Acoustic Data Collection in National Park Units

INTRODUCTION

Acoustic studies in national parks will collect sound pressure level data, frequency data, audibility data, source identification data, meteorological data, and, whenever possible, species-specific biological data. These data can then be used to characterize the natural soundscape and the current ambient soundscape, including human-caused noise. These data will also provide inputs to modeling efforts for estimating impacts of existing or potential noise sources.

Attended Logging (Source Identification)

Observers will conduct attended data logging approximately 50 m (150 feet) from the microphone to ensure that field personnel can move about and conduct whispered conversations without influencing the measured sound. Observations during attended logging will be recorded on a standardized NPS data sheets or pre-programmed data loggers such as Personal Digital Assistant (PDAs) or notebook computers. A standardized hierarchy to provide consistency in determining sound sources is being developed.

On-Site Considerations for Equipment Setup

Acoustic monitors shall be placed in a location representative of the acoustic zone or management zone under study. For measurements related to vehicle noise, the microphone shall be placed 15 m (50 feet) from the centerline of the nearest traffic lane (ANSI 1992). For measurements related to NPS standards as stated in 36 CFR, the microphone shall be placed 15 m (50 feet) from the source under consideration. Equipment used in acoustic studies should be situated so that any potential for contamination of data due to equipment-generated noise is minimized. For example, all cables and wiring should be secured to prevent any noise that might be created in windy conditions (due to wiring hitting other objects). Hard, flat equipment surfaces, such as solar panels, should be situated away from the microphone.

Measurement Parameters: Types of data to be Collected

Types of acoustic data and digital recordings to be collected are discussed below. All measurement data, including location data, should be fully documented. This includes investigator information, instrumentation information (including serial numbers and calibration information), type of acoustic data collected (dBA, 1/3 octave band, Leq, etc.; time weighting used, if any), site photographs, photographs of surrounding habitat and topographic features, and complete site description information (latitude and longitude, elevation, slope/aspect, geologic descriptor, major habitats by percentage within 0.5 km of site, management zone, basic natural acoustic environment, dominant human-caused sound, access).

Sound pressure level data (decibel)

Sound pressure level is a measure of sound pressure. Sound pressure is the physical characteristic of sound; it is the instantaneous difference between the actual pressure produced by a sound wave and the average barometric pressure at a given point in space. It is the amplitude of the oscillating sound pressure and is measured in Pascals (Pa), Newtons per square

meter, which is the metric equivalent of pounds per square inch. Sound pressure level (SPL) data collected in national parks will include frequency data (at a minimum, 1-second 1/3 octave band L_{eq} data for the entire measurement period; appropriate measurement period discussed earlier). From these 1-second L_{eq} data, other acoustic metrics can be calculated (hourly, monthly, and seasonal dB, dBA, L_{max}, L_{min}, exceedences, L_n values, etc.). The following table is presented to give the reader a relative sense about sound pressure levels measured, and often heard, in various national parks and displayed by dBA.

Table 1: Park sounds, measured sound pressure, and relative decibel levels on an A-weighted[1] scale.

Sound	Sound Pressure (Pa)	dBA
Threshold of human hearing:	0.00002	0
Haleakala National Park: Volcano crater	0.000064	10
Canyonlands National Park: Leaves rustling	0.0002	20
Zion National Park: Crickets (5 m)	0.002	40
Whitman Mission National Historic Site: Conversational speech (5 m)	0.02	60
Yellowstone National Park: Snowcoach (30 m)	0.2	80
Arches National Park: Thunder (est. 700 m)	2.0	100
Yukon Charley Rivers National Preserve: Military jet (100 m AGL)	20	120

Frequency data

Frequency is the number of times per second that the sine wave of sound repeats itself. It is expressed in cycles per second, or hertz (Hz). Frequency data collected will include, at a minimum, 33 1/3 octave bands (12.5-20,000 Hz). Different species of animals hear sounds over a wide range of frequencies. For humans with normal hearing, this range is about 12.5 Hz to 20,000 Hz. Some animals hear better at low frequencies, others at very high frequencies. Most animals can hear a wide range of frequencies, thus several sounds can be heard at the same time. For example, a motorcycle (emitting sound at a low frequency), a coyote howl (at a mid-range frequency), and a bird call (high frequency) can all be heard at the same time. In order to assess the influence of one sound on another, the frequency content of the individual sounds must be known. Also, different frequencies attenuate across the landscape differently; low frequencies travel much farther than high frequencies. For these reasons, it is important to collect frequency data when conducting acoustic measurements in parks. Frequency data that are most often collected are 33 one-third octave bands (12.5-20,000 Hz), although as instruments improve, the range of frequency data we collect will increase.

Audibility data

Audibility represents the biological aspects of sound. Audibility is the ability of animals with normal hearing, including humans, to hear a given sound. This ability is affected by both frequency content (different species of animals hear some frequencies better than others) and amplitude. Audibility data are collected by making high-quality recordings either continuously or at regular, frequent intervals (sampling schemes may vary among different habitats or seasons) throughout the measurement period. Recordings should include events that exceed a user-defined threshold and duration. Recordings can be replayed at a later date to identify sources of human-caused noise and natural sounds. A common misconception is that recordings are useful only to assess what humans hear. This is not true. With knowledge of the hearing ability of specific species (threshold of hearing for various frequencies), we can adjust, with

[1] Adjusted for human hearing potential.

computer software, frequency specific frequency amplitudes to fit that species such that a human listener can hear just as that species would hear. Likewise, we can adjust the playback such that the human listener can hear the soundscape unweighted, or flat.

The number and length of recordings must be of sufficient quantity to provide an adequate representation of natural and non-natural sounds throughout the measurement periods seasons, including samples during all hours of the day and during all seasons. The standard practice of recording 2 – 3 hour digital audio tapes or one-hour attended logging sessions per season is not sufficient. In addition to the time that human-caused noise is above natural ambient levels, the time between human-caused noises ("noise free interval") is important to soundscape management. Digital recordings, and the resulting audibility data gained from the recoridings, are not intended for use solely to assess impacts on visitors, although interpretations could be made from recordings to achieve this purpose.

Source Identification Data

Data that allow the identification of sources of sounds (both natural and human-caused) must be collected in order to fully understand the soundscape in that area. For the most part, past acoustic studies in national parks have included the collection of decibel data with limited recordings or attended logging for source identification data. A major element of NPS soundscape management (as well as assessment of potential impacts of air tours) will focus on percent time human-caused noise is above natural ambient levels and is audible to one or many selected species, including visitors. Using source identification data in combination with audibility data and 1/3 octave band sound pressure level data, metrics of natural sounds and human-caused noise can be calculated. Source identification data will be collected by making high-quality digital recordings and by conducting attending logging during the measurement period.

Meteorological Data

Meteorological data (wind speed, wind direction, temperature, and humidity) can improve the utility of acoustic data. When appropriate and feasible, these data should be collected concurrently with acoustic data.

Biological Data

Current acoustic studies often include making high-quality recordings in conjunction with collection of decibel data. These recordings are most often used for source identification and assessing audibility, and they also can provide decibel data with appropriate post-processing. However, these recordings also have the potential to provide a wealth of biological information (avian surveys, animal and insect vocalizations). Acoustic studies in national parks should make every effort to include collection of useful biological data.