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Using Automated Digital Recording Systems as Effective Tools for the Monitoring of Birds and Amphibians

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Abstract

There is a need to improve the quantity and quality of data in biodiversity monitoring projects. We compared an automated digital recording system (ADRS) with traditional methods (point-counts and transects) for the assessment of birds and amphibians. The ADRS proved to produce better quantity and quality of data. This new method has 3 additional advantages: permanent record of a census, 24 h/d data collection and the possibility of automated species identification. (WILDLIFE SOCIETY BULLETIN 34(1):211–214; 2006)

Key words

amphibians, ADRS, Automated Digital Recording System, birds, monitoring methods, Puerto Rico.

Biodiversity surveys (e.g., rapid assessments and species lists) are commonly used to make species management and conservation decisions. To improve the accuracy of these decisions, managers need survey techniques that increase the quantity and quality of information available to policy makers. In addition, the current trend in ecological research is the development of survey techniques that will increase the spatial and temporal range of observations and the number of taxa studied.

Transects, point-counts, mist-nets, and ad lib observations are the most frequent methods used in diversity surveys of birds (Parker et al. 1993, Foster et al. 1994, Killeen and Schulenberg 1998, Mack and Alonso 2000, Montambault and Missa 2002). Visual encounter and auditory surveys using transects are the most frequent methods used for amphibians (Crump and Scott 1994, Zimmerman 1994, Lips et al. 2001). The utility of recorders for surveying biodiversity is widely recognized, but only as a complement to classical field methods (e.g., Johnson et al. 1981, Parker 1991, Parker et al. 1993, Foster et al. 1994, Killeen and Schulenberg 1998, Mack and Alonso 2000, Montambault and Missa 2002). Although tape recording has been proposed as an alternative to point counts for estimating bird species richness in tropical forests (Haselmayer and Quinn 2000), this technique has never been compared with standard methods for biodiversity surveys.

One way to improve the quantity and quality of data in biodiversity surveys is using automated recording systems (ARS) that could potentially collect data 24 hours per day. Peterson and Dorcas (1994) described an ARS that used a tape recorder controlled by a solid-state timer to automatically record sounds. These recordings were later analyzed in the laboratory to determine the presence of species by identifying their calls.

However, the ARS method used by Peterson and Dorcas (1994) had some disadvantages. First, the recorder required an external clock to provide accurate information on date and time when each recording was made. Second, the timer used to control the recorder had limited programming capabilities. In addition, the system used cassette tapes of up to 90 minutes, limiting the time that could be recorded, thus, the data gathered and deployment time.

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We propose a modification of the ARS by replacing the solid-state timers with a microcontroller and the analog tape recorder with a digital recorder. This Automated Digital Recording System (ADRS) has 2 main advantages over the ARS. First, a microcontroller can be programmed in a more flexible way than the solid-state timers and the drift in time is minimal. Second, a digital recording can easily be transferred to a computer for analysis and to be archived. In the present study, we compared the ADRS with traditional methods: point-counts for bird census and transects for amphibians.

Materials and Methods

We conducted the study in a mangrove/brackish-forested wetland in the municipality of Toa Baja, near the north coast of Puerto Rico (18°28′N, 66°13′W). Within this wetland forest, we selected 10 sites to conduct bird and amphibian surveys and to place an ADRS. Each site was located at least 50 m from a secluded access road, at both sides, to protect the equipment from theft or vandalism. Ten minutes before sunrise, we placed the ADRS at a site. Fifteen minutes after sunrise, we counted birds using a 20-m fixed-radius point count (Wunderle 1994), using the ADRS as center of the radius. At each point we recorded every species heard or seen inside the radius during 10 minutes. After nightfall (2000 hours), we counted every amphibian species heard or seen inside a 50×2-m transect (Crump and Scott 1994), using the ADRS as the center of the transect. We surveyed each site once between 15 June and 20 July 2004.

Our ADRS system consisted of a Sennheiser ME-62 omni-directional microphone with K-6 module (Sennheiser Electronic Corporation, Old Lyme, Connecticut) and a Marantz PMD-670 solid state digital recorder (D and M Professional, Itasca, Illinois) with a 1 gigabyte memory card. We used a custom-made microprocessor-based controller to record 7 minutes of every hour during 24 hours. This custom-made controller used a low-cost and low-power microcontroller MSP430 (Texas Instruments, Dallas, Texas) that triggered the commands needed to record in cycles for a desired period of time. Specifically, we used the MSP430-P-1121M board (Olimex Ltd., Plovdiv, Bulgaria). The microprocessor triggers a relay that closes a circuit in the wired

Table 1. Presence/absence of bird and amphibian species detected by fixed-radius 20-m point counts and 50×2 m transects, respectively, compared with an automated digital recording system (ADRS) in 10 sites located in Toa Baja, Puerto Rico. Sites were surveyed between 15 June and 20 July 2004.

Common name	Species	Traditional method	ADRS
Bird species			
Bananaquit	*Coereba flaveola*	X	X
Black-whiskered vireo	*Vireo altiloquus*	X	X
Common ground dove	*Columbina passerina*	X	X
Gray kingbird	*Tyrannus dominicensis*	X	X
Greater Antillean grackle	*Quiscalus niger*	X	X
Green heron	*Butorides virescens*	X	X
Mangrove cuckoo	*Coccyzus minor*	X	X
Puerto Rican flycatcher	*Myiarchus antillarum*	X	X
Puerto Rican woodpecker	*Melanerpes portoricensis*	X	X
Red-legged thrush	*Turdus plumbeus*	X	X
Shiny cowbird	*Molothrus bonariensis*	X	X
Smooth-billed ani	*Crotophaga ani*	X	X
White-winged dove	*Zenaida asiatica*	X	X
Zenaida dove	*Zenaida aurita*	X	X
Orange-cheeked waxbill	*Estrilda melpoda*	X	
White-crowned pigeon	*Patagioneas leucocephala*	X	
Puerto Rican Spindalis	*Spindalis portoricensis*		X
Red-tailed hawk	*Buteo jamaicensis*		X
Yellow warbler	*Dendroica petechia*		X
Total		16	17
Frog species			
Cane toad	*Bufo marinus*	X	X
Common coqui	*Eleutherodactylus coqui*	X	X
Pig frog	*Rana grylio*	X	X
White-lipped frog	*Leptodactylus albilabris*	X	X
Coquí churí	*Eleutherodactylus antillensis*		X
Total		4	5

remote jack of the recorder. The recorder starts recording when the circuit is closed and stops when the circuit is opened.

The MSP430 microcontroller was easy to program using C language with the free KICKSTART software available from the Texas Instruments website (http://www.ti.com) using a cable (Model MSP430-JTAG, Olimex Ltd., Plovdiv, Bulgaria) that connected to the parallel port of a computer. A program can be written to record at desired intervals (e.g., 5 minutes of every hour from dusk to dawn, during early morning, or all day).

We recorded at a sampling rate of 44.1 kHz in 16 bit wave files, and then listened to the recordings in the laboratory to identify bird and amphibian species by their calls. We analyzed the number of species identified with each technique at the 10 sites using a 1-tailed Mann–Whitney test (Sokal and Rohlf 1995).

Results

The ADRS identified more bird species than the traditional point-count survey in each site ($W = 67.5$, $P = 0.0026$). Of 19 bird species detected in the 10 sites by both methods, 16 were detected by point counts, while 17 were detected by ADRS (Table 1). The white-crowned pigeon (*Patagioneas leucocephala*) and orange-cheeked waxbill (*Estrilda melpoda*) were only detected by point-counts, while the red-tailed hawk (*Buteo jamaicensis*), yellow warbler (*Dendroica petechia*) and Puerto Rican spindalis (*Spindalis portoricensis*) were only detected by the ADRS.

The ADRS identified more amphibian species than the traditional visual transect method ($W = 72.0$, $P = 0.0070$). Of a total of 5 species detected in 10 sites by both methods, 4 were detected by the transect method while all 5 were detected by the ADRS (Table 1). The coquí churí (*Eleutherodactylus antillensis*) was only detected by the ADRS method.

Discussion

The ADRS method improved the quantity and quality of data in comparison with the traditional point-count or transect surveys of these wetland bird and amphibian communities. The major limitations of the ADRS are the lack of density estimates and that detection is limited to calling individuals whereas traditional point counts include visual observations. The two bird species not detected by ADRS were single individuals of white-crowned pigeon and orange-cheeked waxbill. The orange-cheeked waxbill is an exotic species common in disturbed areas but rare inside this forested wetland (M. Acevedo, personal observation).

The ADRS had the advantage of recording 24 samples of 7 minutes during 24 hours, while longer sampling periods can be achieved dependent on the battery life and storage capacity of the recorder. Three bird species were only detected by the ADRS because it was recording every hour for 24 hours and not just during the morning point counts. The coquí churí was detected only with the ADRS because it was near one of the sites but not inside any of the transects.

Management Implications

With the use of an ADRS in biodiversity surveys, researchers can obtain a good estimate of the number of species present in the area with a minimal investment of time in the field. This time can be used to do other surveys to compensate for non-calling individuals, like mist-nests and active nest search for birds and drift fences and larvae sampling for amphibians. This technique may be useful in areas where visibility of individuals is very limited. Other advantages of the ADRS include permanent record of a survey, minimum disturbance to wildlife, and 24 hours of data collection per day. In addition, we can use computer software to filter the recording or isolate a signal to aid the identification process.

Even though the amount of time required in the field is minimal, the recordings have to be listened to later in the laboratory. In this case, in which we recorded 7 minutes of every hour, the total recording time was 168 minutes for each site, more than the time required to do a 10-minute point count. This disadvantage can be eliminated with an automated species identification process. Due to the unique characteristic of species calls, we can use artificial intelligence technology such as hidden Markov chains (Kogan and Margoliash 1998) and neural networks (Chesmore and Ohya 2004) to perform the species identification process. The ADRS joined with this artificial intelligence technology will improve conservation and management decisions by allowing the analysis of a larger dataset than previously possible or economically feasible.

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Campus. His professional interests include vertebrate ecology and conservation, evolution, and public's understanding of science. Luis has developed a website for the general public about the Puerto Rican frogs of the genus *Eleutherodactylus* (CoquiPR.com) as well as co-authored with the senior author an online database of the Puerto Rican birds as well as sightings in the island (AvesPR.org). He also has an interest in the adaptation and use of new technologies in ecological research, like the automated recorders used in this study, and online databases for data dissemination.