THE USEFULNESS OF ERTS-1 AND SUPPORTING AIRCRAFT DATA FOR MONITORING PLANT DEVELOPMENT IN RANGELAND ENVIRONMENTS

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COMPREHENSIVE SUMMARY

Throughout the Western United States, livestock associations, large livestock operators and state Statistical Reporting Services have expressed the need for improved techniques for regional monitoring of the forage resource. What they want is more accurate and timely information regarding the timing of plant development, the duration of the green growth period, the health or condition of the forage during this growth period, and an estimate of forage production. This information is essential for determining (a) the proper levels of stocking, (b) the time when the range can be grazed without being damaged by the animals, (c) the time when animals should be removed from the range to minimize weight loss due to inadequate quality or quantity of forage, and (d) the alternatives which are open to the rancher at the end of the grazing season regarding the movement of animals from his range to other ranges or pastures, or to feedlots and meat processing facilities. In addition this information is valuable to another important user group, namely those involved in wildland fire prevention and suppression, for determining fire danger ratings, and allocating manpower and fire fighting equipment.

In the opinion of the authors, improved techniques for acquiring these kinds of information are provided through the applications and analyses of remote sensing data obtained at frequent and regular intervals over large regional areas. Based upon our remote sensing investigations at annual and perennial rangeland test sites throughout California, we know that specific growth stages in the life cycle of native forage crops can be recognized through analysis of very small scale color-infrared photography (1:120,000 to 1:500,000). Furthermore, we know that the amount and distribution of rainfall and the temperature regime are the primary variables which govern the amount of forage produced. With these inputs (the timing of growth stages from remote sensing data, and the climatic data) we can determine the length of the growth period, evaluate plant health, and infer much about the relative amount of forage produced for a given year (as compared with

the previous year or to a long term average) and from one grazing area to another.

In order to acquire these inputs, so that predictions regarding the condition or production of forage can be made, one must be able to (1) monitor climatic variables and their effect on soil moisture and plant development throughout the growth of the plants, and (2) determine the calendar dates when the forage crop develops through its normal growth stages. The former information can be acquired from local or nearby weather gaging stations where they are available and where they are applicable to the rangeland being monitored. Unfortunately, large rangelands do not have sufficient gaging stations to provide accurate and representative climatic data to determine its effect upon plant development. Therefore, climatic data does not provide an adequate input by itself to assess the timing and rate of plant development.

Alternatively, remote sensing provides a valuable method for monitoring plant development. Small aerial or space imagery taken at a single point in time provides a permanent record of the growth stage or condition (health) of the forage. The rate of plant development, the length of the growth cycle, and inferences regarding the amount of forage produced can be determined by analyzing remote sensing data obtained at frequent intervals throughout the life cycle of the forage crop. Two periods, however, are more critical to monitor in order to evaluate forage condition and productivity; namely, the period of germination (the time of germination affects forage production early in growth season), and the period when plants mature and dry. From this information one can determine whether the current year growth conditions and associated forage production are below, above or average for a particular area by comparing the current repetitive remote sensing data with existing remote sensing data or available ground data which documents the conditions one could expect on the average year. In addition, the analysis of remote sensing data obtained near the end of the growth cycle should enable one to predict the length of time that the forage should remain green.

Synoptic and repetitive remote sensing coverage is required for the analysis of regional range conditions because the timing, the length and the rate of plant development varies within and between regions due to site differences, exposure, elevational change, rainfall zone and temperature regime. Because high resolution imagery is not essential for monitoring the timing of growth stages, the ERTS-1 sensor package with its synoptic, multidate and multiband capability offers the required tools for monitoring range condition and potential fuel hazard within regional rangeland environments. This application may well be one of the most important of the ERTS-1 experiments.

Results applicable to the following subdisciplines: 1.C -- Range Survey and Classification (Agriculture/Forestry/Range Resources); and 7.H, 7.J, and 7.K -- Biome Definition and Monitoring; Phenology; and Wildlife Habitat Surveys (Environment).

RESULTS

Preliminary analysis of ERTS-1 MSS imagery of annual and perennial rangeland in California yields the following observations:

1. Although the entire annual grassland was dry on the dates of the ERTS overpasses, sufficient geomorphological detail can be resolved on the MSS imagery to differentiate upland and bottomland range sites in the foothill range areas.

2. Dry and green meadowland can be differentiated readily on the red band (MSS band #5). Similarly, dry and green meadowland was most readily differentiated on color composites (color enhanced images) which simulate the color renditions of color-infrared film. As a result interpreters could determine which mountain meadows were green and which had dried earlier this year due to below normal precipitation.

3. The color composites prepared by NASA-Goddard were useful for locating perennial rangeland with varying amounts of herbaceous ground cover. Because these kinds of observations can be made, the ERTS-1 imagery should prove valuable for establishing the health or condition of rangeland and for monitoring changes in this condition.

4. The ERTS-1 images received and interpreted thus far cover nearly 50% of the state of California and show nearly two-thirds of the annual grassland type. A mosaic prepared from these images is proving valuable for determining the amount of grassland and brushland in the state which is used for grazing.

5. ERTS-1 imagery obtained during the late summer season should be optimum for differentiating grassland from brushland and forested land.

6. The ERTS-1 imagery clearly shows areas which at one time were part of the annual grassland but which are now used for dry land farming (cropping of cereal grains). Similarly, the ERTS-1 imagery shows areas which have been converted from brushland to grassland.