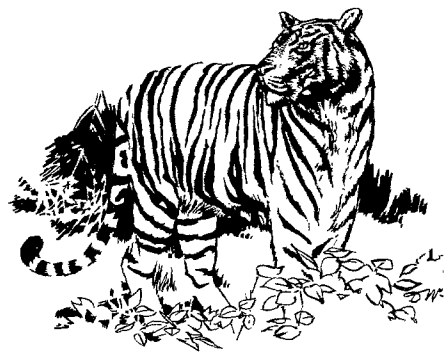
From the Field: Integrating GPS, GIS, and avian call-response surveys using Pocket PCs



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Wildlife monitoring and research often require accurate estimates of population size or density. Since breeding birds advertise their territories through persistent vocalizations, their numbers can be determined using relatively easy and non-intrusive survey methods, at least for those species and seasons in which singing regularly occurs. Avian surveys designed for single bird species often employ a call-response (or tape-playback) methodology, in which recordings of vocalizations are broadcast to elicit responses from birds (Johnson et al. 1981). This technique has proven especially useful for detecting cryptic or elusive species that are poorly sampled by more passive methods; these species include marsh birds, owls, and other raptors (Marion et al. 1981, Gibbs and Melvin 1993, Mosher et al. 1999). Call-response also has been used where accurate population counts are of critical conservation concern, as in the official survey protocol for the endangered southwestern subspecies of the willow flycatcher (*Empidonax traillii extimus;* Sogge et al. 1997). As the alternate term "tape playback" suggests, the equipment normally used to conduct these surveys has been a cassette tape or CD player.

Increasingly, wildlife monitoring and research also have incorporated the spatial arrangement of animals and their habitats, often at multiple spatial scales (Bissonette 1997). Locations recorded using Global Positioning System (GPS) equipment can be combined with existing spatial data, such as vegetation cover, hydrology, or elevation, in the form of Geographic Information Systems (GIS) layers. Spatial analyses can provide insights into landscape- and regional-level processes and facilitate greater communication between research and land management.

Our goal was to conduct call-response surveys for cerulean warblers (*Dendroica cerulea*), a species of high conservation concern, in and around the Allegheny National Forest in northwestern Pennsylvania. We wished to combine our survey results with existing GIS layers of physiographic features and vegetation cover in order to develop a habitat model for this species. To do so, we needed GPS coordinates for all survey points. We also wished to record additional field information on habitat features and avian communities at each survey point. Typically, to simultaneously broadcast vocalizations for surveys, record GPS locations, and collect additional field data would require separate equipment for each task: a CD or cassette player, a handheld GPS unit, and field data sheets on a clipboard. We developed an efficient technique to accomplish all 3 tasks using newly available technology in the form of a single handheld Pocket PC computer with peripherals. In this paper we describe the technique and equipment used.

Equipment and methods used

We used the Dell™ Axim™ X5 (Dell Inc., Round

Rock, Tex.) handheld, a touchscreen-based computer based on the Microsoft® Pocket PC operating system (Microsoft Corp., Redmond, Wash.). Though similar to personal digital assistants (PDA) in size, appearance, and use of a stylus rather than a keyboard, Pocket PCs tend to have greater memory capacity and faster processors, and overall have much of the functionality of laptop computers. In contrast to many other handheld data-input devices, Pocket PCs do not use proprietary data formats; rather, they use versions of common desktop software applications, such as MS Word, Excel (Microsoft Corp., Redmond, Wash.), and ESRI® (Environmental Systems Research Institute Inc., Redlands, Calif.) GIS formats that are automatically converted during the process of synchronization with a desktop computer.

Our Axims were configured with 112-megabyte (MB) internal memory, plus an additional 64 MB in a Secure Digital memory card. We added GPS capability with a Socket™ (Socket Communications Inc., Newark, Calif.) Bluetooth® GPS receiver equipped with a Titan (GPS Outfitters Inc., Stephens City, Va.) GPS antenna and a Dell Bluetooth CompactFlash (Dell Inc., Round Rock, Tex.) card. We places Axims in armored, waterproof Otter Boxes™ (Otter Products, Fort Collins, Colo.) to protect them from moisture and shock. The model and peripherals we used have already been updated (some Pocket PCs now have internal wireless capability), so our costs are no longer applicable but do give an indication of how inexpensive this technology is compared to alternatives. At the time of purchase, the basic Axim plus extra battery, Bluetooth CF card, and SD memory card cost $515 (U.S.) each. The GPS antenna and Bluetooth transmitter assemblage were an additional $359 each, and the amplified speakers with rechargeable batteries (Radio Shack) cost $18, making a total for each unit of $892 (Figure 1).

We copied cerulean warbler songs from several commercial CDs of bird songs and converted them

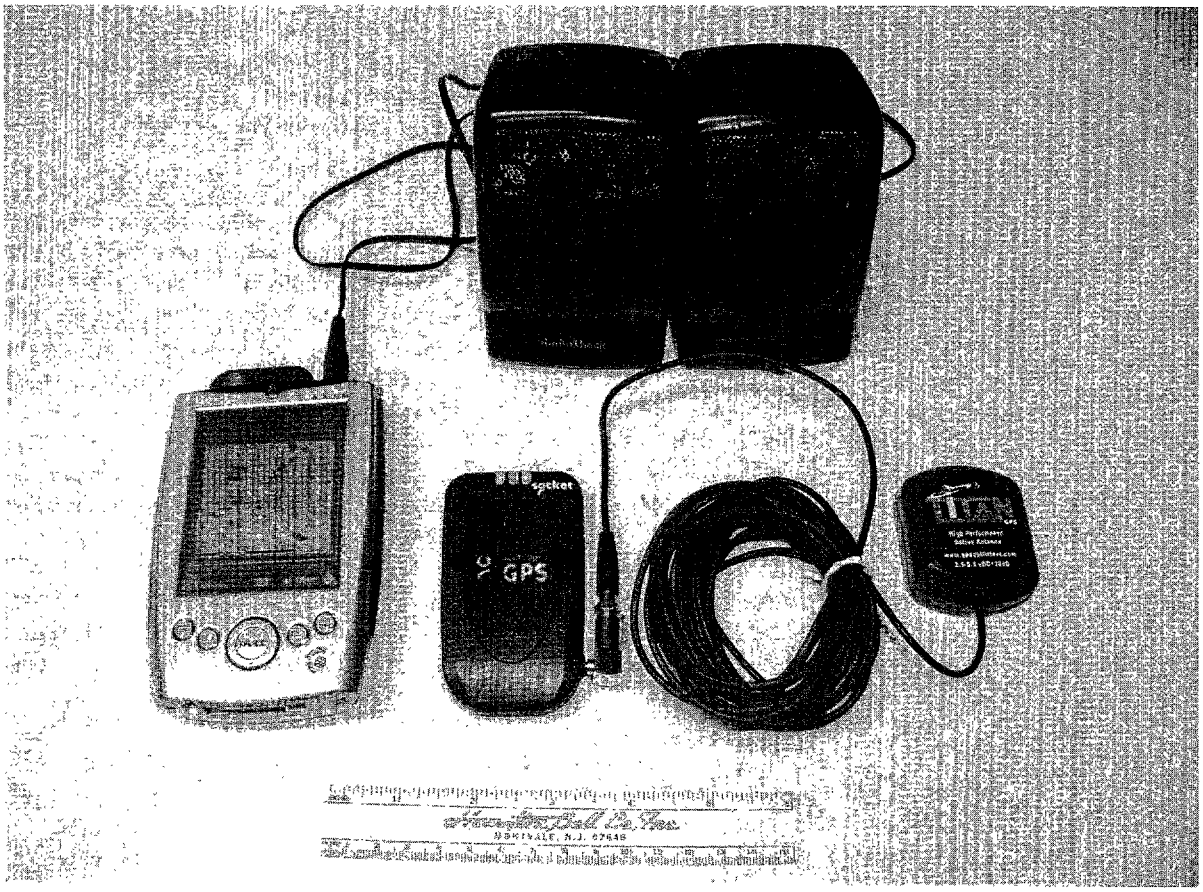

Figure 1. Pocket PC (left) with self-amplified speakers (top), GPS receiver and antenna (right), and a 15-cm (6-in.) ruler for scale (bottom).

into high-resolution mp3 files (we used RipEditBurn for its range of editing and file-management options, available from Blaze Audio, Lopez, Wash. www.blazeaudio.com). We played song files using Windows® Media Player (Microsoft Corp., Redmond, Wash.), a component of the Pocket PC operating system. We broadcast songs through external self-amplified speakers plugged into the Axim's headphone jack. The sound quality seemed to be identical to playing the actual CD. The major constraints on sound quality and volume were the quality of external speakers used and resolution (sampling rate and bitrate) of the mp3 files.

We collected spatial data using ESRI's ArcPad™ (Environmental Systems Research Institute Inc., Redlands, Calif.), a mobile mapping and GIS program designed for the Pocket PC platform (cost: $495). We recorded survey point locations in a shapefile that was created directly in ArcPad. We created attribute fields for point-specific data, such as transect identifiers, date of survey, stand type, and identity of observers, that were entered directly into the shapefile when survey locations were recorded. Shapefiles created in ArcPad were compatible with desktop ArcView® and ArcInfo®. For spatial analysis, we transferred shapefiles to a desktop computer and integrated them with existing GIS coverages of the survey area in ArcView. We also used shapefiles of survey points to navigate back to survey points later in the season for habitat sampling, thus eliminating the need for physical markers (e.g., flagging, stakes), which are subject to damage or loss by vandals, vehicles, livestock, and wildlife.

We entered survey data such as presence or absence of ceruleans, additional bird species observed, vegetation data, and comments in an Excel spreadsheet on the Pocket PC. One advantage of using a spreadsheet for this type of data entry was that repeated entries, such as the transect identifier, can be entered once and easily copied to additional entries. Database programs, such as DB Anywhere (Tiny Pocket Software, Toronto, Ont.), provide an alternative data-entry method. These programs can be used to create custom data-entry forms that can simplify entry of complicated data sets in the field. While each has its own merits, either spreadsheets or databases can be used to enter data directly into the Pocket PC. We backed up all of our data onto a removable memory card as well as a desktop computer.

Advantages

The advantages of direct electronic input of data over transcription of handwritten field sheets have been discussed fully elsewhere (Logan and Smith 1997, Elzinga et al. 2001, Waddle et al. 2003); we highlight just a few. Electronic input of data improves its legibility and standardization among observers. Files are automatically and accurately copied from the handheld to a desktop computer through the process of synchronization, thus avoiding time and risk of errors involved in data transcription. Creation of data-input forms in ArcPad (or any of several Pocket PC-based relational database applications) facilitates standardization of data input through use of data range checks and automatic recording of features such as date and default values. Our use of electronic sound files meant we needed no additional equipment other than external speakers. We experienced none of the deterioration in sound quality due to repeated use that affects tapes, no time lost for rewinding, and none of the risk of scratching or breakage incurred by CDs. Further, mp3 files are easily edited, and transferred directly to the unit through synchronization. The armored waterproof boxes we used worked well; we never experienced a problem with equipment failure despite near-record rainfall and conducting several surveys from boats.

Cautions

We carried extra battery packs for the Axims, so insufficient battery life was never an issue. However, the GPS receivers held less than a full day's charge. Fortunately, they could be recharged quickly using an adaptor plugged into a vehicle. In terms of data management, care should be taken that files in the handheld have priority during the synchronization process, such that they are not overwritten by less current but more recently accessed files on the desktop. This danger of losing data is especially critical because no hard copy of data can be created until data are downloaded onto the desktop computer.

Other potential uses

We described here the use of Pocket PCs with specific add-ons for conducting GIS-based avian surveys using call-response methods. This versatile technology has broad applicability for wildlife research. For example, the broadcast of bird vocalizations has been used as a lure for targeted mist-netting and banding (e.g., Sogge et al. 2001). Our

configuration could be used to efficiently play the vocalizations, record banding information, and, if needed, record netting-site locations.

Additional features and peripherals further expand the range of potential uses of Pocket PC handheld computers. Both Pocket Word and MS Reader, included in the Pocket PC operating system, can display text and images, suggesting uses for in-field instruction or training manuals, protocols, or identification guides. The CompactFlash card slot can accommodate various add-ons (although only one at a time), such as digital cameras, modems, and sensors of various types. Possible uses are too numerous to list, but examples include the recording of photo points or specimens with the digital camera, reading and recording of microchip tags with a flash radio frequency identification (RFID) reader (e.g., from Syscan International, St-Laurent, Que.), and using the modem in conjunction with a cellular phone to transmit data from remote field locations. The functionality of these Pocket PCs, as well as the variety of peripherals available for them, is increasing rapidly; the range of uses for wildlife field work will continue to increase as well.

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