PANEL 3: POLAR BEAR STUDIES

Infra-red Scanning for Polar Bear

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SUMMARY

An airborne imaging infra-red scanner was tested for its ability to detect and record the presence of polar bears on the Chukchi Sea ice pack. The equipment and its manner of use is described. A monitoring oscilloscope failed to reveal bears, although scan data recorded on magnetic tape and subsequently transferred to film did reveal the presence of polar bears and their fresh trails. Additional testing under a wide range of weather and snow conditions appears warranted.

INTRODUCTION

The low visual contrast between polar bears and a background of snow and ice precludes aerial surveying or censusing over large areas, in the manner commonly employed for other wildlife. A consistent ability to detect polar bears within a reasonable distance of an overflying aircraft demands a detection method superior to vision, and infra-red sensing offers an alternative possibility. Infra-red scanning equipment is available that has the potential of detecting large mammals under certain conditions. This paper describes limited tests of such equipment to evaluate its usefulness for detecting polar bears on the polar ice pack. The assistance of Theron A. Smith who piloted the aircraft carrying the equipment during the tests and Charles P. Allen who flew the second aircraft and helped in locating bears is gratefully acknowledged.

EQUIPMENT AND METHODS

Croon *et al.* (1968) explain the principles of infra-red sensing and imaging line scanners in connection with game censusing. A résumé of actual or potential applications for infra-red scanning is given by Thackrey (1968), and a basic account of theory is offered by Wolfe (1965). To review briefly, infra-red sensing is based on the phenomenon that all solids and liquids above absolute zero emit electromagnetic radiations. Infra-red radiation lies in the band of wavelengths between 0.75 and 1,000 microns and is invisible. The amount and spectral range of emitted energy vary with the temperature and surface characteristics (among other things) of the emitting object. Thus, it can be expected that two objects as dissimilar as a mammal and snow covered ice would differ in energy emitted within a particular infra-red band. It is this difference that we seek to detect. Maximum radiation from mammals seems to occur between 8 and 14 microns so this is the wavelength region of most promise for detecting them. Fortunately, emissions in this region suffer relatively little atmospheric absorption and there are detector elements that are most sensitive to these wavelengths.

The airborne infra-red scanning equipment tested is basically composed of three elements: a detector, an optical-mechanical scanning mechanism, and a signal processing and recording system. The detector receives infra-red energy and converts it to electric signals which are processed for recording on magnetic tape (or they may be monitored on an oscilloscope in flight.) Because the detector has an instantaneous field of view of only 2.5 milliradians, a means of moving it laterally to scan a line is required. This function is performed by the optical-mechanical mechanism that provides 120 scans/second within a field of 120°. The forward movement of the aircraft furnishes two dimensional coverage. The tape recorded signals are subsequently transferred to 70mm film strips in the laboratory.

Daedalus Enterprises, Inc., of Ann Arbor, Michigan, furnished the test equipment on a lease basis. The equipment was mounted in a U.S. Fish and Wildlife Service de Havilland Beaver aircraft having a camera hatch to accommodate the detector and scanning unit. The cabin also provided ample room for the tape recorder, oscilloscope and control panel. A second aircraft (Cessna 185) was employed to assist in locating or verifying polar bears and as a safety precaution in the event of a forced landing. Operations were based at Cape Lisburne on the northwest coast of Alaska and flights were made over the frozen Chukchi Sea.

To facilitate obtaining imagery that could be evaluated in relation to polar bears, it was decided to initially locate a bear by the usual method of tracking, and then make scanning passes over the animal. A flight on April 4, 1970, failed to yield imagery because the tape recorder malfunctioned. On April 5 testing was continued with all equipment operating normally. Ice cover on the Chukchi Sea area investigated was complete, 1.5 inches of new snow covered the ice with scattered packed snow drifts associated with pressure ridges. The temperature was −5° F., the wind was north at 5 knots and the sky was clear. The tests were flown at midday.

The aircraft made several passes at an altitude of 500 feet over a polar bear using a trimetal detector (Hg:Cd:Te) which is most sensitive in the 8-14 micron range. This detector was then replaced by another type (In:Sb) having best sensitivity between 1.5 and 5 microns, and several additional passes were flown over the bear. Upon returning to the base, the magnetic-taped data were transferred to 70mm film which allowed visual study and photographic enlargement of selected sections.

RESULTS

In-flight imagery displayed on the oscilloscope did not reveal polar bears, though the pattern of smooth versus rough ice was visible. At flight altitude (500 feet) the strip scanned measures 1700 feet wide so a target as small as a polar bear becomes invisibly small, if it appears at all, on the small oscilloscope screen. Furthermore, an image remains on the screen only a few seconds which makes it impossible to focus long on a single 'hot spot' within the varied background pattern.

The imagery obtained with the indium-antimonide detector was of poor quality when viewed on the photographic film strip. According to Dr. Carl Miller, of Daedalus Enterprises, Inc., the aircraft exhaust probably interfered with the reception of infra-red energy from the surface.

The trimetal (Hg:Sb:Te) detector yielded much better results. On film, the infra-red imagery showed good resolution and contrast. When enlarged by projection on a screen or on photographic paper, an object the size of a polar bear would register but not in a way discernibly different from the background pattern. However, it was immediately noticed that any movement of a polar bear left a warm trail that would be recorded. The trail persisted for several minutes after the animal moved over a given spot. This distinctive trail would lead to the bear and permit its recognition if it were within the field being scanned (see Fig. 1). Because observations indicate that polar bears (unless denned, which is uncommon on the ice pack) invariably move upon the approach of a low flying aircraft, it is probable that most or all bears in the area being scanned would be detected under conditions that existed during these tests.

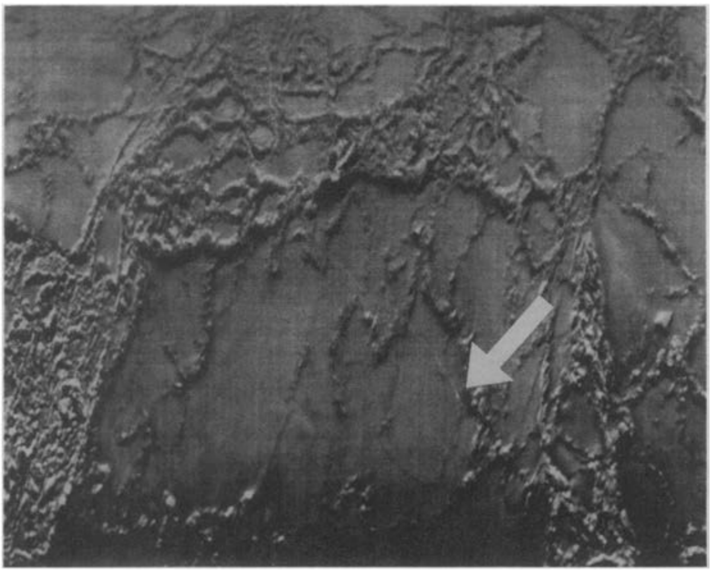

Fig. 1. Photographic reproduction of a recording obtained from an imaging infra-red line scanner. A bear trail is visible with the animal located at the point of the arrow.

DISCUSSION

Imagery on the oscilloscope monitor did not reveal polar bears or their trails, although it served as a quick reference to assure that the scanning equipment was functioning properly.

The tests utilizing a trimetal detector (Hg:Sb:Te) in combination with the tape recorder yielded imagery on film that would permit identification of polar bears. Unfortunately, opportunity did not allow testing under the variety of conditions that would surely be encountered in extensive surveys. It is not known how long the bear trails might be detected if wind velocities were higher, though it is expected that they would dissipate more quickly. Differing states of cloud cover and thickness would probably influence background contrasts, perhaps enhancing the imagery as far as bears and their trails are concerned. The depth of snow on the ice may influence the character of the bear trails and the ability of the equipment to record them. Additional testing will be required before the technical practicality of the method under a wide range of conditions can be judged.

The costs of buying or leasing imaging infra-red scanners and the expense of operating aircraft are substantial. Nevertheless, the initial testing indicates that this method is probably superior to any other and could have application in line transect sampling systems aimed at yielding estimates of bear numbers over fairly large regions.

REFERENCES

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