

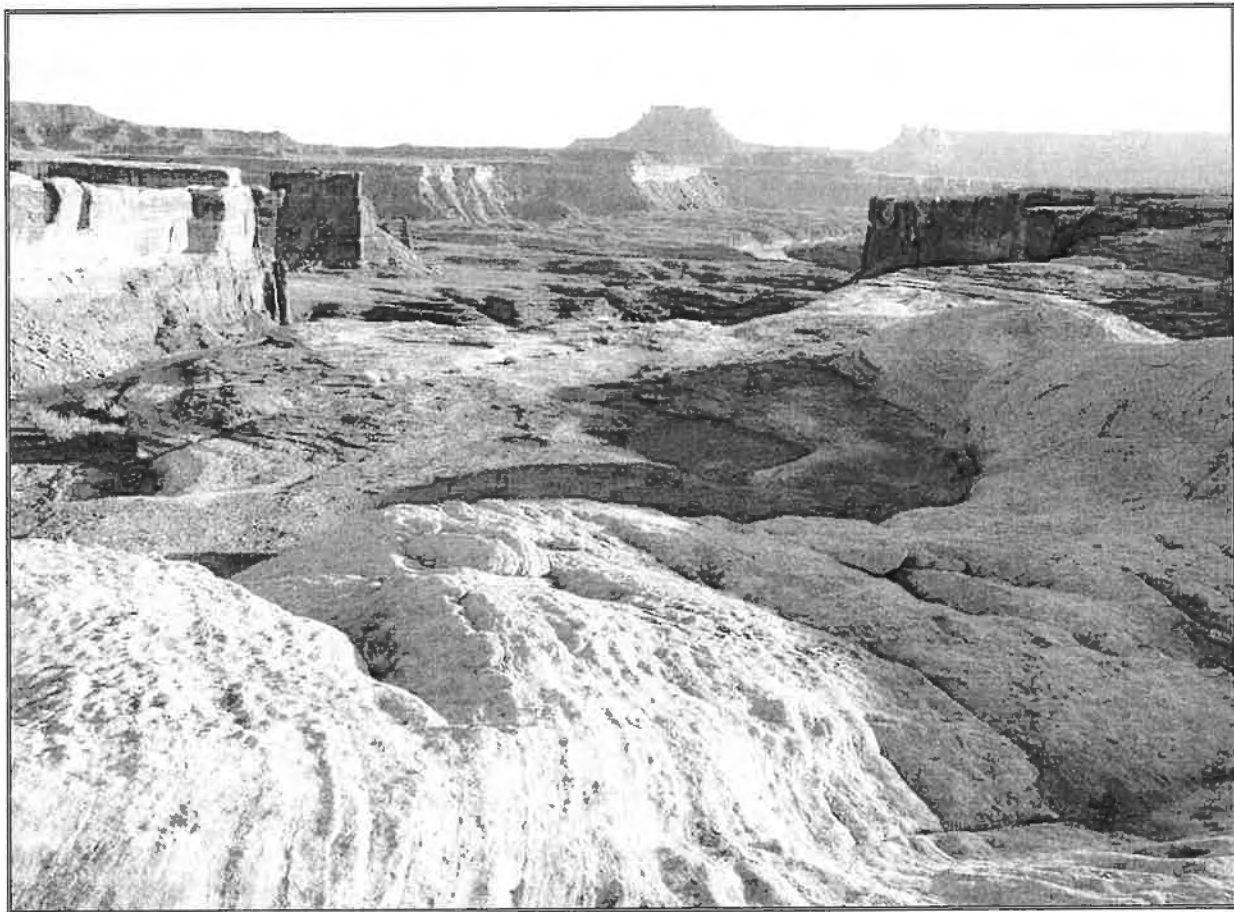


**Arches
Canyonlands
Hovenweep
Natural Bridges**



Resource Management Division

**Using Digital Recordings to Supplement Avian Surveys,
Canyonlands National Park, 2002.**



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March 2003

ABSTRACT

The Natural Sounds Program (NSP) of the National Park Service is interested in investigating the usefulness of digital audio recordings made by acoustic monitors to supplement avian surveys. The NSP supported Canyonlands National Park in collecting near-continuous audio recordings at one location in the Park where ongoing point count avian surveys were being conducted. Powered by solar panels and twelve-volt batteries, the acoustic monitor collected 1-minute digital audio recordings every 5 minutes between 0500 and 0900 throughout the month May. Forty-five species of birds (plus five potential additional species) were detected using the audio recordings compared with 11 species detected during 2 days of point count field surveys in the same location. Audio data revealed patterns in the frequency of singing and in species richness from early to late May, and also in peak vocalization times during the morning. The digital recordings collected by the acoustic monitor in our study proved useful as a supplement to species richness information gathered by avian surveys, and by revealing temporal patterns in vocalizations. High quality digital recordings of unusual species may potentially serve as an official voucher of presence, where existing documentation is questionable or inadequate. There may be limits to the use of digital recordings for avian surveys.

TABLE OF CONTENTS

1. INTRODUCTION	1
1.1 Objectives.....	2
2. METHODS	2
2.1 Study Area	2
Location	2
Area Description and Importance	3
2.2 Equipment and Sampling Times.....	4
2.3 Data Entry.....	6
3. RESULTS	6
3.1 Effort	6
3.2 Unidentified Sounds	7
3.3 Interference of Wind on May 20, 21	7
3.4 Species Richness Based on Sound Data	7
3.5 Singing Patterns Based on Sound Data	7
3.6 Comparing Sound Data with Point Count Survey Data.....	12
4. DISCUSSION	13
4.1 Potential Ways in Which Sound Monitors May Supplement Avian Surveys	13
4.2 Potential Limitations of Sound Monitors in Supplementing Avian Surveys	14
5. RECOMMENDATIONS.....	14
5.1 Recommendations/Troubleshooting	14
6. LITERATURE CITED	16
APPENDIX A: MS Access Data Entry Screen	17

TABLES AND FIGURES

TABLE 1.	Avian species detected by the sound monitor, and by point count field surveys, at point count station 4, Salt Creek, Canyonlands National Park.	8
TABLE 2.	Avian species included or excluded from analysis of singing frequency, based on the relative distinction between their song and call.	10
TABLE 3.	A comparison of the number of avian species detected by different sound monitor sampling schemes, with point count field surveys. Results are based on samples from one location in Canyonlands National Park, in May of 2002.....	13
FIGURE 1.	Location of Canyonlands National Park and Study Area	4
FIGURE 2.	Avian species richness in May, 2002, from one location in Canyonlands National Park	9
FIGURE 3.	Neotropical migrant bird species richness in May, 2002, from one location in Canyonlands National Park.	9
FIGURE 4.	Frequency of singing by neotropical migrant birds in May, 2002, in one location in Canyonlands National Park	11
FIGURE 5.	Frequency of singing by resident birds in May, 2002, in one location in Canyonlands National Park.	11
FIGURE 6.	Peak vocalization times between 0500 and 0900 in the morning at one location in Canyonlands National Park	12

ACKNOWLEDGEMENTS

We would like to thank the Natural Sounds Program, including Chris Florian, Shan Burson III, and Linda Franklin, for technical support on this project. Charlie Schelz provided photographs and helpful comments for the report. Thanks also to Margaret Beer for creating the Access database to enter and store acoustic data.

1. INTRODUCTION



Canyonlands National Park, Needles District, Salt Creek, just downstream of study area.

The Southeast Utah Group of the National Park Service recently initiated a sound monitoring program in response to concern about degradation of the natural soundscape due to human-caused noise. Typically, acoustic monitors used in programs such as this collect decibel data for relatively short periods of time (days or weeks), primarily to assess noise from human-caused sources, such as aircraft. Decibel data alone do not provide identification of sources of natural and human-caused sounds, and identification of the source of sounds is essential for soundscape management. New acoustic monitors developed by Far North Aquatics (Fairbanks, Alaska) have the capability of collecting standard 1-second decibel data as well as making high-quality digital recordings at programmed (user-defined) intervals. These audio recordings provide the ability to identify sources of natural and human-caused sounds. The purpose of this project was to test the usefulness of digital recordings collected by these acoustic monitors as supplements to avian surveys in Canyonlands National Park.

Declining numbers of neotropical migrant birds (NTMB) over the past few decades has led to increasing concern about their populations. This pilot study was designed to assess the usefulness of digital recordings collected by acoustic monitors to supplement ongoing point count avian surveys being conducted at the same location in the Park. The monitor was programmed to collect a wide range of acoustic measurements for soundscape planning, and also to collect digital recordings that could be used for identifying singing birds. The monitors have large storage capacity and can be deployed for the entire breeding season, and thus should be able to expand the

researcher's knowledge of the number of species in the study area. This is especially important in determining presence of rare or uncommon birds that might be missed during regular surveys.

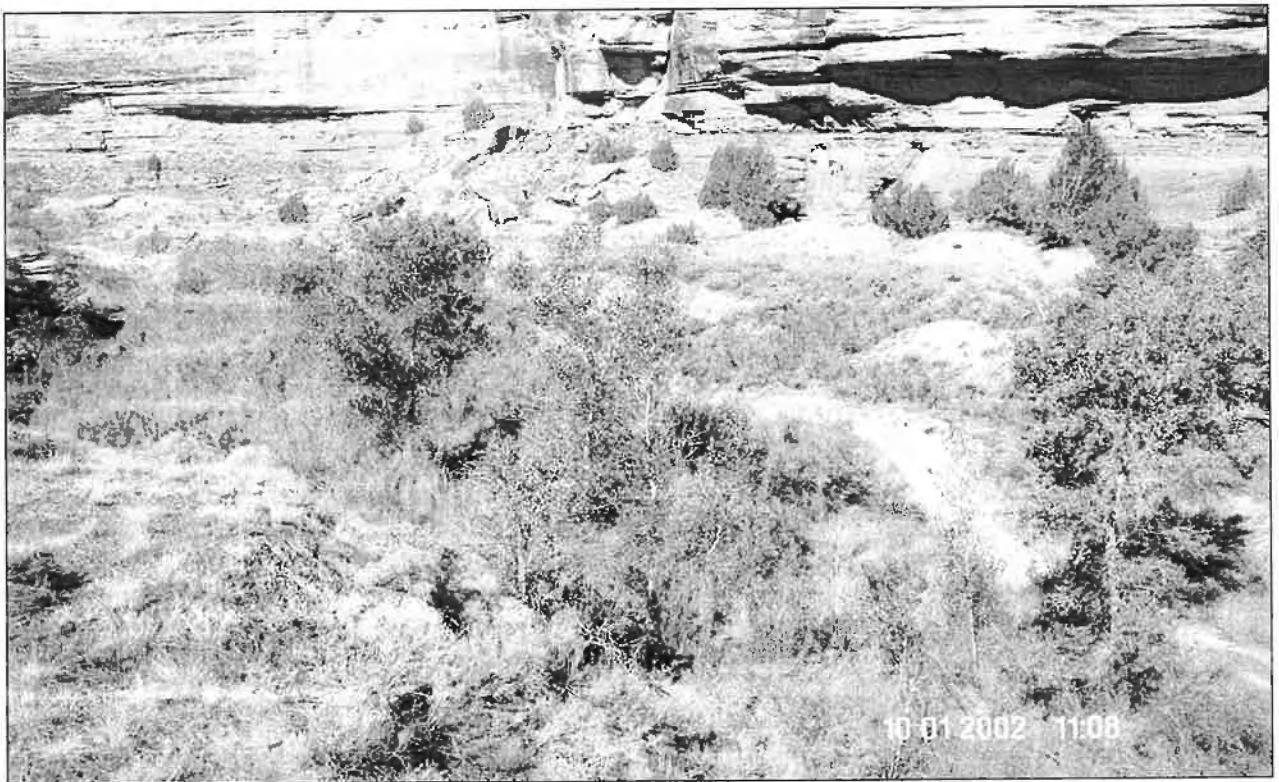
1.1 Objectives

The primary objective of this project was to test the feasibility of using digital recordings made by remote acoustic monitors to supplement avian survey information collected by park staff in Canyonlands National Park (CANY). Specifically, we assessed the usefulness of the digital recordings to add to our knowledge of species richness and the presence of rare and uncommon bird species. Additionally, we collected standard acoustic data needed for soundscape monitoring and management in CANY.

2. METHODS

2.1 Study Area

Location: Canyonlands National Park is located in southeast Utah along the Colorado and Green Rivers in Grand, Garfield, San Juan and Wayne Counties (Figure 1). The park is southwest of Moab, Utah.



Canyonlands National Park, Needles District, Salt Creek, looking upstream from study area.

Area Description and Importance

The study area is located in Salt Creek in the Needles District of CANY. Excluding the Green and Colorado riverine habitat, Salt Creek is the most extensive riparian/wetland area in Canyonlands National Park. It is an intermittent stream with perennial water: the closest in the park to a perennial stream. It is the only canyon system with a direct hydrological and ecological link to the nearby Abajo Mountains, and thus serves as the major wildlife corridor in the park. Classic desert riparian vegetation composed of cottonwood (*Populus fremontii*) and willows (*Salix* spp.), and a host of other typical riparian plants such as tamarisk (*Tamarix ramosissima*), rabbitbrush (*Chrysothamnus nauseosa*), and big sagebrush (*Artemisia tridentata*) are present. In addition, the stream channel itself is unique because of the well-developed macrophyte, periphyte, and macroinvertebrate community. There are periods during the year when water does not flow in Salt Creek, but unlike most areas in CANY, there are many pools and wet sections that always persist. These provide ideal habitat for many riparian avian species in CANY. To facilitate comparison of audio data with ongoing avian point count surveys, the acoustic monitor was set up approximately 30 m from an established point count station in Salt Creek.

Elevation at the site is 1544 m, and the climate of CANY is arid. It is characterized by hot, dry summers and cool to cold winters. Temperatures in the park vary with altitude and latitude: in the Needles District, at an elevation of 5,040 feet, the average maximum temperature is 68.3⁰ F, the average minimum is 37.8⁰ F (Brough et al.1987). The average annual precipitation is 8.62 inches.

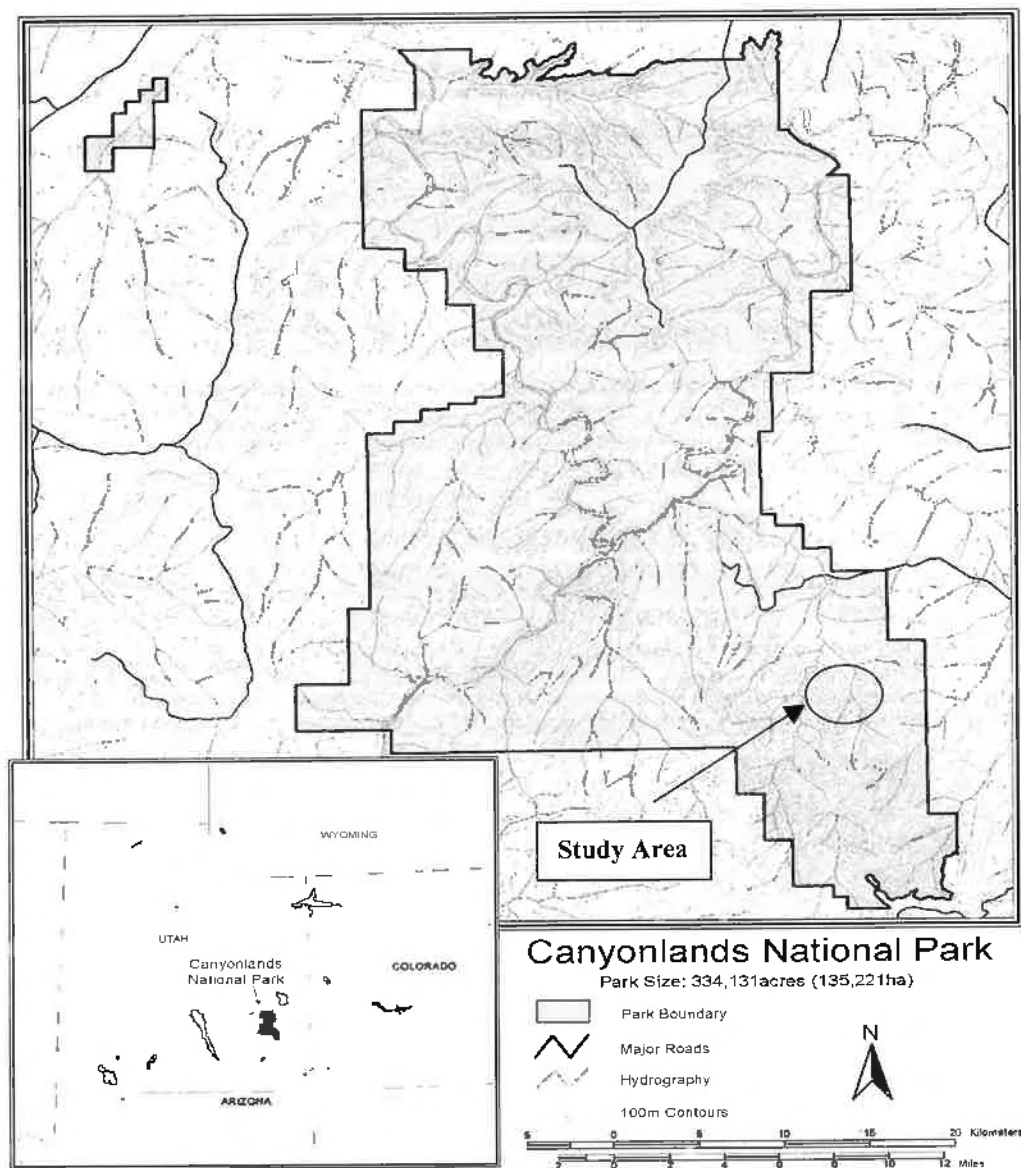


FIGURE 1: Location of Canyonlands National Park and Study Area

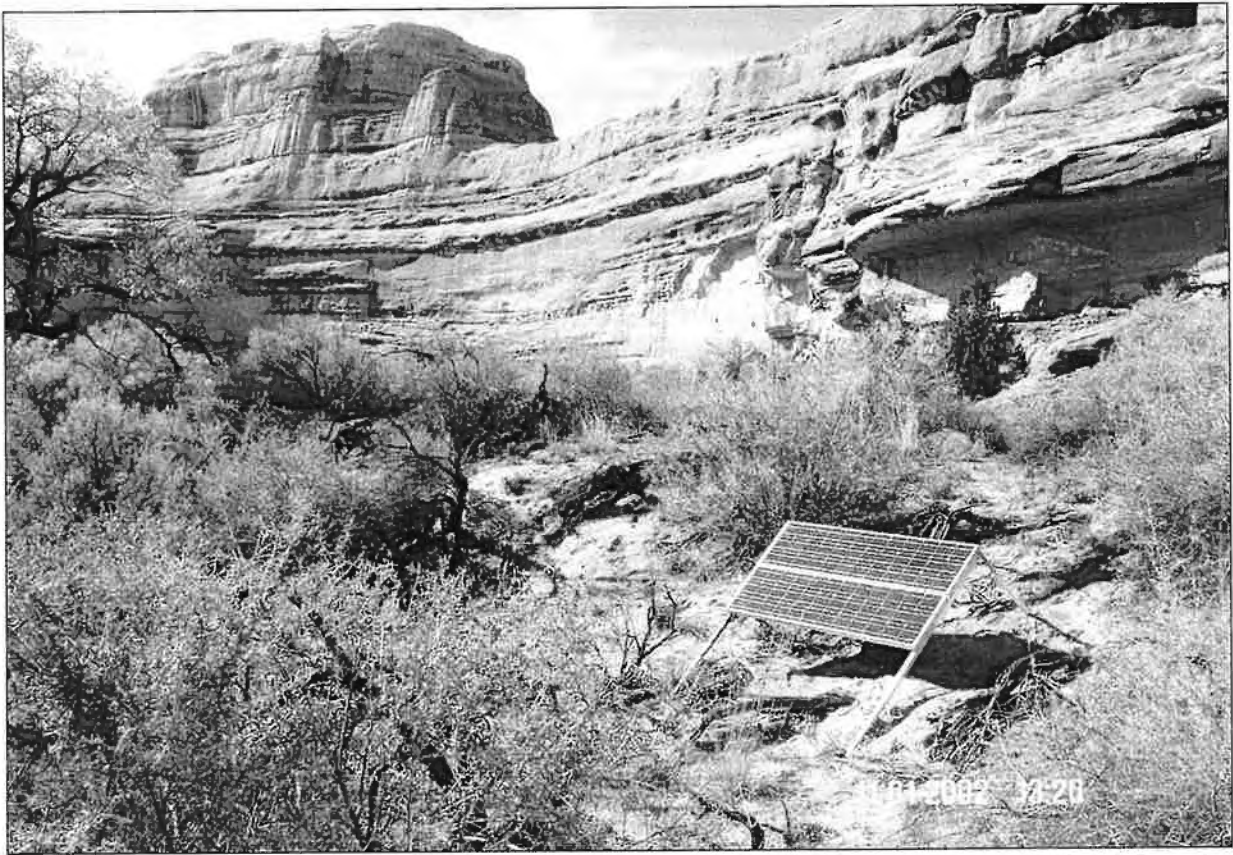
2.2 Equipment and Sampling Times

Acoustic data and digital recordings were collected using Sound Monitor 6.4e software (© Far North Aquatics, Fairbanks, AK) and a Larson Davis 812 sound level meter, connected to a Panasonic CF 45 notebook computer (Ambrose and Donaldson, 2001). A Type 1 (ANSI-standard) random-incidence microphone was placed 1.5 m above the ground, oriented vertically. The acoustic monitoring equipment was placed in a weatherproof container and was powered by 12-volt batteries charged by solar panels. The system was programmed to collect 1-minute digital audio recordings every 5 minutes between 0500 and 0900, daily between May 2 and May 31. The system also collected digital audio recordings during the remainder of the day, but these were smaller duration (5 seconds every 5 minutes). Up to six different sampling schemes can be programmed using current software. Data were downloaded from the monitor using a portable hard drive during monthly visits to the site.

The audio recording sampling scheme was designed to overlap with ongoing avian surveys being conducted at the station as part of a larger breeding season point count survey throughout the Southeast Utah Group of National Parks. Methodology for the ongoing point count surveys requires 3 visits each to all stations in May and June. At each station, all birds seen and heard are recorded during an 8-minute sampling period between 0545 and 0900 (Daw 2002).



Microphone and Stand at Salt Creek Location



Solar Array at Salt Creek Location

2.3 Data Entry

A Microsoft Access database was designed to accommodate the following fields of data, some of which were automatically linked: Record ID, Date, Sample Number (1-48 each day), Sample Start Time, Sample End Time, Sample Duration, Species Code (4-letter AOU codes), SongCall (song or call), and Other Sounds. For any given 1-minute recording, if one species of bird both called and sang, "s" (song) was recorded for that species. For each 1-minute sample, only unique species were listed, not unique individuals. Thus, 2 rock wrens might be heard counter singing, but only 1 entry for rock wren went into the database for that sample. Abundance data are not available because individual birds cannot be distinguished using a single, monaural recording. Audio recordings were played back using Windows 98 Media Player software, and a Whirlwind PA-1 personal amplification system to amplify the sound.

3. RESULTS

3.1 Effort

The 60-second recording every 5 minutes sampling scheme produced 1,418 minutes of audio recordings, which resulted in 4,556 data entries (the last day of recording was cut short by 22 sampling minutes). The 100 hours of time budgeted for this project were allocated in the following way:

Equipment set up (with additional help from NPS Sound personnel):	12 hrs
Listening to recordings:	51 hrs
Writing report/Exploring some of the unidentified sounds:	<u>37 hrs</u>
	100 hrs

Time spent listening to the recordings was, obviously, where most of the effort was spent. Efficiency increased with time, partly from having already learned the uncommon sounds early on in the data, and partly because I stopped taking time to identify ambiguous sounds later on in the project. They were marked "?" and left to identify for later. When I first began listening to recordings, I averaged nearly 2 minutes to process 1 minute of audio data, whereas towards the end, it took me 1.18 minutes to process 1 minute of audio data.

3.2 Unidentified Sounds

Of the 4556 records, 197 (4%) were unidentified avian sounds, most of which were calls that were either faint or not easily distinguished among species. Several factors make identification more difficult: distance from the microphone, overlap with other singing birds, background noise from wind or aircraft, odd variations from fledglings learning to sing, and the simple fact that birds make certain sounds very infrequently that are therefore not well known. One specific difficulty in identifying sounds was distinguishing the whir of hummingbird wings from that of large insects. I did not spend extra time trying to identify most of the unidentified sounds. Only 5 unidentified vocalizations were clearly unusual enough to be potential additional species.

3.3 Interference of Wind on May 20, 21

May 20 and 21 were days with very strong winds, which resulted in significantly fewer avian sound detections. This can be clearly seen in the pronounced downward spike on graphs showing trends in detections through the month of May.

3.4 Species Richness Based on Audio Data

Total species richness detected by the sound monitor during the month of May in Salt Creek, was 45 (plus the 5 potential additional species) (**Table 1**). Over time, richness increased slightly towards the end of May, probably driven by the return of neotropical migrant bird species to the area (**Figures 2, 3**). Three species not usually detected during point counts were detected by the recordings: the common poorwill, the great-horned owl, and the mountain bluebird. These species usually sing at dawn or earlier, which is outside of the normal point count sampling period.

3.5 Singing Patterns Based on Audio Data

I originally attempted to distinguish songs from calls in the database in order to look for diurnal and seasonal patterns in the frequency of singing. Despite the guidance of Sibley (2000), I found that many species (18 of 45), (**Table 2**), did not make a distinct song and call, or I decided that the distinction was ambiguous. Using the 27 species with distinct songs, the frequency of singing remained steady for resident birds (**Figure 4**), but showed a moderately increasing trend in May for neotropical migrant species (**Figure 5**). This most likely corresponds to differences in breeding season phenology between the two groups.

TABLE 1. Avian species detected by the sound monitor, and by point count field surveys, at point count station 4, Salt Creek, Canyonlands National Park.

Sound Monitor Data (aural detections only - 30 days in May)	Point Count Survey Data (aural and visual detections - 2 days in May)
1. American kestrel	1. Ash-throated flycatcher
2. Ash-throated flycatcher	2. Bewick's wren
3. Black-chinned hummingbird	3. Black-throated gray warbler
4. Bewick's wren	4. Broad-tailed hummingbird
5. Blue-gray gnatcatcher	5. Common yellowthroat
6. Brown-headed cowbird	6. House finch
7. Black-headed grosbeak	7. Lucy's warbler
8. Blue grosbeak	8. Spotted towhee
9. Black-throated sparrow	9. Violet-green swallow
10. Black-throated gray warbler	10. Western scrub jay
11. Bullock's oriole	11. White-throated swift
12. Chipping sparrow	
13. Cooper's hawk	
14. Common poorwill	
15. Common raven	
16. Common yellowthroat	
17. Dusky flycatcher	
18. Great-horned owl	
19. Gray vireo	
20. Hairy woodpecker	
21. House finch	
22. Juniper titmouse	
23. Lesser goldfinch	
24. Lucy's warbler	
25. Mountain bluebird	
26. Mourning dove	
27. Pinyon jay	
28. Plumbeous vireo	
29. Rock wren	
30. Red-tailed hawk	
31. Say's phoebe	
32. Scott's oriole	
33. Spotted towhee	
34. Violet-green swallow	
35. Virginia's warbler	
36. Warbling vireo	
37. Western bluebird	
38. Western kingbird	
39. Western scrub jay	
40. Western tanager	
41. Western wood peewee	
42. White-throated swift	
43. Yellow-breasted chat	
44. Yellow warbler	
45. Yellow-rumped warbler	

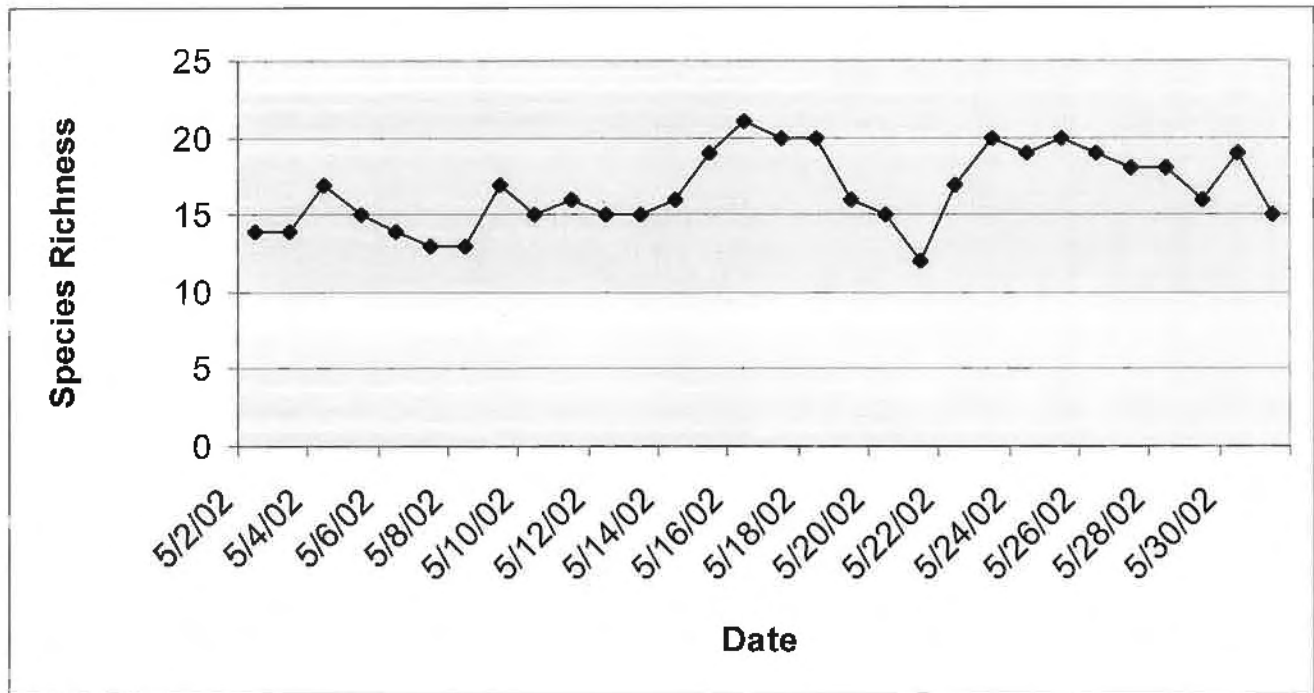


FIGURE 2. Avian species richness in May, 2002, from one location in Canyonlands National Park

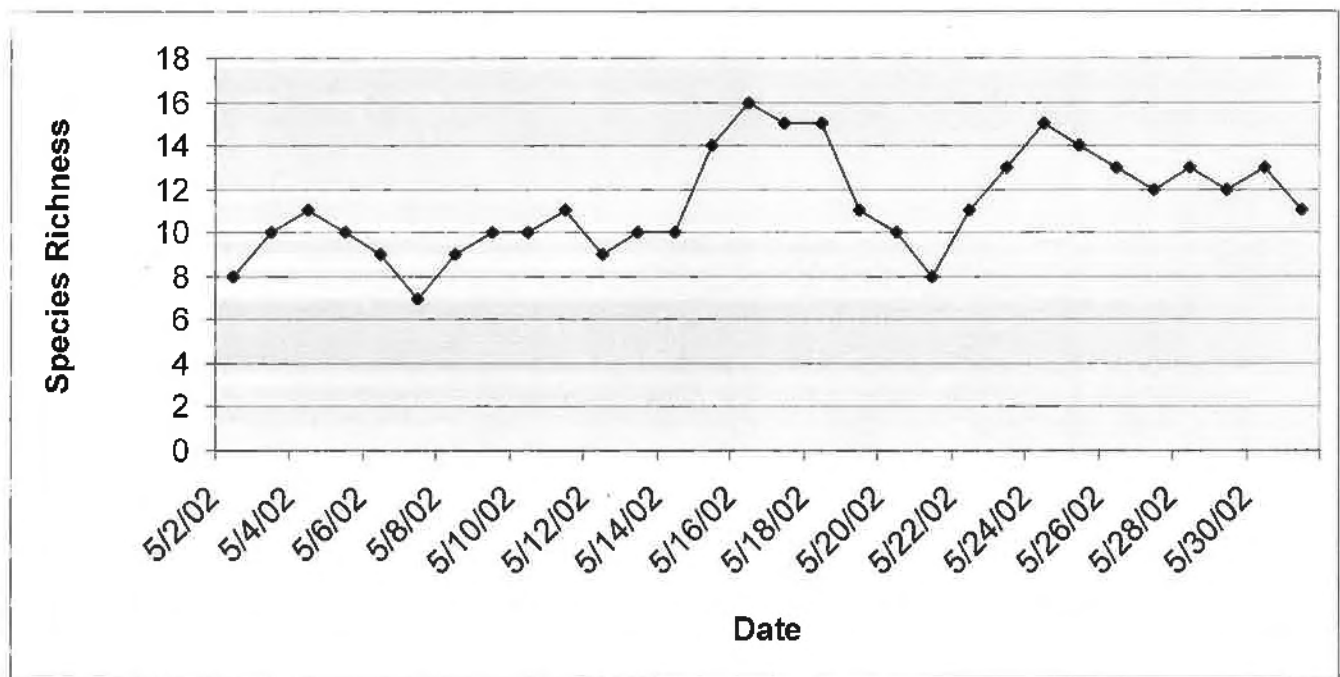


FIGURE 3. Neotropical migrant bird species richness in May, 2002, from one location in Canyonlands National Park.

TABLE 2. Avian species included or excluded from analysis of singing frequency, based on the relative distinction between their song and call.

Avian Species Grouped as "Singers"	Avian Species Excluded from "Singers"*
1. Bewick's wren	1. American kestrel
2. Brown-headed cowbird	2. Ash-throated flycatcher
3. Black-headed grosbeak	3. Black-chinned hummingbird
4. Blue grosbeak	4. Blue-gray gnatcatcher
5. Black-throated sparrow	5. Common raven
6. Black-throated gray warbler	6. Cooper's hawk
7. Bullock's oriole	7. Hairy woodpecker
8. Chipping sparrow	8. Juniper titmouse
9. Common poorwill	9. Lesser goldfinch
10. Common yellowthroat	10. Mountain bluebird
11. Dusky flycatcher	11. Pinyon jay
12. Great-horned owl	12. Red-tailed hawk
13. Gray vireo	13. Violet-green swallow
14. House finch	14. Western bluebird
15. Lucy's warbler	15. Western kingbird
16. Mourning dove	16. Western scrub jay
17. Plumbeous vireo	17. White-throated swift
18. Rock wren	18. Yellow-breasted chat
19. Say's phoebe	
20. Scott's oriole	
21. Spotted towhee	
22. Virginia's warbler	
23. Warbling vireo	
24. Western tanager	
25. Western wood pee-wee	
26. Yellow warbler	
27. Yellow-rumped warbler	

- * Some of these species may arguably have a distinct song, but because I did not clarify this before completing the database, I excluded them from analysis of "singing" frequency charts in this report.

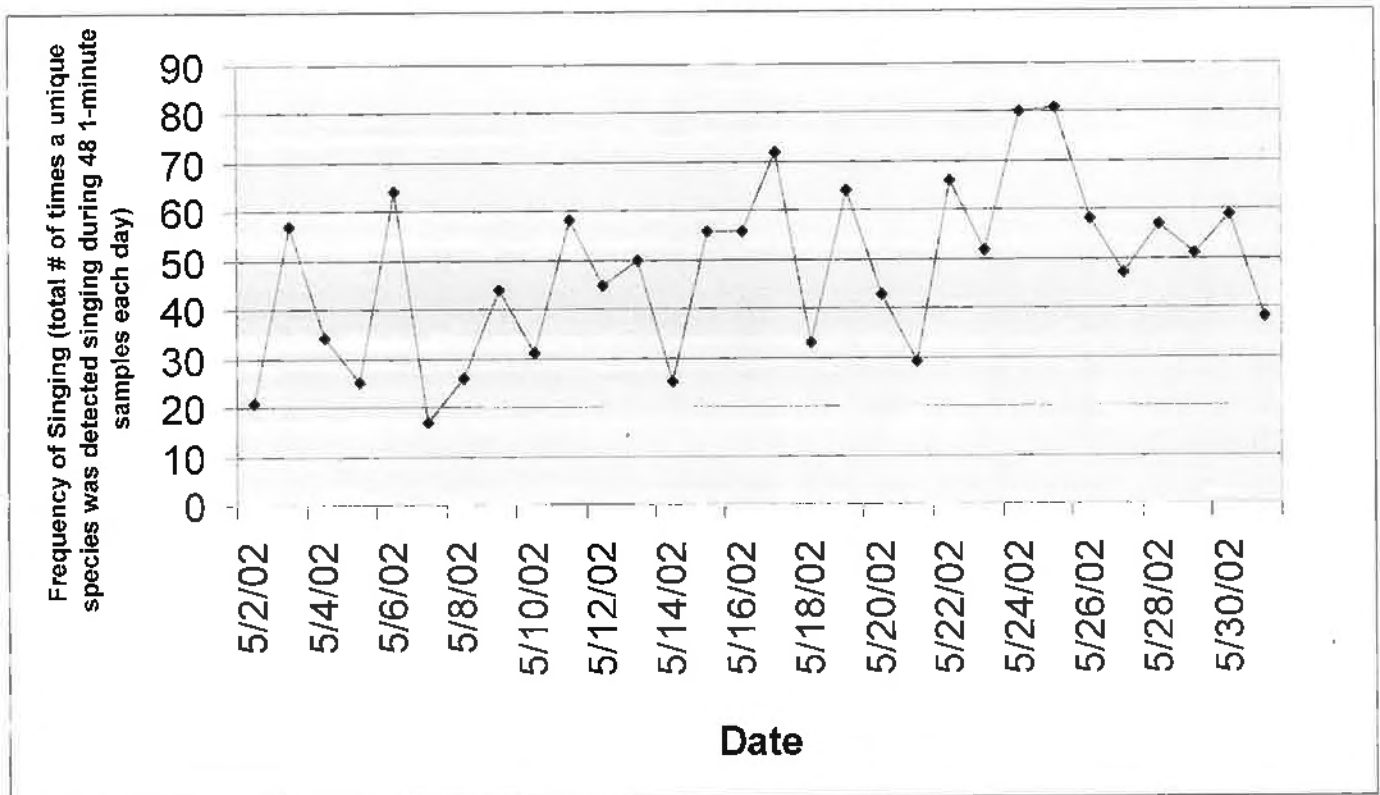


FIGURE 4. Frequency of singing by neotropical migrant birds in May, 2002, in one location in Canyonlands National Park.

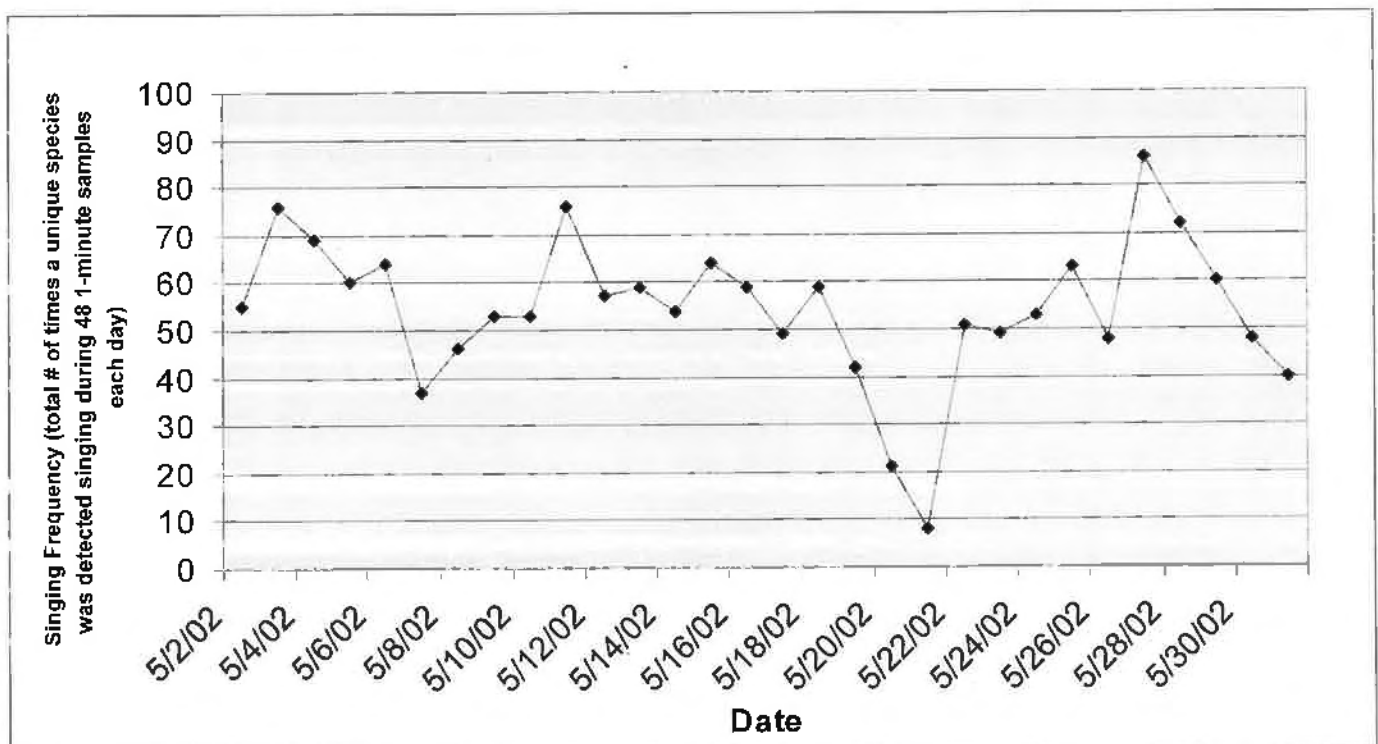


FIGURE 5. Frequency of singing by resident birds in May, 2002, in one location in Canyonlands National Park.

I looked at diurnal patterns using all vocalizations, both song and call, because I was interested in when birds could be most easily detected by sound in the morning. **Figure 6** shows that the most frequent vocalizations occurred between 0550 and 0655 in the morning (during which time the sound monitor recorded 31 species in May), and that vocalizations began to decline after 0835. This drop in detections resembles the pattern observed from 2 years of point count data in southeast Utah (Daw 2002).

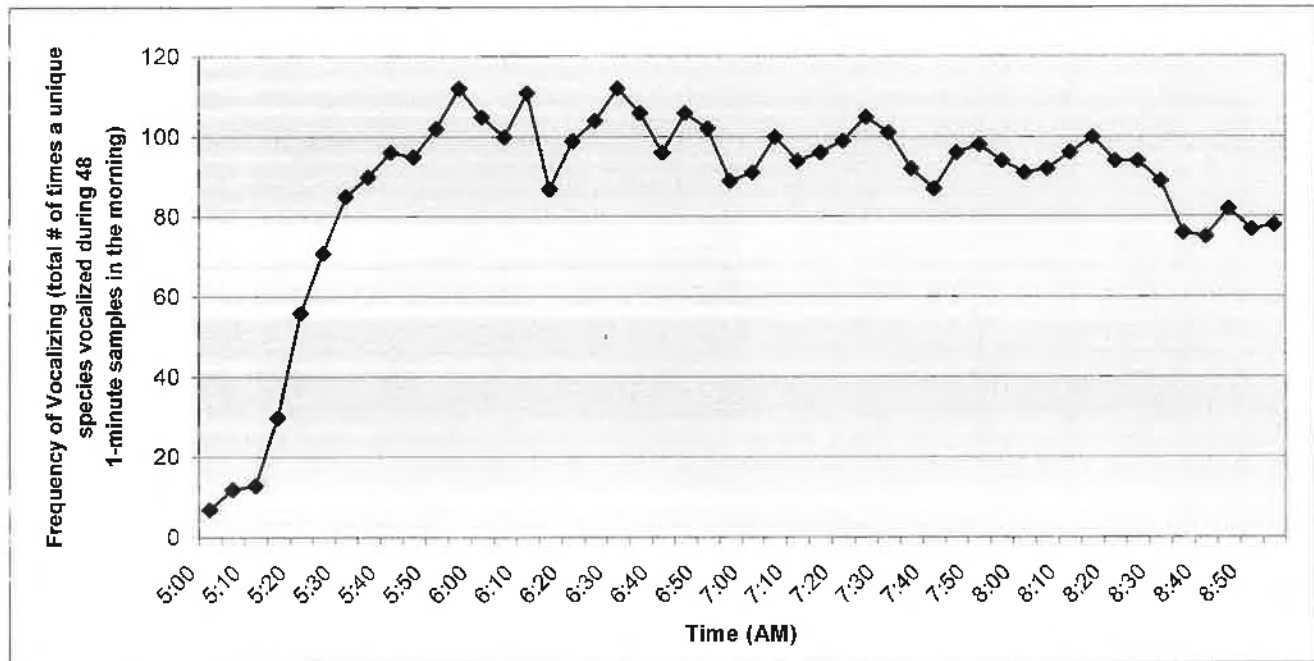


FIGURE 6. Peak vocalization times between 0500 and 0900 in the morning at one location in Canyonlands National Park.

3.6 Comparing Sound Data with Point Count Survey Data

Point count surveys detected only 11 of the 45 (25%) species detected by audio recordings in May (Tables 1 and 3). If point count data are compared to audio data for the period between May 14 and May 31 (to exclude migrants that the field survey dates were designed to exclude), point counts detected only 33% of the species known to use the area in May (11 species detected by point counts and 35 species detected by audio recordings). The only species not detected by the acoustic monitor was the broad-tailed hummingbird.

Looking at the relationship between effort and accurate species richness data, Table 3 shows how different sampling schemes would compare with a point count field survey, based on these data. Even with a comparable effort (16 minutes each of sound monitor and field survey data), the acoustic monitor detected more species than the field surveys, presumably because the acoustic monitor sampling was spread throughout the morning rather than being clumped into a single 8-minute stretch. The audio data collected by this single monitor provided much more information about species richness at the local scale. Standard transect survey methods in CANY along Salt Creek and two adjacent drainages detected 55 species (30 stations total). The single monitor used in Salt Creek detected 45 species and thus could not substitute for point count species richness data at the broader scale; however, additional monitors would likely provide higher species richness data if deployed in a like manner to the current transect lines.

One interesting comparison is in the frequency of detections of brown-headed cowbirds at the station. The acoustic monitor detected brown-headed cowbird on 10 of the last 18 days in May, while the point count surveys never detected a cowbird at the station. While cowbirds were occasionally detected at other stations along Salt Creek by the point count surveys, I was surprised to learn how often they had visited this station, undetected by field surveys.

TABLE 3. A comparison of the number of avian species detected by different sound monitor sampling schemes, with point count field surveys. Results are based on samples from one location in Canyonlands National Park, in May of 2002.

METHOD OF DATA COLLECTION	SOUND MONITOR DATA*								POINT COUNT FIELD SURVEY DATA
SAMPLING SCHEME (Days)	All 30 Days in May				May 14 and May 31 only				May 14 and May 31 only
SAMPLING SCHEME (Minutes)	1 min sampled/ 5 min = 1440 min total	1 min sampled/ 10 min = 720 min total	1 min sampled/ 20 min = 360 min total	1 min sampled/ 30 min = 240 min total	1 min sampled/ 5 min = 96 min total	1 min sampled/ 10 min = 48 min total	1 min sampled/ 20 min = 24 min total	1 min sampled/ 30 min = 16 min total	8 continuous min/day = 16 min total
SPECIES RICHNESS	45	35	29	29	19	18	16	16	11

* The sound machine stopped recording at 7 am on May 31, thus these richness numbers may have been slightly under-represented.

4. DISCUSSION

One factor that will not be addressed in this report is the funding requirement of using these acoustic monitors to supplement avian surveys. The acoustic monitor described herein costs approximately \$11,000 (the sound level meter being the most expensive single item). Other less expensive methods of collecting digital audio recording are being developed. Additionally, because of time constraints, this report reflects only a tentative exploration of the audio data collected by the acoustic monitor. Further exploration may more fully elucidate the role that audio recordings could play in supplementing avian surveys.

4.1 Potential Ways in Which Sound Monitors May Supplement Avian Surveys

Clearly, audio recordings have the potential to provide valuable information for avian surveys. The ability of acoustic monitors (or other digital recorders) to collect continuous or near continuous audio data at specific times of the year has many potential uses, especially in providing intensive, local information. It would be highly impractical for field workers to collect continuous or near-continuous data because of weather, attention span, logistics, etc. The near-

continuous data we collected using an acoustic monitor added significantly to the variety of species detected during point count field surveys in the same location. It provided information about brown-headed cowbird use of the area, which was not provided by point count field surveys. Potentially, audio data could be used to identify the most stable survey period during the breeding season by revealing trends in species richness and in the arrival of neotropical migrants to an area. Patterns in singing frequency, made obvious by the audio data, could also provide insight into the peak survey times, either diurnally or seasonally, for a particular area. For special status species that are secretive, or disturbed by human presence, audio data could provide an alternative means of detection. Finally, quality audio recordings of unusual species are potential vouchers of presence where existing documentation is inadequate (USDI National Park Service 2002).

4.2 Potential Limitations of Audio Recordings in Supplementing Avian Surveys

Some general limitations exist for the use of monaural recordings in surveying birds. First, non- or rarely-vocal species may not be detected. These relatively non-vocal species include raptors, the Lewis woodpecker, non-singing migrants, hummingbirds, and others. Another aspect of avian surveys, species abundance, is not comparable with this audio data. No attempt was made to compare and calibrate distance estimates from observers and the acoustic monitor. Observer distance estimates and monitor signal strength could, in some cases, be compared and calibrated and could provide some abundance estimates, although the problem remains of double counting a bird that moves during the sample period. And finally, the time required to playback and identify bird songs and calls from long recordings can be extensive, considering as well that no visual clues are available on an audio recording. Although more time is required for playback and identification, this pilot project demonstrates the potential audio recordings have for detecting avian species.

While the added information about species richness contributed by audio recordings can be valuable for specific uses, there may be limits to its usefulness for general surveys, such as to supplement extensive breeding season point count surveys. Data from audio recordings are primarily local, making inference across broader regions limited. Data from audio recordings are not comparable to point count surveys in terms of methodology and results, which prohibits the data from being directly used in current and historical data sets (using current standardized methods), or from being compared directly with any other data sets based on field observation. Finally, the primary objective of point count surveys is often aimed more towards monitoring population changes of common breeding species over time, rather than the detection of rare migrants or occasional visitors to an area.

5. RECOMMENDATIONS

5.1 Recommendations/Troubleshooting

1. Collect data from May through August to identify trends in species richness over the breeding season for the purposes of survey planning, and for supplementing the Canyonlands N.P. species list.
2. To improve the efficiency and accuracy of interpreting sound data:

- Spend adequate time in the field during the recording period to become familiar with species of the area.
- Listen to recordings continuously so that the way in which one identifies odd/unusual sounds is consistent.
- Listen to recordings soon after the field season to maximize one's ability to identify calls and/or unusual sounds.
- Clarify the distinction between song and call for species of interest before beginning to listen to recordings, in order to avoid having to re-listen to all the recordings.

6. LITERATURE CITED

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APPENDIX A

Screen used to enter data into MS Access.

