Appendixes I, II, and III

Appendix I. Location of selected wetland sampling sites

[Locations shown in latitude and longitude]

Ponds		
Big Cove Beaver Pond	35 30 27N	83 18 02W
Bone Valley Beaver Pond	35 31 07N	83 40 51W
Finley-Cane Sinkhole Ponds (4)	35 36 37N	83 44 38W
Gourley Pond	35 35 36N	83 47 19W
Gum Swamp	35 35 21N	83 50 17W
Methodist Church Pond	35 36 24N	83 49 01W
Sewage Treatment Pond	35 36 14N	83 46 57W
Shields Pond	35 35 33N	83 48 54W
Stupkas Sinkhole Pond	35 35 23N	83 50 52W
Swampy and mucky wetlands		
Cataloochee	35 37 44N	83 06 00W
Cataloochee Trout	35 39 12N	83 04 28W
Indian Creek	35 28 51N	83 24 51W
Little Cataloochee	35 39 43N	83 05 55W
Smokemont	35 33 06N	83 18 35W
The Sinks	35 40 10N	83 39 38W
Woodland pools		
Abrams Creek	35 35 40N	83 50 41W
Big Cove Pool	35 30 29N	83 18 02W
Cane Creek	35 39 01N	83 53 15W
	35 39 42N	83 52 41W
	35 39 07N	83 53 05W
Gourley Sinkhole	35 35 34N	83 47 14W
Sugarlands	35 41 11N	83 32 17W
Tremont Roadside Ditches	35 39 15N	83 42 08W
	35 39 07N	83 41 47W
Grassy pools (Cades Cove)		
	35 36 19N	83 47 44W
	35 36 20N	83 48 31W
	35 36 03N	83 48 33W
	35 36 16N	83 48 10W

GREAT SMOKY MOUNTAINS NATIONAL PARK
AMPHIBIAN SURVEY FORM

Date:_____   **Site No**. _____   **Personnel** _____

Weather: clear / partly cloudy / cloudy / rain / fog / other: _ _____

Altitude:_____**ft/m**   **Wind:** calm / slight breeze / moderate / windy

General Location: _ _____

Specific Location (UTM): E _____; N _____; Quad: _ _____

Start Time: _____   **Standing Water: Y / N**   **Water Level:** _____ **m**

End Time: _____   **AT:** _____; **WT:** _____; **ST:** _____; RH: _____; pH_____; **Cond** _ _____

Habitat Type (circle one): terrestrial / large stream / med. stream/ small stream / seep / pond / woodland pool / mucky area / open grassy pools / cave / rock face / other: ____ _____

Vegetation: spruce-fir / deciduous / cove hardwood / oak / pine / hemlock / open field / other: _____

Canopy: open / sparsely covered / closed **Slope Aspect:**_____ **Drainage Dir:** _ _____

Amphibian Species	No. of Individuals	Life Stage	Method of Capture	Notes

Method of capture: tc= time constraint; ac= area constraint; em= egg mass count; nets= dip or sweep nets; PVC= pvc pipe; cb= cover board; ft= funnel trap; FL=frog logger; mt= minnow trap; pf= pitfall; tr= transect; V= visual; C= calling. Life Stage: A= adult, SA= subadult; L= larvae, E= eggs.
Invertebrates present: Y / N Species:_____
Active Sampling Effort: _____

Further notes should be written on back of sheet

On the Trail

Weatherproof flat map case containing:
    USGS 7.5' topographic maps
    Great Smoky Mountains National Park trail guide
    Field Data Sheets (on Rite in the Rain® paper)
    Notebook
    Pencils/sharpener
    Copy of permits

Equipment (in a sealable rainproof bag):
    GPS
    Compass
    Clinometer
    Palm pilot (where appropriate for data entry)
    Digital temperature gauge
    Extra temperature gauge probe
    Digital relative humidity meter
    Camera, preferably digital
    Binoculars
    Pesola® spring scales (10 g, 50 g, 100 g)
    Ziploc® bags for carrying and weighing animals (various sizes)
    Clear plastic metric ruler
    Small mesh hand dip net (for larvae)
    Hand lens
    Stump ripper (Fuhrman® Diversified)
    Extra batteries
    Small pen light (for searching crevices)
    Leatherman® tool
    Fluorescent flagging

Biosafety:
    Ziploc® bags for dead or diseased animals (various sizes)
    Sanitary Handwipes
    Vinyl gloves (several pair)

Other:
    First-aid supplies
    Sting-eze® or other sting remedy, especially if anyone is allergic to yellowjackets
    Extra water
    Lightweight cell phone (may not work in valleys or remote areas)

At Ponds (in addition to the above)

    Oxygen, pH, Conductivity meters
    Dip nets (both large and small of appropriate mesh size to capture larvae)
    Waders
    Shrimper (Lacrosse® Majesty 12") boots (excellent in small marshes and creeks)
    Tape measure (50 or 100 m) or laser range finder
    Meter ruler
Biosafety:
    Pre-mixed bleach solution in appropriately-sized tub or in a spray backpack firefighting pump

Appendix IV

Guidelines for building and operating remote field recorders (automated frog call data loggers)

by

William J. Barichivich

Guidelines for building and operating remote field recorders
(automated frog call data loggers)

By William J. Barichivich[1]

Automated frog call data loggers have been used successfully to provide information on: (1) species presence at the time of sampling (that is, species likely to be overlooked during time-constraint sampling can be recorded with greater reliability); (2) life history and phenology information, such as when frogs call (especially if different species call at different times of the day), what environmental influences affect calling; and (3) a relative index of the number of males calling. Although species can be easily identified, categorizing abundance may be very difficult in even moderately sized choruses because of call-overlapping interference. It is also often not possible to separate individual callers, allowing the possibility that a single calling male could be counted multiple times. Because environmental variables influence the number of animals calling, differences among abundance categories over time may be only reflective of differences in environmental conditions during sampling periods. Thus, call surveys using automated frog call data loggers must be conducted at multiple occasions during the potential breeding season. Further, call surveys tell nothing about the presence and number of females and non-breeding males, or whether reproduction was successful. Frog call surveys using automated data loggers are best implemented where researchers have limited access by road or when rare species are suspected.

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What is an automated frog call data logger?

Automated frog call data loggers are recorders that can be programmed to operate for a specified duration at specified intervals (for example, one minute every hour) and over a specified period (for example, 18:00 until 06:00). They can operate remotely without maintenance for extended periods under most environmental conditions, including extreme heat, cold, rain, and snow. The automated frog call data logger described in this section is a conglomeration of stand-alone components, whereas the original design (Peterson and Dorcas 1992, 1994) required building several components on a printed circuit board or using an expensive commercial data logger to control the tape recorder. The literature regarding previous designs is helpful and should be reviewed not just for construction details but also for study design (see related literature).

Why build an automated frog call data logger?

Automated frog call data loggers produce an archivable record that can be analyzed or confirmed at a later date. Unlike standard aural surveys, no observers are present, so the behavior of calling anurans is likely unaffected. Since automated frog call data loggers can be deployed prior to monitoring, they can synchronously monitor any number of sites 24-hrs/day.

How do you build an automated frog call data logger?

The basic automated frog call data logger consists of an analog tape recorder, timer(s), power source (battery) and voltage step-down, container, and microphone (figs. 1-2). The battery powers the timer(s) that regulate power, also from the battery, to the tape recorder. The tape recorder, timer(s), battery and voltage step-down are housed in a weatherproof container and an external microphone picks up nearby sounds (for example, frog calls) and relays the signals to the tape recorder in the container (fig. 1).

Construction

1. *Parts*-gathering materials can be time consuming. Vendors are often out of stock and no single source carries all the necessary components to build an automated frog call data logger (table 1).

a. A wide range of analog **tape recorders** have been utilized and can range in price from tens to hundreds of dollars. Since the recorder is the heart of the system, consider the highest quality recorder within reason. The following features are highly desirable:

  (1.) **Stereo recording** provides left and right channel recording.

  (2.) **Extended record time** slows the speed of the tape so less tape is used to record a given interval.

Continuous auto-reverse changes the tape head direction after one side of the tape has been used. This avoids the need for a researcher
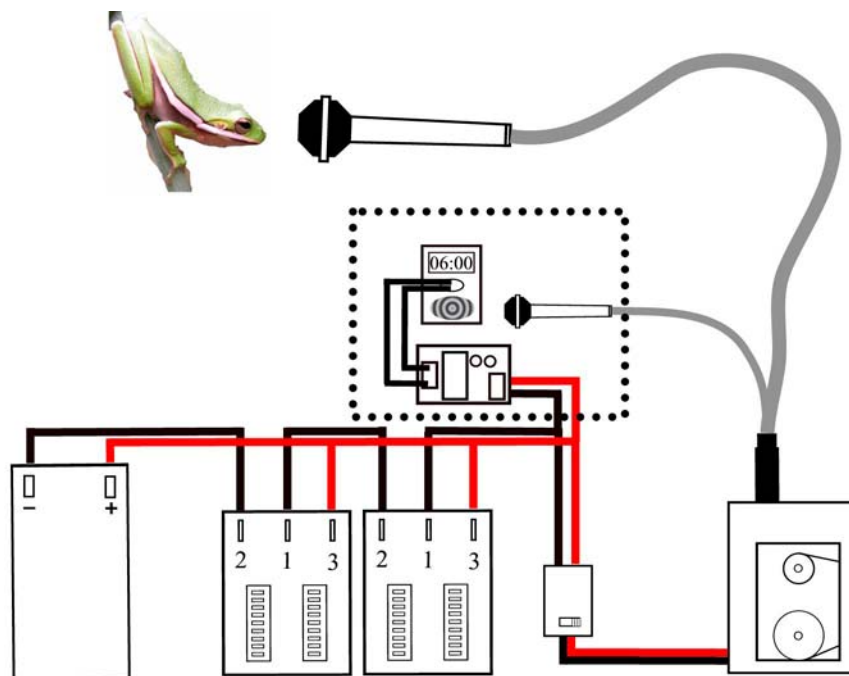

Figure 1. Wiring schematic for an automated frog call data logger. The components within the dotted box are required only for the voice time stamp.
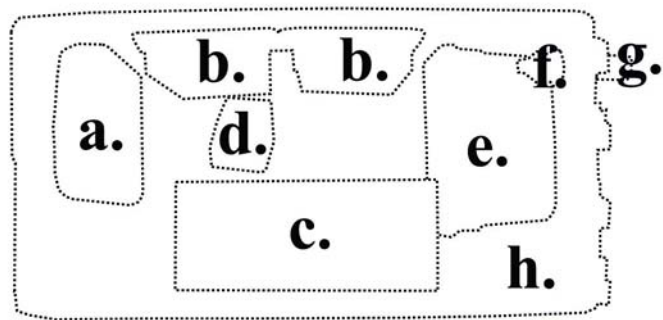
Figure 2. Example of the interior layout of an automated frog call data logger; a.) analog tape recorder, b.) two solid state recycle timers, c.) 12v, 7amp sealed lead acid battery, d.) voltage regulator, e.) voice stamp assembly, f.) ¼" microphone female jack, g.) ¼" male microphone jack on microphone cable, h.) 50-caliber ammunition can.

Table 1. Primary components used in the sample automated frog call data logger		
Items needed for each unit	**Model**	**Approximate Price**
Tape recorder	SONY TCS-60DV Pressman	120
Microphone	Shure Omnidirectional Dynamic	50
Recycle timer (Hour/minute)	SSAC RS1A34	55
Recycle timer (Minute/second)	SSAC RS1A12	55
12-volt battery	7Amp SLA	15
DC power converter	Cigarette lighter adapter	10
Container	50-caliber ammunition can	5
Voice-time stamp	Keychain voice clock	10
	Timer/relay	20
	Microphone[1]	0
Total		$340
[1]The secondary microphone used for the voice-time stamp was included with the tape recorder.		

to flip tapes over before the first side is spent. This feature varies from standard auto-reverse in that continuous auto-reverse functions while the tape recorder is in record mode and standard operates only in play mode.

b. One or two 12-volt **timer(s)** are needed to run each automated frog call data logger. If the automated frog call data logger is intended to sample continuously (24-hr/day), then a single (minute/second) timer is necessary. If a specific period within a day is desired a second (hour/minute) timer is required. Solid-state encapsulated recycle timers have been widely used in automated frog call data loggers. These timers are programmed by adjusting two series of binary switches, one series for "ON" time and the other series for "OFF" time. The programmer must make absolutely sure the combined "ON" and "OFF" times equal 1 hour for the minute/second timer and 24 hours for the hour/minute timer. Greater detail regarding timer programming and technical data are available at the supplier's website (www.ssac.com). Other types of timers (555, BioQuip 12v DC timer) are available and have been used with success but require advanced knowledge of electronics, are less flexible to program, and can be less reliable.

c. Any single or combination of **batteries** totaling 12 volts will suffice. The greater the amperage the longer the automated frog call data logger can operate without changing or replacing the batteries. Rechargeable batteries are recommended including the 12-volt, 7-amp sealed lead acid battery (SLA) illustrated in the sample automated frog call data logger (fig. 2). If multiple batteries are used, a battery holder is recommended. No batteries are used in the tape recorder as the main battery powers the entire unit.

d. Although the recycle timers run on 12v, tape recorders typically require 3 to 6v DC power. Rather than build a **voltage step-down**, this design uses an automotive cigarette lighter adapter capable of converting from 12v to 9, 7.5, 6, 4.5, and 3v. The DC power input of the cigarette lighter adapter can be modified by cutting off the cylinder and contacts and splicing the timer outputs directly to the adapter input leads. The power adapter output will be connected to the external power jack or directly to the battery connections of the tape recorder. Attaching the power directly to the tape recorder battery terminals provides a more reliable unit than using the external power jack due to the small surface area of the external jack. This connection can easily be made by building insulated dummy batteries with the power connections at the ends (fig. 3).

e. The main purpose of a **container** is to protect the electronics from the elements in any easy-to-transport package. Figure 3 shows a very economical (< $5) surplus 50-caliber ammunition can. Alternatives include plastic pails, toolboxes, tackle boxes, and Otter® or Pelican® cases.

f. **Microphones** should be omni-directional and should not require an additional power source. In most cases monaural models are the only choices given these criteria, but they work adequately. Superior recordings are possible with DC powered stereo microphones, although the relatively short battery life can increase the maintenance schedule of the data loggers. The microphone cable can be passed through a port placed in the container or a microphone jack can be installed in the side of the container. Microphones can be shielded from the elements by placing them inside a cut-off plastic soda bottle. Additionally, foam can be placed between the bottle and the microphone head to reduce wind noise but this can introduce moisture wicking.

g. Most tape recorder manufacturers recommend **tapes** no longer than 90-minutes, because tapes of greater length are too thin and stretch under the tension of
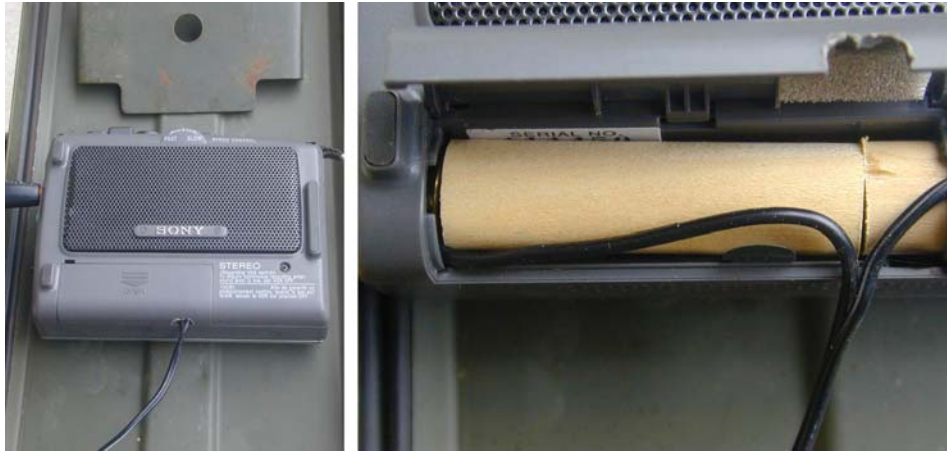
Figure 3. Example of a dummy battery, an external power jack alternative. The battery door on this tape recorder has been notched to allow clearance for the wires. Wooden dowels (3/8", 0.9525cm) were used as insulators between the battery terminals.

recording, thus reducing recording quality and reliability.

h. An optional **voice-time stamp** is highly recommended especially if calling phenology is of interest. This feature allows the researcher to know the time of each recorded interval with reasonable precision and makes reviewing the tapes considerably more easy. A voice-time stamp is made by triggering a talking clock at the same time the tape recorder is activated. This is accomplished by splitting the timer output to both the tape recorder and a relay that triggers the voice clock. To prevent the voice clock from continuously announcing the time during a recording, the relay must be supplied power only briefly at the beginning of the recording period. This can be accomplished by building a binary logic circuit or by using a timer. A second microphone picks up the announcement of the voice clock while the tape recorder records signals from both the primary external microphone and this smaller secondary internal microphone. The internal microphone should be placed away from the tape recorder and near the voice clock. In the example data logger, the voice clock, secondary microphone, and relay are housed in their own container and are

at the opposite end of the can from the tape recorder (figs. 2-4).

2. *Tools*

a. **Wire cutters** for cutting rolls of wire into shorter lengths.

b. **Wire strippers** for removing the insulation from the ends of the wires.

c. **Wire crimps** are necessary for making wireless connections.

d. A **drill** or **Dremel®** can be useful for making modifications to the container.

e. A **soldering iron** is necessary for making solder connections and should be used to prepare multistrand wire for solderless connections.

f. A **multimeter** can be very helpful in troubleshooting connections as well as checking and maintaining batteries.

g. A **12v automotive battery charger** can be used to charge a single battery or to run a bank-charging system (fig. 5). If a bank-charger is used, each battery should be individually fused and the fuse rating should be less than the maximum amperage of the battery and greater than the charge amperage. This will allow the batteries to be charged without blowing fuses. If a battery does short, however, it will blow only its fuse.
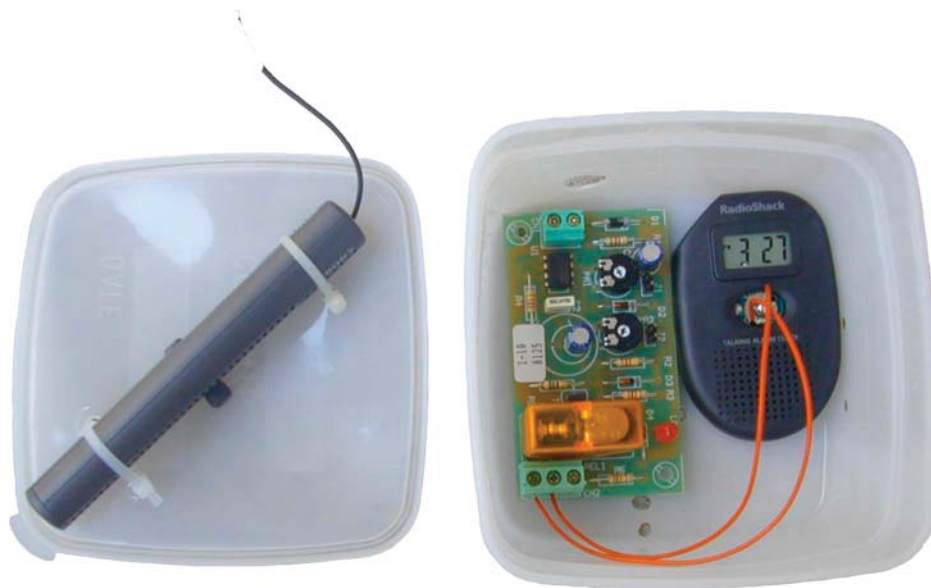
Figure 4. Example of a voice stamp assembly. The voice clock (far right) and timer/relay are secured in a plastic food container and the microphone is mounted to the lid. Enclosing the assembly in its own container helps isolate the microphone from the sound of the tape recorder running.

3. Consumable materials
   a. Stranded hook-up **wire** (18AWG). Multiple colors can be helpful to prevent confusion in polarity.
   b. Female **terminal connectors** (1/4")
   c. Light-duty 60/40 rosin core **solder** (0.050" diameter).
   d. **Heat-shrink tubing** or **liquid tape**.

4. Assembly
   a. Charge all the batteries if using rechargeable batteries.
   b. Make any modifications to the container that may be necessary (for example, drilling holes for ports or jacks) and install the appropriate hardware.
   c. Program all timers to the desired schedule.
   d. Dry fit all the individual components in the container to determine the best placement and layout.
   e. Build the wiring loom to accommodate the location of the components.
   f. Outside the container, attach the wiring loom to all the components except the battery.
   g. Connect the battery to test the unit and make necessary corrections until the unit operates.
   h. Disconnect the battery and transfer the partially assembled unit into the container.
   i. The automated frog call data logger is now ready for use.

Setup

1. **In the lab or office**
   The timers begin cycling when power is applied; therefore, make the power connections at the time the automated frog call data loggers are intended to begin recording. The voice clock should announce the correct time and the LED on the voltage step-down should remain on for the duration of the

Figure 5. Example of a six battery bank charger. Each battery is individually fused to prevent catastrophic failure should an accidental short occur.

programmed recording interval. In the example automated frog call data logger the batteries would be turned on at 06:00. At this point the timers would be cycling but the unit will not record until the record button is depressed in the field. This step should be performed the day before field deployment. Make sure the tape recorder is turned off. Label and insert a cassette tape into the recorder. Make sure the tape is rewound, on side "A," and the tape recorder, if it has auto-reverse, is set in the correct direction. If there is any interruption of power to the timers they will reset to the time the power was reapplied.

2. **In the field**
   Depress the record button on the tape recorder, connect the microphone, and close the case. The unit will not begin to record until the time the timers were started the preceding day. The microphone should be secured to woody vegetation or to a microphone stand if there is no structure available. It is important to place the microphone near the breeding site but the main unit can be placed anywhere the microphone cord can reach, which should be a secure site, away from possible flooding or vandalism. The data loggers can be locked closed and secured a tree or other sturdy object. Notify managers as to the location and appearance of the data loggers, because they could be easily mistaken as an explosive device (fig. 6). Tapes can be changed in the field, but it is not practical to change batteries without retrieving all the units.

3. Listening to tapes

Tapes can be reviewed at any time, and depending on the number of units deployed, it is easy to accumulate a backlog of tapes. Tape review should be conducted in a quiet area with as few distractions as possible. Listening requires about twice the recording time. All observations should be recorded on a data sheet (see fig. 7 for a sample data sheet). Important data fields should include the site, recording dates, time of each interval, and species calling. Additional data could include NAAMP call rank (fig. 7). Observations of sounds other than frog calls (for example, rain falling on the microphone, aircraft) can be useful in the interpretation of the tapes and should be noted.

Tips

- Twist and tin (apply small amount of solder) all stranded wires before crimping if using solderless connectors, and use heat-shrink tubing to cover and protect all solder and crimp joints. This greatly improves the reliability, durability and longevity of the data logger.

- Start by building a single prototype unit and after all the "bugs" have been worked out, use an assembly line technique to speed the process of building the others.

- Consider the research questions/objectives before programming and deploying your data loggers. Listening to the tapes can be very time consuming, so recording time should be minimized while still meeting research goals.

- Use high quality headphones that completely cover the listeners' ears for reviewing the recorded material. While doing so, try not to multitask, because it can be easy to overlook a call if the listener is distracted.

- If recordings were made using an extended record time feature, then playback must be performed on a like unit. This could require purchasing additional tape recorders to review the tapes.

Figure 6. Automated frog call data logger setup near a small pond.

Okefenokee NWR Frog Logger Data Sheet

Site Name/Number: _____   Dates: _____

Logger Number: _____   Listener 1: _____
                                        Listener 2: _____

Int/Hour	Night 1	Night 2	Night 3	Night 4
1/				
2/				
3/				
4/				
5/				
6/				
7/				
8/				
9/				
10/				
11/				
12/				
13/				
14/				

** include species heard and NAAMP calling codes at each interval in parentheses

0= no frogs can be heard calling; 1= individual calls not overlapping; 2= calls are overlapping; but individuals are still distinguishable; 3= numerous frogs can be heard; chorus is constant and overlapping

Notes:

Figure 7. Sample data sheet used to review automated frog call data logger tapes from Okefenokee National Wildlife Refuge.

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Mazanti, L.E.,1999, The effects of atrazine, metolachlor and chlorpyrifos on the growth and survival of larval frogs under laboratory and field conditions: Unpublished Ph.D. dissertation, University of Maryland.

Peterson, C.R. and Dorcas, M.E., 1992, The use of automated data-acquisition techniques in monitoring amphibian and reptile populations, *in* McCullough, D.R., and Barrett, V., eds., Wildlife 2001: Populations: London, Elsevier, Applied Science, p. 369-378.

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Rand, A.S., and Drewry, G.E., 1994, Acoustic monitoring at fixed sites, *in* Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., and Foster, M.S., eds., Measuring and monitoring biological diversity: Standard methods for amphibians, Washington, DC, Smithsonian Institution Press, p. 151-152.

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RELATED WORLD WIDE WEB SOURCES

http://www.uga.edu/srelherp/ecoview/Eco19.htm
http://www.parcplace.org/education/techniques/froglogger.htm
http://www.bedfordtechnical.com/index.htm
http://www.bio.davidson.edu/people/midorcas/research/StResearch/Cocklinetal00/Cocklinetal.htm
http://www.bio.davidson.edu/people/midorcas/research/StResearch/Briggs99/scottprop.html
http://www.bio.davidson.edu/people/midorcas/research/herppub-pres/dorcas-pdfs/MohrDorcas1999.pdf
http://www.bio.davidson.edu/people/midorcas/research/herppub-pres/dorcas-pdfs/PetersonDorcas1994.pdf
http://www.bio.davidson.edu/people/midorcas/research/herppub-pres/dorcas-pdfs/PetersonDorcas1992.pdf

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