Ecological & Environmental Acoustic Remote Sensor (EcoEARS) Application for Long-Term Monitoring and Assessment of Wildlife

Gonzalo Sanchez; President, Sanchez Industrial Design, Inc., 3510 Beltline Hwy, Middleton, WI 53562; Tel: (608) 824-9428; gsanchez@sid-inc.com
Co-Authors- Stuart H Gage, Subir Biswas, and Robert C. Maher, Ph.D.

Gonzalo Sanchez is the President of Sanchez Industrial Design Inc. His work is in the area of transportation noise and acoustics. He is also involved in the design, manufacturing and installation of specialized electronic hardware used to collect both acoustic and environmental data. He holds a BS in Biomedical Engineering from Boston University.

Dr. Stuart Gage is a Professor of Entomology at Michigan State University. His research and teaching interests are in the areas of Biological Information Systems and Earth System Science. He is also the Associate Director of the Center for Global Change and Earth Observations and Director of the Computational Ecology and Visualization Laboratory. He holds a BS degree in Agriculture from North Dakota State University and both MS and PhD degrees from Michigan State University in Entomology & Systems Ecology.

Dr. Rob Maher is an Associate Professor of Electrical and Computer Engineering at Montana State University-Bozeman. His research and teaching interests are in the application of modern digital signal processing techniques to problems in digital audio and acoustics. He holds a BS degree from Washington University in St. Louis, an MS degree from the University of Wisconsin-Madison, and a Ph.D. from the University of Illinois-Urbana, all in Electrical Engineering.

Acoustic signals produced by birds, amphibians, insects, and other organisms, collectively comprising the *Biophony*, are a valuable ecological attribute. Combined with sounds caused by human activity (the *Anthrophony*) and sounds due to water, wind, geologic activity (the *Geophony*), acoustic signals can provide information about the function of ecosystems. Because acoustic signals change hourly, daily, seasonally and annually, environmental acoustics must be measured at these time scales, yet the frequency range and temporal dynamics of acoustic signals can defy our ability to measure and classify the signal properties. To measure acoustics at appropriate temporal scales and simultaneously measure at appropriate spatial scales can also be challenging and costly. Fortunately, the application of innovative sensors, computational platforms, and communication network technologies is providing new opportunities and enabling new insights into the meaning of acoustic signals in the environment. The new strategies and technologies help optimize the scope and geographic coverage of these measurements while reducing human labor. In addition, we have developed analytical technology and computer software to classify environmental sounds into the Anthrophony, Biophony and Geophony groupings, thereby providing a method to categorize a habitat and assess its ecological integrity. Real-time interpretation remains a challenging problem, but we have also successfully demonstrated algorithms to identify in real-time human made sounds generated by jets, propeller aircraft, helicopters and motor vehicles, which will be used to better understand the effects of these human made sounds on the environment. Signal analysis techniques to identify wildlife and simultaneous collection of environmental parameters like wind, rain, solar radiation and temperature will be used to study the interactions among these variables and to monitor changes and trends in the environment.

The instrumentation we utilize for measurement of environmental acoustics ranges from commercially available computer systems with automated recording software to specially constructed hardware designed to measure and archive environmental acoustics at timed intervals. We have developed automatic methods to transmit acoustic signals via satellite to remote servers where the signals can be archived, processed and classified without human intervention. We will describe the field deployable hardware used to monitor acoustics, the cyber infrastructure required for large scale acoustic monitoring, and the methodology used to automate the classification of acoustic signals. We will also discuss future requirements for design of networks for long-term environmental monitoring.