APPENDIX C

MAPPING RANGELAND VEGETATION USING LANDSAT MSS DIGITAL DATA FOR RESOURCE MANAGEMENT PLANNING

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ABSTRACT

The objective of this project was to produce usable map products showing present rangeland vegetative communities based on Landsat MSS digital analysis and appropriate ancillary data. These products have provided the Bureau of Land Management, Cascade Resource Area (CRA) staff with a base inventory for the CRA Resource Management Plan and Environmental Impact Statement (RMP/EIS). They have also provided the Soil Conservation Service (SCS) with an inventory of private rangeland within BLM grazing allotments. Of particular interest was the ability of Landsat spectral data to distinguish non-native homogeneous stands of medusahead grass (Elymus caputmedusae) and cheatgrass brome (Bromus tectorum) from native plant communities. This project represents a cooperative interagency effort to generate uniform vegetation cover data at least possible cost.

INTRODUCTION

The Bureau of Land Management (BLM) resource inventory process is structured in a manner that meets legislative and policy requirements. It provides decisionmakers with the information necessary to make sound land-use and resource management decisions. Inventory data provides the factual basis for development of Resource Management Plans (RMP's). The Federal Land Policy and Management Act of 1976 states that inventories be maintained, on a continuing basis, of all public lands. These inventories are to be kept current to reflect changes in conditions and to identify new and emerging resource values (FLPMA 1976).

Traditional inventories in the Boise District BLM were conducted by a Resource Inventory Team (RIT). This team consisted of up to twelve resource specialists and was responsible for all inventory work associated with RMP's. The team concept was an effective but costly method of accomplishing the task. Costs for vegetation inventories alone averaged $.15/acre.* Faced with decreasing budgets and personnel, the Resource Inventory Team disbanded in 1982. Alternative methods to accomplish resource inventories were needed.

A rangeland inventory need existed for the BLM's Cascade Resource Area (CRA) in preparation for their Resource Management Plan. Limited rangeland inventory data existed for the CRA in 1982. A very scattered land ownership pattern and limited access contributed to this lack of current inventory. Some lands in the resource area had never even been visited by BLM personnel.

The use of remote sensing techniques was chosen by the CRA manager as an alternative method for gathering vegetation inventory data. The use of Landsat MSS digital data was available as a tool to accomplish this task. Of particular concern to the CRA manager was the continued proliferation of non-native homogeneous stands of medusahead grass (Elymus caputmedusae) and cheatgrass brome (Bromus tectorum). These two annual grass species encompass the majority of poor condition rangeland in the CRA. The ability of Landsat MSS digital data to distinguish these non-native homogeneous stands from native plant communities was imperative in this inventory effort.

USER REQUIREMENTS

The production of present rangeland vegetation maps based on Landsat MSS digital data was the basic requirement to meet the vegetation inventory needs for the CRA Resource Management Plan. In addition, the USDA Soil Conservation Service (SCS) was interested in using data gathered on private rangelands within BLM allotments for developing conservation plans. The information was planned for use in future SCS-BLM coordinated rangeland planning efforts.

Specialized image processing equipment was needed to process Landsat MSS data. The BLM's Branch of Technology Applications Assistance, at the Denver Service Center, was capable of processing the necessary data. However, due to an existing work schedule and limited personnel, this facility was unable to provide these services in the required timeframe. An alternate remote sensing facility was needed. With the limited funding available for this project, it was necessary that an alternate facility meet the following criteria:

1. Low cost. The contracted facility should benefit from the results and be willing to absorb certain processing costs associated with the project, a true cost share effort.

2. Close proximity. Due to restricted travel funds available for this project, the contracted facility must be close to both the project area and the Boise District Office.

3. Personnel interaction. Past experience has shown that the close interaction of contracted remote sensing facilities and BLM resource personnel is essential for the most effective use of the data.

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*Average costs from 1977-1981 as reported by Boise District Resource Inventory Team Leader.

4. Computer compatibility. The alternate facility must have a computer hardware/software package capable of interacting with the BLM's Interactive Digital Image Manipulation System (IDIMS) at Denver. This was required for hard copy output.

5. Interagency cooperation. The project was designed to be a cooperative effort and learning experience for all participants. The alternate facility must provide necessary training to BLM personnel to assist in data processing, therefore reducing costs.

IMAGE ANALYSIS FACILITY

The only facility meeting these requirements was the State of Idaho, Department of Water Resources, Idaho Image Analysis Facility (IIAF). It is a complete image processing facility, established by executive order, to service Landsat MSS user needs in the State of Idaho.

The IIAF is located in Boise, Idaho, close to the BLM Boise District Office and the project area. Travel costs were eliminated enabling BLM personnel to participate in data processing on a routine basis. This participation provided a better understanding of the complexity of the project and a more effective use of the output products.

The IIAF supports a suitable hardware/software computer package (VICAR/IBIS) which is compatible with BLM's IDIMS at the Denver Service Center. Computer compatible tapes were produced for hardcopy output. BLM personnel were able to work directly with IIAF personnel for data output. The IIAF was willing to provide all necessary training in the use of the (VICAR/IBIS) image analysis software and the interactive digital image display device. The primary emphasis of the IIAF is technology applications through development and application of operational remote sensing management and assessment programs.

The required data generation would normally cost about $.06/acre to process. The IIAF provided the required data to the BLM for about $.02/acre. The $.04/acre difference was absorbed by the IIAF to enhance its data processing capabilities for future project work. This facility is non-profit by directive.

DESCRIPTION OF THE PROJECT AREA

The CRA supports a diverse environment for a variety of vegetation types. A combination of man's actions, fire history, climate, elevation, aspect, and soil types account for this diversity.

The resource area stretches approximately 120 miles from north to south and 70 miles from east to west. The temperature/moisture regimes associated with this large area account for a variety of vegetation zones. The vegetation zones represented in the CRA include the following:

1. Sage/Grass Zone
2. Wheatgrass/Bluegrass Zone
3. Ponderosa Pine Zone
4. Douglas-Fir Zone
5. Spruce/Fir Zone

Because of the size and diversity of the CRA, it was decided that a sample area would be selected for processing in order to evaluate its usefulness over the entire area. This sample area, or Phase I, encompassed 508,000 acres. Native vegetation is primarily big sagebrush/perennial grass. Average annual precipitation is about 12 inches. About 75% of the soils are formed in residuum, alluvium, and colluvium from tertiary flow basalt and about 25% are formed in residuum, alluvium and colluvium from Pliocene stream and lake deposits. Elevations range from about 2400 feet to 6100 feet.

Of the 508,000 acres, about 350,000 acres are BLM administered public lands. The remaining 158,000 acres are private and state lands.

The limitations on fiscal year budgeting necessitated breaking the project into three distinct phases. Phase 2 and Phase 3, consisting of an additional 500,000 acres of public and private rangeland, were added to the project area after the successful completion of Phase I. The area of each phase was no larger than could easily be field checked in one field season. The Phase 3 classification was budgeted entirely by the SCS.

PROCEDURES

This project represents the operational use of Landsat MSS digital data. The classification techniques and inventory methodology developed as a result of the BLM-NASA Cooperative ASVT projects in Alaska, Arizona, and Idaho were used.

Environmental Stratification

Using geologic maps (1:250,000), the project area was stratified to separate soils derived from igneous and sedimentary parent materials. Agricultural lands were manually interpreted on National High Altitude Aerial Photography (NHAP) and transferred onto 1:100,000 scale maps using a Zoom Transfer Scope (ZTS). The strata were digitized and rasterized into image masks and were used to remove riparian confusion in the classification. Classification output for each geologic strata were treated separately, and the agricultural stratum was embedded into the final classification.

Administrative Stratification

BLM personnel compiled grazing allotment information onto the 1:100,000 scale Surface Management Map Series. Grazing allotment boundaries and BLM administered lands were digitized and converted to raster format. Image masks of grazing allotments by ownerships were created and used in an overlay process with the classified Landsat data. Tabular reports of landcover acreage for BLM and non-BLM lands by grazing allotment were then generated.

Classification of Landsat Data

A guided clustering methodology was employed to generate training statistics. BLM and SCS personnel familiar with the CRA selected training sites using NHAP and a 1:250,000 scale Landsat FCC (path:45 row:29 date:July 17 1980 Id #:82201317514XO). The Landsat MSS data for each training area (50x50 pixels) was clustered and classified into 10-12 spectral classes.

The spectral classes were color coded, displayed, and photographed on a cathode ray tube (CRT). Display photographs and NHAP photography were registered using the ZTS. The delineated photos were taken into the field and each spectral class was labeled and ground checked for:

1. Physiography
2. Elevation
3. Slope %
4. Parent Material
5. Stratum
6. Aspect
7. Species Composition %
8. Range Site
9. Range Condition
10. Surface Stones %
11. Bare Soil %
12. Rock Outcrop %

A master statistics file was compiled from the individual training area statistics files. Spectral plots (band 5 vs. 7) for each training area were overlaid on a light table and the measurement space filled with as many distinct (Swain-Fu distance) spectral classes as possible. In this way a master statistics file containing 57 spectral classes representing 15 vegetation cover types was assembled (number of spectral classes and cover types varied for each phase). The project area was classified using a maximum likelihood decision rule.

The classified data were then resampled and registered to a 57 meter UTM grid. The agricultural stratum was embedded into the classified data and the spectral classes combined into the final output classes.

Continuity Evaluation

Due to time and funding limitations, a statistically designed accuracy assessment of the spectral data could not be conducted. An alternative action to assess the accuracy of the data was developed in the form of a continuity evaluation. This proved most useful in determining the reliability of individual spectral classes within each stratum and for developing land cover descriptions.

Random 40 acre sites were selected for individual spectral classes in each stratum. Each spectral class was evaluated at least twice within each stratum. The sites were transferred to 1:24,000 USGS quads for field verification.

A special "field" form was developed to record information at each site. Land surface feature data recorded included present vegetation, surface soil conditions, rock outcrop or stoniness, slope, aspect, and the probable presence of shadow. Care was taken to ensure that each spectral class was precisely located on the ground prior to documentation.

This data was used to evaluate the composition of each spectral class. As was expected, some spectral classes were very uniform in terms of land cover composition while others showed a wide range in composition. This data was also used to develop land cover descriptions for each spectral class. The actual composition of each description was based on the field data. A range-in-characteristics was developed indicating what could be expected in terms of vegetation and land surface composition within each spectral class.

The documentation of the variability within each spectral class served as the accuracy assessment for the project. Those classes having a wide diversity in land cover feature data were judged to be less accurate than those having a narrower diversity. Those land cover units having a wide diversity in composition were isolated for further analysis.

Output Products

Computer compatible tapes (CCT's) produced through IIAF were sent to the BLM's Denver Service Center. Through the BLM's Interactive Digital Image Manipulation System (IDIMS), hardcopy color maps were produced for the entire project area. In this form, the interpreted data was conveniently input to a geo-based information system. The data was smoothed and output at 1:100,000 scale to correspond to BLM planning base maps. These computer generated maps were used to compile the final rangeland vegetation and condition maps for the CRA Resource Management Plan.

The output products generated in the project include the following:

1. Tabular reports listing authorized grazing allotments showing acreage of vegetation cover types within BLM and non-BLM lands. This simplicity in cover type area determination is an additional cost advantage over manual map interpretation.

2. Color-coded maps (Applicon) of the CRA at 1:100,000 scale showing vegetation cover types.

3. Symbol mylar map overlays (Versatec) for the 7.5 minute topographic maps of the project area at 1:24,000 scale depicting vegetation cover types.

SUMMARY

Map products showing present rangeland vegetation based on Landsat MSS digital analysis have provided the CRA with a base inventory for resource management planning. These computer generated maps were used to compile the final rangeland vegetation and condition maps for the CRA Resource Management Plan and Environmental Impact Statement.

Landsat MSS data was able to easily distinguish and quantify non-native homogeneous stands of medusahead grass (Elymus caputmedusae) and cheatgrass brome (Bromus tectorum) from other native plant communities. This study has established baseline information for monitoring the changes in the distribution of these two species.

Interagency cooperation reduced traditional inventory costs of about $.15/acre to about $.06/acre. Through the use of a local remote sensing facility, IIAF, uniform vegetation cover data was generated at least cost. This facility, non-profit by law, absorbed some processing costs associated with the project. With a close proximity to the Boise District Office and project area, travel costs were virtually eliminated. The facility provided training to BLM and SCS personnel to assist in data processing which allowed close interaction of remote sensing specialists and professional resource specialists. This interaction is essential for the most effective use of the output products. Computer compatibility between IIAF and the BLM's

Denver Service Center allowed the transfer of CCT's for the production of hardcopy color (Applicon) and mylar symbol (Versatec) maps.

A continuity evaluation was used to assess the accuracy of the image classification. This proved most useful in determining the reliability of the data and for developing land cover class descriptions.

The documentation of the variability within each spectral class served as the accuracy assessment for the project. The successful results of the continuity evaluation required close involvement between the remote sensing analyst, the image data, the field specialists, and the users of the data. The quality of the image classification can only be as good as the quality of the training data and accuracy evaluation used to perform the classification.

The entire project represents a cooperative effort by three agencies to generate uniform vegetation cover data at the least possible cost. The sharing of digital data bases and cooperative efforts are necessary cost saving mechanisms which should be addressed in future Bureau of Land Management remote sensing projects.

REFERENCES

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