

# Noiseconomics: The relationship between ambient noise levels and global economic trends

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## I. BACKGROUND

In recent years, the topic of long-term trends in ambient noise levels in the sea has attracted considerable attention from both the scientific community and the general public [1]. This interest stems primarily from concerns over the potential impact of increasing sound levels on marine mammal behavior and has stimulated the growth of a new and exciting research area. Specifically, the following two fundamental questions have been raised: (1) What have been the historical changes in ambient noise levels over decadal time scales, and can reliable predictions be made of future changes in noise levels for the decades to come? (2) What is the impact of a changing acoustic environment on the behavior of marine mammals, since they rely so heavily on acoustics as a primary means of communicating, navigating, and foraging in the marine environment? This paper addresses the first question and introduces the idea that, at lower frequencies (several hundred Hz and below), the ambient noise levels can be directly related to global economic trends.

## II. HISTORICAL TRENDS IN AMBIENT NOISE LEVELS

The recent literature [1-3] describes a mounting body of evidence which suggests that low-frequency noise levels have increased approximately 15 dB during the time period 1950–2000. This increase corresponds to about 3 dB per decade, a value that has become the focal point of a working hypothesis that ambient noise levels in the sea have not only increased historically at this rate, but may continue to increase at this rate in the future. It is important to point out that the available data supporting this premise are very limited and are restricted to the northern hemisphere. A second component of this working hypothesis is that the primary cause of this increase is anthropogenic and can be attributed to increases in commercial shipping activity. This notion arises from the observations that shipping activity is the dominant source of noise at low frequencies and that the major shipping lanes are concentrated in the northern hemisphere.

## III. CORRELATIONS BETWEEN NOISE LEVELS AND SHIPPING ACTIVITY

The correlations between ambient noise levels and shipping activity have been examined at several levels in the past [1]. At the microscopic level, it is well known that shipping noise arises primarily due to propeller cavitation and machinery. Models have been developed that examine in detail the principal mechanisms causing ship-generated noise and their relationship to parameters such as ship speed and length [4], [5]. This approach is particularly useful in developing methodologies for noise mitigation, both in existing and future vessels. However, this paper suggests that a macroscopic view of the noise issue may provide more insight into historical, as well as future, trends in ambient noise levels. In particular, the following observation has been made concerning the change in noise level  $\Delta NL(\text{dB})$  and its relationship to gross tonnage (M GT= mega gross tons) over a given time period [1]:

$$\Delta NL(\text{dB}) = 20 \text{Log}_{10} \left[ \frac{\text{Final Gross Tonnage}}{\text{Initial Gross Tonnage}} \right]. \quad (1)$$

Substitution of the values for the gross tonnage increase during the period 1950–1998 into (1) yields the following result [1], [6]:

$$\Delta NL(\text{dB}) = 20 \text{Log}_{10} \left[ \frac{531.893 \text{ M GT}}{84.583 \text{ M GT}} \right] = 15.97 \text{ dB}, \quad (2)$$

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or 3.33 dB per decade, a value which is remarkably close to the observed increase in noise levels of 3 dB per decade.

#### IV. CORRELATIONS BETWEEN NOISE LEVELS AND GLOBAL ECONOMIC ACTIVITY

The scope of the macroscopic view may be expanded still further based on the following reasoning: If low-frequency ambient noise levels are correlated with commercial shipping activity, and shipping activity is a reflection of global economic growth, then noise levels may be related to global economic trends. In fact, it is hypothesized that the change in noise level over a prescribed time interval can be related to the change in world gross domestic product (GDP) [7], which is a standard measure of economic growth:

$$\Delta NL(\text{dB}) = 20 \text{Log}_{10} \left[ \frac{\text{Final Gross Domestic Product}}{\text{Initial Gross Domestic Product}} \right]. \quad (3)$$

Substitution of the values (in 1990 international mega \$) for the GDP increase [7] during the period 1950–1998 into (3) yields the following result:

$$\Delta NL(\text{dB}) = 20 \text{Log}_{10} \left[ \frac{\$33,725,635}{\$5,336,101} \right] = 16.02 \text{ dB}, \quad (4)$$

or 3.34 dB per decade, which corresponds almost exactly to the result in (2), as well as the 3 dB per decade increase in noise levels.

#### V. FUTURE WORK

This initial attempt at exploring the apparent correlation between ambient noise levels and economic growth suggests that the topic of “noiseconomics” should be explored further. Specifically, is it possible to use mathematical models of global economic growth as reliable predictors of future ambient noise levels? Conversely, can measurements of ambient noise levels be used as metrics for accurate assessments of economic growth rates? Mathematical modeling of global economic trends has historically been a very active area of research in the economics community and has produced a variety of models to explain the direction of the dynamic world economy [8-10]. These models can potentially be used to make predictions of future noise levels as well. When combined with additional noise, shipping, and economic data, these models may provide new insight into the fascinating problem of long-term trends in ocean noise levels and their origins.

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