

International Workshop on Shipping Noise and Marine Mammals

Held By Okeanos - Foundation for the Sea
Hamburg, Germany, 21st-24th April 2008

Statement of Participants

A diverse group of stakeholders from around the world was convened with expertise in the areas of underwater acoustics, naval architecture, marine engineering, ship building, marine mammal bioacoustics, marine operations, and noise control, as well as in international maritime and environmental law and policy.

Marine mammals are acoustic specialists and depend on sound for survival (e.g., communicating, navigating, finding food and mates, detecting predators). For example, blue and fin whales produce intense infrasonic songs that can be heard over an entire ocean, while humpback songs can be heard over many hundreds of miles. With the advent of modern shipping, ocean noise in the low-frequency range (10-300 Hz) has been doubling approximately every decade,¹ drastically reducing these ranges. Although the long-term impacts on marine mammals from this increased noise are not yet known with certainty, increased noise obscures an animal's ability to hear, and therefore has serious implications for reproduction and survival. This is a global problem.

There is a relationship between commercial shipping and the amount of underwater noise. Given that shipping is increasing and expected to expand into new areas, e.g., the Arctic, incidental noise from shipping will continue to rise.

Unlike chemical pollution, noise does not persist in the environment. Thus, if a source of noise is reduced, the amount of noise energy in the water is immediately lowered. Under these favorable circumstances, the goal is to reduce the amount of incidental underwater noise from shipping to mitigate or eliminate the impacts of noise on marine mammals.

To achieve this goal we call for initial global action that will reduce the contributions of shipping to ambient noise energy in the 10-300 Hz band by 3dB in 10 years and by 10dB in 30 years relative to current levels. This goal would be accomplished by reducing noise contributions from individual ships.

The engineering tools and methodologies currently available are sufficient to reduce radiated noise from ships, or can be developed with limited effort. Some operational measures can be implemented immediately.

The widespread application of technical and operational noise reduction measures applied on an individual ship basis would lead to the 3 dB reduction in ambient noise within a decade and would result in an overall increase in potential communication/hearing ranges for marine mammals. It was clearly recognized that shipping noise is a trans-boundary, international issue. All participants called for the coordination of action at the international level, i.e. by the International Maritime Organization and its members.

¹ In sound level terms, a doubling in the power of sound is measured as 3 dB, while a ten-fold increase is measured as 10 dB.



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MARINE ENVIRONMENT PROTECTION
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ANY OTHER BUSINESS

Shipping noise and marine mammals

Submitted by the United States

SUMMARY

Executive summary: This information document advises the Committee of the issue of noise generated by international shipping and its potential adverse impact on marine life. It requests Member Governments to note this information; inform all interested entities, in particular those from the shipping industry, shipyards, and ship builders of this issue, and invite them to participate in the ongoing dialogue regarding identification of potential adverse impacts associated with vessel noise and the potential mitigation of those impacts; and submit any pertinent information on this issue to the U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Ocean Acoustics Program.

Action to be taken: Paragraph 14

Related documents: A.468(XII), MSC/Circ.1014, A.720(17) and A.982(24).

Introduction

1 The issue of human-produced noise and its effects on marine life is becoming of increasing interest to scientists and public policy makers.¹ Since the dawn of industrialization, humans have been adding ever more sound into the marine environment. While repeated measurements in an area to determine overall trends are limited, levels of background sound in the ocean (“ambient noise”) are consequently thought to be increasing in certain areas and certain sound frequency (“pitch”) bands. A significant human contribution to overall ambient noise is thought to be generated by the growing use of the ocean for international shipping. The number of commercial ships has doubled between 1965 and 2003 and shipping industry analysts forecast that the amount of cargo shipped will again double or triple by 2025, with an attendant increase in the amount of ambient noise entering the ocean from commercial shipping. While individual ships represent point sources, and efforts directed at quieting will likely be approached on a ship-by-ship basis, the primary concern in terms of adverse effects to marine life is likely to be the overall contributions of many vessels to increasing background noise.

¹ “Noise” is the term to describe unwanted sound, whereas “signals” are detectable sounds generated with a specific purpose that may have some biological importance. The generic term “sound” is used where the intent is not to distinguish between noise and signals or where the utility or effect is ambiguous or unknown; “noise” is used to refer specifically to exposures with adverse effects or in specific technical terms such as “ambient noise” (the general background din) or “masking noise” where interfering sound is by definition “noise.”

2 Most marine animals use sound for critical life functions, such as communicating, foraging, evading predators, and navigating. Scientific investigations of many marine animals (including mammals, fish, and even some invertebrates) have shown that the production and reception of sounds are critical to various aspects of life history. Human-produced noise has the potential to disturb behavior and/or interfere with various important biological functions of marine animals. The range of potential impacts is highly dependent on characteristics of the sound source, the operational environment and the animals receiving the sounds. As the input of human-produced sound increases, its potential to interfere with these functions is becoming of increasing concern, both from higher intensity acute events (such as explosions) and from lower intensity but more chronic sound sources such as large vessels.

Nature of the issue

3 Although specific knowledge is limited regarding the relative contributions of various sources of sound in the marine environment, a significant portion of human noise input is attributable to the increasing number of large and increasingly larger commercial ships operating over wide-ranging geographic areas. Large commercial ships produce relatively loud and primarily low-frequency sounds, the exact characteristics of which depend on ship type, size, propulsion type, operational mode and speed. Much—and in some conditions most—of the noise generated by large ships results from propeller cavitation, although onboard machinery and turbulence around the ship's hull also generate sounds that may be transmitted under water via direct or secondary paths. Various parts of ships produce different frequency sounds which propagate differently in the water, with low frequencies generally traveling farther due to the physical properties of sound and water. Low frequency sounds from ships travel hundreds of miles and can increase ambient noise levels in large areas of the ocean, interfering with sound communication in species using the same frequency range over relatively large areas.

4 Noise exposure may pose a host of potential problem for marine animals, including in particular marine mammals (e.g., whales, dolphins, seals, sea lions), sea turtles and fishes. Natural or human noise can have various adverse effects on animals, including: alteration of behavior; reduction of communication ranges for social interactions, foraging and predator avoidance; temporary or permanent compromise of auditory or other systems; and/or in extreme cases, habitat avoidance or even death. Potentially widespread adverse effects may result from increasing background ambient noise levels due to human activities. With regard to the noise generated by shipping, the general (low) frequency band of large vessel noise overlaps the frequencies generally produced by some marine animals, primarily large whales, seals and sea lions, and fish (see figure 1). Additionally, as noted above, given the wide-ranging geographical occurrence of shipping, the fact that the low-frequency sounds from ships travel great distances, and its ever-increasing prevalence, the potential problems for acoustically-oriented marine animals from noise generated by shipping is of increasing concern.

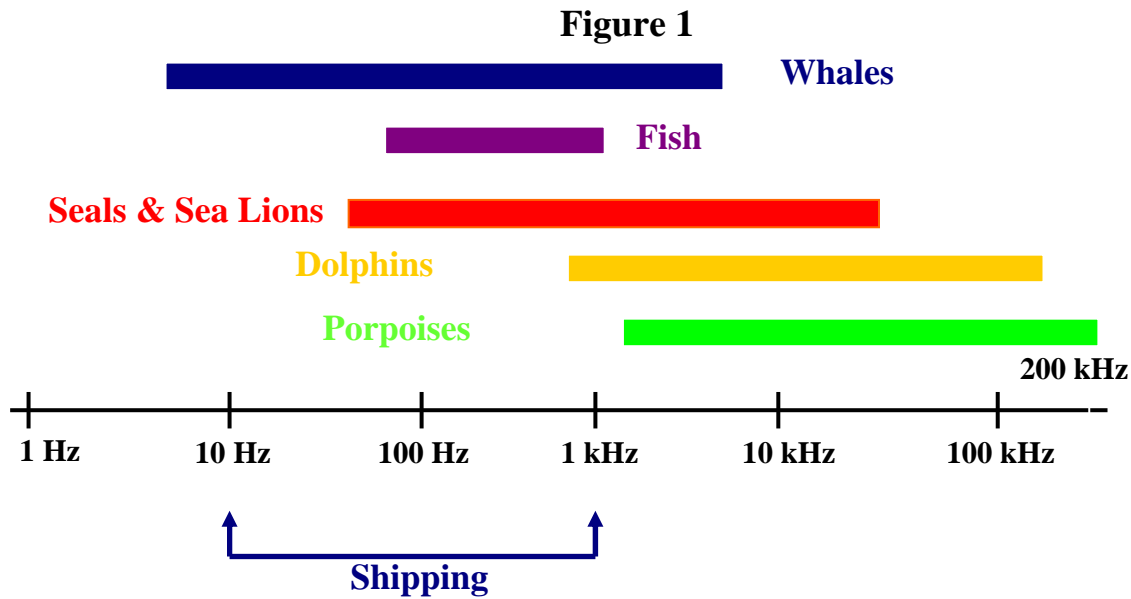


Figure 1. Frequency Relationships Between Marine Animal Sounds and Sounds from Shipping

5 The primary concern regarding potential adverse effects of shipping noise is not related to acute exposures, but rather to the general increase in background ambient noise that may result from concentrations of vessel operation. That is to say, the potential environmental impacts from ship noise are likely related to masking of communication systems. While there is insufficient longitudinal data to conclude that ambient noise levels are increasing in large areas of the ocean as a function of vessel sounds, two recent studies off California analyzing measurements over several decades do indicate changes that, for these particular areas, suggest an increasing trend in background noise of ~ 3 dB/decade in the low-frequency band (Andrew et al., 2000; McDonald et al., 2006; see figure 2 below). Because of the logarithmic nature of sound and what is known about hearing systems in mammals, seemingly small changes in background noise levels can result in large reductions of communication ranges (see Figure 3 below).

Figure 2

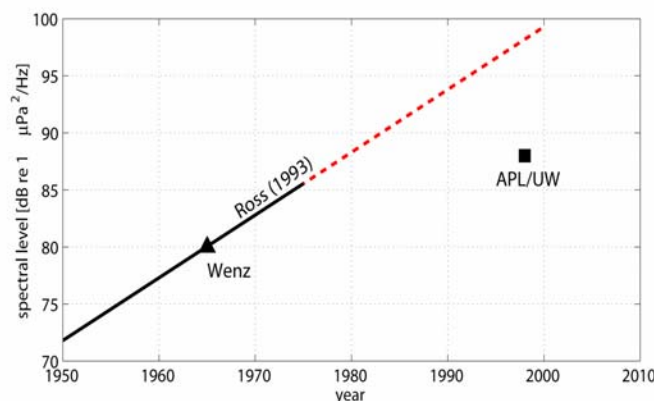


Figure 2. Ambient noise measurements in the 100-200 Hz band measured off California in the 1950's (Wenz, 1962; Ross, 1993) and Applied Physics Laboratory/University of Washington (APL/UW) noise measurements in the late 1990's (Andrew *et al.*, 2002).

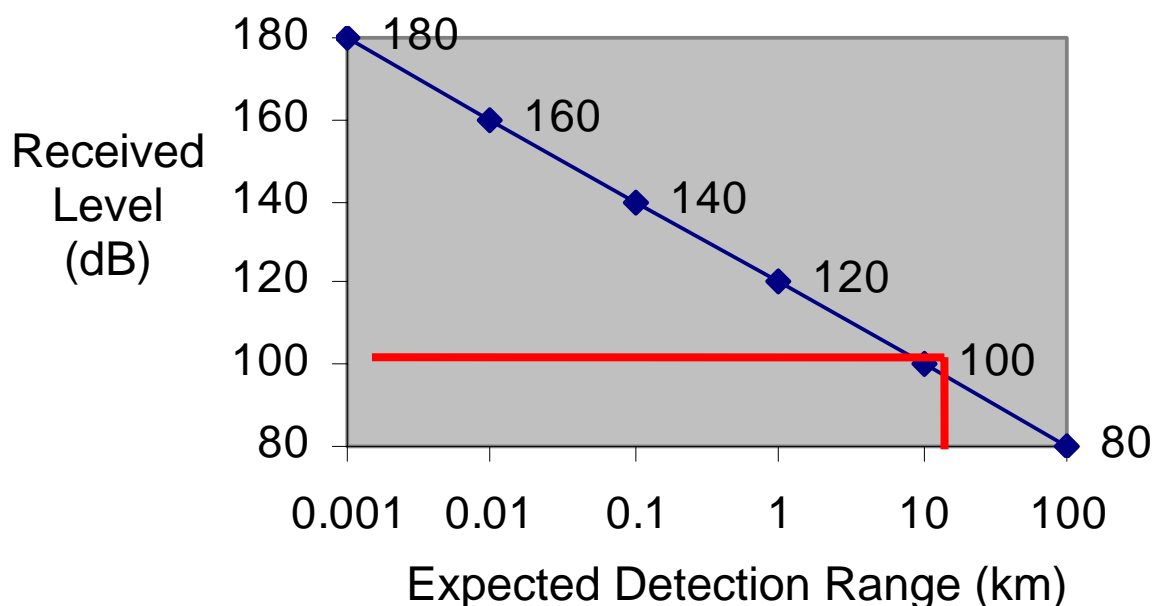
Figure 3

Figure 3. Simplified figure demonstrating the expected change in detection range as a function of received noise level. Each 20-dB increase in background noise results in an order of magnitude decrease in expected detection range.

IMO recognition of noise and potential benefits to be gained by noise reduction

6 The IMO has recognized the issue of noise and the importance of noise reduction in the context of providing safe working conditions for seafarers and ensuring the safety of the ship (see e.g., Code on noise levels on board ships, A.468(XII) (19 Nov. 1981) and Guidance on fatigue mitigation and management, MSC/Circ.1014 (12 June 2001)). In the context of noise and the environment, the Guidelines for designation of Special Areas and the identification of Particularly Sensitive Sea Areas (PSSA)(A.720(17)(1991)) and the 2005 Revised PSSA Guidelines (A.982(24)(2005)) recognize that noise from ships may adversely affect the marine environment and living resources of the sea. The general issue of noise and marine mammals has also been addressed by other international fora, including through regional arrangements under the Convention on Migratory Species (e.g., the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Area (ACCOBAMS) and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) have passed resolutions and commissioned research on the effects of noise on marine mammals).

7 Sound produced as an incidental byproduct of vessel operation serves no particular function in the transportation of goods and may, to some extent, represent wasted energy. Although the issues involved are complex and need to be further considered, quieter vessels could coincidentally also be more efficient, as a reduction in noise may represent a reduction in ship-board vibration with the potential for reduced operational and maintenance costs. Moreover, reduction in ship sound may have important benefits for crew and vessel safety as well as the comfort of passengers as recognized by the action IMO has taken to address these issues. Furthermore, environmentally sensitive modifications of ship design, construction, maintenance, and operations may have public perception and/or societal benefits. Given these factors, as well as the potential interference with acoustic communication in marine life, an important question is whether noise output from large vessels should and could be realistically reduced.

Ongoing research and dialogue needed

8 Sustained research and dialogue with key industry players (extending from individuals involved with vessel design and production to those concerned with maintenance and operation) and other interested entities are necessary to address the critical technical, economical, and practical considerations bearing on the necessity and feasibility of reducing noise from shipping. Some preliminary considerations include attempting to identify the nature and extent of all potential effects on species in question and identifying mitigation strategies. Second, a key action item is whether vessel quieting applications in other contexts can be feasibly scaled up for use on large commercial vessels. The issue of applying quieting technology to large vessels requires further investigation to determine the likelihood of meaningfully reducing noise output and identify cost magnitude as well as potential socio-economic benefits to industry. This will require careful analysis and considerable open dialogue among individuals representing various disciplines and interests.

9 Dialogue on this issue has begun in the United States. In responding to a committee formed to look at the impacts of anthropogenic noise on marine mammals, a commercial shipping industry representative urged, in a statement made to the Committee, that the United States inform and take any appropriate action through IMO. It was also noted by this advisor that, “any sound producer that is conducting activities that negatively impact marine mammals must be willing to further investigate those activities with a focus on the specific origins and characteristics of those sounds and possible mitigation methods.”² This representative also noted that the transmission of noise respects no jurisdictional boundaries and thus mitigation strategies must be international in nature to address adequately the impacts of commercial shipping noise on living marine resources.

10 The National Oceanic & Atmospheric Administration (NOAA) has been facilitating the dialogue and consideration of noise generated by shipping. It hosted two international symposia in 2004 and 2007 for representatives from government, industry, academia, and environmental groups to consider the effects of noise from large vessels on marine life. At the 2004 symposium, overarching issues of the sounds produced by large vessels, their potential effects on marine life, and whether design and operational modifications might have environmental as well as economic benefits were considered. While many participants acknowledged that there are many uncertainties and complexities regarding the potential effects of vessels sounds, many also acknowledged that noise introduced into the marine environment today is likely to have various negative effects on marine life. With the projected increase in vessels engaged in the global maritime trade, these impacts will only increase. The symposium presentations also clarified that large vessels represent a significant (and in some areas predominant) contribution to overall ambient noise in certain, primarily low-frequency, bands. It was further noted that the potential for interference with marine animal communication and other signals occurs where there is an overlap between vessel noise and the hearing of biologically-significant signals. For a report of the 2004 symposium (and eventually the 2007 symposium as well), please see: http://www.nmfs.noaa.gov/pr/pdfs/acoustics/shipping_noise.pdf.

11 The 2007 symposium included experts from the international community and was more narrowly focused on issues such as the rationale and explicit target levels for quieting vessels of various classes, whether known or existing vessel-quieting technologies used in other

² Federal Advisory Committee Act (FACA). 2006. Advisory Committee on Acoustic Impacts on Marine Mammals, Report to the Marine Mammal Commission, February 2006.

applications have the potential to achieve these goals for large commercial vessels, and the likely costs and any tangible benefits associated with the application of various technologies on existing ships and in vessel construction.

12 NOAA, in conjunction with interested entities, will continue to work on this issue. In addition to hosting the two international symposia, NOAA is actively funding passive acoustic deployments in key areas of high shipping density (e.g., near the ports of Boston, Massachusetts and Long Beach, California) to measure noise levels arising from dense vessel activity and animal use of these areas. It is also working with stakeholders in considering potential green-certification programs with regard to noise issues for proactive members of industry.

13 The United States requests that Member Governments inform all interested entities, in particular those from the shipping industry, shipyards, and ship builders, of this issue and invite them to participate in the ongoing dialogue. Member Governments are also requested to provide any relevant information to the U.S. Department of Commerce, NOAA's Ocean Acoustics Program, Brandon.Southall@noaa.gov.

Action requested of the Committee

14 The Committee is invited to note the foregoing information and that further information on this issue is available at: <http://www.nmfs.noaa.gov/pr/acoustics/shipnoise.htm>.
