

## Understanding and Managing Soundscapes in National Parks: Part 3 – Computer Simulation

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### Introduction

Natural sounds are increasingly being recognized both as a natural resource of national parks and related protected areas to be conserved, as well as an integral part of visitors' experiences of parks and protected areas. For example, in response to growing concern about the effects of scenic air tours on the "soundscapes" within national parks and visitors' enjoyment of natural sounds, the U.S. National Park Service established a Soundscapes Program Center to assist parks in developing air tour and soundscape management plans. Furthermore, recent studies of national park visitors have found that enjoyment of quiet, solitude, and natural sounds adds to the quality of the visitor experience, while human-caused noise can interfere with visitors' enjoyment.

Recent research at Muir Woods National Monument (California), a unit of the U.S. National Park System, was designed to enhance understanding and management of the park's soundscape. This research was designed using the framework of indicators and standards as developed in contemporary park management and carrying capacity frameworks, including Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protection (VERP). The first phase of research was conducted to measure and analyze the natural and human-caused sounds that visitors hear in the park. A second phase of research was designed to explore normative standards of quality for human-caused noise in the park. Resulting data provide an empirical basis to help formulate indicators and

standards of quality for the soundscape of the park. These two phases of research are described in companion abstracts by Pilcher et al. and Manning et al., respectively.

Indicator-based frameworks like LAC and VERP are applied by monitoring the condition of indicator variables and initiating management responses if standards of quality are violated. However, due to the dispersed nature of recreation within national parks and related protected areas, it is often difficult to monitor indicators of quality through direct observation. For example, research at Muir Woods has been conducted to identify indicators and standards of quality related to visitors' experiences of the parks' soundscape, yet it is difficult to monitor on-the-ground whether those standards have been violated. Similarly, it is difficult and politically risky to test the effectiveness of alternative management practices through on-the-ground trial and error when standards are violated.

### Methods

Recent research suggests that computer simulation may be a useful tool to monitor "hard to measure" indicators. For example, computer simulation modeling has been used to monitor the number of people at one time at popular attractions sites within Arches National Park, USA (Lawson et al., 2003), the percentage of groups who must share backcountry campsites with other groups at Isle Royale National Park, USA (Lawson & Manning, 2003) and the number of hiking and camping encounters among groups in the John Muir Wil-

derness of the Inyo National Forest, USA (Lawson et al. in press). In addition, previous research has demonstrated the utility of computer simulation modeling to test the effectiveness of alternative management practices in a manner that is more comprehensive, less costly, and less politically risky than on-the-ground trial and error. For example, simulation modeling has been used to assess the effects of changes in infrastructure at Twelve Apostles National Park, Australia (Itami 2005); implementation of trailhead quotas in Yosemite National Park, USA (van Wagtendonk 2003); regulation of travel routes in Isle Royale National Park, USA (Lawson in press); and alternative transportation systems in Arches National Park, USA (Lawson et al. 2003) on crowding-related indicators of quality.

## Results

This paper will draw upon examples from the research reviewed above to demonstrate, conceptually, the potential utility of integrating data from simulation models of ambient sound in national parks into computer simulation models of visitor flows within the same areas to monitor sound-related indicators of quality. Further, this paper will explore the potential utility of computer simulation modeling to examine the effects of alternative management policies (e.g. air tour management alternatives, alternative transportation planning) on the soundscapes visitors experience within national parks and related protected areas.

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