

Case Studies

Tools of the trade: An example of using spectrograms to count fixed-wing aircraft

By Laura Levy and Sarah Falzarano

SPECTROGRAMS ARE A USEFUL TOOL

that many National Park Service (NPS) soundscape scientists employ to examine decibel data. For example, they translate decibel data collected in daily or hourly units into a visual format, enabling a quick scan of hundreds of hours' worth of data for the occurrence of natural and human-caused sound sources at a particular site. Each sound source has its own signature based on frequencies, loudness, and timing, making it easy to identify. Spectrograms are created by converting 1-second decibel and one-third-octave band data into a visual format using statistical analysis software, called "R," and an "R" script written by the NPS Natural Sounds Program.

Recently the Soundscape Program at Grand Canyon National Park was tasked with determining the number of fixed-wing aircraft using the Fossil Canyon general aviation corridor over the park (Levy and Falzarano 2007). This corridor is located in a remote part of the park (fig. 1), making an on-site, real-time tally of fixed-wing aircraft unrealistic. Park staff placed an acoustic system in the corridor for one year starting 1 November 2006 (fig. 2). The acoustic system consisted of a Panasonic CF-i8 Toughbook laptop, an ANSI type 1 Larson-Davis sound-level meter (model 824), a microphone (GRAS 40AE), and a preamplifier (Larson-Davis 902). Twelve-volt, lead-acid batteries powered the system, recharged by two 80-watt arrays of solar panels. Total system cost was approximately \$14,000. Though this may seem cost-prohibitive for some parks, it is important to keep in mind that equipment can be shared between parks, and the

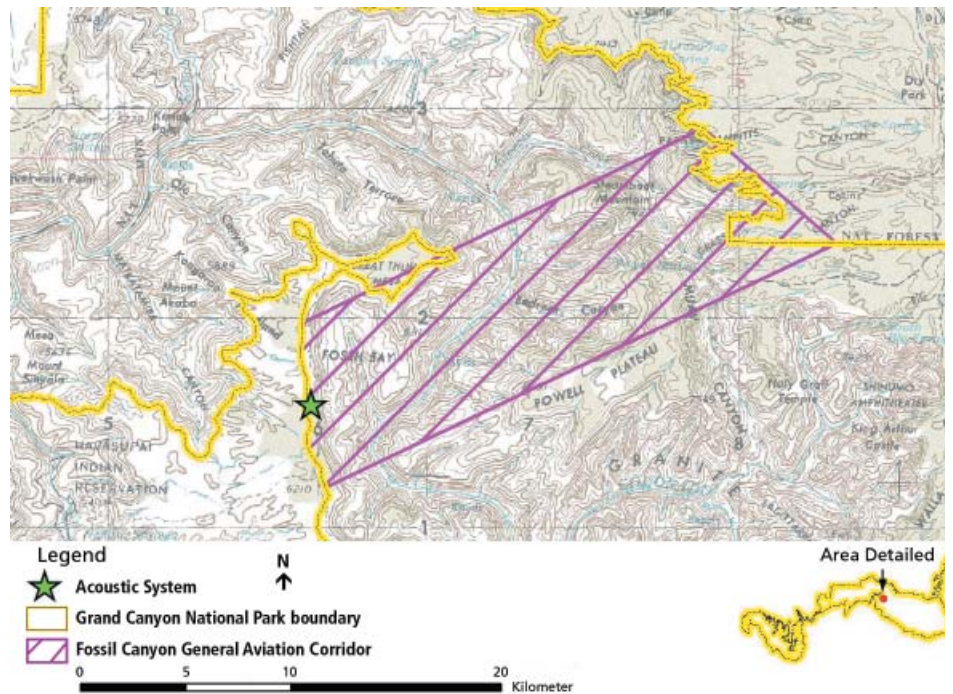


Figure 1. The map depicts the Fossil Canyon general aviation corridor in Grand Canyon National Park. The acoustic data collection system location is identified by the green star, located approximately 40 miles (64 km) from the South Rim Village via dirt roads.

data collected could serve a multitude of purposes. Twenty-four-hour spectrograms were created for 365 days of decibel data, enabling program staff to count fixed-wing plane signatures. Spectrograms provided timely, quality information and obviated the need to listen to hundreds of hours of sampled recordings. Instead, park staff were able to identify fixed-wing aircraft on the spectrograms by their "staircase" or "corkscrew" signature shape (fig. 3), which were confirmed by listening to corresponding recordings.

Results show that a total of 1,504 fixed-wing aircraft used the corridor over 10 months with an average of 5 fixed-wing planes per day. Two months of data (August and September) were lost due to equipment failure when an elk knocked

over the microphone, which filled with water. Beyond tallying aircraft, park staff used the spectrograms to ensure quality control of collected data, to monitor times of helicopter flights, and to quickly locate recordings of interesting wildlife sounds such as coyotes howling and elk bugling. Spectrograms can be generated in a matter of minutes and display 24 hours of data at a time. Therefore, spectrograms can quickly show data gaps (system failure) or noise interference (e.g., field staff checking the system on site). The park Soundscape Program continues to use spectrograms in a variety of ways to aid management, and this tool has great potential for park interpretive and education programs.



Figure 2. Laura Levy checks the acoustic monitoring station for the Fossil Canyon general aviation corridor at Grand Canyon National Park. The solar arrays measure approximately 24 x 30 inches and 42 x 30 inches.

NPS PHOTO/SARAH FALZARANO

References

Levy, L. B., and S. R. Falzarano. 2007. General aviation use of the Fossil Canyon corridor, Grand Canyon National Park. NPS Report GRCA-08-02. National Park Service, Grand Canyon National Park, Arizona, USA. Accessed at http://www.nps.gov/grca/naturescience/airoverflights_documents.htm.

About the authors

Laura Levy and **Sarah Falzarano** were formerly with the Soundscape Program at Grand Canyon National Park. Laura is now a graduate student at Dartmouth College in the Earth Science Department studying past glacier fluctuations in Greenland; Sarah is with the Army Corps of Engineers in Hawaii. Correspondence can be directed to Jane Rodgers (jane_rodgers@nps.gov).

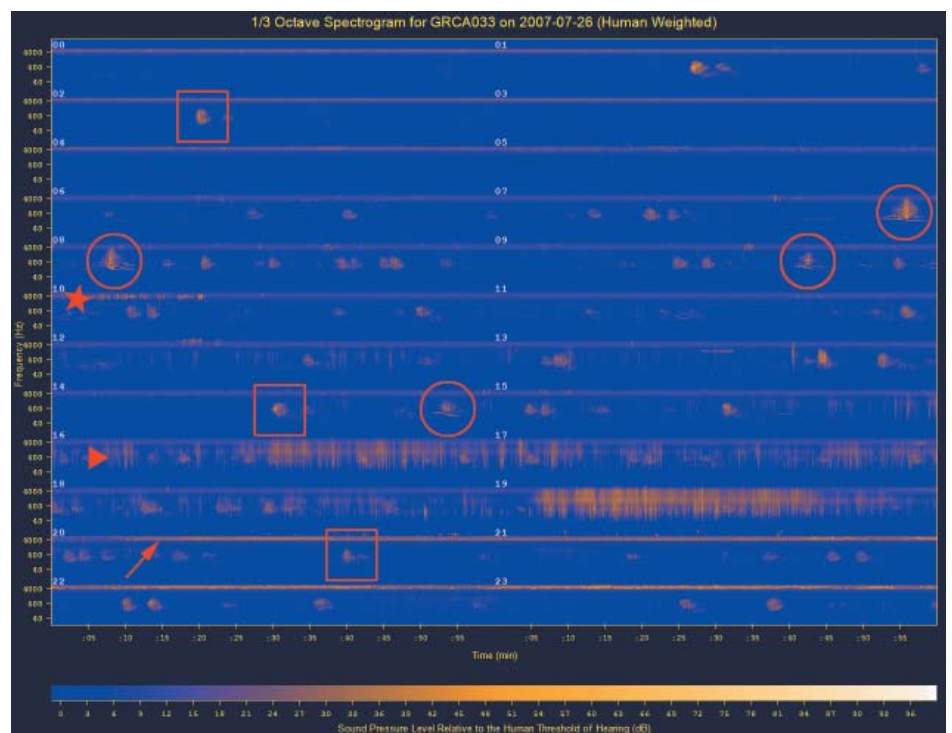


Figure 3. This spectrogram shows sound pressure level (i.e., volume) data for the Fossil Canyon general aviation corridor on 26 July 2007. White numbers (00 to 23 hours) signify time of day, frequency is indicated on the Y axis in Herz, and decibel levels are indicated by color (dark blue through yellow) relative to the human threshold of hearing (0–100 dB). Propeller planes are circled, some but not all jets are marked by rectangles, arrows indicate insects, the star illustrates birds, and the triangle points to wind signatures.