

PARKScience

Integrating Research and Resource Management in the National Parks

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SPECIAL ISSUE: SOUNDSCAPES RESEARCH AND MANAGEMENT

Understanding, protecting, and
enjoying the acoustic environment
of our national parks

- **Measuring and monitoring park soundscapes**
- **Overflights management**
- **Profile: Acoustic Scientist Kurt Fristrup**
- **Consequences of noise to wildlife**
- **A quiet zone at Muir Woods**
- **Planning for soundscapes protection**

ON THE COVER

A lone hiker explores the wilderness shore of Shi Shi beach at Olympic National Park, Washington. The experience is characterized by solitude to be sure, but not by silence. Rather, a rich suite of natural sounds envelops the hiker: waves breaking on the shore, wind in the trees, birds calling, deer munching grass, and even gently shifting grains of wind-blown sand. Protecting the sounds of nature is an increasingly important priority of national park managers. This photograph by Pablo McCloud was a winning entrant in the recent NPS-Olympus Photo Contest—2009.



From the Guest Editors

From landscapes to soundscapes: Introduction to the special issue

By Peter Newman, Robert Manning, and Karen Treviño

A GROWING BODY OF RESEARCH HAS DOCUMENTED THE

potential impacts of outdoor recreation and other activities in national parks and related areas (Hammit and Cole 1998; Leung and Marion 2001). These impacts apply to multiple components of the landscape, including soil, vegetation, water, and wildlife. For example, visitors to parks can trample fragile vegetation, compact and erode soils, pollute water, and disturb wildlife. Moreover, there are often aesthetic implications of these impacts that can degrade the quality of the visitor experience (Manning et al. 2004). Research and management attention has logically extended from conventional landscapes to “soundscapes,” or the acoustic environment, and includes consideration of aural impacts of human-caused noise.

Impacts of noise are increasingly pervasive

Excessive anthropogenic noise is becoming increasingly pervasive in society (Goines and Hagler 2007). Noise pollution can affect the physical and mental well-being of people through psychological annoyance, interference with speech, interruption of sleep, disruption of cognitive processes, temporary or permanent hearing disorders, and negative impacts on the cardiovascular and endocrine systems (Gramann 1999; Goines and Hagler 2007). Anthropogenic noise exposure can also significantly detract from the experience of visiting a national park. For example, significant decreases in scenic evaluations have been reported in association with the presence of anthropogenic sounds (Benfield et al. 2009, 2010).

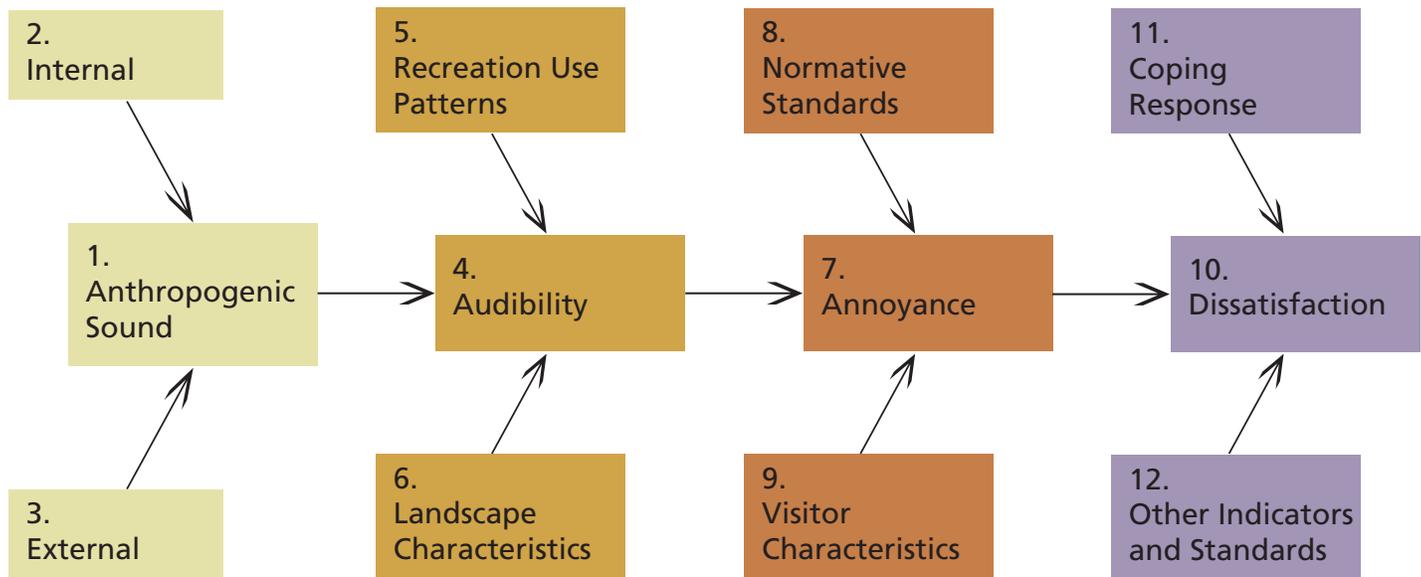
Research has also begun to explore the restorative effects of natural environments, including the sounds of nature (Anderson et al. 1993; Tarrant et al. 1995). For example, people who have been exposed to cognitive fatigue reported higher positive emotional states and performed better on mental tasks after walking in a park, and these restorative effects were higher than for other treatments, such as walking in an urban area, reading, and listening to music (Hartig et al. 2003). Increased noise levels can also reduce the distance and area over which wildlife can detect changes in sounds. Research now indicates that human noise intrusions can produce substantial changes in wildlife behavior, breeding, and species success (Rabin et al. 2006).

Evolution of soundscapes as a management concern

With greater knowledge and understanding of the important role the acoustic environment plays in overall ecosystem health and visitor enjoyment as well as the potential impacts of anthropogenic noise, protection of the acoustic environment has received growing attention by managers and policy makers. In 1972, the Noise Control Act required that the federal government establish and enforce noise controls in work and other places, including national parks. Subsequent legislation to limit air tours and enforce minimum flight altitudes (to limit noise) was enacted for national parks such as Grand Canyon and Hawai'i Volcanoes. Legislation from the 108th Congress also limited snowmobile use at Yellowstone and Grand Teton national parks, and this has led to improved technology designed to reduce noise caused by snowmobiles, aircraft, and other forms of mechanized travel in national parks and related areas (Sheikh and Uhl 2004).

In 1987, the National Parks Overflights Act was passed by Congress and required assessment of noise impacts of overflights in national parks. In response, Grand Canyon National Park is developing an air tour management plan to ensure public safety and substantially restore natural quiet. In its 2003 *Federal Register* notice, the park defined substantial restoration of natural quiet as 50% or more of the park's airspace being free of aircraft noise for at least 75% of the day. Additionally, it specified that minimum flight altitudes must be observed and defined routes must be followed by air tour operators (Schwer et al. 2000).

Though the topic of noise was first addressed in the 1978 edition of *NPS Management Policies* (and later updated in 1988), the 2001 policies revision devoted an entire section to the protection of the acoustic environment as a resource just like air, water, and wildlife (National Park Service [NPS] 2001, section 4.9). Chapter 8 on "Visitor Use" also describes the importance of the acoustic environment to visitor enjoyment and states that recreation, including motorized recreation, cannot intrude on the opportunity to hear the sounds of nature in units of the National Park System or interfere with park interpretive talks. In 2000, Director's Order 47 (NPS 2000) was promulgated as a precursor to the pending management policies and further "requires, 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 order specifies how parks should monitor and plan to protect park soundscapes. The current version of *NPS Management Policies* (NPS 2006, section 5.3.1.7) added yet another section establishing the concept of "cultural soundscapes" for NPS protection.



Understanding soundscapes

Since 2003, the NPS Natural Sounds Program has partnered with researchers and acoustic science practitioners to better understand the challenges and benefits of protecting soundscapes. These partners have formed the core of a working group made up of university researchers and students, consultants, and NPS planners and managers to study the relationships among sound/noise, society, and ecosystems. In spring 2006 and fall 2007, workshops were held in Fort Collins, Colorado, cosponsored by the National Park Service and Colorado State University, providing a forum for planners, managers, and researchers to collaborate in organizing an approach to protecting soundscapes in national parks. One of the action items arising from these workshops was to prepare a special issue of *Park Science* addressing understanding and management of soundscapes in the national parks.

The workshops have developed an evolving conceptual model of soundscapes in parks that is related to similar models of human-caused impacts to parks and protected areas (Manning 1999). The model in figure 1 suggests that anthropogenic sounds (box 1) can emanate from both inside (e.g., park visitors, park administration, and services; box 2) and outside (e.g., aircraft; box 3) parks. The audibility

of anthropogenic sounds (box 4) can be affected by recreation use patterns (e.g., recreation activities, behavior; box 5) and landscape features (e.g., topography, vegetation; box 6). Audible human-caused sounds can lead to annoyance (box 7), but this relationship is mediated by normative standards of visitors (societal judgments about acceptable conditions in parks; box 8) and related visitor characteristics (e.g., visitor motivations; box 9). This is the point at which the objective measure of sound becomes the more subjective notion of noise. When anthropogenic sounds are judged to be annoying (or otherwise undesirable), they can lead to dissatisfaction (box 10) with the quality of the park experience. But this can be mediated by a variety of cognitive and behavioral coping responses by visitors (box 11). For example, some visitors might be displaced from the park because it is too noisy, so they are no longer present to register their dissatisfaction. Moreover, soundscape-related issues are only one of potentially many indicators that might affect the quality of the visitor experience (box 12), and soundscape-related indicators may be more or less important depending on the context of the park. Though this model was constructed primarily from the standpoint of visitor impacts of human-caused noise, it might also be useful in the context of wildlife-related concerns. For example, stress might be substituted for annoyance,

Figure 1. This model of soundscapes is conceptual and evolving, but provides a way to begin to organize and integrate multiple themes of research taking place in park units across the country. This systems approach allows park managers and researchers to explore the complex web of soundscapes and their intricate relationships with visitors, wildlife, and society that make up our National Park System.

and impacts on feeding, reproductive, and migratory processes might be substituted for dissatisfaction.

Special issue

The articles in this special issue of *Park Science* address multiple components of this conceptual model. For example, Fristrup et al. (page 32) illustrate the science of measuring and monitoring anthropogenic sounds in national parks, including a variety of metrics associated with audibility. Manning et al. (page 54) describe research to identify normative standards for visitor-caused noise at Muir Woods National Monument and the efficacy of a series of experimental educational programs designed to influence visitor behavior and reduce visitor-caused noise. Park et al. (page 59) use a computer-based simulation model of road corridor noise at Rocky Mountain National Park to demonstrate the effects of landscape characteristics on the audibility of noise. Barber et al. (page 26) examine how human-caused

noise can cause stress in wildlife, affecting reproductive success and predator-prey relationships. Such stress can lead to coping behaviors, but some species may not be able to adjust to increased levels of noise. Bell et al. (page 65) focus on the noise caused by aircraft overflights and explain the way in which the source of such noise can influence annoyance, normative standards for the maximum acceptable levels of noise, and visitor attitudes toward alternative management actions. McCusker and Cahill (page 37) describe the ways in which the National Park Service is addressing soundscape-related issues in park planning and management. Finally, this issue includes six “case studies” that demonstrate how park staff are managing and mitigating issues related to noise in national parks across the country (pages 42–53).

References

- Anderson, G., R. Horonjeff, C. Menge, R. Miller, W. Robert, C. Rossano, G. Sanchez, R. Baumgartner, and C. McDonald. 1993. Dose-response relationships derived from data collected at Grand Canyon, Haleakala and Hawaii Volcanoes National Parks. NPOA Report No. 93-6/HMMH Report No. 290940.14. Harris, Miller, and Hanson, Inc., Lexington, Massachusetts, USA.
- Benfield, J. A., P. A. Bell, L. J. Troup, and N. C. Soderstrom. 2009. Aesthetic and affective effects of vocal and traffic noise on natural landscape assessment. *Journal of Environmental Psychology*, in press. Available from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WJ8-4XFY0KW-1&_user=1493582&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_acct=C000053133&_version=1&_urlVersion=0&_userid=1493582&md5=d39d8e590ca5941696f84097ca5b37dc.
- Benfield, J. A., P. A. Bell, L. J. Troup, and N. C. Soderstrom. 2010. Does anthropogenic noise in national parks impair memory? *Environment and Behavior*, in press. Available from <http://eab.sagepub.com/cgi/rapidpdf/0013916509351219v1>.
- Goines, L., and L. Hagler. 2007. Noise pollution: A modern plague. *Southern Medical Journal* 100(3):287–294.
- Gramann, J. 1999. The effect of mechanical noise and natural sound on visitor experiences in units of the National Park Service. *Social Science Research Review* 1(1):1–16.
- Hammit, W., and D. Cole. 1998. *Wildland recreation: Ecology and management*. John Wiley, New York, New York, USA.
- Hartig, T., G. Evans, L. Jamner, D. Davis, and T. Garling. 2003. Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology* 23(2):109–123.
- Leung, Y., and J. Marion. 2001. Recreation impacts and management in wilderness: A state-of-knowledge review. *Proceedings: Wilderness Science in a Time of Change*. USDA Forest Service Proceedings RMRS-P-15-Vol-5.
- Manning, R. 1999. *Studies in outdoor recreation*. Oregon State University Press, Corvallis, USA.
- Manning, R., S. Lawson, P. Newman, M. Budruk, W. Valliere, D. Laven, and J. Bacon. 2004. Visitor perceptions of recreation-related resource impacts. Pages 261–273 *in* R. Buckley, editor. *Environmental impacts of ecotourism*. CAB International, Cambridge, Massachusetts.
- National Park Service. 2000. Director’s order #47: Soundscape preservation and noise management. Accessed 16 December 2009 from <http://www.nps.gov/policy/DOrders/DOrder47.html>.
- . 2001. Management policies 2001. U.S. Department of the Interior, National Park Service, Washington, DC, USA.
- . 2006. Management policies 2006. U.S. Department of the Interior, National Park Service, Washington, DC, USA. Accessed 16 December 2009 from <http://www.nps.gov/policy/MP2006.pdf>.
- Rabin, L. A., R. G. Coss, and D. H. Owings. 2006. The effects of wind turbines on antipredator behavior in California ground squirrels (*Spermophilus beecheyi*). *Biological Conservation* 131:410–420.
- Schwer, R., R. Gazel, and R. Daneshvary. 2000. Air-tour impacts—the Grand Canyon case. *Annals of Tourism Research* 27(3):611–623.
- Sheikh, P., and C. Uhl. 2004. Airplane noise: A pervasive disturbance in Pennsylvania Parks, USA. *Journal of Sound and Vibration* 274(1–2):411–420.
- Tarrant, M. A., G. E. Haas, and M. J. Manfredo. 1995. Factors affecting visitor evaluations of aircraft overflights of wilderness areas. *Society and Natural Resources* 8(4):351–360.

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