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INVESTIGATING THE FEASIBILITY OF CENSUSING DEER BY REMOTE SENSING OF THERMAL INFRARED RADIATION

by

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Indiana has employed several techniques for censusing deer since their reintroduction in the 1930's. Early efforts included interviewing land owners and conservation officers and the establishment of census trails. All were quite time-consuming and as the deer extended their range and became more numerous, new techniques became necessary. Pellet-group surveys are now used to provide population figures for various state and federal properties, but these surveys are subject to many variables and are better suited to provide population indices than actual numbers. Recent advances in remote sensing prompted us to investigate the feasibility of censusing deer by the detection of infrared radiation.

The Laboratory for Agricultural Remote Sensing* at Purdue University is concerned with applying remote sensing techniques to various agricultural purposes -- mapping of vegetation and soil types, crop disease detection, etc. Relatively little work has been done in the past on the detection of animals using thermal infrared techniques. After discussions on the use and potential of such applications, a small livestock detection research program was initiated as a first step toward evaluating the application of remote sensing techniques to deer census.

By thermal infrared radiation, we mean the heat energy or rays given off by an object. These rays are not visible, being of much longer wavelengths (3 - 16 microns) than those rays to which our eyes are sensitive (0.4 - 0.7 microns). If you approach a hot soldering iron, it is impossible to see the thermal infrared rays coming from it, but they are easily detected by holding your hand a short distance from the iron. Detecting such thermal infrared

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radiation from a distance is a form of remote sensing; touching the hot soldering iron with your finger would be direct sensing.

Scientists have developed techniques for using extremely sensitive intrared detectors (using such materials as mercury - doped germanium cooled to -269° centigrade) to record the "apparent temperature" (relative thermal emission) of various objects. By incorporating such infrared detectors into a complex system of electronics and optics, the differences in apparent temperatures which are remotely sensed may be processed to produce a photographic-like image. These instrument systems, commonly called "thermal infrared scanners", can be mounted in aircraft. It is then possible to fly over an area of interest and obtain a thermal infrared image of the area below.

By utilizing temperature differences rather than visible light to produce images, these thermal infrared scanner systems are capable of accomplishing things not possible with normal aerial photography. Many such capabilities are being investigated in various research programs. The U. S. Forest Service has recently begun using infrared scanners on an operational basis for mapping fire perimeters on large fires in the west. In ordinary visual photographs, one sees only clouds of smoke. On infrared images, however, the heat from the fire makes the actual fire perimeter clearly evident. The Forest Service is also conducting intensive tests on fire detection in remote areas, particularly following severe lightning storms.

Thermal infrared scanners offer unique features which may be of considerable value in census work and are not available with conventional aerial photography. Imagery can be taken at night as well as during the day. During daylight hours, animals may blend very well with their background, to the point where it is impossible to detect them on photographs. By sensing temperature differences between the animals and their normally cooler background, the scanner can produce images on which one can readily determine animal locations.

Various features of an individual scanner system (electronics, optics, cryogenics) affect the sensitivity and resolution which are possible with that system. Temperature differences between various objects being sensed, the size of these objects, and the aircraft altitude also influence the capability for detecting such objects on the imagery. Through the use of scanner systems with sufficient resolution and by flying at altitudes consistent with the instrumentation and program objectives, it is possible to obtain thermal infrared images of animals. On the imagery, animals appear as white "blips" as

they are relatively intense sources of thermal infrared radiation in contrast to the "cooler" (lower emitting) background.

To date, most research on potential use of thermal infrared techniques for animal detection has involved livestock. It has been shown that cattle are more readily detected on night-time imagery than on comparable imagery obtained during the day. Against certain backgrounds (such as transpiring, green vegetation), the cattle were more apparent on infrared imagery than on aerial photographs taken at the same time during the day. Because of the altitude - resolution relationship of scanner equipment utilized, current indications are that relatively low altitudes (1000-2000 feet) are necessary for livestock detection work. With better equipment, it seems reasonable to assume that such census work could be conducted from altitudes of at least 5,000 feet. As mentioned earlier, animals appear on thermal imagery as white "blips". Solely on the basis of such blips, it is impossible to separate similar sized animals of different species. Relative sizes of individual animals can not be reliably determined by blip sizes. Furthermore, when animals are grouped, the individual blips merge in such a manner as to make determination of actual numbers impossible.

On the basis of our current knowledge, the application of remote sensing of thermal infrared radiation as a deer census technique would involve coping with several problems. Since overhead vegetation would not allow accurate detection of individuals, the count would have to be made during the winter. Indiana does not have appreciable amounts of conifers to complicate matters as would be the situation in other regions of the country. A late winter - early spring count would provide a base population figure - prior to fawning and hopefully past most winter losses. The deer commonly occur in groups at this time of year, possibly making an accurate count difficult.

Night flights would probably be best for deer census purposes. The environment has had a chance to cool off from solar radiation absorbed during the day, causing the animals to contrast more distinctly against their background. Deer would more likely be in open locations during nocturnal flights, making their detection that much easier. Work this past summer, however, demonstrated that navigation during night flights is much more difficult.

Since recent work indicates that relatively low flight altitudes would be necessary with the currently available instrument systems, total deer counts would be practical only on limited areas. A sampling system would have to be devised to arrive at a state-wide population figure. Care would have to be exercised in laying out flight lines to avoid possible confusion of deer with domestic livestock.

The cost of acquiring and maintaining a remote sensing system is very substantial. A system would hardly be justified merely for census work. The most practical manner of conducting a deer census utilizing infrared detection would be to contract the flights to a concern owning and maintaining an operational scanner. The U. S. Air Force uses such equipment in much of their work, and as mentioned earlier, the U. S. Forest Service is using aerial infrared scanners for fire detection and mapping. More and more agricultural uses for remote sensing are being developed. Altogether, prospects are good for the existence of more operational scanners in the near future. Further research work will clarify the possibilities of censusing animals through infrared sensing. Even if annual censuses are not considered justified, an accurate, periodic check on deer numbers would be a welcome asset for better deer management.

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