Sounds as an element of human-coupled systems: Social-ecological evidence from Muir Woods National Monument

***Peter Newman**, Ph.D., The Pennsylvania State University, USA, pbn3@psu.edu*
***Zachary D. Miller**, Ph.D., The Pennsylvania State University, USA*
***Mitch Levanhagen**, Boise State University, USA*
***Clint D. Francis**, Ph.D., California Polytechnic State University, USA*
***Alissa R. Petrelli**, Ph.D, California Polytechnic State University, USA*
***Lauren C. Abbot**, Ph.D., The Pennsylvania State University, USA*
***Yao-Huo Shr**, Ph.D., The Pennsylvania State University, USA*
***B. Derrick Taff**, Ph.D., The Pennsylvania State University, USA*
***Crow White**, Ph.D., California Polytechnic State University, USA*
***Kurt Fristrup**, The National Park Service, USA*
***Chris Monz**, Ph.D., Utah State University, USA*
***Christopher J.W. McClure**, The Peregrine Fund, USA*
***Jesse R. Barber**, Ph.D., Boise State University, USA*

Sounds have a profound impact on both social and ecological components of the environment (Francis et al., 2017). Although many studies have studied the social and ecological soundscape components independently (Francis et al., 2017), no research has examined the coupled social-ecological impacts of natural sounds. In this presentation we discuss findings from Muir Woods National Monument (MUWO) in California, USA, that shows how both social and ecological components of the soundscape influence and are influenced by each other in a dynamic and synergistic human-natural coupled system.

Background

Soundscapes are a collection of all the sounds in a designated area at a specified time (Pijanowski et al., 2011). This includes both natural sounds and human-caused sounds. Ecological, natural sounds fill acoustical niches and provide a variety of functions (Pijanowski et al., 2011). For instance, sounds help wildlife locate prey, avoid predators, and secure mates. Increases in human-caused sounds interfere with the ecological functions of natural sounds and have a variety of deleterious impacts, like interfering with animal abundance and changing key behaviors of animals (e.g. foraging, vocalizations, and movement) (Francis & Barber, 2013; Francis et al., 2017). Socially, soundscapes also influence humans. For instance, increased human-caused sounds impact mood states, recreational experiences, and cognitive restoration (Abbott et al., 2016; Francis et al., 2017; Stack et al., 2011). Conversely, natural sounds are more preferred by people and contribute to human health and well-being (Francis et al., 2017) Collectively, this body of research illustrates the profound roles that sounds play in our social-ecological systems.

As we begin to recognize the value of intact soundscapes free from human-caused sounds, we are also recognizing that areas without human-caused sounds are becoming scarce (Buxton et al., 2017). For instance, cross the entire National Park Service (NPS) of the USA, human-caused sound is a wide-spread problem (Buxton et al., 2017). This includes some of the most wild and uninhabited protected areas of the USA, in which 12.1% have noise pollution levels above naturally ambient levels (Buxton et al., 2017). Considering many park and protected areas try to protect valuable resources while also providing visitor experiences, these findings illustrate a critical need to study and manage soundscapes to provide both social and ecological benefits.

Methods

The findings from this research were collected at MUWO during the summer of 2016. Mutli-disciplinary approaches were used to collect data for this project using a quasi-experimental approach. Previous research showed that signage can reduce visitor cause noise at MUWO (Stack et al., 2011). Thus, our treatment in the approach was to introduce signage about reducing visitor-caused sound at MUWO, and the control was to remove signage (existing conditions). To collect ecological data, trained researchers conducted point counts to record bird diversity information. Social science data were collected using intercept surveys of MUWO visitors. Social science data were analyzed using stated-choice modeling to develop utility scores for visitor preferences of management strategies related to reducing visitor-caused sounds. Ecological data were analyzed using a variety of statistical models that account for both the treatment and control periods.

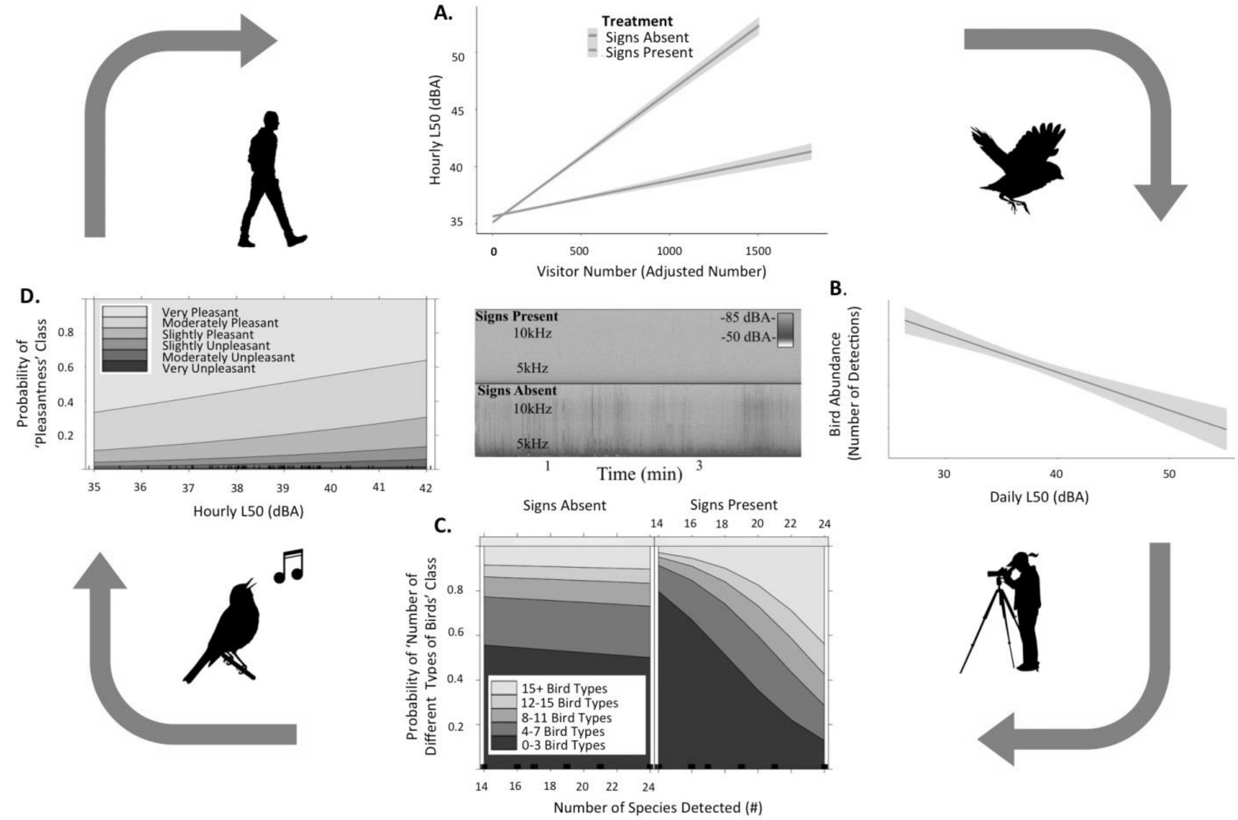

Figure 1. Soundscapes couple human and natural systems. (A.) Signage asking visitors to 'Maintain Natural Quiet' in Muir Woods National Monument USA led to lower sound levels across a range of visitor numbers (p<0.001). The center of the figure displays spectrograms (frequency x time) of audio recordings taken during 'signs present' and 'signs absent' weeks. (B.) Bird abundance increased 5.92% with every 5 decibel decrease in sound level (dBA, L50; <0.001). (C.) Human visitors reported experiencing more 'Different Types of Birds' with signs present (Treatment: p=0.039; Number of Species: p=0.59; Treatment*Number of Species: p=0.035) and (D.) ranked the soundscape as more pleasant with decreasing sound levels (p=0.012).

Results

Figure 1 displays the coupled human-natural relationships from natural sounds. We found that similar to previous research (Stack et al., 2011), signs about reducing visitor-caused sound were effective in reducing the decibel levels in MUWO (Figure 1, A). Ecological monitoring of bird diversity found showed that bird abundance increased nearly 6% for every five decibel decrease in sound level (Figure 1, B). Visitors to MUWO also perceived significantly higher levels of bird biodiversity when signs were present (Figure 1, C). Additionally, visitors reported the soundscape as more pleasant with decreased visitor-caused sound levels (Figure 1, D).

Discussion

When viewed collectively, we believe the positive feedback cycle displayed in Figure 1 has potential to markedly increase the effectiveness of parks protected areas for both wildlife and human experience. Natural sounds provide a way to link both social and ecological components of parks and protected areas. Socially, visitors achieve more satisfaction from their experiences as visitor-caused sound decreases. Part of the reason for this is that visitors may be able to see more wildlife, which is a key motivating factor for visiting park and protected areas. Additionally, visitors indicated that they supported management actions that reduced visitor-caused sound. Visitors who experienced the quieter treatment days expressed even higher preferences (through utility scores) for management that reduced visitor-caused sounds. This is additional evidence that visitor experiences are improved through reducing visitor-caused sounds. Ecologically, as visitor-caused sound was reduced, bird diversity increased. This shows that reducing visitor-caused sound also has ecological value. The findings from this research provide evidence that sounds provide a measurable link that couple human-natural systems.

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