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ABSTRACT

Urban forested wetlands and rural forested wetlands were studied to investigate the effectiveness of night-vision image intensifier equipment in the observation of medium-to-large animals and to investigate if surrounding landscape type influences wetland habitat value. Bats, cats, dogs, owls, deer, and humans were easily observed using the night-vision equipment. Differences in species use between the rural and urban forested wetland were observed. Light levels and noise levels were significantly higher ($p<0.05$) in the urban versus the rural wetland. We conclude that image intensifier equipment can be used to quantify nocturnal animal activity in different landscape types and that surrounding land use can reduce the habitat value of forested wetlands to certain species.

Keywords: night-vision, image intensifier, forested wetlands, urban, rural, domesticated animals, nocturnal

INTRODUCTION

Nontidal wetlands have long been recognized for their function and value as wildlife habitat. Certain animals are known to spend portions of their lives frequenting wetland areas. In the United States, 50% of all rare, threatened, and endangered wildlife species occur in or depend upon wetlands for survival (Niering, 1988). An estimated 1.4 million ha of palustrine forested wetlands were lost in the United States during the mid-1970's to mid-1980's with the majority of the loss occurring in the southeast (Dahl and Johnson, 1991). The loss of wetland habitat, particularly forested wetland systems, has resulted in a decline in certain animal populations and, in some cases, a shift to introduced species (Harris and O'Meara, 1989). Large tracts of contiguous habitat connected with a diversity of other wetland types is considered of high value to wildlife (Forsythe and Roelle, 1990), while fragmentation of habitat by development has been shown to impact some species (Oxley et al., 1974; Harris and Vickers, 1984; Harris, 1985; Blackner, 1986; Dickman and Doncaster, 1989).

Regulations such as the Clean Water Act of 1972 generally restrict encroachment into wetlands, yet do not regulate development along the wetland periphery. Urban development can literally encircle a wetland system with residential, industrial, or commercial construction encroaching to the wetland/upland interface resulting in isolated wetland pockets without forested buffers. While wildlife management experts recognize landscape and watershed level influences, there is a perception amongst the general public that protection of the wetland area while developing the adjacent upland can be accomplished with minimal impact to the functions associated with the wetland. However, residential developments are generally accompanied by an increase in noise and light levels, an increase in human activity, a loss of upland forested habitat, and the introduction of domesticated dogs and cats. These activities may cause a reduction in native animal use of the wetland and/or a shift from native animal populations to domesticated animals.

Flash photography, red-light observation, radio-tracking, and baiting all have been used to study behavior of nocturnal animals (Dickman, 1982; Brown et al., 1988; Wolfe and Summerlin, 1989; Daly et al., 1992). However, the usefulness of these methods is limited because all likely result in a modification of the animal's behavior. Night vision devices are sensitive to electromagnetic wavelengths outside of the visible light band (approximately 0.4 - 0.7 microns) and thus, detect electromagnetic wavelengths or frequencies beyond the range or below the threshold of vision. The night-vision equipment used in this study are considered image intensifiers and allows covert observation of the natural activity of medium to large animals.

The purpose of this study is to investigate the use of night-vision equipment in the observation of wildlife and to explore the hypothesis that surrounding land use may influence nocturnal animal activity.

MATERIALS AND METHODS

Two sites were selected for observation. One site (urban) was located in Newport News, Virginia and was surrounded by a single family housing development. The second site (rural), York County, Virginia, was part of the Colonial National Historic Park. Both sites were approximately 1.2 ha in size and were mapped by the U.S. Fish and Wildlife Service National Wetlands Inventory. The wetlands were classified as palustrine forested broad-leaved deciduous temporarily flooded (PFO1A) (Cowardin et al., 1979). The dominant vegetation of each site was red maple, *Acer rubrum*, sycamore, *Platanus occidentalis*, hornbeam, *Carpinus caroliniana*, and golden ragwort, *Senecio aureus*.

Three observation areas were selected within each wetland with one observer at each area. Each observer was equipped with a pair of PVS-5 night-vision goggles, an infrared aiming light, a 3x night vision pocket scope, and a hand-held two-way radio. The PVS-5 night-vision goggles have a 40^{0} circular field of view and a range of 50 m at an illumination of 0.0003 lumens/m^2 for man-sized objects. The 3x night-vision pocket scope has a range of 300 m and the infrared aiming light has a range of 150 m. The infrared aiming light was used for directing other observers to a particular site for positive identification of an object. Each site was observed from dusk to midnight once in the spring, summer, and fall (May 18,19; August 10,11; October 11,12, 1992). The dusk to midnight observation period was selected because the majority of nocturnal animals are most active during this time (Alkon and Saltz, 1988; Longland, 1990). Sites were visited on consecutive nights in order to minimize variability in climate and moonlight. Time of observation was noted for each animal. Noise level from the 20 to 20,000 Hz frequency range was measured each sample night with a Simpson Sound Level Meter Type 886 and recorded in decibels. Light level was measured each sample night using a LI-190SB Quantum Sensor and was recorded in Einsteins per 30 minutes

TABLE 1. Bat activity in minutes by hours after sunset between urban and rural wetlands sites.

Hours after Sunset	Bat Activity (min.) Urban	Rural
1	15	25
2	48	45
3	46	15
4	5	0

TABLE 2. Species, number, and time of activity (in minutes) of animals in both rural and urban wetland sites.

Species	Rural (number, time)	Urban (number, time)
Dogs	0	2 (35 minutes)
Humans	0	3 (24 minutes)
Cats	0	2 (65 minutes)
Deer	8 (35 minutes)	0
Owls	2 (10 minutes)	0
Bats	6 (85 minutes)	13 (114 minutes)

per square meter and converted to lumens per square meter. Both sound level and light level meters were placed in the center of the site at the forest floor.

RESULTS

Six species were observed resulting in 130 minutes of activity in the rural wetland and 238 minutes of activity in the urban wetland. Bats (family Vespertilionidae) were the only animals observed in both rural and urban wetlands across the seasons and were the animal most observed with 114 minutes in the urban wetland and 85 minutes in the rural wetland. Significantly longer periods of bat activity were observed in the urban versus the rural wetland (chi-square, $p<0.001$) (Table 1). The next highest observation times were the domesticated cat and the domesticated dog in the urban wetland (27% and 15%, respectively) and the white-tailed deer, *Odocoileus virginianus*, in the rural wetland (27%). Humans accounted for 11% of the urban wetland activity (Table 2).

Average light illumination between sites differed as much as 2.0 lumens/m^2 from 1900 h to 2030 h and 5.0 x 10^{-5} lumens/m^2 from 2100 h to 2330 h (Figure 1) with significant ($p < 0.05$) higher illumination levels in the urban wetland from 2000 h to 2200 h. Average decibel levels between sites are shown in Figure 2. The urban wetland

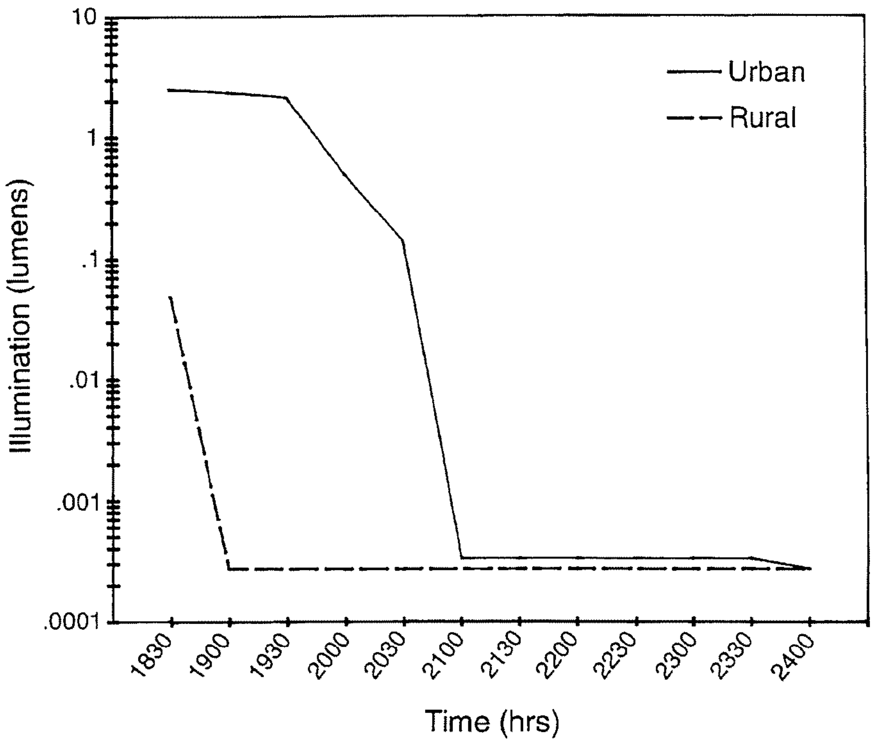

FIGURE 1. Average illumination between urban and rural sites from 1830 to 2400.

had average decibel levels at least 18 units higher than the rural wetland and peaks of as high as 90 decibels. Decibel levels in the rural wetland never exceeded the minimum for the instrument at 50 decibels.

Four predators were observed in this study, domesticated dog, domesticated cat, human, and barred owl, *Strix varia*. The dog, cat and human were observed in the urban wetland with the human and dog activity occurring during the early evening under higher light illumination and the cat activity occurring closer to midnight under lower light illumination. The predator observed in the rural wetland was the barred owl.

DISCUSSION

The increase in bat activity in the urban versus the rural wetland may be the result of the higher light illumination levels in the urban wetland from street and porch lights and the subsequent increase in flying insect activity. The absence of deer from the urban wetland may be attributable to the presence of humans and their pets, the higher light levels, and the absence of a forested buffer. The absence owls from the urban wetland may be attributable to a lack of prey resulting from an avoidance of the area by rodents due to increased light levels and predation by cats. Heteromyid rodents

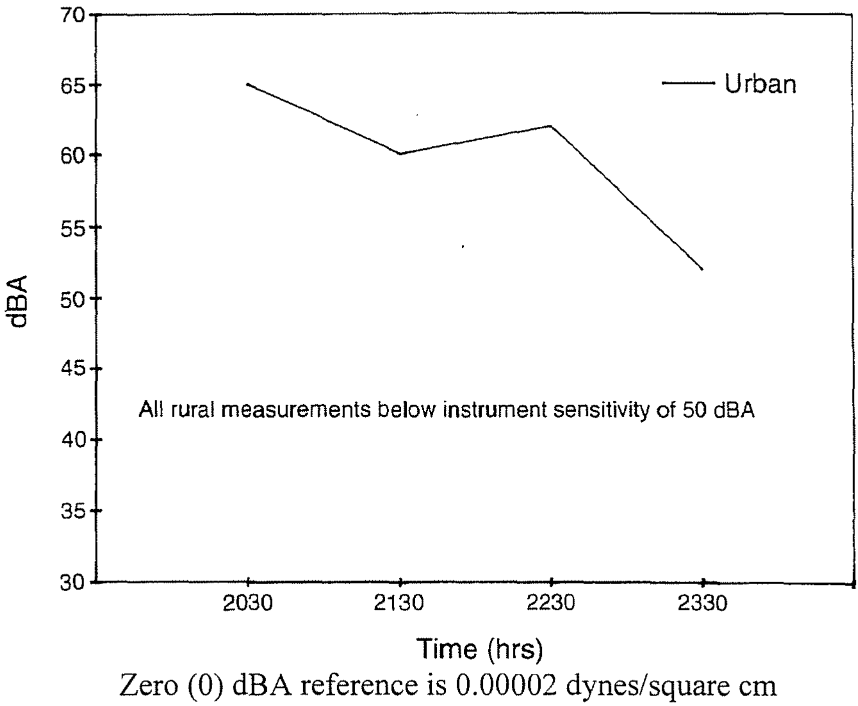

FIGURE 2. Maximum noise levels in decibels (dBA) between urban and rural sites

have been shown to reduce feeding activity under increased illumination (Brown et al., 1988; Wolfe et al., 1989; Daly et al., 1992). The differences in light illumination between the urban and rural wetland sites ranged from 2.432 lumens/m^2 at dusk to 6.0 x 10^{-5} lumens/m^2 just before midnight. An illumination increase of 2.0 x 10^{-6}lumens/m^2 was shown to considerably increase an owl's ability to locate prey (Dice, 1945). Similarly, Clarke (1983) noted an increase in owl hunting efficiency with increasing moonlight illumination. Domesticated cats have been shown to be major predators of birds and mammals and it is suggested that a cat's urge to hunt is independent of the urge to eat (Haspel and Calhoon, 1993).

Noise levels in the urban surrounded wetland were noticeably higher than in the rural or forest surrounded wetland. The urban surrounded wetland showed average noise levels that ranged from that typical of a quiet automobile of around 50 decibels to slightly less than that typical of busy street traffic of around 70 decibels. Decibel peaks in the urban wetland of up to 90 decibels occurred periodically throughout the sample period coinciding with noise associated with sirens, horns, barking dogs, slamming doors, and a train. The rural wetland site had decibels levels lower than the sensitivity of the sound level recorder and never exceeded the minimum level of 50 decibels. A more sensitive recorder that can be adjusted to lower intensities and higher frequencies (20,000 - 50,000 Hz) should be used to more accurately investigate noise levels that are within most animal hearing but beyond human sensitivity. Ancillary

FIGURE 3. Deer photographed under three-quarter moon illumination at 25 meters using 3200 speed film and a 35mm camera equipped with a 3x image intensifier lens. (Photo by W. I. Priest).

information such as small mammal population densities would significantly enhance conclusions regarding predator use of these areas. High decibel levels, high nighttime illumination, reduction in upland forest buffer, and the presence of domesticated pets could reduce the attractiveness of a site as habitat for certain reclusive animals and more intensive investigation using replicate sites should be conducted.

The use of night-vision equipment has significant potential for the concealed observation of medium to large nocturnal animals. The methodology used in this study can be improved by limiting the study times to early spring before leaf-out or late autumn after leaf-fall to eliminate interference due to dense foliage. Better observation would be obtained by establishing elevated observation platforms. Inexpensive infrared light sources can be constructed using infrared diodes and nine-volt batteries. These can be placed throughout the study site to illuminate the observation area and increase visibility through the image intensifier equipment. Cameras can be outfitted with image intensifier lenses to allow photography of nocturnal animal activity (Figure 3). Video cameras outfitted with image intensifier lenses can be stationed on site and the signal transmitted to a remote location for real time, off site viewing and recording. The primary author is presently investigating the use of night-vision video cameras randomly distributed within a study area that, with the use of lithium batteries and solar cells, can remain on site for weeks or months (Havens and Sharp, 1995).

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