Report on

Films and Filters in Forestry Aerial Photography

Submitted to

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Introduction

This report is written about films and filters as used in aerial photography for forestry purposes. The author knew very little about this subject prior to this writing. Therefore, the purpose of this report is to better acquaint the author with some one subject of aerial photography.

The information herein was obtained from a series of notes taken while reading the literature written on this subject as listed on the bibliography page. The report will cover general information on some of the uses, advantages, and disadvantages of each of the more widely used types of films and filters, as well as some background material for each main topic.

Summary

The success or failure of any aerial photography project may well hinge on the right choice of film and filter combination. This decision is made by the contractor in order to produce photographs that will provide the information the forester needs.

Filters, which are commonly made of colored glass, must be used to eliminate the effects of the ever-present atmospheric haze and to accentuate certain features of the terrain in the finished photographs. There are six filters which are the most widely used and each has its own particular characteristics. Many factors must be taken into consideration before the correct filter is chosen for a project.

The human eye is sensitive to a range of light waves from 400 to 700 millimicrons called the visible light spectrum. Plants, rocks and each object on the ground are photographed by reflecting light waves of their particular color and these waves produce a certain tone on the film. Panchromatic, infrared, and color film are the three types that are currently being used for aerial photography. Panchromatic registers in shades of black and white, the same light waves that the human eye sees. Infrared film is sensitive to infrared light, which humans cannot see, and therefore, it produces photographs which show objects in a different manner than we see them. Color film, although very expensive, is of particular importance because it produces photographs in color, as they are naturally seen.

Importance of Film and Filter Combinations

When aerial photographs are used in forestry, they are usually used for a specific purpose which is predetermined by the forester. This specification is included in the agreement with the contractor and the pictures must provide the desired information.

All the equipment is the same for each project, except for one variable--the correct film and filter combination. The contractor, after considering the forester's needs, decides which film and filter will be used. Upon this decision lies not only the success or failure of the project, but also the chance of losing a considerable amount of time and money by both the forester's company and the contractor himself.

Filters

In all aerial photography, filters are used to eliminate the effects of atmospheric haze, which is more or less present at all times, or to increase the contrast of certain desired features of the terrain. A filter may be thought of as a colored plate which transmits certain portions of the light spectrum and absorbs the remainder. In general, it maybe said that a filter transmits light of its own color. Filters made of colored glass are considered the best to use for accurate work. (1)

Atmospheric haze, which does not include fog or smoke, consists of dust, water vapor, and to some extent the air itself. It is almost universally present as an atmospheric condition and becomes more pronounced as the altitude is increased. As the light rays from the sun pass through the atmosphere to the earth, haze has the property of scattering portions of the light spectrum, which have a certain wave length. For photographic purposes, it is convenient to subdivide the light spectrum into the following five regions: ultra-violet, blue, green, red, and infrared. Ultra-violet and blue light are scattered by haze more than the other three groups are; consequently, the deeper the color of the filter, the greater is its ability to offset the effects of atmospheric haze. (2)

The type of filter chosen for any particular job depends upon several items; such as, flying height, density of the atmospheric haze, type of film used, the portrayal of tones desired, and character of the terrain. (1) With these points in mind and considering the properties of the various filters, it

is possible to select the one which will give those portions of the light spectrum which are best suited for each type of work.

There are six types of filters which stand out as the ones which are most frequently used. Light yellow, which absorbs ultra-violet and some blue, is used to penetrate slight haze, or at low altitudes where very short exposure is required to overcome rapid motion of the plane relative to the ground. Medium yellow, which absorbs ultra-violet and most of the blue, is used for greater haze penetration than light yellow, where slightly longer exposure can be tolerated as from higher altitudes. Dark yellow (minus-blue), which abosrbs ultra-violet and practically all of the blue rays, is used for maximum haze penetration. (2) The more blue light the yellow filters cut out, the better the haze pentration, but the longer the film must be exposed, the wider the lens must be open. Green filters absorb red and blue light and intensify the green light. The use of green filters increases the forestry value of aerial photographs. (7) Medium red filters absord ultra-violet, blue and green rays. They are used for haze penetration and minimize contrasts between different types of vegetation. Deep red filters abosrb ultra-violet, blue, green, and practially all visible red and are used for extra haze penetration with infra-red-sensitive film.

A number of experiments were carried on by Spurr using all the various filters. In no case were adequate pictures obtained without the use of a filter. (9)

Film

Aerial photographs are concurrently being taken with three types of film, which are panchromatic, infrared, and color. It is of utmost importance that the right type of film be used in order to obtain the desired results because each has its own characteristics.

The visible light spectrum is a range of light waves between 400 and 700 millimicrons which are sensitive to the human eye. The ultra-violet radiation, which has the longest wave length, are just outside the visible spectrum, at either end. (7)

Foresters are primarily interested in the plant cover as shown on aerial photographs. Vegetation is photographed by relfected light from the trunks, branches, and especially from the leaves. Leaves have an epidermis and in addition, some have hairs or waxy coatings. This condition reduces the amount of radiation that enters the leaf either by reflection or by absorption. The amount of light reflected from a leaf depends upon the texture, age, vigor, species, tissues of the leaf and the geographical location. (6) Also the amount of light reflected will vary with different groups of trees. Trees which have large shiny leaves and reflect more light, will appear lighter on the photograph than those trees with small dull leaves. Trees have a different brightness according to height and age. A young stand of a given species shows up lighter than an old stand. (6) Also changes in foliage color from spring to fall will vary the tone on the photograph. (7)

Panchromatic Film

Panchromatic film was first introduced in 1930 and was

improved on until now it is probably the most widely used for aerial photography. Aerial panchromatic is sensitive to red, green and blue radiation and registers very nearly the same part of the light spectrum that the human eye sees, except in tones of black and white. It is particularly sensitive to red, which permits short exposures for the long, penetrating, red wave lengths at high altitudes.

The ideal in photograph recognition is to make the object to be identified as visible as possible. With panchromatic film, filters make it possible to increase or decrease the tone of the object until it appears the same as seen by the naked eye. (6) Panchromatic film with a dark yellow filter shows detail, tree heights, and timber density well, but is limited in that it brings out only the obvious timber type boundaries. However, panchromatic with a dark yellow filter has a slight advantage over panchromatic green for total tree and shrub contrast. (5) For panchromatic film, the larger the scale of the photographs, the more the details can be resloved, which, of course, is an advantage in plant identification.

Spurr has given three distinct uses for aerial panchromatic photography:

1. For fall photography after the foliage of the deciduous trees has changed color, but before the leaves have fallen, which is a time when better tonal contrasts between species and types are obtained.

2. For photography when deciduous trees are leafless.

3. For photography where broadleaf trees are of very limited aerial importance, as in many parts of the West. (9)

Infrared Film

In the early 1930's infrared film was developed; however, it was not until 1942 that it was perfected to the point where it could be used for aerial photography.

Infrared film has several important differences from the other types of film. The chief difference is that it is sensitive to infrared waves which are not visible to humans so that one cannot say by inspection how a given object will show up on an infrared photograph. Another difference is that chlorophyll of plant leaves does not reflect or absorb infrared light. Instead, it is the leaf tissues that reflect the light.

There are two major divisions that infrared makes in vegetation types. Conifers register in black or dark gray tones and the non-confiers in white or very light tones. The older stands appear darker due the more irregular crowns which absorb more infrared light than do the smooth crowns of the younger stands. (8)

The infrared minus-blue or modified infrared, generally gives the best results for vegetation. The constrasts are softened so that the deciduous leaves show a slightly darker tone and the conifers display tones of dark gray instead of black.

Infrared film will give good information on forest types and the location of boundaries between them. This characteristic makes infrared photographs particularly desirable for forest inventory work.

The angle of elevation of the sun affects the tone of foliage on infrared photographs by influencing the amount of reflection.

Spurr believes that as one goes from north to south the spectral qualities of solar radiation change to the shorter wave lengths which reach the ground because of the higher angle of elevation. (9) For this reason, the tonal contrast in infrared photography seems to be greater in the fall than early summer. The changes in the reflecting properties of the foliage as the season progresses, influence the tonal contrast too; however, it is not as important as the angle of elevation.

Infrared photography has proven to be better suited to smaller scales, other factors being equal. One reason for this is that shadows register black on infrared photographs and some information is lost. However, on the smaller scale this disadvantage is minimized.

On infrared photographs, water registers black because it absorbs infrared light. This is an advantage in looking at shore lines, rivers and streams. It is particularly useful in agriculture for evaluating soil moisture content. (7)

Infrared film seems to have the best haze-penetrating ability of any of the film used for aerial photography. In considering the visibility of objects, the effectual light is that reflected by the object. Plants, soils and other objects do not emit their own light, but instead they reflect it through the haze to the camera. Infrared light can penetrate a thin haze. If the haze is so dense that the visual range is less than one-third of a mile, no satisfactory results can be expected beyond that limit with infrared film and for that matter, with any film. (8)

Color Film

Color film was first used in 1935 in the motion picture industry, but was not used for aerial photography until World War II. (7) It is probably the least used for aerial photography, and there is still much research and experimental work being with it.

Perhaps the greatest advantage of color photography is that it tends to record vegetation as it naturally appears. This is particularly invaluable to both the layman and the expert as it clearly indicates the changes or forest types that would otherwise not be noticed.

Color film is not difficult to use but there are a few rigid requirements; proper exposure and filtering are perhaps most critical as the latitude of color film is not as great as that of other film.

There are several uses of color film where it has proven quite valuable. The military personnel know that it is well-adapted for camouflage detection and in depth-of-water studies. (1) In examining color photographs, the use of filters which transmit only long wave lengths may increase tonal contrast between water and vegetation. This aids in recognizing swamp areas by trees. With the use of filter, the detection of insect-infested trees in green timber or the mapping of uniquely colored soils may be facilitated. (3)

On the other hand, until more advances are made with color film, the disadvantages greatly limit its use. In the first place, color film is about five times more expensive than black

and white or infrared. Too much time is required to develop color film and each print costs approximately $8.00. (10)

The problem of haze is greater in color photography than for black and white. It can partially be corrected by using the specific filter recommended for each roll of film. Weather limitations are great, and the chances of satisfactory results are never too good. (6) Stereoscopic study of color photographs requires special viewing equipment. Experience indicates that over a period of several year, color in the photographs fades to an appreciable extent. (10)

As with any new product produced, it takes awhile to work the "bugs" out of it. Color photography is steadily being improved and undoubtedly will play a more important role in aerial photography in the near future.

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