The Effect of a Vegetation Buffer on Sound Levels

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Introduction

Background

- Noise pollution is a growing concern in the environmental health community. Unlike other common exposures, such as air and water pollution, noise is uniquely difficult for an individual to protect themselves from. It can travel through walls, windows, and against wind, making noise a pollutant that impacts nearly everyone in the world.
- Noise pollution can come from many types of sources, including traffic (road and railroad), air (helicopters, airplanes, etc.), occupational activities (industrial), and recreational activities (community events, concerts, sports, etc.). Noise levels are typically measured in decibels (dBA). The EPA recommends a 24-hour exposure *limit* of 55 dBA to protect public health interests. In 1981, it was estimated that 46% of the US population was experiencing noise levels above the recommended exposure limit.
- Studies have shown multiple adverse health outcomes resulting from exposure to noise pollution, including hearing impairment, negative social behavior and annoyance, sleep disturbance, cardiovascular disturbance, and disturbances in mental health. It is estimated that over 100 million individuals are at-risk of hearing loss due to excess noise. Studies also show a strong association between noise pollution and high cardiovascular risk, linked with high blood pressure, stroke incidence, and myocardial infarction. Much of this increased cardiovascular risk, and that of other adverse health outcomes, can be attributed to the stress of noise disturbance and loss of sleep due to nighttime noise.
- Aside from legislation and regulations, one way to reduce public exposure to noise pollution is through traffic sound barriers. Nearly 50% of the population experiences exposures to traffic noise alone high enough to adversely impact health.

Study Aims

- This study is designed to assess the effects of a tree barrier in reducing traffic noise.
- We hypothesized that the vegetation buffer will reduce sound levels from traffic noise.

Methods

Site

- Noise monitoring was conducted at Saint Margaret Mary Catholic School. The school is situated behind a lawn. On the east side of that lawn, there is a buffer of vegetation, whereas the west side is almost entirely bare. We conducted monitoring on both the east and west sides of the lawn to assess the effect of the vegetation on sound levels.

Monitoring

- Four monitors were used to track sound levels in eight different spots (see Image 1). This was accomplished by alternating two of the monitors between three spots (labeled A, B, and C) over the course of 24-hours. Monitor locations 1 and 2 were 'buffer' locations, whereas 3 and 4 were 'non-buffer'. Both buffer and non-buffer measurements were equal distance from the road.
- 24-hours of monitoring were conducted from 21:00 on July 22 – 21:00 on July 23. Every four hours, monitors 2 and 4 were alternated between locations A and B. For the last hour of monitoring (20:00 – 21:00, July 23), monitors 2 and 4 were moved to location C.

Equipment

- The sound level meters used were Larson Davis SoundExpert LXT monitors. They were powered with D-cell external battery packs and placed on tripods for the duration of the monitoring (see Image 2).

Data

- Sound levels were collected in decibels (dB) every second and averaged by hour over the 24-hour monitoring period, then averaged together once again per monitor location to produce a 24-hour sound level average.
- LASeq is a parameter used to describe sound levels that vary over time by taking into account the total sound energy over the period of time of interest to produce a single decibel value. LASeq must be measured in total sound energy because the decibel values recorded per second are logarithmic values and cannot be added and averaged directly. The values must be converted from decibels to sound pressure levels and back to decibels again.
- LASmax describes the maximum value in decibels that the sound pressure levels reached over the measurement period. Because this is a 24-hour average, the value displayed is not the maximum sound at any given time during monitoring, but instead the average of the maximum sound that occurred every hour.

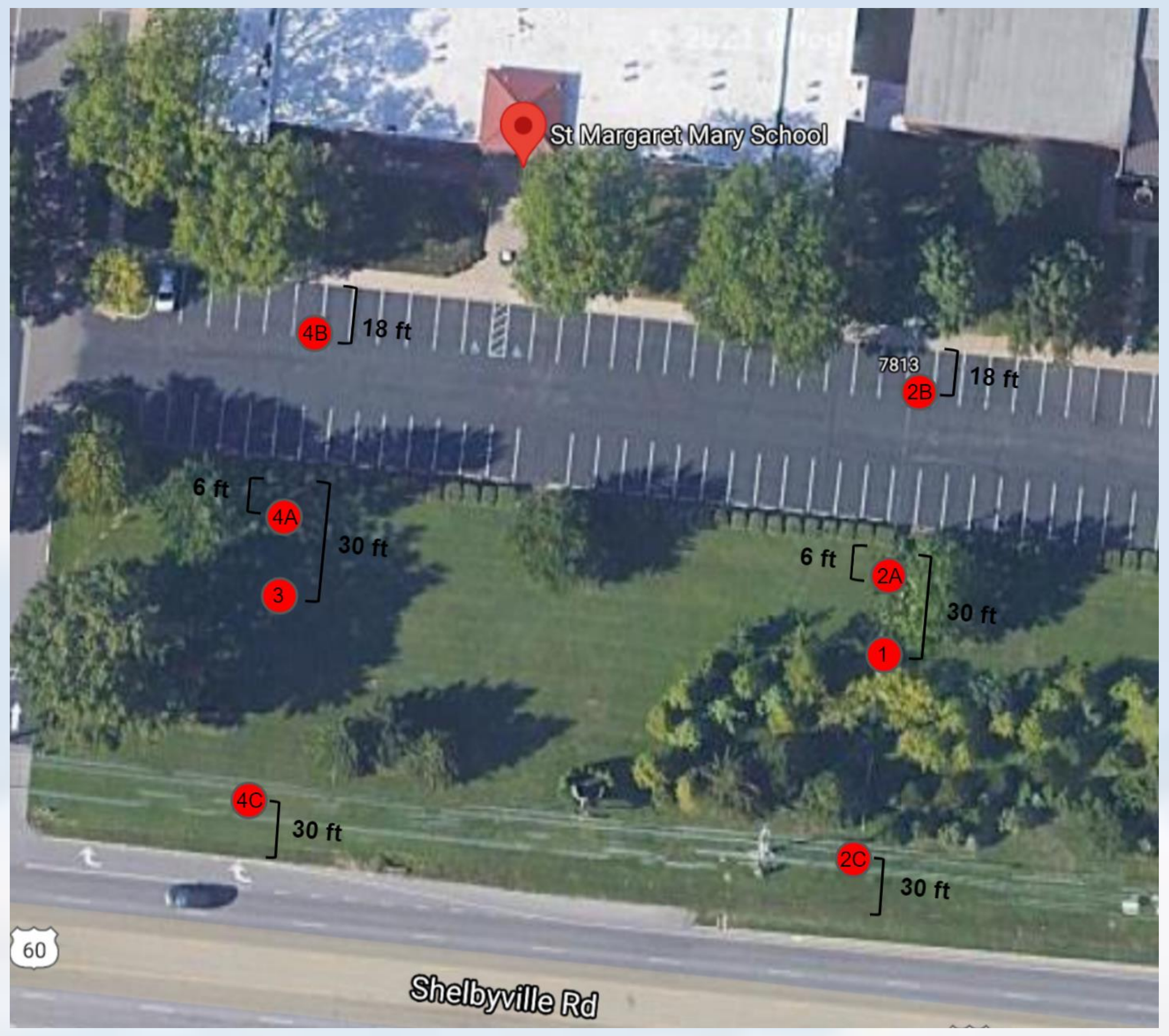

Image 1: Placement of monitors. Satellite image lifted from Google Maps.

Image 2: Monitors 3 (far) and 4 (near).

Results

Sound Levels

- Monitor locations 1, 2A, and 2B all record an LASeq of approximately 2 dB lower than that of locations 3, 4A, and 4B, respectfully. See Figure 1 for more information. In other words, monitor locations behind the buffer recorded sound levels around 2 decibels lower than those locations without a buffer. This trend, however, becomes less significant as the monitor locations get farther from the buffer.
- Locations 2C and 4C present the loudest LASeq and LASmax.
- The difference between buffer and non-buffer locations decreases when examining LASmax, only varying about a decibel on all locations other than 2C and 4C, which recorded much higher LASmax values.

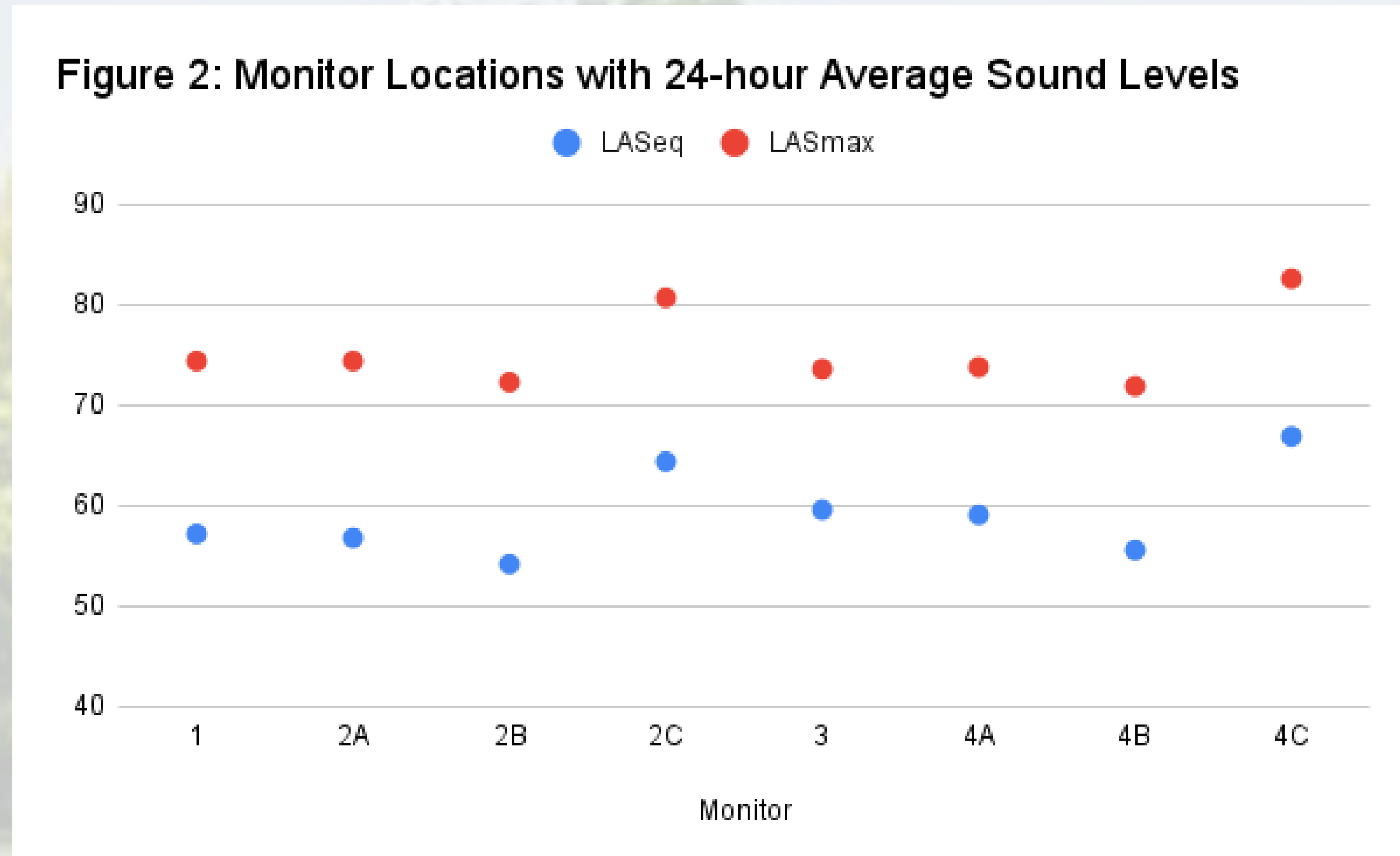

Figure 2: Graphical representation of the values in Figure 1, displaying LASeq values and LASmax values per monitor location over a 24-hour period. Sound levels are displayed on the y-axis in decibels.

Discussion

Conclusions

- The sound levels measured from locations behind the buffer versus without any buffer indicate that the presence of the buffer slightly lowered sound levels in a very consistent manner. It also shows that the effects of the buffer may decrease as the monitor is moved farther away from it, as locations 2B and 4B record a 1.4 dB difference, whereas locations 2A and 4A record a 2.3 dB difference.
- The fact that 2C and 4C recorded the highest levels of LASmax and LASeq is reasonable, as those locations were (1) without any buffer and (2) the closest to the road.
- LASmax varies less than LASeq between monitor locations. This may indicate that a noise buffer has less of an effect on sudden, loud noises, and a stronger effect on average noise levels.
- Overall, this data shows that there is a small effect on average sound levels when utilizing a vegetative noise buffer.

Future Direction

- Noticing that the effects of the buffer may decrease as the monitor is moved farther away from it, the data begs the question: is there a point (in distance away from the buffer) at which the sound-dampening effects of the buffer become insignificant?
- Future studies should examine the effects of denser vegetation on lowering noise levels. Is there a limit to the amount of noise that vegetation can reduce as density in that vegetation increases?
- Because the effects of noise pollution on health are well-known, an experiment using similar noise monitors could examine the effects of a noise buffer on health.
- There is much to be learned about the long-term effects of noise pollution, especially regarding sleep disturbance and stress.

Limitations

- There was one individual at a time tending to the monitoring site, meaning that each monitor, when locations needed to be changed, were moved a few minutes apart.
- Measurements, especially in locations 2B and 4B, were conducted fairly close to a large building and parking lot. This could cause sound to bounce off of those structures, and influence sound level measurements.
- This monitoring was conducted at the end of the weekday (Thursday-Friday) in the summer. Noise levels will certainly vary throughout the week and year.

Monitor Location	LASeq (dB) 24-hour average	LASmax (dB) 24-hour average
1	57.2	74.4
2A	56.8	74.4
2B	54.2	72.3
2C	64.4	80.7
3	59.6	73.6
4A	59.1	73.8
4B	55.6	71.9
4C	66.9	82.6

Figure 1: Table displaying LASeq values and LASmax values per monitor location over a 24-hour period.

Acknowledgements

Thank you to Saint Margaret Mary Catholic School for their cooperation on-site. Thank you to the Envirome Institute and everyone working there for being welcoming and helpful throughout the summer. Thank you to the Summer Research Opportunity Program and Billye Potts for this experience.

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