National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Sand Creek Massacre National Historic Site
Acoustic Monitoring Report

Natural Resource Report NPS/NRPC/NRTR—2009/001

ON THE COVER
(Acoustic monitoring system)
NPS Photo

Sand Creek Massacre National Historic Site
Acoustic Monitoring 2009

Natural Resource Report NPS/NRPC/NRTR—2009/001

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June 2010

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Fort Collins, CO

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Please cite this publication as:

National Park Service. 2009. Sand Creek Massacre National Historic Site. Acoustic Monitoring Report. Natural Resource Report NPS/NRPC/NRTR—2009/001. National Park Service, Fort Collins, CO.

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Executive Summary

In 2009, the Natural Sounds Program (NSP) received a request to collect baseline acoustical data at Sand Creek Massacre National Historic Site (SAND). During the months of July and August, one acoustic monitoring system was deployed for 45 days. The baseline data collected during this period will help park managers, planners, and tribal representatives develop desired conditions for soundscapes in the park's first general management plan (GMP). Sand Creek Massacre National Historic site is a unique case in terms of soundscape monitoring because the park was opened to the public in 2007. This is the first time the NSP has collected data at a new park.

Data will also inform decision makers about the potential impacts of noise from military jets during the Colorado Air National Guard's (COANG) National Environmental Policy Act (NEPA) process for the proposed expansion of the Cheyenne Military Operations Area. The NSP is working with the COANG to document the nature and extent of impacts from the current level of military overflights. To this end, the COANG has provided the NSP with a detailed log of nearby military overflights during the monitoring period. The monitoring site was chosen to fulfill the needs of the GMP baseline measurements and the proposed airspace expansion, but it may serve an additional purpose because of its proximity to a proposed footpath through the park.

In determining the current conditions of an acoustic environment, is important to examine how often sound pressure levels exceed certain values because variations in levels can be observed over time (or between sites). These values are useful for making comparisons, but should not be construed as thresholds of impact. Table 1 reports the percent of time that measurements were above four key sound pressure levels. The first value is from recent studies that suggest that sound events as low as 35 dB can have adverse effects on blood pressure in sleeping humans (Haralabidis, 2008). The second value addresses the World Health Organization's recommendations that noise levels inside bedrooms remain below 45 dBA (Berglund et al., 1999). The third value, 52 dBA, is based on the EPA's speech interference threshold for speaking in a raised voice to an audience at 10 meters. This value addresses the effects of sound on interpretive presentations in parks. The final value, 60 dBA, provides a basis for estimating impacts on normal voice communications at 1 meter. Hikers and visitors viewing scenic vistas in the park would likely be conducting such conversations.

Table 1. Percent time above metrics for SAND001

		% Time above sound level: 0700 to 1900				% Time above sound level: 1900 to 0700			
Site	Frequency (Hz)	35 dBA	45 dBA	52 dBA	60 dBA	35 dBA	45 dBA	52 dBA	60 dBA
SAND001	20-800	9.7	0.5	0.1	0.0	3.3	0.1	0.0	0.0
	12.5-20,000	74.1	21.1	6.3	0.9	42.2	6.8	1.7	0.1

Table 2 shows results from in-depth off-site analysis. The first two columns report the percent of time that certain sound sources were audible during eight continuous days of sound source analysis. During analysis, technicians identify each audible sound source and compile overall statistics by hour. The remaining columns report existing sound levels as well as estimated natural ambient sound levels. This study indicated that human-caused sounds are audible over 36% of the time at SAND. However, most audible human-caused sound sources recorded at the site were distant, as indicated by low sound pressure levels. Secondly, natural ambient levels were elevated by the wind, which may have masked the effects of some noise intrusions. Please see methods and results section for detailed explanation of findings.

Table 2. Mean percent time audible for extrinsic sounds and aircraft sounds

	Mean % time audible		Median Existing Ambient (in dBA)		Median Natural Ambient (in dBA)	
Site Location	All Extrinsic sounds	All Aircraft sounds	Day	Night	Day	Night
SAND001	36.5	29.8	38.6	33.6	36.4	32.3

In order to facilitate the cooperative effort with NPS, the COANG shared records of nearby flights during the monitoring period (Colorado Air National Guard 2009). One flight was audible on July 16 at approximately 10:25 a.m. This flight was a low-pass at 5,000 feet above ground level, within 5 nautical miles of SAND and registered between 58 and 60 dB on the sound level meter for less than 40 seconds. Other flights were either too distant to be heard, or masked by other sounds.

Table 3. Colorado Air National Guard overflight log (from COANG email,

Date	Time	Location in airspace		Altitude Block		Type & number		Remarks
	Local	West	South	Bottom	Top	F-16	F-5	
14-Jul	1010-1050	X	X	10,000	29,000		2	
14-Jul	1345-1415	X		10,000	29,000	1	2	
15-Jul	0940-1105		X	500	29,000	2		Low Level 10nm of SC at 500' above ground ~1050L
16-Jul	1400-1440	X		10,000	29,000	4		
16-Jul	1020-1100		X	5,000	20,000	2	1	Low pass within 5nm of SC @ 5,000' above ground
17-Jul	1400-1440	X	X	10,000	29,000		4	
17-Jul	1010-1050	X	X	10,000	29,000		3	
22-Jul	0935-1035	X		9,000	20,000	3		
12-Aug	0915-1005	X		10,000	26,000	4		
13-Aug	0905-0945	X		5,000	29,000	2		

Introduction

A 1998 survey of the American public revealed that 72 percent of respondents thought that providing opportunities to experience natural quiet and the sounds of nature was a very important reason for having national parks, while another 23 percent thought that it was somewhat important (Haas Wakefield 1998). In another survey specific to park visitors, 91 percent of respondents considered enjoyment of natural quiet and the sounds of nature as compelling reasons for visiting national parks (McDonald et. al 1995). Acoustic monitoring provides a scientific basis for assessing the current status of acoustic resources, identifying trends in resource conditions, quantifying impacts from other actions, assessing consistency with park management objectives and standards, and informing management decisions regarding desired future conditions.

National Park Service Natural Sounds Program

The NPS Natural Sounds Program (NSP) was established in 2000 to help parks manage sounds in a way that balances access to the park with the expectations of park visitors and the protection of park resources. The NSP addresses acoustical issues raised by Congress, NPS Management Policies, and NPS Directors Orders. An important element of this mission is working with the Federal Aviation Administration (FAA) to implement the National Parks Air Tour Management Act. Congress mandated that FAA and NPS jointly develop Air Tour Management Plans (ATMPs) for more than 106 parks where commercial air tours operate. The program also provides technical assistance to parks in the form of acoustic monitoring, data processing, park planning support, and comparative analyses of acoustic environments throughout the national park system.

Soundscape Planning Authorities

The National Park Service Organic Act of 1916 states that the purpose of national parks is "… to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." In addition to the NPS Organic Act, the Redwoods Act of 1978 affirmed that, "the protection, management, and administration of these areas shall be conducted in light of the high value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

Direction for management of natural soundscapes[1] is represented in 2006 Management Policy 4.9:

> The Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts. Using appropriate management planning, superintendents will identify what levels and types of unnatural sound constitute acceptable impacts on park natural soundscapes. The frequencies, magnitudes, and durations of acceptable levels of unnatural sound will vary throughout a park, being

[1] The 2006 Management Policy 4.9 and related documents refer to “soundscapes” instead of “acoustic resources.” When quoting from this authority, it is advisable to note that the term often refers to resources rather than visitor perceptions.

> generally greater in developed areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes [acoustic resources], including noise caused by mechanical or electronic devices. The Service will take action to prevent or minimize all noise that through frequency, magnitude, or duration adversely affects the natural soundscape [acoustic resource] or other park resources or values, or that exceeds levels that have been identified through monitoring as being acceptable to or appropriate for visitor uses at the sites being monitored (NPS 2006a).

It should be noted that "the natural ambient sound level—that is, the environment of sound that exists in the absence of human-caused noise—is the baseline condition, and the standard against which current conditions in a soundscape [acoustic resource] will be measured and evaluated" (NPS 2006b). However, the desired acoustic condition may also depend upon the resources and the values of the park. For instance, "culturally appropriate sounds are important elements of the national park experience in many parks" (NPS 2006b). In this case, "the Service will preserve soundscape resources and values of the parks to the greatest extent possible to protect opportunities for appropriate transmission of cultural and historic sounds that are fundamental components of the purposes and values for which the parks were established" (NPS 2006b).

Study Area

One acoustic monitoring system was deployed in the summer of 2009. This site was selected because it was representative of the dominant vegetation, and therefore, the acoustical environment within the park.

Table 4. Site location

Site	Site Name	Dates Deployed	Vegetation	Elevation	Latitude	Longitude
SAND001	Massacre Site	7/13/09 - 8/26/09	Blue grama w/ sage. Near riparian area.	1208m	38.55259	102.50508

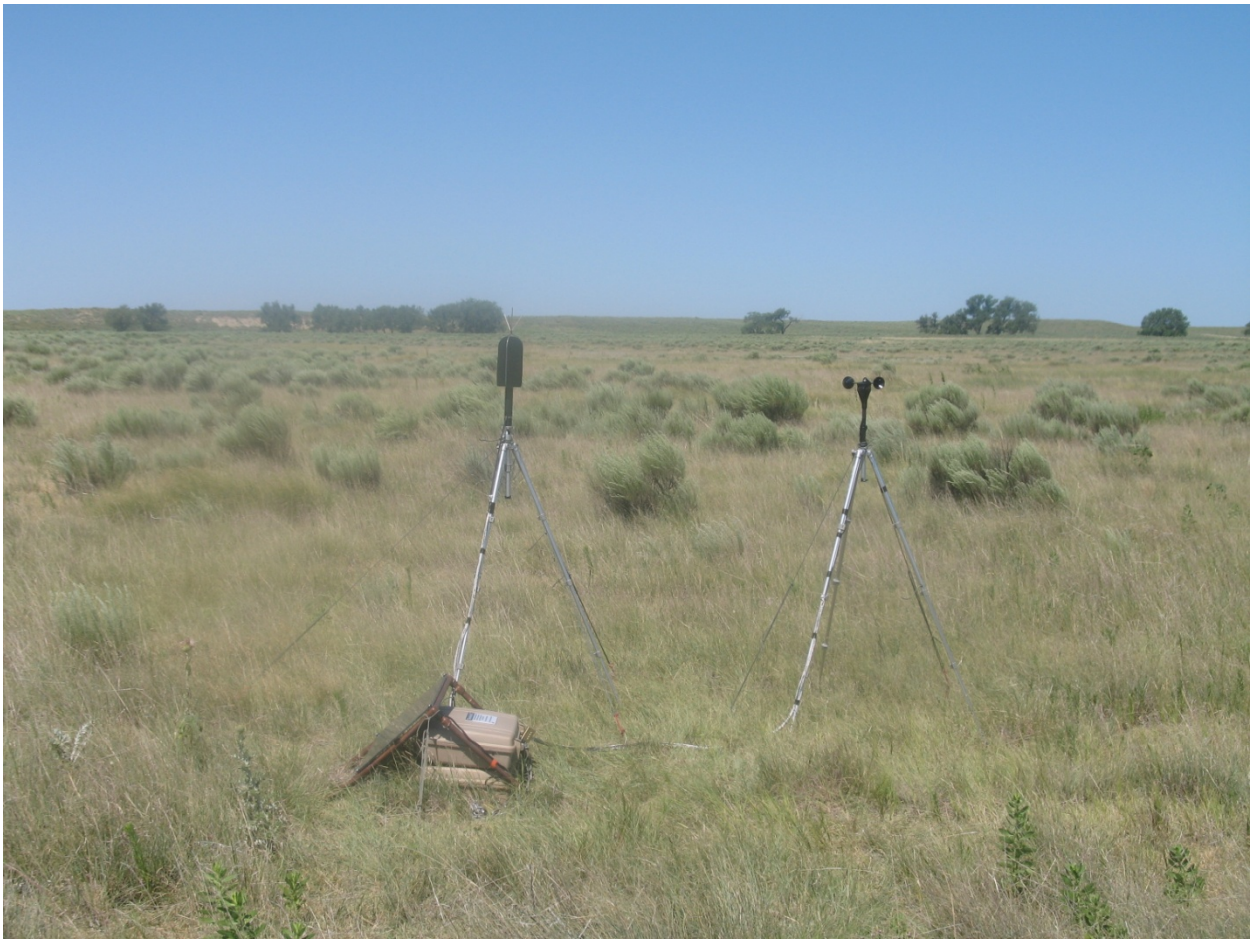

Figure 1. SAND001, near massacre site and riparian area. Looking westward.

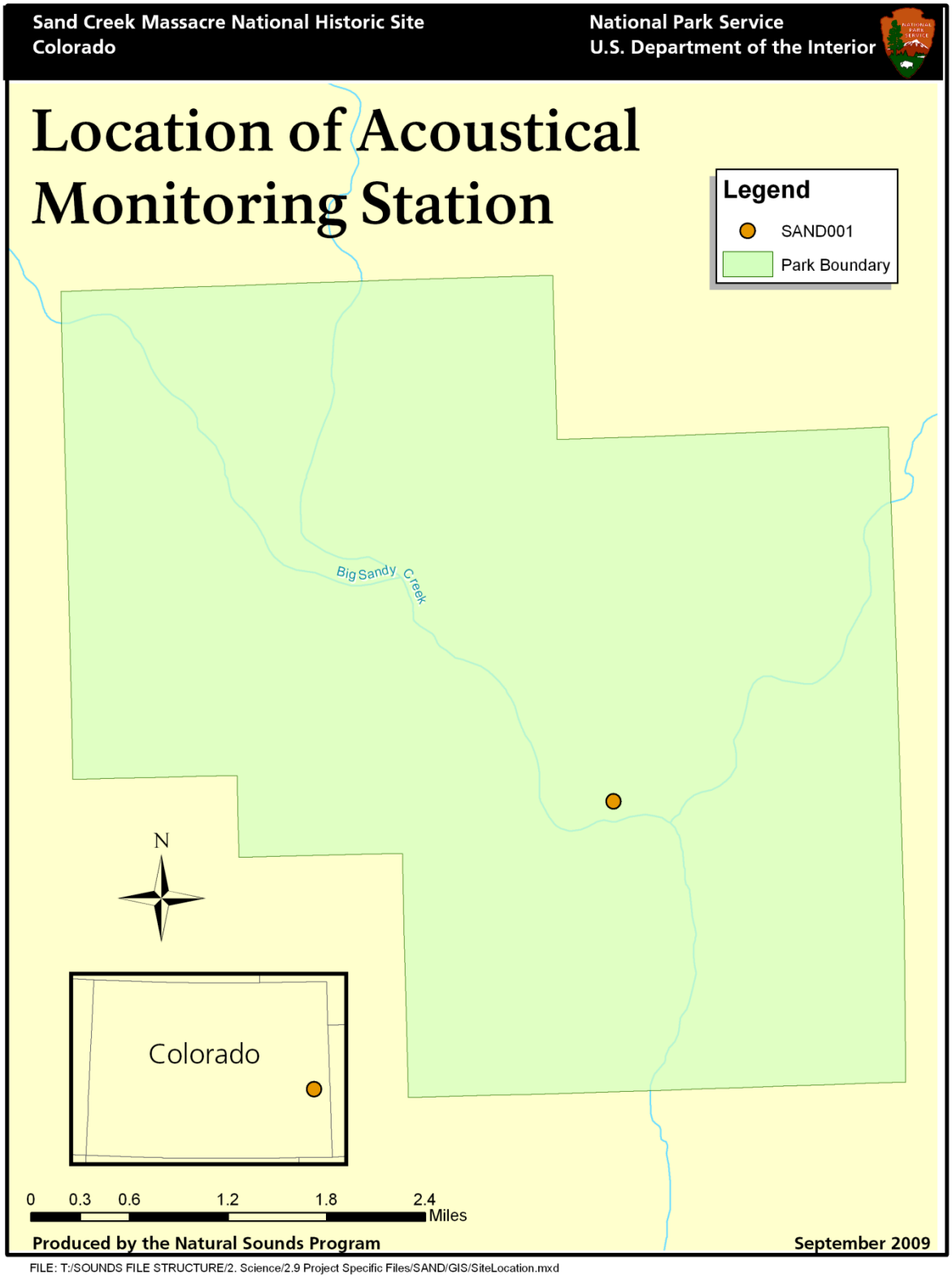

Figure 2. Location of SAND001.

Methods

Automatic Monitoring

A Larson Davis 831 sound level meter (SLM) was employed over the length of the monitoring period at SAND. The Larson Davis SLM is a hardware-based, real-time analyzer which constantly records one second sound pressure level (SPL) and 1/3 octave band data, and exports these data to a portable storage device (thumb drive). This Larson Davis-based site met American National Standards Institute (ANSI) Type 1 standards.

The Larson Davis sampling station consisted of:

- Microphone with environmental shroud
- Preamplifier
- Three 12 V NiMH batteries
- Anemometer
- MP3 recorder
- Meteorological data logger

The acoustic sampling station collected:

- SPL data in the form of A-weighted decibel readings (dBA) every second
- Continuous digital audio recordings
- One third octave band data every second ranging from 12.5 Hz – 20,000 Hz

Off-Site Listening

Because fully analyzing 45 days of continuous audio data would take far too long, NSP examines a subset of data. For this site, Natural Sounds Program (NSP) staff visually analyzed eight days of spectral data in order to identify durations of audible sound sources. See Example of Visual Analysis at the end of this report for more information on this method. Audio data were employed to confirm identification. Analyzing this number of days out of a 45 day monitoring period provides a prediction of sound source audibility. The total percent time extrinsic sounds were audible was used to calculate the natural ambient sound level for each hour. Bose Quiet Comfort Noise Canceling headphones were used for off-site audio playback to minimize limitations imposed by the office acoustic environment.

On-Site Listening

On-site listening is the practice of placing an observer near the acoustic monitoring station with a handheld Personal Digital Assistant (PDA). The observer listens for a designated period of time (in this case, one hour), and identifies all sound sources and their durations. On-site listening takes full advantage of human binaural hearing capabilities, and closely matches the experience of park visitors. Logistic constraints prevent comprehensive sampling by this technique, but selective samples of on-site listening provide a basis for relating the results of off-site listening to the probable auditory perception of events by park visitors and wildlife. On-site listening sessions are also an excellent screening tool for parks initiating acoustic environment studies.

They produce an extensive inventory of sound sources, require little equipment or training, and can help educate park staff and volunteers.

Thus, one period of on-site listening was conducted in order to discern the type, timing, and duration during sound-level data collection at SAND. Staff recorded the beginning and ending times of all audible sound sources using custom-designed PDA software. This on-site listening session provided the basis for the calculation of metrics including the period of time between noise events (average noise free interval [NFI]), percent time each sound source was audible, and maximum, minimum, and mean length (in seconds) of sound source events.

Calculation of Metrics

The current status of the acoustic environment can be characterized by spectral measurements, durations, and overall sound levels (intensities). The NSP uses descriptive figures and metrics to interpret these characteristics. Two fundamental descriptors are existing and natural ambient sound levels. Existing ambient (L_{50}) is characterized by spectra (in dB) drawn from uncensored data, and encompasses all sound sources. Natural ambient (L_{nat}) is an estimate that attempts to remove the sound energy contributed by all extrinsic or anthropogenic noises from the existing ambient. For a given hour (or other specified time period), L_{nat} is calculated to be the decibel level exceeded x percent of the time, where x is defined by the equation

$$x = \frac{100 - P_H}{2} + P_H ,$$

and P_H is the percentage of samples containing extrinsic or anthropogenic sounds for the hour. For example, if human caused sounds are present 30% of the hour, x = 65, and the L_{nat} is equal to the L_{65}, or the level exceeded 65% of the time. Note: all samples with local wind speed greater than 5 m/s are excluded from analysis. To see the results of these calculations, please see Figure 3.

Results

On-site Listening

Table 5 below displays the results of the on-site listening session. It is essentially an inventory of the sounds one is likely to hear at or near this location. Each audible sound source is listed in the first column. Percent time audible, or PA, is the second column. The third column, Max, reports the maximum event length (in mm:ss) among the sessions for each sound source. Likewise, mean event and min event columns report the mean and minimum length of events. SD reports the standard deviation among event lengths, and count reports the number of times that each sound source was audible. The last row in the table, noise free interval (NFI), is a metric which describes the length of time between extrinsic or human-caused events. Event lengths are reported in mm:ss.

The results of this daytime on-site listening session indicate that the most dominant non-natural sound is commercial jets. The wind-induced natural sound is the sound of nearby cottonwoods rustling in the wind. This sound, along with birdsong and insects are the most prevalent natural sounds at SAND001.

The maximum noise free interval (NFI) at the site was 15:50, indicating that for at least one 15 minute period during this session, the only sounds one could hear were natural. It is likely that an attended logging session performed at night or very early in the morning would produce an even longer NFI.

Table 5. Summary of on-site audible sound sources for one hour at SAND001 n=1.

Sound Source	PA	Max Event	Mean Event	Min Event	SD Event	Count
Jet, commercial	13	2:03	0:46	0:18	0:30	10
Aircraft, Propeller	8	1:34	0:55	0:26	0:34	5
Wind	0	0:04	0:04	0:04	0:00	1
Bird	31	3:59	0:54	0:10	1:21	21
Insect	100	60:0	60:0	60:0	0:00	1
Wind-induced natural sound	100	57:9	29:58	2:46	38:27	2
All Aircraft	20.4					
All Non-natural Sources	20.4					
All Natural Sources	100					
Noise Free Interval		15:50	3:11	0:30	5:11	15

Off-Site analysis: Audibility Results

Table 6 shows the percent time that certain sound sources were audible during eight days of analysis. No military jets were audible on analysis days. The most frequently identified extrinsic sound source was commercial jets, which were audible about 25 percent of the time. On average, there were about 108 commercial jet overflights per day. See Figure 5 for an hourly breakdown of aircraft audibility. There were a number of audible sound sources which were unexpected. First of all, NSP staff noticed a distant, constant mechanical sound around 50 Hz in the evening hours. Sound sources which commonly display this profile are generators, AC units, and fans. This sound was commonly audible in the late evening hours, but was masked by other sounds during mid day. Secondly, cows were audible, particularly in the late night and early morning hours. The park is surrounded by a number of cattle operations, the nearest of which is about ¼ mile north of the monitoring site. When atmospheric conditions are right, it is not uncommon for sound to travel this sort of distance. On one occasion, NSP staff also identified the sound of a train rumbling in the distance.

Only extrinsic noise intrusions were logged during analysis. However, a number of remarkable biologic sounds were noted in the process. These included multiple great horned owls, western meadowlarks, bullfrogs, coyotes, and at least one unknown bat species. Recordings of these sounds can be made available to the park.

Table 6. Summary of off-site analysis of audible sound sources at SAND001.

Sound Source	00h-23h	07h-18h	19h-06h	08h-15h	16h-07h	Avg # Events 00h-23h
Jet	24.0	30.5	17.5	30.2	20.9	108.6
Propeller	5.9	9.6	2.1	10.4	3.6	22.1
Non-natural unknown	4.3	2.4	6.2	2.4	5.3	11.2
Cow	1.1	0.6	1.6	0.0	1.6	2.6
Grounds care	1.0	2.0	0.0	3.0	0.0	1.2
Train	0.5	0.0	1.0	0.0	0.7	0.5
Vehicle	0.2	0.2	0.2	0.2	0.2	1.4
Motor	0.1	0.2	0.0	0.3	0.0	0.2
Helicopter	0.0	0.0	0.0	0.1	0.0	0.1
Voices	0.0	0.0	0.0	0.1	0.0	0.1
Total Vehicle	0.2	0.2	0.2	0.2	0.2	1.4
Total Aircraft	29.8	39.9	19.6	40.4	24.4	130.9
Total Non-Natural	36.5	45.0	28.1	45.7	31.9	148.2

Off-Site Analysis: Metrics

In order to determine the effect extrinsic noise audibility has on the acoustic environment, it is useful to examine the median hourly exceedence metrics. Figure 3 shows existing ambient levels and natural ambient levels. The existing ambient (or median) level for each hour is marked by the upper limit of the gray boxes while natural ambient levels (L_{nat}) are marked by the lower limit of the gray boxes. The height of the box is a measure of the contribution of anthropogenic noise to the existing ambient sound levels per hour. Thus, the size of these boxes is directly related to the percent time that human caused sounds are audible. When boxes do not appear, the natural and existing ambient levels were either very close to each other, or equal for that hour. As is evident in the figure, human-caused sounds raised the natural ambient levels more during the daytime hours than at night. However, human-caused sounds were still present during the evening hours.

This figure also shows exceedence metrics L_{10} and L_{90}, which essentially mark the average maximum and minimum levels over the 30 day monitoring period. In order to find a monitoring site representative of the dominant vegetation at SAND, NSP had to place the equipment in a place that was exposed to a great deal of wind, especially in the afternoon hours. This might be the cause of elevated L_{10} sound levels in the afternoon.

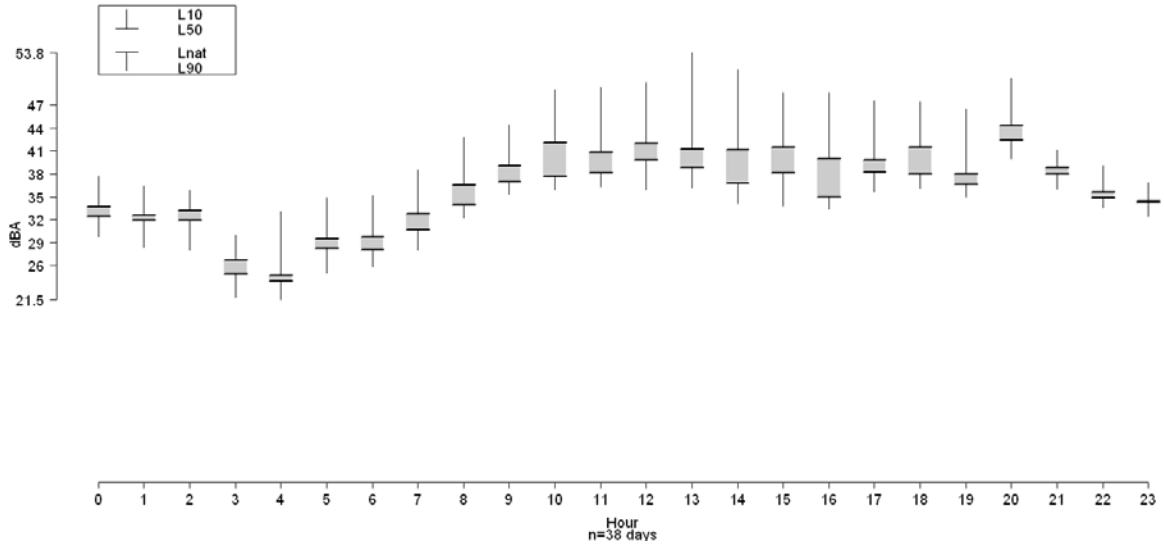

Figure 3. Median hourly exceedence metrics at SAND001 in dBA

High frequency sounds (e.g. a cricket chirping) and low frequency sounds (e.g. transportation noise) often occur simultaneously, and do not always occur constantly throughout the day. Figure 4 illustrates these concepts by dividing the full frequency spectrum into 33 smaller frequency bands (each encompassing a one-third octave range), and by plotting the daytime and nighttime SPL range for each band. The grayed area in the background of the graph represents sound pressure levels outside of the typical range of human hearing. The typical frequency ranges for transportation, conversation and songbirds are presented on the figure as examples for interpretation of the data. These ranges are estimates and are not vehicle-, species-, or habitat-specific. However, the obvious daytime peak in high frequency bands is likely due to insects which were audible 100 percent of the time during the on-site listening session.

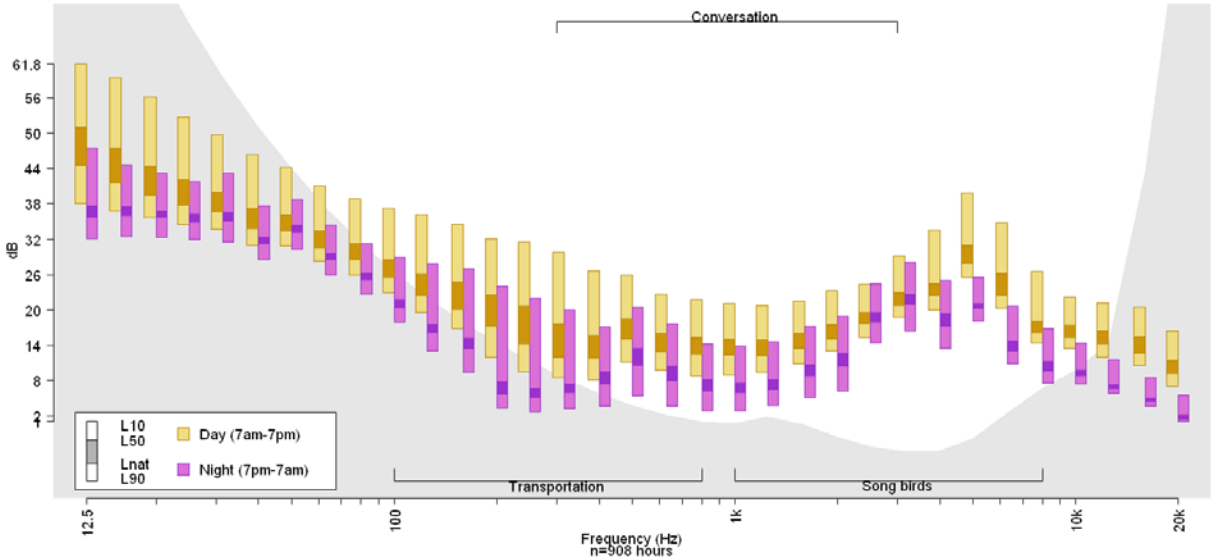

Figure 4. Day and night dB levels for 33 one-third octave bands at SAND001

Both on-site and off-site listening results suggested that the most frequent human-caused sound during the monitoring period at SAND was high-altitude commercial jets. Figure 5 illustrates this by showing how much aircraft contribute to the total percent time audible of non-natural sources. The density of aircraft (both jet and propeller) is greatest during the daytime hours. There are two peaks: one in the morning and one in the afternoon. This is a pattern commonly observed by NSP in national parks.

At 4 and 5 am, when aircraft are heard less than 10% of the time, the total percent time audible is still over 20%. If we refer to the off-site listening data in Table 6, it appears that the most commonly audible source during these hours is the distant 50 Hz tone produced by a generator, air conditioning unit, or fan. Other sound sources which contributed to the total percent time audible at SAND included road vehicles and grounds care vehicles (e.g. seed collector).

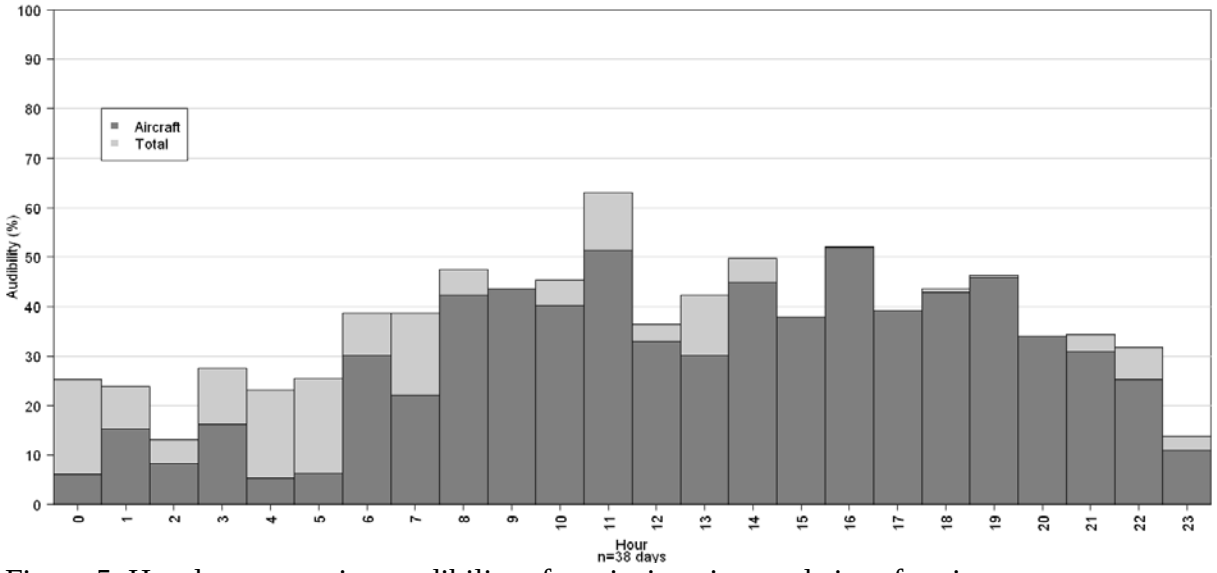

Figure 5. Hourly percent time audibility of extrinsic noises and aircraft noises.

Conclusion

Acoustic monitoring in national parks not only permits us to gain insight into biologic activity, but also allows us to determine the prevalence of extrinsic noise, and perhaps estimate its effects. This study was successful in determining current acoustical conditions at Sand Creek Massacre National Historic site. Results included measures of existing ambient levels, calculations of sound source durations, and estimates of natural ambient levels. We determined that human-caused sounds were audible an average of 36.5 percent of the time, and specifically, commercial jets were audible an average of 24 percent of the time. Nevertheless, there are still periods of time of over 15 minutes or more, where visitors can experience tranquility and solitude at SAND. The information gathered within this report will be used to inform park managers, tribal representatives, and planners as they compile the upcoming general management plan, but it will also serve as a permanent record of what the park sounded like in 2009. Sound pressure level data as well as continuous digital audio recordings will be stored at the Natural Sounds Program office for archiving purposes.

Management suggestions

A major impetus for this study was the development of the Colorado Air National Guard's (COANG) NEPA document for expansion of the Cheyenne Military Operations Area. NSP and the COANG are working together to document the nature and extent of impacts from the current level of military overflights. During the monitoring period, the COANG logged all flights conducted near the park. When compared against spectral data, only one of these flights was detected by the monitoring equipment. This flight was conducted within 5 nautical miles of the park at 5,000 feet above ground level and registered 58 to 60 dB on the sound level meter and lasted for less than a minute. Noise from military overflights has the potential to adversely affect the natural and cultural soundscape of SAND.

The data gathered in this study can be used to inform desired conditions for the general management plan, develop standards and indicators for a Resource Stewardship Strategy or document conditions for a Natural Resource Condition Assessment. The data also document that some park equipment on site may be affecting the natural soundscape, especially when wind is not present or when wind speeds are low. The natural soundscape is an important characteristic of the park unit, particularly for the solitude and intrinsic spiritual aspects of the park. Therefore, any noise from mechanical sources may adversely affect the natural soundscape. Management options for improving soundscape conditions at the park could include use of quieter equipment, replacement of generators, quieter air conditioning units or fans, or limiting use of mechanical equipment during times when tribes conduct ceremonies or other activities and these sounds would not be culturally appropriate.

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Glossary of Acoustical Terms

Acoustical Environment
The actual physical sound resources, regardless of audibility, at a particular location.

Amplitude
The instantaneous magnitude of an oscillating quantity such as sound pressure. The peak amplitude is the maximum value.

Audibility
The ability of animals with normal hearing, including humans, to hear a given sound. Audibility is affected by the hearing ability of the animal, the masking effects of other sound sources, and by the frequency content and amplitude of the sound.

dBA
A-weighted decibel. A-Weighted sum of sound energy across the range of human hearing. Humans do not hear well at very low or very high frequencies. Weighting adjusts for this.

Decibel
A logarithmic measure of acoustic or electrical signals. The formula for computing decibels is: 10(Log10(sound level/reference sound level)). 0 dB represents the lowest sound level that can be perceived by a human with healthy hearing. Conversational speech is about 65 dB.

Diel
A 24-hour period usually consisting of a day and the adjoining night.

Extrinsic Sound
Any sound not forming an essential part of the park unit, or a sound originating from outside the park boundary.

Frequency
The number of times per second that the sine wave of sound repeats itself. It can be expressed in cycles per second, or Hertz (Hz). Frequency equals Speed of Sound/ Wavelength.

Hearing Range (frequency)
By convention, an average, healthy, young person is said to hear frequencies from approximately 20Hz to 20000 Hz.

Hertz
A measure of frequency, or the number of pressure variations per second. A person with normal hearing can hear between 20 Hz and 20,000 Hz.

Human-Caused Sound
Any sound that is attributable to a human source.

Intrinsic sound
A sound which belongs to a park by its very nature, based on the park unit purposes, values, and establishing legislation. The term “intrinsic sounds” has replaced “natural sounds” in order to incorporate both cultural and historic sounds as part of the acoustic environment of a park.

Listening Horizon
The range or limit of one’s hearing capabilities. Just as smog limits the visual horizon, so noise limits the acoustic horizon.

L_{eq}
Energy Equivalent Sound Level. The level of a constant sound over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period.

L_x
A metric used to describe acoustic data. It represents the level of sound exceeded x percent of the time during the given measurement period.

Masking
The process by which the threshold of audibility for a sound is raised by the presence of another sound.

Noise-Free Interval
The period of time between noise events (not silence).

Noise
Sound which is unwanted, either because of its effects on humans, its effect on fatigue or malfunction of physical equipment, or its interference with the perception or detection of other sounds (Source: McGraw Hill Dictionary of Scientific and Technical Terms).

Off-site Listening
The systematic identification of sound sources using digital recordings previously collected in the field.

On-site Listening
The systematic identification of sound sources at a specific monitoring site using a personal digital assistant (PDA). Custom PDA software records begin and end times of audible sound sources. These sessions often last for one hour.

Sound
Variations in local pressure that propagate through a medium (e.g. the atmosphere) in space and time.

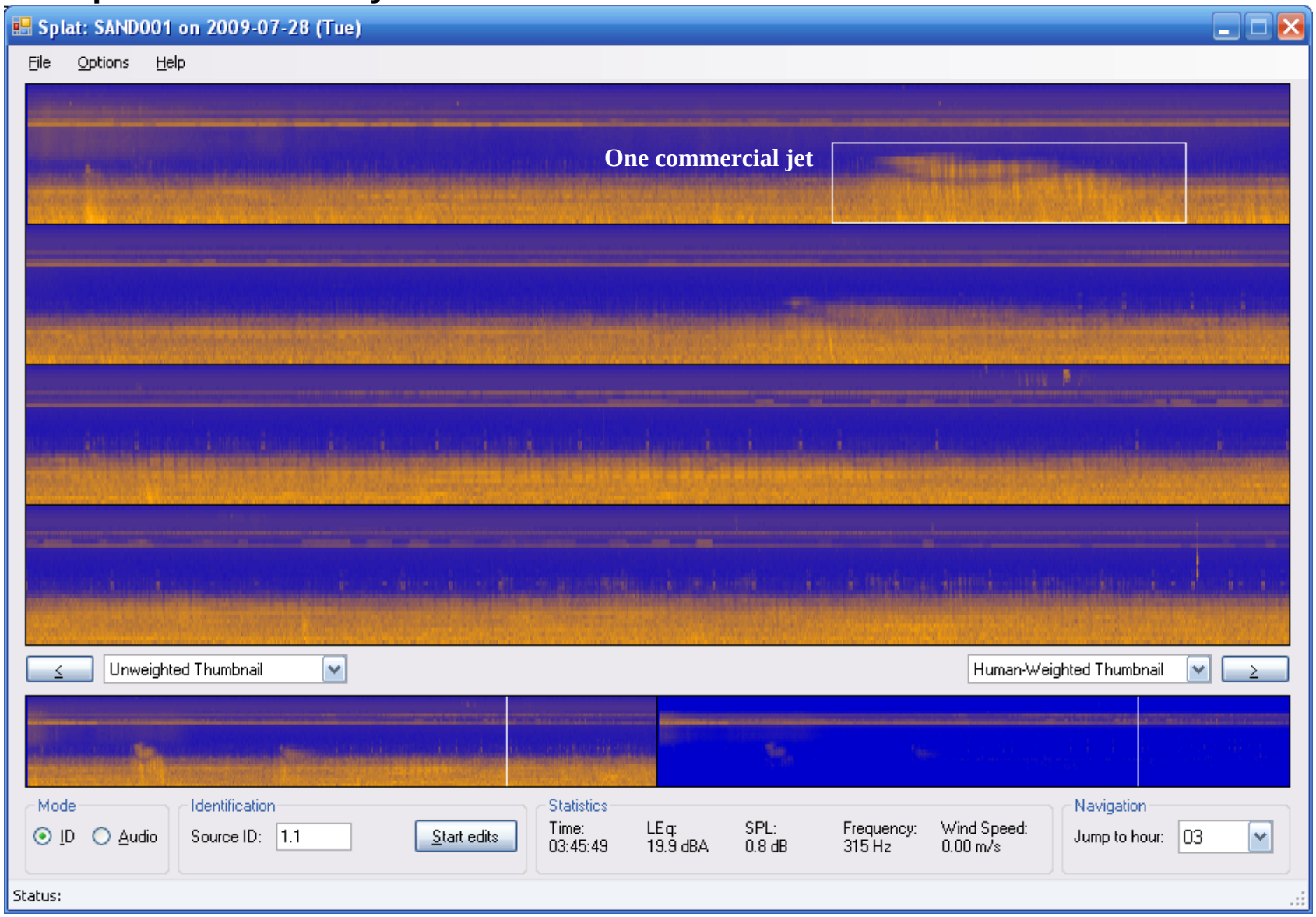
Soundscape
Human perception of the acoustical environment.

Sound Pressure
The difference between instantaneous pressure and local barometric pressure. Measured in Pascals (Pa), Newtons per square meter, which is the metric equivalent of pounds per square inch.

Sound Pressure Level (SPL)
A calibrated measure of sound level, expressed in decibels, and referred to an atmospheric standard of 20 micro Pascals.

Time Audible
The amount of time that a sound source is audible to an animal with normal hearing.

Example of Visual Analysis



The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS D-XXX, Month Year

National Park Service
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