A PLAN FOR RESEARCH IN FIELDS OF AERIAL PHOTO INTERPRETATION

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ABSTRACT

Photo interpretation is now recognized in geology, agriculture, engineering, and many other related fields as an essential method of investigating both basic and applied earth sciences. With a few exceptions the aerial photos used for photo interpretation are general purpose, "run of the mill" photos. Such photography has paved the way but many special uses or refinements in present uses create special requirements which cannot be met because of inexperience. To overcome this deficiency, need exists for an organized research program in photo interpretation. This paper illustrates this need and outlines an organized research plan aimed at expanding and improving the uses of aerial photographs for interpretation purposes.

RECENTLY the author was approached by a fellow forester who was interested in recognizing spruce trees and fir trees on aerial photos. This forester was especially anxious to get aerial photo specifications insuring such identification. Experiences were reviewed in aerial photo interpretation of spruce-fir forests in Northeastern United States and articles were recalled written by Seeley,[2] Spurr,[3] Losee,[1] and Young,[4] on photo interpretation of such forests. Many discussions and conferences on such subjects as held in various places were remembered. At these there would be a lengthy discussion of photo scales, films, filters, cameras, tree shadows, tree form, locations, forest density and other matters that seemed important. A combination that seemed satisfactory in one place, would fall down in other locations. For all, there seemed to be no satisfactory solution, only vague generalizations. All of these hinged on the experiences of individuals with no satisfactory method of evaluating and choosing the best.

Finally, the author told the forester that *probably* a 1:10,000 scale with infrared film and yellow filter would be best. The forester was disturbed with the qualification of "probably." Justification for the use of aerial photography was based on being able to identify spruce trees and fir trees; if that could not be done, aerial photos would be of no help. Despite the author's past experiences, a definite answer could not be furnished.

The inability to provide reliable and adequate information stimulated study and thought with the result of a plan for research requirements in photo interpretation. As outlined in the following pages, the plan presents a logical approach to solving research problems in many fields of aerial photo interpretation. These factors associated with the recognition of images on aerial photos are:

1. *Scale* of aerial photography.
2. *Difference in parallax* for the object.
3. *Per cent exposure* of object.
4. *Contrast* of photo image and background.
5. *Resolution* of photo image.
6. *Ability of interpreter.*
7. *Type of equipment* for viewing aerial photos.

Where:

Scale of aerial photos is evaluated in representative fractions ranging between 1:1,000 and 1:20,000.

Difference in parallax is measured in inches.

Per cent exposure is the expected portion of objects visible to camera eye. This is evaluated in per cent.

Contrast of photo image and its background is measured by the difference in Munsell grey scale values for these two items. These values range from 0 to 5.

Resolution of photo image for the photographic system is measured in lines per mm.

Ability of photo interpreter is relative and based upon mentality, visual acuity, education, experience and training. It is measured from a low of 1 to a high of 10.

Type of photo interpreter equipment is rated from 1 to 10 depending on its suitability for the job.

The job is to so assemble all of these factors that the probability of recognition

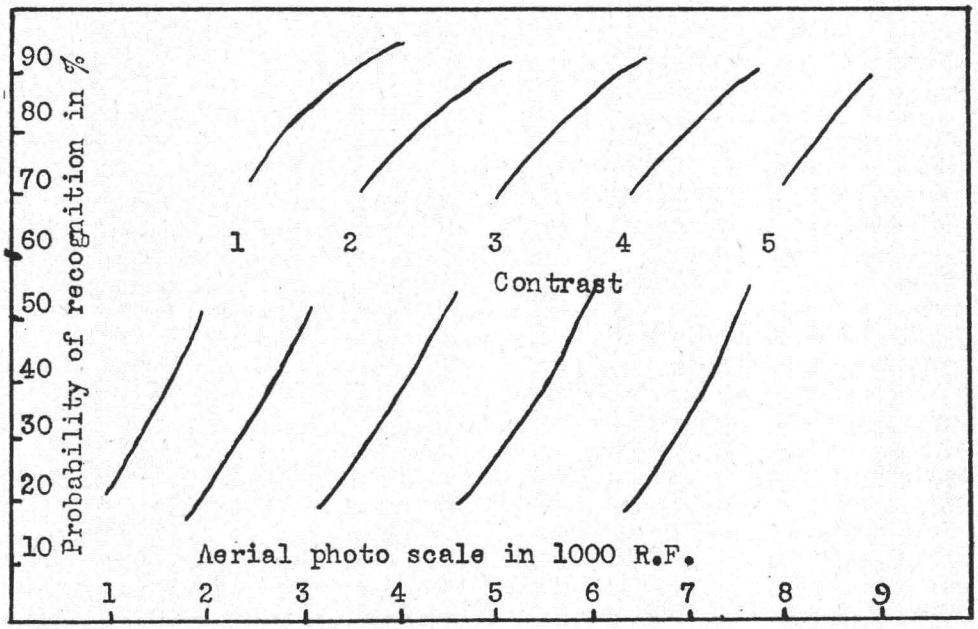

FIG. 1. The assumed probability of recognition as a function of contrast and photo scale at assumed values for difference in parallax, degree of image exposure, resolution of photo system, ability of photo interpreter and type of viewing equipment.

of an image can be readily determined. Charts, tables, figures or diagrams may be used to show such an arrangement. An example with assumed values will illustrate the objective.

If it be assumed that viewing equipment has a value of *5*, ability of interpreter *8*, degree of exposure *60*, resolution of photo system *20*, and difference in parallax .020 of an inch for 20 foot difference in elevation then the probability of recognition of the photo image may be estimated for various photo scales and contrasts (Figure 1). Similar figures are anticipated for other combinations of the above factors.

To carry out the suggested method, two studies are needed: first, an evaluation of the seven factors is essential and this should be based on the probability of recognition of an image: second; studies directed at firming up the control of factors are needed.

The evaluation of factors should be directed toward investigating the relation of assumed values given in Table 1.

The standards discussed for the control of factors apply to this section.

The scale of aerial photography necessary to assure recognition of an object is not established. Within the range of 1:1,000 and 1:20,000 representative fractions, it is suggested that certain scales in particular be investigated (Table 1).

The parallax difference for the image on aerial photos definitely aids in the recognition. But as the values of parallax differ-

TABLE 1

ASSUMED VALUES INVESTIGATED FOR SEVEN FACTORS

Scale, RF	Difference in Parallax, Inches	Exposure, %	Contrast, MV Diff.	Resolution in Lines/mm.	Ability of Interpreter	Viewing Equipment
1,000	.003	25	1	5	1	1
5,000	.017	50	3	25	3	3
20,000	.030	75	5	50	7	7

ence for assuring recognition are not established, it is suggested that certain of such values be investigated (Table 1).

Per cent of exposure, contrast, resolution, ability of interpreter and viewing equipment are not satisfactorily controlled. Further studies will probably be needed to establish a control. Their importance will be indicated from the evaluation of factors investigation.

PER CENT EXPOSURE OF OBJECT

Exposure if found important will require a technical study to determine the per cent of exposure for the various conditions existing in one location of the object. This object may be in dense, partly open or open forest lands, hay or grain fields, pasture lands, cut grain or cultivated fields or urban areas. Also the season of the year may have a great effect. Because of the difference in appearance of the object for these various situations, an estimate is needed of the degree of exposure for each one. When shadows are clear, they should be considered in estimating the degree of exposure. Also the relative influence of parallax should be given weight. Table 2 may serve as a guide.

TABLE 2

PER CENT EXPOSURE OF ASSUMED OBJECT BY COVER

COVER	PER CENT EXPOSURE
Forest	
Dense, 70% crown closure	0
Partly open, 30–70% crown closure	10
Open, 0–30% crown closure	20
Fields	
Hay and grain	60
Pasture, cut grain and cultivated fields	100
Urban areas	
Open streets	90

CONTRAST OF PHOTO IMAGE

If contrast is important, research is required to establish control of contrast on aerial photos. Because of the many factors affecting this contrast such a study is very complex. These factors include negative materials, positive materials, photo equipment, techniques, and light conditions. The purpose of the proposed study is to learn the combination of these factors that will furnish optimum contrast for the recognition of the assumed object.

Tests should be made for the various negative materials which would include orthochromatic, panchromatic, infrared, color and camouflage detection films. Tests should also be made of positive materials which include matte, semi-matte, glossy, ferrotype, five contrasts of paper, black and white transparencies and color transparencies. The photo equipment tested should include glass filters which should be of the same optical quality as the camera lens.

The techniques tested should cover various exposure times of the negative materials, printing exposure of positive materials, and the processing of negative materials. The light conditions should include light reflectance characteristics of background areas, light reflectance of the object, sun's altitude and atmospheric conditions. The season of the year will affect the sun's altitude and the reflectance characteristics and hence should also be included in one study.

RESOLUTION OF THE PHOTO SYSTEM

If resolution of the photo system is found to be important, ways and means should be investigated to improve this resolution under field conditions.

Resolution of the photo system is now being studied at various research institutions such as Eastman Kodak Company, Wright Field Air Development Center, Optical Research Laboratories of Boston University, Navy Photo Interpretation Center, U. S. Geological Survey, U. S. Coast and Geological Survey and Army Engineer Research and Development Laboratories. All of these institutions are engaged in various phases of research. Some of these studies may be irrelevant to photo interpretation; others may be of great significance.

Most of the above-mentioned studies are not aimed at solving the problems of the foresters. While undertaken for other purposes, some may be pertinent to the forester's research problems. Accordingly thorough investigation of all such research is needed to evaluate its importance to photo interpretation. Such an analysis will re-

sult in an excellent opportunity for listing further resolution research requirements for photo interpretation of an assumed object.

ABILITY OF INTERPRETER

The ability of the photo interpreter depends on several factors. These are initiative, mentality, visual acuity, education, training and experience. Photo interpreters should be carefully selected. Otherwise the result will be poor caliber of the working personnel.

Studies are needed to show the relationship of these factors to photo interpretation. Some factors are doubtless more important than others, and this should be considered when making ratings. These ratings should be from 1 to 10 with the higher number indicating the better photo interpreter. The following ratings in Table 3 may indicate the pattern that a study should produce.

TABLE 3

RATING OF PHOTO INTERPRETERS

Rating	Qualifications
1	High school graduate, no experience, no formal training, poor visual acuity, no experience and little initiative.
3	High school graduate, some experience, photo interpretation training from short courses, fair visual acuity, and good initiative.
5	College graduate, photo interpretation training from short courses, no experience, good visual acuity and fair initiative.
7	College graduate, formal training in photogrammetry, several years experience in photo interpretation, good visual acuity and good initiative.
10	College graduate, some graduate work in photogrammetry, many years' experience, excellent visual acuity and excellent initiative.

VIEWING EQUIPMENT

A scheme is needed for classifying viewing equipment that may be used in photo interpretation. Studies should be conducted for testing equipment in order to rate such equipment for such use. Some of the factors to be considered in such a rating are magnification, portability, fatigue, manipulation, orientation, lighting and accessories.

These factors should be studied to show their relation to photo interpretation. Some will be more important than others, and this should be considered when establishing a rating of viewing equipment. Ratings should be from 1 to 10 with the higher number indicating the better viewing equipment for a given purpose. The ratings in Table 4 may indicate a pattern that such a study would produce.

TABLE 4

RATING OF VIEWING EQUIPMENT

Rating for Photo Interpretation	Qualities of Viewing Equipment
1	Simple direct vision lens. Stereoscope, low magnification, very portable, high fatique, fair orientation, no lighting, no accessories.
3	Mirror stereoscope, low magnification, fair portability, high fatigue, fair orientation, no lighting, no accessories.
5	Simple direct vision lens stereoscope, high magnification, low fatigue, very portable, fair orientation, fair lighting and no accessories.
7	Mirror stereoscope, high magnification, fair manipulation, low fatigue, good portability, excellent orientation, fair lighting and few accessories.
10	Mirror stereoscope, excellent magnification, excellent manipulation, excellent orientation, very portable, good lighting, excellent accessories.

SUMMARY

What is proposed in this paper is a systematic approach to the study of problems in photo interpretation. Such study would include problem analysis, preparation of work plans for research and actual conduct of further research in fields of aerial photo interpretation.

If the studies suggested by the outline had been completed the forester could have been given information with assurance that the "photo specs" would be adequate and satisfactory for recognizing

spruce trees and fir trees on aerial photos. The author would have been confident in the recommendation because it was based upon a scientific study of the facts and free from personal bias.

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PHOTOGRAMMETRY FOR PRACTICING FORESTERS AND WOODLAND MANAGERS

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ABSTRACT

Most programs in photogrammetric education have been prepared to meet the specific needs of the engineer or professional map maker. However, the professional forester and forest land manager likewise need information on photogrammetric techniques applicable to their specific profession. Thoughtful consideration has been given to the organization and presentation of a short course in Forest Photogrammetry, and a basic program to satisfy this deficiency in photogrammetric education is proposed.

PHOTOGRAMMETRY in the field of forestry education has found considerable favor during the past decade, and most forestry schools are presently offering elective undergraduate and graduate courses of instruction in this relatively new science. However, this training has been somewhat ineffectual in the field of practical forestry for several reasons. The educational institutions have restricted registration in such courses or have included the topic as an adjunct to a course in surveying, because of limited equipment, available space, inadequate instructional staff, and curtailed budgets. Students who have secured more than an introduction to the theory and practice in the science of photogrammetry have been able to secure better compensation with engineering and mapping agencies than in forestry positions. Foresters and forest using industries have labored under the impression that the use of aerial photographs or photogrammetric techniques is much too expensive to show economic justification in average forest management problems.

Admittedly, few forest operators, particularly the smaller organizations, can economically justify the employment of a thoroughly trained photogrammetrist for his ability in this field alone, and are equally dubious concerning the economic feasibility of negotiating contracts with aerial mapping concerns for photo coverage of scattered holdings. Some of these operators are aware that definite benefits are available through the efficient use of the aerial photograph, and encourage certain members of their present forestry personnel to acquaint themselves with the techniques involved in using this pictorial encyclopedia of information. Other forest land managers, realizing a potential value in the aerial photograph but being uninformed of its limitations, have become discouraged and even hostile, because the photograph was not a "cure all" for his forest management problems, or accuracies developed were far beyond his needs, thus rendering their use entirely uneconomical.

These foresters and woodland managers need guidance as they master the profitable techniques, realize potentials and limitations of using aerial photographs, and evaluate the data drawn from them. This seems to indicate that the establishment of short, practical courses of study, geared to the practicing forester and woodland manager, and presented by institutions for forestry education, is desirable.

A few forestry schools have already in-