Paper A 18

USEFULNESS OF ERTS-1 SATELLITE IMAGERY AS A DATA-GATHERING TOOL BY RESOURCE MANAGERS IN THE BUREAU OF LAND MANAGEMENT

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ABSTRACT

ERTS-1 satellite imagery can be an effective data-gathering tool for resource managers. Techniques are developed which allow managers to visually analyze simulated color infrared composite images to map perennial and ephemeral (annual) plant communities. Tentative results indicate that ephemeral plant growth and development and potential to produce forage can be monitored.

INTRODUCTION

The United States Department of the Interior, Bureau of Land Management (BLM) administers the natural resources of approximately 470 million acres of public domain lands in the 11 western states and Alaska. Funds and manpower have become more and more limited as costs rise and additional tasks are required by a public demanding increased services and a higher quality environment. A tool is needed which will allow resource managers to quickly collect initial information and effectively update that information on a regular schedule. Approximately 160 million acres of public lands in the western United States are grazed by livestock. A knowledge of the soils and vegetation of this land is basic to good resource management.

Studies were conducted during 1973 on public lands in Arizona, California, Oregon and Alaska. Results show that color composite satellite imagery can be used to map soils and vegetation to varying intensities depending upon the area being studied and the scale to which satellite imagery has been reproduced. For example, the density and height of vegetation affect how well soil boundaries can be mapped. In the California desert, where only three to five percent of the ground is covered by perennial vegetation, soils can be mapped accurately to the series level. In southeastern Oregon, where 30 to 50 percent of the ground is covered by perennial vegetation, soils are not as easily delineated. In the desert region of southern Arizona, production of ephemeral forage can be mapped fairly easy on sites which have a very open cover of Larrea tridentata - creosotebush, but this is a more difficult task on sites with a dense cover of mixed desert trees and shrubs. On all sites, photo enlargements yielded more information than the 1:1,000,000 contact prints.

Results from all sites lead to the conclusion that satellite imagery can be a useful tool. However, only detailed results for the south central Arizona study site are reported in this paper, see Figure 1. Of equal importance to results is a knowledge of the techniques employed in deriving this information from satellite imagery. The techniques described below can be applied on any grazing lands administered by BLM. For a detailed discussion of results the reader is referred to the authors' Type III Final Report due January, 1974.

USE OF IMAGERY

General Procedure

Color composite simulated color infrared images at 1:1,000,000 scale were used for gathering resource information. Color composites were made by the Principal Investigator from NASA 9x9 inch multiband positive transparencies using a camera triple-exposure technique described in the authors' final report. The following is a discussion of the specific techniques used to obtain vegetation data from satellite imagery.

At the time of the satellite overpass ground truth data is collected. The resource manager (interpreter) gathers data concerning plant species composition, percent of ground covered by perennial plants and pounds per acre of ephemeral forage plants. This data is gathered on representative sample sites. It is important that data be gathered on at least one site representing each of the several different homogeneous areas identified on satellite imagery. If imagery of a previous flight is not available to help guide the location of sample ground truth sites, the resource manager should be careful to locate sites in vegetative types with obvious differences as seen on the ground. If sites are improperly located, corrections can be made when measurements are taken to record changes in vegetation later in the growing season. After the initial selection of sample sites, collection of ground truth data takes about one and one half days per satellite frame. The manager traverses five to ten percent of the 13,225 square miles as best he can depending upon the available road network.

When a current color composite satellite image is received it is first analyzed visually in the office by an interpreter. Homogeneous areas on the image are delineated on the basis of color, tone and texture, Krumpe (1973). Boundaries around distinct areas are recorded directly on overlay material. This process requires two to three hours. The interpreter then makes a reconnaissance flight from low flying aircraft (up to 10,000 ft. AMT) over the area covered by the ERTS-1 frame, using the satellite image and overlay for reference. During the flight he checks the content of homogeneous areas and boundaries between them with what he can see on the ground. Necessary corrections are made directly on the overlay. This process takes two to three hours.

Finally, information gained from analysis of satellite imagery is correlated with ground truth data taken on the representative sites. A specific color tone and textural pattern (signature) which separates one homogeneous area from another on the image is matched with the combination of topography and vegetative community which produced that particular signature. All areas scattered over the image with the same signature are then assigned the same vegetative characteristics as identified by ground measurements collected on a representative site. Subsequent field checks made as the growing season progresses provide an opportunity to check the accuracy of this extrapolation process. The end product is an up-to-date map of vegetative conditions.

Detailed Analysis

Using ERTS-1 color composite frame 1085-17330, 16 Oct. 72, three distinct areas important to livestock management in the desert were clearly apparent. Dark blue areas with a rough texture identified desert mountain rock outcrops; sites with a shallow rocky soil which produce a light cover of ephemeral forage and impede access by livestock. Light blue or bluish-purple areas with a striated texture identified a complex mixture of desert trees and shrubs (Table 1) located on foothills and upper bajada slopes at the base of mountains. White areas with a striated to smooth texture identified nearly pure stands of creosotebush (Table 1) located on lower bajadas and valley floors.

Analysis of ERTS-1 color composite frame 1211-17334, 19 Feb. 73, revealed three broad classes of ephemeral forage production for both the tree-shrub and creosotebush sites. The color-texture key shown in Table 2 was used to separate areas producing various amounts of forage. Because the creosotebush sites produce very little perennial vegetation and have a potential to produce a large quantity of ephemeral forage they were designated as Ephemeral sites (Tables 2 & 3). The tree-shrub sites producing a large amount of perennial vegetation and a good variety of ephemeral species but a smaller quantity of ephemeral forage were designated as Perennial-Ephemeral sites (Tables 2 & 3). Forage classes for each of these two vegetative types showing pounds of ephemeral forage per acre are shown in Table 3.

PRODUCTS OBTAINED FROM ANALYSIS OF SATELLITE IMAGERY

Forage production of ephemeral plants was mapped for central Arizona from ERTS-1 color composite frame 1211-17334, 19 Feb. 73, 1:1,000,000 scale, see Figure 2. Growth and development of ephemeral plants can be monitored on periodic images taken during the growing season. Even slight differences can be seen when comparing images 1085-17330, 16 Oct. 72 and 1103-17332, 03 Nov. 72. Potential of areas to produce ephemeral forage can be determined, see Figure 3. This was done by comparing current forage production from Figure 2 with precipitation data from several stations scattered over the general study area and elevation of each specific site. The potential map is tentative since it is based on only one years data.

BENEFITS TO RESOURCE MANAGERS

Satellite imagery can theoretically be useful to resource managers as a data gathering tool. In a discussion of the usefulness of satellite imagery the assumption is made that imagery in a usable form can be placed in the hands of the resource manager within one week of the date of the satellite overpass. At present, the most useful form of imagery is a second generation color composite at a scale of 1:250,000. This is because sophisticated analysis equipment is not readily available. Also, most BLM field personnel are trained in visual analysis techniques and additional training needed to use satellite imagery would be minimal. The 1:250,000 scale corresponds to the scale of U.S.G.S. Quadrangle maps now being used in many field offices.

When the ERTS system is fully operational, data such as shown in Figure 2, will be useful as a guide to the numbers of livestock which can properly harvest ephemeral livestock forage in the southwest. Ephemeral forage conditions are subject to extreme changes within a very short time (weeks). Periodic satellite imagery can be used as a tool to monitor these changes, providing up-to-date information over very large areas. This kind of information would be difficult to collect on the ground because of long distances and very short time periods involved.

REFERENCES

Krumpe, P.F. 1973. A regional approach to wildland resource distributional analysis utilizing high altitude and earth orbital imagery. Proc. American Soc. of Photogrammetry, 39th Annual Meeting, Washington, D.C. March 11-16, 1973. 336-371 p.

Figure 1 - Map showing location of the central Arizona test site.

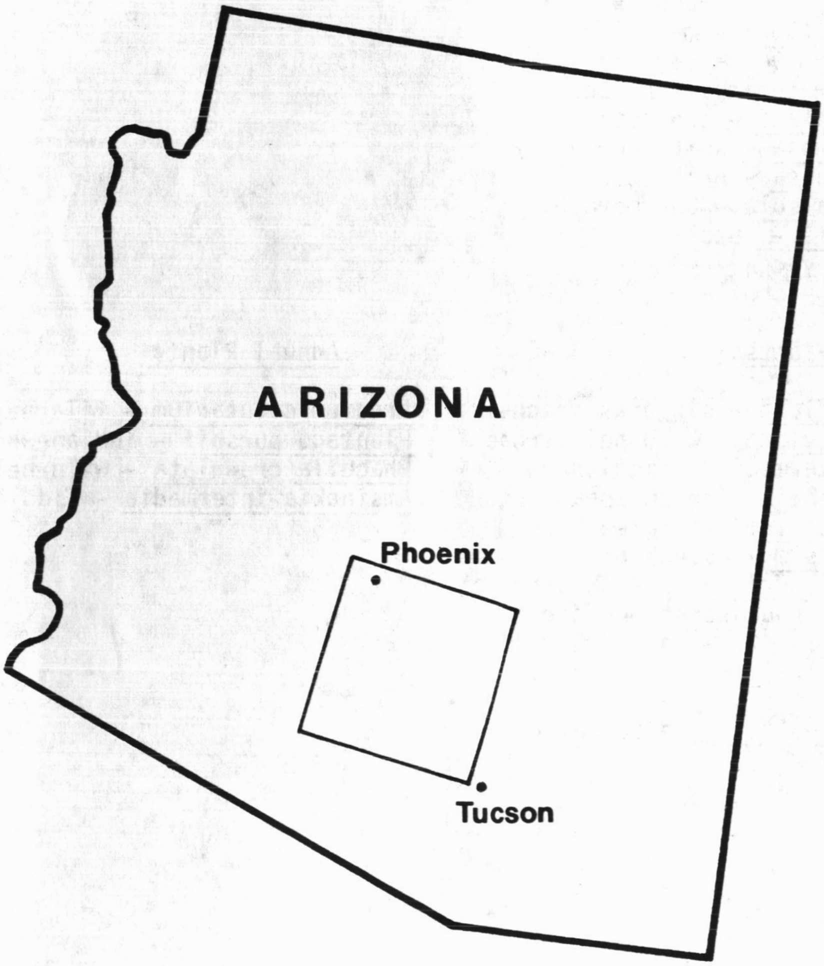


TABLE 1. List of perennial and ephemeral plants found on tree-shrub and creosotebush sites in central Arizona.

Tree-Shrub Sites

Perennial Plants

Cercidium floridum - paloverde
Olneya tesota - ironwood
Prosopis juliflora - mesquite
Carnegiea gigantea - saguaro
Berberis haematocarpa - barberry
Larrea tridentata - creosotebush
Franseria dumosa - white bursage
Encelia farinosa - brittlebush
Hymenoclea salsola - burrobrush
Acacia greggii - catclaw
Yucca spp. - yucca
Opuntia spp. - cholla

Annual Plants

Festuca octoflora - sixweeks fescue
Phacelia crenulata - wild-heliotrope
Amsinckia intermedia - fiddleneck
Plantago purshii - indian-wheat
Erodium cicutarium - filaree
Eriogonum densum - buckwheat
Nemacladus glanduliferus - threadplant
Orthocarpus purpurascens - escobita
Descurainia pinnata - tansy-mustard
Astragalus nuttalianus - milkvetch
Lupinus sparsiflorus - lupine
Sphaeralcea coulteri - globemallow

Creosotebush Sites

Perennial Plants

Larrea tridentata - creosotebush

Annual Plants

Erodium cicutarium - filaree
Plantago purshii - indian-wheat
Phacelia crenulata - wild-heliotrope
Amsinckia intermedia - fiddleneck

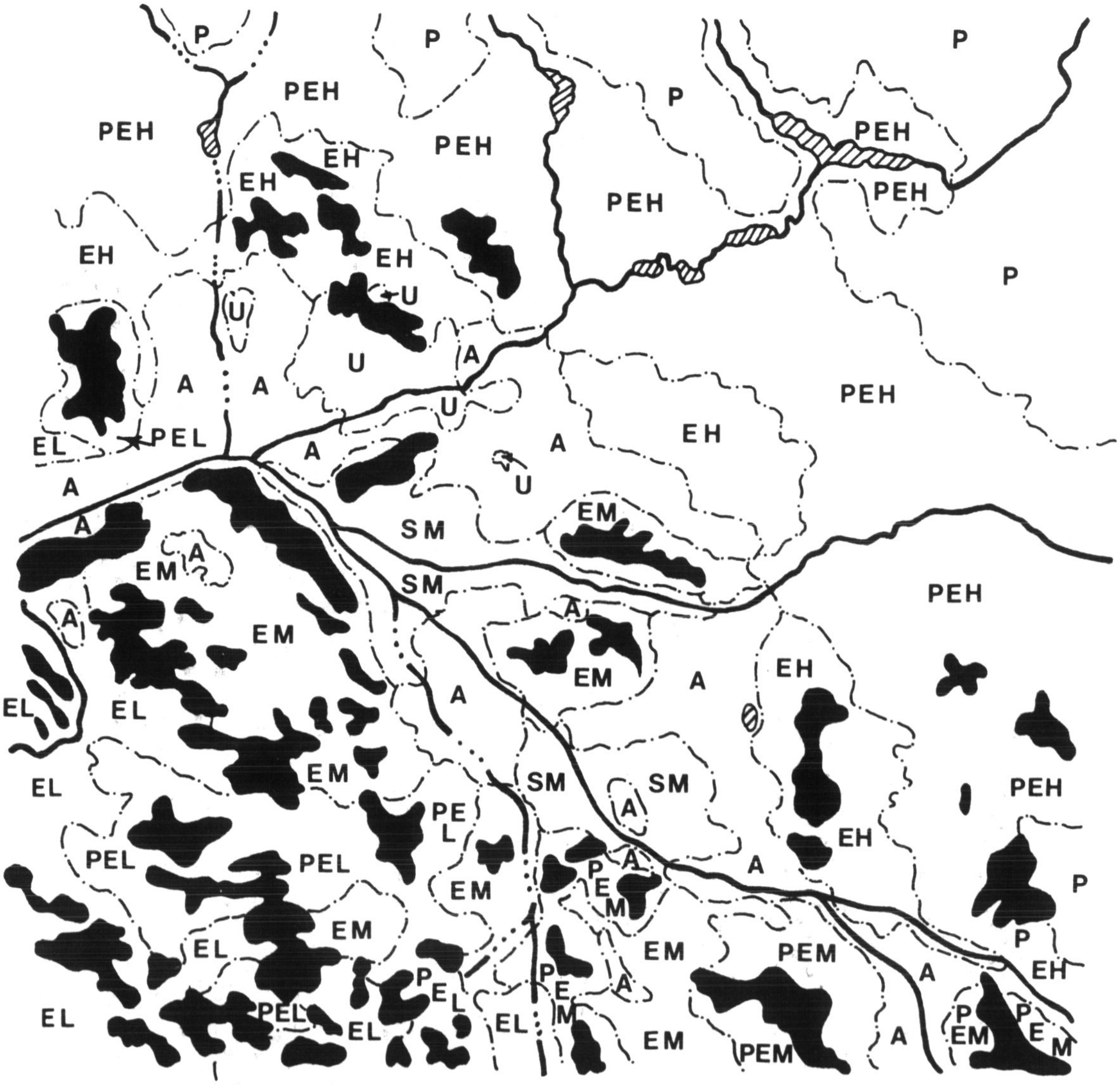
Table 2 - Color-texture key used to separate ephemeral forage production classes.

Color	Texture	Vegetation Type	Ephemeral Forage Production Class
Blue with red spots & streaks intermixed	Striated	Perennial-Ephemeral	Heavy
Bluish gray with pink blotches	Striated to smooth	Perennial-Ephemeral	Moderate
Blue	Striated to smooth	Perennial-Ephemeral	Light
Bright red	Mottled to smooth	Ephemeral	Heavy
Pink	Smooth	Ephemeral	Moderate
Light pink to white	Smooth	Ephemeral	Light
White, dark purple to red	Streaked	Drainage channel	Moderate
Blue to gray	Rough	Desert Mtn. outcrops	Light
Red to brownish red	Rough	Perennial	None

Tabel 3 - Ephemeral forage production for Winter Season 1972-73, as of April 18-19, 1973

Vegetation Type	Production Class	Forage Production lbs./acre
Urban	----	----
Agricultural Land	----	----
Perennial	----	----
Perennial - Ephemeral	Heavy	1000-1500
Perennial - Ephemeral	Moderate	500-1000
Perennial - Ephemeral	Light	up to 500
Saltbush (drainage channels)	Moderate	500-1000
Ephemeral	Heavy	3000-5000
Ephemeral	Moderate	2000-3000
Ephemeral	Light	up to 2000
Perennial - Ephemeral (Desert mtns-rock outcrops)	Light	up to 1000

Figure 2 - Ephemeral forage plant production as determined from ERTS satellite frame 1211-17334, 19 Feb. 73.

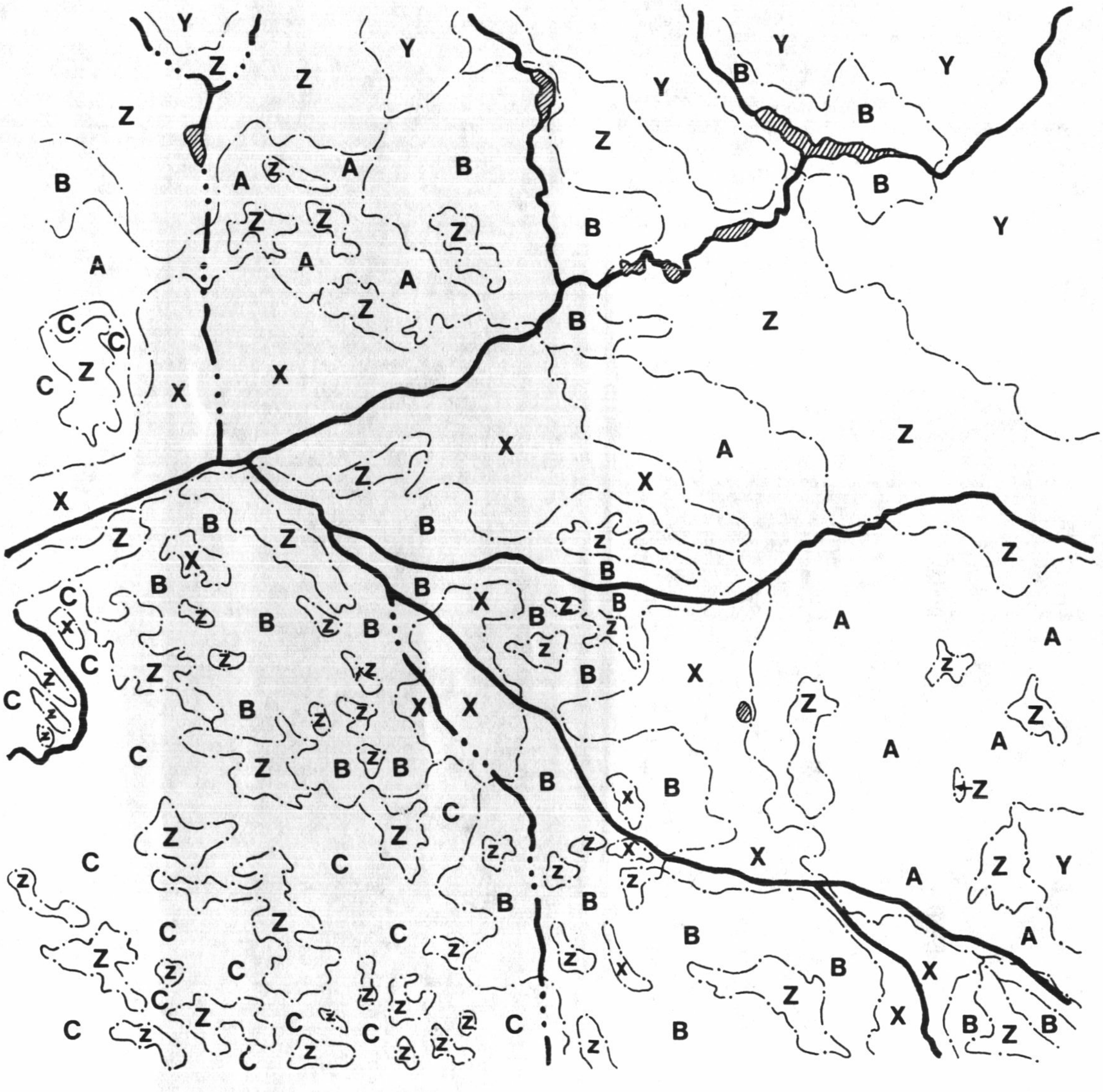


LEGEND

U – Urban Area
A – Agricultural Land
P – Perennial Plants
PE – Perennial – Ephemeral
E – Ephemeral
S – Saltbush

H – Heavy Production
M – Moderate Production
L – Light Production
Rock Outcrop (light production)
- Lake

Figure 3 - Potential of areas to produce ephemeral forage plants.



LEGEND

X – No Ephemeral Potential (urban & agriculture)

Y – No Ephemeral Potential (perennial plants)

Z – Low Useable Ephemeral (steep topography)

A – High Ephemeral Potential

B – Moderate Ephemeral Potential

C – Low Ephemeral Potential