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Comparison of 3 devices to observe white-tailed deer at night

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Abstract To further reduce deer–aircraft collisions, a method for observing deer on airports at night that does not affect aircraft operations is required. We compared the effectiveness of forward-looking infrared (FLIR), spotlight, and night vision goggles (NVG) to monitor the abundance of white-tailed deer (*Odocoileus virginianus*) along a 10-km route in Ohio during 12 nights in winter (Jan–Feb) and summer (Jul) 1997. Numbers of deer observed with FLIR (825 in winter, 570 in summer) and spotlight (716 and 445) were similar ($P>0.05$); number of deer observed with NVG (243 and 152) was less ($P<0.05$) in winter and summer. The FLIR provided the best overall observability of deer of the 3 devices tested. The FLIR was less affected than spotlights by inclement weather and was not obtrusive. Biologists working in suburban areas or on airports can use FLIR to detect deer in areas where a spotlight would be inappropriate. Under conditions tested, we do not recommend using NVG to detect white-tailed deer at night.

Key words infrared sensing, night vision, *Odocoileus virginianus*, spotlight, survey, white-tailed deer

Deer residing on airport facilities pose a direct hazard to operational and public safety, as evidenced by the increase in numbers of reported deer-aircraft collisions (Bashore and Bellis 1982). From 1992 to 1996, 214 deer collisions with civil aircraft were reported to the Federal Aviation Administration (FAA, Cleary et al. 1997). Deer-aircraft collisions occur typically at night (Wright et al. 1998). To determine the abundance of deer at an airport and maximize effectiveness of deer harassment or removal efforts at night, efficient, accurate methods to detect deer are required. Such methods also are needed in areas where increased deer populations create problems for wildlife managers, including deer-vehicle collisions, damage to landscape plants, and reduced ecosystem diversity (Frost et al. 1997, McCullough et al. 1997, Peck and Stahl 1997).

Night spotlighting is a technique that has been used frequently to detect presence and provide estimates of deer populations (McCullough 1982, Fafarman and DeYoung 1986, Cypher 1991, Whipple et al. 1994). Various infrared detection devices also have been used to census wildlife (Boonstra et al. 1994, Garner et al. 1995, Naugle et al. 1996, Butfiloski et al. 1997). Benefits of spotlights include low cost, ease of use, and comparability of data with other studies. Benefits of FLIR include minimal disturbance to target animals. However, both devices are limited by vegetation concealing target wildlife. The intense light projected by spotlights also may be undesirable near runways and taxiways of airports or in suburban areas. Night vision devices, which enhance available light, have been used to detect deer (Frost et al, 1997) and also may be appropriate to monitor deer at night. Our objective was to compare the relative effectiveness of a spotlight, night vision goggles, and a FLIR device for detecting white-tailed deer at night.

Study area

We conducted our study during January–February and July 1997 at the National Aeronautic and Space Administration's Plum Brook Station

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(PBS), Erie County, Ohio. The 2,200-ha facility is enclosed by a 2.4-m-high chain-link fence with barbed-wire outriggers. Vegetation within PBS consisted of canopy dogwood shrubs (*Cornus* spp., 39%), grasslands (31%), open woodlands (15%), and mixed hardwood forests (11%, Rose and Harder 1985). During winter 1996-1997, PBS had an estimated minimum white-tailed deer population of 475 ($\geq$21/km^2, A. J. Montoney, United States Department of Agriculture, unpublished data).

Methods

We established a continuous 10-km survey route along a series of roads at PBS. Because the person using the devices worked from the passenger side of the vehicle, we observed deer on one side of the route only. We categorized vegetative associations along this side of the route, based on the dominant vegetation observed every 0.2 km, as grassland (39%), shrub (30%), and wooded (31%).

We used a FLIR P100 Nightsight (Texas Instruments, Dallas, Tex.) mounted on top of the cab of a pickup truck. The FLIR was filtered for operation in the 8- to 10-um spectral band and had a wide (27 × 18°) field of view. The FLIR could be rotated 360° and tilted -20 to 45° from horizontal by using a control in the vehicle. A 12.7-cm, diagonal, black-and-white monitor was mounted on the vehicle dashboard in front of the observer. We used AN/PVS-7B night vision goggles with a GEN II^{PLUS} image intensifier tube (M962; Litton Electron Devices, Tempe, Ariz.). These goggles had 1X magnification with a 40° field of view. We used 2 brands of hand-held spotlights (model SL 240 Blitz, Lightforce PTY Ltd., Cleve 5640, South Australia; and Q-beam, model 800-2500-0, Brinkman Corp., Dallas, Tex.); each emitted 1,000,000 candlepower of light.

In 1997, we conducted 2 trials of 12 consecutive nights each, the winter (leaf off) trial from 21 January to 1 February and the summer (leaf on) trial from 7 to 18 July. We initiated surveys 30 minutes after sunset. During each night, we conducted 3 surveys, once with each device. To reduce the effects of vehicle lights, headlights were covered with black cardboard so that light was emitted from 2 12- × 1.5-cm slits. We drove the vehicle continuously during the survey at 15–17 km/h. Each survey lasted about 35 minutes, with 5–10 minutes between consecutive surveys. We used a systematic randomization such that each device was used an equal number of times during the first, second, and third surveys and followed the use of other devices an equal number of times.

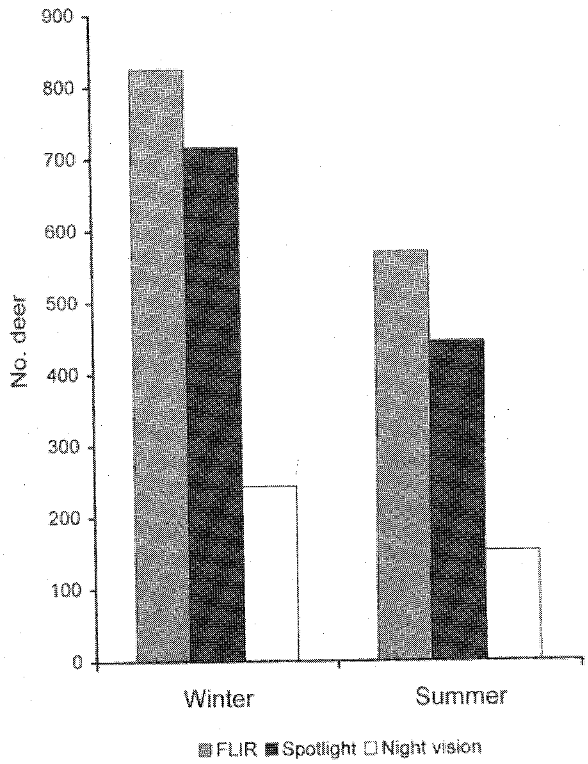


Figure 1. Number of white-tailed deer observed with forward-looking infrared (FLIR), spotlight, and night vision goggles during 12 night surveys in winter and summer along a 10-km route (120 km surveyed/device/season), Erie County, Ohio, 1997.

The observer recorded number of deer seen during each survey; the driver did not participate in observations. We used Kruskall-Wallis χ^2 approximation and Dunn multiple comparison (for tied ranks) tests (Zar 1984) to compare mean rank scores among devices for each season using Proc NPAR1WAY (SAS Institute, Inc. 1988).

Results

In winter, we observed 825 deer with FLIR, 716 with spotlight, and 243 with night vision; number of deer observed differed ($\chi^2_2 = 19.88$, $P < 0.01$) among devices (Figure 1). Numbers of deer observed with FLIR and spotlight were similar ($P >$ 0.05).

Percentages of deer observed among vegetation associations with FLIR and spotlight were similar, with about 82% of deer observed in grasslands and 18% observed in shrub or wooded areas. In contrast, about 99% of deer observed with night vision were in grasslands; only 1% were observed in shrub and wooded areas.

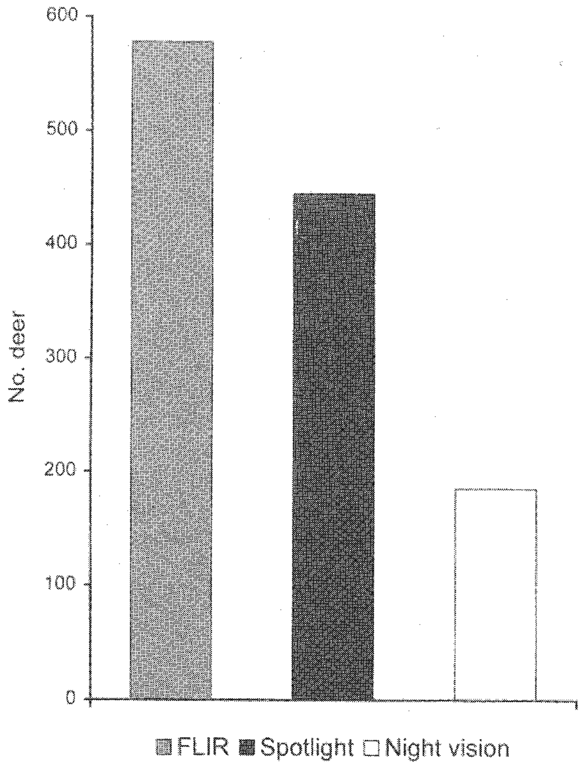


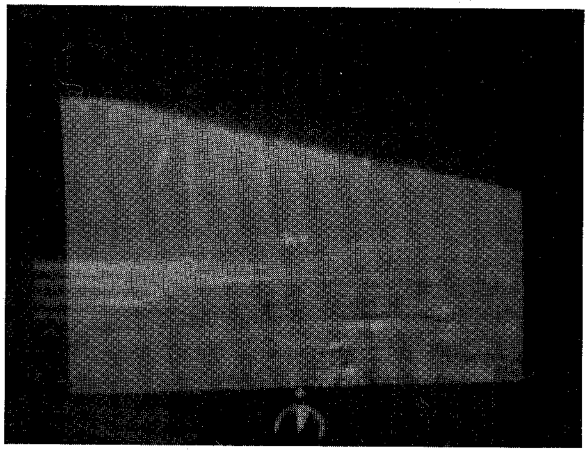
Figure 2. Number of deer observed with forward-looking infrared (FLIR), spotlight, and night vision goggles (NVG) during 8 survey nights with fog, rain, or snow on a 10-km route (80 km surveyed/device), Erie County, Ohio, 1997.

In summer, we observed 570 deer with FLIR, 445 with spotlight, and 152 with NVG; numbers of deer observed differed ($\chi^2_2 = 25.97$, $P < 0.01$) among devices (Figure 1). We observed more ($P < 0.05$) deer with FLIR and spotlight than with NVG. Numbers of deer observed with FLIR and spotlight were similar ($P > 0.05$).

As in winter, we observed most deer in grasslands: 87% with FLIR, 82% with spotlight, and 93% with NVG. We observed about 2% of all deer in shrub associations with each device. Observations in wooded areas were 16% for spotlight, 10% for FLIR, and 5% for NVG.

Inclement weather

On nights ($n = 8$) with snow, rain, or fog, numbers of deer observed differed ($\chi^2_2 = 12.72$, $P < 0.01$) among devices (Figure 2). We detected more deer ($P < 0.05$) with FLIR than with NVG. Numbers of deer observed with FLIR and spotlight were similar ($P > 0.05$), as were numbers of deer observed with spotlight and NVG ($P > 0.05$).

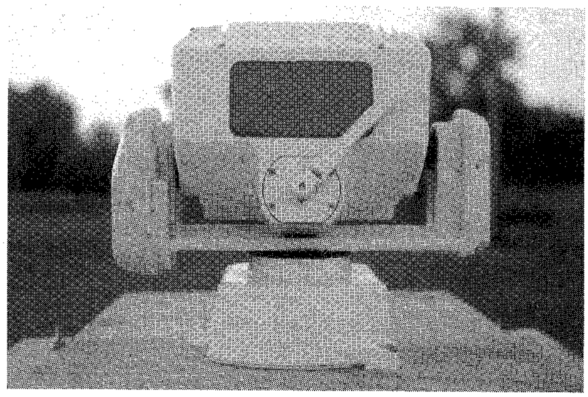


White-tailed deer (white object, center screen) as displayed on monitor.

Discussion

Each device was limited by vegetation blocking either the line of sight or infrared wavelengths, particularly in shrub and wooded areas. However, with NVG, deer were more difficult to detect because they blended with vegetation and did not reflect any visible light. The spotlight sometimes was effective at distances where deer were not easily visible (>50 m) because the observer could see light reflected from the tapetum lucidum of the deer's eye. The FLIR was effective because often only a portion of the infrared image of a deer was necessary to identify the animal. Also, detection of deer by the observer was not dependent upon deer looking at the device.

Although numbers of deer detected with FLIR and spotlight were similar under poor weather conditions, it appeared easier to detect deer with FLIR than with the spotlight. Light fog, snow, and



Forward-looking infrared device (FLIR P100 Nightsight) used to observe white-tailed deer.

rain made detection with spotlight difficult because moisture in the air reflected emitted light back to the observer. The FLIR also was affected by fog, snow, and rain, but infrared light appeared to penetrate moisture better. The NVG did not penetrate fog or snow and was severely limited during lightning storms. Because of low numbers of deer detected and intermediate costs, we do not recommend using NVG under conditions tested during this study.

Spotlights can create a visual intrusion to deer and people. In contrast, FLIR can be used to survey deer unobtrusively and can be used in places where a spotlight would be unacceptable. For example, areas adjacent to airport runways and taxiways or occupied dwellings would not likely be suitable for survey with a spotlight, yet could be searched with a FLIR device.

Unlike infrared equipment used by some researchers (Graves et al. 1972, Wiggers and Beckerman 1993, Naugle et al. 1996), the P100 Nightsight images can be identified by a biologist. Experience with the equipment and knowledge of the landscape and wildlife species of the area can allow biologists to detect wildlife without using specially trained scanner operators.

Costs (1997 prices in U.S. dollars) varied widely among devices we tested and within the product lines themselves. The FLIR devices varied from about $8,000 (the cost of the unit we tested) to over $30,000. Spotlights, in comparison, ranged from $20 to $130. The cost of NVG ranged from $400 to $2,000.

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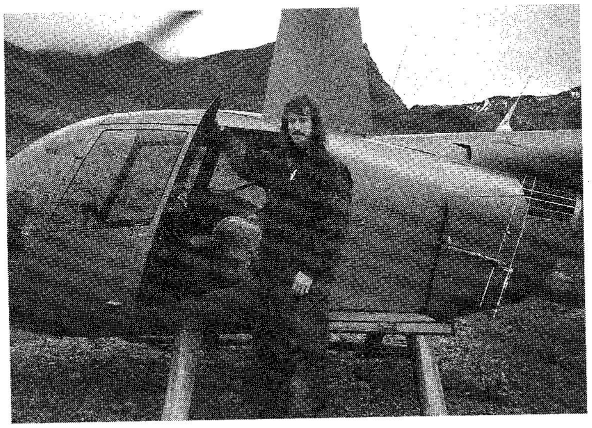

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