Low-Level Aerial Photography as a Management and Research Tool for Range Inventory

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Abstract

An inexpensive technique is reviewed for using low-level aerial photography as a management and research tool for range. Modifications of a previously documented camera mount are reported that allow greater flexibility in the use of aerial photography for range evaluation. This technique involves the use of color infrared film with a 135-mm telephoto lens double filtered with orange and magenta filters.

As increasing demands are placed on our private and public rangelands, care must be taken to manage these valuable resources in such a way as to maintain them in a productive condition. To manage rangelands properly, records of annual vegetative changes should be maintained and evaluated. Vegetation samples are usually clipped to provide records for documenting changes in vegetation. This requires a substantial amount of labor, time, and money. Collecting information about changes in vegetation utilizing low-level aerial photography can reduce time, labor, and expense.

Aerial photographs from a light plane can be obtained rapidly with a minimum amount of labor. These photographs contain valuable information that can be used for managing private and public lands, and for range research purposes. Many agencies already have the necessary equipment at their disposal for collecting aerial photographs. The Bureau of Land Management in Montana has used a 35-mm aerial photography system for several years (Meyer and Gerbig 1974). This method of data collection enabled them to inventory study plots more rapidly than from the ground. Small format (35-mm) aerial photography from light aircraft has great potential as part of a coordinated system of range inventory. Aerial photographs of the same area at different times during the year and from year to year can provide information on patterns of growth and utilization of range vegetation, vegetative change, range condition, and occurrence of biotic disturbance as well as an overall view of the area.

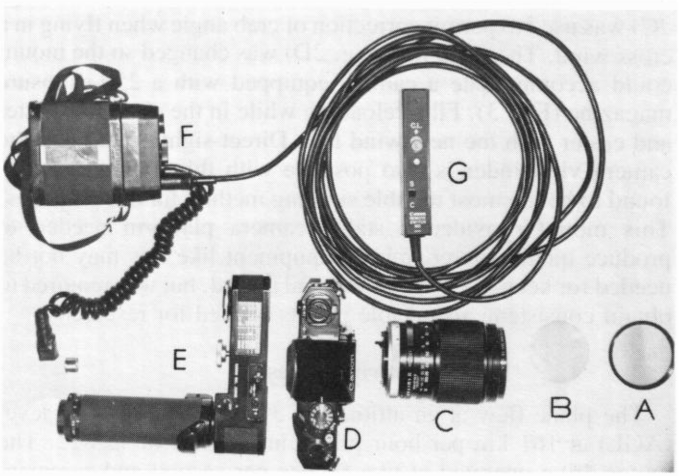

Fig. 1. *Camera set up with a Tiffen 15 orange filter (A), Kodak magenta filter (B), Canon 135 mm telephoto lens (C), Canon F-1 (D), Canon motor drive (E), Canon power pack (F) with remote switch (G).*

Part of the range research at South Dakota State University uses low-level aerial photography to obtain high-quality infrared stereograms in 35-mm format. These pictures are used for determining sample collection programs and maintaining a pictorial record of vegetation on experimental ranges at the Range and Livestock Experiment Station, Cottonwood, South Dakota.

Equipment

Photographs were collected using a 35-mm Canon[1] F-1 camera equipped with a motor drive and a 135-mm telephoto filtered with Tiffen 15 orange and Kodak magenta filters (Fig. 1). A camera mount using the same basic design of Meyer (1973) was built by university personnel to fit light, high-wing aircraft (Fig. 2). Various modifications were made to improve the mount. The base unit (Fig. 2B), which fastens to the door of the plane, was modified to make the mount usable on tandem aircraft with conventional landing gear that can operate from

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[1] Mention of product names in this paper does not constitute a recommendation by the South Dakota Agricultural Experiment Station.

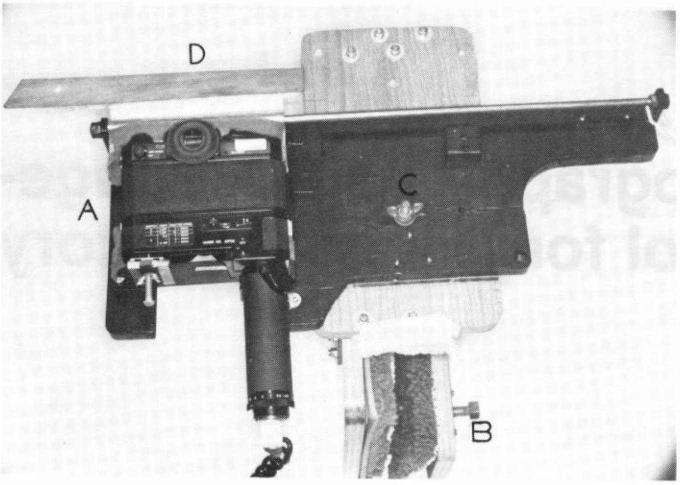

Fig. 2. *Camera with 36-exposure magazine (A) attached to the camera mount. The camera mount attaches to the door of the airplane with the window in the up position by a cushioned clamp base unit (B). [Note the center pivot-point (C) and the wind foil (D)].*

rough or nonexistent landing fields. A center pivot-point (Fig. 2C) was used to permit correction of crab angle when flying in a cross wind. The wind foil (Fig. 2D) was changed so the mount could accommodate a camera equipped with a 250-exposure magazine (Fig. 3). Film reloading while in the air is also faster and easier with the new wind foil. Direct-sighting through the camera viewfinder is also possible with this mount and was found to be the most reliable sighting method for our purposes. This mount provided a stable camera platform needed to produce quality stereograms. Equipment like this may not be needed for keeping a yearly pictorial record, but was required to obtain consistent, repeatable results needed for research.

Procedures

The plane flew at an altitude of 381 m above ground level (AGL) at 161 km per hour producing a scale of 1:2822. The motor drive operated at two frames per second and a camera shutter speed of 1/500 second was used. This provided approximately 50% overlap of consecutive frames for stereo coverage. Color infrared Ektachrome film was used, with a combination of both Tiffen 15 orange and Kodak magenta filters attached to the lens.

Color infrared film was used because it provided more information than color Ektachrome. Living vegetation was easily distinguished on the infrared film and changes in vegetation throughout the growing season could be more easily documented. Live vegetation appeared as shades of red and dead plant material as shades of green when color infrared pictures were taken with the orange and magenta filters.

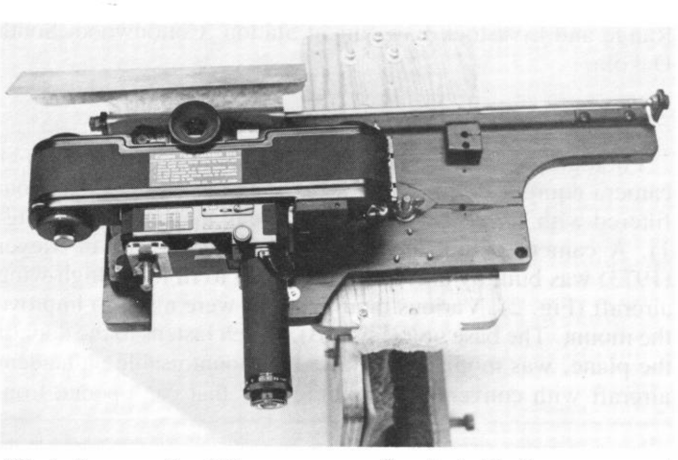

Fig. 3. *Camera with a 250-exposure magazine attached to the camera mount.*

The color infrared film was processed in a field laboratory at the Range and Livestock Experiment Station. This was accomplished by converting part of the laboratory into a darkroom, using a controlled-temperature waterbath, Kodak E-4 color processing kits, Kodak color control processing strips, and Durst developing equipment. Film was removed from the film cartridge within a Burke and James changing bag and put into a light-tight developing canister, eliminating the need for a total darkroom. Actual processing time in the developing tank was 55 minutes. The total procedure required about 70 minutes, including time for getting the film onto the reels and into the developing tank, developing the film, wiping the film, and hanging it up to dry. The result was high-quality imagery that exhibited remarkable detail.

Problems

Problems encountered with this method of data collection are many and varied, but can be solved with experience and practice. The weather in South Dakota is especially unpredictable. One can never pick a day in advance to take pictures from a light aircraft. Cloud conditions are often quite variable, and winds are often too gusty for a small plane to fly in a precise line. Consequently, a pilot and airplane with a flexible schedule are needed.

Reliable camera equipment is a necessity. A dependable system that gives consistent results is required, particularly in research work. Valuable time and money may be lost if inferior equipment is used. Thus, the most economical camera for such a job may be one of the more expensive, but highly dependable, models.

Color infrared film was available only in twenty exposure rolls making reloading film while in the air a necessity in our operation. This presented certain hazards. When the camera was in the operating position outside the plane, it was buffeted by a substantial blast of air. Thus, a camera mount that allowed the camera to be brought inside the airplane was needed for removing and loading film. Empty and loose film canisters rolling around the floor of the plane also made it difficult to maintain an organized process. This problem was solved by taping film canisters together into a belt and numbering them. The lens was taped at infinity to prevent it from being accidentally turned out of focus.

The major problem encountered in flying relatively low-level aerial photography in a light plane was marking the area so that it could be seen easily from the air and then lining up and staying on the flight line to achieve accurate, repeatable coverage. This problem was solved by marking the flight lines with white planks and numbering them with formations of white painted rocks. The rock formations were 1.83 m in length and planks were 3.05-3.66 m long and 25.4 cm wide. The white markers stood out well and were easy to see from a distance (Fig. 4).

In order to stay on the flight lines, the photographer leaned out of the airplane and looked through the camera viewfinder. This gave the photographer the opportunity to check the camera setting immediately before shooting and to start the motor drive at the proper time. This also gave the photographer the option of not shooting if the plane was not properly lined up, or if it was blown off target at the last minute. A periscope was constructed which was mounted on the camera mount and allowed the

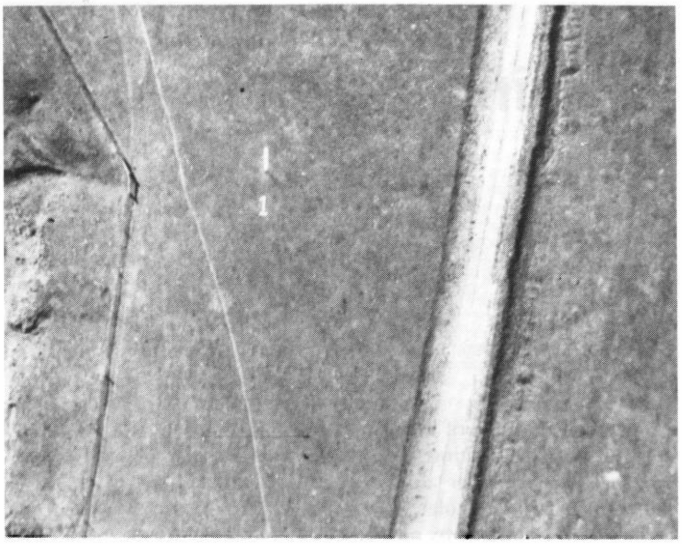

Fig. 4. *Aerial photo (scale 1 cm=4.1m) taken from 381 m above ground level with 135-mm telephoto lens (Note: number 1 formed with white rocks and white planks identifying the flight line).*

operator to view the flight line from the rear seat of the airplane. However, direct observation through the viewfinder was found to be the most foolproof sighting method available for use with the removable outside mount. Goggles were necessary to protect the photographer's eyes.

Use of Imagery

Imagery from this system was used to delineate soil and vegetation patterns and to stratify clip-plot locations in range research projects. Stratification of clip-plot locations on a solodized-solonetz soil complex near Rapid City using low-level aerial photography reduced the number of samples needed for sampling weight of western wheatgrass (*Agropyron smithii;* Beetle 1970, Van Bruggen 1976)[2] to within 10% of the mean with 95% probability from 430 to 30 plots (Waller et al. 1978). This resulted in a great saving of time, labor, and money.

Also, pictures were taken along permanent flight lines located in the experimental pastures at Cottonwood. These flight lines ranged from 182 m to 914 m in length and were located on key use areas in low, medium, and high range condition. Pictures were taken monthly during the growing season in 1976 and 1977 in conjunction with color infrared stereograms taken from a height of about 1 m supplemented with clip-plot information. This imagery was taken as part of a range ecosystem inventory method which is being developed.

Costs

The cost of this method of data collection was relatively low after the initial purchase of the camera system. About $900 was invested in the camera, lens, and motor drive, with the mount costing $60 and developing equipment $60. Airplane expense was $31 per hour, film $2.75 per roll, and processing chemicals about $1.20 per roll. Labor costs must also be included for the photographer and film processor. When comparing these costs to those incurred when using larger format (small-scale photography) aerial photography, such as that from a remote sensing agency, the method described in this article is a very economical method of data collection. One routine photo mission flown over the Range and Livestock Experiment Station by the nearest remote sensing agency would have cost over $1,100. The cash cost of one mission with nearby light aircraft was only $70. Thus, the saving derived from the first mission was sufficient to more than offset the cost of all the photographic equipment. Not only is this system economical, but it also possesses outstanding flexibility with regard to flight time and film processing, which is extremely important in a region with variable weather.

Summary

Land managers need a fast, reliable, inexpensive method of gathering information to wisely manage their resource. Photography from light aircraft can partially replace traditional labor-intensive information gathering methods and holds great promise for the future.

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[2] Nomenclature follows Beetle (1970) for common name and Van Bruggen (1976) for scientific name.