficient effort by all collaborators. The failure was primarily blamed on lack of funds.⁴³

The International Maritime Organization (IMO), being the most significant regulatory body for international shipping and with its MARPOL Protocol of 1978, only recognizes substance pollution through its six annexes. The energy form of radiated noise of marine vessels is yet to be identified as a pollutant, and due to the lack of credible and quantifiable cause-and-effect database the regulatory framework has not yet materialized. In 2002, the IMO, through its resolution A.927(22), accepted noise as a hazard. It instituted the concept of 'Particularly Sensitive Sea Areas' (PSSAs) and designated five areas as PSSAs: Great

Barrier Reef, Australia; the Sabana-Camaguey Archipelago, Cuba; Malpelo Island, Colombo; the Florida Keys, the US; and the Wadden Sea in North Europe. The PSSA guidelines designate a category of special measures that incorporate speed limitations and special construction requirements that could potentially be directed towards controlling acoustic emissions. However, till date, IMO has not specifically addressed noise as a threat to any of the PSSAs.⁴⁴ The mere recognition of noise as an hazard by the UNEP and declaration of PSSA by IMO is not enough to comprehensively address the concern. The regulations put in place by International Council for the Exploration of the Sea (ICES) for research ships need to be extended to the entire shipping industry under the IMO and beyond.

The International Whaling Commission (IWC) did address the issue of disturbance of marine mammals by noise generated during whale-watching activities in 1996 and specifically noted that (i) cetacean species may respond differently to low and high-frequency sounds, relative sound intensity or rapid changes in sound; (ii) vessels operators should be aware of the acoustic characteristics of the target species and of their vessel under operating conditions; (iii) and particularly the need to reduce, as far as possible, production of potentially disturbing sound. In spite of these warnings, the IWC has yet to make any policy framework on noise and whales and, to date, no scientific research on the effects of noise on marine mammals has been promulgated by the IWC.

The ICES formed a study group on research vessel noise to address the concern over the effects of underwater noise radiated from research vessels. The study group produced an interim report in 1993 that was submitted to the statutory meeting in Dublin. The report recognized that insufficient information was available to fully address the mandate that 'research vessel engaged in underwater observations and measurements need to be quiet and should not impact the species being studied.' The report brought out in detail the impact of radiated noise on several species and tried to formulate benchmark for radiated noise of research vessels. The report deals with the radiated noise of a marine vessel with its significant contributors and presents the acoustic hearing levels of various marine mammals.⁴⁵ The proposed underwater radiated noise specification at 11 knots free-running for all vessels used in fisheries research is presented in Figure 6. Figure 7 presents a comparison of radiated noise of certain fisheries research vessels and the promulgated benchmark.

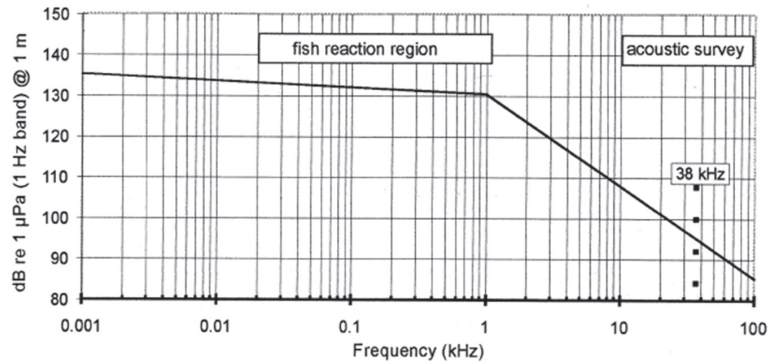


Figure 6 Proposed Underwater Radiated Noise Specification at 11 Knots Free-running for All Vessels Used in Fisheries Research⁴⁶

Note: The defined radiated noise level for research vessel at a specific speed (as level of radiated noise depends on the speed) becomes a regulatory provision for them to comply.

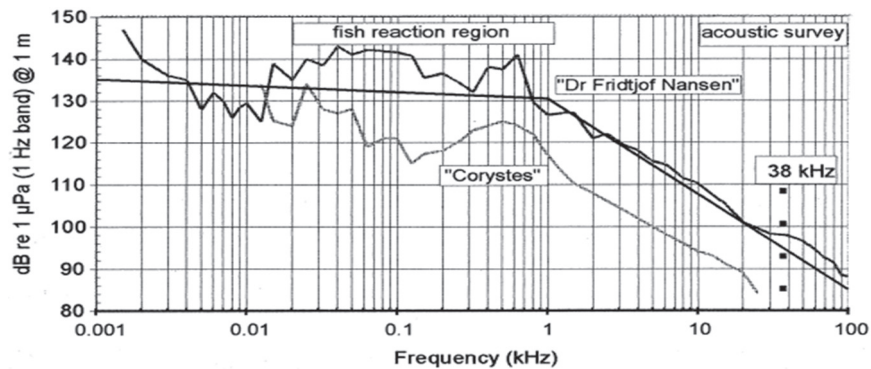


Figure 7 Noise Signatures at 11 Knots of Two Modern Research Vessels against the Proposed Radiated Noise Specification⁴⁷

Note: This is the comparison of the defined regulatory provisions and the actual radiated noise of certain research vessels.

The European Union (EU) has addressed the issue of ocean noise in the context of habitat conservation. Specifically, the European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora requires member states to take measures to prevent inter alia deliberate disturbance of cetaceans. This directive lists all species of cetaceans as in need of strict protection. Recently, several regional agreements have addressed the issue of ocean noise pollution.

These are OSPAR Convention, the Arctic Council, the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), and the Agreement on the Conservation of Cetaceans of the Black and Mediterranean Seas (ACCOBAMS). However, the transborder nature of ocean noise ensures that these regional agreements will not be able to monitor and regulate it effectively. A much broader framework under the UNEP or the IMO needs to be worked out in line with CRR-09 by ICES.

WAY AHEAD

The path is not simple and multiple aspects need to be deliberated by the strategic thinkers and policymakers, sooner rather than later. The following aspects merit attention for appreciating the enormity of the issue:

1. The available literature belongs to the work done at distant locations by advanced nations in their territorial waters. No such inputs are available in the IOR for our policymakers to even estimate the extent of degradation for the various species that inhabit these waters and how they use sound. Enormous marine conservation efforts are completely ignorant of this aspect and continue to attribute inferences in isolation.
2. Participation of academia in field experiments and long-term programmes for solving real-world problems like these is more or less non-existent. The organizational mandates of big public sector organizations with significant resources do not encourage effective partnerships with academia. Small entities with vision never have the resources to undertake such work.
3. This requires a top-down approach and the long continental outlook did not help the cause. Formulating maritime strategy started late and we could not put systems/organizations in place for long-term data collection in the maritime domain for credible analysis. Ambient noise in the ocean requires observatories for long-term data collection and analysis.
4. The military and non-military applications in the maritime domain could have a collaborative approach. The Sound Surveillance System or SOSUS deployed by the US in the peak of the Cold War to detect Soviet fleet movement collected enormous amount of data that was subsequently utilized by numerous researchers

in the US academia and the NATO countries for varied non-military research problems. The author's proposal is a result of literature available on such research findings. India needs to gear up for such long-term programmes and collaborations.

5. The vast 7,500 km of India's coastline with extended EEZ requires mass participation and the second-largest population figure is hardly able to contribute due to lack of vision. Vision to strategy, strategy to effective policies, policies to organizational structure and mandates, goals and incentives, all have to follow. Unlike the information technology (IT) and the telecom sector, this cannot happen without government participation.
6. Regulations have to come; self-regulation is not possible with private participation post-liberalization. Regulation can happen only with government directives. Regulations require precise cause-and-effect inputs, which is not available today. A broad framework is required for initiating efforts. Most important aspect is the monitoring mechanism. Monitoring ocean ambient noise requires special technology and customized solution, specifically in the IOR. We have to start soon before it is too late. Calibrated and regulated development will be sustainable.
7. A task group is required to put the entire issue into perspective. An organizational structure needs to be drafted along with procedure and resource allocation for working out the regulatory framework and monitoring mechanism. The gaps in the inputs need to be identified and measures initiated to collect specific Indian ground realities.

CONCLUSION

Rightly so, the continental outlook we had over several years has changed to more emphasis on the maritime aspects. Numerous maritime activities have commenced to maximize the exploitation of the maritime resources towards economic and political gains. More and more forums have started deliberating on varied aspects—strategic, technological, commercial, and regulatory—related to the maritime domain. However, the undersea noise pollution has failed to get the attention it deserves and credible research inputs suggest that the situation is fast turning to a very dangerous and irreversible scenario. The aspiration of the country to emerge as a strategic player in the IOR could be in jeopardy if urgent measures are not initiated. It is not an easy problem to solve and no quick fixes are

available. Sustained efforts by multidisciplinary and multi-organizational initiatives are required with meticulous planning to make any headway. The inaccessibility of the marine environment precludes the possibility of passionate and highly motivated individuals or smaller groups making any impact.

The technology inputs are available and hardware can be imported. However, the ground validation in the IOR cannot be imported and we have to initiate efforts to collect ground data and undertake analysis to understand our waters and provide customized solutions. The tropical littoral waters in the IOR are a perennial nightmare for any sonar operator and developer. Collaborative opportunities are immense for combining military strategic research and such non-military but equally strategic cause. In India, the military versus non-military debate is the biggest challenge for any effective collaboration. Defence research is highly classified and academic collaborations and data sharing is non-existent. The private sector is too sceptical to expend on marine research.

It is essential that we begin soon. We are racing against time, and we need to come out with our own regulations and monitoring mechanism prior to the IMO's Marine Environment Protection Committee (MEPC) recommendations get imposed on our shipping industry. The present state of affairs in the private and public sector yards is that they do not recognize the importance of noise for the commercial shipping. Their present infrastructure development programme will fail to keep up with the future requirements. Most of the advanced shipyards worldwide, which are engaged in warship building along with commercial merchant liners, participate in the design aspects and incorporate noise control right from the design stage to construction as well. They recognize that improved noise control for commercial ships also translates to more efficient operations and cost effectiveness—the main mantra. The concern is the low awareness and vision to build futuristic capability. The complete noise and vibration and radiated noise control right from the design is presently being monitored by the Indian Navy. Regulations will probably encourage participation by these shipyards and motivate them to develop their in-house capabilities.

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