

Humans have dramatically altered many of the natural soundscapes in the Alps. Already under climatic stress from global warming, the mountain ecosystems are especially vulnerable to noise impacts. The high topographic relief produces meteorological patterns that amplify noise, which also refracts long distances up valley walls. Lying between economic centers in northern and southern Europe, the Alps are exposed to heavy noise from ground and air traffic. As the austrian landscape of rugged peaks, alpine meadows, and lush valleys draw an increasing crowd of tourists every year, the ambient noise is increasing. To better understand the impacts, I propose to help ecologists at the University of Innsbruck study the relationship between anthropogenic noise and the natural soundscapes of the Alps.

A major research focus at universities in the Alps is the relationship between humans and the alpine environment, but noise studies have been limited. A recent large-scale project, named ALPNAP, investigated the impact of pollution and noise from major transportation routes through the Alps, such as the Brenner Motorway. The study detailed the noise impacts to humans, but it did not investigate impacts to the rest of the environment. Recent studies suggest that human noise significantly impacts other species. A study near the city of Leiden in The Netherlands showed how birds raised the pitch of their calls to an empty frequency band to avoid the lower frequencies of anthropogenic noise. A project in Yellowstone National Park in the United States demonstrated that noise from snowmobiles increased stress levels in elk and wolves. Still, the impact of noise on the environment is little understood, and most published papers cite the need for further research.

With the support of the ecosystem and landscape ecology research group at the University of Innsbruck, I will investigate alpine soundscapes in different land uses and at different altitudes. The research group, headed by Dr. Ulrike Tappeiner, will offer their expertise in landscape ecology and knowledge of the region. The group will help me carefully select at least four recording sites and obtain permission to install recorders. I will select and obtain the recording equipment, made simple and inexpensive by recent developments of the digital recorder. In addition to open-source sound analysis software, we will use advanced sound-propagation and geographic-information-system software to follow a new approach for our sound study.

Natural sound research is well-established; however, sounds are typically analyzed individually, out of context with other sounds in the environment. Bernie Krause from the Wild Sanctuary in California and Bryan Pijanowski from Purdue University suggest that listening to all the sounds together in a soundscape can yield a significant amount of information about the ecosystem. The scientists refer to this holistic approach as soundscape ecology. Soundscape ecology differs from well-established acoustic fields by studying all the sounds from a landscape at multiple spatial and temporal scales. The scientists separate the soundscape into three parts: the geophony, sound produced by the earth (e.g. from wind, flowing water, and avalanches); the biophony, sound produced by organisms (e.g. bird songs, insect stridulations, and mating calls); and the anthrophony, sound produced by humans (e.g. from cars, ski lifts, and cow bells). Our study will consider the relationships between these parts.

As soundscape ecology is an emerging field and unknown to most ecologists, I will bring my knowledge of sound propagation and recording techniques to the project. I will visit the recorders frequently to collect data, change batteries, and film and photograph the surrounding landscape. Simultaneously analyzing the collected data, we will calculate quantitative parameters of the recordings such as acoustic diversity, activity, and evenness. These parameters were developed by ecologists and are familiar to the entire group. We will produce maps and data visualizations that illustrate the soundscape parameters and how they change spatially and temporally. I intend to record data for the entire 9-month grant period, allowing me to capture the effects of weather, terrain, and phenology. The recorders could remain after the grant period for a longer-term study.

Only a small number of studies have gathered soundscape data for long periods of time. A one-year study in Indiana at Purdue University recorded the soundscape at several different sites with varying amounts of forest, wetlands, agriculture, and urban land cover in a 100-meter radius around each recorder. The study

found clear relationships between each soundscape and its land cover, but it also identified the need to collect data from soundscapes around the world.

Innsbruck's central location in the Alps and close proximity to large natural areas will provide the perfect environment for my study, but I am also drawn to Austria for the combined English teaching assistant opportunity. I became interested in language after taking a German class as a college freshman. I immediately became addicted and continued to take classes as they balanced my scientific studies and provided a refreshing break. While studying abroad in Germany, I further realized the benefits of being bilingual and better commanded the strict German grammar. Learning German caused me to develop a deeper understanding of English syntax, and I feel I could clearly explain the rules of English and easily relate to the learning experience of the students. I am confident that my connection to Austria will be stronger by teaching and simultaneously conducting research. The combined opportunity will be invaluable as I begin my pursuit of a career in academia.