

COLORADO STATE UNIVERSITY
DEPARTMENT OF HUMAN DIMENSIONS OF NATURAL RESOURCES

To: Muir Woods Soundscape Working Group
From: Peter Newman and Vicki McCusker
CC: Karen Trevino and Dave Stack
Date: 12/10/2013
Re: Information for choosing MUWO Indicators

Two potential indicators were discussed and analyzed using data from MUWO visitor surveys as well as sound recordings made by the NPS Natural Sounds Program from 2005-2008. They were:

1. Percent of time human sounds are audible:
 - a. Visitor Surveys indicate that conditions related to soundscapes drop below acceptability at about tape three which is the equivalent to about 45% time human sounds are audible.
 - b. 84% of visitors identified the conditions they experienced as being between tape two and three. This indicates that visitors were able to assess actual conditions. Actual conditions recorded by the NPS NSP were about 40-45% time human sounds are audible.
 - c. This indicator can be measured in several ways:
 - i. Attended Logging by Park Staff.
 - ii. Short Visitor Survey
 - iii. Recording devices
2. Sound Pressure Level:
 - a. Based on data from a 2006 survey of visitors, dBA levels dropped below acceptability between tapes 2 and three. This is equivalent to conditions between 34 and 39 dBA.
 - b. Actual conditions (Hillside Site summer 2005? Daytime?): Lnat: 28; L50:30; L90: 26.¹
 - c. Cathedral Grove site 2006 Daytime 0700-1900: L₉₀: 28.0, L₅₀: 33.3 L₁₀: 42.4
 - d. Cathedral Grove Site 2007 Daytime (0700-1900) L₉₀: 29.7, L₅₀: 34.7, L₁₀: 43.2

Comment [VM1]: Was this based on the Hillside Site?

Comment [VM2]: Is this an L50 or Lnat during daytime?

Comment [VM3]: Ericka and I couldn't figure out where these #'s came from. I asked Damon to run exceedance metrics on the Hillside Site (MUWO #1) and the results were L90: 26.1, L50: 28, L10 32.7. I looked at the MUWO acoustic monitoring report and the L_x values were reported by hour not by day. The Cathedral Grove site would be a better site to use for actual conditions for the scenic corridor,

¹ Percentile Noise Level (L₁₀, L₅₀, L₉₀)

The x-percentile-exceeded sound level is the sound level that is exceeded x percent of the measurement period. For example, the hourly L₁₀ is the sound level that is exceeded 10 percent of a measurement hour. The hourly L₅₀ is the sound level that is exceeded 50 percent of the measurement hour. The L₅₀ is also known as the median sound level. Similarly, the hourly L₉₀ is the sound level that is exceeded 90 percent of a given measurement hour.

- e. Visitors also identified current conditions at L_{50} .
- f. This indicator can be used to as a surrogate for decrease in listening area
- g. This indicator can be measured two ways:
 - i. Sound recordings
 - ii. Visitor surveys

These two indicators are measureable, objective, sensitive to change and manageable. Initially, a maximum sound level was suggested as a standard for sound pressure level but it is problematic to set a standard based on it since the maximum sound level may only occur for an instant and does not provide a good representation of existing conditions. A standard that is based on an exceedence metric or percentile noise level (L_x) provides a better representation of the existing conditions and is easier to use for comparisons to detect changes in the ambient conditions.

Our latest studies indicate that noise measured in dBA (hourly Leq^2), generated by visitors can be decreased by 3-5 dBA which is the equivalent to at least a 70% increase in listening area. These 3-5 dBA increases are considered by agencies to be “significant impacts” under NEPA processes³. The dBA of the average quiet day treatment was 1.96 dBA lower than the control. By dividing the change in dBA by the average dBA increment per person on a control day (.0025), the effects of these treatments can be quantified per person. The reduction of 1.96 dBA by the quiet day treatment, is equivalent to removing the acoustical effects of 793 visitors. The effect of quiet zone treatment on dBA was a lowering of 2.84 dBA as compared to the control levels. Using the same formula described above, the quiet zone signs removed the acoustical effects of 1150 visitors. This implies that setting overall use limits is only one of many option of dealing with capacity and behavioral shift through management actions is an attractive alternative.

It is interesting to note that the L_{50} for the Cathedral Grove area in 2006 and 2007 was 33.3 and 34.7 respectively. The American National Standards Institute Classroom Acoustic Standard recommends noise levels not exceed 35 dBA in an empty classroom (ANSI S12.60). Hourly $Leqs$ at the Cathedral Grove site exceeded 60 dB between 9 a.m. – 6 p.m. Loud events raise the Leq , however less than 11% of the time were sound levels above 45dBA and rarely (less than 1%) were they above 60 dBA..

Sound pressure level can also be used to determine how much human-caused sounds raise the ambient sound level above the natural ambient. This would be a better standard to use for the Natural and Sensitive Resource Zone where we do not have acoustic data and we would have no basis for establishing standards for % time audible or selecting a specific L_{50}

² *Equivalent Continuous A-Weighted Sound Level (L_{Aeq})* – The A-weighted level of a steady sound that would have the same time-mean-square A-weighted sound pressure as the time-varying sound under measurement in a given time period. For example, the hourly L_{Aeq} is a logarithmic measure related to the average A-weighted sound energy (not the average A-weighted sound level) observed over a one hour measurement period;

³ the metric used by other agencies is called “change in exposure.” The Listening Area reduction is based on the concept of change in exposure but relates the change in noise level to masking. As the sound pressure level of a noise source(s) increases, it masks other sounds.

value. However, we can look at how much extrinsic or human caused sounds raise the ambient levels. Findings from the Hillside site data suggest that during daytime hours, extrinsic sounds raised the natural ambient between 1 and 3 dBA. The Natural and Sensitive Resource Zone is farther away from trails, so a 3 dBA change would be too much in this zone and would indicate that visitor use was raising the ambient comparable to the scenic corridor zone. It should be noted that we do not know if other noise, such as highway noise, is louder in this area. The disadvantage to this metric is that it needs to be collected with a Type I sound level meter. However, using the L_{50} as a metric for the scenic corridor also requires the same type of equipment to collect it too.