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Period: January 16, 1975 - March 15, 1975

INVENTORY OF FOREST AND RANGELAND RESOURCES, INCLUDING FOREST STRESS

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Principal Investigator: Robert C. Aldrich

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A. Overall Status

1. Manitou, Colorado-range inventory site (161313)

The SL-3 S190B photographs taken August 4, 1973, were used to update a cultural feature inventory of part of the Manitou site. The latest USGS Quadrangle (1956) was used as base reference material. Features to be interpreted were paved highways, gravel roads, jeep trails, (unplanned meandering roads with no specific roadbed construction), utility corridors, buildings, mines (primarily open pit), cemeteries, and windmill sites. Those features easily identifiable in the S190B photographs under 7-30x magnification were paved highways and gravel roads. Small segments of gravel roads that passed through and under tree canopies or across treeless areas could not be differentiated due to lack of scene contrast in open areas. Utility corridors through the forest and newly constructed (within 10 years) corridors in the grasslands were identifiable. Kind of corridor could not be determined from the Skylab material. Earth excavation activities including underground mining (refuse dumps), open quarries, and sand and gravel pits are identifiable as a group but not as a specific activity. Buildings are visible but the kind, except large industrial facilities, could not be differentiated. Cemeteries could not be differentiated in the S190B photographs even though they were located in treeless areas and grassland vegetation was dissimilar inside and outside the cemetery areas. Jeep trails and windmill sites were not identifiable in the S190B photographs.

All data analysis of visual photo interpretation tests has been completed. These tests were for plant community classification to the Regional (Level I) and Series (Level II) categories. Tables of commission errors have been completed and the results of the analysis are being summarized.

Ground-truth maps of plant communities to the Regional and Series levels have been completed and their relationships to interpretations from the SL-2 and SL-3 photographic products are proceeding.

2. Augusta, Georgia-forest inventory site (177512)

Positive color transparencies of S190B imagery for SL-3, Pass 36 (Sept. 12, 1973) have been reordered. S190A positive transparencies (SL-4, Pass 54-Nov. 30, 1973) have been received, but they are not usable for analytical purposes because the films were exposed without filters.¹ Our Technical Monitor, Clayton Forbes, is checking out S190A imagery for Pass 85 (Roll 70, frames 168 & 169) taken on January 18, 1974, as a possible substitute for the Pass 54 imagery.

a. Photo interpretation of forest and other land use:

The interpretation/mapping of two 10,000-meter sample blocks has been completed. Corrections based on ground data collected during the December field trip were included in the final maps. Also, after comparing the enlarged photos used in the field with the 1:120,000 color infrared transparencies, it appeared that Level III forest classes could be further mapped by stand size. This delineation was done on five 1,000-meter grid blocks selected at random within each of the sample blocks. The stand size was determined by a combination of crown closures, crown size, amount of bare ground, and the arrangement of vegetation on the photographs. Stand sizes were seedlings and saplings, pole timber, and sawtimber. Each 1,000-meter grid block took an average of 15 minutes to set up on the zoom transfer scope, interpret the land-use classes, and delineate the boundaries. The total time to complete the task was approximately 25 hours per map.

Overlays have been prepared and reproduced for the four counties within the test site. County boundary lines, 10,000-meter UTM coordinate intersections, and ground control points are included in the overlays to correlate with both Skylab and ERTS data products. The overlays have been reproduced at 1:250,000 and 1:500,000 scales as aids for human and microdensitometer classification portions of the study.

All S190A data has been combined on the International Imaging Systems (I²S) combiner and color internegatives made for producing color transparencies and color prints. To meet the requirements of our contract we have reproduced color transparencies of all

¹Skylab Program-L. B. Johnson Space Center. Sensor Performance Report. Vol. 1 (S190A) (Engineering Baseline, SL2, SL3, and SL4 Evaluation). Sept. 6, 1974. (p. 3-6d).

Skylab products received to date at 1:250,000 and 1:500,000 scales. All products have been made to match map overlays using established ground control.

b. Sampling designs for forest stratification and forest area estimates:

A map of pine, hardwood, nonforest, and water (Level I and II) has been completed for McDuffie County. The map was made by interpretation of 1:120,000 scale CIR photography from RB-57 Mission 274. A matrix of approximately 132,000 points within the map is being digitized for computer handling of the classification data. A dot grid representing 1.24 acres per point has been placed over the map. Each point is classified according to its mapped land-use type. The location of each point is known by row number in the matrix and position in the data string along that line. Data are then recorded directly on magnetic tape through a keyboard. The area of each of the land-use types will be determined from enumeration of this data. The data matrix generated from the map can then be sampled as would the real surface area represented by the data.

c. Microdensitometer classification and mapping of forest and nonforest land use:

In preparation for producing color-coded, digitized, computer-generated forest and related land-use maps, the following has been accomplished:

(1) Algorithms for analyzing digitized photographic data, developed during the ERTS-1 program, have been updated and integrated into a new system to analyze the microdensitometer data.

(2) Digitized microdensitometer data obtained from Skylab S1908 color transparencies, representing a 10,000-meter-square area near Augusta, Georgia, have been partially analyzed using the above algorithms. A histogram and a frequency distribution of the optical densities for each of four filters and one aperture (one complete block scan) have been produced. Optical densities representing cut-off points dividing each frequency distribution into eight equal segments were selected. A computer gray-scale map has been produced using eight print characters to replace the corresponding optical densities. This has been done for one filter aperture combination.

(3) Procedures relating to the processing of film transparencies and their sensitometric data are being continually updated and documented as experience dictates.

d. Reflectance measurements for correction of Skylab photographic data:

Ground radiance and solar irradiance data for the January 1974 flights were digitized and preprocessed by computer. Corrections for radiometer zero-offset were made and the ratios of radiance to irradiance were found on a point-by-point basis. There were slight variations in solar irradiance along the flight line due to a light and variable cirrus overcast. The ratio represents (within a factor of π) the terrain reflectance. Mean reflectance values were found for 13 areas or image blocks which looked to be relatively homogeneous on the S190A photos.

The general area under study as portrayed by the yellow-green band (Station 6) was scanned on a microdensitometer. The measuring intervals and effective apertures were 8, 16, and 32 micrometers. The least of these distances represents about 23 meters on the ground, which was the approximate sampling interval used in the digitization of the reflectance data stream.

The previously mentioned image blocks were found in the microdensity data matrix, and mean values were computed. Conversions to diffuse density and film exposure were performed. The absolute exposure scale (E) was converted to broadband radiance (N) in engineering units by the equation:

$$N = \frac{4F^2}{\pi t T} E, \text{ where}$$

F = camera lens f-number

t = integrated exposure time

T = total transmittance of camera lens, filter, and window

The distribution of satellite radiance values correlated linearly to the reflectance values with a correlation coefficient of 0.978. The offset value of the regression line (zero reflectance point) was $196 \mu\text{w}/\text{cm}^2\text{-ster}$. This is a reasonable value for atmospheric path radiance. The slope of the regression line yields a path transmittance of about 0.81. These preliminary results are very encouraging.

3. Black Hills, South Dakota-forest stress site (191312)

There is no status report for this reporting period. The investigation status for this period will be included in the report due May 15, 1975.

B. Recommendations Concerning Decisions Required to Ensure Attainment of Experiment's Scientific Objectives

1. Manitou, Colorado-range inventory site (161313)

None at present.

2. Augusta, Georgia-forest inventory site (177512)

None at present.

3. Black Hills, South Dakota-forest stress site (191312)

None at present.

C. Expected Accomplishments

1. Manitou, Colorado-range inventory site (161313)

We expect to have the initial draft of our final report on applications of Skylab photographic products for plant community classification completed during the next reporting period.

2. Augusta, Georgia-forest inventory site (177512)

a. All photographic products to be used in the photo interpretation test should be completed.

A photo interpretation test using S190A and S190B products for two dates (September 12 and November 30, 1973) should be completed. This test will include interpretation of land use, forest type, and forest disturbances on 158 Forest Survey cluster sample locations in four counties. In addition, we will classify 2,528 cluster points by land use.

Two 10,000-meter ground truth maps will be photographed and prints and film overlays will be made to the scale of digital maps produced by microdensitometry and computer-assisted classification.

Aerial photo training aids will be made to illustrate forest and nonforest land-use classes using Skylab imagery, RB-57 aircraft imagery, and ground photographs.

b. The map of forest and nonforest classifications for McDuffie County will be completely digitized and areas within each classification summarized and compared with Forest Survey area

estimates. Samples of the data matrix will be taken to determine the most effective sampling intensity to measure forest land area.

A scanning microdensitometer will be used to sample an S-190B photograph from SL-4 using the same matrix of points, with the same spatial relationship to the ground, used to sample the land-use map. By simple density-level slicing, we will stratify the county into forest and nonforest components. These strata will be used in a stratified sampling of the data matrix generated from the land-use map. A density slice will be chosen that is biased in favor of including all forest land at the risk of also including some nonforest land. The accuracy of the stratification derived from the density slice can be checked by comparing it with the data matrix generated from the land-use map. The effectiveness of using Skylab photography for stratifying high-altitude aircraft photography for sampling will be determined by an increase in accuracy and/or by a decrease in required sampling intensity in subsequent sampling stages.

If time permits, a color-coded land-use map will be prepared by a computer-controlled plotter from the digitized data for McDuffie County. Photo interpretation of Forest Survey ground inventory points which have been relocated on the Mission 274 high-altitude CIR photography will determine whether this type of photography can be used to replace some of the costly ground checking now required to gather forest inventory statistics.

c. We hope to have our first computer classification map of the 10,000-meter test area completed during the next reporting period.

d. The computer programs for direct conversion of micro-density to relative exposure, having just been written, will be checked and applied to the Whiskeytown Station 6 data. We will see if the mean values after the point-by-point conversion produce any better correlation to reflectance data than we got by converting the mean values of microdensity for the image blocks. Since the conversions are nonlinear the two techniques should give different results.

In the next reporting period we should complete the scanning of film from the other camera stations and begin to compare satellite radiance to the reflectance in those bands. Variations in aircraft ground speed do not now appear to be significant, but correction for analog recording time-base will be necessary on the flight lines representing all but Station 6.

3. Black Hills, South Dakota-forest stress site (191312)

Work will continue as reported previously with an expected completion date of June 15, 1975.

D. Significant Results, Practical Applications, and Operational Problems

1. Manitou, Colorado-range inventory site (161313)

Skylab photographic products can be used to update existing maps of certain cultural features in mountainous, variable-vegetation terrains. Major transportation corridors, paved highways, and constructed gravel roadways are interpretable from Skylab photographs and their location transferable to base maps. Utilities corridors through forested areas are interpretable and transferable. Building locations but not kind of building, except large industrial facilities, are transferable. Also, mining activities, including quarries and dumps from tunnel mining, are transferable. Jeep trails, windmill sites, and cemeteries are not resolved in the Skylab photographic products in this test site.

2. Augusta, Georgia-forest inventory site (177512)

None this reporting period.

3. Black Hills, South Dakota-forest stress site (191312)

None this reporting period.

E. Travel Plans - March 16 to May 15, 1975

1. Manitou, Colorado-range inventory site (161313)

None planned.

2. Augusta, Georgia-forest inventory site (177512)

None planned.

3. Black Hills, South Dakota-forest stress site (191312)

None planned.