STATEMENT OF GRANT PURPOSE
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The Effects of Automobile Traffic Noise on Foraging Bats

As humans expand into all corners of the globe, the world is becoming radically altered. Habitat loss, overfishing, air and water pollution, and global warming are some of the large issues that we face today. Due to a relatively recent human population explosion, we find ourselves abusing natural resources, polluting the Earth, and losing species faster than ever recorded. This loss of biodiversity has numerous consequences, many of which are unknown.

Most human-induced land impacts are well documented, and have received scientific attention for some time. However, one particular form of pollution, anthropogenic (man-made) noise, is vastly understudied. Unlike other disturbances, sound can travel nearly unabated around objects for many miles before attenuating. Additionally, sound emanates in all directions from a point source, which allows for the disruption of incredibly vast land areas. With the dramatic increase of urban development, energy extraction, and transportation even our last 'wild' places are extremely disturbed. Many animals depend on sound while interacting with the environment around them. Listening for predators, foraging, and communicating with others are important tasks often involving acoustic signals that cannot escape being masked by anthropogenic noise.

Bats are an under-appreciated group of mammals, which perceive their world almost entirely through auditory cues. Most species navigate using ultrasonic echolocation signals, and rely on sound to communicate with mates and offspring. Bats also use sound to obtain food, both by echolocation and by listening to prey sounds. Because bats have such an extreme dependence on sound, they are ideal organisms in which to investigate how human-borne noises affect animals, a field that has so far been dominated by research with birds. While bats are the second-most species-rich group of mammals, many may face grave danger with increasing human dominance of the soundscape. Thus, understanding if bats have difficulty completing daily tasks (such as finding food) in a noise-filled background is absolutely critical for the conservation and management of the 1200+ species found worldwide.

If I am awarded a Fulbright grant, I will investigate these questions over the course a year in the lab of Dr. Holger Goerlitz at the Max Planck Institute for Ornithology (MPIO) in Seewiesen, Germany. This research setting is an excellent choice for a variety of reasons. Firstly, Germany hosts many organizations that are specific to bat conservation, and takes great pride in supporting bat research. Moreover, the MPIO is a leader in publishing some of the most remarkable and exciting bat research in the world. Additionally, biologists at this institute conduct some of the only research focusing on the effects of noise on bats. My proposed advisor, Dr. Goerlitz, is the Acoustic and Functional Ecology research group leader at the MPIO, and is a well-respected sensory ecology expert. For the aforesaid reasons, I cannot imagine a more appropriate mentor and institution for this research. Dr. Goerlitz and the MPIO have shown their full-support by offering laboratory space, equipment, help planning the experimental design, and assistance gathering necessary resources (bats, permits, etc.) for my project.

I will conduct a set of experiments in which I measure a bat's perception threshold of an object as a proxy for foraging ability, and will determine how noise affects that threshold. During each trial, a single bat will be released into a flight cage where it will have to discriminate a rippled plate from a smooth plate in order to obtain a food reward. The ripple height can be varied so that the discrimination task is easier (taller ripples) or more difficult (shorter ripples). The perception threshold is the point at which the bat can just discriminate between the plates, that is if the plate had slightly shorter ripples the bat would not be able to distinguish one plate

from the other. The bat *Phyllostomus discolor* will serve as my study organism because the frequency range of their echolocation calls overlaps considerably with the frequency range emitted by automobile traffic. This overlap makes their echolocation signals vulnerable to being masked by traffic noise. Thus, noise is expected to have a detrimental effect on foraging ability.

Foraging success will be measured as the success rate of choosing the rippled disc over the smooth one. This laboratory choice serves as a proxy for real-life foraging scenarios in which subtle texture differences allow bats to distinguish prey from non-prey via echolocation. I will measure the threshold detection necessary for the bat under multiple noise conditions. If the threshold were higher under noisy conditions, it would imply that bats have more difficulty differentiating substrates under these conditions. This would suggest high foraging costs to the bat in the presence of noise. I will note the time it takes the bat to reach the correct plate (foraging efficiency), and the proportion of time the correct plate was chosen (success rate) in the noise conditions. The first scenario will be silence, which will serve as a baseline of the general foraging efficiency of each bat. Then, in random order, I will broadcast traffic noise and white noise covering the same frequencies as the bats' echolocation calls (as a positive control). I will also record individual echolocation signals in order to distinguish differences in call structure during each scenario. These measures will allow me to assess how bat foraging is effected by anthropogenic sound. The first month of my proposed project will be devoted to training bats to associate the rippled plates with a food source. Once bats are trained, over the next six months I will conduct discrimination tests, recording echolocation signals and gathering feeding efficiency and success data for the different noise treatments (silence, traffic noise, and white noise). The remaining three months will be devoted to data interpretation, statistical analyses, and writing. I will submit this work for publication in an international, peer-reviewed, academic journal.

Working with Dr. Goerlitz and the MPIO will allow me to continue my current trajectory of studying bats, while branching out into the up-and-coming field of anthropogenic noise disturbance. I have full confidence that I will be able to carry out this research under the supervision of Dr. Goerlitz, as he is a world expert in this field. By the start date of this project, I will have over a year of intensive bat handling, care, and independent investigational research experience through my current internship at the Smithsonian Tropical Research Institute.

As knowledge of the German language is not a requirement for conducting Fulbright research in Germany, and English is the standard language of use at the MPIO and in the scientific community at large, I anticipate no linguistic barriers to conducting research during my stay in Germany. Even so, I will commit myself to learning as much German as I can before and during my stay. I will work with online language software, and (if it is available) I will arrive in August to participate in a German language intensive course to better facilitate the cultural exchange between members of the community and myself. Public outreach is a crucial and forgotten part of conducting science. If findings are kept silent, then they are effectively rendered useless. I will regularly contribute to the MPIO's science seminar series where young researchers have the opportunity to interact with the general community and youth. These outreach events often take place at the University of Konstanz, which allows for broad community interaction.

The Fulbright experience would be instrumental in my academic research career. Working with world-renowned researchers at this prestigious institution will prepare me for asking similar questions during my doctoral research when I return to the United States. Additionally, it will foster necessary international collaborations in which to carry out this much-needed bat sensory ecology research in the future.