Miranda Freeman
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Consequences of Anthropogenic Noise on Wildlife and Ecosystems

Introduction

This examination of sound pollution came about as the result of working with my faculty mentor Dr. Aaron Allen in the development of the Ecomusicology Bibliography, a database of scholarly, journalistic, and popular sources that connect music, culture, and nature. While adding materials to the bibliography, I noticed articles by musicians that pointed out how very few places in the world remain completely unaffected by human noise. Like pieces of litter that pile up, the cumulative noise that people make affects the natural world, disrupting the hunting, reproduction, and communication of many species of cetaceans, fish, and more. Since such activities are essential to the survival of any species, sound pollution may result in the decline of affected populations.

I sought to answer three questions in my research: First, what is the importance of protecting wildlife from sound pollution? Second, what measures have already been taken to protect the environment from sound pollution? And third, how can musicians help resolve sound pollution issues? To answer these questions, I examine the implications of population devastation on the environment and people, observe the history of increasing sound pollution, examine three representative case studies in which species have been affected by noise pollution, discuss sound pollution prevention measures, and identify ways in which the musician's unique skill set can be helpful in resolving potential problems.

Wildlife Population Balance: The Nature of Ecosystems

"The first law of ecology is that everything is connected to everything else" (Smith 1995). When the population of one species declines (or increases), the entire ecosystem is affected (Beschta and Ripple 2006). For example, it has been observed that the loss of top predators such as gray wolves (*Canis lupus*) causes an overpopulation of ungulates in the region, ultimately resulting in severe degradation of flora in the area (Beschta and Ripple 2009). Eliminating or reducing populations can have unintended consequences on humans as well. In the 1980s, cod and other fish were overfished from the northwest Atlantic Ocean. With their primary predators almost gone, lobsters, sea urchins, and crabs became overabundant in the early 1990s. Now these species were overfished. In just a few years, sea urchins – second only to lobsters on the Maine seafood market – were nearly extinct from the area. When lobster and sea urchin populations decreased, kelp and algae populations exploded. The lack of predators and the overabundance of algae allowed Jonah crabs to dominate as the main predators. When thirty-six thousand adult sea urchins were shipped in to replenish the area, they were eaten by the Jonah crabs. Because of the devastation of specific species in the region, the coastal area can no longer sustain one of the most valuable species on the seafood market (Estes and Terborgh 2010). As this example demonstrates, it is important to protect the naturally balanced biodiversity of an ecosystem because it is difficult to predict the consequences that the environment and humans will face as a result of the loss of species.

Backdrop: Sound Pollution on the Rise

Technological and industrial advancement has increased the level of man-made noise and the size of the affected area dramatically over the past two hundred and fifty years, both on land

and underwater. Industrial machines invented for mass production have become increasingly common since the mid to late 1700s. In the 1830s, construction of the United States railway system began; by 1860, the railway covered about thirty thousand miles of the North American continent. The length of the railway system in Britain more than tripled during the 1840s. Tens of thousands of commercial wind "engines" appeared after 1854 throughout the United States. These were used for pumping water, providing mechanical power to agricultural equipment, and later for generating electricity. Then in the 1890s, automobile development for market began. In 1919, Ford developed his method for mass production, and by 1927, the Ford company alone had built and distributed more than fifteen million Model Ts across the States (McNeil 1990). Common land-based sources of noise today include road traffic, airports, urban life, military bases, wind farms, mining, and factories (Blickley and Patricelli 2010).

Inventions such as the propeller-driven ship engine have increased underwater sound pollution since the mid 1800s. In the early 1900s, sonar was invented, and over the following century, it led to drastic increase in underwater noise levels. Sonar was used heavily during World War II, and following the war, sonar and similar radio technologies became more widely used as common methods for navigation (Firestone and Jarvis 2007). Now, commercial industries and military branches both utilize sonar, affecting the shallower coastal waters where commercial fishing and military training occurs (Blickley and Patricelli 2010).

Within just the last fifty years, underwater sound levels have increased by about fifteen decibels, precipitated by a huge increase in commercial shipping, military activities, marine-based research, and fishing (Firestone and Jarvis 2007). The noise level of such ships is approximately one hundred fifty to one hundred ninety decibels – louder than the average jet engine. Because sound travels farther and almost five times faster underwater than through air, noise from ships and from such activities as deep-sea drilling can affect sea life up to several thousand miles away (Smith 2010) – especially when emitted at low-frequency (Firestone and Jarvis 2007). Technological advancement has also allowed oil and gas companies to expand their extraction activities into deeper waters, affecting more area with noise pollution. The advent of these technologies and activities has dramatically increased anthropogenic noise.

Many species attempt to cope with sound pollution. Some birds sing louder or at a different time of day, or shift the sound frequency of their songs to avert overlapping with the frequencies of surrounding noises. Certain species of amphibians and dolphins employ similar techniques (Schaub and Siemers 2008). Scientists have noticed individual whales trying to adapt and tolerate marine sound pollution by adjusting the frequency and intensity of their calls, increasing the number of times they produce their calls in order to raise the likelihood that they will be heard by conspecifics, and attempting to find another habitat. While these measures may be of some benefit to particular species, the issue of masking still warrants concern (Firestone and Jarvis 2007) because species have not had time to evolve to fully adapt to the rapidly increasing noise levels (Blickley and Patricelli 2010).

Case Studies: Hunting, Reproduction, Communication

In 2005, a study was conducted in Tübingen, Germany to determine the effects of noise pollution on animals that hunt using "passive listening." These hunters locate their prey by listening for the small echoes of the rustling sounds prey make as they move along the ground. The species examined, the greater mouse-eared bat (*Myotis myotis*), lives across central and southern Europe in caves, large attics, bell towers, and bridges. To determine the effects of traffic noise on hunting patterns and hunting success, greater mouse-eared bats were placed in an enclosed room of multiple compartments during their natural hunting time. In one compartment, recordings of noise from along a major highway in Germany were played through a sound system, simulating the hunting environment the bats would encounter approximately ten to fifteen meters from a highway. The other compartment was silent. In general, the bats avoided the noisy compartment, and in the quiet compartment, their hunting was more successful and efficient. Further evidence suggested that the hunting of such foraging bats is affected by traffic noise up to fifty meters away from a highway (Schaub and Siemers 2008). If the current anthropogenic noise level stays the same or increases, these greater mouse-eared bats are likely to face population decline in the near future.

The greater mouse-eared bat is not the only predator to hunt in this way. Others use passive listening to locate prey include owls, insectivorous primates, other bat species (Schaub and Siemers 2008), and transient killer whales (Slaughter 2011). It is possible that these creatures – including North Carolina's Northern long-eared bats – will experience similar problems to those of the greater mouse-eared bats.

From 1995 to 2009, a study was conducted to evaluate the effects of traffic noise on the reproductive success on great tits (*Parus major*) nesting at the Buunderkam in the Netherlands. These birds' woodland habitat lies between two highways, and there have been no significant changes made to the area. In the results of the study, it was observed that in the noisier parts of the habitat, the birds' clutches were smaller, and fewer chicks survived. Because mate selection amongst great tits depends on perceived song quality, one possible reason for this lowered reproductive success rate is that noise pollution is detrimental to quality assessment of mates and lowers maternal investment in the young. A second potential reason is that the birds breeding in noisier territories may be the less experienced birds. Because prey is more difficult to locate when noise pollution is present, a third explanation for lowered reproductive success is extra physiological stress resulting from a decrease in foraging opportunities. High noise levels may also have a negative impact on adult-offspring communication, resulting in the inability of parents to properly care for their young (Halfwerk et. al. 2011). Regardless, noise pollution has been shown to affect the reproductive success of great tits in this location. Other birds living in urban areas or habitats near roads may face similar reproductive problems.

A study by Thierry Lengagne observed the effects of sound pollution on the European tree frog *Hyla arborea*. This species is native to the Pierre Vérots Foundation, a natural reserve twenty kilometers north-east of Lyon, France. Like many other species, *H. arborea* males rely on acoustic calls to attract females during breeding season. Results of the study showed that when the frogs were exposed to playback of traffic noise, not only were they unable to adapt the frequency or duration of their calls to avoid masking, they even emitted fewer calls (Lengagne 2008). Similarly, in a study conducted by Sun and Narins in 2005, three out of four anuran species observed also decreased calling activity in the presence of airplane and motorcycle noise (Sun and Narins 2005**)**. The results of the Lengagne study also suggested that noise may cause males to gather closer together, causing mate selection to be more difficult for the females. Because acoustic communication is crucial to the reproductive success of *H. arborea* and other species, anthropogenic noise could result in a population decline of these species (Lengagne 2008).

Measures to Regulate Anthropogenic Noise…?

Over the past several decades, as awareness of the effects of noise pollution has grown, the topic has become of greater concern to individuals and organizations. Unfortunately, there are still currently neither U.S. nor international laws specifically designed to regulate noise pollution for the protection of wildlife populations (Firestone and Jarvis 2007). Noise ordinances such as 42 USC 4901 (U.S. federal Noise Control Act of 1972) regulate noise according to *human* needs, but they do not meet the needs of *noise-sensitive wildlife species* (Blickley and Patricelli 2010). However, certain laws that do exist could be interpreted as a basis for regulating certain types of sound pollution. For example, State members of the United Nations are required under Article 194(1) of the United Nations Convention on the Law of the Sea (UNCLOS) to do whatever is "necessary to prevent, reduce, and control pollution of the marine environment of any source." Included in the definition of such pollution is "energy" introduced "by man, directly or indirectly… into the marine environment" which is or may be harmful to marine life (United Nations 1982-2012). Since sound is a form of energy, this law and others with similar wording can be used to protect wildlife on both land and underwater until sound pollution laws are enacted.

A number of ideas have been generated to reduce the impact of anthropogenic noise on the environment, both in the oceans and on land. A way to reduce traffic noise pollution could be a "noise tax" for traveling near the breeding grounds of sensitive species during mating season. Traffic noise may also be reduced through the construction of sound barriers, the implementation of efficient transportation systems through crucial breeding areas, and the use of pavement that generates less noise (Halfwerk et. al. 2011). These types of measures have been adopted in the Netherlands (Lengagne 2008). Michael Jasny, an environmental lawyer for the Natural Resources Defense Council, has suggested requiring large marine vessels to be outfitted with quiet, energy-efficient propellers. (Slaughter 2011). Although many of these measures require significant monetary investment, both in the initial implementation and the upkeep, the long-term results would benefit both human and animal populations (Halfwerk et. al. 2011).

Some possible regulations to protect wildlife from noise pollution are highly controversial. One such mandate is the legalization of firearm silencers for hunting guns. The noise level produced by hunting guns ranges from one hundred-forty to one hundred-ninety decibels – louder than a jet engine upon take off (one hundred decibels). Not only is this noise level dangerous to human hearing (Sparano 2007); such noise may also detrimental to the animals living in the habitats used for hunting. Legalizing and allowing ready access to gun silencers, however, is a very controversial concept in America. About one-third of the states in the U.S. ban the possession of silencers. Federal law dictates that the possession of a silenced firearm during a crime currently results in a mandatory minimum jail sentence of thirty years – a more severe punishment than that received by many rapists and murderers – and simply having an unregistered silencer in one's possession can result in a sentence of up to ten years. Both of these federal laws are based on the assumption that silenced firearms are inherently more dangerous than those without silencers. However, a study by Paul A. Clark of the Alaska Public Defender Agency demonstrates that the use of silenced firearms during crime is rare and not associated with organized crime. Clark also pointed out that "it is unlikely that laws banning [home-made] silencers are likely to have any real effect on crime" because "true professionals… can avoid the penalty quite easily" (Clark 2007:54) He posed the question of whether silencers should remain illegal at all. If, as Clark's research suggests, crime is not highly related to silenced firearms, it may be valuable to consider the benefits that legalizing silencers could provide to the environment and to people (Clark 2007).

Musicians and Sound Pollution

Musicians can play a valuable role in the identification of sound pollution problems. Through their training, they gain the ability to recognize acoustic patterns or changes in patterns readily. While scientists can quantify and qualify the meaning of such patterns within the environmental context, musicians may be able to more quickly notice them and may therefore serve as helpful guides for the scientists to sources of information.

For example, the collaboration of musicians with scientists may be useful when identifying call emission characteristics or vocalization patterns of a particular species. Many animals, including humpback whales and numerous species of birds, produce “songs” characterized by rhythmic and melodic features of human compositions. Whales in particular use phrase lengths, structural forms, tone, and timbre common to human music. They also sing refrains with rhyming material, presumably for the same reason people do: to aid musical retention of the song (Gray, et al 2001). Because musicians develop the listening skills necessary to identify acoustic patterns and musical qualities, it may be useful to have them involved in long-term studies of various species to help identify patterns and abnormalities of – or absence of – calls as scientists determine the functions and significance of such calls.

One musician who has identified useful information about natural acoustic patterns is American naturalist Bernie Krause (b.1938). Through his field recordings, he recognized that in a natural environment, each animal that lives in that environment calls with its own specific frequency, amplitude, timbre and duration – much like the instruments of an orchestra (Gray, et al 2001). The unobstructed use of a species’ frequency range is critical to its communication. If a species is forced to alter the frequency range of its call, it may be forced to share the “sound niche” of another species, leaving both calls less efficient. Understanding the way that the species of a given habitat "share the air" may help scientists determine what manmade noise could be particularly harmful to those species. Musicians may also be able to aid scientists in detecting situations in which two or more species are being forced to share a sound niche, thereby providing an opportunity to resolve the issue.

Another way that musicians can help lessen the issue of sound pollution is through promoting an appreciation of natural sounds. Many composers over the years have been inspired by nature; some have even included audio recordings of nature in their own work. Others, such as R. Murray Schafer, intentionally have their music performed outdoors in a natural setting away from large cities so that nature's "music" is a part of the performance. Awareness of and appreciation for the beauty of natural sounds may help motivate people to alleviate noise pollution in small ways in their own lives.

Conclusion

Through the examples of the greater mouse-eared bats, great tits, and tree frogs, it is clear that sound pollution has a negative impact on crucial life activities of wildlife that could lead to the decline of species populations. This population change in the environment, like in the case of the sea urchins in the northwest Atlantic Ocean, may in turn have adverse, unexpected consequences for humans. More regulations are needed to protect ecosystems – and, thereby, people – from potentially irreversible damage caused by such species deterioration. With their unique ability to identify acoustic patterns, musicians can collaborate with scientists to identify and mitigate acoustic issues, as well as help promote appreciation of natural sounds in order to encourage the public to turn the volume down.

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