Just Listen:
Involving Youth in Soundscape Conservation and Education at ROMO

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Now I will do nothing but listen.
I hear all sounds running together, combined, fused or following,
Sounds of the city and sounds of the city, sounds of the day and night."
Walt Whitman-Song of Myself.

Introduction:

How do we connect today's youth to nature and natural parks? In the critically acclaimed book, *Last Child in the Woods,* journalist Richard Louv (2006) writes that society has taught young people to avoid direct contact with the outdoors, and that nature has become something to watch, in the form of *Planet Earth* videos, or to simply ignore. While excessive screen time has been implicated in what Louv terms "nature deficit disorder", additional causes - such as the fear of nature, fear of the bogeyman, and nature as "other" - have been similarly cited in the outdoor to indoor migration process common among today's youth (Barton 2012). If accurate, this new geography of recreation is worrisome in that young people may lose vital connections to nature perhaps more common to previous generations.

The majority of scholarly and popular criticism for nature deficit disorder has been directed at increased electronic usage among the younger generation. However, it has become progressively clear that some novel programs *effectively link nature and youth* together in pursuit of field science and outdoor education. Citizen science or active learning programs such as Project Noah actually encourage smartphone users to photo-document their encounters with nature using a mobile application that helps them identify plants and animals and collect data. These programs maintain the added bonus of allowing young people to physically experience nature while participating in science. These experiences may be directed at those natural resources found in national parks or the more local backyard geography of fields and streams - all using the power of photography. Indeed, scholarly research on active and schoolyard enhanced learning shows that distant citizen science programs are not the only solution for getting kids outside (Broda 2007; Brody 2005; Ferreira 1998; Lackstrom and Stroup 2009; Smith and Williams 1999). Field trips to greenways or vacant lots reveal the effectiveness of nature education at the local and more accessible scale.

This proposed research is unique in that it explores the relationship between active learning, youth, and soundscapes. In this project, we asked, what happens when today's youth listen to as opposed to photograph places - using soundscape techniques and methodologies? Does the use of sound methods enable, constrain, or enhance youth's interaction with the

natural world? More generally, do soundscapes help contribute to sense of place and place attachment for youth participants (as well as those visiting national parks)? While projects such as PhotoVoice (http://www.photovoice.org) have become increasingly popular in documenting visual components of natural or cultural spaces, sound based methodologies are employed far less often in contemporary research. Yet audio based research has the potential to capture an acoustical snapshot in time (or across time, in the case of sound walking) in the same way that analog or digital photos encapsulate visual data and experiences. This study investigates the value of sound methodologies in a national park setting among today's college age youth.

Literature on Soundscape Ecology

As early as 1962, biologist Rachel Carson's "Silent Spring" began with a "fable for tomorrow" where she utilized examples drawn from real communities where the use of the pesticide DDT had caused damage to wildlife, birds, bees, livestock, domestic pets and humans. This **geography of silence** created in the aftermath of environmental damage revealed the key ways in which soundscapes - though not yet popularized as a scientific term - were being negatively affected by species loss.

What, exactly, are soundscapes? Today, a **soundscape** is often defined as a sound or combination of sounds that derives from an immersive environment. The term is meant to include natural sounds (animal vocalizations), the collective habitat (wind and waterfalls), as well as sounds created by humans (aircraft flyovers). The phrase itself was first noted by Michael Southworth in a 1969 article titled "The Sonic Environment of Cities," published by *Environment and Behavior*. However, the early concept was later elaborated upon in more detail by the 1970s composer and naturalist, R. Murray Schafer, in his seminal work, "Tuning of the World." Shafer's passion for acoustic ecology led to the creation of the World Soundscape Project, in which one of his most notable reflections on soundscapes was as follows:

> "The soundscape of the world is changing. Modern man is beginning to inhabit a world with an acoustic environment radically different from any he has hitherto known. These new sounds, which differ in quality and intensity from those in the past, have alerted many researchers to the dangers of an indiscriminate and imperialistic spread of more and larger sounds into every corner of a man's life. Noise pollution is now a world problem. It would seem that the world soundscape has reached an apex of vulgarity many experts have predicted universal deafness as the ultimate consequence unless the problem can be brought quickly under control."

Research by Bernie Krause, noted musician, naturalist, and soundscape ecologist, eventually redefined the concept of soundscapes to include **three specific component**s: (1) geophony (geophysical sounds), (2) biophony (sounds from non-human organisms), and (3) anthropophony (human-generated sounds). Krause's work helped to lay the foundations for what is now the ecological subfields of soundscape ecology and soundscape conservation. Krause described soundscapes as "the sum of all sounds" present in an environment in a given time interval. And perhaps more importantly, he was the first to note that stable and healthy ecosystems exhibit

soundscapes with recognizable patterns of time-frequency acoustic niches (leading to the acoustic niche hypothesis). Thus in the same way that different animals occupy different physical niches in the environment, those same animals fill sound niches that are unique and specific to both individual and community needs.

Today**,** soundscape ecology has expanded, and its scholars now seek to investigate the structures of soundscapes, how sounds are generated, or how these sounds affect organisms. Much of the academic literature focuses on the theory, application, methods, historical perspectives, and values of soundscape in soundscape ecology (Pijanowski and Farina 2011). For example, Dumyahn and Pijanowski (2011) point out that soundscapes possess ecological and social value and that they should be considered natural resources worthy of management and conservation. Their work discusses the human and ecological benefits of soundscapes, including sense of place, cultural significance, interactions with landscape, and perceptions and wildlife as being a few of these values (2011: 155). Indeed research shows how unaltered landscapes hold value for wildlife as demonstrated by the negative effects of anthropogenic noise (planes, cars) on various species. In this vein, the field of sound activism promotes the act of listening through public soundwalks and other formal and informal exercises builds environmental and social awareness and promotes changes in social and cultural practices (Polli 2012). In sum, soundscape conservation research encourages biologists to consider natural soundscapes as resources worthy of conservation efforts.

The field of soundscape ecology is also unique in that it incorporates and synthesizes many existing disciplines, making its interdisciplinary nature one of its greatest strengths. Looking back, soundscape research has grown significantly from its foundations in the 1960s, and **geographers** - given that landscape it at the heart of geographical inquiry - have a tremendous opportunity to contribute to this growing body of literature. Research by (Rossi et al. 2017) is one of the few to point out that sound is a multi-dimensional geographic space that carries decision-making information needed for some dispersing species to locate resources and evaluate their quantity and quality, pointing to the important role of geography in soundscape studies.

Geographical research on the ways in which people connect through nature through sound has clearly not kept pace, particularly as this line of inquiry applies to youth. There is an inherent assumption that “no one is listening” to the landscape, yet this paper makes the argument that those skills simply need further development and refinement. While the study of landscape lies at the heart of human geography, geographic research has historically been more attentive to the visual (Smith 1994). Smith notes that in general, the social sciences have afforded an epistemological privilege to sight over hearing, and the majority of human geography is devoted to seeing the world, or speaking about it (Smith 1994: 232-234). Smith points out that the idea of “landscape as text” has established the relevance of experience and emotion in the study of social life. But she also notes that this tradition has been rooted in the visual and neglected the role of sound (and music) and the ways in which it structures space and characterizes place. Her work suggests some solutions for finding a balance between the

visual and the aural. And while ethnographic research has become central to cultural geography, focusing on the critical importance of the micro-scale, it nonetheless emphasizes the collection of visual images to to accompany a researcher's societal observations. Sound is deprioritized, despite the central role acoustics play in instructing us about the health of geographic landscapes. Geographers have much to contribute to the conversation surrounding soundscapes, given its discipline's interdisciplinary nature and its emphasis upon landscapes. The aesthetic aspect of landscape has been well documented in geography; again, little emphasis upon acoustic dimensions of landscapes.

Embodied Learning Experiences

In the past decade, geographers have increasingly sought to recognize the role of the "visceral" - or emotional - in education including nature based instruction. Research by Pierce and Widen (2017: 48) explores the issue of how we should "understand, engage with, or promote students' visceral and embodied learning experiences". In geographic scholarship, the visceral is described as embodied reactions to the material environment that people navigate (Hayes-Conroy and Hayes Conroy 2008; 2010: Longhurst, Johnson and Ho 2009). Many of these studies focus on topics that highlight emotional experiences, such as interactions with food, dancing or music. Pierce and Widen (2017), for example, build upon the field of emotional geography emphasizing a visceral pedagogy that helps students understand experience of decay and decline in urban context. They make the argument that some topics in fact might be *better taught* through emotionally activated learning activities. Yet, while the field of visceral or emotional geography highlights an often overlooked pedagogy that is deprioritized in favor of cognitive learning, there is still room for growth. Specifically, few studies have explored of embodied learning experiences in nature or natural spaces such as parks and protected areas. This research aims to expand upon the field of soundscape studies by infusing such geographical perspectives into its research design.

National Parks and Protected Areas, Soundscapes, and Policies

Some scholars have focused their soundscape work specifically upon the setting of parks and protected areas. Fristup, Joyce and Lynch (2009-2010) argue that listening is an immersive experience and in national park settings it can amplify visitor awareness of resources and their value. Because noise disrupts this experience, the authors argue that acoustic monitoring is essential for managing the sonic environment. Research by Miller (2007) similarly outlines how the park service has been developing the methods, processes and skills required to effectively monitor soundscapes. His work addresses the fundamental questions that need to be answered, types of noise issues in parks, need for data, and approach for developing criteria.

In addition to fieldwork on acoustics in national parks, historical federal policies have long recognized the importance of preserving soundscapes. The 1964 *Wilderness Act* created a legal definition of wilderness and protected 9 million acres of federal land; the importance of "tranquility" and "solitude" are explicitly addressed in the policy. Similarly, the Organic Act of 1916 created the National Park Service, and outlines it purpose as follows: "to conserve the

scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them". The Park Service clearly considers soundscapes as inherent components of "the scenery and the natural historic objects and wildlife" protected by the NPS Organic Act. They are perceived as vital to the natural functioning of parks while also providing early indicators of the health of certain ecosystems.

While in reality soundscapes of a national park or protected area are often taken for granted, they represent an important part of the park environment. Like water, scenery, or wildlife, sound is a valuable resource that may be easily compromised or destroyed. In this vein, the Natural Sounds Program Center was established in 2000 to "assist park and regional staff in protecting, conserving, or restoring the soundscape resources". NPS's Natural Sounds Program (NPS) differentiates between (1) the physical sound resources; and (2) human perceptions of those same sounds. The physical sound resources, regardless of audibility, at a particular location comprise what is known as the acoustical environment. In contrast, the human perception of acoustical environment is defined as a soundscape. Examples of acoustic resources include sound resources such as wildlife, waterfalls wind, rain and history and cultural sounds, and the quiet background in which to hear them (US Department of the Interior, Capitol Reef's Voice, Natural Sounds Program Retrieved January 15, 2013).

Capitol Reef National Park and Grand Canyon National Park represent just two areas that have focused on integrating soundscape and acoustic resources into their interpretive programs. Most notably, Capitol Reef developed a soundscape program with the goal of using sound to foster *connections between people and the park.* Visitor objectives included: (1) to become aware of how natural sounds enhance experience; (2) learn to key in on their natural environment by listening; (3) to understand the importance of preserving natural soundscapes and (4) to identify ways to reduce noise in the parks. The 2009-2010 issue of ParkScience - published by the Natural Stewardship and Science Office - was entirely devoted to these types of soundscape projects. Research related to Colorado's ROMO, however, was largely overlooked in this issue, which we turn to now in this study and associated report.

Methodology:

In light of this literature and research to date, this CDLC project set out to:

1. Transport up to 300 youth to the park over an 18-month period to experience and evaluate soundscapes of Rocky Mountain National Park; this will include post-visit questionnaires.
2. Create a detailed report for ROMO which outlines perceptions of soundscapes and their values for national parks.
3. Design curriculum materials related to soundscapes for Weld County and adapted for ROMO.

Study Site:

Rocky Mountain National Park has been selected as a research site for multiple reasons. (1) First, the project is an extension of a pilot study conducted in 2010 at ROMO that was later published in the *Journal of Geography.* The earlier research explored youth attitudes toward nature and technology among youth undergraduates in a relatively "green state" (Barton 2012). Results confirmed that even within the context of "Colorful Colorado," where a "land of scenic wonder awaits", barriers to getting youth outside remained, yet active learning and citizen science showed significant potential in bridging the nature-society disconnect **In essence this second phase of the research aimed to test whether active learning through sound better connects youth to nature and fosters place attachment in national parks and protected areas.**

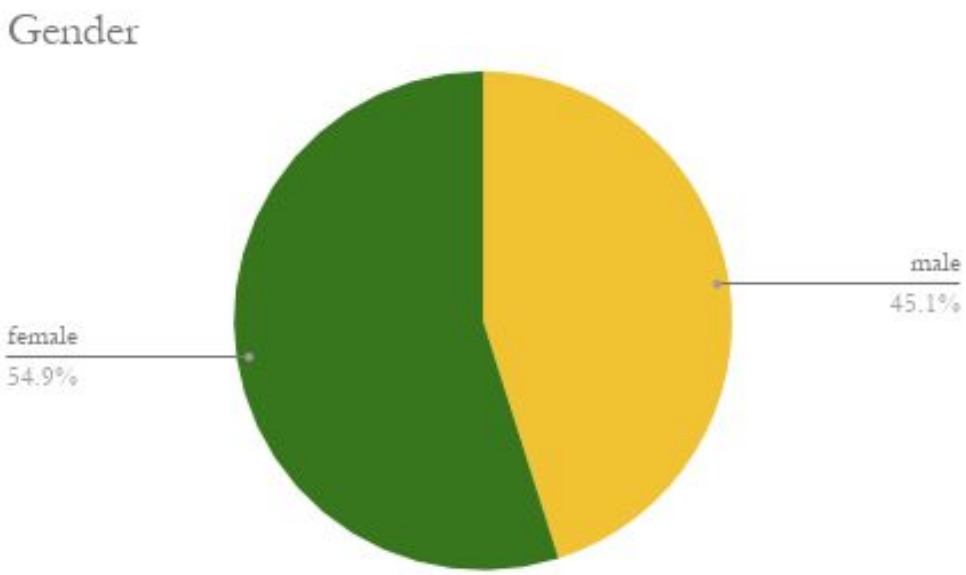
(2) Second, ROMO provides a unique research site because much of the park is now categorized as U.S. wilderness. In 2007, then Colorado Senators Ken Salazar and Wayne Allard launched a bipartisan effort to designate about 250,000 acres or 95% of the existing park as wilderness, which includes 14,259-foot Longs Peaks and the remote Mummy Range. While the National Park Service has permission to battle beetle kill infestations and fight fires, the Omnibus Public Lands Management Act of 2009 affords permanent protection from other human impacts in RMNP wilderness territory. *Allowing schools and youth to focus on soundscapes within this unique environment may* lead to long term place attachment.

Results:

The total sample of university aged students brought to the park was 255, typically in groups of 7 or 8 individuals at one time but sometimes smaller. In order to accommodate such a large sample, the timeline for the project extended nearly 18 months including field visits to ROMO and the analysis of post-visit results. Trips from Greeley to ROMO were often rescheduled due to road closures along the Big Thompson canyon; however, the final sample of 255 is robust. Students were recruited from the University of Northern Colorado based on their interest in nature and citizen science. No compensation was provided to study participants other than a free trip to Rocky Mountain National Park, so it is apparent that the self-selection process may have biased the study.

Figure 1 below reveals that the gender breakdown including 55% female, and 45% male students, which is fairly consistent with the demographics represented in the PI's millennial study at ROMO in 2012 as well as the overall gender breakdown at this institution today.

Figure 1. Gender (55% female, 45% male, N = 255)

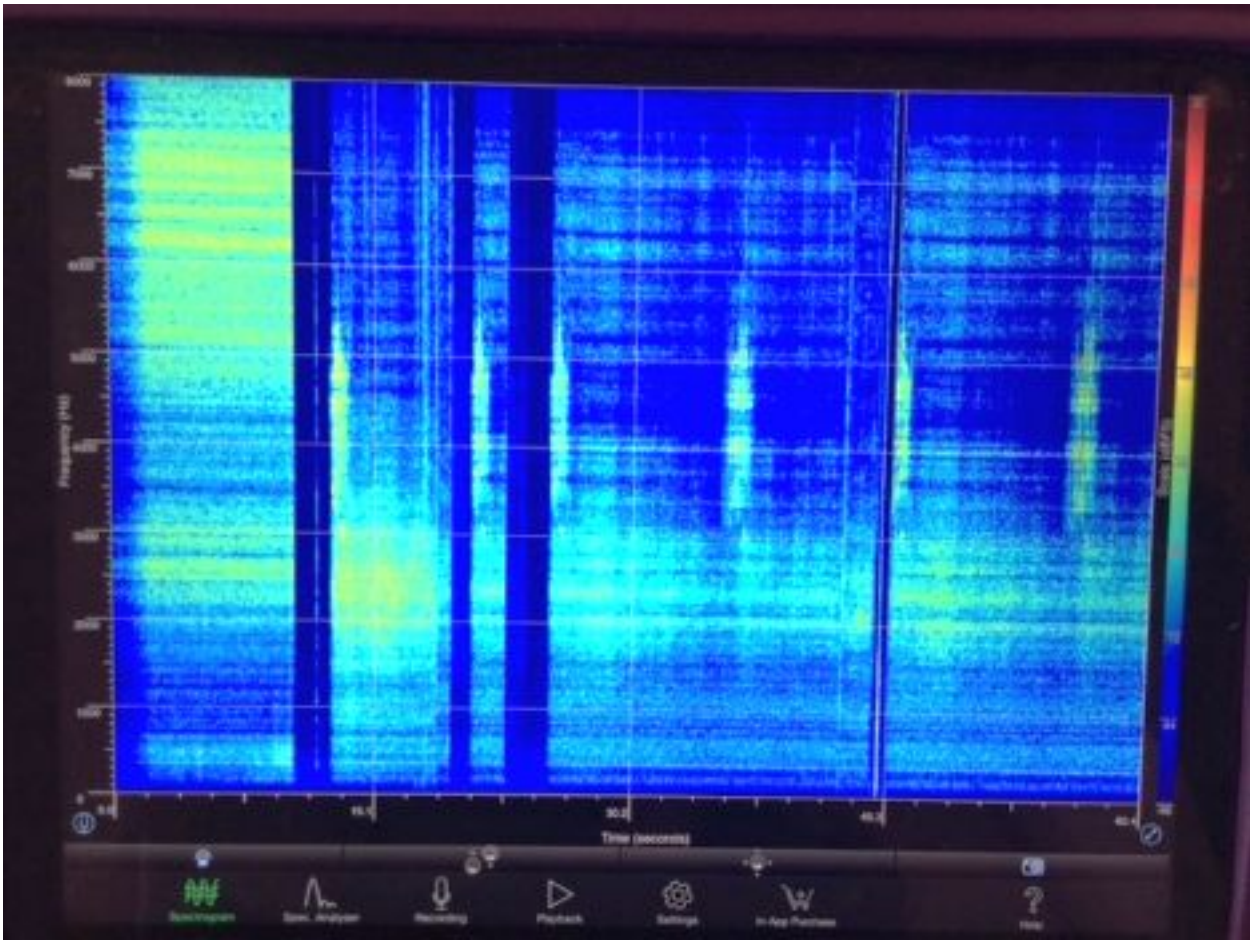


In advance of field visits to ROMO, participants were given a 30-45 minute introduction to soundscapes and soundscape components, including a discussion on the meaning of anthrophony, geophony, and biophony and specific examples (Figure 2). Students held varying levels of experience in field environments prior to visiting Rocky Mountain National Park particularly with regard to individual wildlife sounds. This data has not been correlated with soundscape attitudes as per the writing of this report, as it was not the intention of the study.

Figure 2: Soundscape Component Instructional Tool

Study participants were also given basic instruction on recording, soundwalking, spectrograms and the ecological niche hypothesis for soundscapes, where certain species occupy sound niches in an acoustic environment. The Oxford Wave Research App, which is free for ipads and iphones, was used for this purpose, which meant that recordings were limited to 15 seconds (Figure 3). Students also had the ability to learn how to use static sensors in the wake of the trip to Rocky Mountain NP. We are submitting a publication to Digital Focus on Geography which will incorporate sounds from the fieldwork.

Figure 3: Oxford Wave Research App (Free for ipads and iphones)
Spectrogram recordings and analysis (recording limits: 15 sec)



Recognition of Anthropophony, Geophony and Biophony:

Student participants were also asked to use field journals to note sounds heard during their time at ROMO. One caveat is that although participants were given the freedom to visit whichever trail they preferred while at ROMO, they were required to record the dates visited given the seasonal importance of their visit, as well as time spent on the trails and distance from trailhead. No student participant spent less than one hour on individual trails, and some students stayed the full day at Rocky Mountain National Park.

Below are a sample of Wordle infographic created based on sounds heard and displayed by frequency (Figure 4). The Wordles are not adjusted for season nor time spent in the park on trails, as the main objective was to see which types of sounds were heard most frequently. The first Wordle illustrates that geophonic sounds such as" rocks, breezes, and wind" dominate the acoustic spectrum for individual participants who traveled less than five miles from the trailhead, though participants likely underreported their own anthropophonic noises (e.g. zippers, boots)

due to lack of proper instruction. Traveling in groups of 7-8 on trails also creates human induced noises as individuals may inevitably want to communicate about what they see or hear.

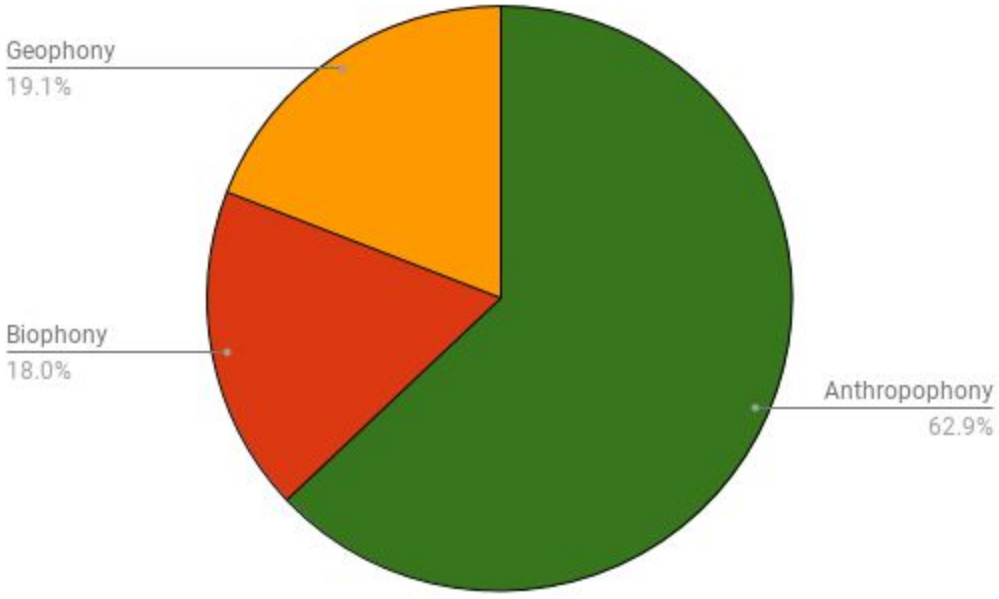
Figure 4: Sounds Recognized and Displayed by Frequency (traveled < 5 miles from a trailhead) N = 140 of 255 students

The second Wordle displays sounds recognized and displayed by frequency for the full sample size for the 115 of 255 students who traveled farther than 5 miles beyond a trailhead (Figure 5). The graphic reveals a greater frequency in both geophonic and biophonic sounds and a reduction in anthropophonic noise (raw data will be provided in Appendix). Note that for the sample who traveled beyond 5 miles of the trailhead their sound recordings also included all sounds heard up to five miles.

Figure 5: Sounds Recognized and Displayed by Frequency for the full sample size (traveled 5 miles from a trailhead) N = 115 of 255 students

Post-ROMO visit students were asked to identify which sound categories were most dominant based on their field journal notations, as evidenced in the Figure below (6). It is interesting to note that participants overwhelmingly agreed that human-induced noises dominated the soundscape (63%), with geophonic and biphonic sounds being equal in measure. However, according to the previous data sets, anthropophonic sounds were dominant but not to the degree that students state in their field journals.

Figure 6: Acoustic Recognition During ROMO Visit: Human Noises as Dominant Metric Anthropophony (63%), Geophony (19%), and Biophony (18%), Sample = 255



Soundscape Comparisons with Local Parks or Protected Areas:

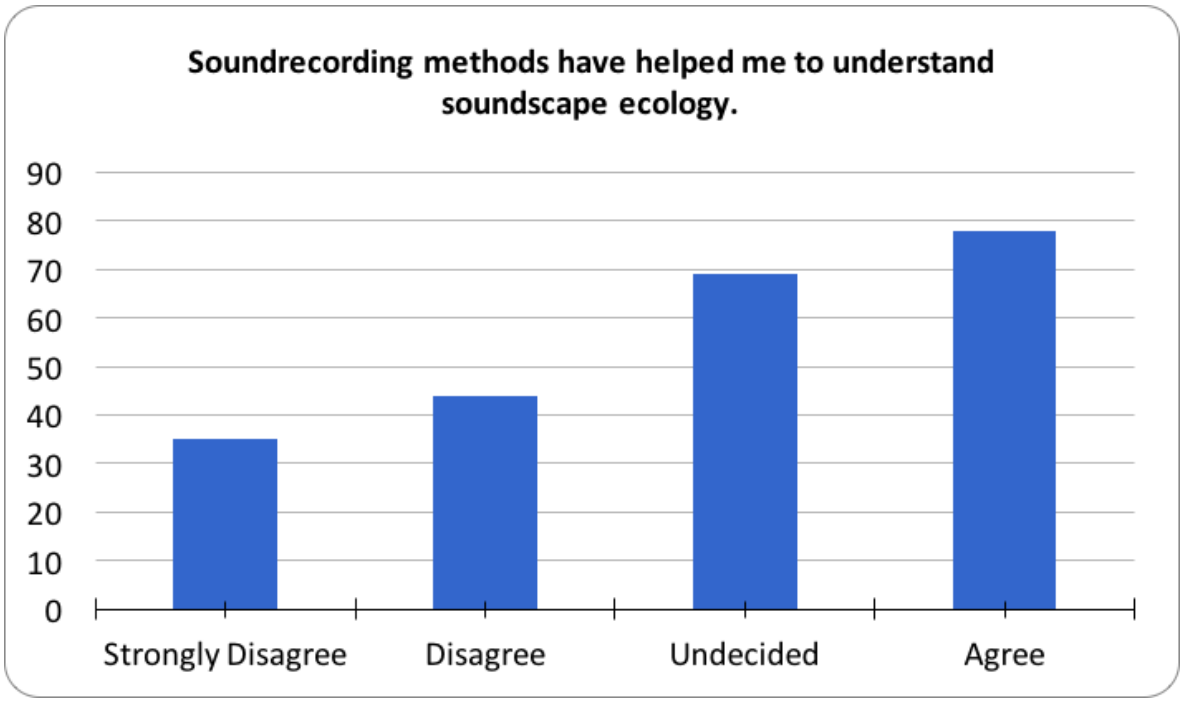
Of the 255 who were represented in the sound methodology study, 48 of those participants agreed to participate in visit to the Poudre River Watershed as a basis for comparison (Figure 7). The Wordle graphic below illustrates the sounds noted among this subset of participants. The major finding is that these 48 participants were able to note and specifically identify the names of species rather than record their observations in generalities. Also, biophonic sounds are noted more frequently *than in any of the othe*r ROMO data.

Figure 7:
Variety of sounds identified in Poudre River Watershed among subset of group (N= 255, N = 48), notice level of specificity increases based on proximity and experience.

While the sample of student participants above is large and the data is ample, the PI felt it important to dig deeper into students perspectives' during post-visit survey questions. Such a methodology enabled a better understanding of the importance of soundscapes to student participants, since the focus of the study was not on recording precise sounds per se but on the value of soundwalking itself. It was important to learn not just what participants heard but to better understand their perceptions of soundscapes in the wake of the fieldwork. Therefore, the student sample of 255 was administered a Likert scale survey designed to better understand the value of soundscapes and the importance in promoting attachment to ROMO as a place. The following section presents data from (1) the Likert scale questionnaire and (2) focus group discussions.

Student Perspectives Post-Visit

Post Visit Figure 1.
Sound Recording Methods as a Valuable tool (N=255)



For Figure 1 no “strongly agree” responses were recorded by participants but the majority of students “agreed” with the statement that “sound recording methods helped me to understand soundscape ecology.” For future research it will interesting to gather longitudinal data with the purpose of understanding how soundscape methods aided students in deciphering sounds and soundscapes over time. It is clear that one park visit is not sufficient for understanding the science of sound at ROMO.

Post Visit Figure 2. Visitor Center’s Role in Promoting Soundscapes at ROMO.

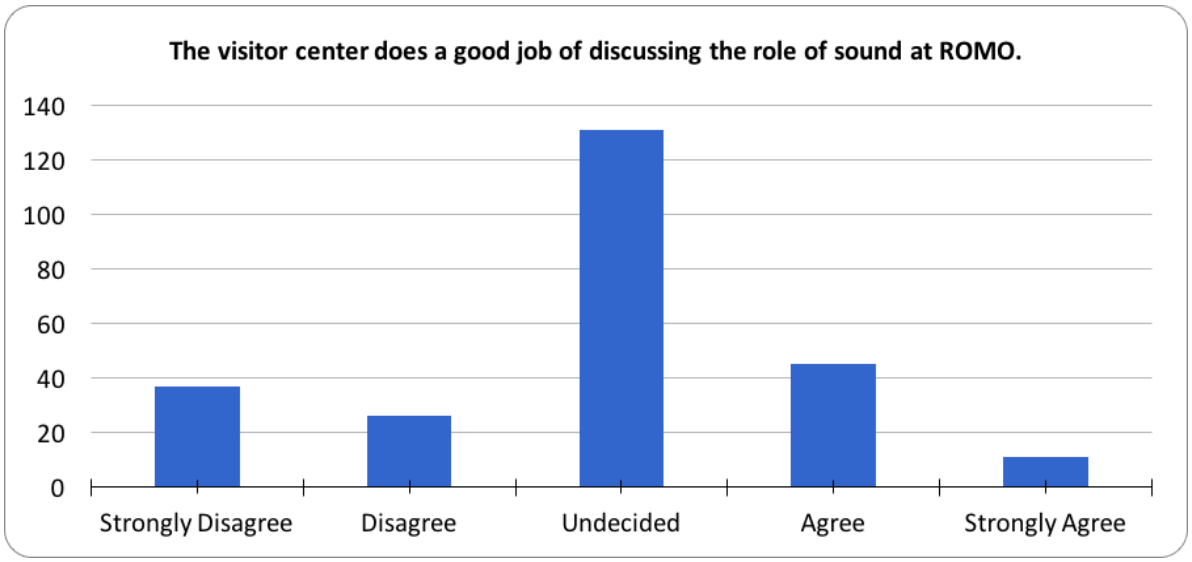
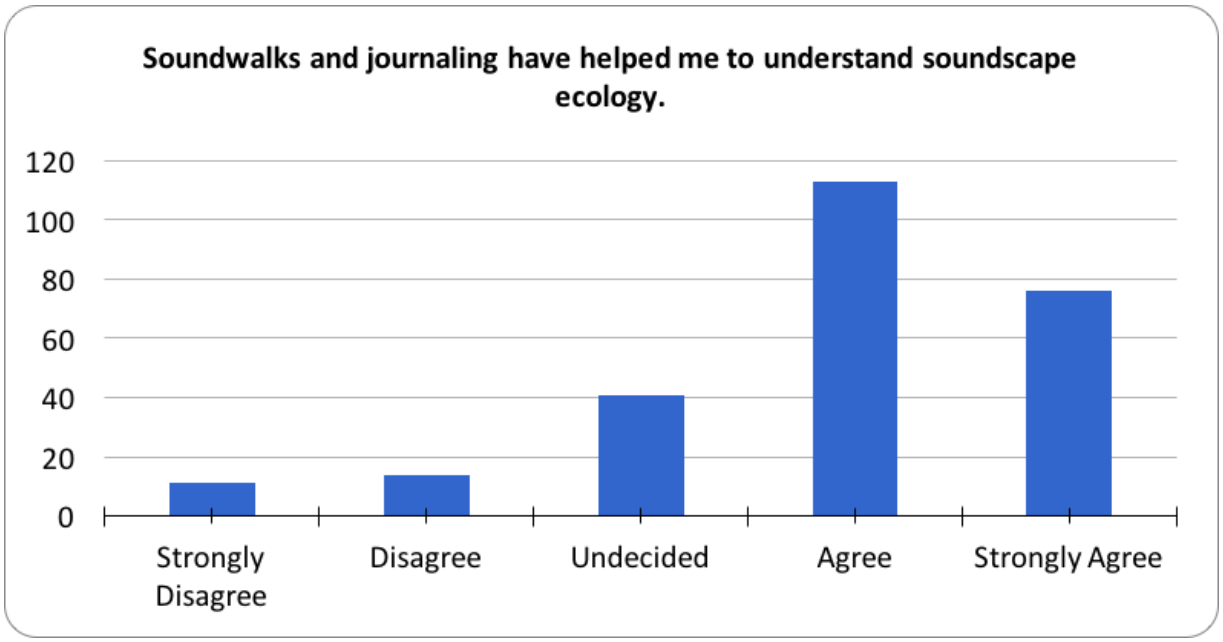


Figure 2 reveals that the majority of student participants were undecided as to whether the Visitor Center might do a better job in discussing soundscapes at Rocky Mountain National Parks. In focus group conversations, students discussed the issue in greater detail, providing more nuance to the statistics provided in Figure 2. For example, some students mentioned how "the park was already tasked with numerous responsibilities" and it was "not their job to teach the value of both visual and acoustic resources, unless they were given greater funding to do so". Thus these statistics indicate a sensitivity to the already onerous jobs of park personnel, rather than a criticism of the park's approach toward maintaining soundscapes. In conversations with participants it was made clear that "soundscape education needs to start in primary school", as one student said. Or, as another focus group participant mentioned: "We should be spending more time thinking about sound in our daily interactions with natural spaces, so when we get up to the park, we'll consider that as a resource". Another student said: "If we start this education at a young age, the park will not have to do that work, too".

Post Visit Figure 3. Soundwalks and Journaling as a Tool for Understanding Soundscape Ecology.



As Figure 3 illustrates, an overwhelming number of participants agreed or strongly agreed that soundwalks and journaling helped them to understand soundscape ecology at ROMO. In focus groups, student participants elaborated in greater detail, citing how soundwalks "forced me to slow down and listen even if I did not understand what type of biophonic sound I'd heard." Another student mentioned: 'The experience made me realize that Rocky is a very geophonic park, as opposed to other places I've visited along the Poudre which are full of wetland acoustics. This is something I'd not thought of until I visited the park with UNC. I was frustrated that I couldn't identify specific biophonic sounds at first, but I don't think the experience is about checking boxes on a list of what's been heard. The project forced me to quiet myself and be more mindful."

Post Visit Figure 4. The Relative Noise from Humans, Geophony, and Biophony.

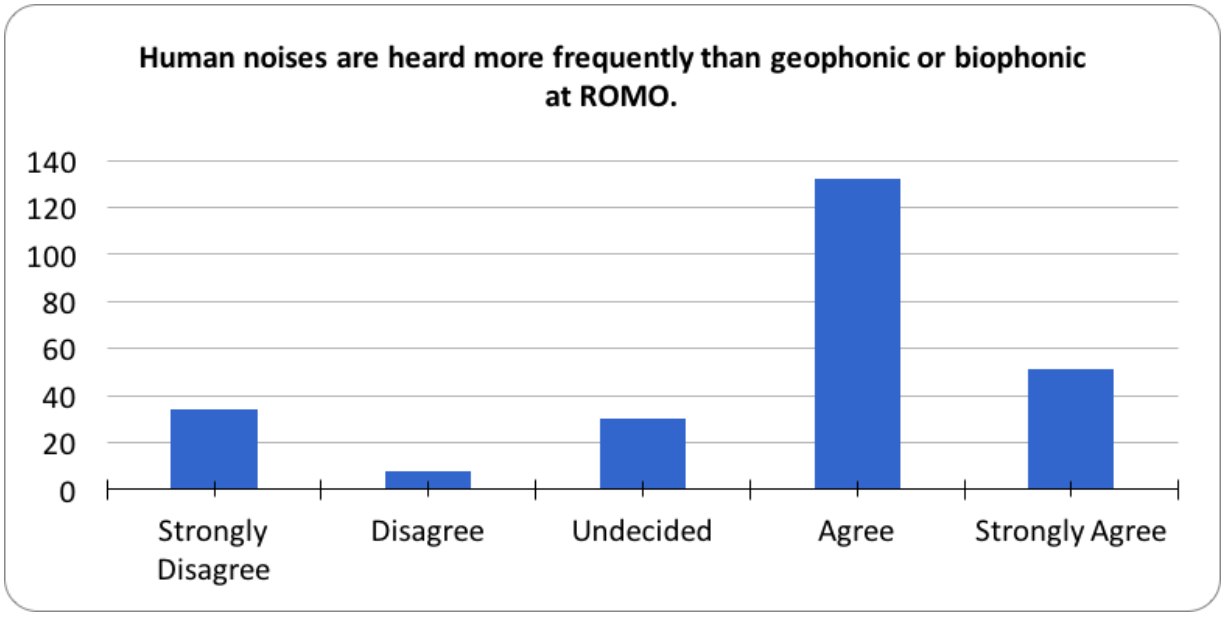


Figure 4 underscores what was expected in the initial project design. That is, that participants would hear more anthrophony noises than those in the geophony or biophony categories. This Likert question is, in fact, overly simplistic, as many of the anthrophony noises were created as part of the group dynamic rather than from jet flyovers. In focus groups, students reported that it was "distracting to be in a mix of 7 or 8 students, since you could not help but hear zippers, the movement of Gortex, laughter, or the crunch of boots". But as another student noted: "Many of these human-induced noises are not in fact negative in the sense that while we are disrupting nature by our very presence, we are also here, at Rocky, enjoying it." Having said that, it's also important to note that this study did not involve more advanced soundscape methods such as the incorporation of hydrophones into its study design. Such methods would have enabled students to hear the acoustics that happen out of human reach, without amplification, including that of soil biophony. Future research will incorporate these unique methodologies, in which a hydrophone might be placed in an ant mound to listen to and record activity. Similar work can be done in streams with hydrophones to record trout movement and acoustics.

Post Visit Figure 5. The General Importance of Soundscapes.

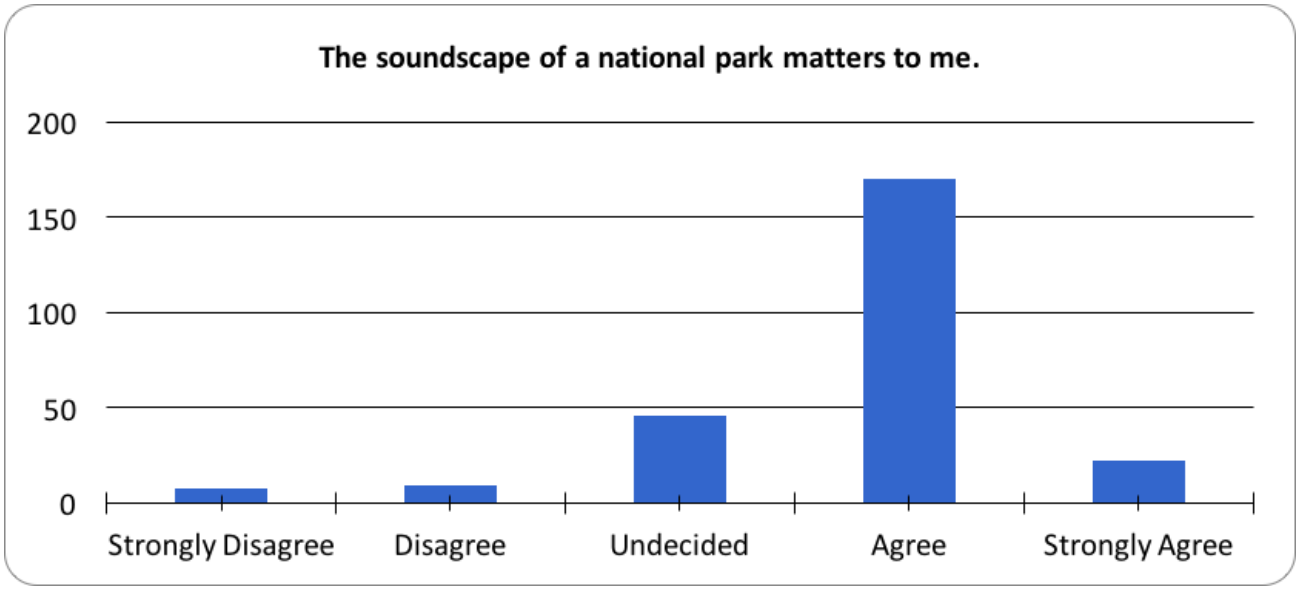


Figure 5 confirms that students strongly believe that the soundscapes of national parks matter and have value for them personally. In focus group discussions, participants confirmed that acoustics were “important but underappreciated”, “part of the park’s sensory experience,” “transformative”, “peaceful”, “vital”, “profound”, “amazing”, and “refreshing”. One student noted that “biophony is more important than ever as visitation to parks increases, and we need to find ways to protect these resources”.

Post Visit Figure 6. The Value of Soundscapes for Landscapes and Biological Communities.

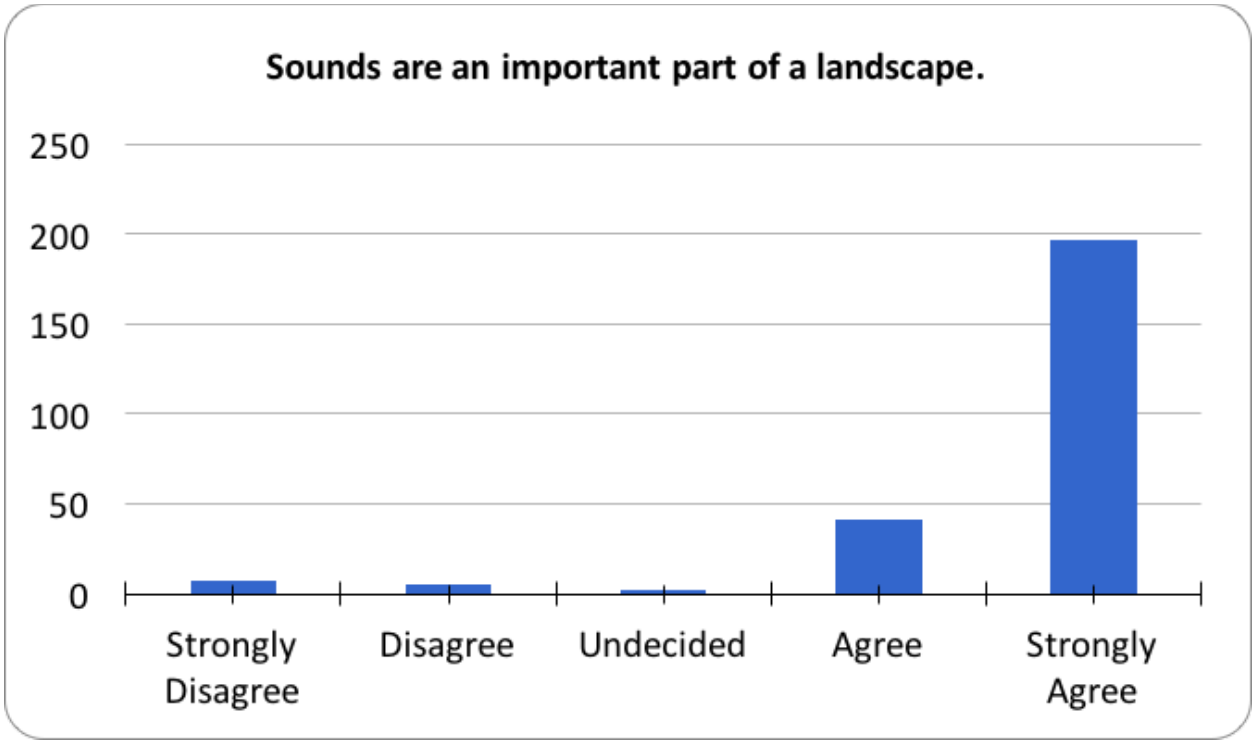


Figure 6 illustrates that sounds were viewed as an important part of the landscape among most participants. Unlike several other of the Likert-scale questions, there was little disagreement on the notion that the geographic landscape includes acoustics as a component.

Post Visit Figure 7. Awareness of Soundscapes in the Wake of the ROMO Study.

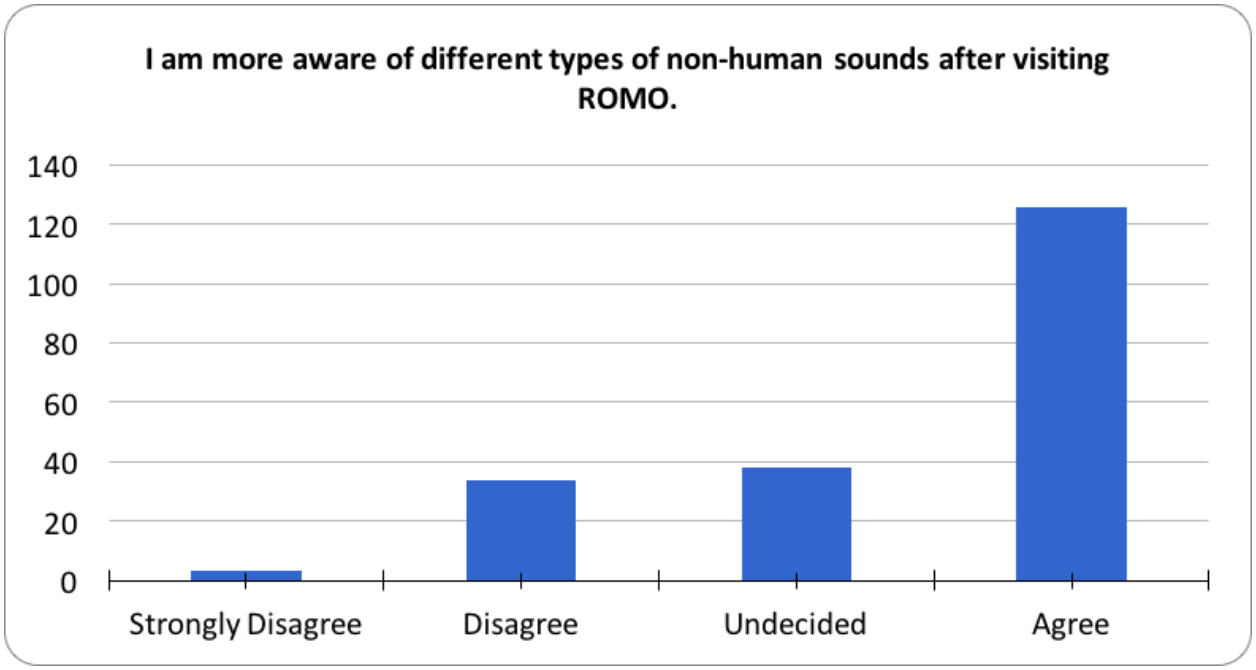


Figure 7 shows that the majority of participants became more mindful of non-human sounds (geophony and biophony) after visiting Rocky Mountain National Park. While a few disagreed with this statement, and no students strongly agreed, a large percentage cited more familiarity with acoustics after their experience. In focus groups, a few students elaborated: “I have a clear sense of the three types of sounds that comprise the soundscape, and a better indication of different biophonies, since geophony was already quite obvious. But what matters more is desire. Before I hadn’t thought of the relative importance of these categories, and why that matters.” Another student suggested: “My knowledge is incremental. I now have something to build upon. Birders don’t learn all of the birds by sight after one trip to a wetland. The same goes for us.”

Post Visit Figure 8. Perceived Importance of Law and Policy in Protecting Sound Resources.

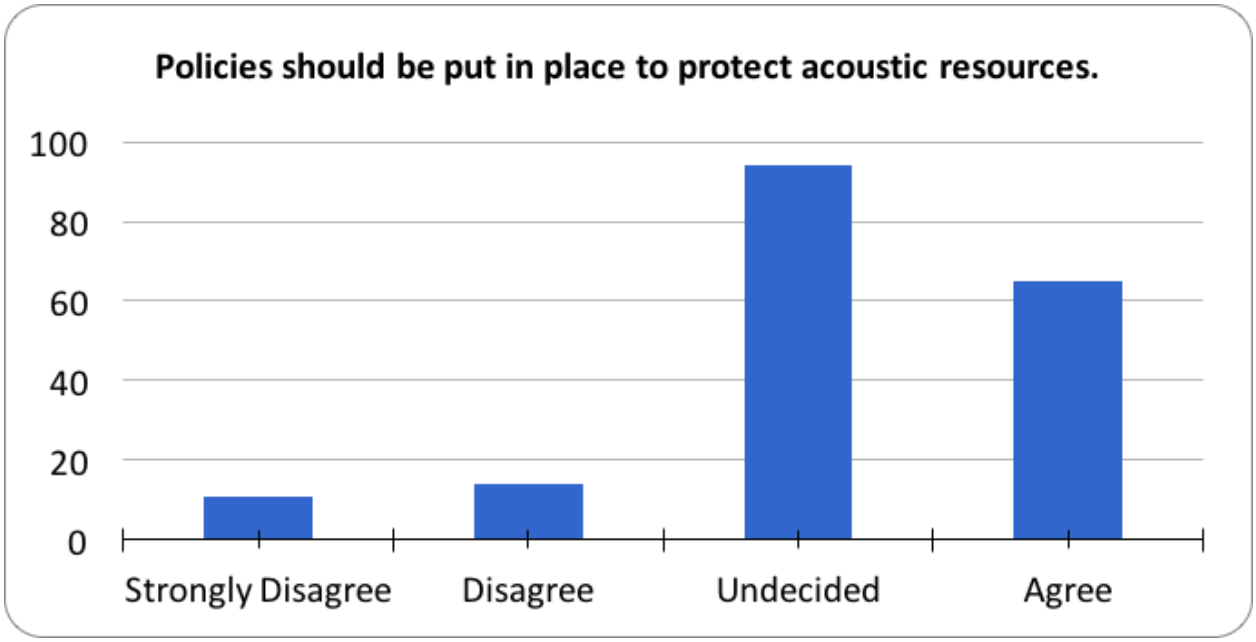


Figure 8 illustrates how participants agree (though no students strongly agreed) that policies should be put in place to protect acoustic resources, though a large number remain undecided. In group discussions, the complexity of this became apparent. One student noted: "Of course I want to see better policies to protect park sounds, because it means fundamentally protecting those species in order to protect their voices, if that makes sense. However, those policies might also mean I'm prohibited from visiting certain parts of the park, so I'm undecided." As another participant said: "Yes, I agree. I like the idea of protecting acoustic resources, but I'm not sure what that means exactly. I disagree with (name of student sitting nearby) that I don't like the idea of being barred from part of a park to protect those sounds and species. I'm fine with that. In fact, it's a great idea. What's troubling in general is visitation numbers and how as we have more people in the parks, I wonder what will happen to our access. More policies are good but the truth is I worry how it'll affect us".

Post Visit Figure 9. Relative Importance of Acoustic Versus Aesthetic Resources at ROMO.

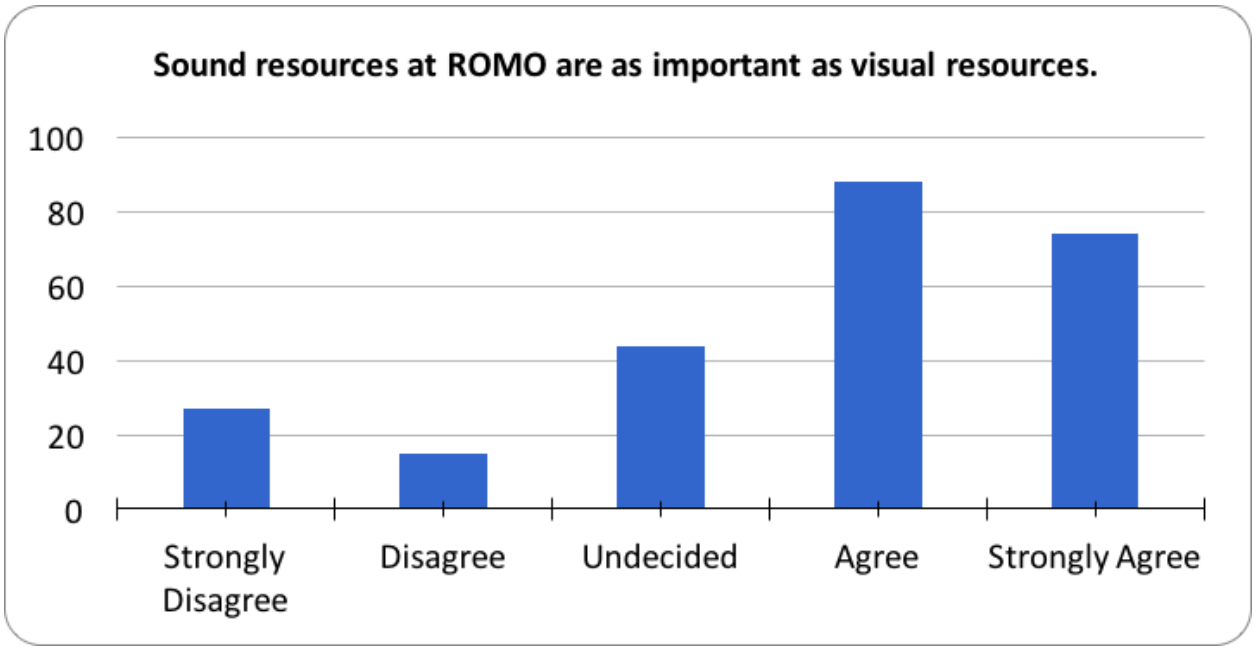


Figure 9 reveals some of the most important results from the study regarding the relative perceived value of acoustics versus aesthetics at ROMO. While approximately 35 participants strongly disagreed with the statement "Sound resources at ROMO are as important as visual resources", the majority did not. Some students (approximately 43) were undecided on this Likert scale statement, but most agreed that both resources were critical for park preservation. As noted in the focus group discussions by one student: "Now, had you asked me this question beforehand (before the visit), I most likely would have disagreed. But having been up the park with the task of focusing on sound, you get a good sense of why all senses matter." As another student noted: "I really think that we're becoming more aware of just how important sound is for a full immersive experience. We learned about "Silent Spring" in class but this finally brings Rachel Carson's concept to life". Naturally, not all participants agreed. A few students wrote in journals, or shared in discussions: "I still think that as a society we have an inclination toward the aesthetic and I don't see that changing anytime soon. The only way I can say it's important is that it's important for the species. But sound is not important to me, specifically." One student replied: "Ecological niche hypothesis doesn't care so much about you." The focus groups were very interesting in that they allowed the PIs to provide a setting in which to discuss the study, but also to participate in a larger conversations about the human role in nature.

Perceived Limitations of the ROMO Soundscape Project (Focus Group Sessions: N = 48)

Of the subset of participants who visited both ROMO and the Poudre River watershed, these students reported in the more intimate space of focus groups that one study limitation was their "lack of experience with soundwalking", recording,"listening in general", "let alone the skills to identify geophonic or biophonic sounds" not central in their everyday lives. Participants

recommended that the PI employ a pre-visit curriculum that prepared visitors for what to “hear” in the park. For example, a lesson on species identification (specific to ROMO) by sound was recommended. This was not part of the original study design, but nonetheless provides evidence that student participants wish to learn more about acoustics in advance of their journeys to ROMO. This gap could be filled using soundscape curriculum beginning in K-6 schools that is supplemented with activities such as ranger led “sound walks” at ROMO and elsewhere. Students in group discussion cited “experience”, “noise” and lack of “knowledge” as obstacles in a successful sound recording experience at the park. Some participants also reported “laughing” or “talking” as a barrier to proper soundwalking. However, it could be noted that communication between hikers is an integral part in place attachment in natural parks and protected areas. It could also be said that species identification by sound is a lesson best learned in the field rather than the classroom.

Summary Recommendations

Based on the research findings from this report, including both quantitative and qualitative results, the PIs submit the following recommendations as we move forward with future soundscape research:

1. Expose K-6 students to soundscape ecology both in the classroom and the field. It was clear from the sample of 255 college age students that soundscapes were a new concept, and it would be prudent to introduce these important concepts to students in formative years. The curriculum included in the Appendix, and submitted to partner schools in Weld County, is a good start in this regard.
2. Improve ESRI’s functionality to incorporate sound mapping on ESRI’s online platform. Story Maps have a tremendous ability to allow students to upload citizen science data into an online space but could be made easier than at present. Currently ESRI story maps permit image uploads but sound clips require greater functionality in the program.
3. Create silent spaces or zones in natural parks and protected areas within walking distance of certain trailheads. This would expose the majority of park visitors to the concept without them having to traverse distant wilderness areas to locate them.
4. Fund citizen science based research on soundscapes in national parks and protected areas. To date there is a growing body of literature on soundscapes but more effort must be focused on the value of citizens working to document acoustic changes in their backyards. This study shows that most students agree that soundscapes are as important as visual resources. The difference is that few participants were aware of these acoustic resources until they participated in the project.

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Appendix 1

Sound Curriculum for K-6 Social Studies classrooms.
Soundscapes in Everyday Life

1. Have students think about the sounds they hear every day.

Ask: *When you are asked to describe where you live, what do you say? Do you describe the homes, shops, and businesses? Do you describe the people? The landscape?* Explain to students that all of these natural and human-made things help to define a sense of place, or what makes a certain place have its own distinctive character. When people describe places, sound is often forgotten. But sound is often a major part of what makes a place special—what gives it a "sense of place." Ask: *Is there a sound that makes you think of your home? What is it? Why does it make you think of your home?*

2. Discuss how sounds define a sense of place.

Ask students to imagine another place they are familiar with, such as a grocery store, a bus stop, or a neighborhood park. Ask: *What are some of the distinctive sounds in those places?* Encourage students to think about what the grocery store would sound like without the sound of shopping carts clanging together in the cart corral and the beep of the checkout counters. Have them think about what a bus stop would sound like without the sound of the engine mixing with the whoosh of the doors opening; or the park without the sound of children playing. Ask: *Does the one sound that makes you think of your home define your home's sense of place?*

3. Ask students to listen to the sounds around them.
Have students close their eyes and listen to the sounds that surround them in the classroom. Remind them that they might hear natural sounds or sounds made by humans. They might hear the rustle of paper, buses or birds outside the window, or students talking in the hallway. All of these sounds build a soundscape. Explain that a landscape is made up of all of the different landforms, trees, houses, yards, and roads. A soundscape is made up of all of the different sounds that help to create a sense of place. Discuss the soundscape of your classroom.

4. Distribute worksheets and introduce the home activity.
Give each student a copy of the worksheet Soundscapes: Types of Sounds. Explain that their assignment is to go home and walk in and around their home or apartment for a few minutes, concentrating on all of the sounds that they hear. Have them write the following questions on the backs of their worksheets and think about them as they complete the activity.

- *What sounds do you hear?*
- *Are they natural, human-made, or the sound of humans and the environment interacting?*

- *What sounds do you hear that you don't usually pay attention to?*
- *How different would your home feel if those sounds were no longer part of the soundscape?*

Tell students they may have to walk around several times. Then they should complete the worksheet and try to choose the one special sound that helps define their home's sense of place.

5. Have students share their results.
Back in the classroom, have students share their home's sense of place and some of the distinctive natural sounds, human-made sounds, and sounds of humans and the environment interacting.

Learning Objectives:

1. Identify the sounds that create a sense of place in the classroom and where they live.
2. Write descriptions of the sounds or record sounds for others to hear.
3. Identify sounds as natural sounds, human made, or sounds of human-environment interaction.

Skills Summary
This activity targets the following skills:

1. Critical thinking (analyzing)
2. Geographic skills (acquiring geographic information)

National Geography Standards

Standard 4: The physical and human characteristics of places

Appendix 2

Lessons for Post-Secondary Classes and Public Audiences

Program 1:
Here is a list of questions to engage visitors in the process of locating natural soundscapes.

1. What do we mean by a quiet spot?
2. What do we mean by noise?
3. What types of natural sounds within a given habitat make us feel good?
4. What types of sounds help us feel relaxed?
5. What types of sounds interfere with our experience of the wild natural?
6. What types of sounds are acceptable within this park?
7. How can we take what we've experienced soundscape wise in the park to our cities or rural areas?

Activities that may help visitors find quiet spots:

1. Help visitors find quiet spots = where there are no mechanical or human noises but only geophonic sounds. Stream. Meadow. Mountain Beach.
2. Encourage them to give the experience time to discover the aural fabric unique to that location. Sounds that visitors hear each time of day - dawn, midday, afternoon
3. To reach these spheres of sound visitors might need to walk a distance away from well worn trails or aircraft patterns.
4. Encourage visitors to shut off electronics.

Activity site

1. Visitor Center.
2. Outreach programs thru local and regional schools that focus on the power of soundscapes.
3. Interpretive talks prepared by park staff.

Equipment:

1. Ears
2. Pencil or pen
3. Notebook

Program 2: Identifying Sources of Natural Soundscapes

A. Questions to Ask

1. How is biophony expressed in the natural world?
2. How is geophony expressed in the natural world?

B. Activities

1. Have visitors listen with eyes closed to the ways in which the combinations of creature voices (birds, insects, mammals, amphibians) create a soundscape and comprise a biophony. Each type of habitat - even within the same park - will provide a unique sound signature, much like our individual voices.
2. Have visitors listen critically to zones with few creature voices but where there is a stream, waterfall, the effect of wind in the trees, the effect of snow and other weather conditions on sound. These geophonies are distinctive. Characterize the subtle differences expressed by the stream as it follows one course.
3. Demonstrate how, in certain biomes, some creatures prefer to focus at different times of day.

Program 3: Experience Unusual Components of Natural Soundscapes

A.Questions to ask: How can we listen to ants, termites, and other small ground dwelling creatures?

B. How can we hear fish and crustaceans in their respective habitats?

C. What can some of these sounds tell us?

Activities: Note (requires amplification or recording gear)

1. Find a carpenter ant nest and lay a small lavaliere mic over the entrance to the mound. Turn on the recorder or amp and listen.
2. Compare sounds of diff species of ants.
3. In fresh water spools during spring and summer, drop a hydrophone (underwater mic) into a nearby pool. Hear water boatmen and insect larvae.

Tips: Don’t get stuck on megafauna. The very small creatures, nearly microscopic, sing (they have an audible signature). Several species of ants sing. Insect larvae in pools of water sing. Listening can be done as a group effort. No talking. No rustling of Gore Tex clothing. Everyone must be dedicated to being quiet. Concentrate on the experience of listening. Adapted from Dr. Bernie Krause (2012).