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COMPARISON OF TWO SYSTEMS FOR VIEWING BAT BEHAVIOR IN THE DARK

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ABSTRACT: A night vision device, Star-Tron Technology Corporation Model MK 426 Night Vision System with a 75 mm Cosmicar television lens, was compared with a model 525 Inframetrics imaging radiometer to observe and record on video tape, with minimal disturbance, behavior of the big brown bat, *Eptesicus fuscus*. Both devices allowed for unobtrusive observations under low light conditions. The night vision device, which uses ambient light, provided clearer images. The infrared imager, which provides images from radiant heat sources, yielded images in conditions where ambient light was virtually non-existent. It also helped locate bats in inaccessible crevices. The sensitive night vision system must be protected from stray light sources entering the lens. The bulkiness of the model 525 Inframetrics made it unwieldy in climbing into attics for closer views of the bats. Both instruments were superior to daytime or light-supplemented VHS camcorders in documenting bat behavior.

INTRODUCTION

Among the many devices used to detect and observe the nocturnal behavior of bats are night vision systems and infrared imagers (Kirkwood and Cartwright, 1991). In this study, the authors compared two systems while observing and recording behavior in a maternal colony of big brown bats, *Eptesicus fuscus*. The two systems were used to view the emergence of the colony at dusk and to locate and observe the bats inside the bell tower and attic just before dawn. The images were recorded on VHS video tape.

THE NIGHT VISION SYSTEM

The electronics in a night vision system intensify natural light and near infrared light so that images too dim for the naked eye can be seen quite clearly. The Star-Tron Technology Corporation passive Night Vision System, model MK 426, was used in this study. Due to its sensitivity to small amounts of light, it could only be used when the light intensity was low enough not to damage it. In absolute darkness, a normal flashlight with a Wratten No. 87 filter was fitted to the night vision system to provide an unobtrusive, infrared light source. The wavelength of this infrared light is just beyond the red range of human vision. A number of relatively inexpensive lenses are available to extend its use. The system will accommodate a Minolta 70-200 mm telephoto lens. However, the 75 mm Cosmicar objective lens was the only lens used in this study. The night vision system can be hand-held or mounted on a tripod. To tape the image, it was attached to a camcorder. The night vision system is lightweight, portable, and is easy to set up and use.

THE INFRARED IMAGING RADIOMETER

An infrared detector senses heat emitted or reflected from the surface of an object. The Inframetrics model 525 infrared imaging radiometer was used in this study. The model 525 has an optical zoom lens and detects in the mid-range of infrared wavelengths (10 to 12 microns). It does not "see" shorter infrared such as that produced with the flashlight and filter used with the night vision system. Unlike that system, the infrared imager senses heat values and converts them to a visual image similar to that of a normal black and white TV. Because the infrared imager senses reflected or emitted heat, not light, it can be used at any time, with or without illumination.

The infrared image detector is cooled with liquid nitrogen. The scanner, the electronics control unit, a small TV monitor, and a battery powered VCR are all mounted on a portable cart. Although it is easy to move on the ground, it is bulky compared to the night vision system. The electronics control unit is powered by a small, 12-volt car battery, also mounted on the cart.

The infrared image shows warmer items as white and cooler items as black. The image is easily interpreted providing the researcher understands two factors. Reflective surfaces often indicate the temperature of backgrounds that are mirrored — not the actual temperature of the surface under study. For example, glass, which is opaque to infrared wavelengths, is highly reflective and can mislead the observer. The second source of confusion occurs because sunlight warms objects and surfaces and can deceive the observer. Once the sun has begun to warm the structure, the bats "disappear" from view as the roost structure heats up to the body temperature of the bats. A skilled operator, aware of the behavior of bats, can usually interpret or explain ambiguous images.

Figure 1 compares the two systems along with VHS video and human vision, showing their use relative to light availability. Note that light availability has no effect upon the infrared image, since it senses heat, not light.

METHODS

To compare the two systems, the infrared imager was set up outside a rural church near Upland, Indiana, at 7:57 pm on 16 July 1992. Sunset that evening was at 8:11 pm. In addition, a VHS camcorder was used to provide a recorded approximation of human vision. With the VHS camcorder, bats entering and leaving the roost were recorded from the time the experiment started until nearly dark. The infrared imager also recorded the same information and continued to do so after dark. The night vision system could not be set up until after dark.

The camcorder image rapidly deteriorated as night fell. When the bats could no longer be viewed using the camcorder (8:45 pm), it was attached to the night vision system as if it were a lens. The camcorder and the night vision system complement each other very well in their use of light: at the point where the VHS camcorder image failed, conditions became optimal for the night vision system.

On 16 August 1992, the two systems were set up inside the attic of the church. The equipment was tested just before sunrise to minimize the warming effects of the previous day's sun on the structure. The attic was totally dark to unaided vision. Illumination for the night vision system was provided by an ordinary flashlight covered with a Wratten #87 infrared filter. The infrared imager required no assistance to image the scene.

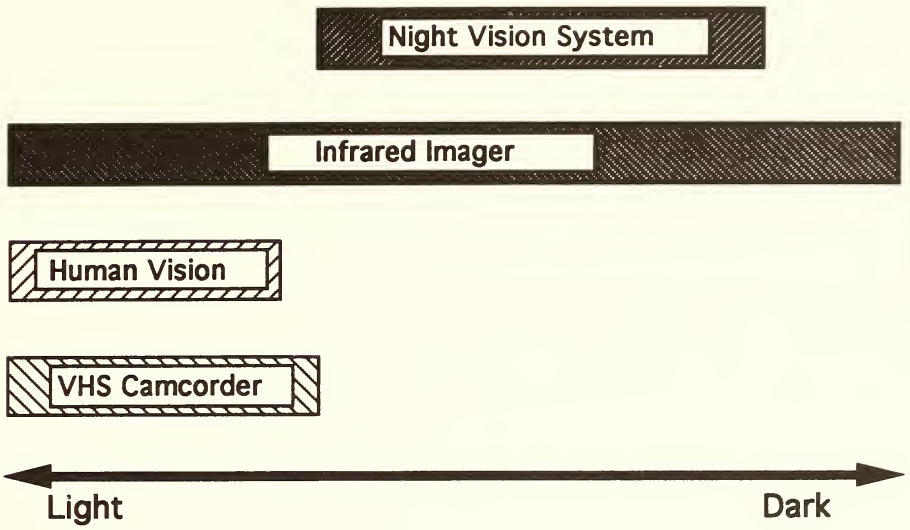

Figure 1. Comparison of two systems for viewing bat behavior in the dark with VHS video and human vision.

RESULTS

Exterior observation. The bats used a single exit and entry point almost exclusively, allowing for a stationary placement of the equipment. The bats could be clearly seen by eye at first, but as night approached, the camcorder and the infrared imager were better than our unaided vision. Both the camcorder and the infrared imager recorded a significant amount of activity at and around the exit and entry point of the bell tower of the church. Since the infrared imager sees heat, not light, changing light conditions did not influence the infrared view. The infrared imager provided clear views of the bats emerging and flying around the bell tower from the time it was set up until more than an hour after the sun had set and the light had stopped diminishing. The imager would have continued to provide a clear record of the bats' behavior throughout the night.

The night vision system could not be used until approximately 30 minutes after sunset, when light levels were sufficiently low to prevent damage to the intensifier tube. At this point, the camcorder image failed, and the night vision system was attached to the camcorder. Illumination for the night vision system was simple at this site. A security light outside the church provided a sufficient amount of light for viewing the entrance and exit behavior of the bats throughout the night, and the bats were already accustomed to it. The amount of light was not sufficient for ground observers to see the bats, but it provided a clear, monochromatic, realistic, and unambiguous image with the night vision system.

Interior observation. The air temperature in the attic was 20° C. There was no activity at the bats' entrance and exit point. At first, no bats were seen with either system. The bats were visually located using a flashlight.

One bat was discovered at the apex of two rafters. The night vision system provided a clear image of the bat, but it showed no activity and appeared dead. A line scan taken by the infrared imager showed that the bat approximated the temperature of the wooden

beam, being, at most, a half degree Celsius warmer than the wood. The bat was nearly impossible to detect with the infrared imager, since there were other heat anomalies that presented similar thermal signatures. Only a slow, thorough search by an infrared technician skilled in detecting the thermal signature of bats permitted identification.

Assuming the bat was in torpor, the authors purposely disturbed it, and the infrared image became much clearer as the bat's metabolic rate increased. A line scan taken about five minutes before it flew showed the surface temperature of the bat to be about three or four degrees Celsius higher than the surrounding surface. At this time, the image of the bat appeared quite white (warm) against the dark background.

As this bat awoke from torpor, a small cluster of bats, that was hidden under a piece of wood roofing, was inadvertently aroused. They were completely invisible to the naked eye and to the night vision system. However, the body temperature of the bats had warmed the piece of wood behind which they were hidden so that the infrared imager easily spotted the heat anomaly in the wood roofing. Their activity was then observed using the infrared imager through a crack between the boards. They remained in place, huddled together, not grooming nor moving around, and maintained their warm temperature until we left them. No other bats were observed that morning.

Either technique permitted unobtrusive observation of bats in the roost site. Studies of mother-young interactions could be carried out with either system.

DISCUSSION

The obvious advantage of either system of night viewing over the camcorder is that they can be used in low-light or no-light conditions. The night vision system enhances very low light. The infrared imager can be used with absolutely no light, and in this study, it was used day and night. Neither system disturbed the bats. The images from each were relatively easy to understand; the infrared image required a bit more interpretation, primarily because it images heat. Both devices allowed video taping for later analysis and quantification of bat behavior. Slow motion and video stills helped in assessing transient behaviors. The infrared imager was sensitive to the heat produced by bats as they roosted and allowed detection of bats that were located in inaccessible crevices which the night vision system could not penetrate and in which they could not be seen visually with the aid of a flashlight. Without the infrared imager, these bats would have gone unnoticed. This study demonstrated the advantages of unobtrusive viewing of visible bats and the discovery of hidden bats with the infrared imager.

If the bats' surface temperature was a degree Celsius above that of their environment, the infrared imager was better at locating them, even when they were out of sight behind the wood. If visual contrast was better than heat contrast, then the night vision system was more effective in locating bats which were in the line of sight but completely ineffective in locating bats which remained out of the line of sight.

The size difference between the two systems is an important factor. The night vision system is easy to transport, making it ideal for use in a typical attic. The infrared imager is much larger and heavier and is difficult to get into small areas. The Inframetrics 525 can be removed from the cart and carried on a harness that fits over the shoulders of the operator, but it is still very bulky. The system had to be dismantle and then reassembled to get it into the attic.

The night vision system cost about $4,000. The cost of the 525 infrared imaging system was nearly $40,000. Newer models with more capabilities can be twice that. How-

ever, the newer infrared imagers are more self-contained and are electrically cooled. Because they are much smaller, more like a camcorder, they can be taken into tight spaces. In addition, they can record exact temperatures and other quantitative image data that can be manipulated later with compatible software. The newer imagers also record in color, making the image easier for novices to interpret.

ACKNOWLEDGMENTS

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