Profile

A conversation with Acoustic Scientist Kurt Fristrup

By the editor and associate editor

Editor's Note: This interview grew out of our interest to explore the science of soundscapes, and immediately Kurt Fristrup was suggested as our person. Articulate and energetic, Fristrup is a great scientist, eager to broaden his understanding and incorporate interdisciplinary applications of acoustics science. His vision, high motivation, and training are helping to advance our knowledge of park soundscapes in leaps and bounds.

Park Science: **Acoustical monitoring is a far step from biomedical engineering, the field in which you began your career. Which experiences led you to the National Park Service and the Natural Sounds Program?**

Kurt Fristrup: My family spent many wonderful vacations in national parks, and I have always been interested in applications of physics and engineering in biology. When I became aware that my interests could apply in environmental science, my focus shifted from biomedical research to ecology and evolutionary biology, and I got my PhD in these disciplines at Harvard. Although acoustics played no role in my graduate work, it was central to my subsequent research at Woods Hole Oceanographic Institution and the Cornell Laboratory of Ornithology. While at Cornell, I provided technical assistance to the Natural Sounds Program regarding acoustical monitoring and analysis. The program contacted me when a position opened that I could compete for, and I was thrilled to be able to unite my interests in national parks and research.

"Soundscape" is a new concept to many people. What is it? Which natural features and processes are part of a soundscape? Which cultural features and processes are part of a soundscape?

KF: "Soundscape" refers to the entire environment as perceived through hearing. This includes perception of the spatial arrangement of sounds as well as the scheduling and structure of each sound. "Soundscape" is sometimes used to refer to the physical environment that supports sound propagation, though I prefer to call this the acoustical environment.

Our ability to perceive the soundscape relies upon the presence of sounds, our hearing capacity, and the way we categorize and identify incoming sounds. The integrity and authenticity of a soundscape depend upon the presence of the appropriate sounds and a quiet background in which to perceive them. The richness of what we perceive depends upon attentive listening and

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knowledge of what to listen for.

Which sounds are threatened? Which sounds do we need to preserve for future generations?

KF: The most threatened resource is a noise-free background in which to hear natural sounds. Very distant noise sources can damage the setting of quiet sites, interfering with the capacity of wildlife and park visitors to perceive subtle sounds. The National Park Service has strong legislative and policy mandates to conserve the sounds of wildlife along with healthy populations.

What research is needed to help understand and preserve soundscapes in national parks?

KF: Although there are numerous studies documenting the responses of visitors and wildlife to loud noise events, the effects of chronic exposure to less obvious noise sources are not as well understood. The effects of noise on backcountry visitors and on visitor perceptions of wilderness are also important research topics.

How are sounds important for overall ecosystem health?

KF: Hearing is the universal alerting sense for animals. Sounds alert animals to events all around them, even when the animals are occupied with foraging, parental care, or even sleeping. When noise compromises this awareness, animals may have limited options to compensate through increased visual scanning. Many predators rely heavily on listening to find prey, and many of their targets listen intently to avoid being eaten. In addition, many animals rely heavily on acoustical communication to defend territories, attract mates, and communicate with their young.

How is sound different for wildlife and humans?

KF: Many park visitors do not listen as intently as a wild animal would. Noisy urban environments can train us to ignore sounds, and many visitors may be unaware that attentive listening can enrich their experience of park resources. Some animals have much more sensitive hearing than humans—owls are a good example—but humans are rarely able to take full advantage of our hearing because noise levels in our communities mask our capacity to hear quiet or subtle sounds. Increasingly, noise is masking the ability of animals to take full advantage of their hearing capabilities.

Is there a catalog or library of unique sounds throughout the National Park System?

KF: We have some examples of natural sounds on our Web site (http://www.nature.nps.gov/naturalsounds/). We have tens of thousands of hours of digital audio files in our archive, which includes a selection of unusual or illustrative recordings.

How have park managers applied your data? Would you give specific examples?

KF: Acoustical monitoring data are informing the development of many NPS management plans: off-road vehicles at Cape Hatteras, winter use at Yellowstone, and air tours at Grand Canyon and many other national park units.

Research and acoustical monitoring at Muir Woods revealed that visitors responded very favorably to signs asking them to make special efforts to be quiet. The success of this program encouraged Muir Woods to permanently designate a quiet zone in Cathedral Grove.

The Natural Sounds Program is relatively new. What lessons have you learned helping to develop a fledgling program within an established organization like the Natural Resource Program Center and the National Park Service?

KF: Effective resource conservation always involves partnerships. Innovative acoustical monitoring analysis has been one part of our program's effort. Another major effort has been to develop collaborations with other divisions in the Natural Resource Program Center, and to demonstrate the relevance of our work for the regions and park units. Interpretation and outreach have proven critical to enhancing our value within the service, just as they are critical to enhance the experience of park visitors.

In what direction(s) would you take the Natural Sounds Program?

KF: The planning staff is working to establish consistent management practices for all acoustical resources. The science and engineering staff is working to extend our efforts to provide continuous, real-time monitoring of park acoustical conditions, information that could enliven interpretive programs and support law enforcement. We need to extend our capabilities to cover underwater sounds and vibration. Noise and vibration can present significant problems for cultural and historic sites. The grand challenge is to devise innovative approaches for providing access to parks that enhance visitor experience and minimize noise intrusions.

In order for the Natural Sounds Program to be successful, how do park managers and visitors need to change how they think about sounds/noise? What are the opportunities for education and outreach?

KF: We can all be better listeners. Parks provide outstanding opportunities to resuscitate visitor hearing, to help them enjoy an immersive experience of park soundscapes. Educational materials can help visitors identify unusual or ecologically important sounds, and train their ears to guide them to compelling views of wildlife behavior.

What significant findings has the program revealed? How are these helping to shape Service-wide practices and policies?

KF: Most backcountry areas in national parks experience substantial numbers of noise events per day. Noise is typically audible 20–30% of the day, and some remote areas have hours in which noise is audible almost 70% of the time. This emerging picture of pervasive noise exposure poses a fundamental challenge to the management of wilderness in national parks and other federal lands.

Take us through a monitoring scenario. Which methods do you apply? What equipment do you use? What are some of the logistics?

KF: The first step is to work with the park unit to discuss acoustical issues that pertain to park management objectives, and identify monitoring locations that will provide relevant data. Monitoring locations are often identified using Geographic Information Systems analyses. The equipment must often be packed into backcountry locations, so it has been designed to minimize size and weight. If the park envisions a need for modeling of potential scenarios or evaluation of monitoring data in relation to specific noise sources, then each monitoring station will have a sound level meter, a digital audio recorder, and a weather station. Inventories of natural sounds and noise sources can be accomplished without the sound level meter and weather station, resulting in a smaller and much less expensive package. Four years ago the monitoring stations weighed more than 250 pounds and consumed 14 watts of power. Today they weigh less than 50 pounds (with batteries) and consume about 2 watts.

All equipment is housed in weather- and bear-resistant containers, and all cabling is sheathed to inhibit chewing. Field technicians must survey the general vicinity of the chosen location to find a site that has representative vegetation, soil, and topography, and is not especially exposed to wind. Wind generates pseudonoise when it flows over a microphone wind shield, which inhibits monitoring of the wind sounds that are part of the natural environment. The microphone and anemometer are set up on tripods, each of which is secured with guy wires and stakes to prevent tipping. Solar panels are often used at exposed sites, to extend battery lifetime, but our monitoring systems can run for more than a month with batteries of reasonable size and weight. The acoustical and weather instruments must be set up with proper monitoring parameters. When everything is connected and ready, the field technicians start up the instruments and secure the housings.

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What are the standards for acoustical monitoring? How would you improve these?

KF: Historically, acoustical monitoring in parks focused on ANSI Type 1 sound level measurements. We have improved on this practice by adding continuous audio recording. The combined data enable us to identify and archive the natural and cultural sounds of park settings, as well as the sources of noise. In the future, we expect to utilize multichannel audio recording to preserve the spatial structure of the soundscape, as well as the identities of the sounds and the background sound level. The multichannel systems will allow us to localize sound sources, enabling us to map wildlife activity and track noise sources.

What is the most exciting natural sound you've experienced in the field?

KF: Equipment that I helped develop and deploy recorded sounds of ivory-billed woodpeckers, and I may have heard the bird in Congaree National Park. This species was previously thought to have gone extinct. This project combined the thrill of discovery with a profound opportunity to revitalize conservation efforts for eastern floodplain forests.