1972

Application of Remote Sensing Techniques for Analysis of Desert Biome Validation Studies

Paul T. Tueller

Garwin Lorain

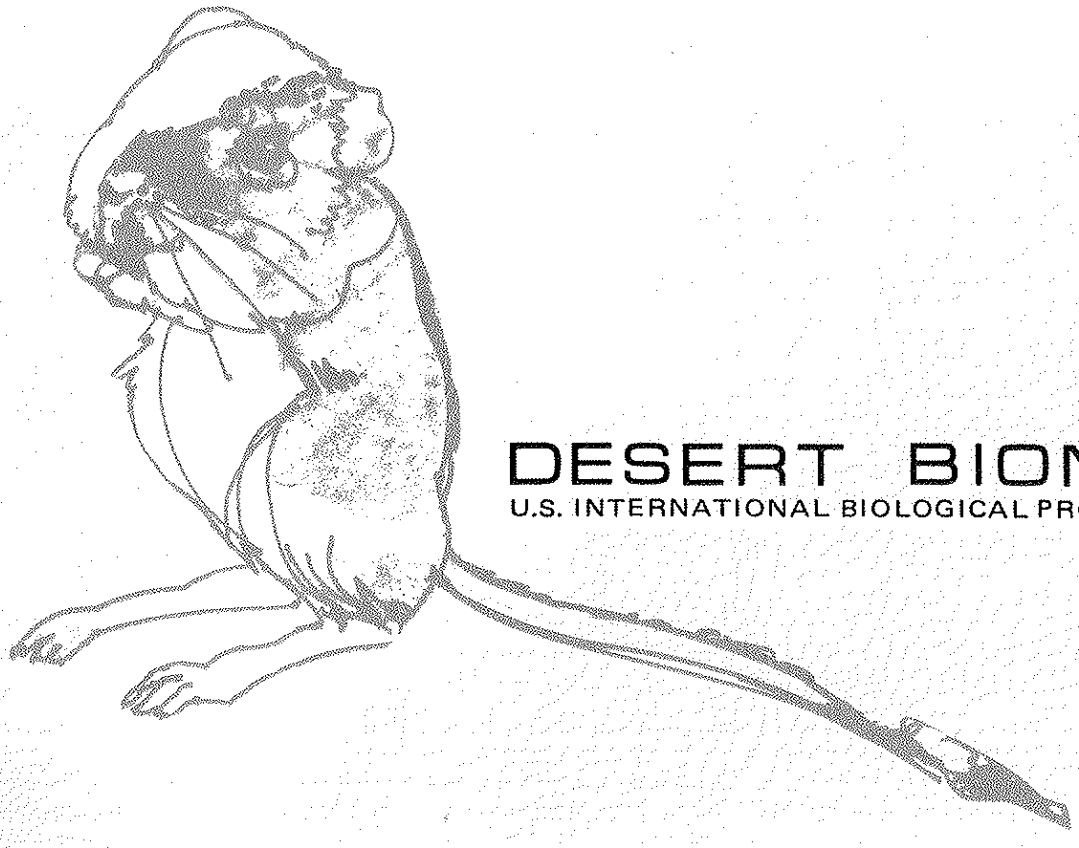
IBP

RESEARCH MEMORANDUM

RM 72-7

APPLICATION OF REMOTE SENSING TECHNIQUES FOR ANALYSIS OF DESERT BIOME VALIDATION STUDIES

Paul T. Tueller
&
Garwin Lorain



DESERT BIOME
U.S. INTERNATIONAL BIOLOGICAL PROGRAM

1971 PROGRESS REPORT

APPLICATION OF REMOTE SENSING TECHNIQUES FOR ANALYSIS OF DESERT BIOME VALIDATION STUDIES

Paul T. Tueller
and
Garwin Lorain

Renewable Resources Center
University of Nevada

Reno, Nevada

MARCH 1972

ABSTRACT

Aerial photographs of Desert Biome validation sites were taken in 1971 to assist site Coordinators with the measurement and evaluation of a variety of ecological parameters. Colour, infrared stereo transparencies were obtained with a 70 mm Hulcher rapid sequence camera attached to a single engine aircraft at scales ranging from 1:600 to 1:21,000. Missions over the sites were run in June at Rock Valley, during June and October at Curlew Valley, and in late August at the Jornada and Silver Bell sites. At least two scales of photographs were obtained at each site; the larger scales being intended to provide information on species number, distribution of species and soil surface characteristics, the small scales being useful for depicting plant community distribution and defining topographic features. A degree of ground truth was established for the Silver Bell and Jornada sites, while at the Rock Valley and Curlew Valley sites the interpretation was left to competent personnel with the offer of assistance as required. By means of the photographs, it was possible to separate communities, make reasonably accurate identification of species, measure vegetation cover by species and community, determine species density and distribution, and obtain considerable information on relief features such as gullies and washes. Since live vegetation appears in shades of red on film recording infrared refectance, dead plants could be distinguished as a separate class.

INTRODUCTION

Large scale aerial photographs have been shown to be an effective tool for the measurement and evaluation of a variety of ecological parameters in desert shrub ecosystems. These ecosystems, because of their generally large interspaces and relatively few species, lend themselves to rapid study by non-destructive photographic remote sensing techniques. Large scale (1:600-1:5,000) color infrared photography has been obtained for use on all active validation sites.

OBJECTIVES

1. To provide color infrared stereo transparencies of the Jornada, Silver Bell and Rock Valley validation sites at scales of 1:5,000 and 1:1,600.

2. To provide color infrared stereo transparencies of the Curlew Valley validation site at a scale of 1:2,133. At a later date, provide color infrared 1:600 scale transects, some additional coverage at 1:2,133 scale, provide complete coverage of the two intensive study sites at 1:15,000 scale in color infrared and completely cover both sites with color negative film at 1:21,000.

3. To provide advice and technical assistance on the use of large scale aerial photography to validation site Coordinators.

4. To begin the correlation of photo data with ground truth data on validation sites and to begin the development of interpretive keys.

These objectives differ somewhat from the original and reflect the involvement of validation site Coordinators with photographic remote sensing techniques.

METHODS

All photographs were taken from a single engine aircraft equipped with an 18-inch camera hatch. The camera used was a 70 mm Hulcher rapid sequence camera capable of being exposed singly, at five frames per second, ten frames per second, or pulsed at a given framerate with an external intervalometer. The 1:21,000 scale photographs at Curlew Valley were taken with a Komura 2-inch focal length lens while the remainder of the photographs were taken with a Schneidar-Xenator 6-inch lens.

The two films used were color infrared and color negative and cost about $0.50 per foot. Color infrared type 2443 (Kodak) is a false color film sensitive to the green, red and near infrared portions of the electromagnetic spectrum. These layers are also sensitive to blue light which is filtered out with a Wratten #12 filter. Soil, rocks and litter appear in shades of blue and green on film representing the green and red visible portions of the spectrum. Live vegetation appears in shades of red on film representing their near infrared reflectance. Color infrared film is processed to a positive transparency.

Color negative film type 2445 is processed to a negative, making it useful for either color or black and white prints. This film duplicates the visible portion of the electromagnetic spectrum by recording subjects on film sensitive to the blue, green and red visible wavelengths.

Both films have been processed by Rapid Color, Inc. of Glendale, California, at an approximate cost of $0.50 per foot. A quality control monitoring system is employed on their Kodak Versamat Processor which guarantees less than 0.50% color shift. The Versamat is reported to be the finest film processor available in the United States today. After processing, copies of the film were shipped to the site Coordinators. Offers were made to assist in photo interpretation and analysis.

All photographs were obtained with stereo overlap for three-dimensional viewing. this was accomplished with a single camera by coordinating the aircraft speed, it's height above the terrain and the interval at which the photographs were exposed. The height of the aircraft above the terrain, along with the focal length of the lens, are the determining factors for photographic scale and ground coverage per frame. Using the 6-inch focal length lens and flying 300 feet above the terrain gives a scale of 1:600. The linear ground coverages for given scales are presented in Table 1.

Table 1. Photographic scales used on Desert Biome IBP Validation Sites and the linear coverage per frame.

1:600	112-feet
1:1,600	300-feet
1:2,133	400-feet
1:5,000	937-feet
1:21,000	3,937-feet

FINDINGS

Photographic data were obtained in June at Rock Valley and Curlew Valley, and in August at Jornada and Silver Bell (Table 2). A second photographic mission was flown over the Curlew Valley site in October. Approximately 3,725 frames were obtained, mostly in color infrared (Table 2).

Table 2. Mission summary data for validation sites.

Site:	Rock Valley	Curlew Valley	Jornada	Silver Bell
Date: (1971)	June 3	1. June 8 2. Oct. 12	Aug. 24	Aug. 26
Film Types:	Color Infrared	1. Color infrared 2. Color negative	Color Infrared	Color Infrared
Approx. Amount of Film Used:	120 feet	430 feet	150 feet	150 feet
No. of frames:	600	2,150	815	670
Time of Day:	10:15 am 12:00 pm	9:30 am 1:40 pm	10:00 am 11:30 am	9:00 am 10:30 am
Weather:	Clear, some clouds over last 3 transects	Mostly clear	Perfectly clear	Few thin clouds
Lens (inch):	6	1. 6 2. 2	6	6

Scales varied from 1:600 to 1:21,000 depending upon the anticipated needs of site Coordinators. At least two scales were obtained at each site and the larger scales were used to subsample the validation study areas (Table 3). The larger scales provide information on species number, distribution and soil surface characteristics. The smaller scales were useful for depicting plant community distribution, defining drainage systems, landforms and larger features.

Table 3. Actual scales and photographic coverages obtained on each of the Desert Biome validation sites.

Site	Approximate Scale	Type of Coverage
Curlew Valley June 8, 1971	1:2,133	Complete coverage of 4 square kilometers
Curlew Valley October 12, 1971	1:600	.2% of 4 square kilometers
	1:2,133	Edges of 4 square kilometers area
	1:15,000	Complete coverage of 4 square kilometers
	1:21,000	Complete coverage of 4 square kilometers
Silver Bell	1:5,000	Complete coverage of 2.56 square kilometers
	1:1,600	Complete coverage of 0.56 square kilometers
Jornada	1:5,000	Complete coverage of 0.61 square kilometers
	1:1,600	95% coverage of 0.61 square kilometers
	1:1,000	2.8% coverage of 0.61 square kilometers
Rock Valley	1:5,000	Complete coverage of 0.96 square kilometers
	1:1,600	Complete coverage of 0.5 square kilometers

Copies were made of the Silver Bell and Jornada photography to produce a map provided to site Coordinators showing the location of each of the transects. Ground markers at the Jornada site allowed calculation of the exact scales of each of the transects and these were also given to the site Coordinator.

Several days were spent both at the Silver Bell and Jornada validation sites with photographs in hand. The purpose was to determine if plant communities could be delineated on small-scale photographs, whether individual species could be identified and measured on larger scale photos, and if drainage courses and erosion features could be studied.

Field trips were not made for ground truth or for any other purposes to the Rock Valley and Curlew Valley sites. Dr. Neil West, who is familiar with large scale photo interpretation, is assisting on the Curlew Valley site. Dr. Sam Bamberg, also familiar with photographic remote sensing techniques, is assisting at Rock Valley. Our assistance was generally requested, but no photographs were returned for interpretation or other help. It was felt that there was less familiarity with large scale photo interpretation by workers at the Silver Bell and Jornada validation sites. We are using our copies to suggest possible uses for the photographic data at these sites.

At the Silver Bell site, two communities were easily distinguished on the 1:5,000 scale photographs -- the plant community found strictly on the upland sites a few feet higher than the washes and a second community adhering strictly to the washes. Two size classes of washes were detected exhibiting somewhat different species composition. Using the 1:1,600 scale photography, most of the species in the upland community could be identified with a reasonable degree of accuracy. Species identification in the small washes was also good, but the large washes became so complex that only certain species could be identified with success. Total vegetation cover, however, can be obtained, as well as cover by shrub size class.

The playa and adjacent areas at the Jornada Experimental Range were broken into five recognizable plant communities on the 1:5,000 scale photographs. On the 1:1,600 and 1:1,000 scale photos, considerable information on species composition and distribution was attainable. On the upland bajada site at the Jornada range, two communities were apparent on the 1:5,000 scale photos. These were the upland areas dominated almost exclusively by creosote bush *(Larrea divaricata)* and the much more complex community following the major arroyo. Using the 1:1,600 and 1:1,000 scale photographs, most of the major components of the arroyo community could be differentiated.

Species identification is a necessary first step before other community parameters can be assessed photographically. After certain species have been identified, known techniques can be employed to ascertain their ground cover and density. In the case of the desert biome, however, determination of biomass production is a major objective. Discussions with site personnel have indicated that cutting and weighing of vegetation is a time-consuming endeavor and that only a limited amount of this data can be collected. A seemingly logical approach to this problem is to use the limited information gathered on the ground and extrapolate this to the community-at-large through use of the large-scale photographs. Characteristics such as height, ground cover and foliage density can all be obtained from large-scale aerial photographs such as the 1:1,600 scale currently available. Color infrared is useful for differentiating the live portion of the crown as well as being very useful for estimating the density of the live foliage.

At Silver Bell, four-wheel drive vehicles are being driven over a selected area to assess the damage caused by them. The photographs taken in the summer of 1971 were obtained prior to this treatment. In 1972, subsequent photos, especially infrared, would yield invaluable information on the reduction of plant cover from this activity. Plants that are destroyed or damaged immediately lose some or all of their infrared reflectance which allows them to be easily detected on infrared film. The actual number of damaged plants can be easily counted and the number and extent of actual vehicle tracks can easily be quantified.

Considerable information on erosion features is apparent on the photos. Depth, width and possible volume of lost sediment for larger arroyos can be measured. Active erosion can be differentiated from relatively stable areas. Accumulation of sand is apparent around the plant bases of certain species.