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A Proposal for Acoustic Data Collection in Parks and Wilderness Areas

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Abstract

Over the past ten years, HMMH has worked with The U.S. National Park Service (NPS), the U.S. Air Force, and the U.S. Federal Aviation Administration to develop an approach for assessing sounds in U.S. National Parks. Currently, the work by HMMH and other consultants to the NPS has focused on developing technical information for use in a guidance manual that will describe procedures to document and preserve the existing natural acoustic environments (soundscapes) and to manage noise intrusions in U.S. National Parks. Based on the accumulated work of the past decade, the author offers a method for acoustic data collection in park / wilderness settings that addresses the many special considerations that arise in these special acoustic environments.

1. Introduction

Most analyses of environmental noise problems have been designed to address noise issues in urban or suburban residential areas. At least four specific characteristics of parks make them very different from these traditional areas of concern and give rise to issues that complicate the design of a park-oriented method and pose new technical challenges.

2. Special Considerations Related to Parks

2.1. Parks are very large

Parks can be ***very large***, containing thousands to millions of acres (Grand Canyon is about 1.2 million acres), and there are ***over 300 units*** of the National Park system. Both within parks and from park to park, there are tremendous variations in geology, topography, vegetation, sensitive wildlife species, visitor activities, infrastructure or the lack of it, etc.

Large size complicates selection of acoustic data collection sites. The existing soundscape includes all natural and human-produced sounds in the park. Currently, the approach, yet to be fully validated, is to assume that parks contain multiple different "acoustic zones." It is assumed that areas having similar topography, foliage, wildlife habitats, and water drainage or flow conditions should have similar natural soundscapes. Dividing a park *a priori* into different zones should mean that measurements made at a few or several locations within each zone are sufficient to quantify the existing natural soundscape. Full statistical validation of this concept of acoustic zones is likely to occur only after long-term (months-long) monitoring has been completed in many park environments.

2.2. Parks can be extremely quiet

Sound levels in parks can often be very much below the sound levels found in typical urban and suburban environments – at times ***below the human threshold of hearing***. Not only do these low levels mean that intruding sounds can be heard and may need to be measured and/or analyzed at great distances from the source of the intruding sound, but that standard sound measuring equipment may be unable to accurately quantify these levels. Figure 1 compares A-weighted levels measured in Great Meadows located in suburban Bedford Massachusetts near a general aviation airfield, and levels measured in Haleakala Crater in Hawaii (Maui).

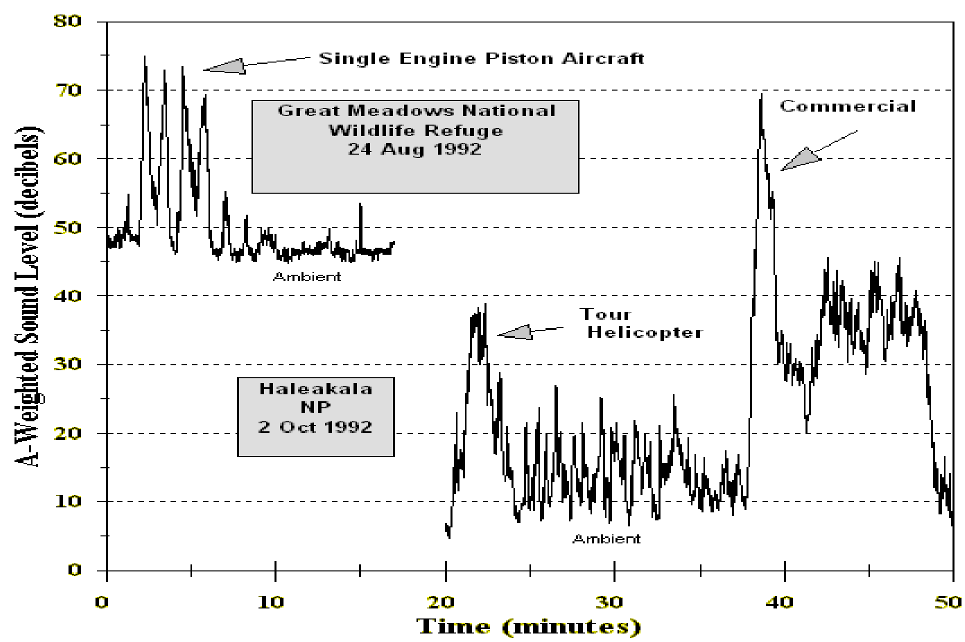

Figure 1: A-weighted time histories comparing typical suburban sound levels and aircraft levels with sound levels in a park with aircraft sound levels.

2.3. Sound intrusions are relative

The effects of intruding sounds cannot be judged solely on the basis of their sound levels. Whether visitor enjoyment or natural soundscape protection is considered, it is not only the level of an intruding sound that matters, but also the level of that sound ***in relation to*** the levels of the natural ambient soundscape. For example, the effects of distant traffic sounds are quite different in forested and desert locations because wind in the former raises ambient sound levels, while wind in the desert produces little sound at all.

2.4. Sound intrusions have two important dimensions

Finally, the intruding sounds must be quantified in ***two dimensions*** if their effects on park environments are to be understood. Not only is the ***sound level*** of the intrusion (and of the natural ambient) required, but the ***duration of audibility*** is also needed. Research has shown that both audibility and sound level considerations are important for judging and understanding visitor reactions [1]. Additionally, we have observed, not surprisingly, that park management is likely to be interested in both how loud the intrusions are, and in how long and at what distances the intrusions will be audible.

These four characteristics mean that special approaches to quantifying, measuring, predicting and analyzing sound from intruding sources are required. The remainder of this paper describes a suggested method for collecting acoustic data in parks that will address all four special park characteristics.

3. A Suggested Measurement Method

3.1. The general method

The suggested method may be summarized in 5 steps:

1. Select measurement locations;
2. Determine time period of interest;
3. Set up continuous, one second sampling 1/3 octave band (1/3 OB) and wind monitoring instrumentation;
4. Periodically visit site to:
    a. Download data,
    b. Calibrate instrument and determine instrument noise floor,
    c. Conduct source identification logging,
    d. Make calibrated DAT recordings,
5. Reduce / review data after they are downloaded.

3.2. Method specifics

Site selection should be based, at first, on the concept of acoustic zones and on the purpose(s) of the data collection. Is the purpose to: 1) Develop a general base line of measured data? 2) Identify the effects of a specific intruding source? 3) Plan for proposed / expected changes of intruding source(s)? 4) Document a specific, valuable soundscape resource to be preserved / restored? Since monitoring will likely be conducted for weeks or months, and sites will likely need to be visited regularly (if radio download is not feasible), ease of access will also be important.

When first conducting monitoring, it is important to monitor for the full time period of interest. Current understanding of the time patterns of natural sound environments is limited; it is very likely that the natural soundscape will change in unanticipated patterns. Random sampling over time would also be appropriate, but due to the likely limits on the labor hours to conduct such sampling, the lower cost approach is judged to be continuous monitoring.

One-third octave band monitoring is necessary for two important reasons. First, intruding sounds are often difficult, if not impossible to identify from an A-weighted time history. Much of the acoustic data will be collected from unattended monitors, and frequency data can often reveal, especially in quiet natural environments, the presence of mechanically generated intrusions (e.g., sounds produced by internal combustion engines, propellers, etc.). Second, instrumentation noise may make A-weighted measurements of the quieter sound environments incorrect. However, if the instrumentation noise floor by 1/3 OB is regularly determined during site visits, measurement data may be accurately adjusted for the noise floor and provide resultant A-weighted levels down to approximately 8 to 10 dBA.

At the low levels of sound in park environments, wind may generate spurious "sound levels" as recorded by the monitor. Current data strongly suggest that only through collection of simultaneous wind data will accurate measurements of quiet environments be reliable by identifying when wind may have corrupted the data.

Regular site visits are important and necessary. First, the quantity of data collected will likely require regular downloads. Second, it is extremely important that observations be regularly made of the sources of noise. Only through human observation can sources of noise / changes in sound levels be reliably identified. Third, instrumentation noise floor should be regularly determined – at least until instrumentation stability is known. Fourth, DAT recordings of samples of the soundscape will be valuable for: 1) providing full frequency data for possible analysis needs; 2) testing automated source identification algorithms; 3) developing aural presentations to demonstrate the various intrusions and soundscape qualities.

Data should be reduced and reviewed as they are collected. Such a review will reveal whether the periodic site visits are falling within typical or within unusual periods of the sound environment. This review will also suggest whether visits should be more or less frequent. Finally, examining the data regularly will ensure that the instrumentation is operating properly and will provide personnel with a sense for how sound levels change over time.

4. Conclusions

It is possible, with current technology, to collect the data needed for detailed analysis of park and wilderness soundscapes. Nevertheless, the instrumentation to conduct the proposed method is moderately expensive, will require regular maintenance and calibration, and staff will require training for its proper use. The fundamental question is whether resources allotted to parks will ever be adequate to undertake the type of data collection and analysis suggested here.

5. Acknowledgements

The enormous amount of work that has been done includes the efforts of too many NPS, FAA, USAF, HMMH and Wyle staff to list here. The author takes sole responsibility for the suggested method, but acknowledges that it could not have been made without the work provided by these many people.

6. References

1. See Miller, N.P., "The effects of aircraft overflights on visitors to U.S. National Parks," Noise Control Eng. J. 47(3), 199 May-Jun. This article is also on the HMMH web site http://www.hmmh.com/resource.html as a technical paper given at the ASA meeting in Columbus, Ohio, U.S.A., November 1999.