

Acoustic Environment and Soundscape Resource Summary Great Smoky Mountains National Park

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
Natural Sounds & Night Skies Division



The acoustic environment is a resource with intrinsic value. It is important as a natural resource, a cultural resource, or both. It is a critical component of wilderness character and plays an important role in wildlife communication, behavior, and other ecological processes. Results from multiple surveys of the American public indicate that hearing the sounds of nature is an important reason for visiting national parks. Therefore, the value of acoustic environments and soundscapes is related to an array of park resources and has broad implications for park management. The quality of the acoustic environment is relevant in nearly every unit in the NPS System. When developing the foundation document, park staff should consider the acoustic environment as a resource with inherent value. The topics in Attachment 1 discuss the importance of the soundscape and the acoustic environment in relation to park resources and values.



At **Great Smoky Mountains National Park**, acoustic resources protection and noise reduction are related to the following park priorities:

- enhancing visitor experience
- providing quality backcountry and overnight opportunities
- conducting interpretive programs for cultural and natural resources
- the diverse settings (rural, remote, historic, natural) throughout the park
- preserving quality wildlife habitat

Potential Threats

- Noise from park facilities and operations
- Noise from nearby development, transportation, and aircraft
- Noise from visitors such as visitor vehicles, music, shouting, electronics

Potential Opportunities

- Reduce noise from park operations (i.e. time activities to preserve quiet times, purchase quieter equipment)
- Outreach to visitors about reducing noise from sources such as electronics and idling vehicles
- Communicate with visitors about benefits of noise reduction to park experience and wildlife health
- Collaborate with partners and neighbors to manage noise sources that could affect park resources
- Participate in vehicle noise display/motorcycle outreach program

Existing data/planning:

- Baseline acoustic conditions from sampling in 2005 and 2006
- Predicted acoustic conditions based on continental acoustic model

Future data/planning:

- Re-measure acoustic conditions to describe trend
- Develop acoustic goals, indicators and standards in an acoustic resources plan or related park plans or strategies

NPS policy guidance:

Management Policies 2006: 4.9 Soundscape Management, 5.3.1.7 Cultural Soundscape Management, 8.2.2 Recreational Activities; 8.2.3 Use of Motorized Equipment, 8.4 Overflights and Aviation Uses

Director's Order 47: Preservation of the Acoustic Environment and Noise Management

Quality of the Resource at Great Smoky Mountains NP

A baseline acoustic inventory was conducted for Great Smoky Mountains National Park in 2005 as part of an Air Tour Management Plan development process. The planning process stalled, but the data remains useful to acoustic resources management at the park. This research provides a comprehensive description of the acoustic environment by characterizing existing sound levels, estimating natural ambient sound levels, and identifying audible sound sources. The methods, data and results of this monitoring effort are provided in an acoustic monitoring report from 2007, included as Attachment 2. Field data was collected at 7 sites ranging from forested areas to open pastures. In general, natural sounds dominated the acoustic environment at most sites in the winter while human-caused sounds were more prevalent during the summer. Figure 1 shows the location of data collection sites. Figure 2 shows tables from the report that summarize the acoustic measurements at all locations during both seasons. Further data was collected in 2006 and is summarized in 2009 snapshot reports, included as Attachments 3 and 4.

One way NSNSD examines acoustic conditions is to determine whether existing sound levels exceed certain decibel (dBA) values that relate to human health and speech. At 35 dBA, human and wildlife sleep can be interrupted (Haralabidis, et. al., 2008). The World Health Organization's recommends that noise levels inside bedrooms remain below 45 dBA (Berglund, et. al., 1999). At 52 dBA, a listener wouldn't clearly hear another person speaking in a raised voice at 10 meters (Environmental Protection Agency, 1974). At 60 dBA, normal voice communications can be interrupted at 1 meter. Visitors in the park would likely be conducting such conversations.

The mean existing sound level at Great Smoky Mountains National Park was taken for daytime hours and night time hours in both winter and summer seasons. In winter, the average hourly decibel levels ranged between data collection sites from 28.7 dBA to 35.6 dBA. In summer, the range was 28.5 to 47.3. By comparing the median sound level data to the exceedance levels listed above, it is evident that people should be able to hear a speaker at both raised voice level and normal conversational level at all locations sampled. At locations GR6 and GR7, sleep may be interrupted by elevated sound levels. At locations closer to noise sources such as roadways and visitor centers, the decibel levels may be higher.

Geospatial modeling of acoustic conditions at the park also demonstrates important information about the acoustic environment. As demonstrated in Figure 2 and Figure 3, the park has lower ambient sound levels than some of the surrounding areas. Thus, the park provides important un-fragmented habitat and a refuge for wildlife and visitors from human-caused noises of the built environment.

- Prepared by Jim Renfro,
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Table 11. Summary of day versus night diurnal trends (winter season).

Site #	Overall (24 Hours)			Daytime (7 am to 7 pm)			Nighttime (7pm to 7 am)			Difference (Daytime – Nighttime)		
	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)
GR1	42.6	33.0	20.9	42.3	33.2	21.7	43.0	32.8	19.8	-0.7	0.4	1.9
GR2	44.4	30.1	19.4	43.8	31.8	21.1	44.9	27.2	19.0	-1.1	4.6	2.1
GR3	45.2	32.8	28.2	45.3	33.0	27.9	45.1	32.5	28.3	0.2	0.5	-0.4
GR4	44.0	29.1	18.9	45.3	30.8	19.3	42.0	27.6	18.6	3.3	3.2	0.7
GR5	43.8	28.7	24.3	44.9	30.0	24.8	42.3	27.6	24.0	2.6	2.4	0.8
GR6	42.1	33.5	29.1	42.6	35.0	30.2	41.5	32.4	28.4	1.1	2.6	1.8
GR7	46.1	35.6	23.8	44.6	35.2	24.1	47.1	36.0	23.5	-2.5	-0.8	0.6
Average										0.4	1.8	1.1

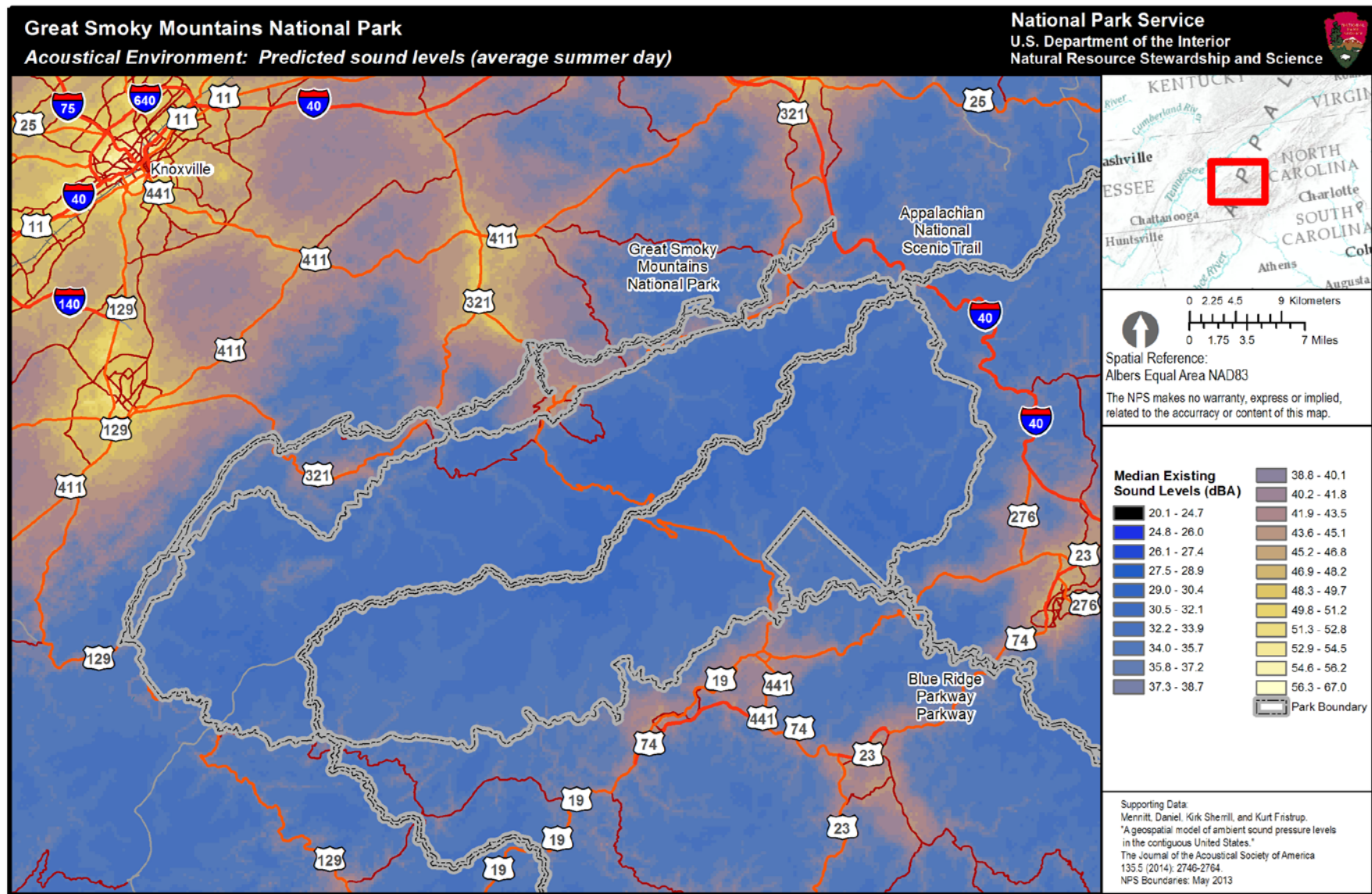
Table 12. Summary of day versus night diurnal trends (summer season).

Site #	Overall (24 Hours)			Daytime (7 am to 7 pm)			Nighttime (7pm to 7 am)			Difference (Daytime – Nighttime)		
	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)
GR1	46.4	29.1	19.9	47.6	29.9	22.1	39.6	26.2	18.8	8.0	3.7	3.3
GR2	51.3	29.1	21.2	52.6	30.0	23.3	41.6	24.4	20.2	11.0	5.6	3.1
GR3	50.5	35.9	32.8	51.9	35.9	32.7	39.9	35.9	33.1	12.0	0.0	-0.4
GR4	47.8	29.4	20.4	49.0	30.1	22.8	42.4	27.2	18.8	6.6	2.9	4.0
GR5	49.1	31.6	25.1	50.0	32.3	26.1	45.4	29.5	23.4	4.6	2.8	2.7
GR6	57.1	47.3	35.9	56.8	45.4	35.7	57.9	50.9	37.3	-1.1	-5.5	-1.6
GR7	43.9	28.5	22.0	44.3	28.9	23.1	42.4	26.7	20.6	1.9	2.2	2.5
Average										6.1	1.7	1.9

Table 13. Seasonal differences between day versus night diurnal trends.

Site #	Overall (24 Hours)			Daytime (7 am to 7 pm)			Nighttime (7pm to 7 am)			Difference (Daytime – Nighttime)		
	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)	L _{Aeq} (dBA)	L ₅₀ (dBA)	L ₉₀ (dBA)
GR1	-3.8	3.9	1.0	-5.3	3.3	-0.4	3.4	6.6	1.0	-8.7	-3.3	-1.4
GR2	-6.9	1.0	-1.8	-8.8	1.8	-2.2	3.3	2.8	-1.2	-12.1	-1.0	-1.0
GR3	-5.3	-3.1	-4.6	-6.6	-2.9	-4.8	5.2	-3.4	-4.8	-11.8	0.5	0.0
GR4	-3.8	-0.3	-1.5	-3.7	0.7	-3.5	-0.4	0.4	-0.2	-3.3	0.3	-3.3
GR5	-5.3	-2.9	-0.8	-5.1	-2.3	-1.3	-3.1	-1.9	0.6	-2.0	-0.4	-1.9
GR6	-15.0	-13.8	-6.8	-14.2	-10.4	-5.5	-16.4	-18.5	-8.9	2.2	8.1	3.4
GR7	2.2	7.1	1.8	0.3	6.3	1.0	4.7	9.3	2.9	-4.4	-3.0	-1.9

Figure 2. Tables from 2005 acoustic monitoring report.



NPS Natural Sounds & Night Skies Division and NPS Inventory and Monitoring Program MAS Group 20150723

Figure 3. *Median existing sound pressure levels for Great Smoky Mountains National Park.* This park-specific existing sound level map is generated by version 3.0 of the geospatial model. The color scale indicates the decibel level that is predicted in the park based only on both human-caused and natural sound sources. Sound level is measured in A-weighted decibels, or dBA, with 270 meter resolution. Black and dark blue colors indicate low existing decibel levels while yellow or white colors indicate higher existing decibel levels. Sound levels in national parks can vary greatly, depending on location, topography, vegetation, biological activity, weather conditions and other factors. For example, the din of a typical suburban area fluctuates between 50 and 60 decibels (dBA), while the crater of Haleakala National Park is intensely quiet, with levels around 10 dBA. Note that due to the national scale of the model inputs, this graphic may not reflect recent localized changes (such as new access roads or development). (note: although the color ramps are similar, each figure has different legend values)

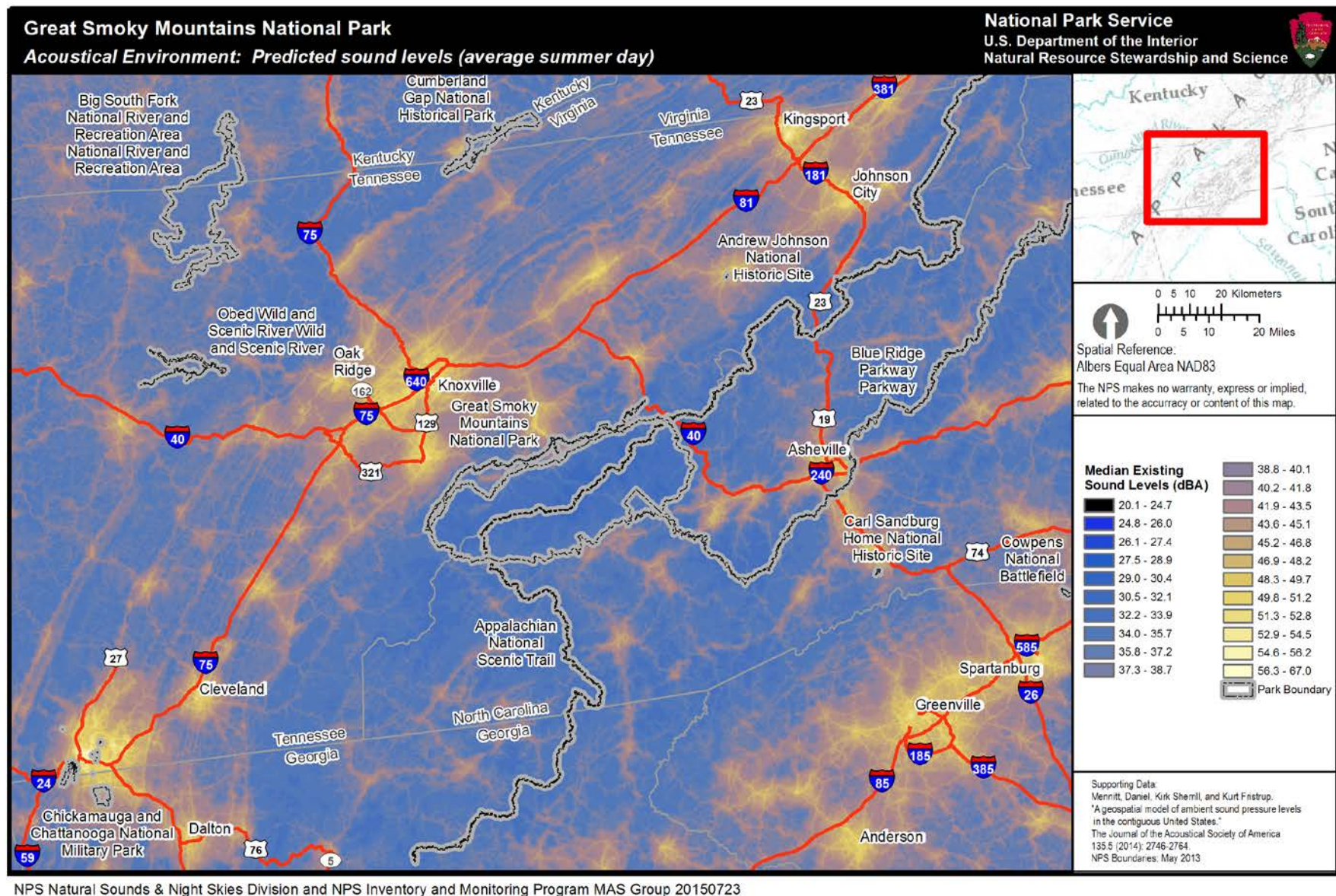


Figure 4 b. Median *existing* sound pressure levels, small scale of figure above.