CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Noah R. Crousore

Project Number
J2114

Project Title
Investigating Optimal Sound Frequencies for Rescue Signaling

Abstract

Objectives/Goals
My family and I spend a lot of time hiking in the Idaho forest. Most of the time we don#t have cell phone service. I carry a whistle in case of emergency. This made me wonder if there might be certain frequencies that could be heard for greater distances. The goal of my project was to see if certain frequencies maintain their amplitude for greater distances than others. I believed some frequencies might demonstrate less decibel degradation than other notes.

Methods/Materials
I used two digital keyboards, a digital grand piano, an anemometer, a digital decibel meter, a metric measuring tape, an altimeter, a digital thermometer, a hygrometer, and phone "apps" for tuning and recording. I measured the decibel levels, from 75 meters away in a forest setting since attenuation is a consideration. I compared keyboard notes, a rescue whistle at 2.5 kHz, and sounds of yells (human voices).

Results
After performing more than 100 tests of 40 frequencies, I narrowed my optimal frequencies to 20 that seemed to sustain their amplitude for greater distances. I then found eight frequencies that seemed to show the least degradation at 75 meters. I used logarithmic doubling rules to extrapolate the decibels at 150 meters, 300 meters and 600 meters, and 600 meters with the impact of A-Weighting (the ear's sensitivity to certain frequencies, perceiving sounds as either louder of softer).

Conclusions/Discussion
Although the degradation for the eight notes did not vary greatly, a difference of even one decibel is a noticeable difference in loudness. When A-Weighting is considered, the perceived loudness of notes at similar decibel levels may be significantly different. Yells or "screams" had the least degradation, possibly due to the harmonics, formant resonance, and overtones in the human voice. The two chamber whistle at 2.5 kHz also lost less amplitude with distance, making it a good choice for rescue. I extrapolated to compare all music note frequencies at 600 meters. I found that of the keyboard notes I tested, Ab4 (417.9 Hertz) was significantly louder with distance than the other notes in the five octave range I evaluated.

Summary Statement
I investigated optimal sound frequencies for rescue signaling, explored loss of amplitude over distance in a woodland environment, then compared the test frequencies to a commercial rescue whistle and human "yells" for help.

Help Received
Thanks to my parents for their support and assistance when I conducted my tests. Thanks to my science teacher for lending me equipment and for her guidance.