

Is the ocean really getting louder? An evaluation of marine biological noise from pre-industrial whaling times. (Lay language version)

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In 1975 Donald Ross indicated a long term trend of low frequency anthropogenic noise increased 0.55dB/year between 1958 and 1975 (Ross 1976). This trend in ocean ambient noise levels has been due to expansion of global shipping and has yielded an increase in the ambient noise levels in the ocean that is anywhere from 4 to 15 times louder than what it was in 1958 (depending on location). There is a concern that the increase in anthropogenic ambient noise is masking biologically significant sounds.

It is also likely that the post WWII baseline for the Donald Ross' prediction was set at a historic time when the ocean was as quiet as it had been in millions of years – because a high percentage of “noisy” whales had been extirpated since the beginning of commercial whaling in the early nineteenth century.

Finding out whether this hypothesis is true was somewhat of an excavation into the history of whaling – trying to tease out how many whales were in the ocean prior to industrialized hunting. This task was hindered by the fact that fishermen – including whalers are prone to prevarication. The whalers also had no incentive to give accurate numbers because they were typically taxed on their takes. As a consequence accurate population counts based on whaling records are evasive at best.

In 1946, realizing that whales were being unsustainably harvested, the International Whaling Commission was established to coordinate whaling efforts and set quotas. One

of their policies was to require onboard biologists to take an accounting of the species and number of whales taken. But even with the quotas and onboard biologists it was clear that the whale populations continued to decline (suggesting illegal whaling) – to the point that by 1984 there was a global moratorium on taking whales.

The first clues to the extent of illegal whaling came with the publication of actual whale counts taken on a Soviet factory ships by onboard biologists. The publication of these data was made possible by the fall of the Soviet Union. During the last years of commercial whaling Soviet enterprises had their biologists “sign off” on dramatically reduced take counts. The Soviet fleet was apparently taking any whale they could find and falsifying records. With the fall of the Soviet Union some of the actual catch data became available. In one example the Soviets reported taking 2,710 humpback whales from the late 1950’s to the mid 1960’s. The actual number was closer to 48,000.

Another breakthrough came with Joe Roman and Steve Palumbi’s work on estimating population densities using mitochondrial DNA in which the sequence does not change through the succession of the females so that sequence diversity serves as a proxy for diversity in the original female populations. These estimates substantiated the population counts from the post-Soviet-era publications.

Sifting through the data it appears that millions of whales were killed in the 20th century:, including some 380,000 sperm whales, 350,000 blue whales, 750,000 fin whales, 160,000 humpbacks, 180,000 sei whales, and countless minke, right whales, Bryde’s whales and bowheads.

In our paper we reviewed the range of whale populations from animals which had a good record of vocalization characteristics – amplitude, sound density, and length of calls. We assigned each whale an ‘acoustic output value.’ We then modeled various ocean basins as reverberant chambers, and then set the whale populations loose in the model. The resulting numbers give us some idea about how loud the ocean may have been in 1820 – prior to the advent of commercial whaling.

While there are many uncertainties in the model due to variability in number, behavior, and distribution of the whales, and the model is necessarily simplified due to the complexities of marine acoustics and animal behavior, the numbers tell us that the North Atlantic humpbacks may have accounted for 103.5 dB of sound, the North Atlantic fin whales contributed 126 dB, the southern Pacific blue whales contributed 136 dB, and North-East Pacific blue whales contributed 151dB! (all referenced to $1\mu\text{Pascal}$).

These are noise levels equivalent to the noise levels found in busy shipping channels. The difference being that shipping noise is very broad-band – covering all of the communication frequency bands of each of these whales. The whales on the other hand focus their communication channels into frequency and time-specific “acoustical niches” which they have likely adapted to over the 30 million years of cohabitating and communicating in the ocean.

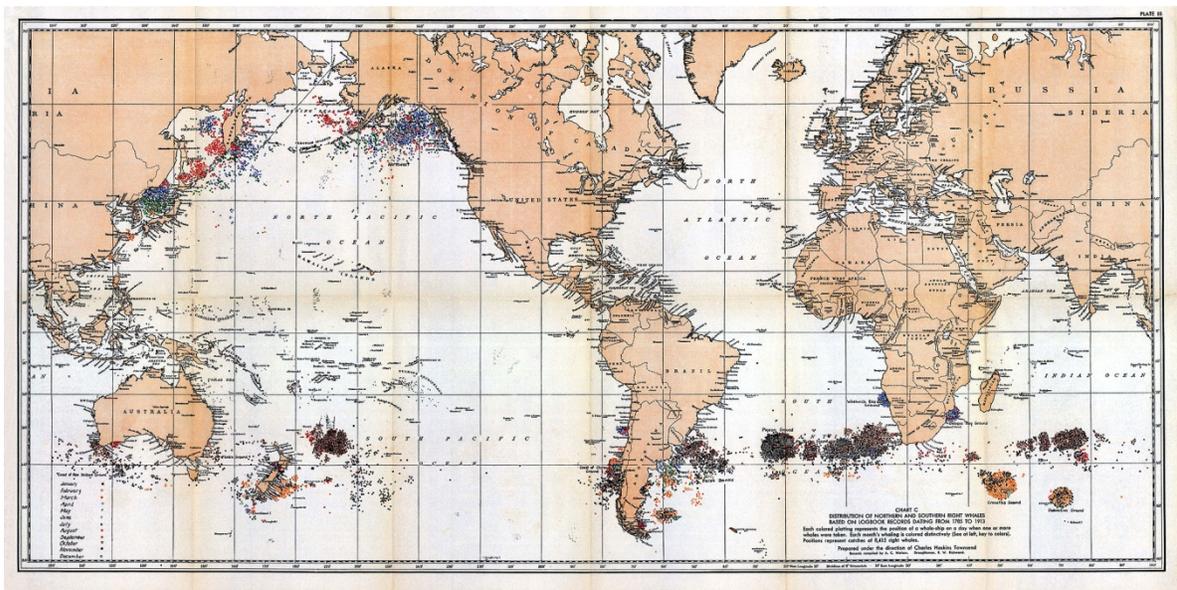


Figure 1: 8,415 right whales taken from 1785 – 1913 based on logbook records. (Townsend 1935)