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Transportation Noise and Recreational Lands

Nicholas P. Miller
Harris Miller Miller & Hanson Inc.
Burlington, Massachusetts 01803, USA

Abstract

An active and widely distributed transportation system is virtually a requirement for and a hallmark of countries that have a vigorous economy. As this conference demonstrates, one of the products of such a system is noise, and it is most certainly true that the prevalent type of noise experienced by the populations of these countries is the noise produced by transportation vehicles. A further result is that the sounds of transportation vehicles can be heard almost everywhere. The question addressed by this plenary lecture is: do these countries that value and use multiple types of transportation vehicles and systems also wish to preserve opportunities for their populations to experience natural outdoor environments that are essentially free of human produced sounds? The combination of technical complexities and political challenge may make such a preservation goal unachievable.

1. Introduction

The transportation system in the U.S. creates noise, and since the 1970's, analysis and mitigation of this noise where people live has become a routine part of the transportation planning process. This analysis generally focuses on specific projects for specific transportation modes. It is, in the author's experience, rare that a systems approach has been applied to examine multi-modal tradeoffs in transportation performance and environmental effects. The focused analyses aid in limiting the most significant effects of noise in the immediate vicinity of the source, and feasibility considerations always play a role in determining the area over which noise effects are examined and mitigated. The result is that there has been little or no real attention given by the acoustics community in the U.S. to the summed effects of all sources of noise over wide areas of the country.

This is not to say that there are not many professional individuals and organizations worldwide that are concerned with a broader perspective of the "soundscape". This broader perspective may address the quantifiable effects of all noise sources on people living in built environments (for example [1], [2], [3]), on developing a coordinated approach to use of noise indicators and assessment methods for examining environmental noise [4], on the qualitative values and effects of the soundscape [5], or on soundscapes in national parks [6]. These types of professional efforts are significant and necessary if we are to develop an understanding of the relationship of the sound environment to human health and well being, and if the soundscapes are to be managed to preserve or improve the quality of life.

This paper suggests yet another perspective on soundscapes. The complexity and extent of the modern transportation system, and the ways in which that system is planned, modified and expanded, mean that, in the U.S., there is little attention given to the countrywide extent of its influence on the acoustic environment or soundscapes across the country. Further, if the extent of acoustic influence of the transportation system were better understood, on the one hand there might be more emphasis on total system acoustic design and on the other, the public perception of the value of managing and preserving natural soundscapes might be altered.

The goals of this paper are to:

1. Estimate the geographic extent of transportation noise in the U.S.
2. Raise the question: What is the importance to the society of seeking to manage natural soundscapes for restoration and preservation?
3. Review some of the technical issues associated with managing and preserving natural soundscapes.
4. Recount some of the efforts to manage specific sources of sound in U.S. National Parks.
5. Raise the question: Can the society achieve an equitable balance between competing perceptions of the value of natural soundscape management?

2. Geographic Extent of Transportation Noise in U.S.

The method used here for estimating the geographic extent of transportation noise is based on separately examining the layout and noise "influence" of each of the three major transportation networks. These networks may be defined as: 1) highways, including primary limited access highways, primary roads and secondary roads, 2) freight railway lines, and 3) commercial air carrier jet routes.

In order to generalize the noise "influence" of these three transportation systems for the U.S.[1], a simplified calculation method is used. The method used here is based on several assumptions.

1. All calculations are done county-by-county.
2. All calculations are for a typical daytime hour.
3. Population density is used to derive a "baseline" sound level.
4. This baseline level, produced primarily by the local vehicular transportation network, serves to determine the area in which the noise of the three major networks will be "noticed," where a transportation source is assumed to be noticed when its A-weighted sound level equals the A-weighted background or baseline level. [7]
5. The higher the baseline sound level, the less the area over which the transportation networks will be noticed, and conversely, the quieter the baseline, the greater the area over which the noise of the three networks is noticed.
6. "Influence" by the noise of each of the three networks is determined by:

[1] For simplicity, this examination focuses on only the contiguous forty-eight states.

   a. Determining the maximum distance from the transportation corridor at which the transportation noise source can be noticed.
   b. Multiplying this distance by the length of the corridor in the county, giving an area within which the noise of the particular transportation corridor can be noticed. [8]
   c. Comparing the area in each county over which each of the three transportation networks can be noticed with the total area of the counties to compute the percent of each county in which each network can be noticed.
7. Nationwide, the degree of influence is depicted by categorizing the counties by the percent of land in which each transportation noise can be noticed.

In the U.S, there are federally approved mathematical models for computing the sound levels produced by any of these types of transportation. [9] For present purposes, however, the approach is to use only the source sound levels and propagation algorithms of these models to produce estimates of the maximum distance at which the source can be noticed. [10]

2.1 Baseline Sound Levels

The baseline levels used to determine the maximum distances at which the various transportation types can be noticed are derived from a long-standing simple relationship between community sound level and population density. The relationship of day-night sound level, L_{dn}, to population density was investigated by the U.S. EPA in 1974 [11], and recently reconfirmed [12]. This relationship

$$L_{dn} = 22 + 10\log(\rho) \qquad (1)$$

where

$$\rho = \textit{population density}$$

is intended to estimate the day-night sound level due to general community activity, and assumes that no major highways or airports are affecting the sound environment.

The relationship of equation (1) was applied to the population densities of U.S. counties to produce Figure 1. As might be expected, higher sound levels are in the counties with significant urban / suburban populations. Because of the map size, some areas of high baseline sound levels, notably San Francisco and metropolitan New York, cannot be distinguished.

For determination of areas of noticeability, the comparison made is between the sound level of the specific transportation source (highway, rail, aircraft) and the "baseline" sound level derived from the levels given in Figure 1. The best representation of such a baseline level is assumed to be the daytime median sound level or L_{50}. Equation (1) yields L_{dn}, so this value must be transformed to L_{50}. Using information collected in 18 communities, [13] the following approximate relationship was derived.

$$L_{50} \approx L_{dn} - 5dB \qquad (2)$$

Hence, for each of the transportation sources, the comparison is between the maximum sound level of the source and the baseline of L_{dn} – 5 dB. The distance from the transportation track to the point where the maximum level equals L_{dn} – 5 dB is the distance of noticeability.

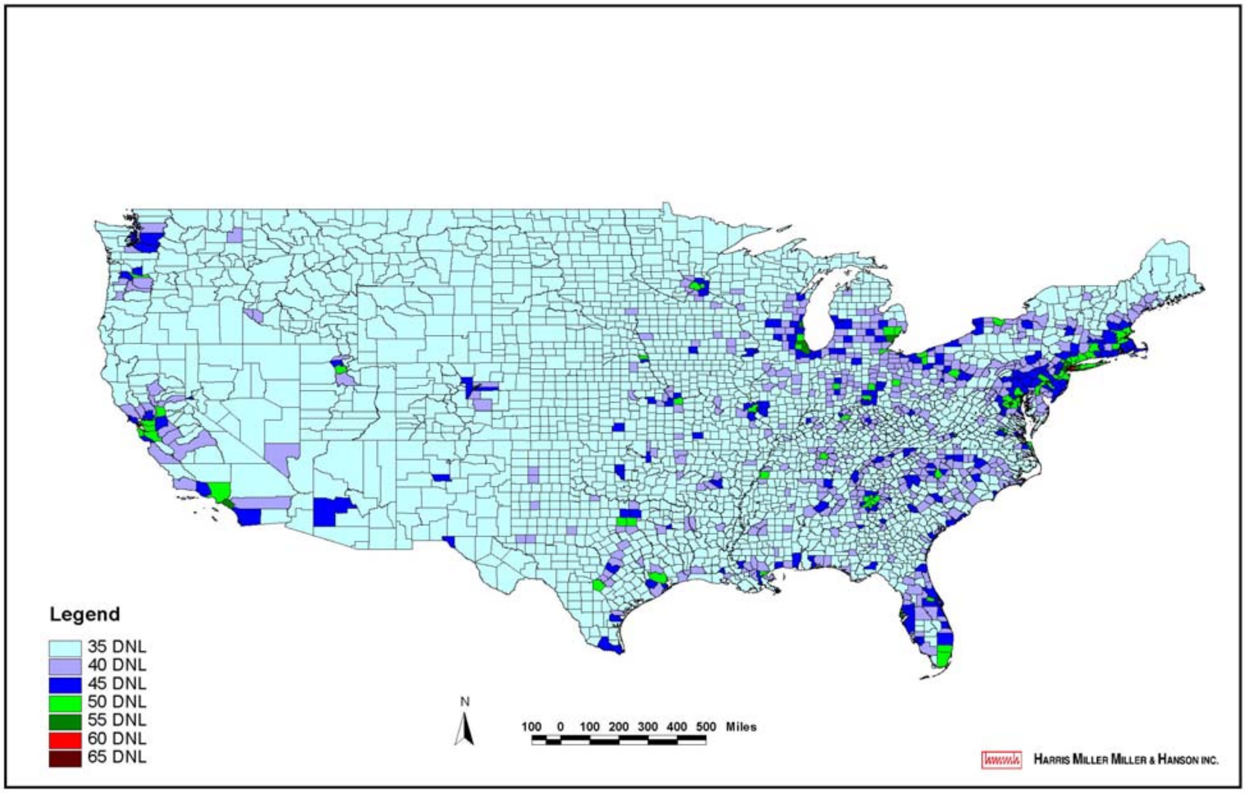

Figure 1 DNL by County, Developed from Population Density, Equation (1)

2.2 Highways

Figure 2 presents the results of the noticeability calculations for highway traffic noise. The specific divisions that depict the percent of county area where the noise is noticeable were chosen assuming that the greater the estimate of noticeable area, the higher the likelihood that the estimates are inaccurate. As the area of noticeability increases, the greater the probability that individual noticeability areas from different transportation segments will overlap. Hence, the divisions increase in size, as the percent increases.

The percent of a county in which noise is noticeable depends upon two variables: 1) the number of transportation corridor segments in the county, 2) the baseline sound level in the county. Thus, a county may have a low percentage of noticeable highway noise either because the baseline level is high or because there are few highways in the county.

2.3 Railways

Figure 3 presents the results of the noise influence calculations for railway noise.

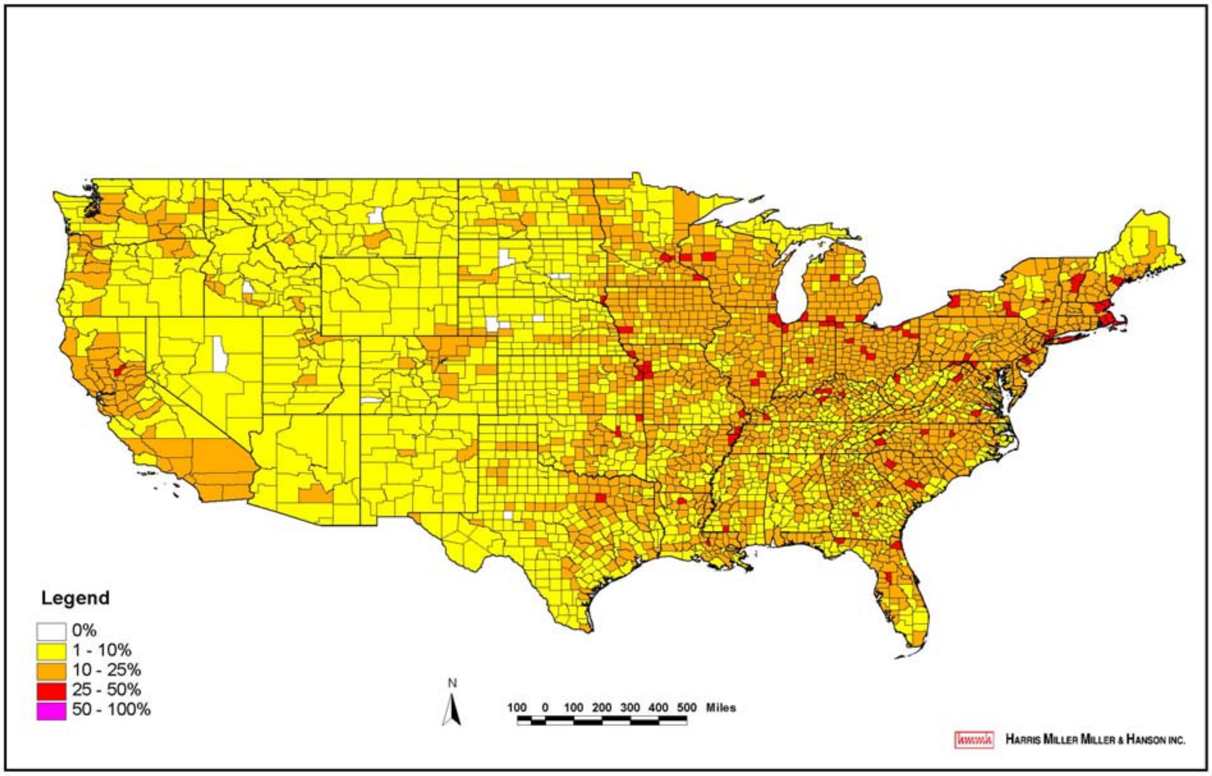

Figure 2 Percents of County Areas in which Highway Traffic Noise is Noticeable During the Day

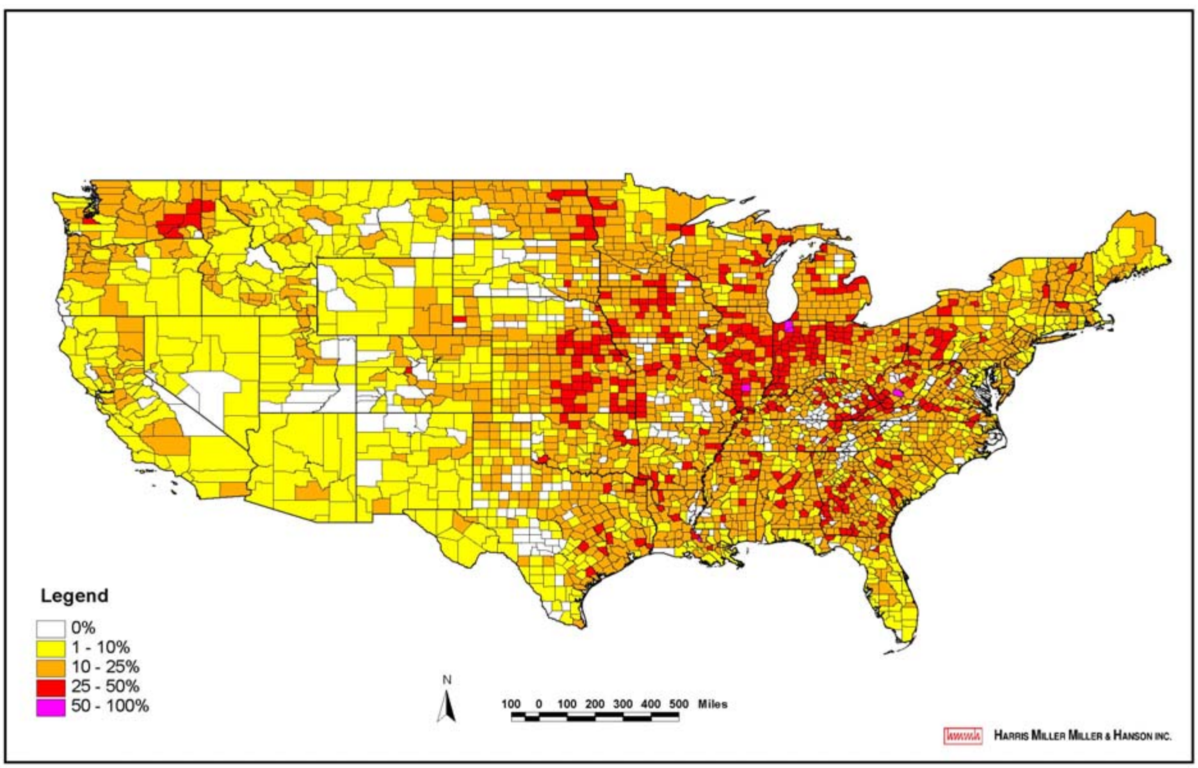

Figure 3 Percents of County Areas in which Rail Traffic Noise is Noticeable During the Day

2.4 Commercial Jet Routes

Figure 4 presents the results for high altitude jet routes. Unlike highways and railways, each jet follows a unique path. Though in some cases there are fairly distinct corridors, for much of the country the paths are quite dispersed.

The tracks used for the calculations of Figure 4 are shown in Figure 5. These are all jet departures that occurred between 3:00pm and 4:00pm on October 17, 2000, showing the full track to the first destination. Three to four pm was chosen as typical of the numbers of flights during the day, and should include most common routes.

There are a few areas of the country where the estimation method is probably inaccurate. For some locations, the method likely overstates the extent of the audibility of jet traffic. Those areas that have several flights following a relatively narrow corridor, as in parts of Nevada, are likely to have overestimates of areas. In areas that have both high baseline levels and airports, such as the Los Angeles, Dallas-Fort Worth and Atlanta areas, the method is likely to underestimate the noticeability. For simplicity, all tracks are assumed to be at 30,000 feet, and hence there are no decent and climb portions so that these segments around airports have sound levels that are lower than realistic. This combination of high baseline sound levels and too low aircraft sound levels probably results in under-estimation of the area affected.

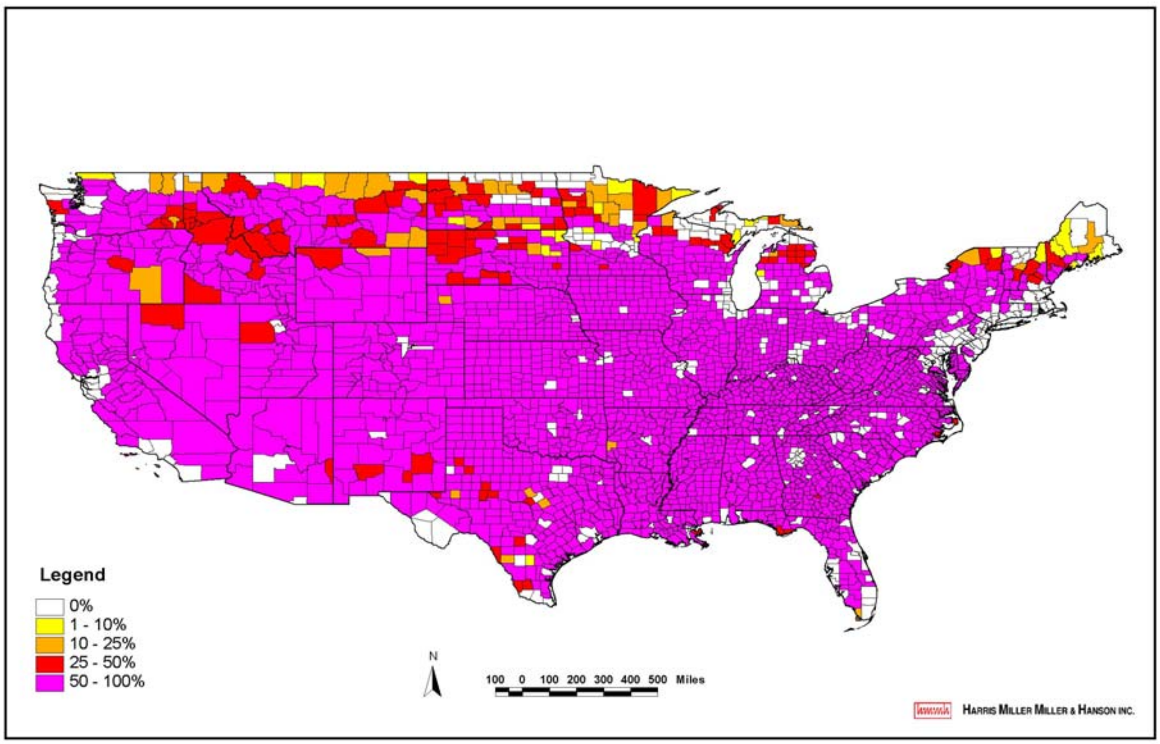

Figure 4 Percents of County Areas in which Jet Traffic Noise is Noticeable During the Day

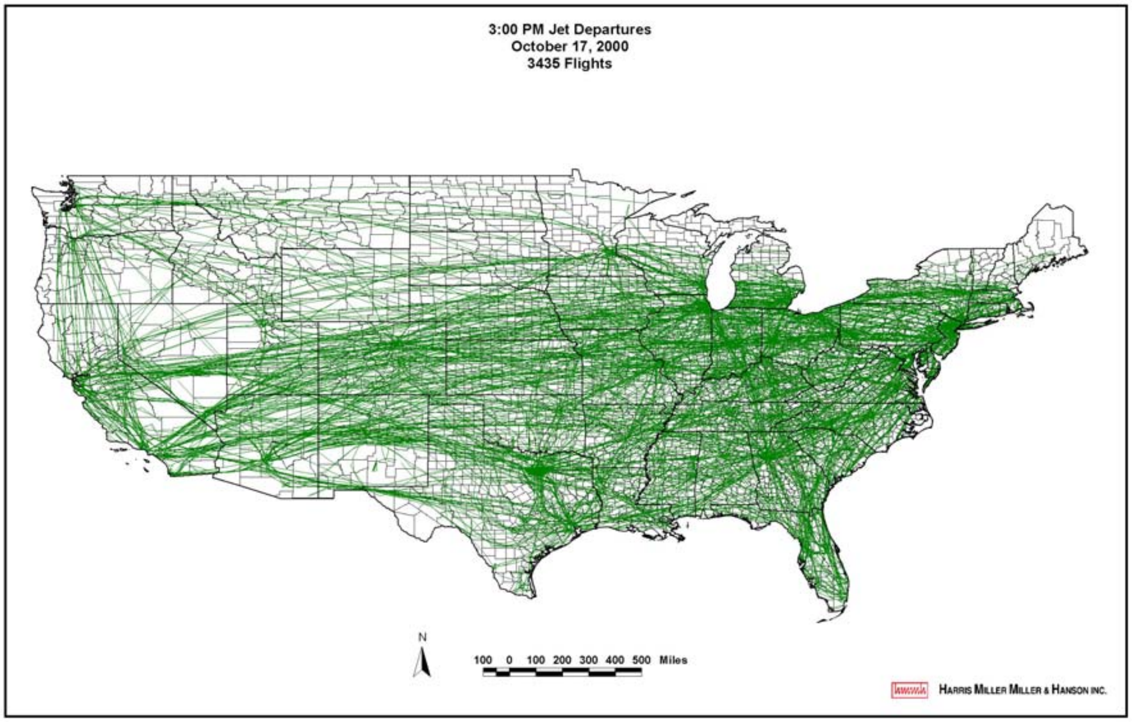

Figure 5 Jet Flight Tracks Used to Compute Noticeability Areas, Figure 4

3. Interest in Preservation of Natural Soundscapes

Can knowledge of the extent of transportation noise alter our perceptions of the value of preserving, restoring, and managing selected natural soundscapes? As we continue to strengthen our transportation systems, making them more effective in geographic reach, will recognition of the nation wide spread of the associated noise alter how the public (and our government) views the value of managing to preserve areas where natural soundscapes can be experienced? Will it matter if there are no locations in the U.S. where one can sit for an hour and hear only the sounds produced by the natural environment?

It can be said that there is currently no national consensus on the value of natural soundscapes. On the one hand, the U.S. Congress (supported by various interest groups) and various Federal agencies have traditionally demonstrated a commitment to preserving natural settings including the natural soundscapes. On the other hand, some businesses that provide motorized park activities, such as snowmobile rides or air tours, and their associated user / interest groups are concerned that preservation of natural soundscapes will prevent the businesses from meeting park visitor needs and make these recreational activities unavailable to those who want them.

U.S. public lands are designated through acts of the U.S. Congress. These acts identify the purposes to be served by the specific land or type of land, and several types of public lands carry the mandate of preserving, restoring, providing for an experience of the natural soundscape. National Parks can be established for many different purposes, but overall, the National Park Service (NPS) was created primarily to preserve the resources of National Parks [14], [15].

Though NPS management policy has identified the importance of preserving natural sounds, the Director of the National Park Service recently issued Director's Order #47 that states that:

"The purpose of this Director's Order is to articulate the 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." [6]

The Wilderness Act of 1964 [16] established a process to identify specific areas as "wilderness" each of which would be an "area of undeveloped Federal land retaining its primeval character and influence … which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation…."

Wild and Scenic Rivers Act of 1968 [17] also established a study process to identify and protect free-flowing rivers. Two relevant management objectives for the system are: 1) provide recreationists with the opportunity to experience a river setting similar to that seen by the first explorers; 2) ensure that the rivers retain an essentially wild and pristine nature. [18]

Figure 6 shows Federal areas of the continental U.S. that might be the subject of soundscape management; these are National Parks, National Seashores, Wild and Scenic Rivers, designated Wildernesses and areas designated as potentially wilderness. These areas account for about 3 % of the 48 states.

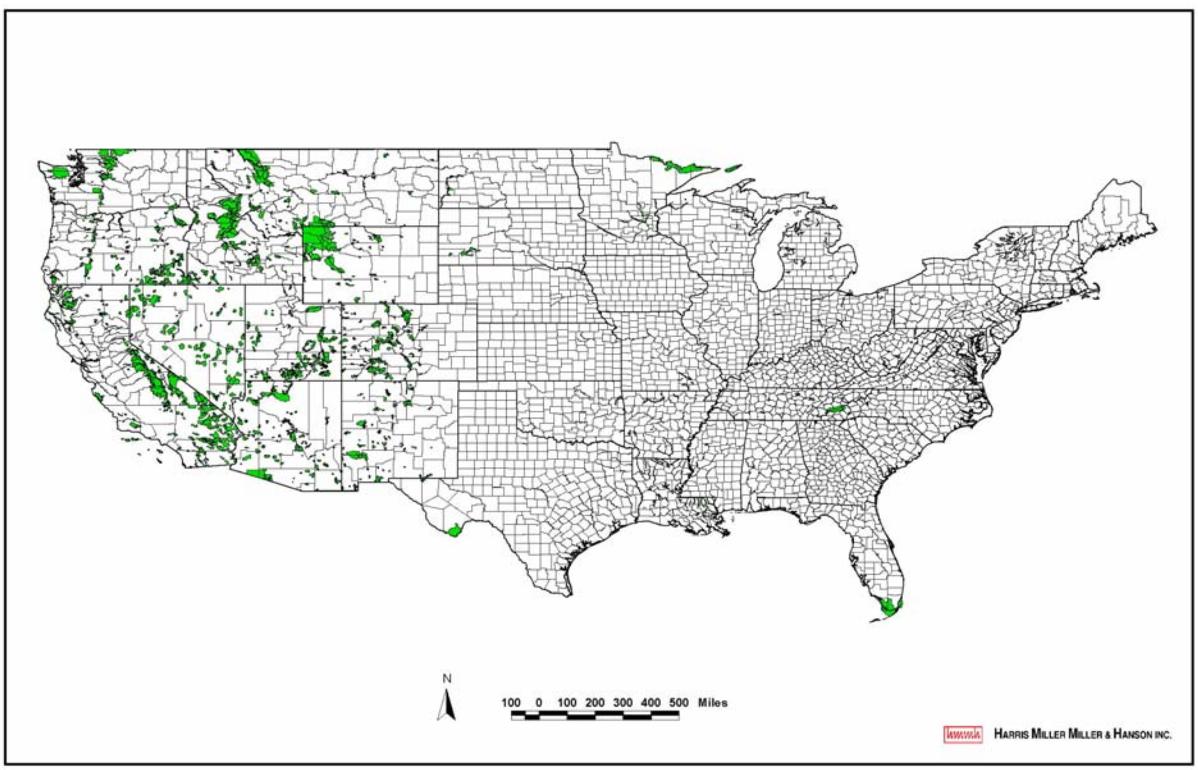

Figure 6 Federal Lands that Might be Considered for Soundscape Management

These different public lands have been established for varieties of reasons, most of which are preservation, and the NPS has specifically identified natural soundscape preservation as a management objective for national parks. Users of these public lands and associated interest groups, however, can have a wide range of expectations that may or may not include experiencing the outdoors in a natural state. The popularity of snow machine use in Yellowstone, the use of personal water craft in parks or recreation areas such as Glen Canyon National Recreation Area, and the many passengers on air tours over Grand Canyon National Park and over the Hawaiian parks suggest that many visitors seek experiences other than witnessing natural settings free of the effects of "man's work."

The validity of such park experiences is not here in question, but these experiences conflict with another view of the purpose of parks, expressed by Joseph Sax. [19] In this view, parks are to provide the opportunity for members of the public to experience nature on its own terms. Visitors should be able to temporarily leave behind their to-do lists, their pursuit of objectives, even if recreational, to discover what they themselves are like when surrounded by the natural environment. Clearly, to provide opportunities for both this type of experience and for the more active motorized recreational experiences (bus, air and car tours, power boats, snowmobiles, etc.), management of park soundscapes is required.

4. Some Technical Issues of Managing Natural Soundscapes

Managing natural soundscapes requires some means for identifying the presence (or absence) of both natural and human-produced sounds in a way that provides useful information for making decisions about whether management goals are being met. Some special characteristics of parklands mean that characterizing the soundscape and judging the effects of human-produced sounds raise difficult technical issues.

4.1 Characterizing the Natural Soundscape

4.1.1 What to Measure

Some would argue that natural soundscapes cannot be described quantitatively. [20] In the broadest sense, this perspective is a truism. What really matters is what the environment sounds like, not what the numbers are that quantify it. However, it is the author's opinion that in order to effectively and efficiently manage soundscapes, some sort of quantification is necessary. Quantification helps identify long-term trends and enables the prediction of future conditions. It also permits development of verifiable goals – goals that can be monitored for achievement. Whether the objective is to eliminate intrusions or to limit intrusions, without quantification, such goals will be very difficult to set or test. The challenge is finding metrics that make sense to decision-makers and that will give them confidence that decisions based on the metric values will yield the expected results.

If quantification is necessary, then what metrics should be quantified and how will they be measured or estimated? Additionally, how can the natural sounds be separated from the intruding sounds? One possible approach, consistent with most current practice in acoustics is with the use of sound levels. Figure 7 shows a one-hour sample of one second A-weighted sound levels measured in White Sands National Park. In this figure, the periods when aircraft flew over the site are clearly visible in the sound level time history. The maximum levels are 65 dBA to 70 dBA. As identified in the figure, these overflights were audible for 21% of the time and produced an equivalent sound level of 53 dBA.

What is less obvious from the time varying sound level is the almost continuous presence of road vehicle sounds. Because an observer was present throughout the measurement making a second-by-second log, it is possible to determine when the various sources were audible. Road vehicles were audible 61% of the time. Even though for most of the time the sound levels were low (15 dBA to 25 dBA) this is clearly an hour when the natural soundscape was rarely solely audible – only 10% of the time.

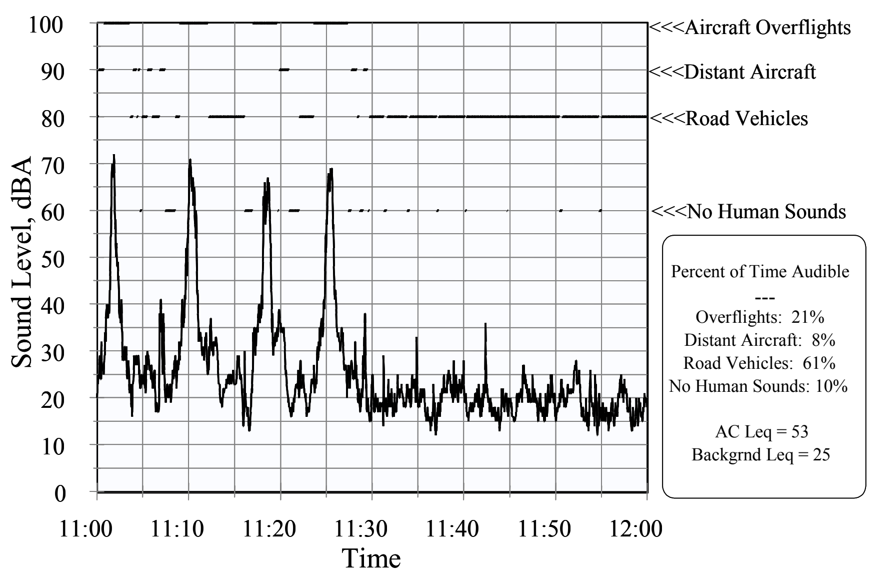

Figure 7 One Hour of One-Second Sound Levels, White Sands National Park

Figure 8 shows a second hour of data collected at the same site when no aircraft flew overhead. Even though the sound levels were slightly higher, there was considerable time, 57% of the time, when no human-produced sounds were audible; that is, the natural soundscape existed without intrusions for 57% of the hour.

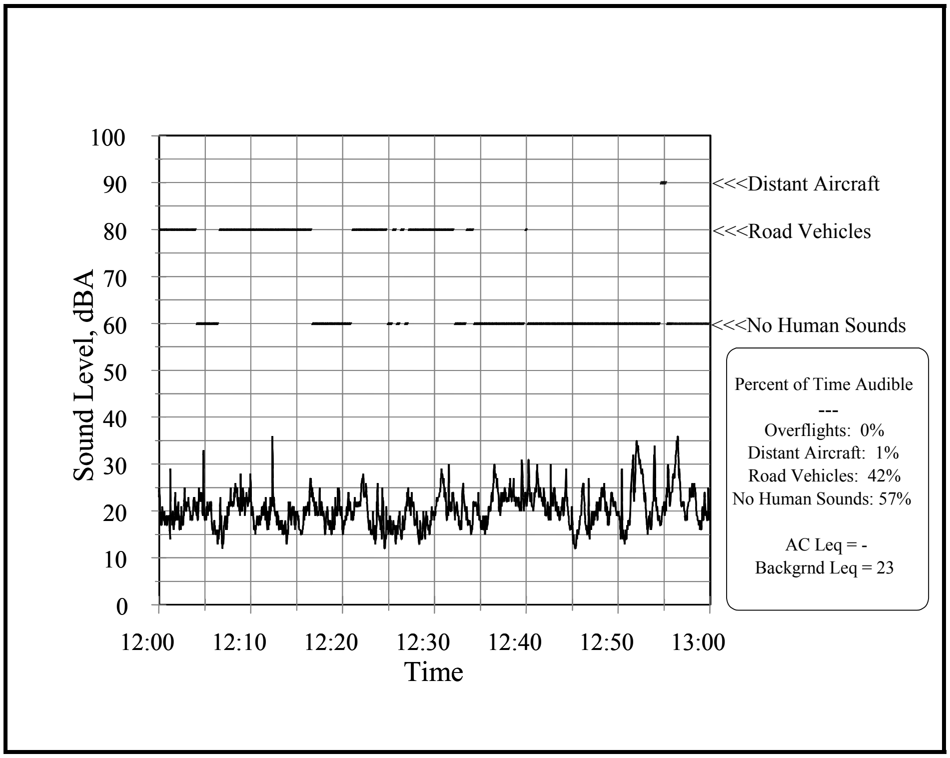

Figure 8 Second One-Hour Sample of Sound Levels, White Sands National Park

These two figures show that determining the presence or absence of intrusions is either a labor-intensive process, requiring a full-time observer to identify sources, or one that requires more sophisticated methods than basic A-weighted monitoring. One possibility for determining whether sounds are of natural or human origin is the monitoring of spectral data. Many sources have characteristic spectra, and it is these spectra that make a source audible to a listener. Figure 9 provides an example of the value of collecting spectral data.

A source becomes audible to a listener when the sound levels in one or more narrow frequency bands (approximately one-third octave bands) approach or exceed the background sound levels in the same band or bands. [21] Figure 9 presents a hypothetical situation of a propeller aircraft spectrum overlaid on a Grand Canyon background spectrum at the level when the aircraft would just be detectable by an attentive listener. Though measurements of such a situation will naturally show only one level for each frequency band, it is possible through continuous time analysis to identify increases in specific bands that indicate the approach of an intruding source of sound.

Figure 9 also identifies an important consequence of using audibility of sounds as a metric. Audibility, as mentioned, depends upon frequency. A-weighted levels lose the frequency information and result in a single number. Figure 9 shows the A-weighted sound level of the background to be 17.0 (dBA) and the A-weighted level of the aircraft to be 6.5 (dBA). Thus, in this example, the intruding sound of the aircraft is just audible when the A-weighted level of the aircraft is 10.5 dB lower than the level of the background. Thus, though it may be confusing, it is nevertheless correct to say that an intrusion can be audible when it is 10 dB quieter than the background sound level, if the levels are A-weighted.

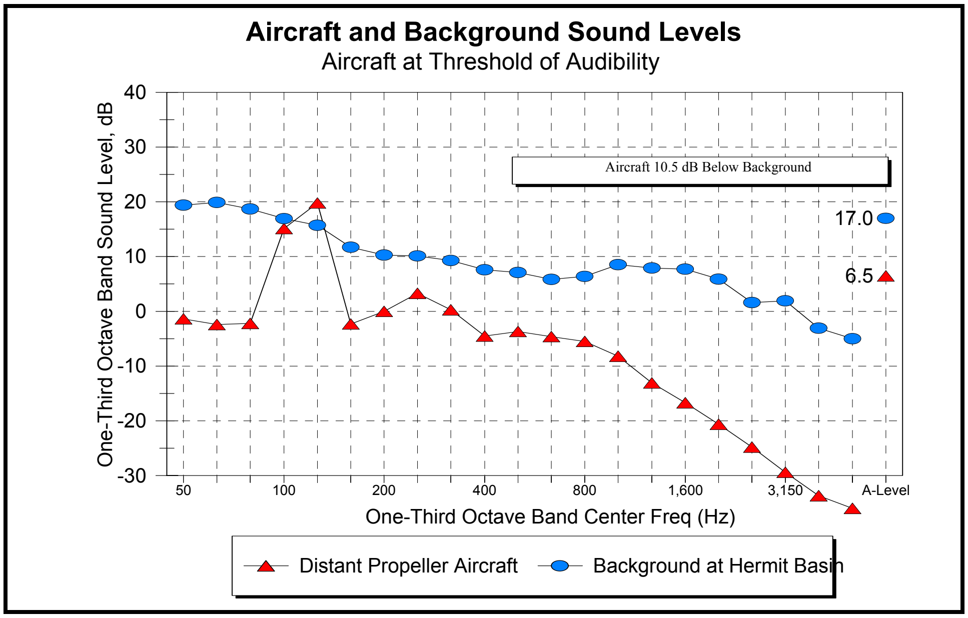

Figure 9 Example Aircraft Spectrum Compared with Background at Threshold of Audibility

One additional complicating factor related to choosing appropriate metrics of public land soundscapes is the relationship of the intruding sound to the sound levels that exist when no intrusion sound is present. Studies relating visitor response to the sounds of tour aircraft have shown that metrics that correlate best with human reaction are measures of the difference between the aircraft and background sounds. [22] [23] [24] Typical correlated metrics can be a difference in decibels, such as the equivalent level of the intrusion minus the equivalent level of the background, or a measure of the duration of the intrusion, such as the percent of time the intrusion was audible. These metrics are quite different from the metrics commonly measured and computed for analysis of environmental noise and will require new methods and new understanding.

4.1.2 Where to Measure

Parks can be very large, containing thousands to millions of acres (Grand Canyon is about 1.2 million acres), and there are over 300 units of the National Park system. Both within parks and from park to park, there are tremendous variations in geology, topography, vegetation, sensitive wildlife species, visitor activities, infrastructure or the lack of it, etc.

Large size complicates selection of acoustic data collection sites. The existing soundscape includes all natural and human-produced sounds in the park. Currently, the approach, yet to be fully validated, is to assume that parks contain multiple different "acoustic zones." It is assumed that areas having similar topography, foliage, wildlife habitats, and water drainage or flow conditions should have similar natural soundscapes. If a park can be divided *a priori* into different acoustic zones then measurements made at a few or several locations within each zone would be sufficient to quantify the existing natural soundscape. Figure 10 shows how the Grand Canyon may be divided into zones likely to be related to types of natural soundscapes. Full statistical validation of this concept of acoustic zones is likely to occur only after long-term (months-long) monitoring has been completed in many park environments.

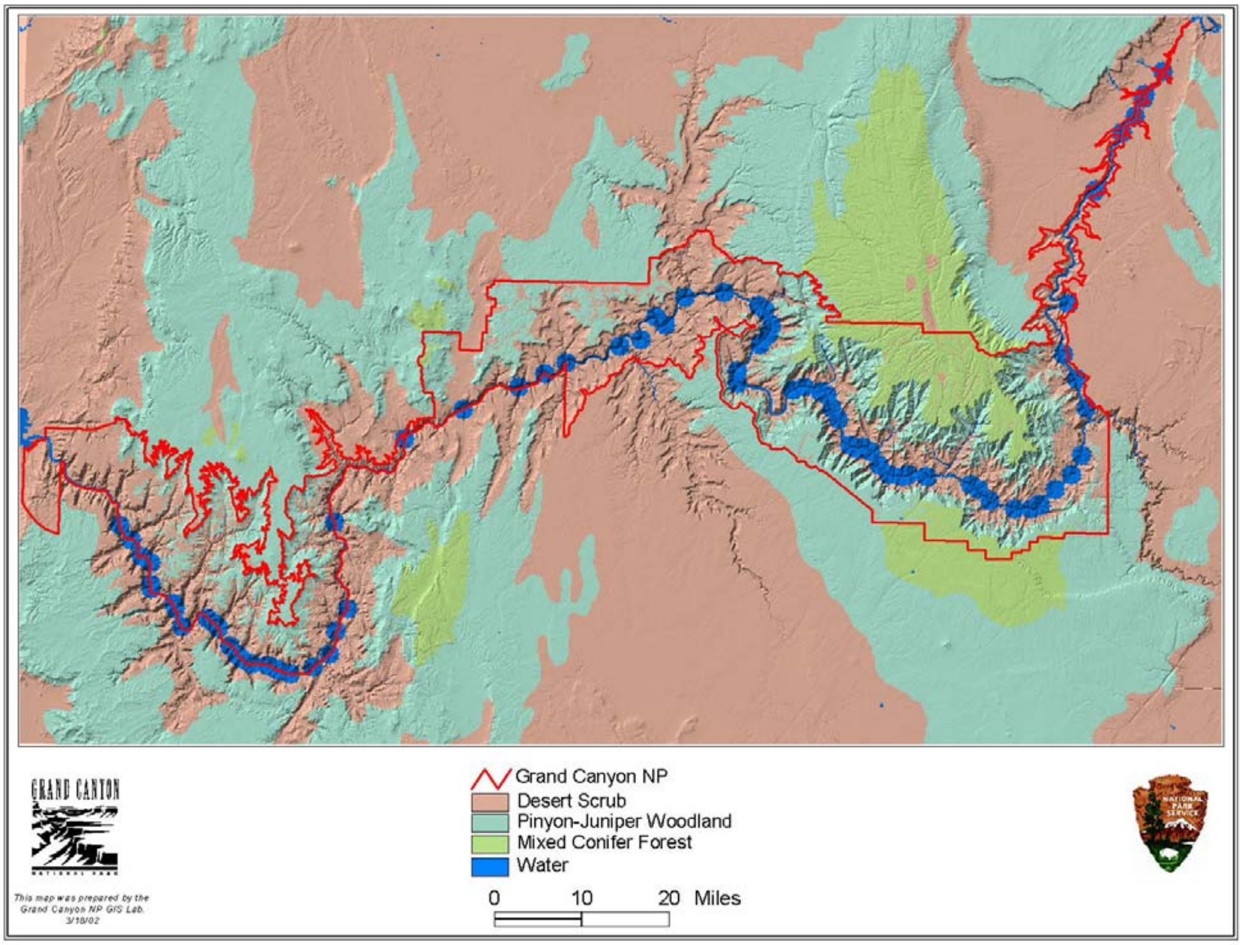

Figure 10 Division of Grand Canyon NP into Different Acoustic Zones

4.1.3 When and How Long to Measure

Different parks may have different periods of interest, depending upon the soundscape management objectives. Also, the periods of interest may be quite long, varying from several months to an entire year. Determining the periods of interest is a park management responsibility and these determinations would presumably include consideration of what times / days / seasons the intrusions are judged to be present or are expected to be present, and what times / days / seasons are most sensitive to intrusions.

Once the time period or periods of interest are determined, the appropriate length for the measurement remains unknown. Should the measurement be conducted continuously for each full period of interest, or is a limited time of measurement, say one or two weeks sufficient? It is likely that initial measurements should be made for as much of the full time period of interest as possible, recognizing that available staff and equipment will limit the duration of the measurements. This large amount of data is necessary because, prior to measurements, the variability of the natural soundscape will be unknown. The measurements will be used, not only to show what sound levels and sound sources were present, but how the sounds changed over time.

Figure 11 presents an example of the time variation of the sound metric hourly L_{90} over a period of about 2½ months in Canyonlands National Park. [25] In this location and for this time period, one measurement of one or even two weeks would clearly have yielded an incomplete assessment of the variability of the sound levels. Perhaps it is more appropriate to ask not "How long should measurements be?" but "What are the 'acoustic seasons' and how long do they last?" Simple statistical tests suggest that visual inspection of time histories like that of Figure 11 are adequate for determining periods of constancy and periods of change. The real challenge is identifying the sources of the sound levels and the causes of the changes.

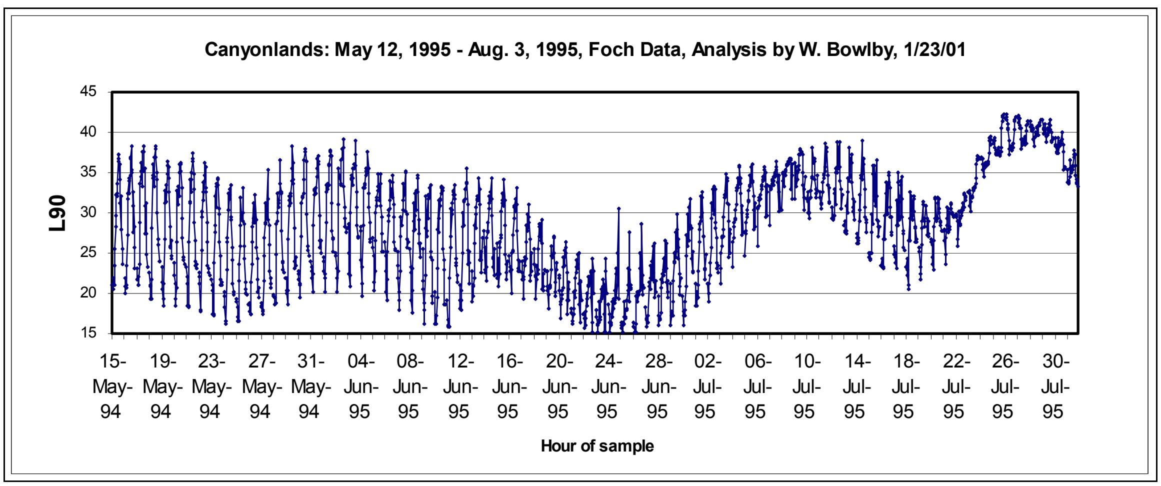

Figure 11 Example Variation of Sound Metric with Time, L_{90}, dBA

4.2 Low Levels of Natural Soundscape

The natural soundscapes in parks can have sound levels that are very low in comparison with typical levels experienced in common living and working outdoor environments. Figure 12 depicts possible relationships of these various levels.

These low levels raise technical issues, while also making management of park soundscapes more difficult. Specific technical issues include selecting equipment and methods that will yield accurate results. Off-the-shelf acoustic instrumentation may have insufficient sensitivity to accurately detect and record low sound levels. Winds of even relatively low speeds can induce turbulent noise at microphone windscreens resulting in spurious sound level data. Winds can also significantly alter the sounds generated by foliage and vegetation, thus requiring measurement methods capable of determining why sound levels have changed.

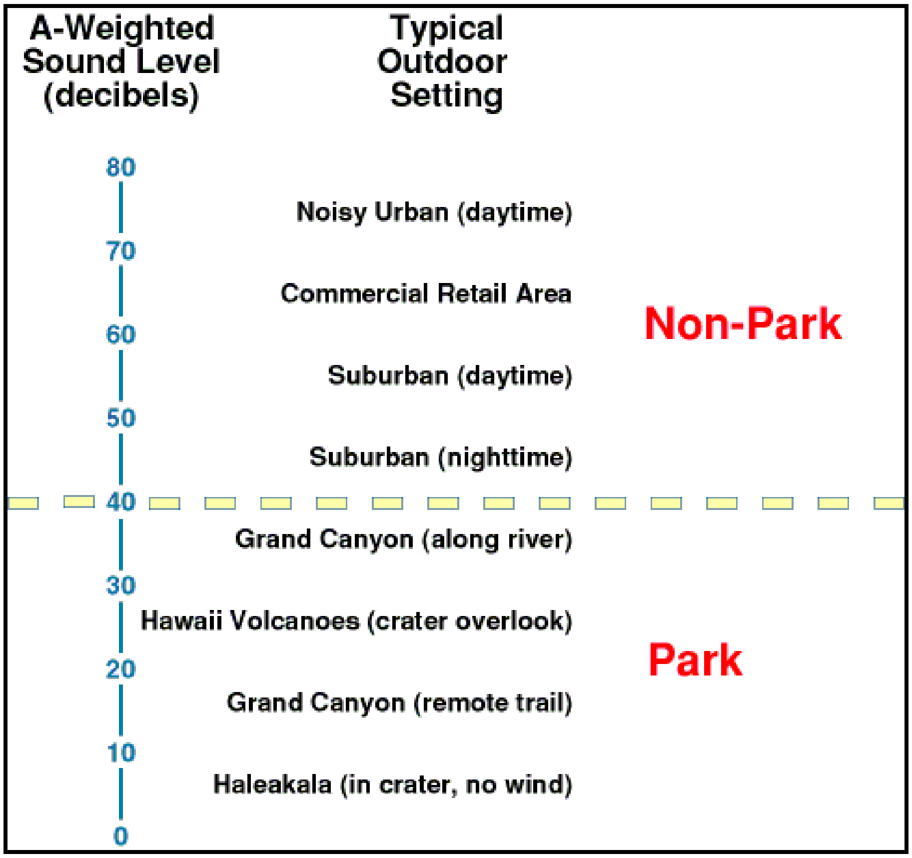

Figure 12 Comparison of Various Common Outdoor A-Weighted Levels in Different Environments

Finally, the low natural sound levels mean that very distant sources of sound may be audible. In most environmental noise analyses, the area over which the sound levels are of concern are generally confined to lie within hundreds of feet of, or at most within a few thousand feet of the source under investigation. Where natural background sounds are commonly below 20 dBA, however, a source such as a snowmobile may be audible at distances of 2 to 3 miles [26], and an aircraft may be audible as far away as 10 to 12 miles. If hearing an intrusion is considered an impact, then impacts may extend over very large areas, and mitigation of impacts could entail significant limitations on where, when and how the intruding sources may be operated.

4.3 Judging the Effects of Intrusions

Resolution of the technical issues will take time and trial, and their solution will provide decision makers with, at best, some objective data on which to base judgments of the effects of intruding sounds. Non-natural sounds may alter not only the experiences of recreationists or visitors to parklands, but may also have adverse effects on wildlife and wildlife habitats. Intruding sounds can also adversely affect cultural and historic settings, or disrupt tribal religious ceremonies. In general, parkland management will need to develop policies that identify the appropriateness or inappropriateness of human-produced sounds in specific settings and locations during specific times. Some quantitative guidance may be derived from such tools as acoustic measurement results, visitor surveys and wildlife research, but developing specific soundscape management policies will require considerable coordination among managers and, ultimately, agreement on what will be informed subjective judgments of appropriateness, if the policies are to be uniformly applied and be effective.

5. Recent Efforts at Managing Natural Soundscapes

Three examples of on-going efforts to manage human-produced sounds in U.S. National Parks provide insights on the conflicts that appear to be inherent in soundscape management.

5.1 Air Tours

In August 1987 Congress enacted the Overflights Act. [27] Section 3 of the Act states that "noise associated with aircraft overflights at the Grand Canyon National Park is causing a significant adverse effect on the natural quiet and experience of the park…." In this act, Congress required the Secretary of Transportation, the Federal Aviation Administration, the Secretary of the Interior, and the National Park Service, to work toward the goal of providing for "substantial restoration of the natural quiet" in the Grand Canyon. Former President Clinton, in an Earth Day memorandum directed that the restoration of the natural quiet be achieved by 2008.

Reports, proposed rules and notices were developed over the subsequent years. On December 31, 1996, the FAA issued a final rule and proposed two additional rules. The Final Rule adopted three NPS definitional determinations: 1) the appropriate measure for quantifying aircraft noise was the percentage of time that aircraft are audible; 2) an aircraft was audible if it increased the ambient noise level by three decibels; and 3) the phrase "substantial restoration of the natural quiet" requires that 50% or more of the park achieve "natural quiet" (no aircraft audible) for 75-100 percent of the day. It also established new and modified existing flight free zones, established new and modified existing flight corridors, instituted flight curfews, set caps on the number of aircraft that can fly in the park and established reporting requirements. The two proposed rules were 1) to establish new and modify existing flight routes and 2) to require operators to use quieter (and larger) aircraft.

Litigation regarding the Final Rule in November 1997 addressed differing concerns. The Air Tour Coalition argued that the Rule was too restrictive in its meaning of "natural quiet" and in what should be used to determine quiet and visitors' disturbance. Clark County, Nevada felt that the flight free zones were issued too soon; they should have been proposed in association with the new flight corridors and tour routes. The Hualapai Tribe also argued that the Final Rule was promoted too soon and that it failed to consider whether the establishment of expanded flight free zones would push aircraft noise off the Park and onto the Hualapai Reservation.

Since that time, the FAA has made further steps to enact the Rule. Each step that they have taken has been challenged either by those who criticize that the Park Service is going too far (the Air Tour Industry) or is moving too slowly (environmentalists).

5.2 Snowmobiles

The Park Service Organic Act of 1916 established the National Park Service and stated that parks should be maintained "unimpaired for the enjoyment of future generations." [14] In May of 1997 a group of environmental organizations sued the NPS over the Winter Use Plans at Yellowstone and Grand Teton National Parks, specifically over the use of snowmobiles. They felt the NPS was "putting tourists ahead of the natural beauty." They stated that the NPS failed to conduct adequate analysis under NEPA and failed to take into account the threat on endangered species and wildlife of grooming trails. As part of the settlement the NPS was required to consult with the EPA to regulate snowmobile emissions, with OSHA to look in to excessive carbon monoxide emissions for park staff, and with the NTSB to study accidents involving snowmobiles. The Park Service selected Alternative B from the draft EIS – which would allow public shuttle buses, instead of snowmobiles, to use the west entrance. However, snowmobiles would be allowed to use other trails.

In response to the draft EIS, the Bluewater Network, an association of organizations which want to preserve the natural quiet, petitioned the NPS to consider a total ban on snowmobiles in order to protect "wildness, natural sounds and solitude." In response to this action a Final EIS (FEIS) was published October 2000 and Alternative G – the elimination of recreational snowmobile use by 2003 / 2004 and the initiation of snowcoaches for winter use – was selected by the NPS.

In response to the findings of the FEIS, The International Snowmobile Manufacturers Association, along with the State of Wyoming, the Wyoming State Snowmobile Association, and the BlueRibbon Coalition, an organization of manufacturers of recreational vehicles and individual recreationists, sued the Secretary of the Interior to maintain the use of snowmobiles on public lands. The Supplemental EIS, produced as result of the litigation, is currently open for public comment. The BlueRibbon Coalition advocates the selection of Alternative 2, which proposes a reservation system for snowmobilers, with daily caps based on historic average use levels; the use of 4-stroke and clean 2-stroke snowmobiles; regulation of snowmobile sound – at a "reasonable" level; and a speed limit of 35 mph for safety.

5.3 Personal Water Craft

The National Park Service began examining the use of personal watercraft (pwc) in the parks in 1996. In 1997, the Bluewater Network, along with over 65 environmental and recreational groups and over 6,000 individuals, petitioned the NPS to create strong regulations. On March 21, 2000, the NPS published a regulation in the Federal Register, which banned personal watercraft (PWC) in 66 of the 87 national parks. The remaining 21 parks were given 2 years to work with the public in deciding on pwc use in their parks.

In April 2001, after further litigation by the Bluewater Network, the NPS agreed to do full environmental assessments under the National Environmental Policy Act. If the analyses were not done by the deadlines, April 2002 for 13 parks and September 2002 for 8, the parks were to be closed to pwc use until the rules were issued.

The Personal Watercraft Industry Association (PWIA) attempted to intervene in the lawsuit, but was denied the opportunity because the court felt that the rulemaking process required by the settlement allowed for public comment. The PWIA would be able to comment at that time. The PWIA believes that the industry has made great advances in pwc technology since 1998. According to the PWIA website (http://www.pwia.org/), "Today's personal watercraft are 75% cleaner and as much as 70% quieter."

On March 5, 2002, the National Parks, Recreation & Public Lands Subcommittee of the House Resources Committee passed HR 3853, which included a section to extend the deadline for the environmental assessments an additional two years, to December 31, 2004, for all 21 parks. This would allow for more accurate environmental studies. It must still pass through the full Resources Committee and a floor vote.

6. Can Natural Soundscapes be Preserved?

There has long been recognition that portions of the nation's natural heritage should be preserved, and the extent of transportation noise throughout the U.S. emphasizes the importance and difficulty of this preservation as applied to natural soundscapes. Yet several current attempts to preserve / restore natural soundscapes in National Parks are being strongly resisted through both political and legal means. From an acoustical perspective, the technical complexities of characterizing and assessing natural soundscapes are significant and open many opportunities for dispute. This combination of significant resistance and significant complexity suggests that development of a uniform, feasible, effective soundscape management approach will at best be extremely difficult and time consuming.

7. References

1. B. Berglund & T. Lindvall, Community Noise, A*rchives of the Center for Sensory Research,* Volume 2, Issue 1**,** 1995.
2. B. Berglund, T. Lindvall, D.H. Schwela, Guidelines for Community Noise, World Health Organization, Geneva, 1999.
3. HME Miedema, "Noise & Health: How Does Noise Affect Us?", Proceedings, InterNoise 2001, August 27-30, The Hague.
4. Commission of the European Communities, Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL relating to the Assessment and Management of Environmental Noise, COM (2000) 468 final, 26.07.2000.
5. R. M. Schafer, "The Tuning of the World," McClelland & Stewart, 1977
6. R. Stanton, Director's Order #47, "Soundscape Preservation and Noise Management", U.S. National Park Service, December 1, 2000.
7. As used here, "notice" has a specific definition based on signal detection theory and associated laboratory and field developed data that relates human detection of "target" sounds masked by background "noise". [See for example, Green, D.M. and J.A. Swets, "Signal Detection Theory and Psychophysics," Peninsula Publishing, 1988.] This theory and the derived calculations have shown that, for broad-band sources such as jet aircraft or road traffic vehicles, human detection of these in the presence of typical human-activity

influenced background noise occurs when the source in terms of A-weighted levels, is about 5 to 10 dB below the A-weighted level of the background noise. [See Miller, N.P. "A-weighted Level Differences Compared with Detectability" in April 25, 1997 memorandum to W. Henry, National Park Service, published in "Review of Scientific Basis for Change in Noise Impact Assessment Method Used at Grand Canyon National Park," National Park Service, DOI, January 2000.] Further, laboratory experiments have demonstrated that people engaged in a specific activity demanding concentration are about 10 dB less likely to identify an intruding sound than when they are intent on listening for the sound. [See Potter R.C. *et al*, "Detectability of Audible Warning Devices on Emergency Vehicles," Bolt Beranek and Newman Inc. Report No. 3333, July 1976.] This result is interpreted here to mean that noise from a transportation corridor is noticeable when its maximum level is approximately equal to or greater than the background sound level, in A-weighted terms.

8. Because there are multiple corridor "segments" within each county, a method was needed to sum the areas of noticeability for all segments without double counting overlapping areas. The method used was to first compute the area lying within the "noticeability" width for each corridor segment located within the county. By assuming these segments are randomly distributed throughout the county, the overlap of the areas of noticeability were computed statistically then subtracted from the total area of noticeability for all segments in the county. This method will overestimate the area in which the corridor segments are noticeable to the extent that the segments are parallel and lie close to each other, and will underestimate the area of noticeability to the extent that the segments are parallel and widely separated.

9. •Highway traffic noise is generally computed using the Federal Highway Administration's Traffic Noise Model, TNM, as describe in Anderson, G.S., C.S.Y. Lee, G.G. Fleming, and C.W. Menge, "FHWA Traffic Noise Model, Version 1.0 User's Guide". Federal Highway Administration Report No. FHWA-PD-96-009, January 1998.
   •Rail noise and vibration prediction methods and assessment are described in "Transit Noise and Vibration Assessment," DOT-T-95-16, Federal Transit Administration, April 1995.
   •Aircraft noise is computed for commercial aviation using the Federal Aviation Administration's program, the Integrated Noise Model, INM, described in "INM User's Guide," FAA-AEE-99-03, September 1999.

10. For each transportation network the sound levels for the following sources were used to determine maximum distances of noticeability. The sound levels were taken from the methods described in endnote 9.

    Highway–
    Primary, limited access roads – L_{max} for Heavy Truck at 65 mph, 86 dBA @ 50 ft.
    Primary, unlimited access roads – L_{max} for Medium Truck at 50 mph, 79 dBA @ 50 ft.
    Secondary roads – L_{max} for Auto at 50 mph, 72 dBA @ 50 ft.

    Rail-
    Diesel Locomotive – L_{max} for 50 mph, 88 dBA @ 50 ft.

    Aircraft –
    Boeing 737-400, SEL for level cruise, 30,000 MSL, converted to L_{max} using measured data of B727 departures, ~85 dBA@ 1000 ft..

11. U.S. Environmental Protection Agency. "Population Distribution of the United States as a Function of Outdoor Noise Level," Report 550/9-74-009, June 1974.

12. C. M. Stewart, W.A. Russell, G.A. Luz, “Can population density be used to determine ambient noise levels?, paper presented 137th Meeting Acoustical Society of America, Berlin, Germany, March 1999.
13. Wyle Laboratories, “Community Noise,” EPA Report NTID300.3, December 31, 1971.
14. 16 USC. §§ 1-18f, 39 Stat. 535, the National Park Service organic act of 1916.
15. 16 U.S.C. §§ 1, 1a-1, Public Law No. 95-250, Redwoods Act of 1978.
16. 16 U.S.C. §§ 1131-36, Public Law No. 88-577, Wilderness Act of 1964.
17. 16 U.S.C. 1271- 1287 as amended, Public Law 90-542, Wild and Scenic Rivers Act of 1968
18. Bureau of Land Management, “Upper Missouri National Wild & Scenic River, maps 1&2, Floater’s Guide” GPO 1980 699-878.
19. J.L. Sax, “Mountains without Handrails,” The University of Michigan Press, 1980.
20. Personal communications with Gordon Hempton, The Sound Tracker
21. D.M.Green and J.A. Swets, “Signal Detection Theory and Psychophysics,” Peninsula Publishing, 1988.
22. Anderson, G.A., et al, “Dose-Response Relationships Derived from Data Collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks, HMMH Report No. 290940.14, NPOA Report No. 93-6, October 1993.
23. N.P. Miller, et al, “Mitigating the Effects of Military Aircraft Overflights on Recreational Users of Parks,” USAF Report AFRL-HE-WP-TR-2000-0034, (or DTIC ADA379467 at http://www.ntis.gov/), July 1999.
24. Fleming, et al, “Development of Noise Dose/Visitor Response Relationships for the National Parks Overflight Rule: Bryce Canyon National Park,” DOT-VNTSC-FAA-98-6, July 1998.
25 . Special thanks to James Foch of Foch Associates who measured the sound levels, and to William Bowlby of Bowlby & Associates Inc. who plotted the data.
26. Ross, J.C. and C.W. Menge, “Technical Report on Noise: Winter Use Plan Final Environmental Impact Statement,” HMMH Report 295860.18, June 2001.
27. 16 U.S.C. 1a-1 note, Public Law No. 100-91.