

# Grand Canyon National Park

Special Flight Rules Area in the Vicinity of Grand Canyon National Park

National Park Service  
U.S. Department of the Interior



## Sound Basics

### Understanding Acoustic Resource Terms

**Soundscape:** The aggregate of all sounds in an area, both natural and human-caused. The park's total acoustical environment. Considered synonymous with the term "existing ambient sound."

**Natural Soundscape:** The subset of soundscape composed completely of natural sounds without any human-caused sounds. Considered synonymous with the terms "natural quiet" and "natural ambient sound."

**Percent Time Audible ("How much time can you hear it?"):** In the Draft EIS, percent of the 12-hour day (7 a.m. to 7 p.m.) in which aircraft sounds can be heard by humans and other animals with normal hearing. Refers to potential to detect presence of sound, and provides information primarily related to duration of impacts.

**Average Sound Level ("How loud is it?"):** Also called Equivalent Sound Level (Leq), the logarithmic energy average of aircraft sound pressure levels. In the Draft EIS, expressed in A-weighted decibels (dBA) experienced over the 12-hour day (LAeq<sub>12</sub>). Provides information primarily related to sound energy levels.

**A-weighted decibels (dBA):** Sound is usually measured in a logarithmic scale using units called decibels (dB). The A-weighted decibel scale (dBA) was developed to simulate the relative response of human hearing at various sound frequencies between 20 and 20,000 Hertz (Hz).



**"Natural ambient"** is considered synonymous with the term **"natural quiet,"** although natural ambient is more appropriate because nature is often not quiet.

Natural sounds are influenced by seasons and can include birds, other wildlife, and weather conditions.



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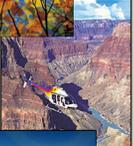
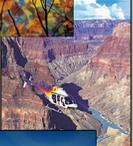
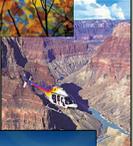
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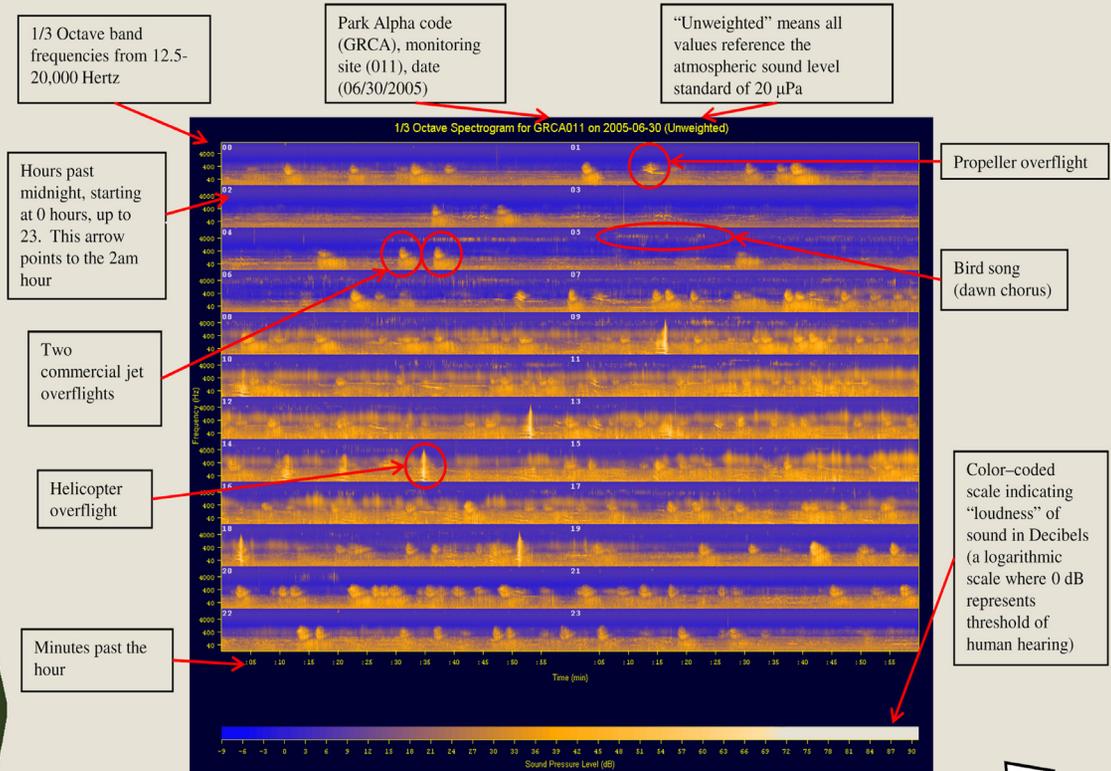
### Examples of sound levels (dBA) in National Parks

	dBA
 Haleakala Nat. Park, volcano crater	10
 Canyonlands Nat. Park, (natural ambient, leaves rustling)	20
Grand Canyon Nat. Park (non-river natural ambient)	18-23
 Zion Nat. Park, crickets (5m)	40
Suburbs – Night	45
Suburbs – Day	55
 Grand Canyon Air Tours (Dragon Corridor)	45-60
 Whitman Mission Nat. Historic Site, conversation (3m)	60
 Grand Canyon Nat. Park (river/rapids natural ambient)	25-66
 Yellowstone Nat. Park, snowcoach (30m)	80
 Arches Nat. Park, thunder	100
Yukon-Charley Rivers Nat. Preserve, military jet (100m AGL)	120

Sounds are variations in air pressure that we hear in terms of pitch (frequency), loudness (amplitude), duration, and timing

- **Amplitude:** Related to the loudness or volume of a sound, described in decibels (dB). Amplitude is shown in colors in the spectrogram following the Sound Pressure Level legend at the bottom
- **Frequency:** Related to the tone or pitch of a sound, described in Hertz (Hz). The position of the colors in the spectrogram shows the sound frequencies measured at the site, corresponding to the frequency legend at the left of each row
- **Think of music:** It varies over time in patterns of frequency (pitch, tone and structure) and amplitude (loudness) from varying combinations of sound sources (instruments, voices) to convey information which can have different meanings to different listeners
- A 10 dBA increase in sound level usually sounds about twice as loud
- A 10 dBA decrease in sound level usually sounds about half as loud
- Changes of 3 dBA are usually perceptible to humans

## How a day actually sounded in Grand Canyon ponderosa pine forest



### How to read a 24 hour spectrogram

Each row in the spectrogram represents two hours of the day, starting with midnight in the upper left and ending with the following midnight in the lower right. The spectrogram provides sound frequency, amplitude, duration and timing in one graphic.



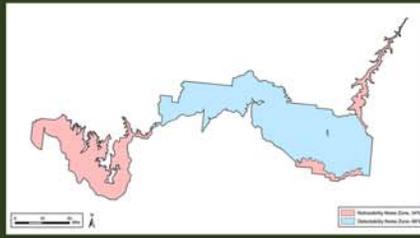
## Noise Modeling

### Inputs

- Number of operations by each aircraft type on each route
- Flight routes and altitudes
- Operational flight procedures, such as climbing and descending
- Operation type (for example, commercial air tour, transportation, Grand Canyon West related, general aviation)
- Topography
- Natural ambient sound data
- Location point data grouped into four geographical areas (Marble Canyon, East End, Central, West End)
- Base Year vs. 10-year Forecast
- Peak Season vs. Off-Peak Season

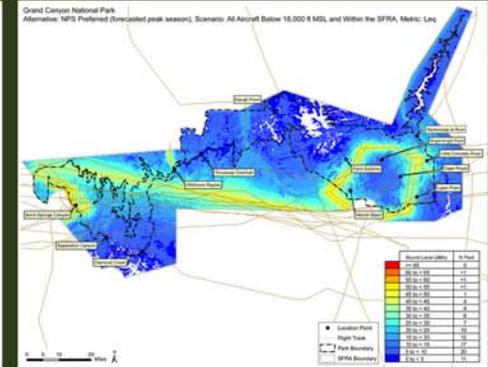
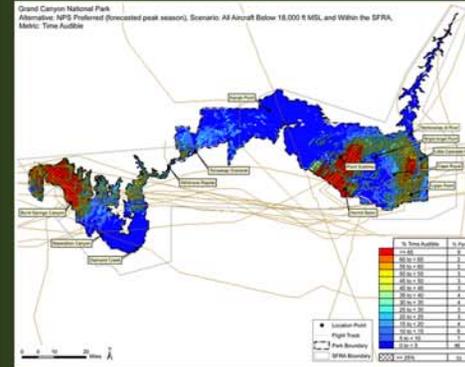
Noise Modeling used FAA's Integrated Noise Model (INM) 6.2a.

### Dual Zone Modeling Approach



In Detectability Zone areas, natural ambient sound levels based on field measurements were used directly in the model. In Noticeability Zone areas, 10 dB was added to the natural ambient sound levels in the model. This modeling approach was established in 1999.

## Noise Model Results



### Contour Analysis: Examples from NPS Preferred Alternative

### Cumulative Impact Analysis:

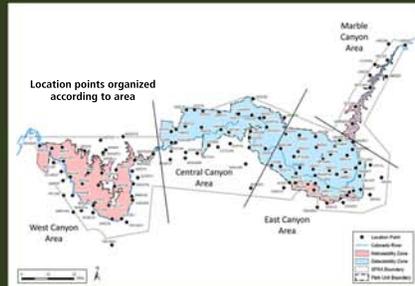
Similar maps and tables are provided for cumulative impacts of each Alternative in the Draft EIS Volume 2, Appendix D, starting on page D-177.

A separate GIS analysis was done to determine distances between points/areas of interest and aircraft routes.

## How noise model results were used

- To determine how much of the park achieves substantial restoration of natural quiet at the minimum level (i.e., areas with less than or equal to 25 percent time audible)
- To present noise predictions at points and areas of interest using several different noise metrics

## Location Point Analysis: Examples from NPS Preferred Alternative



Location Point Name	Alternative A						NPS Preferred Alternative						Off-Peak Season							
	Base Year		Forecast		Peak Season		Base Year		Forecast		Peak Season		Base Year		Forecast		Peak Season			
	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))	Percent Time Audible (%)	Average Sound Level (dB(A))		
<b>South Rim</b>																				
Desert View	76	79	29	30	74	-2	46	-13	29	0	24	-6	88	8	51	-27	29	-1	23	-5
El Tovar	64	67	15	16	67	3	47	-20	36	1	31	-5	79	15	54	-13	14	-1	11	-4
El Tovar	95	96	19	20	93	-2	16	-80	20	0	14	-6	44	23	8	-87	13	-6	8	-10
<b>Bright Angel Flight Free Zone</b>																				
Chimney Rock	3	4	12	12	-2	-1	1	-1	10	-2	6	-6	1	-2	1	-5	5	-2	5	-2
Cedar Ridge	81	82	19	19	89	-9	6	-78	19	1	14	-5	60	23	9	-73	10	-2	13	-2
<b>North Rim</b>																				
Desert Inn	66	68	38	39	48	-17	11	-56	18	-20	16	-22	33	13	6	-42	14	-24	14	-23
Bright Angel Point	47	48	24	24	58	12	18	-30	24	0	17	-7	99	12	9	-79	10	-4	13	-9
Cape Royal	59	61	25	26	72	13	40	-23	27	2	23	-11	81	22	54	-3	29	4	23	-1
<b>East Point Corridor</b>																				
1 Loop Point	54	57	14	15	78	5	57	-20	15	0	30	-5	87	14	65	-12	34	0	32	-3
<b>Little Colorado River/Northwest Area</b>																				
Northwest Mesa	67	68	43	43	78	-9	37	-31	11	-12	29	-14	79	-8	54	-36	28	-15	26	-17
Northwest on River	7	8	14	15	0	-7	0	-8	15	-19	13	-22	0	-23	0	-8	13	-22	13	-22
Little Colorado River	34	37	43	43	61	-26	8	-53	25	-19	27	-16	7	-62	3	-114	24	-19	23	-18
<b>Dragon Corridor</b>																				
Horizon Bend	99	100	42	42	96	-4	50	-20	20	-22	16	-26	35	24	13	-66	11	-29	11	-31
% Mile Canyon	72	74	47	47	65	-9	23	-41	23	0	17	-6	10	-61	5	-68	30	-13	29	-16
<b>Shoshone Flight Free Zone</b>																				
Point Substation	100	100	15	15	100	0	64	-36	35	0	28	-7	73	-27	33	-67	24	-12	18	-13
Quartz Watch	98	98	20	21	99	-1	68	-33	27	8	21	0	48	-20	15	-83	19	-3	15	-6

Location Point Grouping	TAUD <sup>1</sup>	Base Year				Peak Season <sup>2</sup>			
		TAUD <sup>1</sup>	L <sub>max</sub> <sup>2</sup>	TALAS5 dBA <sup>3</sup>	TALAS5 dBA <sup>3</sup>	TAUD <sup>1</sup>	L <sub>max</sub> <sup>2</sup>	TALAS5 dBA <sup>3</sup>	TALAS5 dBA <sup>3</sup>
		0%	0%	0%	0%	0%	0%	0%	0%
Marble Canyon	1%	18 dBA	0%	0%	1%	18 dBA	0%	0%	
East End	100%	52 dBA	100%	42%	11%	98%	51 dBA	100%	
Central	60%	27 dBA	0%	0%	28%	22 dBA	0%	0%	
West End	94%	49 dBA	77%	31%	9%	88%	48 dBA	77%	
All Location Points	1%	18 dBA	0%	0%	1%	18 dBA	0%	0%	

<sup>1</sup>TAUD = Percent Time Audible  
<sup>2</sup>L<sub>max</sub> = Average Sound Level  
<sup>3</sup>TALAS5 dBA, TALAS4 dBA, and TALAS5 dBA = Percent of time during the 12-hour day used in this analysis that aircraft sounds exceed 35, 45, and 55 dBA, respectively