Motivation and Acceptability Norms of Human-Caused Sound in Muir Woods National Monument

LELAINA D. MARIN
PETER NEWMAN
Department of Human Dimensions of Natural Resources
Colorado State University
Fort Collins, CO, USA

ROBERT MANNING
Rubenstein School of Environment and Natural Resources
University of Vermont
Burlington, VA, USA

JERRY J. VASKE
Department of Human Dimensions of Natural Resources
Colorado State University
Fort Collins, CO, USA

DAVID STACK
National Park Service
Statue of Liberty National Monument
New York, NY, USA

Acceptability of sound, natural or human-caused, was predicted to vary by an individual's motivation for quiet at Muir Woods National Monument. This study used a dose-response methodology where visitors (n = 157; response rate = 54%) listened to five audio recordings varying in the percentage of time that human-caused sound was louder than natural sound (percent time above). Visitors then rated the acceptability (pleasing to annoying) of each recording. Cluster analysis was used to segment individuals into three homogenous groups based on their motivations (i.e., low, moderate, and high motivation for quiet) for visiting the park. Results indicated that as percent time above natural sound increased, visitor ratings of human-caused sound decreased.

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Address correspondence to Peter Newman, Department of Human Dimensions of Natural Resources, Colorado State University, 101A Natural Resources Building, Campus Delivery 1401, Fort Collins, CO 80523. E-mail: Peter.Newman@colostate.edu
Reactions to human-caused sound also decreased as motivation for quiet increased. Consensus regarding the acceptability of sound was greatest when the percent time above natural sound was lowest (i.e., quietest sounds). Recommendations are offered for setting standards to meet soundscape objectives.

**Keywords** soundscape, norms, motivation, Muir Woods National Monument

### Introduction

As noise increases throughout the United States as a result of growing road and aircraft traffic (Barber, Crooks, & Fristrup, 2009), the ability to protect pristine and quiet natural areas becomes more difficult (Mace, Bell, & Loomis, 2004). Silence, relaxation, escaping noise, and experiencing tranquility are important motivations for visiting natural areas (Driver, Nash, & Haas, 1987; Kaplan, 1995). Despite this desire for quiet environments, anthropogenic noise continues to intrude upon natural areas and has become a source of concern. The National Park Service, for example, determined that noise was audible for more than 25% of the time at 55 sites within 14 parks (NPS, unpublished). With the growth of transportation increasing faster than human population (Barber et al., 2009), the potential for noise intrusions into our national parks increases. Researchers have focused on understanding visitor perceptions of natural and human-caused sound in Muir Woods National Monument, Yosemite, Grand Teton, and Hawaii Volcanoes national parks. Managers are realizing how important data are for more than just the physical measures of sound when attempting to regulate or mitigate noise in their parks (Mace et al., 2004). Research in Muir Woods National Monument has defined indicators and standards for “soundscape” (Pilcher, Newman, & Manning, 2008) and explored the effectiveness of particular actions (i.e., quiet zone and a quiet day) in managing sounds in the park (Stack, Newman, Manning, & Fristrup, in press). To date, however, no research has explored the role motivations play in determining a visitor’s acceptability of differing sounds. This article builds upon previous research by incorporating the concept of motivation into visitor acceptability of natural and human-caused sound in Muir Woods National Monument.

The National Park Service (NPS) defines soundscape as the human perception of physical sound resources. Physical sound resources include natural (e.g., wildlife, wind, water) and human-caused (e.g., aircraft, vehicles, talking) sounds. Noise is often used as a synonym for sound but should be distinguished as undesired or extraneous sound (Morfey, 2001). In the case of national parks, Pilcher et al. (2008) found that visitors sought natural sounds and became annoyed by human-caused noise masking those sounds and detracting from their experience. NPS Management Policies mandate the restoration of natural conditions wherever park soundscapes have become degraded by unnatural sounds (noise) and the protection of natural soundscapes from unacceptable impacts (National Park Service, 2006). The NPS also strives to protect this “endangered” resource (Jensen & Thompson, 2004) for the many visitors who treasure it. Seventy-two percent of Americans find opportunities to experience the sounds of nature as important for protecting national parks (Haas & Wakefield, 1998). Nine out of 10 NPS visitors “consider enjoyment of natural quiet and the sounds of nature as compelling reasons for visiting national parks” (McDonald, Baumgartner, & Iachan, 1995).

Research has examined individual responses to human-caused sound, such as aircraft (Bell, Mace, & Benfield, 2009; Krog & Engdahl, 2005; Mace, Bell, Loomis, & Haas, 2004; Miller, 1999). Nonacoustical factors (e.g., visitor motives) influence responses to aircraft noise (Berglund, Lindvall, & Nordin, 1990; Tarrant, Haas, & Manfredo, 1995). Research has found psychological factors are often as important as physiological noise exposure.
when determining reactions (Hatfield, Job, Peploe, Carter, Taylor, & Morrell, 2001; Job & Hatfield, 1998). Prolonged exposure to noise has been linked to “stress symptoms” (i.e., fatigue, headaches, mild depression) (Stansfield, Clark, Jenkins, & Tarnopolsky, 1985), hearing disorders, and negative impacts to the cardiovascular and endocrine systems (Aydin & Kaltenbach, 2007; Babisch, 2003; Gramann, 1999). Anthropogenic noise exposure can also affect one’s performance of an “immediate serial recall task” (Beaman, 2005), such as the ability to remember information learned from interpretive programs (Benfield, Bell, Troup, & Soderstrom, 2010a). The presence of anthropogenic noise negatively affects natural landscape assessment and can detract from the visitors’ natural soundscape and overall park experiences (Benfield, Bell, Troup, and Soderstrom, 2010b). Due to higher expectations for quiet, natural settings are more sensitive to acoustic stimuli than developed settings (Anderson, Mulligan, Goodman, & Regen, 1983); consequently, psychological effects are more prominent in natural environments (Mace, Bell, & Loomis, 1999, 2004). Loudness (Kariel, 1990), the source of sound (e.g., natural vs. human-caused), and visitor characteristics (e.g., motivation) also influence visitors’ acceptability of sound.

**Motivation**

People are motivated to participate in recreation to satisfy certain needs (Driver & Toucher, 1970). Motivation refers to psychological mechanisms that control the direction and intensity of behavior (Kanfer, 1994). The search for some optimum or preferred condition underlies most psychological motives. By incorporating the concept of motivation, managers can address why people recreate and how management can best accommodate their needs (Manfredo & Driver, 2002).

Experience-based Management (EBM) emphasizes that recreation experiences are psychological outcomes or states of mind that are realized in particular settings during recreation activities (Pierskalla, Lee, Stein, Anderson, & Nickerson, 2004). The EBM model proposes that people choose to participate in a recreation activity and a specific type of setting to attain a desired experience (Manfredo, Pierce, Vaske, & Whittaker, 2002). In this model, motivation is viewed as the expectation that efforts will lead to onsite performances and that those performances affect valued psychological outcomes (Manfredo et al., 2002).

Prior to the development of EBM, recreation management techniques focused on activity-based management, where managers attempted to provide as many activity opportunities at a given area as possible rather than provide experience opportunities that were most appropriate for that area (Driver & Brown, 1978). By only focusing on the activity opportunity, management would limit itself to only one of the four types of demand for recreational opportunities. Generally, the four levels of demand for recreation include activities, setting, experience/motivations, and benefits (Driver & Brown, 1978; Manning, 1999). When the manager defines the various types of experience/motivation opportunities, a differentiation can be made between the activities offered (Driver & Brown, 1978).

Our research focuses on motivations for experiencing quiet in natural environments. An understanding of visitors’ motivation for a quiet setting can aid managers in developing recreational opportunities that meet visitors’ desired psychological outcomes and minimize conflicts among users (Manfredo, Driver, & Tarrant, 1996).

**Indicators and Standards**

The Visitor Experience and Resource Protection (VERP) framework (NPS, 1997) highlights the concepts of indicators and standards when making management decisions. Indicators are “specific, measurable, physical, ecological, or social variables that reflect the overall
condition of a zone” (NPS, 1997, p. 58). Indicators consider visitor impacts on both the natural environment and the visitor experience (Manning, 1999). A standard is defined as the “minimum acceptable condition for each indicator variable” (NPS, 1997, p. 59). This article builds on research by Pilcher et al. (2008) that identified indicators and standards for soundscape. For example, a sound-related indicator is the percent of time that human-caused sound is louder than natural sound. The sound-related standard might specify that human-caused sound should be no louder than natural sound for more than 60% of a 12-hour day. The structural norm approach can help in developing such standards.

**Structural Norm Approach**

The structural norm approach displays the characteristics of norms graphically (Shelby, Vaske, & Donnelly, 1996). Referred to as the impact acceptability curve (i.e., social norm curve), impacts are displayed on the horizontal axis and acceptability on the vertical axis (Vaske & Whittaker, 2004). Using this model, individuals’ personal norms can be aggregated to reflect social norms (Manning, Valliere, & Wang, 1999). Personal norms represent an individual’s own expectations (Schwartz, 1977); social norms are averages of evaluations made by individuals within a social group (Shelby et al., 1996).

The highest point on the curve represents the optimal or preferred condition. The range of acceptable or tolerable conditions includes points on the curve above the neutral point. The minimum acceptable condition represents the point at which the curve crosses the zero point of the acceptability scale (Manning et al., 1999). Variation among responses at each impact level refers to the amount of consensus or crystallization (Vaske & Whittaker, 2004). The distance of the curve above and below the zero point defines the norm intensity and provides an understanding of how important or salient the indicator is to respondents (Manning et al., 1999).

The structural norm approach facilitates formulating standards for management, but does not typically display norm crystallization (degree of dispersion). When consensus exists, management standards can be established (Shelby & Vaske, 1991). This article incorporates the second generation of the Potential for Conflict Index (PCI2) (Vaske, Beaman, Barreto, & Shelby, 2010) into the structural norm methodology as a way to display consensus among respondents as well as other structural characteristics of norms.

**Potential for Conflict Index**

The PCI2 was developed to facilitate understanding and applicability of human dimensions findings to managerial concerns. The PCI2 ranges from 0 to 1. The least amount of consensus and greatest potential for conflict (PCI2 = 1) occurs when responses are equally divided between the two extreme values on the scale (e.g., 50% very annoying and 50% very pleasing). A distribution with 100% at any one point on the response scale yields a PCI2 of 0 and suggests complete consensus and no potential for conflict (Vaske et al., 2010).

PCI2 results are displayed on graphs similar to the structural norm model. Consensus is reflected by bubbles. The size of the bubble depicts the magnitude of PCI2 and indicates the extent of potential conflict (or consensus) regarding the acceptability of a particular topic (i.e., degree of dispersion). A small bubble represents little potential for conflict (i.e., high consensus), and a larger bubble represents greater potential for conflict (i.e., less consensus). The center of the bubble represents the mean rating as plotted on the y–axis

1A description of PCI2, as well as programs for calculating, graphing and comparing two PCI values can be found at http://welcome.warnercnr.colostate.edu/~jerryv
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(i.e., central tendency). The bubble’s location relative to the neutral point identifies if visitor acceptability of an action is skewed (Vaske et al., 2010).

By using PCI$_2$ in combination with the structural norm approach, this article examines how the source of sound (i.e., human-caused vs. natural sound) and motivation can affect visitor acceptability and consensus regarding acceptability of sound. The following hypotheses are advanced:

H$_1$: As human-caused sound increases, average visitor acceptability of sound decreases.
H$_2$: As motivation for a quiet setting increases, average visitor acceptability of human-caused sound decreases.
H$_3$: Consensus (i.e., the PCI$_2$ values) regarding acceptability of sound will be greatest for the quietest sounds.
H$_4$: As motivation for a quiet setting increases, consensus (i.e., PCI$_2$ values) regarding acceptability of sound will be greatest for the quietest sounds.

Methods

Study Area

Muir Woods National Monument is a popular tourist area 15 miles north of San Francisco, California. Established in 1908 and totaling 554 acres, the national monument receives approximately 780,000 visitors annually. The park is known for containing one of the last remaining redwood forests in the area. Our survey was conducted in Cathedral Grove, a forest approximately half a mile from the visitor center, containing some of the oldest and largest trees in the park. Despite its “frontcountry” label, Cathedral Grove was chosen because of the reverence and quiet implied by its name as well as park objectives to manage the area as a primeval forest. Visitors come to the park to experience the sounds of nature with minimal noise intrusions (Pilcher et al., 2008).

Study Design

A dose-response methodology was used to measure standards for soundscape quality. This methodology exposes listeners to a particular amount of sound (dose) and documents the individual’s response to that dose (Fidell, Silvati, Howe, Pearsons, Tabachnick, Knopf, Gramann, & Buchanan, 1996). Five 30-second audio clips were recorded in Muir Woods. The sound recordings were ordered by increasing percentages of time (0–100%) that human-caused sound was louder than natural sound (percent time above). For these recordings, the human-caused sound was human voices, while the natural sounds were wind, running water, and bird calls. Previous research at Muir Woods found these to be the most common sounds heard at the park (Pilcher et al., 2008). Groups talking was heard 73% of the time, while natural sounds such as birds, running water, and wind were heard 60%, 81%, and 74% of the time, respectively (Pilcher et al., 2008). The recordings sought to compare differences in ratings between human-caused and natural sound, in general. They do not attempt to compare different human-caused sounds (i.e., aircraft, vehicles, people talking) or natural sounds (i.e., bird calls, wind, insects) to one another. A description of each recording is provided in Table 1. The actual recordings can be found at: http://warnercnr.colostate.edu/psu-research-methods/.

Visitors were randomly selected as they entered Cathedral Grove and asked to participate in the survey ($n = 157$, response rate = 54%). As a check on nonresponse bias, the study sample was compared to other sample populations from previous studies at the park that were representative of visitors to Muir Woods, in terms of race, ethnicity, and gender.
TABLE 1 Description of Five Audio Recordings

| Recording 1 | All natural sounds including wind, running water and birds calling. No human-caused sound (i.e., 0% time above). |
| Recording 2 | Included the baseline natural sounds from recording 1, but with the addition of one human-caused sound; human voices. The human-caused sound was above (or louder than) the natural sounds 30% of the time (i.e., 30% time above). |
| Recording 3 | Included the baseline natural sounds from recording 1, but with the addition of one human-caused sound; human voices. The human-caused sound was above (or louder than) the natural sounds 60% of the time (i.e., 60% time above). |
| Recording 4 | Included the baseline natural sounds from recording 1, but with the addition of one human-caused sound; human voices. The human-caused sound was above (or louder than) the natural sounds 60% of the time (i.e., 60% time above). |
| Recording 5 | Included the baseline natural sounds from recording 1, but with the addition of one human-caused sound; human voices. The human-caused sound was above (or louder than) the natural sounds 100% of the time (i.e., 100% time above). |

The recordings did not control for decibel level.

(Pilcher et al., 2008). No substantive differences in the sample populations were found. Each visitor was administered the listening portion of the survey in a sound booth wearing headphones that electronically cancelled exterior sounds.

**Variables Measured**

After listening to each of the five recordings, respondents rated the recording on a 9-point response scale ranging from −4 (very annoying) to +4 (very pleasing). Three sound-related motivations for visiting Muir Woods were examined: “enjoying peace and quiet,” “hearing sounds of nature,” and “experiencing solitude.” Each motive was rated on a scale of 1 (not at all important) to 4 (extremely important).

**Analyses**

K-means cluster analysis was used to segment individuals into homogenous groups based on their motivations. A Repeated Measures Analysis of Variance (ANOVA) was used to test H1 and H2. The sound recordings represented the within subject factor while the different motivation groups (i.e., clusters) represented the in between subject factor. One-way ANOVAs were used to further examine differences in recording ratings among the motivation groups.

PCI2 was used to estimate consensus regarding the acceptability of the different recordings for the entire sample (H3) and among the motivation groups (H4). The PCI2 values were compared between the five recordings over the entire sample (10 comparisons total) and between the three motivation groups (3 comparisons per recording). Statistical differences between two observed PCI2 values were calculated using the software available from http://welcome.warnercnr.colostate.edu/~jerryv.
TABLE 2  Levels of Motivation for a Quiet Setting for Three Clusters of Visitors in Muir Woods National Monument

<table>
<thead>
<tr>
<th>Cluster–Sample size (n)</th>
<th>Cluster 1 Low Motivation</th>
<th>Cluster 2 Moderate Motivation</th>
<th>Cluster 3 High Motivation</th>
<th>F-value</th>
<th>p-value</th>
<th>Eta (η)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster–Percent</td>
<td>33</td>
<td>58</td>
<td>66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21%</td>
<td>37%</td>
<td>42%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Importance of the following for visiting Muir Woods:

- Experiencing solitude: 1.79\textsuperscript{a} 2.29\textsuperscript{b} 3.73\textsuperscript{c} 125.63 <.001 .79
- Enjoying peace and quiet: 1.97\textsuperscript{a} 3.09\textsuperscript{b} 3.92\textsuperscript{c} 181.68 <.001 .84
- Hearing the sounds of nature: 2.00\textsuperscript{a} 3.33\textsuperscript{b} 3.82\textsuperscript{c} 162.96 <.001 .68

\textsuperscript{1}Cell entries are mean scores coded on a 4-point scale from 1 “not at all important” to 4 “extremely important.” Means with different superscripts across each row are significantly different at \( p < .05 \) using LSD post-hoc tests.

Results

Cluster Analysis

Separate cluster analyses were performed for two-, three-, four-, and five-group solutions. The three-group solution provided the best fit for the data. To validate this solution, data were randomly sorted and a cluster analysis was conducted after each of three random sorts. All of these additional cluster analyses supported the initial three-group solution (Table 2); those who (a) felt that experiencing solitude, enjoying peace and quiet, and hearing sounds of nature were somewhat important (cluster 1 “low motivation,” \( n = 33, 21\% \)); (b) felt that experiencing solitude, enjoying peace and quiet, and hearing sounds of nature were moderately important (cluster 2 “moderate motivation,” \( n = 58, 37\% \)); and (c) felt that experiencing solitude, enjoying peace and quiet, and hearing sounds of nature were extremely important (cluster 3 “high motivation,” \( n = 66, 42\% \)). One-way ANOVAs revealed that the mean ratings were significantly different for all the sound-related motivations (i.e., experiencing solitude, enjoying peace and quiet, hearing the sounds of nature) (\( F \geq 125.63, p < .001, \eta \geq .68 \) in all cases). In addition, mean ratings were statistically significant between all the cluster groups at \( p < .05 \).

Comparison of Visitor Acceptability Ratings (\( H_1 \) and \( H_2 \))

The mean ratings for the recordings varied significantly with percent time human-caused sound was louder than natural sound (percent time above). The Repeated Measures ANOVA revealed that percent time above (as represented in each recording) had an effect on the mean ratings (\( F = 338.55, p < .001, \eta = .86 \)). Although motivation (represented by the clusters) was not significant (\( F = .05, p = .95, \eta = .03 \)), it did have an interaction effect with percent time above (\( F = 5.68, p < .001, \eta = .30 \)) on the mean ratings. Visitors became more annoyed (i.e., mean ratings decreased) as the percentage of human-caused sound above natural sound (percent time above) increased (Figure 1). The norm curve crossed the
neutral point at 75% time above, in between the recordings with 60% and 90% time above. Overall, this inverse relationship between ratings and percent time above supports our first hypothesis.

The one-way ANOVA showed the three motivation groups differed statistically on two of the five recordings: 0% and 100% time above (Table 3). At 0% time above, differences in the means occurred between the low and moderate motivation groups and between the low and high motivation groups ($p < .05$). These differences were substantial ($\eta = .43$). At 100% time above, statistical differences in the means occurred between the low and high motivation groups ($p < .05; \eta = .23$). The largest difference in the means between the three motivation groups was observed at 0% time above ($F = 15.97, p < .001$; Table 3).

**FIGURE 1** Visitor acceptability of sound recordings. After Bonferroni adjustment, all pair-wise mean comparisons are significant at $p < .001$. PCI2 values with different letter superscripts are significant at the $p < .05$ level (based on PCI2 difference test).

**TABLE 3** Comparison of Acceptability Ratings for Three Motivation Groups

<table>
<thead>
<tr>
<th>Recording:2</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>$F$-value</th>
<th>$p$-value</th>
<th>Eta ($\eta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (0%)</td>
<td>1.76$^a$</td>
<td>3.02$^b$</td>
<td>3.31$^b$</td>
<td>15.97</td>
<td>&lt;.001</td>
<td>.43</td>
</tr>
<tr>
<td>2 (30%)</td>
<td>1.27</td>
<td>1.73</td>
<td>1.89</td>
<td>1.77</td>
<td>.175</td>
<td>.16</td>
</tr>
<tr>
<td>3 (60%)</td>
<td>1.06</td>
<td>.83</td>
<td>.81</td>
<td>.26</td>
<td>.770</td>
<td>.06</td>
</tr>
<tr>
<td>4 (90%)</td>
<td>-.59</td>
<td>-1.06</td>
<td>-1.42</td>
<td>2.14</td>
<td>.121</td>
<td>.17</td>
</tr>
<tr>
<td>5 (100%)</td>
<td>-1.84$^a$</td>
<td>-2.38$^{ab}$</td>
<td>-2.84$^b$</td>
<td>3.56</td>
<td>.031</td>
<td>.23</td>
</tr>
</tbody>
</table>

$^1$Motivation refers to how important a quiet experience is to the visitor. Low motivation = quiet experience not very important; Moderate motivation = quiet experience somewhat important; High motivation = quiet experience very important. Responses ratings were coded on a 9-point scale ranging from -4 (very annoying) to +4 (very pleasing).

$^2$Percentages refer to the percent of time that human-caused sound is louder than (or above) natural sound in each recording.

Means with different letter superscripts are significant at the $p < .05$ level, accounting for multiple tests using LSD.
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η = .43). Across the three motivation groups, ratings at 0% time above increased from 1.76 (low motivation) to 3.02 (moderate motivation) to 3.31 (high motivation). At 100% time above, the ratings decreased from −1.84 (low motivation) to −2.38 (moderate motivation) to −2.84 (high motivation). This inverse relationship between motivation for a quiet setting and acceptability of human-caused sound supports our second hypothesis.

Potential for Conflict Index (H3 and H4)

The PCI2 values for the entire sample indicated that consensus regarding the acceptability of sound varied with percent time above. Whether or not the variation was significant depended on the particular recordings that were compared (Figure 1). Statistical differences in PCI2 values for the entire sample were observed for 5 of the 10 comparisons (PCI2 difference test [d] ≥ 2.24, p < .05). These statistical differences occurred for the comparisons between 0% and 60% time above (PCI2d = 3.05), 0% and 90% time above (PCI2d = 3.77), 30% and 60% time above (PCI2d = 4.24), 30% and 90% time above (PCI2d = 4.71), and 30% and 100% time above (PCI2d = 2.24). No statistical differences were observed when the recordings with 60–100% time above were compared to each other. In other words, statistical differences only occurred when the recordings with 0% or 30% time above were part of the comparison. The lowest PCI2 values (i.e., most consensus) were observed at 0% (PCI2 = .06) and 30% (PCI2 = .05) time above (Figure 1). The highest PCI2 values (i.e., least consensus) were observed at 60% (PCI2 = .17) and 90% (PCI2 = .22) time above. For the entire sample, the most consensus occurred at the quietest (0% and 30% time above) recordings. This supports our third hypothesis.

The PCI2 values for each motivation group indicated that consensus regarding the acceptability of the recordings varied with both motivation level and percent time above. Whether or not the variation was significant depended on the particular recording and motivation levels that were compared (Figure 2). Statistical differences were observed at

![FIGURE 2 Visitor acceptability of sound recordings at three motivation levels.](image-url)
0% and 30% time above (PCI$_{2d}$ > 2.00, $p < .05$). At 0% time above, there were statistical differences between the low and moderate (PCI$_{2d}$ = 2.00) and the low and high (PCI$_{2d}$ = 2.00) motivation groups. At 30% time above, a statistical difference was observed between the low and moderate (PCI$_{2d}$ = 2.50) motivation groups. No differences were observed between the moderate and high motivation groups (i.e., PCI$_2$ values for these two motivation groups were similar).

The lowest PCI$_2$ value (i.e., most consensus) for the low motivation group was observed at 30% (PCI$_2$ = 0) time above, while the highest PCI$_2$ value (i.e., least consensus) was observed at 90% (PCI$_2$ = .28) time above (Figure 2). For the moderate motivation group, the lowest PCI$_2$ value was observed at 0% (PCI$_2$ = 0) time above, while the highest PCI$_2$ value was observed at 90% (PCI$_2$ = .19) time above. For the high motivation group, the lowest PCI$_2$ value was observed at 0% (PCI$_2$ = 0) time above, while the highest PCI$_2$ value was observed at 90% (PCI$_2$ = .24) time above. A PCI$_2$ value of 0 indicates full consensus that the sound was pleasing to some degree (i.e., extremely pleasing, very pleasing, moderately pleasing). When comparing PCI$_2$ values over all three motivation groups, the greatest variation in consensus occurred at 0% time above. The smallest variation in consensus, as well as the highest PCI$_2$ values (i.e., least consensus) for the three motivation groups, was observed at 90% time above. As motivation for a quiet setting increased, consensus with regards to acceptability of sound increased. This relationship supports hypothesis four.

**Discussion**

This study showed that sound-related motivations influence a visitor’s response to different sound sources. The results discussed above provide park managers with information for evaluating the quality of opportunities offered to visitors. Overall, this study shows that motivation, in combination with a particular sound condition, can make a difference in a visitor’s sensitivity to noise in a park or natural area. These data provide managers with empirical information to prescribe and manage for a diversity of acoustic experiences.

**Management Implications**

The VERP process emphasizes the use of indicators and standards when attempting to manage for a diversity of experiences (NPS, 1997). The indicator used in this study was the percent time human-caused sound was above natural sounds. By aggregating acceptability norms of survey respondents, our findings suggest a standard no higher than 75% time above (managers may wish to create more restrictive standards based on acoustic data, ecological parameters, and park management objectives, in combination with social science survey information). A park’s current conditions could be evaluated using this potential standard to ensure a quality soundscape experience. To use this standard, a park’s current acoustical conditions would need to be monitored. The acoustic data collected provide the means to calculate the current percent time above in a park. Using this calculated metric, park staff can determine whether additional management strategies should be implemented to meet the suggested standard.

Different standards might be established based on visitor motivation. In this study, the norm curves for the three motivation groups crossed the neutral point at different locations, and suggested standards no higher than: 80–85% time above for low motivation, 75–80% time above for moderate motivation, and 75% time above for high motivation (Figure 3). By understanding visitor motivation for experiencing natural sounds, a manager can minimize the amount of conflict between user groups that are seeking different soundscape experiences (Manfredo et al., 1996).
FIGURE 3 Norm curves showing visitor acceptability ratings for three motivation levels.

One approach to mitigate possible user conflict is the Recreation Opportunity Spectrum (ROS). The spectrum includes a diversity of activity and experience opportunities that vary from one end of the spectrum to the other, and a range of environmental settings that allows for different activities and experiences (Driver & Brown, 1978). This spectrum coincides well with the EBM approach since it recognizes benefits to the visitor (Manning, 1999).

By taking visitor motivation into account, ROS can be used by managers to provide a variety of recreational opportunities that fulfill certain motivations (i.e., quiet setting, solitude, connection with nature). Managers can zone different areas of the park to meet standards for varying levels of motivation to experience a quiet setting (Manning, 1999). Muir Woods, for example, has implemented this type of zoning strategy for soundscape management in the park. Since 2008, Cathedral Grove has been permanently zoned as a quiet zone. Through education programs and informational pamphlets, the park is able to reach visitors of varying motivation levels and inform them of the diverse soundscape experiences offered at the park. In the case of Muir Woods, staff could direct those visitors with high motivation for a quiet setting to Cathedral Grove. The “high” motivation (quiet) zone would be managed to the most restrictive of the three suggested standards; no higher than 75% time above. The “moderate” and “low” motivation zones would be managed to more lenient standards; no higher than 75–80% time above and no higher than 80–85% time above, respectively. To manage each zone to the desired standards, managers could use a variety of techniques including signage, maps with locations of quiet areas, educational materials about how to reduce noise during one’s visit, and/or interpretive programs about the importance of soundscape. Managers may not have to implement any of these management strategies for the “low” motivation zone while implementing a combination of these strategies for the “high” motivation zone. We recommend that managers begin with implementing indirect management strategies (e.g., signage, outreach materials) before implementing direct management (e.g., sanctions, fines).

We also suggest that when managers designate different zones, they consider their proximity to one another. For example, if the “low” motivation zone is located near the
“high” motivation zone, there is potential for sounds from the louder zone to travel and perhaps intrude upon the quieter zone. Using this example, managers could use the “moderate” motivation zone as a buffer or transition zone between the other two. While all parks cannot be zoned in this linear (i.e., “low” to “moderate” to “high” motivation) fashion, we encourage all park managers to consider encroaching sound when designating park zones. By considering this issue, park managers have the opportunity to reduce user conflict even further.

The results from this study also reveal information about visitors’ consensus regarding acceptability of different sound sources. Ratings of particular sound conditions are more similar when the acoustical environment is inundated by a higher percentage of natural sound sources. We assume this is the reason behind the difference in the level of consensus between the 0% and 100% time above recordings. This study revealed that as human-caused sound increases, consensus regarding acceptability generally decreases. One exception to this pattern was observed; consensus increased in the change between the 90% and the 100% time above recordings. We can conclude this resulted not from the change in percent time above but rather the change in the number of sound sources. Since the 90% time above recording includes both natural and human sounds, visitors must consider two sources of sound when determining their ratings, as opposed to the single human sound source in the 100% time above recording. If a visitor is listening to a recording with two sound sources, they are forced to compare the two, while perhaps considering the pros and cons of each (i.e., a trade-off). If the recording only contains one sound source then a comparison is unnecessary and a rating of the condition becomes a simpler task. The level of consensus is affected by not only the number of sound sources, but by the type of sound source as well. Both the 0% and 100% time above recordings had only one sound source, but it was the presence of only natural sound that results in a higher level of consensus.

**Future Research**

Several avenues for future research are suggested by our findings. First, as described in the methods, the percent time above natural sounds changed with each recording. With varying levels of percent time above, we also varied the sound (decibel) level as well. In future research, the decibel level should be controlled throughout each recording. In other words, vary the amount of percent time above natural sounds while holding the sound level constant.

Second, the order of the recordings should be considered in future studies. With each recording, going in order from 1 to 5, the percent time above natural sounds increased gradually. A listener may have noticed this increase, compared one recording with another, and rated them accordingly. For example, if a respondent was listening to recording 4, they may have noticed the slight increase in human-caused sound from recording 3, and thus rated it as more annoying than the previous recording. Future research should randomize the order of the recordings. This would allow listeners to focus solely on each recording, rather than compare one recording to another. Respondents would be less reliant on their previous ratings, and more dependent on their reactions to a particular recording.

Third, Cathedral Grove was chosen because of the quiet experience its name implies. When coming to Cathedral Grove, visitors desire an opportunity to enjoy the park's natural soundscape. With this desire for quiet, even in a frontcountry site, the variance in terms of visitor reactions may have been reduced. Future research should be conducted in a variety of locations. Motivations for a quiet setting, for example, are likely to be lower in an urban park when compared to a wilderness area. This type of research would allow for examining
the effects that expectation can have on visitor ratings of differing sound conditions, and how the variation in responses can differ with location.

Fourth, some research (e.g., Gramann, 1999) suggests that urban residents feel uncomfortable with an all-natural sound environment. Results from this and other soundscape-related studies should be compared with demographic information (e.g., urban vs. rural residents). Urban residents may have a higher tolerance for human-caused sound than rural residents. Such information could help managers target education programs and informational material and ensure that a variety of experiences are offered to meet the needs of all visitors.

By building upon previous research, we have provided park managers with additional variables and techniques that should be considered in the management of park soundscapes. Pilcher et al. (2008) found that visitor reactions depend largely on the loudness or decibel level of a particular sound. This research emphasizes that the source of sound (human-caused vs. natural) and visitor motivation can potentially affect responses to sound heard in natural areas. To provide a variety of high quality visitor experiences, managers should consider all of these factors (i.e., loudness, source of sound, motivation) when managing soundscapes in a park.

References


