

National Park Service  
U.S. Department of the Interior

ZION NATIONAL PARK  
UTAH

---



# **Soundscape Management Plan**

## **September 2010**





# Table of Contents

<b>INTRODUCTION .....</b>	<b>1</b>
<b>THE PLAN .....</b>	<b>5</b>
SOUND SOURCES AND SOUND LEVELS CONSISTENT WITH PARK LEGISLATION AND PURPOSES .....	5
SOUND SOURCES AND LEVELS NOT CONSISTENT WITH PARK LEGISLATION AND PURPOSES.....	11
SOUNDSCAPE OBJECTIVES.....	11
SOUNDSCAPE INDICATORS AND STANDARDS.....	12
MONITORING AND ADAPTIVE MANAGEMENT .....	23
EXISTING CONDITIONS IN THE PARK .....	25
<b>LIST OF PREPARERS .....</b>	<b>34</b>
<b>REFERENCES .....</b>	<b>35</b>
<b>GLOSSARY .....</b>	<b>37</b>
<b>ACRONYMS .....</b>	<b>41</b>
<b>APPENDIX 1: LEGAL AUTHORITIES .....</b>	<b>I</b>

## List of Tables

Table 1: Appropriate Sound Sources for Frontcountry Zone .....	7
Table 2: Appropriate Sound Sources for Wilderness Zone .....	9
Table 3: Inappropriate Sound Sources .....	11
Table 4: Reduction in Listening Area .....	13
Table 5: Indicators and Standards for Frontcountry Zone.....	20
Table 6: Indicators and Standards for Backcountry Zone .....	22
Table 7: Acoustic Monitoring Sites .....	26
Table 8: Median Day and Night L50 and Lnat for Wyle Sites .....	28
Table 9: Median Day and Night L50 and Lnat for 2008 Sites .....	28
Table 10: Percent Time Above for Wilderness Zone.....	29
Table 11: Percent Time Above for Frontcountry Zone.....	29
Table 12: Mean Percent Time Audible for Wilderness Zone .....	30
Table 13: Mean Percent Time Audible for Frontcountry Zone .....	30

## List of Figures

Figure 1: General Location .....	3
Figure 2: Soundscape Management Zones .....	6
Figure 3: Deviation from Natural Ambient .....	13
Figure 4: Reduction in Listening Area .....	14
Figure 5: Speech Interference.....	16
Figure 6: Likelihood of Awakening from Noise .....	17
Figure 7: Acoustic Monitoring Sites.....	27



# Zion National Park Soundscape Management Plan

---

## INTRODUCTION

Zion National Park (ZNP), located in southwest Utah, was established as Mukuntuweap National Monument on July 31, 1909 by Presidential Proclamation under the authority of the Antiquities Act (Figure 1). The proclamation stated that the area was set apart: as "...an extraordinary example of canyon erosion and is of greatest scientific interest, and it appears that the public interest would be promoted by reserving it as a National Monument, with such other land as may be necessary for its protection." In 1918 Presidential Proclamation 1435 (40 Stat.1760) recognized other geologic, archeologic, and geographic resources for protection within the monument and changed the name to Zion National Monument. Zion National Park was established by Congress in 1919. Since that time Congress has added lands to the park several times. The park now encompasses 148,733 acres.

Zion National Park displays important and diverse geologic, biological, cultural, and wilderness resources that are enjoyed by approximately 2.7 million visitors annually. The park is characterized by high plateaus, a maze of narrow, deep, sandstone canyons and striking rock towers and mesas. This varied topography includes five life zones that range from sub-alpine meadows and coniferous forests at the highest elevations, to juniper and pine forests at mid-elevation, and desert shrublands at the lowest elevations of the park.

The park soundscapes offer an array of rich and diverse natural sounds, as well as an environment relatively free of human-caused sound. These soundscapes are an integral component of what makes ZNP a unique place set aside for purposes expressed in both the National Park Service (NPS) Organic Act and the Wilderness Act.

An important part of the NPS mission is to preserve or restore the natural soundscapes of parks and provide for enjoyable visitor experiences. Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials. Some natural sounds in the natural soundscape are also part of the biological or physical resource components of the park, such that protection of the soundscape also constitutes protection of other resource values directly identified as necessary to the park's purpose.

Natural sounds are inherent components of "the scenery and the natural and historic objects and the wild life" protected by the NPS Organic Act. They are vital to the visitor experience of many parks and provide valuable indicators of the health of various ecosystems. Intrusive sounds are of concern because they sometimes impede ecological function and diminish the NPS's ability to accomplish its resource protection mission.

Intrusive sounds are also a matter of concern to park visitors. As was reported to the U.S. Congress in the *Report on the Effects of Aircraft Overflights on the National Park System* (NPS, 1995), a system-wide survey of park visitors revealed that nearly as many visitors come to national parks to

enjoy the natural soundscape (91 percent) as come to view the scenery (93 percent). Noise can also distract visitors from the resources and purposes of cultural areas--the tranquility of historic settings and the solemnity of memorials, battlefields, prehistoric ruins, and sacred sites. For many visitors the ability to hear clearly the delicate and quieter intermittent sounds of nature, the ability to experience interludes of extreme quiet for their own sake, and the opportunity to do so for extended periods of time are important reasons for visiting national parks and one of the driving forces behind the development of this plan.

Increasingly, even those parks that appear as they did in historical context do not sound like they once did. Natural sounds are being masked or obscured by a wide variety of human activities. In some parks, natural sounds are disappearing at such a rate that some may be gone before their existence can even be documented. Thus, soundscape preservation and noise management is one more dimension of the complex problem of achieving the NPS mission of preserving park resources unimpaired for the enjoyment of present and future generations.

Superintendents must identify levels of human-caused sound which can be accepted within the management purposes of parks. Within and adjacent to parks, the NPS should monitor human-caused sound that adversely affects park soundscapes, including noise caused by mechanical or electronic devices. The NPS should take action to prevent or minimize all noise that adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable for visitor use and enjoyment.

## **Purpose**

The purpose of the plan is to protect and manage soundscapes in Zion National Park and to:

- Protect the acoustic experience of park visitors and ensure that natural sounds continue to play an important role in the enjoyment of park resources and values.
- Protect acoustic conditions for wildlife and the role of the soundscape in ensuring healthy and dynamic ecosystems.
- Provide an approach to managing the acoustic environment that is consistent with National Park Service policy.

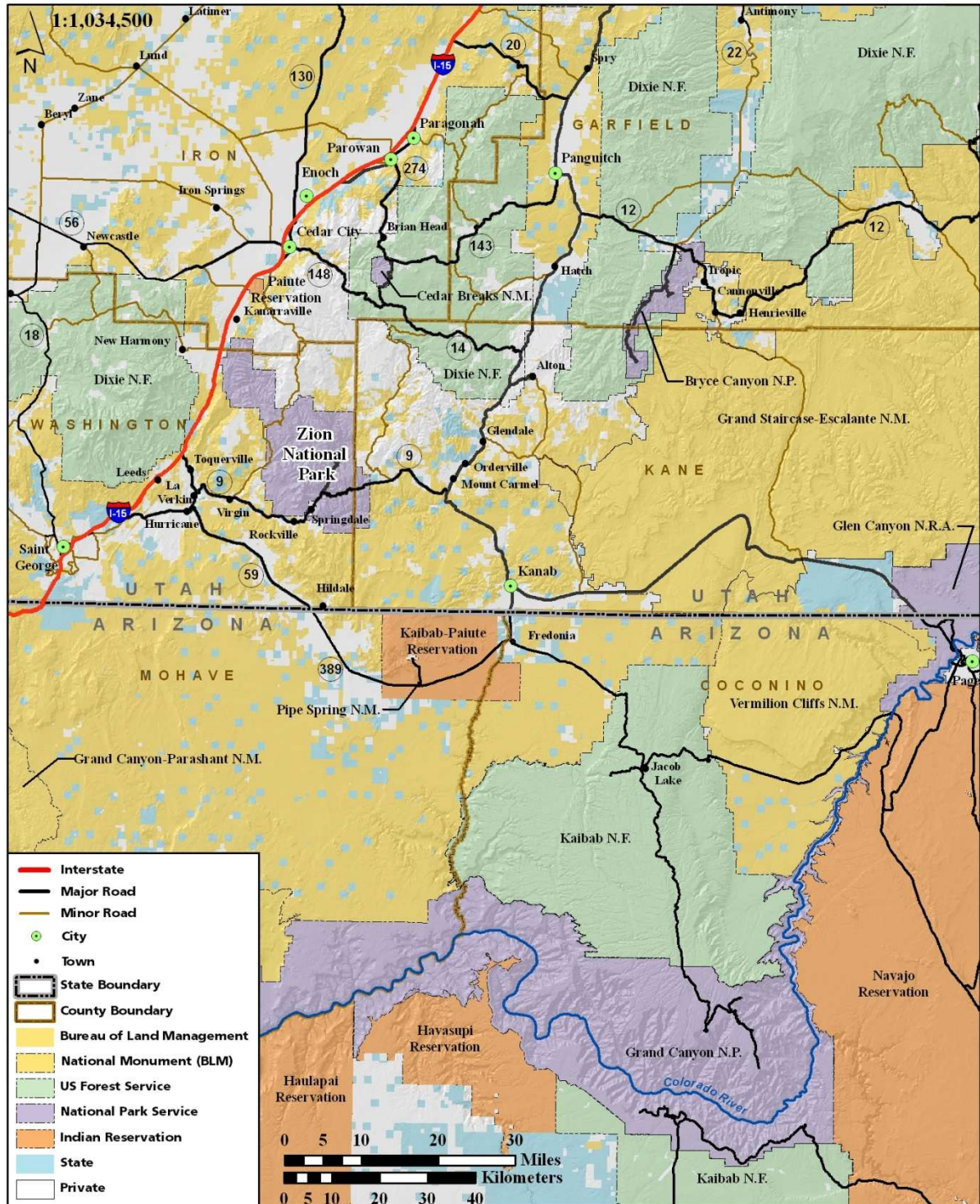
## **Specifically the purpose is to:**

- Identify appropriate and inappropriate sound sources for frontcountry and wilderness areas.
- Identify and implement indicators of soundscape quality.
- Develop soundscape standards for frontcountry and wilderness areas.
- Identify and implement methods for monitoring soundscape conditions to ensure that quality standards are being met.
- Identify management actions to be taken to ensure that soundscape quality standards are not exceeded and to restore degraded soundscapes to desired conditions.
- Identify a process to eliminate or mitigate sources of sound that are not appropriate to park purposes or management objectives.



# Figure 1: General Location

National Park Service  
U.S. Department of the Interior  
Zion National Park



## Need

In surveys of the American public, 91 percent of respondents indicated that providing opportunities to experience natural quiet and the sounds of nature was an important reason for having national parks. In fact, 72 percent felt that it was a “very important” reason. In response to the value the public places on natural sounds, NPS requires park managers to strive to preserve the natural soundscape associated with the physical and biological resources (for example, the sounds of wildlife or wind in the trees). Although nature is not always quiet (e.g., thunder, waterfalls), the absence of human-caused noise was discussed in the *Report on Effects of Aircraft Overflights on the National Park System* (NPS, 1995):

*Parks and wildernesses offer a variety of unique, pristine sounds not found in most urban or suburban environments. They also offer a complete absence of sounds that are found in such environments. Together, these two conditions provide a very special dimension to a park experience — quiet itself. In the absence of any discernible source of sound (especially manmade), quiet is an important element of the feeling of solitude. Quiet also affords visitors an opportunity to hear faint or very distant sounds, such as animal activity and waterfalls. Such an experience provides an important perspective on the vastness of the environment in which the visitor is located, often beyond the visual boundaries determined by trees, terrain, and the like. In considering natural quiet as a resource, the ability to clearly hear the delicate and quieter intermittent sounds of nature, the ability to experience interludes of extreme quiet for their own sake, and the opportunity to do so for extended periods of time is what natural quiet is all about.*

## The plan is needed because:

- Sounds play an important role in maintaining healthy and diverse ecosystems in Zion National Park. Properly functioning soundscapes are important for animal communication, territory establishment, predator and prey relationships, mating behaviors, nurturing young and effective use of habitat. A soundscape management program is needed to promote ecosystem sustainability.
- Visitors to Zion appreciate and value natural sounds and a soundscape management program will help ensure that the soundscape resource is preserved in an unimpaired condition for future generations.
- Appropriate sounds and sound levels are essential to ensuring an authentic experience of cultural and traditional landscapes, resources, and values. Culturally significant sites and resources can be diminished by unwanted or inappropriate sounds.
- Soundscape management activities require collaboration with federal, state, county, tribal and local agencies, and a soundscape management plan provides a basis for communication, coordination, and project planning with partner agencies.

Like many areas in the U.S., including other national parks, the sources and intensity of noise in ZNP has increased in recent decades. Today, 14 operators are authorized by the Federal Aviation Administration (FAA) to conduct commercial air tours over Zion, and commercial airlines, general aviation, and other aircraft routinely fly over the park. Tour buses, trucks, cars, and motorcycles as well as park operations and other activities also add to noise levels in many areas of the park. In response, Zion recently instituted a mandatory shuttle bus system during periods of high visitation to address noise and other issues created by vehicular traffic. The Zion shuttle system carried 2.8 million riders in 2009 resulting in a noticeable reduction in vehicular sound levels. This SMP will continue that effort by providing a systematic approach to addressing noise issues, now and in the future.



## THE PLAN

The Soundscape Management Plan (SMP) for Zion National Park describes appropriate and inappropriate sound sources, soundscape objectives, soundscape indicators and standards, monitoring approaches and protocols, and methods for modifying the SMP using an adaptive management approach.

### **Sound Sources and Sound Levels Consistent With Park Legislation and Purposes**

The GMP identifies, by management zone, the kinds of activities and developments that are appropriate to the purposes of the park (GMP pages 69-76). It is inferred in this plan that the human-caused sounds generated by activities deemed appropriate in the GMP are also appropriate sound sources.

Although the sources of sound may be deemed appropriate, the GMP also recognizes that some noise associated with them is excessive, and should be mitigated to the greatest extent possible. Generally, mitigation can consist of educating park visitors, staff, and concessionaires, reducing the sound level, duration, frequency of occurrence, or changing the frequency spectrum of the sound to one less obtrusive in the soundscape.

The GMP identified seven management zones. For the purposes of this SMP, these management zones have been combined into two zones: Frontcountry and Wilderness (Figure 2).

#### **The SMP Frontcountry Zone (14,814 acres) includes the following GMP management zones:**

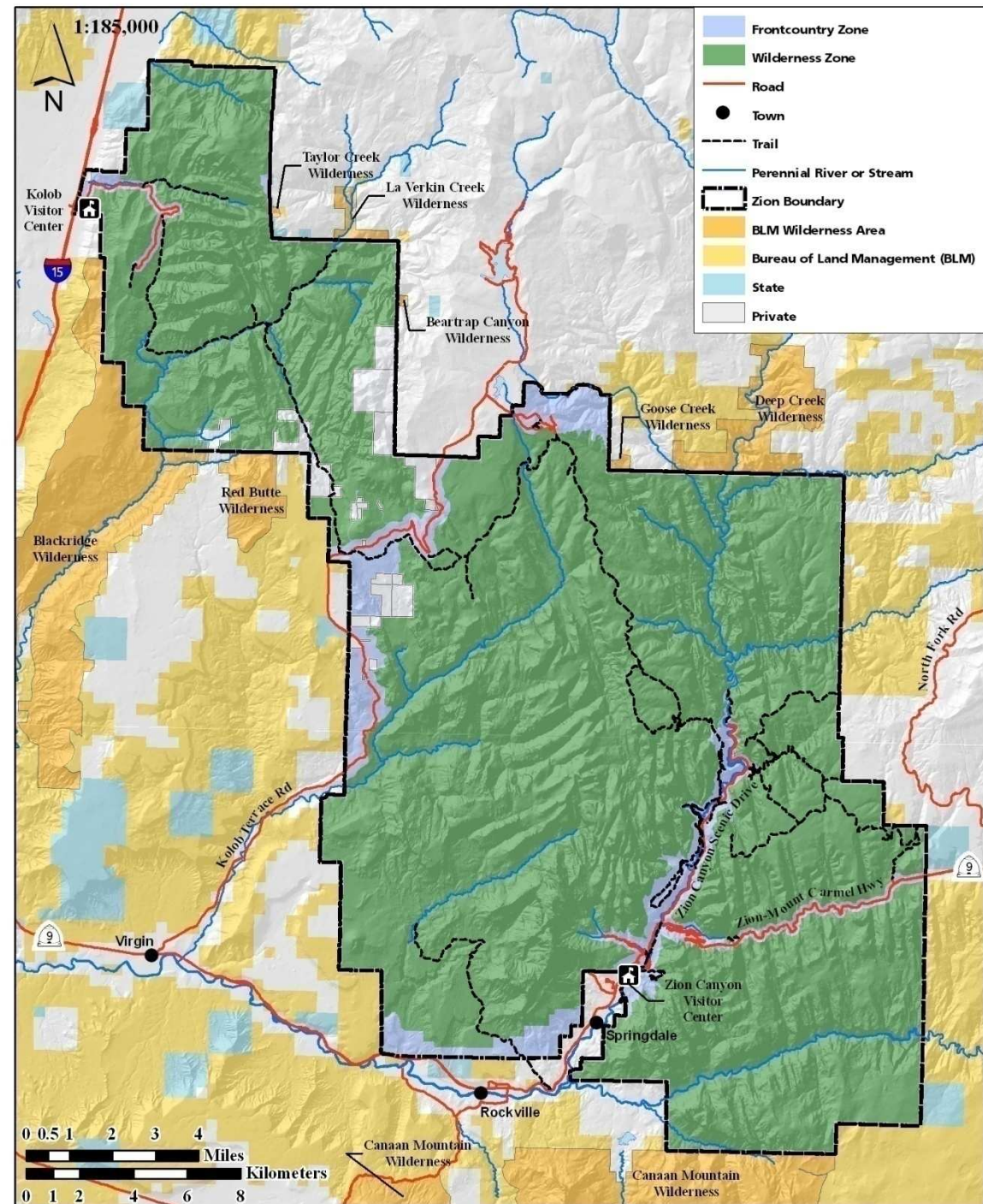
- **Frontcountry High Development:** Most human-made sound sources within the park are generated in this zone, and frequency of their occurrence is relatively high.
- **Frontcountry Low Development:** Most sources of sound within this area immediate, and frequency of occurrence is less than in the frontcountry high development zone.
- **Transition:** Sources are more distant, less immediate, and frequency of occurrence is less than frontcountry low development zone.
- **Administrative:** Most sources of sound are located within this zone, are immediate, and frequency of occurrence is less than in the frontcountry low development zone. There will generally be no sound sources associated with visitors or visitor activities.

#### **The SMP Wilderness Zone (133,919 acres) includes the following GMP management zones:**

- **Primitive:** Sources are immediate or distant, and frequency of occurrence is greater than in the pristine zone, but usually less than in transition zone.
- **Pristine:** Sources are immediate or distant, and frequency of occurrence is low to rare at any given location. Sound sources and their placement in the scale of impact level and appropriateness are the same as in the primitive zone.
- **Research Natural:** Sources are immediate or distant, and frequency of occurrence is low to rare at any given location.

# Figure 2: Soundscape Management Zones

National Park Service  
U.S. Department of the Interior  
Zion National Park



Tables 1 and 2 identify the appropriate sound sources for each zone and management actions that will be considered to minimize the impact of that sound. Management actions carried forward from the GMP are noted below.

<b>Table 1: Appropriate Sound Sources for Frontcountry Zone</b>	
<b>Appropriate Sound Sources</b>	<b>Management Actions</b>
<b><i>People</i></b>	
General: e.g. voices	<ul style="list-style-type: none"> <li>▪ Encourage visitors to be respectful of others by not shouting, yelling, loud conversations, or producing other excessive noise.</li> <li>▪ Enforce quiet hours in campground. Consider expanding the quiet hours.</li> <li>▪ Develop and implement educational and interpretive programs on soundscapes.</li> <li>▪ Encourage and remind visitors to limit noise, turn off cell phones, deactivate beepers on cameras, reduce volume on mp3 players.</li> <li>▪ Discourage the use of stationary or handheld messaging devices on trails and in undeveloped areas.</li> <li>▪ Add article in park paper on the importance of natural soundscape.</li> <li>▪ Consider identifying and designating "Quiet Zones/Areas" in the Frontcountry. These areas will be identified on maps, through signs and interpretation. Visitors will be encouraged to be quiet enough to hear natural sounds in these areas.</li> </ul>
Interpretive talks for visitors	<ul style="list-style-type: none"> <li>▪ Limit use of amplification, use only when necessary and to the minimum level necessary (evening programs at amphitheaters and interpretive tours on shuttle bus, etc.).</li> </ul>
<b><i>Vehicles</i></b>	
General e.g. – idling vehicles, generator use, security alarms	<ul style="list-style-type: none"> <li>▪ Manage parking areas to established capacity limits.</li> <li>▪ Encourage visitors to avoid the use of generators in parking lots and campgrounds (GMP).</li> <li>▪ Provide electric hookups in campgrounds where feasible to eliminate the need for generators.</li> <li>▪ Encourage visitors to deactivate the beepers for locking doors and deactivate car alarms.</li> <li>▪ Encourage maintenance and delivery trucks to deactivate back-up beepers where appropriate.</li> <li>▪ Work with delivery companies to determine appropriate times for deliveries.</li> <li>▪ Enforce quiet hours in campgrounds.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Tour busses, shuttle busses, public address systems on buses/shuttles	<ul style="list-style-type: none"> <li>▪ No idling of vehicles (tour busses, shuttles, etc.) in parking areas for layovers of more than 3 minutes (especially at Temple of Sinawava).</li> <li>▪ Continue to require bus tour companies to comply with regulations that reduce noise levels (e.g., turning off engines when buses are parked) (GMP).</li> <li>▪ Consider quiet technology for replacement shuttle buses.</li> <li>▪ Consider smaller speakers placed closer to the seats to keep public address system volume lower on shuttle buses.</li> <li>▪ Encourage shuttle drivers to talk only on up canyon trips – allowing visitors the opportunity to experience a quieter trip down canyon.</li> <li>▪ Continue operating the shuttle system.</li> <li>▪ Consider shuttle bus timing/schedules to ensure opportunities for</li> </ul>

<b>Table 1: Appropriate Sound Sources for Frontcountry Zone</b>	
<b>Appropriate Sound Sources</b>	<b>Management Actions</b>
	<p>visitors to experience natural sounds in Zion Canyon.</p> <ul style="list-style-type: none"> <li>▪ Eventually phase out private tour buses in Zion Canyon above Canyon Junction to reduce noise levels and eliminate the greatest source of noise in the canyon (GMP).</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Motorcycles, street legal ATVs	<ul style="list-style-type: none"> <li>▪ Encourage quiet and courteous riding through education.</li> <li>▪ Discourage use of modified exhausts that increase noise levels.</li> <li>▪ Require groups of organized riders to acquire a special use permit.</li> <li>▪ Any applications for organized rides must go through the appropriate NEPA analysis.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Aircraft Use (Administrative and Authorized Overflights)	<ul style="list-style-type: none"> <li>▪ Consider other ways of accomplishing the task.</li> <li>▪ Combine flights whenever possible.</li> <li>▪ Require flight following using GPS or similar technology and reporting for all administrative flights.</li> <li>▪ Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery, including aircraft and motor vehicles (GMP).</li> <li>▪ Noise will be a consideration when procuring, contracting, and using park equipment. Prior to purchase, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</li> <li>▪ Any applications for commercial filming permits must comply with existing safety and aviation restrictions and must go through the appropriate NEPA analysis.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
<b>Routine Park Operations/NPS Facilities/Maintenance</b>	
Building security/fire alarms	<ul style="list-style-type: none"> <li>▪ Ensure systems are maintained to reduce false alarms.</li> </ul>
Leaf blowers, lawn mowers, other gas-powered hand tools	<ul style="list-style-type: none"> <li>▪ Limit the hours of operation of motorized tools, etc. from 9:00 am to 5:00 pm. Protecting dawn, dust and nighttime quiet.</li> <li>▪ Minimize the use of leaf blowers, chainsaws, and other mechanical equipment. Consider other products that accomplish the same task (handheld non-power tools, brooms, rakes, electric powered mowers or trimmers, etc.).</li> <li>▪ Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery (GMP).</li> <li>▪ Consider quiet technology when replacing equipment. Prior to purchase, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Use of explosives	<ul style="list-style-type: none"> <li>▪ Limit use to emergency trail or road work.</li> <li>▪ Analyze noise impacts through the appropriate NEPA analysis.</li> </ul>
Heavy equipment for construction and other activities (fire, maintenance, etc.)	<ul style="list-style-type: none"> <li>▪ Consider the effects of human-caused sound when deciding on the equipment needed to perform a task.</li> <li>▪ Limit the hours of operation of motorized equipment from 9:00 am to 5:00 pm. Protecting dawn, dust and nighttime quiet.</li> <li>▪ Noise should be addressed through appropriate NEPA analysis.</li> <li>▪ Consider quiet technology when replacing equipment. Prior to</li> </ul>

Table 1: Appropriate Sound Sources for Frontcountry Zone	
Appropriate Sound Sources	Management Actions
	<p>purchase or contracting, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</p> <ul style="list-style-type: none"> <li>Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery, including motor vehicles (GMP).</li> <li>Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Protection/Administration/Law Enforcement	
Administrative vehicles	<ul style="list-style-type: none"> <li>Increase the use of quiet technology where appropriate.</li> <li>Minimize the use of back-up beepers when appropriate.</li> <li>Encourage alternate forms of transportation when traveling in the park (shuttle, walk, bike, carpool, etc.).</li> <li>Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery, including motor vehicles (GMP).</li> <li>When replacing vehicles, consider hybrid or full electric vehicles.</li> <li>Noise will be a consideration when procuring, contracting, and using park equipment. Prior to purchase, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</li> <li>Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
Sirens, emergency response vehicles	<ul style="list-style-type: none"> <li>Emergency use only.</li> </ul>

Table 2: Appropriate Sound Sources for Wilderness Zone	
Appropriate Sound Sources	Management Actions
People	
Sounds of recreation mostly self-generated (e.g., hikers, camp activities, climbers, limited interpretative programs)	<ul style="list-style-type: none"> <li>Subject to park policy and management direction such as campsite densities or group size limits.</li> <li>Encourage and remind visitors to limit noise, shouting, and loud conversations.</li> <li>Encourage visitors to turn off cell phones, deactivate beepers on cameras, reduce volume on mp3 players.</li> <li>Develop and implement educational and interpretive programs on soundscapes.</li> <li>Add article in park paper on the importance of the natural soundscape in Wilderness. Distribute information with backcountry permits.</li> </ul>
Vehicles	
Aircraft Use (Administrative and Authorized Overflights)	<ul style="list-style-type: none"> <li>In designated and recommended wilderness, the use of motorized equipment will conform to the requirements of the Wilderness Act, minimum requirements procedures, and related NPS policies (DO-41: <i>Wilderness Preservation and Management</i>) (GMP).</li> <li>Combine flights whenever possible.</li> <li>Require flight following and reporting for all</li> </ul>

<b>Table 2: Appropriate Sound Sources for Wilderness Zone</b>	
<b>Appropriate Sound Sources</b>	<b>Management Actions</b>
	<p>administrative flights.</p> <ul style="list-style-type: none"> <li>▪ Consider quiet technology when replacing or contracting for aircraft. Noise will be a consideration when procuring and using park equipment. Prior to purchase, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</li> <li>▪ Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery, including aircraft (GMP).</li> <li>▪ Limit the hours of operation of motorized equipment from 9:00 am to 5:00 pm. Protecting dawn, dusk and nighttime quiet.</li> <li>▪ Any applications for commercial filming permits must comply with existing safety and aviation restrictions and must go through the appropriate NEPA analysis.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
<b><i>Routine Park Operations/NPS Facilities/Maintenance</i></b>	
Habitat rehabilitation, fuels treatment, weed control, large crews, research groups, explosive use, use of chainsaw and other motorized tools	<ul style="list-style-type: none"> <li>▪ In designated and recommended wilderness, the use of motorized equipment will conform to the requirements of the Wilderness Act, minimum requirements procedures, and related NPS policies (DO-41: <i>Wilderness Preservation and Management</i>) (GMP).</li> <li>▪ Mitigate by administrative review with statement addressing soundscape management or address through appropriate NEPA analysis.</li> <li>▪ Limit the hours of operation of motorized equipment from 9:00 am to 5:00 pm. Protecting dawn, dusk and nighttime quiet.</li> <li>▪ Prior to purchase of equipment, research will be conducted in regard to the best available technology and the quietest equipment will be identified and purchased unless there is an overwhelming reason not to.</li> <li>▪ Educate staff on quieter tool choices.</li> <li>▪ Use quiet technology when appropriate.</li> <li>▪ Minimize noise generated by park management activities by strictly regulating NPS and concession administrative use of noise producing machinery, including aircraft and motor vehicles (GMP).</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>
<b><i>Protection/Administration/Law Enforcement</i></b>	
Search and rescue, fire suppression – helicopters, other aircraft, large crews	<ul style="list-style-type: none"> <li>▪ All actions planned and evaluated through the park's "go/no go" checklist.</li> <li>▪ Conduct minimum requirement procedures and NEPA analysis required except for emergency actions.</li> <li>▪ Use quiet technology when appropriate.</li> <li>▪ Require flight following and reporting for all administrative flights.</li> <li>▪ Enforce existing noise ordinances (36 CFR §2.12).</li> </ul>



## Sound Sources and Levels Not Consistent With Park Legislation and Purposes

Other sources of human-caused sound that exist in, or affect the park are not consistent with park purposes. These are also outlined in the GMP. Zion National Park management and staff are obligated under law, policy, and in accordance with the GMP, to take steps in addressing inappropriate sound sources.

Table 3 lists inappropriate sound sources that generally originate from beyond the park boundary or in the airspace above the park. The park does not have the authority to control the sound sources, but the park is committed to working with adjacent property owners, appropriate federal, state, and local agencies, and organizations to mitigate potential soundscape impacts.

Table 3: Inappropriate Sound Sources - Not Consistent With Park Legislation and Purposes	
Inappropriate Sound Sources	Management Actions
<ul style="list-style-type: none"><li>•Commercial aviation</li><li>•General aviation</li><li>•Air tours</li><li>•Gravel pit operations</li><li>•Fireworks</li><li>•Off-Highway Vehicles (OHV's)</li><li>•Snowmobiles</li><li>•Excessive noise from businesses and other facilities</li><li>•Large public events (festivals, concerts, etc.)</li><li>•Amplified handheld or stationary communication devices</li></ul>	<p>Collaborate with adjacent property owners, appropriate federal, state, and local agencies, and organizations with the following:</p> <ul style="list-style-type: none"><li>▪ Engage in the planning efforts of other agencies in which there is a potential to impact park soundscapes. Seek cooperating agency status when appropriate.</li><li>▪ Work with FAA and the NPS Natural Sounds Program to develop an air tour management plan in accordance with Public Law 106-181 (GMP).</li><li>▪ Work with the Department of Defense to address soundscape issues with military overflights (GMP).</li><li>▪ Work with FAA, state and local government, and other parties in developing plans for new or expanded airport facilities, or altered flight routes, that can potentially affect the park.</li><li>▪ Work with adjacent land owners, inholders, or other land management jurisdictions to mitigate impacts of sources of noise from those lands.</li><li>▪ Encourage the use of new, quieter snowmobile and OHV technology.</li><li>▪ Seek active partners to develop and implement quieter technology in and out of ZNP.</li></ul>

## Soundscape Objectives

Below are the soundscape management objectives for the frontcountry and wilderness zones. The objectives are based on and are compatible with the descriptions of park management zones provided in the ZNP GMP. The objectives support the overall desired conditions for soundscape management, as expressed in the GMP: *Natural sounds predominate in ZNP. Visitors have opportunities throughout most of the park to experience natural sounds in an unimpaired condition. The sounds of civilization are generally confined to developed areas.*

### **Soundscape Objectives for the Frontcountry Zone**

- Natural sounds are audible and discernable, with common noise intrusions by visitors and park operations that are concentrated at locations near roads and heavily developed areas.
- Active intensive management is used to maximize noise free intervals and limit the intensity and duration of noise intrusions.
- Noise levels that interfere with general conversation rarely occur and are of limited duration except when caused by emergency services, search and rescue operations (sirens, search and rescue aircraft), and park operations (road repairs, grounds and building maintenance).

- Sound levels that interfere with interpretive programs do not occur except when caused by emergency services and search and rescue operations (sirens, search and rescue aircraft).
- Sound levels that exceed thresholds for sleep interruption rarely occur.
- Noise levels at common rock climbing areas should not interfere with effective communication among climbers.
- Noise levels that mask important auditory signals for wildlife should be uncommon and should be limited to locations near roads and heavily developed areas.
- Noise levels that affect wildlife behavior, distribution and numbers should be uncommon and should be limited to locations near roads and heavily developed areas.

### ***Soundscape Objectives for the Wilderness Zone***

- Only natural sounds are audible and discernable, except for short duration, infrequent human-caused sounds.
- Noise levels that interfere with general conversation are very rare and are of limited duration except when caused by emergency services, search and rescue operations (aircraft), and approved park operations (aircraft, motorized/mechanical tool use).
- Sound levels that exceed thresholds for sleep interruption are extremely rare.
- Noise levels at rock climbing areas and technical canyons should not interfere with effective communication among climbers and canyoneers.
- Noise levels that mask important auditory signals for wildlife should be rare.
- Noise levels that affect wildlife behavior, distribution, and numbers should be rare.

### **Soundscape Indicators and Standards**

The following soundscape indicators are used to determine the extent to which soundscape objectives are being met. For each indicator, a standard is prescribed (Refer to Tables 5 and 6). In the performance of monitoring, a violation of a standard shows that objectives are not being met or that the use/activity is not in compliance. The discussion describes the data collection and analysis required to monitor the indicator and the extent and duration of the monitoring program required to track compliance with soundscape objectives and standards.

#### ***Time audible***

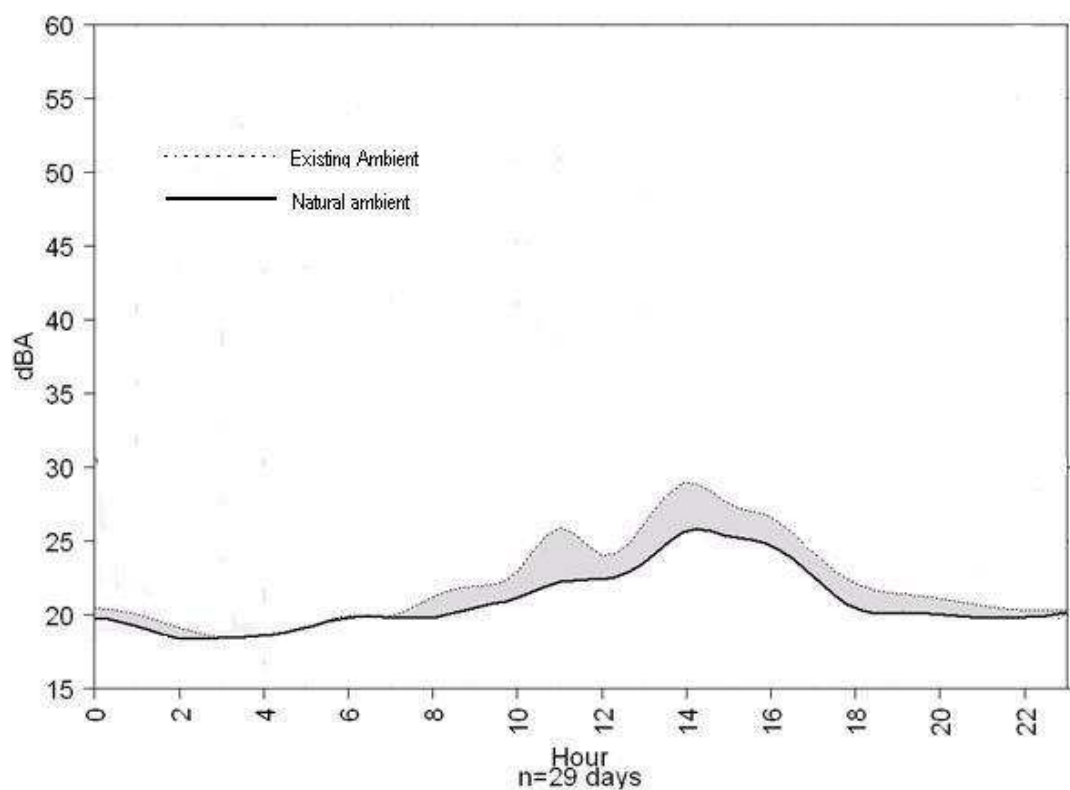
The percentage of time during a 12-hour day that human-caused sounds can be heard by the human ear. For example, 25 percent time audible (TA) means human-caused sounds could potentially be heard in specified areas for 25 percent of the day, or three hours during a 12-hour day – not necessarily consecutive hours, but spaced throughout the day. Time audible or “audibility” is one of the ways NPS measures or characterizes the acoustic environment in national park units.

#### ***Sound Level***

Sound levels are expressed using two metrics: **Deviation from Natural Ambient** and **Maximum Sound Levels** as described below.

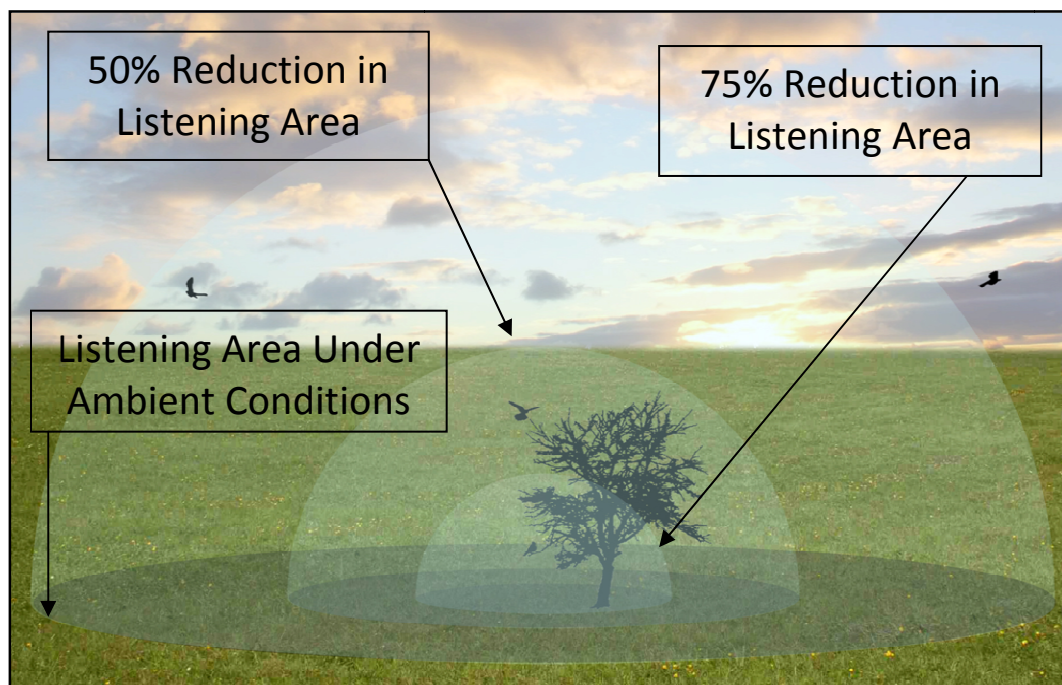
**Deviation from Natural Ambient** is the difference between the average sound level and the natural ambient condition. This metric reports the difference between the average hourly sound level, including all natural and human-caused sounds, and the hourly natural ambient. It represents the extent to which human-caused sounds raise the natural ambient background levels. This metric does not provide information on event duration or timing, nor does it mean that human-caused sound levels cannot be heard at or below the ambient. It means that the sound levels produced by human sources are above the natural ambient sound level.

Deviation from natural ambient is depicted in Figure 3 as the gray shaded area and can have important implications for the protection of visitor experience, wildlife, and other natural resources. For example, deviation from natural ambient can be used to identify reductions in listening area and alerting distance. Reduction in listening area quantifies the loss of hearing ability to humans and animals as a result of an increase in ambient noise level. Under natural ambient conditions a sound is audible within a certain area around a visitor or animal. If the ambient level is increased due to a noise event, the area in which the sound is audible decreases. Table 4 and Figure 4 illustrate the relationship between increased ambient and listening area reduction.



**Figure 3: Deviation from Natural Ambient**

<b>Table 4: Reduction in Listening Area Due to Increases in Ambient Levels</b>				
dBA Ambient Increase	3	6	10	20
Percent Reduction in Listening Area	50%	75%	90%	99%
Percent Reduction in Alerting Distance	30%	50%	70%	90%



**Figure 4: Reduction in Listening Area**

For example, under natural ambient conditions, an owl perched in a tree may be able to hear a mouse scurrying through the brush anywhere within an area of 100-square-meters of the perch. If a noise event increases the ambient level by 3 decibels (dBA), the area in which the owl can hear a mouse would decrease by 50 percent to approximately 50-square-meters.

Reduction in alerting distance is closely related to reduction in listening area. The residual alerting distance is equal to the square root of the residual listening area. Instead of addressing losses in terms of an area, reduction in alerting distance expresses the reduction as a linear distance from a source. For example, under natural ambient conditions, a canyoneer may be alerted to the sound of a flash flood at a distance of 1-mile. If a noise such as an aircraft overflight increases the ambient level by 6 dBA, the distance at which the flood could be detected would decrease by 50 percent to approximately ½-mile or 2,640-feet.

Visitors and wildlife are impacted by their failure to hear natural sounds that would have been audible in the absence of noise: a bird misses the sound of a worm, a mouse misses the footfall of a coyote, a visitor misses the sound of a distant waterfall. Reductions in listening area and alerting distance capture these types of impacts.

Deviation from ambient is calculated from sound pressure data collected at the park.

**Maximum Sound Level (Lmax)** is the loudest sound level in an A-weighted decibel (dBA) generated during a noise event.

### **Noise Free Intervals**

Noise free intervals (NFI) are time periods during which only natural sounds are audible. NFI data is expressed as maximum NFI, minimum NFI, and median NFI. NFI is calculated from on-site listening data and sound pressure data collected at the park. NFIs are calculated for daytime and nighttime hours.

### **Speech Interference**

Speech interference represents the amount of time during which noise may interfere with human speech. The potential for speech interference from a noise depends on the distance between the speaker and listener and the acceptable level of intelligibility. Figure 5 illustrates thresholds for speech interference for various distances and intelligibility levels. The percentage of time or number of minutes per day that speech may be adversely affected by noise is calculated from the sound pressure data collected at the park. Using the chart in Figure 5, speech interference thresholds were determined for each of the different "types" or contexts of speech that is likely to occur at the park: general conversation, interpretive programs, and rock climbers/canyoneers.

#### **General Conversation**

This type of conversation occurs between two or more people standing relatively close together (approximately 2-meters) speaking at normal conversational volume. Hikers and visitors viewing scenic vistas in the park would likely fall in this category. Based on 95 percent speech intelligibility and normal voice communications at 2-meter, the EPA's speech interference threshold for this type of conversation is 60 dBA.

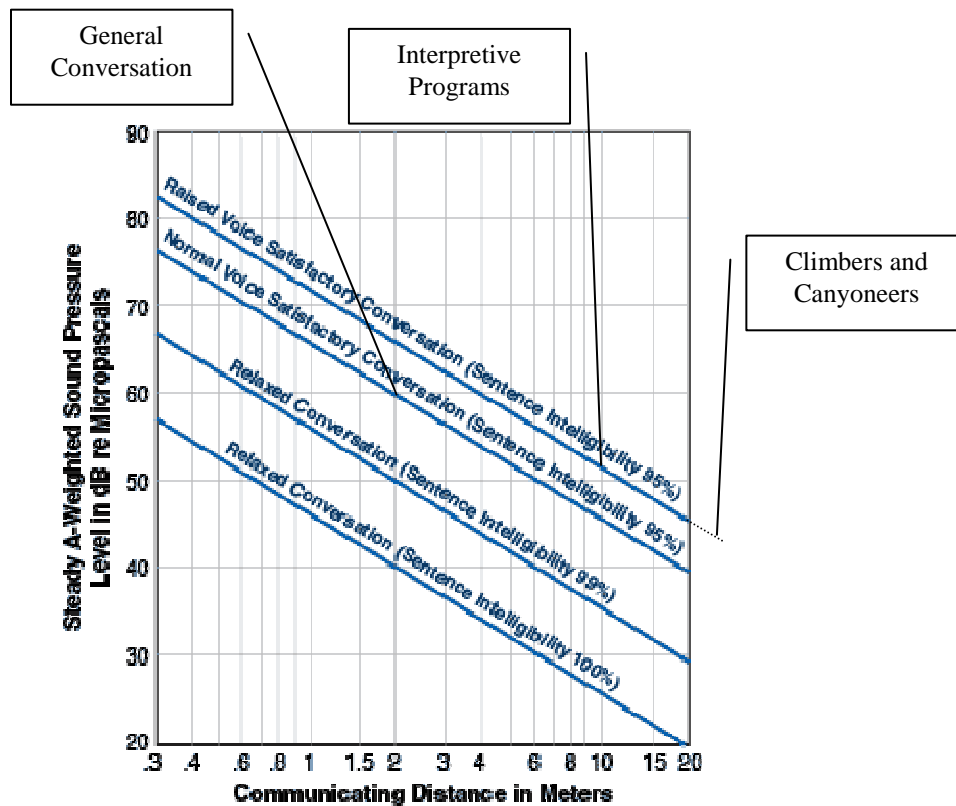
#### **Interpretive Programs**

This type of conversation occurs during interpretive programs conducted by park staff or other groups (schools, tours, etc.). Interpreters typically speak in a "raised voice" with approximately 10-meters between the speaker and the furthest participants. Based on 95 percent speech intelligibility and raised voice communications at 10-meters, the EPA's speech interference threshold for this type of conversation is 52 dBA.

#### **Rock Climbers/Canyoneers**

This type of conversation occurs between technical rock climbers or between climbers and belayers in the climbing areas or technical slot canyons in the park. Climbers and canyoneers appreciate and value a natural setting when climbing and effective communication is critical among climbers and canyoneers for safety reasons. Typically, the distance between rock climbers and canyoneers ranges from less than 1-meter to more than 50-meters. Because 25-meters would likely be the average distance between climbers and canyoneers, a threshold of 44 dBA was used, based on 95 percent speech intelligibility and raised voice communications, to estimate the potential for speech interference for climbers and canyoneers.

Noises that exceed these thresholds are likely to interfere with speech communication. The potential for speech interference is determined by calculating the time that human-caused sounds exceed speech interference thresholds.



**Figure 5: Speech Interference for General Conversation, Interpretative Programs, and Climbers/Canyoneers (Source EPA, 1974)**

### ***Sleep Interruption***

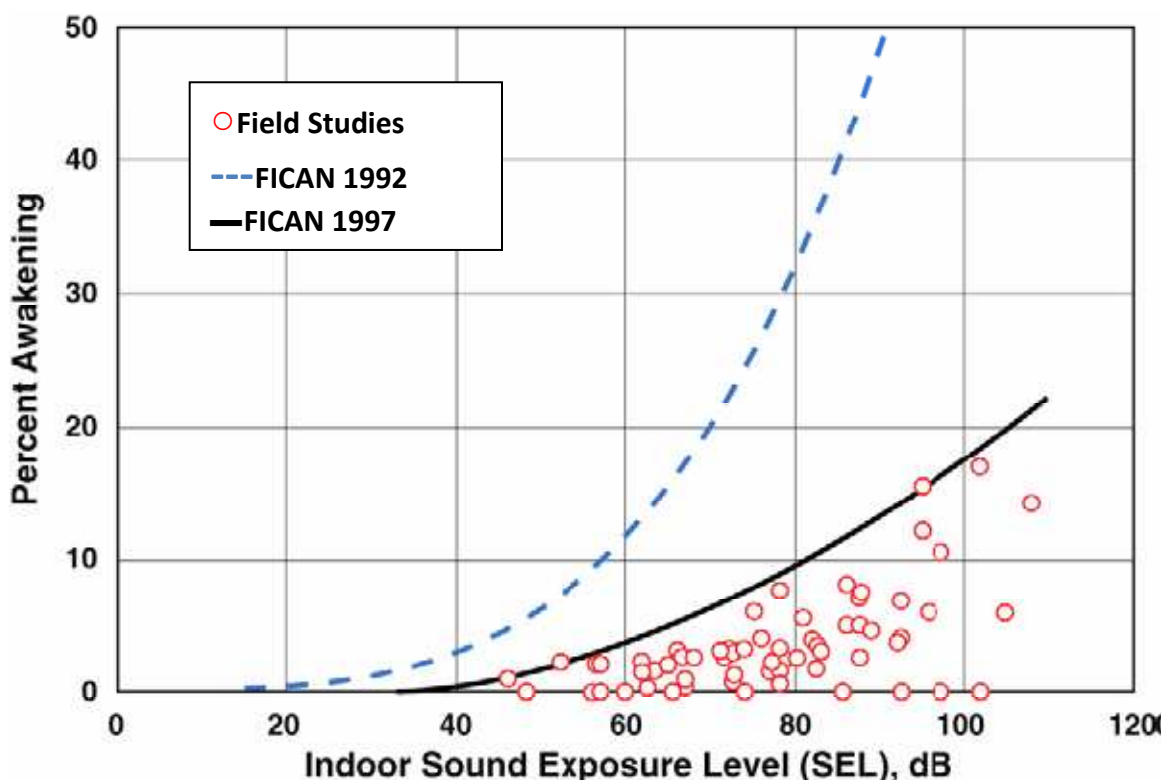
In 1997 the Federal Interagency Committee on Aircraft Noise (FICAN) issued a report on sleep interruption. The report contains a model for estimating the probability of awakening due to a noise event based on the intensity of the sound (see Figure 6). The model developed in 1997 indicates that the likelihood of awaking from a 30 dBA noise event is close to zero percent. At 65 dBA, about the level of a normal conversation, there is a 5 percent chance of awakening, and at 80 dBA, the likelihood increases to 10 percent. The FICAN study uses the sound level exposure (SEL) metric to determine the probability of awakening. The sleep interruption standards in this plan use the maximum sound level (Lmax). This provides a more conservative estimate of sleep interruption because the Lmax of an event is always lower than the SEL. Thus using the values in Figure 6, the Lmax of an event will provide a slightly lower probability of awakening than the SEL for the same event.

The World Health Organization (WHO) (Berglund and Lindvall, 1999) recommends noise levels below 45 dBA inside bedrooms. They state, *it is important to limit the number of noise events with a Lmax exceeding 45 dB... To protect sensitive persons, a still lower guideline value would be preferred when the background level is low.* The likelihood for sleep interruption at campsites, lodges, employee housing, and other areas can be calculated from sound pressure data collected at the park. FICAN explicitly cautions against applying this criterion in campgrounds or other temporary residences, where people are typically more prone to disturbance. Therefore, the actual likelihood of sleep interruption may be greater than those calculated for areas within national



parks. More recent studies (Haralabidis, 2008) suggest that sound events as low as 35 dBA can have adverse effects on blood pressure while sleeping.

Research on the effects of noise on sleep patterns of other animal species is sparse. However, protecting humans from sleep interruption likely provides other vertebrates a level of protection from sleep disruption. The adequacy of standards for sleep interruption should be reexamined as more data on non-human sleep interruption becomes available.



**Figure 6: Likelihood of Awakening from Noise (Source: FICAN 1997)**

Tables 5 and 6 provide standards for each indicator for Frontcountry and Wilderness Zones. The rationale supporting each standard is also included. The indicator will be monitored to determine if the standard is being met. This data will assist the park in determining whether existing management actions are sufficient to protect the park soundscape or if additional management actions need to be implemented.

According to the NPS Visitor Experience and Resource Protection (VERP) Handbook, standards represent the point at which management must take action to protect the resource. Standards do not represent ideal resource conditions, rather standards are defined as the minimally acceptable condition.

According to the VERP Handbook (p. 59 emphasis added):

“...it may be determined that the amount of bare ground at campsites is a key measure of the naturalness of resource condition. Thus, the amount of bare ground at campsites may be a good resource indicator. Moreover, it may be determined that when the amount of bare ground exceeds 50% of the total campsite area, most visitors and agency personnel believe that impacts are **unacceptable**. Thus, the resource standard for bare ground at campsites in zone ‘x’ may be set at 50% of the total campsite area.

Similarly, it may be determined that the number of encounters with other groups along trails is a key measure of the opportunities for solitude. Thus, the number of trail encounters with other groups per day may be a good social indicator. Moreover, most visitors may report that once they encounter more than three groups along a trail per day, they no longer have an **acceptable** level of solitude. Thus, the social standard for the number of trail encounters per day in zone ‘y’ may be set at three— **a minimally acceptable social condition...**

The reason for standards is to ‘draw a line in the sand,’ which clearly shows when conditions are unacceptable and action must be taken. “

Additionally, an important characteristic of effective standards is that they must be realistic and attainable. According to the VERP Handbook,

“Standards must reflect conditions that are attainable. In some cases, managers or the public may prefer conditions that are better than can realistically be achieved. For example, an unrealistically low standard for encounter rates that prohibits most of the visitors from using the resource may not be politically feasible. Moreover, such extreme measures that would place serious restrictions on visitors may not be ethically defensible unless an extraordinary situation, such as imminent loss of a significant resource, would justify the action.

In some cases where existing conditions are significantly below standards (in a highly impacted natural area, for example), strict standards could be set even though achieving the standard could be many years in the future. A standard in this situation would be used to measure long-term improvement in conditions.”

Data collected at ZNP and presented in the Affected Environment section of the EA indicate that acoustic conditions are highly impacted by noise from aircraft overflights and other sources. The standards presented in Tables 5 and 6 represent a considerable improvement to those conditions. The standards represent realistic and attainable conditions, however achieving the referenced conditions will likely take several years of focused and effective management actions including working closely and cooperatively with FAA to address noise effects from overflights.

As discussed in the Monitoring and Adaptive Management section, the SMP also incorporates an adaptive management approach to reassessing standards. If acoustic monitoring indicates that standards established in this plan are being achieved, adaptive management dictates that a

reassessment of the standards be conducted to determine if revisions to the standards are warranted. Other factors such as changes in the availability of new research, an increased understanding of the effects of noise on visitors, wildlife and other resources, a major change in technology, or a significant, unanticipated event occurring inside or outside the park boundary could lead to a reassessment and possible revision of standards. The overall goal of soundscape management at ZNP is protection, restoration, and improvement of acoustic conditions for the enjoyment of future generations. Establishing, monitoring, and reassessing standards when appropriate is an important tool in achieving that goal.

When determining if desired conditions, as outlined in the GMP and soundscape objectives are being met, it is important to understand acoustic conditions throughout the park. Spatial analyses of acoustic conditions will provide information on the proportion of each management zone that is experiencing desired conditions and the proportion that may be exceeding standards. Initially, acoustic monitoring and analyses will only provide information about acoustic conditions in areas near the monitoring sites. As data are collected at additional sites throughout the Frontcountry and Wilderness Zones, conditions can be estimated in terms of the portion of each zone that is in compliance with acoustic standards. In order to ensure that desired acoustic conditions and management objectives are being met, acoustic conditions must be below standards in 95 percent of the Frontcountry Zone and 97 percent of the Wilderness Zone.

Table 5: Indicators and Standards for the Frontcountry Zone <sup>1</sup>		
Indicator	Standard <sup>2</sup>	Rationale
<b>Time audible (TA)</b>	<p><u>Daytime Hours:</u> The hourly percent time audible is less than 50% for 60% of the day. The hourly percent time audible never exceeds 65%.</p> <p><u>Nighttime Hours:</u> The hourly percent time audible is less than 30% for 80% of the night. The hourly percent time audible never exceeds 40%.</p>	<p>These standards ensure even though visitors experience highly social conditions in the Frontcountry Zone, that they will still have the opportunity to experience solitude at certain times.</p> <p>It also ensures management identification and review of areas where human-caused sounds are audible more than 65% (day) and 40% (night) of the time. [exceeds standards by 100%]</p> <p>Acceptable to have 40% of daytime hours that exceed 50% TA. Probably meeting 50% TA for at least 50% of the day currently. 60% of the day will create incentive to reduce extrinsic noise levels further. All of the hourly %TA that exceed the standard are currently below 80% and most are around 70% the 65% maximum. TA provides incentive to reduce levels below current conditions.</p> <p>Night – interval between shuttles increases, less vehicle traffic, park operations are less frequent, quiet hours start in campgrounds – generators prohibited, restrictions on equipment usage by road crews. The 30% TA standard may be exceeded during the early evening hours and in the morning around dawn. This is due to increased human activity (the shuttle begins to run during this time).</p>
<b>Sound level</b>	<p><u>Daytime Hours:</u> The hourly change in exposure is less than or equal to 3 dBA for 40% of the day and does not exceed 6 dBA for 90%.</p> <p>Human-caused sound events never exceed 60 dBA (CFR Audio Disturbance).</p> <p><u>Nighttime Hours:</u> The hourly change in exposure is less than or equal to 3 dBA for 70% of the night and does not exceed 6 dBA for 95%.</p> <p>Human-caused sound levels never exceed 45 dBA (related to sleep threshold).</p>	<p>The daytime standard ensures that human-caused sound levels are not likely to mask natural sounds in most of the zone.</p> <p>An increase of 3 dBA corresponds to a 50% reduction of listening area and a 30% reduction of alerting distance. You can only exceed this condition for 60% of the day.</p> <p>An increase of 6 dBA corresponds to a 75% reduction of listening area and a 50% reduction of alerting distance. You can only exceed this condition for 10% of the day.</p> <p>The nighttime standard also ensures that a reduction in listening area of 50% and a reduction in alerting distance of 30% occurs no more than 30% of the night. Activity for many species increases during these hours (dawn/dusk).</p> <p>An increase of 6 dBA corresponds to a 75% reduction of listening area and a 50% reduction of alerting distance. You can only exceed this condition for 5% of the night.</p> <p>The standard also ensures management identification and review of areas where human-caused sound exceeds 60 dBA (CFR Audio Disturbance) and 45 dBA (WHO Sleep Interruption standard).</p>

Table 5: Indicators and Standards for the Frontcountry Zone <sup>1</sup>		
Indicator	Standard <sup>2</sup>	Rationale
<b>Noise free interval</b>	<p><u>Daytime Hours</u>: The daily maximum noise free interval is at least 19 minutes (over 12-hour-period).</p> <p>The daily median noise free interval is at least 4 minutes (over 12-hour-period).</p> <p><u>Nighttime Hours</u>: The nightly maximum noise free interval is at least 35 minutes (over 12-hour-period).</p> <p>The nightly median noise free interval is at least 6 minutes (over 12-hour-period).</p>	This standard ensures that enough time occurs between noise events to ensure that visitors to frontcountry areas will have the opportunity to experience natural sounds free from human-caused noise intrusions. The standard also provides wildlife needed time to recover between noise events.
<b>Time above speech interference thresholds</b>	<p><u>General Conversation</u> Human-caused sound levels are less than or equal to 60dBA for more than 5% of the 12-hour-day.</p> <p><u>Interpretive Programs</u> Human-caused sound levels are less than or equal to 52dBA for more than 5% of the 12-hour-day in areas where interpretive programs are conducted. The number of events above 52 dBA does not exceed 2-per-hour.</p>	<p>The General Conversation standard ensures that human-caused sound will not interfere with speech among visitors involving normal voice levels over a distance of 2-meters for more than 36-minutes-per-day (3-min/hr).</p> <p>The Interpretive Program standard ensures that human-caused sound will not interfere with interpretive programs involving raised voice levels over a distance of 10-meters for more than 36-minutes-per-day.</p>
<b>Time above sleep interruption thresholds</b>	Noise events during nighttime at designated campsites, hotels, and housing areas do not exceed 45 dBA.	Based on the FICAN study (1997), the likelihood of waking due to a noise events of 45 dBA is approximately 3%. The World Health Organization (Berglund and Lindvall, 1999) recommends noise levels below 45 dBA inside bedrooms.
<p><sup>1</sup>In order to ensure that desired acoustic conditions and management objectives are being met, acoustic conditions must be at or below standards in 95% of the Frontcountry Zone.</p> <p><sup>2</sup> <u>Daytime Hours</u> (1 hour after sunrise to 1 hour prior to sunset) <u>Nighttime Hours</u> (1hour prior to sunset to 1 hour after sunrise)</p>		

Table 6: Indicators and Standards for the Wilderness Zone <sup>1</sup>		
Indicator	Standard <sup>2</sup>	Rationale
<b>Time audible</b>	<p><u>Daytime Hours</u>: The hourly percent time audible is less than 25% for 90% of the day. The hourly percent time audible never exceeds 50%.</p> <p><u>Nighttime Hours</u>: The hourly percent time audible is less than 20% for 90% of the night. The hourly percent time audible never exceeds 40%.</p>	<p>These standards ensure that natural sounds are predominant in the Wilderness Zone, and that visitors have the opportunity to experience solitude (GMP and soundscape objective).</p> <p>It also ensures management identification and review of areas where human-caused sounds are audible more than 50% (day) and 40% (night) of the time. [exceeds standards by 100%]</p>
<b>Sound level</b>	<p><u>Daytime Hours</u>: The hourly change in exposure is less than or equal to 3 dBA for 75% of the day and does not exceed 6 dBA for 90%.</p> <p>Human-caused sound events never exceed 60 dBA (CFR Audio Disturbance).</p> <p><u>Nighttime Hours</u>: The hourly change in exposure is less than or equal to 3 dBA for 90% of the night and does not exceed 6 dBA for 95%.</p> <p>Human-caused sound levels never exceed 45 dBA (related to sleep threshold).</p>	<p>The daytime standard ensures that human-caused sound levels are not likely to mask natural sounds.</p> <p>An increase of 3 dBA corresponds to a 50% reduction of listening area and a 30% reduction of alerting distance. You can only exceed this condition for 25% of the day.</p> <p>An increase of 6 dBA corresponds to a 75% reduction of listening area and a 50% reduction of alerting distance. You can only exceed this condition for 10% of the day.</p> <p>The nighttime standard also ensures that a reduction in listening area of 50% and a reduction in alerting distance of 30% occurs no more than 90 % of the night. Activity for many species increases during these hours (dawn/dusk).</p> <p>An increase of 6 dBA corresponds to a 75% reduction of listening area and a 50% reduction of alerting distance. You can only exceed this condition for 5% of the night.</p> <p>The standard also ensures management identification and review of areas where human-caused sound exceeds 60 dBA (CFR Audio Disturbance) and 45 dBA (WHO Sleep Interruption standard).</p>
<b>Noise free interval</b>	<p><u>Daytime Hours</u>: The daily maximum noise free interval is at least 60 minutes (over 12-hour-period).</p> <p>The daily median noise free interval is at least 7 minutes (over 12-hour- period).</p> <p><u>Nighttime Hours</u>: The nightly maximum noise free interval is at least 73 minutes (over 12-hour-period).</p>	<p>This standard ensures that enough time occurs between noise events to ensure that visitors to park wilderness have the opportunity to experience solitude free from human-caused noise intrusion. The standard also provides wildlife needed time between noise events.</p>



Table 6: Indicators and Standards for the Wilderness Zone <sup>1</sup>		
Indicator	Standard <sup>2</sup>	Rationale
	The nightly median noise free interval is at least 11 minutes (over 12-hour- period).	
<b>Time above speech interference thresholds</b>	<p><u>General Conversation</u> Human-caused sound levels are less than or equal to 60 dBA for more than 1% of the day.</p> <p><u>Rock Climbing/Canyoneering</u> Human-caused sound levels are less than or equal to 44 dBA for more than 5% of the day in commonly used rock climbing and canyoneering areas.</p>	<p>The General Conversation standard ensures that human-caused sound are not capable of interfering with speech among visitors involving normal voice levels over a distance of 2-meter for more than 7-minutes-per-day. This standard will include interpretive programs in the backcountry which involve small groups (maximum 12 people).</p> <p>The Rock Climbing/Canyoneering standard ensures that human-caused sound levels are not capable of interfering with communication among rock climbers and canyoneers involving raised voice levels over a distance of 25-meters for more than 36-minutes-per-day.</p>
<b>Time above sleep interruption thresholds</b>	Noise events during nighttime do not exceed 35 dBA.	Based on the FICAN study (1997), the likelihood of waking due to a noise event of 35 dBA is very close to zero. At levels of 35 dBA and below there is little chance that backcountry visitors will be awakened by noise. In addition, a study by Haralabidis et.al (2008) indicated that noise events above 35dBA (Lmax) contributed to an increase in blood pressure in subjects even when they did not awaken. In the absence of data concerning probability of disturbing wildlife due to sleep interruption, the use of human thresholds provides a reasonable proxy for wildlife impacts.
<sup>1</sup> In order to ensure that desired acoustic conditions and management objectives are being met, acoustic conditions must be at or below standards in 97% of the Wilderness Zone. <sup>2</sup> <u>Daytime Hours</u> (1 hour after sunrise to 1 hour prior to sunset) <u>Nighttime Hours</u> (1hour prior to sunset to 1 hour after sunrise)		

## Monitoring and Adaptive Management

The implementation of this plan requires an assertive and focused monitoring effort. Short-term monitoring is necessary to characterize the natural soundscape and to describe the sources of noise that affect it. Long-term monitoring is designed to meet a number of needs including identifying trends in soundscape conditions. For proper soundscape management, monitoring is necessary for the following reasons:

- Describe the total ambient soundscape, separating the natural from the human-caused elements (baseline monitoring).
- Determine whether a particular use is in compliance with soundscape protection standards or limits provided in the plan (implementation monitoring).
- Determine the effectiveness of specific management actions that could affect the soundscape (effectiveness monitoring).
- Determine whether soundscape management objectives are being met and that the park is in compliance with its plan (implementation monitoring).

- Verify that the soundscape monitoring objectives are appropriate to meet park purposes (effectiveness monitoring).
- Validate the specific soundscape standards/limits that have been set (validation monitoring).
- Validate the monitoring methods and protocols; ensure that they measure what they are intended to measure (validation monitoring).
- Validate links between impact sources and effects on soundscape resources or values (validation monitoring).
- Provide periodic feedback to management about the need for change.

Monitoring is also necessary to implement an adaptive management approach to modify the SMP, as necessary. Decisions to modify soundscape indicators, standards, and other elements of the plan should be based on the results of data collection and analysis conducted as part of the long-term monitoring plan.

The fundamental purpose for monitoring is the identification of resource trends. The overall objectives for monitoring and adaptive management are to provide information to managers about the status and condition of park resources and values relative to law and policy, to assess the long-term effects of management actions on park resources and values, and to adjust the plan as needed as additional data are collected and understanding increases. Monitoring will be conducted throughout the park during various times of the year with the goal of capturing the variability of acoustic conditions throughout the park to the greatest extent possible based on effective use of funds and personnel. The guiding principle for monitoring is to collect purposeful data – even if the amount is limited – rather than collecting a great deal of data that cannot be used to arrive at valid conclusions. In order to meet the goal of collecting useful data, the park will develop a five year monitoring plan that addresses the following items:

- The management zones to be sampled.
- Specific locations for monitoring, and the planned intensity – frequency of monitoring.
- A schedule (times) for data collection and submittal.
- The staff responsible for monitoring and reporting.
- The plan will be updated every five years.

Sampling schedules may vary from year to year, focusing on different areas within the park. It is expected that initial monitoring will be intensive, both in geographic and temporal extent, so that correlations can be made and results can be extrapolated. It is also expected that monitoring over time will become less intensive ultimately resulting in a low intensity, long-term monitoring approach. Initially, routine monitoring should occur for 25 days at each site during each season of the year. In addition, monitoring should occur during special events or activities that may generate soundscape impacts. During monitoring, the following data will be collected:

- *Sound Pressure Levels (SPL)* – SPL data are collected in the form of A-weighted decibel readings (dBA) every second.
- *1/3-Octave Bands* – 1/3-octave band data are collected every second. (The 1/3-octave band data ranges from 12.5 Hz – 20,000 Hz when the Larson Davis system is used).
- *Meteorological Data* – Wind speed and direction are collected every second.
- *Audio Recordings* – Continuous audio is also recorded (mp3).
- *On-site Listening* – Generally last for one hour. Staff record the beginning and ending times of all audible sound sources using custom-designed Personal Digital Assistant (PDA) software. These data provided the basis for the calculated average noise free interval,

percent time each sound source was audible, and maximum, minimum, and mean length (in seconds) of sound source events.

Feedback for management is implicit in monitoring and adaptive management programs. In order for feedback to occur, data must be collected effectively in accordance with a plan. Then, evaluations must be put in meaningful terms for management. The requirement of a formal report is essential to meet this need. A biennial monitoring report will be prepared every other year to provide useful information to park managers. The report will provide information on the following areas:

- Summarize data collected during the previous two year period.
- Calculate the extent to which standards are being met.
- Identify areas where standards are being violated, primary sources of violations, and possible management actions to resolve the violations.
- Assess the effectiveness of any management actions previously implemented to address soundscape issues, adjust actions as necessary.
- Extrapolate the measured conditions to other areas, when possible and appropriate.
- Make recommendations for changes in monitoring locations, protocols, techniques or thresholds that should be considered.
- As data accumulate, report trends in soundscape conditions over time.

## **Existing Conditions in the Park**

### **Description of the Park**

Located in Washington, Iron, and Kane Counties in southwestern Utah, Zion National Park encompasses some of the most scenic canyon country in the United States. The park is characterized by high plateaus, a maze of narrow, deep, sandstone canyons, and striking rock towers and mesas. Zion Canyon is the largest and most visited canyon in the park. The North Fork of the Virgin River has carved a spectacular gorge here, with canyon walls in most places rising 2,000 to 3,000 feet above the canyon floor. The southern part of the park is a lower desert area, with colorful mesas bordered by rocky canyons and washes. The northern sections of the park are higher plateaus covered by forests.

Zion is one of the earliest additions to the national park system. On July 31, 1909, President Taft issued a proclamation setting aside 15,200 acres as the Mukuntuweap National Monument. In 1918 another presidential proclamation enlarged the monument to 76,800 acres and changed its name to Zion National Monument. Congress established the area as a national park in 1919. A second Zion National Monument (now called the Kolob Canyons) was established by presidential proclamation in 1937. Congress added the Kolob Canyons to Zion National Park in 1956.

The park currently encompasses 148,733 acres. Within the park boundary there are 3,490 acres of private inholdings, mostly in the Kolob Terrace area, (The inholding acreage and all of the other park acreage figures included in this document are based on geographic information system (GIS) calculations. These figures may not correspond with legal description acreages.) Zion is part of the Southwest's "Grand Circle" of national parks, monuments, historical areas, and recreational areas. Visitors reach the park via Interstate 15, Utah State Route 9, and Highway 89. Zion is 160 miles northeast of Las Vegas and 320 miles southwest of Salt Lake City. The town of Springdale is adjacent to the park's south entrance. Other nearby towns include: Kanab (41 miles from the Zion Canyon Visitor Center), St. George (43 miles), and Cedar City (60 miles).

## Soundscapes

Over the past decade, several soundscape monitoring efforts have taken place at Zion. In 2000 and 2001, Wyle Laboratories established 12 monitoring sites within the park, and produced a report that summarized their findings (Hobbs & Downing 2003). During the summer of 2008, the Natural Sounds Program (NSP) established two additional monitoring sites. After working with the NSP, ZNP acquired several monitoring systems, and monitoring efforts are continuing at the sites established in 2008, and at some of the Wyle sites. Sandhill Company collected concurrent measurements at several of the Wyle sites in 2001, but these data are not summarized in this report.

Several types of data were collected in 2000-2001, as described in the Wyle report (Hobbs & Downing 2003). At 11 of the 12 Wyle sites, data were collected for 33,  $\frac{1}{3}$ -octave bands. The analysis of this type of data has evolved rapidly over the past decade, and this analysis includes updated results and graphical presentations from the Wyle sites where  $\frac{1}{3}$ -octave data were available. The Lava Point site was abandoned because of early fall snow, so adequate data were not collected. Data from this site was not included in this document.

Starting in 2008, data were collected in accordance with the NPS Natural Sounds Program guidelines for soundscape monitoring (NSP, 2008). ZNP staff received training on these protocols, and will be conducting additional analyses of data collected during the summer of 2008. The 2008 sites each ran for over 3-weeks in July and August, and preliminary results from these sites are included in this EA. These results provide a quantitative description of the acoustical environment at ZNP. For a more detailed description of the results of previous analyses see *Zion National Park Acoustical Monitoring Summary Report* (2010). Table 7 lists the sites monitored by Wyle in 2000-2001 and the park in 2008. Figure 7 illustrates the locations of these sites.

**Table 7: Acoustic Monitoring Sites**

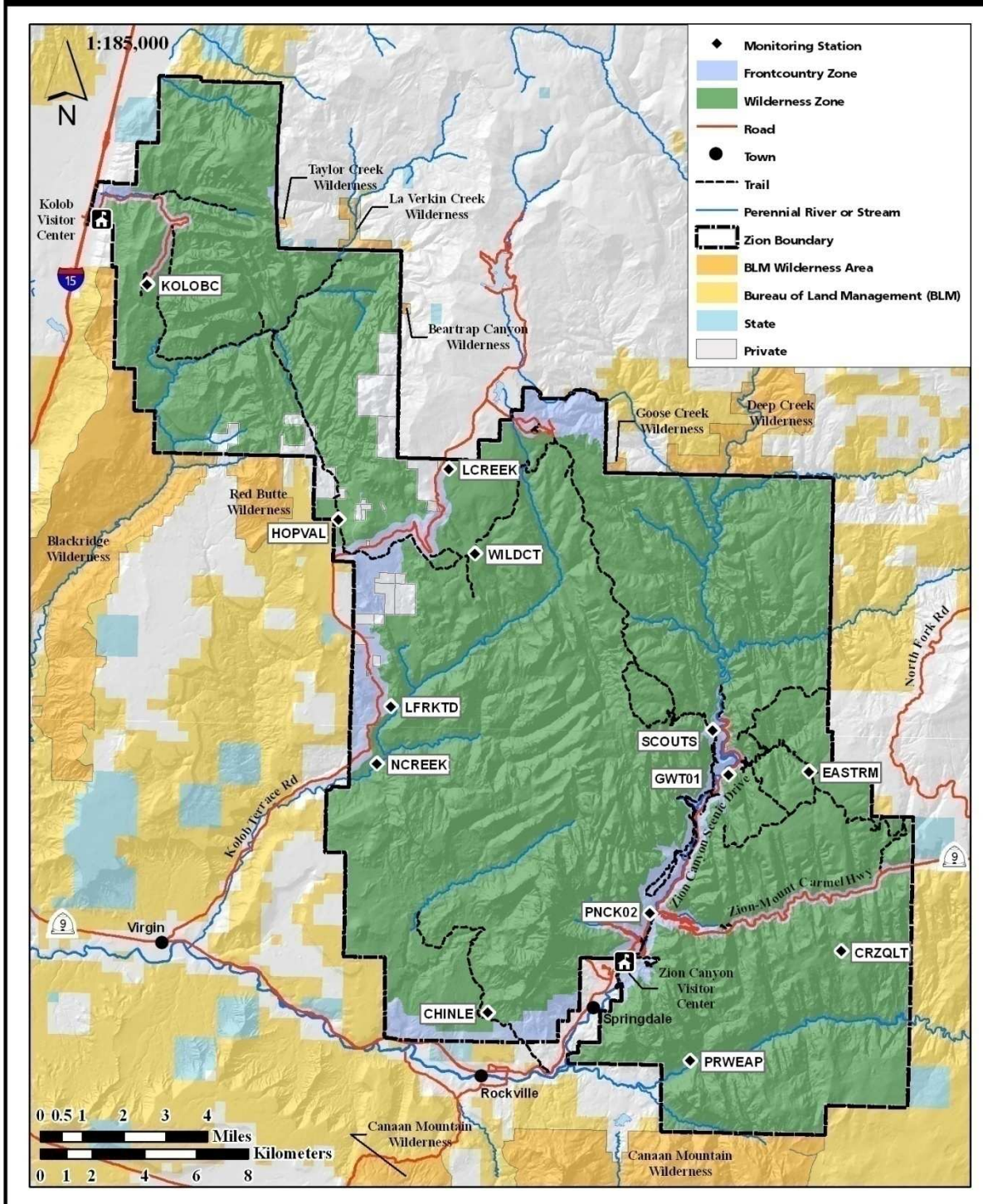
Site ID	Site Name	Days of data	Vegetation	Elevation (in meters)
CHINLE	Chinle Trail Mesa	58.6	Desert scrub	1281
CRZQLT	Crazy Quilt Mesa	46.6	Slick rock	1748
EASTRM	East Rim Mesa	3.7	Mountain brush	1949
HOPVAL	Hop Valley Trail	17.5	Desert scrub	1930
KOLOBC	Kolob Canyon	23.5	Pinyon/ juniper	1874
LCREEK	Upper Kolob Terrace	50.6	Pinyon/ juniper	2365
LFKRTD	Left Fork/ North Creek	21.1	Mountain brush	1563
NCREEK	Right Fork/ Kolob Terrace	19.2	Riparian	1273
PRWEAP	Parunuweap Canyon	9.0	Riparian	1227
SCOUTS	Scout's Lookout	19.4	Slick rock	1769
WILDCT	Wildcat Trail	20.9	Conifer forest	2127
GWT/01	Great White Throne (2008)	23.5	Near riparian area	1328
PNCK/02	Pine Creek (2008)	21.1	Riparian	1240

# Figure 7: Acoustic Monitoring Sites

National Park Service  
U.S. Department of the Interior



Zion National Park



It is important to understand existing conditions when characterizing the acoustic environment and assessing impacts to soundscape resources. The NPS calculates the existing ambient and natural ambient for soundscape studies. The existing ambient ( $L_{50}$ ) is the median sound level recorded at a site and includes sound energy from all natural and anthropogenic or human-caused sources. The natural ambient ( $L_{nat}$ ) is an estimate of what the median ambient level for a site would be if all anthropogenic sources were removed. Because conditions vary based on time of day, existing and natural ambient are calculated for both day and night.

The median existing ambient sound pressure level ( $L_{50}$ ) and the median natural ambient sound pressure levels ( $L_{nat}$ ) can be seen in Table 8 and Table 9. The  $L_{nat}$  values are based on 8-days of sound source identification (with the exception of EASTRM, where only 2-days were available for analysis). The median  $L_{50}$  values are calculated using all of the available data for the site.

<b>Table 8: Median Day and Night <math>L_{50}</math> and <math>L_{nat}</math> for Wyle Sites</b>					
<b>Site ID</b>	<b>Days of available data</b>	<b>Median Existing Ambient (<math>L_{50}</math>) in dBA</b>		<b>Median Natural Ambient (<math>L_{nat}</math>) in dBA</b>	
		<b>Day</b>	<b>Night</b>	<b>Day</b>	<b>Night</b>
CHINLE	58.6	24.1	20.2	21.9	19.3
CRZQLT	46.6	26.4	19.0	23.3	18.3
EASTRM	3.7	25.8	18.6	24.0	18.3
HOPVAL	17.5	28.5	20.2	25.8	19.4
KOLOBC	23.5	31.0	29.0	29.0	28.0
LCREEK	50.6	26.4	19.8	23.6	19.0
LFRKTD	21.1	27.0	26.1	24.5	25.1
NCREEK	19.2	37.0	38.0	37.0	38.0
PRWEAP	9.0	42.0	43.0	--	--
SCOUTS	19.4	26.9	24.8	24.3	24.0
WILDCT	20.9	28.1	27.9	25.1	26.5

<b>Table 9: Median Day and Night <math>L_{50}</math> and <math>L_{nat}</math> for 2008 Sites</b>					
<b>Site ID</b>	<b>Days of available data</b>	<b>Median Existing Ambient (<math>L_{50}</math>) in dBA</b>		<b>Median Natural Ambient (<math>L_{nat}</math>) in dBA</b>	
		<b>Day</b>	<b>Night</b>	<b>Day</b>	<b>Night</b>
GWT/01	23.5	38.8	39.8	37.4	39.6
PNCK/02	21.1	42.9	42.8	37.7	41.8

The data show that the daytime natural ambient levels in the Wilderness Zone range from approximately 22 dBA to 37 dBA with most of the sites below 30 dBA. Nighttime natural ambient levels range from 18 dBA to 38 dBA with many sites below 20 dBA. Existing ambient levels at sites located in the Wilderness Zone range from approximately 24 dBA to 42 dBA during daytime hours and from 18 dBA to 43dBA during nighttime hours.

At Frontcountry Zone sites, natural ambient levels are approximately 37 dBA during the day and 40 dBA to 42 dBA at night. The higher natural ambient levels at these sites are mainly due to proximity



to moving water in the Virgin River. Existing ambient levels at frontcountry sites ranged from 39 dBA to 43 dBA during the day and 40 dBA to 43 dBA during the night.

In determining the current conditions of an acoustic environment, it is important to examine how often sound pressure levels exceed certain values. Table 10 and Table 11 report the percent of time that measured levels were above four key values. These exceedence values were calculated from the existing sound pressure levels (SPL) during the full duration of data collection, and include intrinsic (natural sound) and extrinsic (human-caused) sound sources.

The first threshold, 35 dBA, is designed to address the health effects of sleep interruption. Recent studies suggest that sound events as low as 35 dBA can cause increases in blood pressure and heart rate while sleeping (Haralabidis et al. 2008). The second threshold addresses the World Health Organization's (WHO) recommendations that noise levels inside bedrooms remain below 45 dBA (Berglund et al. 1999). The third threshold, 52 dBA, is based on the EPA's speech interference threshold for speaking in a raised voice to an audience at 10-meters. This threshold addresses the effects of sound on interpretive presentations in parks. The final threshold, 60 dBA, provides a basis for estimating impacts on normal voice communications at 2-meters. Hikers and visitors viewing scenic vistas in the park would likely be conducting such conversations.

<b>Table 10: Percent Time Above Metrics for Wyle Wilderness Zone<sup>1</sup> Sites Monitored in 2000-2001</b>									
<b>Site ID</b>	<b>Days of available data</b>	<b>% Time above sound level: Day</b>				<b>% Time above sound level: Night</b>			
		<b>35 dBA</b>	<b>45 dBA</b>	<b>52 dBA</b>	<b>60 dBA</b>	<b>35 dBA</b>	<b>45 dBA</b>	<b>52 dBA</b>	<b>60 dBA</b>
CHINLE	58.6	13.92	1.18	0.15	0.01	4.09	0.33	0.03	0.00
CRZQLT	46.6	18.58	1.83	0.20	0.00	4.52	0.33	0.04	0.00
EASTRM	3.7	8.71	2.17	0.28	0.05	3.03	0.21	0.01	0.00
HOPVAL	17.5	22.82	3.79	0.64	0.03	6.60	1.99	0.64	0.01
KOLOBC	23.5	35.26	3.40	0.34	0.04	19.24	1.65	0.13	0.01
LCREEK	50.6	16.23	1.66	0.18	0.02	3.46	0.30	0.03	0.00
LFRKTD	21.1	14.68	2.04	0.37	0.02	17.39	2.79	0.18	0.01
NCREEK	19.2	99.69	1.71	0.32	0.02	100.00	0.79	0.11	0.00
PRWEAP	9.0	100.00	4.71	0.61	0.00	100.00	10.81	0.10	0.00
SCOUTS	19.4	11.99	1.57	0.38	0.02	5.62	0.65	0.14	0.01
WILDCT	20.9	22.70	2.95	0.47	0.07	34.89	1.28	0.14	0.00
<sup>1</sup> LFRKTD is not within the Wilderness Zone, but is directly adjacent to the zone.									

<b>Table 11: Percent Time Above Metrics for Frontcountry Zone Sites Monitored in Summer 2008</b>									
<b>Site ID</b>	<b>Days of available data</b>	<b>% Time above sound level: Day</b>				<b>% Time above sound level: Night</b>			
		<b>35 dBA</b>	<b>45 dBA</b>	<b>52 dBA</b>	<b>60 dBA</b>	<b>35 dBA</b>	<b>45 dBA</b>	<b>52 dBA</b>	<b>60 dBA</b>
GWT/01	23.5	99.53	13.07	3.58	0.02	100.00	3.12	0.83	0.00
PNCK/02	21.1	99.84	34.57	1.67	0.04	100.00	32.80	2.92	0.00

At most of the sites located in the Wilderness Zone, sound levels exceeded 35 dBA less than 10 percent of the night. During the times when levels exceed 35 dBA, visitors could experience increases in blood pressure and heart rate. Sound levels at wilderness sites generally exceeded 45 dBA, WHO guidelines for noise inside bedrooms, for less than 2 percent of the night. At most of the sites located in the Wilderness Zone, sound levels exceeded 52 dBA less than 1 percent of the

day and night. During the times when levels exceed 52 dBA, visitors could experience difficulty in hearing interpretive programs. Sound levels at wilderness sites rarely exceeded the 60 dBA threshold for speech interference.

At Frontcountry Zone sites, sound levels exceeded 35 dBA for almost 100 percent of the night. This result is due to nighttime natural ambient sound levels at the frontcountry sites that exceed the 35 dBA threshold. Sound levels at frontcountry sites generally exceeded 45 dBA, WHO guidelines for noise inside bedrooms, for 3 percent of the night at the Great White Throne site and 33 percent of the night at Pine Creek site. The higher percentages at the Pine Creek site are likely due to the nighttime natural ambient levels of 41.8 dBA due mainly to sound energy from the nearby Virgin River. In the frontcountry sites, sound levels exceeded 52 dBA from 1.7 percent to 3.6 percent of the day and 1 percent to 3 percent of the night. Sound levels at frontcountry sites rarely exceeded the 60 dBA threshold for speech interference.

### **Audibility**

Table 12 shows the percent of time that aircraft and other extrinsic sounds are audible for the Wyle sites. Sound source identification was not collected for the PRWEAP site, due to windy conditions. Table 13 displays the 2008 aircraft and total non-natural sound source results. At both of the 2008 sites, vehicle noise was the most pervasive non-natural sound source.

At most of the sites located in the Wilderness Zone, aircraft were the most common source of noise. The amount of time that aircraft were audible ranged from 20 percent to 42 percent. At Frontcountry Zone sites human-caused sounds were audible 44 percent to 65 percent of the time.

<b>Table 12: Mean Percent Time Audible – Wilderness Zone Sites – Wyle 2000-2001</b>			
<b>Site ID</b>	<b>Days analyzed</b>	<b>Mean % time audible</b>	
		<b>All Extrinsic</b>	<b>Aircraft Noise</b>
CHINLE	8	32.5	32.5
CRZQLT	8	30.9	30.9
EASTRM	2	40.5	33.1
HOPVAL	8	28.0	28.0
KOLOBC	8	25.0	20.5
LCREEK	8	33.2	33.2
LFRKTD	8	41.9	41.9
NCREEK	8	24.5	24.5
SCOUTS	8	54.6	29.4
WILDCT	8	34.3	31.0

<b>Table 13: Mean Percent Time Audible – Frontcountry Zone Sites – Summer 2008</b>			
<b>Site ID</b>	<b>Days analyzed</b>	<b>Mean % time audible</b>	
		<b>All Extrinsic</b>	<b>Aircraft</b>
GWT/01	8	43.9	15.0
PNCK/02	8	65.9	6.6

## **Visitor Use and Experience**

Visitation to ZNP has steadily increased over time. In 2009 over 2.7 million people visited the park. Over 264,600 of these people spent at least one night at Zion Lodge or in one of the park campgrounds. Most visitors come to the park in private vehicles. Visitors also come to the park as part of a tour on a passenger bus. Over 923,000 vehicles entered the park in 2009 (NPS Stat. 2009).

Zion offers a variety of activities for visitors that are consistent with the park's purposes and significance. The most common visitor activities include sightseeing, scenic drives, hiking, backpacking, canyoneering, rock climbing, and photography. Visitors can also add to their experience by taking advantage of interpretive programs, museum exhibits, and information at the visitor centers.

As in other national parks, visitors to Zion enjoy the sounds of nature: bird songs, the rustling of leaves, the sound of the river, or wind through the trees. These sounds can have a calming or relaxing effect. Or they can trigger memories of a pleasant past experience.

Zion has made several steps to increase opportunities for visitors to experience the sounds of nature in the Frontcountry. In 2000, the park implemented a mandatory free shuttle system to access Zion Canyon. Shuttles run from April through October. When visitors are in the canyon, even near the road, in between shuttle passes, they can hear the sound of the river, birds calling, and the wind in the trees. The park has also installed electric hookups in the Watchman Campground so that visitors don't have to use generators.

In the Wilderness Zone, the park has instigated group size limits and day use limits in certain areas to ensure that visitors have opportunities to experience solitude. Designated campsites are also located out of sight and sound of other campsites whenever possible. Over 39,000 people visited Zion's backcountry in 2009, with over 10,000 spending at least one night in the backcountry.

## **Park Operations**

Park operations refer to the maintenance of infrastructure by park staff to protect and preserve vital natural and cultural resources and provide for a quality visitor experience. Other park operations include activities performed by law enforcement, search and rescue, resource management, interpretation of park resources, fire management, administrative and concession activities.

Park staff must maintain, repair and sometimes build new facilities in order to provide a positive and safe visitor experience, while protecting park resources for present and future generations. Currently Zion has 3 campgrounds, 2 visitor centers, 1 museum, 21 public restrooms, 1 lodge with 124 hotel and cabin units, 120 miles of maintained trail, 92 administrative/public use buildings, 35 houses, 51 miles of paved road, 6 miles of graded roads, and 30 shuttle busses, with 21 trailers.

In order to maintain and repair this infrastructure in the Frontcountry, park staff use a variety of tools. Some tools needed to accomplish tasks are motorized or produce human-caused noise:

- road grader, snow plow, backhoe, dynamite, etc. for roads;
- gas-powered rock hammers, chainsaws, etc. for trails;
- gas-powered lawn mowers, leaf blowers, gas-powered weed whips, etc. for landscaping;
- gas-powered weed whips, chain saws for noxious weed control, etc.;
- fire management: chainsaws, helicopters, other aircraft, etc.; and
- aircraft for search and rescue, sirens for law enforcement, etc.

In the Wilderness Zone the use of mechanical and motorized tools must go through the minimum requirement procedures. The analysis determines whether the activity is necessary in wilderness and whether the methods and techniques (tools) chosen to accomplish the task are appropriate. The types of human-caused sound related to park operations in the wilderness could include: aircraft, chainsaws, gas-powered rock hammers, or gas-powered weed whips.

### **Wildlife, Threatened and Endangered Animal Species and Animal Species of Concern**

Many animals, insects and birds decipher sounds to find desirable habitat and mates, avoid predators and protect young, establish territories and to meet other basic survival needs. Scientific studies have shown that wildlife can be adversely affected by sounds and sound characteristics that intrude on their habitats. Although the severity of the impacts varies depending on the species, research has found that wildlife can suffer adverse physiological and behavioral changes from intrusive sounds and other human disturbance.

Zion is home to 6 species of amphibians, 28 species of reptiles, 79 mammal species, 289 bird species, and 7 fish species. Many species of birds and some mammal species, such as bats, are migratory. Consequently, the species and the size of populations vary from season to season.

Several threatened and endangered animals and animal species of concern either occur in or have the potential to occur within ZNP. They are described below.

The Mexican spotted owl (*Strix occidentalis lucida*) was listed as a threatened species in 1993. In 1995 the Mexican Spotted Owl Recovery Plan was completed and provided a basis for management actions undertaken by land management agencies to remove recognized threats and to recover the spotted owl. The Recovery Plan divided spotted owl habitat geographically into six recovery units in the United States. ZNP is within the Colorado Plateau Recovery Unit (USFWS, 1995). The park has 26 historical Mexican spotted owl territories, which are widely distributed. A spotted owl monitoring program for the park was initiated in 1995 and continues today.

All of ZNP was designated as critical habitat for spotted owl in August 2004 (USFWS, 2004). The identification of critical habitat is based on data available at the time of designation. The focus for critical habitat is on the physical and biological features essential to the conservation of the species, referred to the primary constituent elements, that are within areas occupied by the species at the time of listing, and that may require special management considerations and protection. The primary constituent elements necessary to ensure the conservation of Mexican spotted owl include: the presence of water; abundance of canyon walls with crevices, caves, and ledges; clumps or stringers of mixed conifer, pine-oak, pinyon-juniper, or riparian vegetation; and a high percentage of ground litter and woody debris.

A nonessential, experimental population (Section 10(j) of the ESA) of the federally endangered California condor (*Gymnogyps californianus*) was reintroduced into northern Arizona in 1996 (USFWS, 1996). The condor must be treated as a listed threatened species under the 10(j) designation on National Park lands. During the summer of 2009, up to 59 condors were sighted in the area north of the park and were known to venture regularly into the park during that time. Condors are now observed in the main canyon year-round. The condors appear to be expanding their range farther to the north and may be expected to visit ZNP more frequently in the future.

The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) has candidate species status and is considered a rare summer resident and migrant in the park (Wauer, 1997). Their primary breeding habitat is an overstory of cottonwood canopy that is present in the park although not in

abundance. Western yellow-billed cuckoos are not known to breed or nest in the park (Wauer, 1997). The park has conducted surveys for western yellow-billed cuckoo for the past 2 years. No birds have been located. For the purpose of this document we will assume that any actions resulting from the implementation of the SMP will have no effect on the cuckoo.

The federally endangered southwestern willow flycatcher (*Empidonax traillii extimus*) nests primarily in mid-to-low elevation riparian habitat along rivers, streams, or other wetlands where a dense growth of willows or other plants are present. There was one confirmed sighting of this neotropical migrant in the park in 1994 along the East Fork of the Virgin River. A 1998 survey of the park's riparian habitat that seemed capable of supporting flycatchers found no birds. One bird was located in the Birch Creek survey area in 1999 but apparently was a migrant. The park has conducted surveys for southwestern willow flycatcher for the past 2 years. No birds have been located. For the purpose of this document we will assume that any actions resulting from the implementation of the SMP will have no effect on the flycatcher.

A small population of federally threatened desert tortoises (*Gopherus agassizii*) occurs in one small area of the park. A study was completed in 2003 using line distance sampling techniques, which resulted in an average of 14 individuals, with a 95 percent confidence interval from 12 to 26 individuals (P. Stephen Corn, personal communication). The Upper Virgin River Recovery Plan unit for the tortoise does not encompass lands within the park, and there is no critical habitat designated within the park (UDWR, 2000). Actions outlined in this plan will likely have a beneficial effect on tortoise by protecting their ability to hear predators approaching.

The endangered Virgin River chub (*Gila seminuda*) and woundfin (*Plagopterus argentissimus*) are not known to occur in ZNP. They are both known to occur downstream from the park in the Virgin River below the town of LaVerkin.

The following are either under conservation agreements or are listed as a Utah sensitive species.

The peregrine falcon (*Falco peregrinus anatum*) was removed from the federal list of endangered and threatened species in 1999 due to its successful recovery. In ZNP peregrine falcons were a regular, but uncommon sight in Zion Canyon from the late 1920s through the late 1940s. The first report of nesting falcons was in about 1933. Peregrine falcons were added to the checklist of birds of ZION in 1935. Beginning in the early 1960s the NPS documented, although not regularly, peregrine observations until the mid-1980s. In the mid-1980s surveys and monitoring studies began and continue today. ZNP hosts a high concentration of breeding peregrines that nest on steep cliffs throughout the park. The park is known to have 18 historic falcon breeding territories.

The bald eagle (*Haliaeetus leucocephalus*) was removed from the endangered species list on July 9, 2007 due to its successful recovery. The bald eagle winters in the vicinity of the park, especially in the Sevier River Valley east of the park. Although they are commonly observed near the Blue Creek Reservoir to the north, only a few bald eagles are observed each year in the park during the winter and early spring months. Birds that occasionally enter the park perch along the North Fork of the Virgin River in the main canyon. Bald eagle use in the park is sporadic, uncommon, and unpredictable. Large congregations of the birds do not occur, and there are no known, regularly used, winter perch sites or known roost sites within the park.

A survey conducted in 1999 found three active northern goshawks (*Accipiter gentilis*) nests in the park (NPS, 1999). Two of the nests are not near any trails, routes, or visitor attractions. The third

site is near a designated trail that does not receive much use. These birds inhabit higher elevations in the park. They prefer coniferous forests, but will also inhabit mixed forests.

The Virgin spinedace (*Lepidomeda mollispinis mollispinis*) and flannelmouth sucker (*Catostomus latipinnis*) are both managed under Conservation Agreements in lieu of listing as a threatened or endangered species. Both fish have similar ranges in the park and are found in the North Fork and East Fork of the Virgin River and several short tributaries within Zion and Parunuweap Canyons. They are found downstream of the park in North Creek and LaVerkin Creek. Since 1994, the Utah Division of Wildlife Resources (UDWR) has been monitoring these fish at two park locations (UDWR, 2003). Monitoring will continue annually.

## Wilderness

The Omnibus Public Land Management Act of 2009 (Public Law 111-11) designated 124,462 acres, 84 percent of the park, within Zion National Park as wilderness. Another 9,047 acres, 6 percent of the park, are recommended for wilderness designation. This means that 90 percent of the park is managed as wilderness, as per NPS policy.

The Wilderness Act of 1964 states that: *A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain....with the imprint of man's work substantially unnoticeable...*

*Management Policies 2006 states that: ...in evaluating environmental impacts, the NPS will take into account (1) wilderness characteristics and values, including the primeval character and influence of wilderness; (2) the preservation of natural conditions (including the lack of man-made noise); and (3) assurances that there will be outstanding opportunities for solitude, that the public will be provided with a primitive and unconfined type of recreational experience, and that wilderness will be preserved and used in an unimpaired condition.*

The GMP completed in 2001 stated the following desired condition: *All of the lands within recommended wilderness areas retain their wilderness characteristics and values. Visitors continue to find opportunities for solitude and primitive, unconfined recreation. Signs of people remain substantially unnoticeable. The area continues to be affected primarily by the forces of nature.*

The opportunities for park visitors to experience the sounds of nature are an important component the wilderness experience.

## LIST OF PREPARERS

Name	Title	NPS Unit
Jock Whitworth	Superintendent	Zion National Park
Kristin Legg	Chief of Resource Management & Research	Zion National Park
Cheryl Decker	Vegetation Program Manager	Zion National Park
Claire Crow	Wildlife Program Manager	Zion National Park
David Sharrow	Hydrologist/Physical Scientist	Zion National Park
Sarah Horton	Cultural Resource Program Manager	Zion National Park
Kezia Nielsen	Environmental Protection Specialist	Zion National Park
Matt Betenson	GIS Coordinator	Zion National Park
Frank Turina	Outdoor Recreation Planner	Natural Sounds Program
Bob Rossman	NPS (Retired)	Natural Sounds Program
Cheryl Eckhardt	Environmental Compliance Specialist	NPS-Intermountain Regional Office

## REFERENCES

- Barber, J.R., Crooks, K.R., and Fristrup, K.M., 2010. "The costs of chronic noise exposure for terrestrial organisms." *Trends in Ecology and Evolution*, 25 (3) 180-189.
- Bayne, E.M. et al. 2008. Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. *Conservation Biology* 22, 1186–1193
- Berglund, B., Lindvall, T., Schwela, D.H. (Eds.). 1999. *Guidelines for Community Noise*. World Health Organization, Geneva.
- Doherty, K.E. et al. 2008. Greater sage-grouse winter habitat selection and energy development. *Journal of Wildlife Management*. 72, 187–195
- Environmental Protection Agency (EPA). 1974. *Information on Levels of Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety*.
- Federal Aviation Administration. 2007. *FAA Long-range Aerospace Forecasts Fiscal Years 2020, 2025 and 2030*.
- Federal Interagency Committee on Aviation Noise (FICAN). 1997. *Effects of Aviation Noise on Awakenings from Sleep*.
- Francis, C.D. et al. 2009. Noise pollution changes avian communities and species interactions. *Curr. Biol.* 19, 1415–1419
- Haas, G.E. and Wakefield, T., 1998. "National Parks and the American Public." *National Parks and Conservation Association*, Washington, D.C
- Haralabidis Alexandros S., et. al. 2008. "Acute effects of night-time noise exposure on blood pressure in populations living near airports" *European Heart Journal Advance Access* published online on February 12, 2008  
<http://eurheartj.oxfordjournals.org/cgi/content/full/ehn013v1?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=1&andorexacttitle=and&titleabstract=airport&andorexacttitleabs=and&andorexactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&resourcetype=HWCIT>
- Hobbs, C., Downing, M., Wyle Laboratories. 2003. Wyle Report-WR 03-08: The Soundscape in Zion National Park. Wyle Acoustics Group, Arlington, VA.
- National Park Service (NPS). 1995. Report to Congress, Report on Effects of Aircraft Overflights on the National Park System. United States Department of Interior, Washington, DC.
- National Park Service (NPS). 2001. Zion National Park. Peregrine falcon management and monitoring information.
- National Park Service (NPS). 2006. Management Policies. United States Department of Interior, Washington, DC. View source at: <http://www.nps.gov/policy/mp/Index2006.htm>

- Palmer, Angela G., Nordmeyer, Dana L., Roby, Daniel D. 2003. Effects of jet aircraft Overflights on parental care of peregrine falcons. *Wildlife Society Bulletin*. 31 (2). 499-509.
- Pilcher, E., Newman, P. and Manning, R., 2009. "Understanding and Managing Experiential Aspects of Soundscapes at Muir Woods National Monument" *Journal of Environmental Management*, 43(3)
- Sawyer, H. et al. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. *Journal of Wildlife Management*. 70, 396–403
- Stockwell, Craig A. and Gary C. Bateman. 1991. Conflicts in National Parks: A Case Study of Helicopters and Bighorn Sheep time Budgets at the Grand Canyon. *Biological Conservation* Vol. 56, pp.317-328.
- United States Department of Commerce. Economics and Statistics Administration. 2000. U.S. Census Bureau 2000.
- United States Fish and Wildlife Service (USFWS). 1995. Recovery Plan for the Mexican Spotted Owl: Vol. 1. Albuquerque, New Mexico.
- United States Fish and Wildlife Service (USFWS). 1996. Endangered and Threatened Wildlife and Plants; Establishment of a Nonessential Experimental Population of California Condors in Northern Arizona; Final Rule; 50 CFR Part 17, October 16, 1996.
- United States Fish and Wildlife Service (USFWS). 2004. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for Mexican Spotted Owl; Final Rule; 50 CFR Part 17, August 31, 2004.
- Utah Division of Wildlife Resources (UDWR). 2000. Desert Tortoise (*Gopherus agassizii*) Distribution Survey, Zion National Park. Publication Number 00-36.
- Utah Division of Wildlife Resources (UDWR). 2003. Baseline Virgin Spinedace (*Lepidomeda mollispinis mollispinis*) Population Demographics in an Area Proposed for Floodplain Restoration and a Reference Reach, North Fork of the Virgin River, Zion National Park, Fall 2002.
- Wauer, Roland. 1997. Birds of Zion National Park and Vicinity. Utah State University. Logan, Utah.



## GLOSSARY

<b>Acoustic Zone</b>	Areas with similar vegetation, terrain, animals, and weather likely have similar acoustic characteristics, including sound sources and sound attenuation characteristics. These areas are referred to as “acoustic zones” and may be helpful in describing acoustic conditions in areas with similar characteristics.
<b>Acoustic Environment</b>	The composite of all sounds, regardless of audibility, at a particular location.
<b>Acoustic Resources</b>	Sound sources (wildlife, waterfalls, wind, precipitation, historic and cultural sounds), factors that modify sound transmission (vegetation, topography, and atmospheric conditions), and the soundscape perceived by park visitors.
<b>Ambient Sound Conditions</b>	Many different soundscapes occur in national parks. In some areas, natural sounds predominate, while in others, both natural and non-natural sounds occur. In order to understand and manage soundscapes, ambient conditions for different soundscapes need to be acoustically described. Definitions of common ambient sound conditions are provided below.
<b>Ambient Sound, Existing</b>	All sounds in a given area (includes all natural and non-natural sounds). The Volpe Center has used the term “Existing” to describe existing ambient sound conditions.
<b>Ambient Sound, Less Source of Interest</b>	All sounds in a given area excluding a specific sound of interest. For example, when assessing the potential impacts of air tour aircraft, the “ambient sound level less source of interest” would be all sources of sound except air tour aircraft.
<b>Ambient Sound, Natural</b>	All natural sounds associated with a given environment, including all sounds of nature and excluding all non-natural sounds. The natural ambient sound of a given environment is comprised of all natural sounds that occur in the absence of mechanical, electrical, and other non-natural sounds. Natural ambient sound is considered synonymous with the term “natural quiet,” although “natural ambient sound” is more appropriate because nature is not always quiet.
<b>Ambient Sound, Non-natural</b>	The ambient sound attributable to human activities. The conditions associated with these sounds are usually composed of many human-caused sounds, near and far, which may be heard individually or as a composite. In a national park setting these sounds may be associated with activities that are essential to the park's purpose, they may be a by-product of park management activities, or they may come from outside the park. These sound conditions need to be defined, measured and evaluated in park planning processes to determine whether or not they are consistent with soundscape management objectives.
<b>Amplitude</b>	The instantaneous magnitude of an oscillating quantity such as sound pressure. The peak amplitude is the maximum value.
<b>Appropriate Sounds</b>	Natural sounds are appropriate in national parks. Other appropriate sounds, not natural in origin, are those types of sounds which are generated by activities directly related to the purposes of a park, including resource protection, maintenance, and visitor services. Appropriate sounds may also be associated with cultural, religious or historical celebrations or interpretive demonstrations that are intended to convey park purposes or use park resources in accordance with its establishment legislation. Natural sounds are not only appropriate, but are considered part of the park's resource base to be protected and enjoyed by the visiting public.

<b>Appropriate Sound Conditions</b>	The appropriate sound conditions in a given area of a park is a determination by the park superintendent or authorized decision-maker about the level and nature of sound that is consistent with or mandated by Organic Act principles, establishment legislation, or other laws pertinent to the specific purposes and values associated with the park. This determination may take the form of management zone objectives for soundscape, as well as measurable indicators and standards for sound.
<b>Audibility</b>	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.
<b>Change in Exposure</b>	Difference between the average sound level and the natural ambient condition. This metric reports the difference between the 12-hour energy-averaged sound level ( $L_{Aeq}$ ) and the ambient ( $L_{50}$ ). This metric does not provide information on event duration or timing, nor does it mean that human caused sounds levels cannot be heard at or below the ambient. It simply means that the sound levels produced by the human sources are above the natural ambient sound level.
<b>Hertz</b>	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.
<b>Impact</b>	For environmental analysis, an impact is defined as a change in a receptor that is caused by a stimulus, or an action. In accordance with the CEQ regulations (40 CFR Parts 1500-1508), direct and indirect impacts (environmental consequences) are to be described in an environmental document by assessing their type, magnitude, intensity and duration. The significance of an impact is to be determined specifically in view of criteria provided in 40 CFR 1508.27, based on the outcome of these assessments. An assessment will take account of the short or long term nature of the impact, the extent to which it is either beneficial or adverse, whether it is irreversible or irretrievable, and, finally, its geographic and societal extent. Lastly, a resource impact is put in the context of all other past, present or reasonably foreseeable actions which affect the same resource, and its contribution to the total cumulative effect is to be disclosed. Under CEQ regulations, the term "impact" is synonymous with "effect" (40 CFR 1508.8).
<b>dBA</b>	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.
<b>Decibel (dB)</b>	A logarithmic measure of acoustic or electrical signals. The formula for computing decibels is: $10(\log_{10}(\text{sound level}/\text{reference sound level}))$ . 0 dBA represents the lowest sound level that can be perceived by a human with healthy hearing. Conversational speech is about 65 dBA.
<b>Extrinsic Sound</b>	Any sound not forming an essential part of the park unit, or a sound originating from outside the park boundary.
<b>Frequency</b>	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.
<b>Human-Caused Sound</b>	Any sound that is attributable to a human source.

<b>Intrinsic Sound</b>	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.
<b><math>L_{eq}</math> or Energy Equivalent Sound Level</b>	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.
<b>Masking</b>	The process by which the threshold of audibility for a sound is raised by the presence of another sound.
<b>Maximum Sound Level (<math>L_{max}</math>)</b>	$L_{max}$ is the loudest sound level in dBA generated in an area. Change in exposure is calculated from sound pressure data collected at the park.
<b>Natural Soundscape</b>	The natural sound environment consists of sounds associated with wind, water flow, rain, surf, wildlife, thermal activity, lava flows, or other sounds not generated by non-natural means.
<b>Noise</b>	Traditionally, noise has been defined as unwanted, undesired, or unpleasant sound. This makes noise a subjective term. Sounds that may be unwanted and undesired by some may be desirable to others. Noise is sound, as defined in this document: a pressure variation, etc. In order to keep terms used in soundscape management as objective as possible, it is more suitable to label all sounds as either appropriate sounds or inappropriate sounds, rather than as “sound” vs “noise.” The appropriateness of any sound in a given area of a park will depend on a variety of factors, including the management objectives of that area.
<b>Noise Free Interval</b>	The period of time between noise events (not silence).
<b>Off-site Listening</b>	The systematic identification of sound sources using digital recordings previously collected in the field.
<b>On-site Listening</b>	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.
<b>Sound</b>	Sound is a wave motion in air, water, or other media. It is the rapid oscillatory compressional changes in a medium that propagate to distant points. It is characterized by changes in density, pressure, motion, and temperature as well as other physical properties. Not all rapid changes in the medium are sound (wind distortion on a microphone diaphragm). Basic analytical parameters of sound include frequency, amplitude, and duration.
<b>Soundscape</b>	Soundscape refers to the total acoustic environment associated with a given area. In a national park setting, the soundscape can be composed primarily of natural sounds, or it can be composed of both natural and human-caused sounds.
<b>Soundscape Management Objective</b>	The appropriate acoustic conditions for a given area of a park as mandated by Organic Act principles, establishment legislation, or other laws pertinent to the specific purposes and values associated with the park. This determination takes the form of management zone objectives for soundscape, as well as measurable indicators and standards for sound.

<b>Sound Conditions</b>	<p>A number of descriptors may be used when describing ambient sound conditions. These include:</p> <ul style="list-style-type: none"> <li>• Source of sound</li> <li>• Audibility and percent time audible</li> <li>• Number of sound events/time</li> <li>• Sound level of events</li> <li>• Frequency content of events</li> <li>• Duration of events</li> <li>• Median and log mean sound levels</li> <li>• Minimum and maximum sound levels</li> <li>• Calculated <math>L_{eq}</math>, <math>L_{50}</math>, <math>L_{90}</math>, <math>L_x</math>, etc., for different time periods (hour, day, month, or season).</li> </ul> <p>Acoustic data from rural or park-like settings are rarely normally distributed (mostly quiet with a few loud events). Therefore, except in certain situations, the most appropriate measure of central tendency is the median rather than the arithmetic mean. If data are normally distributed, then the mean and median will be very close.</p> <p>In some national parks, sound levels can be very low, often lower than some acoustic systems can measure. In such cases, electrical sounds associated with the measurement device can be higher than ambient. Investigations should always report the lowest levels their instruments can measure, and report, when appropriate, that actual sound levels may be lower than the instruments are capable of measuring.</p>
<b>Sound Impacts</b>	<p>With reference to the definition of sound, sound impacts are effects on a receptor caused by the physical attributes of sound emissions. In the context of national parks, human-generated sound represents an impact on the natural soundscape because it causes physical changes in the soundscape that can be detected and measured. The fact that an impact can be measured does not equate immediately to whether the impact is adverse, inconsequential, or beneficial, or whether there are adverse secondary impacts on wildlife, cultural values, or visitors. Based on statistically valid characterizations of the natural soundscape and the total ambient soundscape, levels of impact and impact significance are policy determinations.</p>
<b>Sound Level</b>	<p>Sound level is usually conveyed by expressing the <i>weighted</i> sound pressure level obtained by frequency weighting, generally A- or C-weighted. The weighting used must be clearly stated: For <math>L_{Aeq}</math>, "A" denotes that A-weighting was used, and "eq" indicates that an equivalent level has been calculated. Hence, <math>L_{Aeq}</math> is the A-weighted, energy-equivalent sound level. The most commonly used scale, A-weighting, adjusts the sound levels across the frequency spectrum to those that are audible to humans.</p>
<b>Sound Pressure, Sound Pressure Level</b>	<p>Sound pressure is the instantaneous difference between the actual pressure produced by a sound wave and the average barometric pressure at a given point in space. Sound pressure level is the logarithmic form of sound pressure</p>
<b>Time Audible</b>	<p>The amount of time that a sound source is audible to an animal with normal hearing.</p>

## ACRONYMS

Acronym	Full Name
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
dBA	Decibel – A-weighted
DO	Director’s Order
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FICAN	Federal Interagency Committee on Aviation Noise
GMP	General Management Plan
Hz	Hertz
Leq	Equivalent Sound Level
Lmax	Maximum Sound Level
NEPA	National Environmental Policy Act
NFI	Noise Free Interval
NHPA	National Historic Preservation Act
NPS	National Park Service
NSP	Natural Sounds Program
OHV	Off-Highway Vehicle
PDA	Personal Digital Assistant
SHPO	State Historic Preservation Office
SMP	Soundscape Management Plan
SPL	Sound Pressure Level
TA	Time Audible
UDWR	Utah Division of Wildlife Resources
USC	United States Code
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
WHO	World Health Organization
ZNP	Zion National Park



## **APPENDIX 1: LEGAL AUTHORITIES**

The management of the national park system is guided by the Constitution, public laws, treaties, proclamations, Executive Orders, regulations, and directives of the Secretary of the Interior and the Assistant Secretary for Fish, Wildlife and Parks. The following authorities are invoked as a basis for soundscape management, in addition to those listed in the park General Management Plan (GMP).

### **National Park Service Organic Act (16 USC 1, 2-4)**

This act establishes and authorizes the National Park Service (NPS) "to conserve the scenery and the national and historic objects and the wildlife 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."

### **Wilderness Act of 1964 (PL 88-577, 78 Stat.890, USC §§1131-1136)**

This Act describes those lands designated or eligible to be included in the National Wilderness Preservation System (NWPS). The NWPS was to contain those lands, already owned by the American people, that were "untrammeled by man." They were to be managed "for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness..." No roads or structures were to be built. Vehicles and other mechanical equipment were not to be used. The minimum size was set at 5,000 acres, with certain exceptions. The Wilderness Act put 9.1 million acres of national forest land into the new system. A process was created for congressional designation of future acreage in the national forests, parks, and wildlife refuges. In 1976, the Federal Land Policy and Management Act set forth a process for adding Bureau of Land Management areas to the NWPS. These four sets of public lands total 623 million acres, about 26 percent of our country.

### **National Environmental Policy Act (NEPA) of 1969, as amended**

This Act is landmark environmental legislation establishing as a goal for federal decision-making a balance between use and preservation of natural and cultural resources. NEPA requires all federal agencies to: (1) Prepare in-depth studies of the impacts of and alternatives to propose "major federal actions"; (2) use the information contained in such studies in deciding whether to proceed with the actions; and (3) diligently attempt to involve the interested and affected public before any decision affecting the environment is made.

### **General Authorities Act (1970, 16 USC 1a-1 through 1a-8)**

The purpose of this act is to include all areas administered by the NPS in one National Park System and to clarify the authorities applicable to the system. The act states areas of the National Park System, "though distinct in character, are united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage; that, individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all people of the United States..."

### **Airport & Airway Development Act of 1970 (PL 91-258, 84 Stat.226, 49 USC §2208)**

Requires airport development projects to provide for the protection and enhancement of the natural resources and environmental quality and limits the secretary of transportation in circumventing this purpose. No airports can be authorized with adverse environmental impacts unless it is determined in writing that no feasible and prudent alternatives exist and steps have been taken to minimize adverse effects. Relationship is identical to §4(f) of Department of Transportation Act. This Act also placed the Federal Aviation Administration (FAA) in charge of a new airport aid program funded by a special aviation trust fund.

### **Noise Control Act of 1972, as amended (PL 92-574, 42 USC §4901 et seq.)**

This Act establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. To accomplish this, the Act establishes a means for the coordination of Federal research and activities in noise control, authorizes the establishment of Federal noise emissions standards for products distributed in commerce, and provides information to the public respecting the noise

emission and noise reduction characteristics of such products (42 USC 4901). The Act authorizes and directs that Federal agencies, to the fullest extent consistent with their authority under Federal laws administered by them, carry out the programs within their control in such a manner as to further the policy declared in 42 USC 4901. Each department, agency, or instrumentality of the executive, legislative and judicial branches of the Federal Government having jurisdiction over any property or facility or engaged in any activity resulting, or which may result in, the emission of noise shall comply with Federal, State, interstate, and local requirements respecting control and abatement of environmental noise.

### **Grand Canyon National Park Enlargement Act (1975, PL 93-620 §8)**

Section 8 recognized “natural quiet as a value or resource in its own right to be protected from significant adverse effect.” In addition, it specifically addressed the potential for helicopter operations to cause a significant adverse effect on natural quiet and experience of the park.

### **The Redwood Act (March 27, 1978, PL 95-250, 92 Stat. 163, 16 USC 1a-1)**

This Act affirms the basic tenets of the Organic Act and provides additional guidance on national park system management: “the authorization of activities shall be construed and the protection management and administration of these areas shall be conducted in light of the high public 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...”

The restatement of the principles of park management is intended to serve as the basis for any judicial resolution of competing private and public values and interests in the national park system (Senate Report No. 95-528 on S. 1976 pg.7). The establishment legislation of each park area provides the authority and direction for management of each park area within the national park system. Purposes stated in the parks establishing legislation or proclamation as the resources and values of a park whose conservation is essential to the purposes for which the area was included in the national park system.

### **National Parks Air Tour Management Act of 2000 (PL 106-181, Title VIII)**

This act prohibits a commercial air tour operator from conducting commercial air tour operations over a national park or tribal lands, except in accordance with the act, conditions prescribed for that operator by the FAA Administrator and any commercial air tour management plan for the park or tribal lands. The act sets forth specific requirements with respect to: 1) granting authority to commercial air tour operators to conduct air tour operations over national parks or abutting tribal lands with specified exemptions; and 2) establishment of commercial air tour management plans (ATMPs). The Act requires the FAA, in cooperation with the NPS, to develop an ATMP for each unit of the National Park System to provide acceptable and effective measures to mitigate or prevent the significant adverse impacts, if any, of commercial air tour operations upon natural and cultural resources and visitor experiences.

### **Executive Order 11644 Off Road Vehicles on Public Lands, as amended by EO 11989**

This Act established policies and procedures to ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands. Each respective agency head shall develop and issue regulations and administrative instructions to provide for administrative designation of the specific areas and trails on public lands on which use of off-road vehicles may be permitted, and areas in which the use of off-road vehicles may not be permitted.

### **Director’s Order-12: Conservation Planning, Environmental Impact Analysis & Decision-Making**

The purpose of this Director’s Order (DO) is to provide the policies and procedures by which the National Park Service carries out its responsibilities under NEPA. DO-12 discusses the NPS approach to environmental analysis, public involvement, and resource-based decision making. The following recommendations are incorporated into DO-12:

- Use of interdisciplinary approaches and principles in decision-making;



- Decisions based on technical and scientific information;
- Establishment of benchmarks demonstrating best management processes (such as resource councils and project review teams) in development, analysis, and review of projects;
- Use of alternative dispute resolution and other processes to resolve internal and external disputes;
- Peer review panels to address conflicts among resource specialists regarding validity and interpretation of data and resource information;
- Analysis of impairment to resources as part of the environmental impact analysis process; and
- Post-litigation review and analysis of decision-making for potential improvements to resource-based decisions.

## **DO-47: Soundscape Preservation and Noise Management**

The purpose of the DO is to articulate National Park Service operational policies that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources. The necessity for the order is based on the recognition that natural sounds are intrinsic to resource conditions in national parks and to their enjoyment by the visiting public. The necessity is further based on the recognition that human caused noise, in terms of type, loudness, frequency, duration, and area extent, can disrupt both natural ecological processes in parks and visitor experiences. It is recognized that certain individual types or sources of noise have impacts, and that human caused sound in general may cumulatively impact park resources or visitor enjoyment.

DO-47 describes the following components of a soundscape management plan: “Superintendents will address the preservation of natural soundscapes and the elimination, mitigation, or minimization of inappropriate noise sources through NPS planning processes (see DO-2: Park Planning) and operations policies. Soundscape preservation and noise management can be addressed in appropriate sections of General Management Plans or through a variety of park implementation plans. If needed to deal with the complexity or urgency of a noise issue, a separate implementation plan will be developed. These park planning efforts will (1) describe the baseline natural ambient sound environment in qualitative and quantitative terms; (2) identify sound sources and sound levels consistent with park legislation and purposes; (3) identify the level, nature and origin of internal and external noise sources; (4) articulate desired future soundscape conditions; and (5) recommend the approaches or actions that will be taken to achieve those conditions or otherwise mitigate noise impacts.”

## **36 CFR § 2.12 Audio disturbances**

The following are prohibited:

- (1) Operating motorized equipment or machinery such as an electric generating plant, motor vehicle, motorized toy, or and audio device such as a radio, television set, tape deck or musical instrument in a manner: (i) That exceeds a noise level of 60 decibels measured on the A-weighted scale at 50 feet or, if below that level, nevertheless, (ii) makes noise which is unreasonable, considering the nature and purpose of the actors conduct location time of day or night, purpose for which the area was established, impact on park users, and other factors that should govern the conduct of a reasonably prudent person under the circumstances.
- (2) In developed areas, operating a power saw, except pursuant to the terms and conditions of a permit.
- (3) In non-developed areas, operating any type of portable motor or engine, except pursuant to the terms and conditions of a permit. This paragraph does not apply to vessels in areas where motor boating is allowed.
- (4) Operating a public address system, except in connection with a public gathering or special event for which a permit has been issued pursuant to §2.50 or §2.51.

### **36 CFR § 2.17 Aircraft and air delivery**

Under this regulation the following are prohibited:

- (1) Operating or using aircraft on lands or waters other than at locations designated pursuant to special regulations.
- (2) Where a water surface is designated pursuant to paragraph (a)(1) of this section, operating or using aircraft under power on the water within 500 feet of locations designated as swimming beaches, boat docks, piers, or ramps, except as otherwise designate.
- (3) Delivering or retrieving a person or object by parachute, helicopter, or other airborne means, except in emergencies involving public safety or serious property loss, or pursuant to the terms and conditions of a permit.

### **36 CFR § 2.18 Snowmobiles**

Under this regulation the following is prohibited: Operating a snowmobile that makes excessive noise.

Excessive noise for snowmobiles manufactured, after July 1, 1975 is a level of total snowmobile noise that exceeds 78 decibels measured on the A-weighted scale at 50 feet. Snowmobiles manufactured between July 1, 1973 and July 1, 1975 shall not register more than 82 decibels on the A-weighted scale of 50 feet. All decibel measurements shall be based on snowmobile operation at or near full throttle.

### **NPS Management Policies 2006: 4.9 Soundscape Management**

The NPS will preserve, to the greatest extent possible, the natural soundscapes of parks. Natural soundscapes exist in the absence of human- caused sound. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials.

Some natural sounds in the natural soundscape are also part of the biological or other physical resource components of the park. Examples of such natural sounds include:

- Sounds produced by birds, frogs, or katydids to define territories or aid in attracting mates;
- Sounds produced by bats or porpoises to locate prey or navigate;
- Sounds received by mice or deer to detect and avoid predators or other danger; and
- Sounds produced by physical processes, such as wind in the trees, claps of thunder, or falling water.

The service will restore degraded soundscapes to the natural condition wherever possible, and will protect natural soundscapes from degradation due to noise (undesirable human-caused sound). Using appropriate management planning, superintendents will identify what levels of human- caused sound can be accepted within the management purposes of parks. The frequencies, magnitudes, and durations of human-caused sound considered acceptable will vary throughout the park, being generally greater in developed areas and generally lesser in undeveloped areas. In and adjacent to parks, the Service will monitor human activities that generate noise that adversely affects park soundscapes, 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 or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored. (See Use of Motorized Equipment 8.2.3; Overflights and Aviation Uses 8.4)

### **NPS Management Policies 2006: 5.3.1.7 Cultural Soundscape Management**

Culturally appropriate sounds are important elements of the national park experience in many parks. 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. Examples of appropriate cultural and historic sounds include native drumming, music (at New Orleans Jazz National Historical Park), and bands, marching, cannon fire, or other military demonstrations at some national battlefield parks. The Service will prevent inappropriate or excessive types and levels of sound (noise) from unacceptably impacting the ability of the soundscape to transmit the cultural and historic resource sounds associated with park purposes.

### **NPS Management Policies 2006: 8.2.3 Use of Motorized Equipment**

The variety of motorized equipment—including visitor vehicles, concessioner equipment, and NPS administrative or staff vehicles and equipment—that operates in national parks could adversely impact park resources, including the park's natural soundscape and the flow of natural chemical information and odors that are important to many living organisms. In addition to their natural values, natural sounds (such as waves breaking on the shore, the roar of a river, and the call of a loon), form a valued part of the visitor experience. Conversely, the sounds of motor vehicle traffic, an electric generator, or loud music can greatly diminish the solemnity of a visit to a national memorial, the effectiveness of a park interpretive program, or the ability of a visitor to hear a bird singing its territorial song. Many parks that appear as they did in historical context no longer sound the way they once did.

The Service will strive to preserve or restore the natural quiet and natural sounds associated with the physical and biological resources of parks. To do this, superintendents will carefully evaluate and manage how, when, and where motorized equipment is used by all who operate equipment in the parks, including park staff. Uses and impacts associated with the use of motorized equipment will be addressed in park planning processes. Where such use is necessary and appropriate, the least impacting equipment, vehicles, and transportation systems should be used, consistent with public and employee safety. 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 will be measured and evaluated.

### **NPS Management Policies 2006: 8.4 Overflights and Aviation Uses**

A variety of aircraft, including military, commercial, general aviation, and aircraft used for NPS administrative purposes, fly in the airspace over national parks. Although there are many legitimate aviation uses, overflights can adversely affect park resources and values and interfere with visitor enjoyment. The Service will take all necessary steps to avoid or mitigate unacceptable impacts from aircraft overflights.

Because the nation's airspace is managed by the FAA, the Service will work constructively and cooperatively with the FAA and national defense and other agencies to ensure that authorized aviation activities affecting units of the national park system occur in a safe manner and do not cause unacceptable impacts on park resources and values and visitor experiences. The Service will build and maintain a cooperative and problem-solving relationship with national defense agencies to address the congressionally mandated mission of each agency and prevent or mitigate unacceptable impacts of military training or operational flights on park resources, values and the visitor experience. Cooperation is essential because the other agencies involved have statutory authorities and responsibilities that must be recognized by the Service.

