



**Final Report:**  
**Passive Audio Monitoring of Federally Threatened Mexican Spotted  
Owl and Yellow-Billed Cuckoo**

*Submitted to the Western National Parks Association  
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## **Introduction**

The Mexican Spotted Owl (MSO) and the Yellow-Billed Cuckoo (YBCU) are designated as Threatened species under the Endangered Species Act (ESA). The U.S. Fish & Wildlife Service recovery plans for these species emphasize Federal agency requirements for providing information and assessing MSO and YBCU population trends. The National Park Service (NPS) is also required to conduct MSO and YBCU surveys to meet ESA Section 7 consultation requirements. Thirty NPS units have either MSO or YBCU occurrence records, or designated MSO Critical Habitat. NPS units are engaged in a wide range of activities for which accurate information on MSO and YBCU habitat occupancy is needed, including fire management, riparian area management, grazing management, infrastructure projects, and changes in visitor and recreation use. MSO and YBCU have low population densities, low reproductive rates, occupy specialized habitat niches, and are likely vulnerable to climate change impacts. Since 2009, an innovative survey method using portable audio recorders has been pilot tested at Walnut Canyon National Monument. Researchers utilize portable audio recorders and bird song detection software to find mated bird pairs and nesting/roosting sites. Funding was requested from the Western National Parks Association (WNPA) to provide technical support, equipment, supplies, and training for passive audio surveys at park units throughout the Four Corners region.

## **Methods**

The primary objective of this project was to enable NPS natural resource staff to identify and locate important nest and roost core areas of two federally threatened bird species: the Mexican Spotted Owl (MSO) and the Yellow-Billed Cuckoo (YBCU). This was achieved

through the utilization of portable audio recorders and bird song recognition software. Both bird species communicate to potential breeding mates and defend territories by projecting a series of calls unique to their species. Passive audio surveys at Walnut Canyon National Monument (WACA) led to the discovery of nine MSO nest/roost sites, including the first documented nesting activity since 1994. The resultant audio data possess considerable information describing MSO biology and life history characteristics: courtship and nesting calling behavior, food begging and food exchanges, territorial defense and disturbance responses, and nestling vocalizations.

#### Recording Equipment:

Researchers utilized the AGPTEK U3 recorder to perform passive audio surveys. This recorder model is compact, lightweight, and very inexpensive. When retrofitted with external, high-capacity D-cell batteries, it will continuously record for about 22 days. Audio files are recorded in single-channel, WAV64 format and stored in internal static memory in a compressed format.



AGPTEK U3 recorder

#### Recorder Deployment:

Site selections for recorder deployments were prioritized to match preferred habitat for each species and confirmed historical sightings. NPS units also deployed recorders in sites of planned project activity or within a systematic survey route.

Recorders were appropriately spaced to provide effective overlapping microphone range coverage

for survey habitat (0.4 km/0.25 mi). Recording stations were mapped with GPS and a field log was maintained to document recorder deployment data. Recorder deployments were



SCA intern Althea Weeks at Chiricahua National Monument

scheduled at least seven days apart to minimize potential disturbance to bird breeding and nesting areas. Recorders were deployed just prior to active breeding and throughout nesting and fledging dates for bird young (March - September).

#### Audio File Processing:

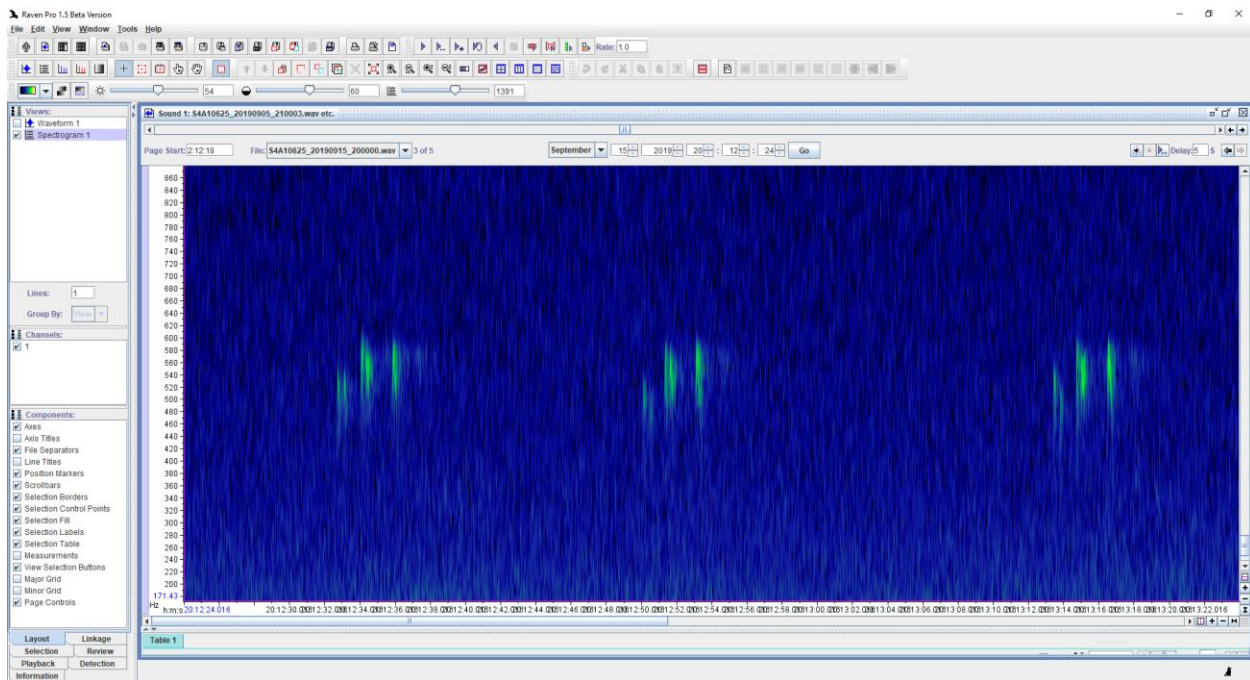
Upon retrieval of portable recorders from the field, digital audio files were downloaded to office computers for processing and analysis. The field recordings constituted 8 GB of compressed WAV file data for an average 22-night recording. Each recording session was converted to uncompressed WAV format and then split into a sequence of separate, 1-hour long WAV files. File decompression, splitting, and renaming were accomplished through the AudioSplit application (Don McClimans, 2019).

#### Audio File Analysis:

Following initial file processing, the audio files were analyzed for target bird calls. Researchers utilized Raven Pro© (Version 1.5) interactive sound analysis software for the ability to identify and catalogue bird calls. The Raven Pro© program builds a real-time spectrogram - a visual representation of the spectrum of frequencies present in the audio recordings - for the entire length of each recording session. The spectrogram signature for target bird calls is unique and



can quickly be detected by a trained technician. Spectrograms were then visually scanned for bird calls, which were verified by human listening, categorized by call type, and catalogued by sound data technicians. An entire 22-day recording session can be visually scanned, audibly verified, categorized, and catalogued in approximately four work hours.



RavenPro Spectrogram showing a Mexican Spotted Owl 4-Note call.

WACA Natural Resource staff continue to develop automated bird call recognizers within the Raven Pro® program, termed a “Band Limited Energy Detector”. Automated searches of entire 22-day recording sessions can be completed in 15 minutes. Following an automated call recognizer scan, the Raven Pro® program produces a spreadsheet report of all sound events matching the programmed parameters, including the time and date of the sound event. Software-detected target bird calls can then be individually verified by viewing the resultant call spectrogram or listening to the call.

All verified target bird call detections were entered into a Microsoft® Access® database. Calls were not logged if there was any uncertainty regarding the origin of a file, poor audio quality, or difficulty in call identification. Call-response interactions between target bird male and female pairs was noted and may signal the presence of a bonded bird pair, defended territory, or nesting site. Database queries provide summary call statistics for each station at each NPS unit, and combined station summary statistics for the entire season.

## Results

Twelve NPS units supported by the WNPA utilized AGPTEK U3 recorders to perform passive audio surveys in the 2018-2019 bird breeding seasons:

- Bandelier National Monument
- Canyon de Chelly National Monument
- Carlsbad Caverns National Park
- Chiricahua National Monument
- Coronado National Memorial
- Gila Cliff Dwellings National Monument
- Montezuma Castle National Monument
- Navajo National Monument
- Pecos National Historic Park
- Saguaro National Park
- Tuzigoot National Monument
- Walnut Canyon National Monument

Guadalupe Mountains National Park, Organ Pipe Cactus National Monument, and Tonto National Monument are expected to participate in passive audio surveys in the 2020 bird breeding season. Results from passive audio survey data analysis are reported in Table 1.

Table 1: Passive audio survey data analysis by park unit.

<b>NPS UNIT</b>	<b>Total Number of Recorder Stations</b>	<b>Total Number of Recorder Sessions</b>	<b>Total Number of Nights Surveyed</b>	<b>Total Number of Hours Surveyed</b>	<b>Total Number of Bird Calls Detected</b>
<b>Bandelier NM</b>	8	10	173	2070	17
<b>Canyon de Chelly NM</b>	33	33	730	8755	247
<b>Carlsbad NP</b>	10	10	220	2640	0
<b>Chiricahua NM</b>	11	25	496	5957	1737
<b>Coronado NM</b>	7	15	348	4170	4
<b>Gila Cliff Dwellings NM</b>	3	6	132	1584	Data analysis in process
<b>Montezuma Castle NM</b>	3	12	264	3168	Data analysis in process
<b>Navajo NM</b>	7	11	246	2949	1
<b>Pecos NHP</b>	5	5	110	1320	Data analysis in process
<b>Saguaro NP</b>	21	27	594	7128	1384
<b>Tuzigoot NM</b>	2	4	88	1056	137
<b>Walnut Canyon NM</b>	10	19	338	4803	2564
<b>ALL Park Totals</b>	115	172	3629	44280	6091

All park units combined surveyed 115 unique sites for bird activity, resulting in over 44,000 total survey hours and over 6,000 total bird call detections.

## Discussion

Passive audio survey equipment and bird song detection software provided by the WNPA greatly enhance the ability of National Park units to survey larger areas of habitat over a greater period of time in a very cost-efficient manner. Seven of the twelve participating park units had not conducted systemized surveys in over 10 years due to resource limitations. Travel times needed to access remote backcountry sites can be a limiting factor to survey site prioritizations, but the use of recording equipment reduces that administrative burden and enhances survey durations. Though initially designed for bird call detection, these portable audio recorders are now being used by National Park units to detect frog and toad calls at remote and ephemeral water sources.

## **Interpretive Products**

Saguaro National Park is currently creating a professionally produced video short (15 minutes) to be shown within visitor centers and on web sites within National Park units. The video will include scenic park footage, Mexican Spotted Owl footage, and interviews with biologists, natural resource managers, and interpretation staff discussing the passive audio surveys from participating park units. The completed video project is expected to be delivered in 2021.

Four 2-hour presentations were conducted at the Walnut Canyon National Monument visitor center on the dates of August 29, September 03, September 05, and December 01, 2019. Two 2-hour presentations were conducted at the Sunset Crater Volcano and Wupatki National Monuments visitor centers on November 27, 2019. All presentations showcased the passive audio recording equipment used at participating park units and the bird call detection software. The presentation also highlighted the science of sound and bioacoustics monitoring. Visitors were introduced to concepts of sound wave travel, sound pressure level measurements, “sound” versus “noise”, and soundscape monitoring in parks. Concepts of remote field monitoring, Endangered Species Act legislation, Critical Habitat protection measures, and National Environmental Policy Act (NEPA) were also discussed. A portable laptop computer was set up to demonstrate how software scans an audio sample and finds target bird sounds. Park visitors were shown spectrograms of Mexican Spotted Owl and Yellow-billed Cuckoo calls. Audio samples of bird calls recorded at participating parks were played for park visitors. One 1-hour presentation was conducted for the 2018 Flagstaff Festival of Science at the Lowell Observatory on September 25, 2018. This presentation also showcased the passive audio recording equipment used at participating park units and the bird call detection software.