A new method for wireless video monitoring of bird nests

David I. King, Richard M. DeGraaf, Paul J. Champlin, and Tracey B. Champlin

Abstract Video monitoring of active bird nests is gaining popularity among researchers because it eliminates many of the biases associated with reliance on incidental observations of predation events or use of artificial nests, but the expense of video systems may be prohibitive. Also, the range and efficiency of current video monitoring systems may be limited by the need to deploy video transmission cables, thereby increasing human disturbance and possibly affecting the behavior of nest predators. We describe a wireless video nest monitoring system that is much cheaper than currently available systems, can transmit up to 200 m in forest and 600 m in open habitats, and may reduce the influence of human disturbance on nest predator behavior.

Key words birds, nesting, nest predation, video monitoring, wildlife

Predation is an important cause of avian nest failure (Ricklefs 1969), and elevated rates of nest predation can potentially compromise the viability of forest bird (Donovan et al. 1995) and waterfowl (Greenwood et al. 1995) populations. Substantial effort has been expended to study habitat fragmentation and other factors associated with increases in nest predation (Clark and Nudds 1991, Robinson et al 1995), but identifying nest predators is handicapped by the absence of techniques for unbiased and systematic study of predation events. Because patterns of nest predation among treatments or habitats may vary with the predator species (Clark and Nudds 1991, Donovan et al. 1997), identification of nest predators is an important component of efforts to mitigate predation's effects on avian reproductive success (Lariviere 1999).

Previous attempts to identify nest predators have met with limited success. Direct observations of predation on natural nests are scarce (Pettingill 1976), and chance observations are biased toward diurnal predators and those that are most conspicuous in appearance and behavior. Researchers also have attempted to identify predators using the appearance of depredated nests (Best and Stauffer 1980, Sargeant et al. 1998), but recent studies indicate that there may be little correspondence between appearance of a depredated nest and predator identity (Marini and Melo 1998, Lariviere 1999).

Artificial nests, combined with plasticine eggs (Major 1991, Haskell 1995), hair catchers (Major 1991), tracking boards (Angelstam 1986), or still photography (Major 1991, Danielson et al. 1996, Cutler and Swann 1999), also have been used to identify nest predators. However, artificial nests differ from natural nests in appearance and conspicuousness (Martin 1987, King et al. 1999) and egg size (DeGraaf and Maier 1996), and lack the presence of adult birds, which may deter predators (Montgomerie and Weatherhead 1988) or reveal the nest's position (Skutch 1985). Predators also may visit artificial nests and trigger cameras without actually damaging the eggs, yielding erroneous information on predator identity (Maier and DeGraaf, 2000). Thus, the extent to which patterns of predation on artificial nests reflect predation on natural nests remains unclear (Major and Kendall 1996, King et al. 1999).

Using still cameras is not feasible for applications in which the subject makes frequent movements

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that would trigger cameras (Cutler and Swann 1999) or for applications in which detailed information on predator behavior is needed (Craig 1998; Maier and DeGraaf, 2000). Although videography is a promising alternative to using still cameras, currently available video monitoring systems are very costly in terms of equipment and the labor required to maintain a complete recording system for each camera (Thompson et al. 1999). We describe an original wireless video monitoring system that provides an efficient and relatively cheap alternative to current video monitoring systems.

Methods

Our system used Minemax® CM11R black-and-white, active infrared cameras, weatherized with the use of a transparent 500-ml plastic beverage bottle cut approximately 6 cm from the base (Figure 1). The mounting screw of the camera passed through a hole drilled in the base of the bottle and the camera lens faced out of the open end of the bottle toward the nest. The camera was concealed using a 15-cm-wide strip of camouflage cloth wrapped loosely around the cover and stapled in place, leaving the lens uncovered. Cameras were connected to a 2.4-GHz Wavecom® Jr. video transmitter by 10 m of cable. Transmitters were placed in plastic bags and then into 0.05 × 0.1 × 0.2-m plastic food containers and strapped to the trunk of a tree approximately 2 m above the ground, facing in the direction of the recording station. Transmitters and cameras were powered by 34-amp, deep-cycle batteries via a socket attached to the battery with alligator clips and an auto plug Y adapter with a DC power cord leading to the camera and another leading to the transmitter. Recording stations (Figure 2) consisted of 4 2.4-GHz Wavecom® Jr. video receivers connected to a Sylvania® SRV194 videocassette recorder through a Provideo® RQS-1A quad video processor. Data were recorded on 10-hr T-200 videotapes. Recording stations were powered by 2 12-volt, deep-cycle batteries connected in parallel. AC power for the VCR was provided by a Whistler® PP140AC power inverter via 2 RCA® 15-amp, 120-VAC power strips. DC current for the quad processor and the receivers was provided by 500-mA transformers plugged into the power strips. Plastic storage tubs, 1.0 × 0.6 × 0.5 m size, were placed over recording stations and covered by camouflaged waterproof fabric to conceal them and to provide extra protection from the weather.

We tested the effectiveness of our camera system by deploying cameras at active bird nests between May and July 1999 at the Bartlett Experimental Forest on the White Mountain National Forest, New Hampshire (44°04′N, 71°17′W). We mounted cameras on sticks 0.1–0.4 m above the ground and 0.3–0.5 m from nests. Because of previous evidence that cameras may influence predator behavior (Thompson et al. 1999, Pietz and Granfers 2000), we calculated nest survival using the Mayfield (1975) estimator and compared daily survival rates between monitored and unmonitored nests (Sauer and Williams 1989).

Figure 1. The transmitter in its case is fastened to a tree (left) with the battery below it, and the camera in its waterproof housing is to the right (arrow). All 3 components would be covered in camouflage cloth when in use, and the transmitter and battery would be placed 5–10 m from the camera and nest.

Results and discussion

Several features of our camera design promoted economy and efficiency of operation. The quad video processor allowed us to record up to 4 images with only 1 VCR, thereby reducing equipment costs, because fewer components were required, and labor costs,

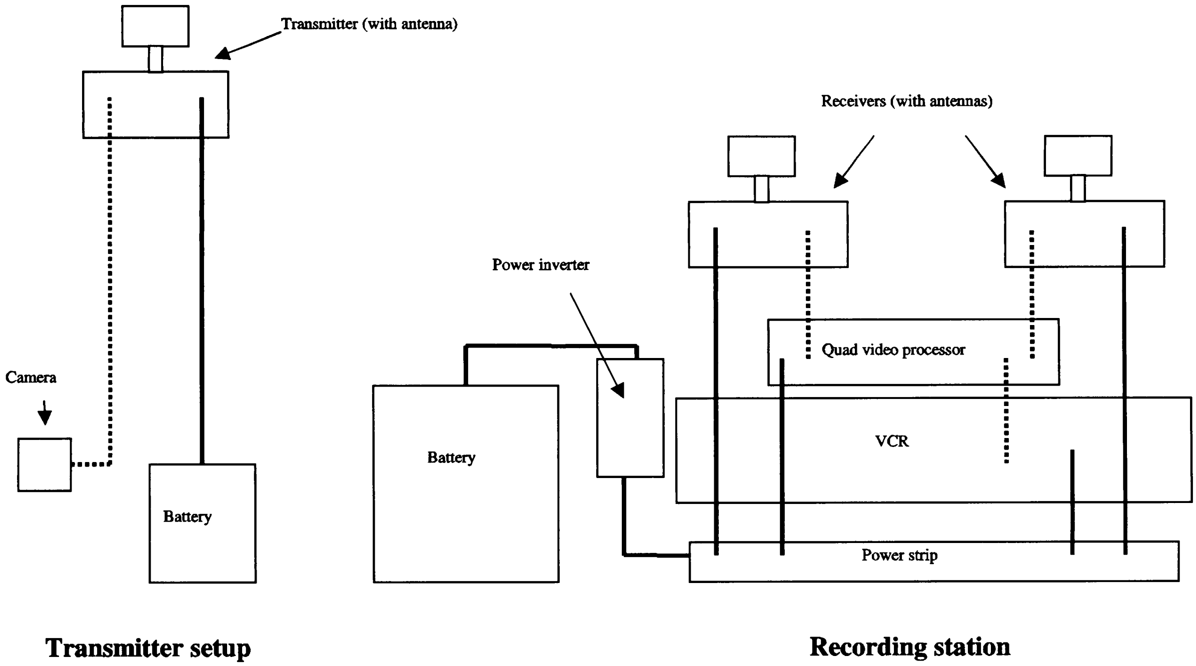

Figure 2. Schematic diagram illustrates our wireless video nest monitoring system. Solid lines depict power transmission, dotted lines depict video signal transmission. Only 2 of 4 receivers and 1 of 2 power strips on the recording station are shown.

because of fewer battery and videotape changes. Further savings were realized because our system can be assembled easily from readily available components. Thus, the equipment required to monitor 1 nest using our system is only $750, compared with $4,000/nest for currently available systems (Thompson et al. 1999). Absence of cables between the transmitters and the receivers, combined with the ample range of the transmitters (see below), facilitated camera deployment and permitted coverage of 4 ha by a single setup. The absence of cables also reduced the vulnerability of the system to cable damage (Thompson et al. 1999).

Our camera system also may have resulted in fewer nest disturbances caused by equipment and associated human activity. Thompson et al. (1999) reported that predation rates on field sparrow (*Spizella pusilla*) nests were lower with cameras than without, and Thompson et al. (1999) and Pietz and Granfers (2000) reported

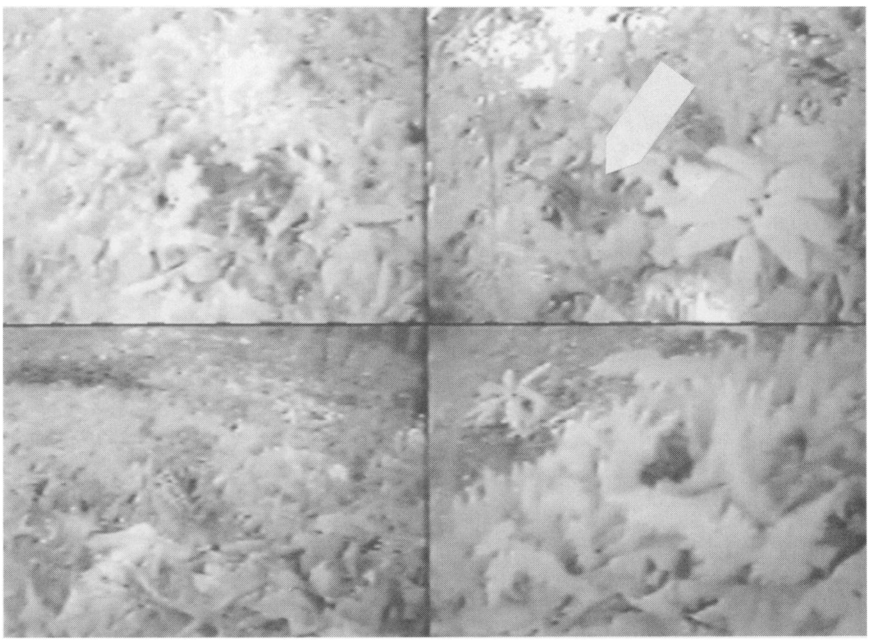

Figure 3. This image, captured from a video recording of the output of our wireless video monitoring system, illustrates 4 bird nests being monitored simultaneously and 1 of the 4 (upper right) being depredated by an eastern chipmunk.

substantial abandonment of monitored nests in response to camera deployment. By contrast, we detected no difference in daily survival rates between monitored (0.967) and unmonitored (0.964) nests ($\chi^2_1 = 0.63$, $P = 0.43$, $n = 30$) and observed no instances of nest abandonment attributable to the deployment of cameras. Amount of equipment deployed near nests using our system was limited to the camera and the transmitter, and the system required only biweekly visits to nest sites to change batteries. Although longer cables could address some problems of currently available systems, longer cables would present logistical problems and added expense, as well as vulnerability to damage.

Our video transmitters transmitted ≤200 m through the forest, but occasionally the signal was blocked by dense understory vegetation or dense stands of large trees. In these instances, alternative sites for the recording station were selected, often by walking to different locations carrying a single receiver connected to a portable monitor and evaluating sites on the basis of signal clarity. Without vegetation between the video and transmitter and the receiver, our transmitters had a range of approximately 600 m. Thus the potential utility of this system in situations where the antennas of the receivers and transmitters could be elevated above the level of the vegetation, such as grasslands or shrublands, might be increased substantially.

Our batteries powered the VCR, the quad, and 4 receivers for >3 days. Transmitters were powered for ≤6 days, although the transmitter battery life varied with distance to the recording station and vegetation density. Our use of 10-hr videotapes required 2 tape changes/day. We recommend the substitution of a time-lapse VCR (Thompson et al. 1999, Pietz and Granfors 2000) for the conventional VCR we used, which requires only 1 tape change/day, thus reducing labor costs.

Once our system was set up and adjusted, we found it easy to operate and almost maintenance free. Day and night images were of high quality (Figure 3), and we recorded predation by eastern chipmunks (*Tamias striatus*), red squirrels (*Tamiasciurus hudsonicus*), and bluejays (*Cyanocitta cristata*) on eggs and nestlings of ovenbirds (*Seiurus aurocapillus*) and hermit thrushes (*Catharus guttatus*). We believe that our system represents a significant advance over current video monitoring systems in terms of decreased cost, increased range, and increased ease of deployment and maintenance.

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