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MARINE MAMMALS AND NOISE
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The year-round navigation of large icebreaking tankers in arctic waters raises
a number of environmental issues, one of the least understood being the effects
of noise on marine mammals. In a recent article, Bertel Mehl of the University
of Aarhus in Denmark, discusses the possible implications of very high-powered
ships for these mammals. He points out that no estimate of noise levels from LNG
or oil icebreaking tankers is available, and that all calculations to date have
therefore been based on the noise spectrum level of a World War II cruiser, a ship
with a displacement and horsepower rating one order of magnitude below that of
the proposed icebreaking tankers. Excerpts from the article are reprinted below.

Introduction

This paper summarizes data available for the natural, very low ambient
noise in arctic waters, as well as spectral composition of noise from various kinds
of ships, and present estimates of the audibility of the ship noise under various
environmental conditions. Finally, the somewhat meagre literature on the effects
of noise on marine mammals is discussed.

When evaluating the effect of noise on marine mammals, it is necessary
to realize the vital importance of sound for marine mammal orientation. Olfaction
is ruled out underwater, and vision is severely restricted due to scattering
and absorption of light, and also because of the extremely low light levels
encountered during the winter. For long range orientation and communication,
marine mammals therefore exclusively rely on audition. Among other consequences,
this limits the herd to the group of animals that are within calling range. The
range of any given call depends on its sound power and frequency composition,
on how the call is propagated, on the hearing sensitivity of the listening animal
(or rather on the required signal to noise ratio), and on the ambient noise.

Since the hearing sensitivity of marine mammals in general is so low
that ambient noise sets the effective limit on minimum audible sound level, the
range for a given call (assuming unchanged transmitted level and transmission
losses) is reduced by a factor of 10 each time ambient noise is raised 20 dB.
This is valid, irrespective of the function of the call, whether it is a message
(communication), or active or passive acoustic orientation (sonar), the only
condition being that the noise power is distributed in the same frequency bands
as the calls. Frequency overlap of ship noise and calls is the case for walruses,
seals and baleen whales, while the situation for dolphins and toothed whales is
more complex.

Noise Levels

Acknowledging that 40 dB is representative for quiet, under-ice conditions,
in the quiet case at a range of 100 km., [an LNG tanker] will raise ambient noise
by 40 dB. From the point of view of a baleen whale this means that when previously
he could inform his fellows within a radius of, say, 10 km. about a good concen-
tration of food, he can now, with the ship 100 km. away, reach other whales only
within a 100 m. range, where the message is hardly of much use anyway. When the
ship gets closer than 100 km., conditions deteriorate further.

It is unfortunate that not even a rough estimate of the noise levels
generated by the LNG tankers has been given. All calculations are based on data

(over)
from the WW II cruiser, which has a displacement and hp-rating one order of magnitude below that of the LNG tankers. Noise from aircraft carriers and battle ships is known to be 10 dB above that of the cruiser, and yet these ships are neither as large, nor as powerful as the LNG tankers. . . . Further contributions to the noise level can be expected at multiples of propeller rate frequency, and from the milling of ice by the propellers. However, information on propeller specifications and operation is required before any estimates from these sources can be made. . . .

Sound Channel

A key property of arctic waters is a speed of sound profile that creates a sound channel just below the surface. The importance of this channel for marine mammal communication was pointed out by Payne & Webb (1971). In such a channel with geometrical propagation, sound is attenuated by 3 dB per doubled distance. . . . Geometric attenuation, however, is dominating only at some distance from the source. At 100 km, an estimated 15 dB from the channel effect should be added to the raise of ambient noise. Besides the channel effect, the so called megaphone or coastal region enhancement effect is relevant for the proposed [Arctic Pilot Project] route along the coast of Greenland. This effect will raise the expected noise levels from 3 to 10 dB. . . . In terms of area, about 30,000 sq. km. around the tanker will be ensonified with 67 dB or more above ambient. In the baleen whale example given above, calling range within this vast area will be below 5 metres. This is clearly absurd and rather at variance with the claim of the proposal, that impacts on whales will be minor. . . .

Deterioration of Marine Mammal Habitat

Due to the extraordinarily high noise levels to be expected from the LNG tankers, other effects than the massive interference with the primary channel of information of the marine mammals should be considered. Temporary, and even permanent impairment of hearing is one such effect. Another is infra-sound induced nausea. Naturally, no marine mammal data directly relevant to such problems are available; a tentative conversion of data from humans indicates that such effects could occur within one kilometre from the tanker, whence exposure could in theory be reduced by escape reactions. It should be understood, however, that in ice-covered waters, the escape options of marine mammals are severely restricted, and when their only conceivable means of long range orientation, their sonar, will be jammed by noise, such reactions could well be fatal. The primary wintering quarters for narwhals, belugas, ringed seals, walruses and the few remaining bowhead whales, are along the coast from Disko [Northwest Greenland] and northwards, and in "Nordvandet" outside Lancaster Sound, where the ice is less solid than elsewhere in Baffin Bay. For the very same reason, the planned route of the LNG tankers runs through these wintering quarters. With an average of one tanker passing every 6th day [the Arctic Pilot Project's average frequency], making a noise worse than that of a roaring gale and dominating the entire Baffin Bay, how can the conclusion be avoided that the project will seriously deteriorate the marine mammal habitat of Northern Greenland? The importance of marine mammals for the economy of this part of Greenland needs no emphasizing.