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NATURAL RESOURCE INVENTORY AND MONITORING IN OREGON WITH ERTS IMAGERY

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ABSTRACT

Multidiscipline team interpretation of ERTS satellite and highflight imagery is providing resource and land use information needed for land use planning in Oregon. A coordinated inventory of geology, soil-landscapes, forest and range vegetation, and land use for Crook County, illustrates the value of this approach for broad area and state planning. Other applications include mapping fault zones, inventory of forest clearcut areas, location of forest insect damage, and monitoring irrigation development. Computer classification is being developed for use in conjunction with visual interpretation.

1. INTRODUCTION

Land use planning is receiving high priority attention at state and local levels in Oregon. ERTS imagery has the potential to provide much resource data urgently needed in the planning process throughout the state.

Rapid population growth and accelerating urban, industrial and recreational development are placing unprecedented demands on the fixed amount of land resources available. Conflicting land uses and speculative land conversions are leading to an increased recognition of potential problems and the need for long range planning.

Problems of growth and attendant pressures on the fixed land resource are common to some degree in most states. The situation in Oregon is similar to that of other Western states. Mountainous terrain, wide variations in climate, intermingled public and private land ownership, varied land use and highly variable population densities characterize much of the Western region. Inadequate planning for land use and urban expansion has contributed to the problems apparent in rapidly urbanizing regions such as the Los Angeles Basin, and could lead to similar problems for the Willamette Valley in Oregon. Extensive and largely uncontrolled speculative growth of recreation subdivisions in remote areas is adversely affecting open space attributes over wide areas of the West.

Oregon exemplifies much of the West in its stage of development and is an excellent test area. The very fact that much open space remains, often in attractive surroundings, is creating demands on land that threaten to diminish quality of environment and liveability in the state. Oregon citizens are becoming aware that direction and control of land development is needed to achieve a balance between economic growth and environmental quality. Land use planning in all counties is required by recent legislation and will be further strengthened through current legislative proposals for state wide standards.

2. PURPOSE OF THE STUDY

The Oregon ERTS project is directed toward applications in land use planning. Present planning efforts in the state although commendable, are often based on inadequate, incomplete and sometimes outdated land resource information. Our primary objective is to demonstrate the usefulness of ERTS imagery in compiling and presenting a coordinated resource and land use information base for land use planning. We are utilizing multiple-discipline team interpretation of ERTS satellite and high flight imagery, and ground truth to provide planners with a current, comprehensive inventory of range and forest vegetation, soils, geology, water areas and land use. The resource information is compiled on ERTS imagery for working with local planners to analyze and assess applications and methods of presentation for land use planning.

3. APPROACH

ERTS imagery for all of Oregon is given a quick-look analysis for information content and usefullness. However, we are doing a comprehensive pilot study of land use planning applications in only one county at present. Crook County in Central Oregon was selected for an in-depth study because land use planning there is just beginning, the county has an active interest in obtaining resource information; county boundaries largely coincide with a major watershed, and the area is representative of much of Oregon east of the Cascade Mountains. The county has a varied terrain of rangeland, forested mountains and irrigated valleys. The population is relatively low and Prineville is the major town. Ranching, forest products, farming and recreation are the major enterprises.

Most of our work to date has been in generalized mapping of the resources and land use through ERTS image interpretation, on-the-ground observations, and existing resource information. Black and white prints of MSS, band 5 imagery at 1:1,000,000 scale were initially used. Recently we have been able to start work with color-reconstituted transparencies of bands 4-5-6 and 4-5-7, and enlargements of band 5 at a scale of 1:250,000. NASA highflight photography at 1:120,000 and larger scales is being used in conjunction with ground truth observations, and will be used later in multistage sampling experiments of forest inventory and larger scale analysis of resources.

4. RESULTS

Generalized maps of Crook County showing geology, soil-landscapes, vegetation and land use, and timber density are illustrated in Figure 1 to 4. Abbreviated explanatory legends for the map symbols are appended. Figure 5 shows the geographic distribution of several land resource units defined by a high degree of similarity in resource and land use characteristics as determined from the individual resource maps. These maps are drawn on ERTS color-reconstituted, 1:1,000,000 scale imagery and constitute a broad, synoptic picture of the terrain, land uses, and resources of the country.

The individual resource maps of Crook County (Figures 1 to 4) show 12 soil-landscape units, 8 geologic divisions, 17 vegetation and land use units, and 5 classes of timber density. Surface water areas show on several of the maps. Overlaying these maps provide an ideal mechanism for informed, rational solution of specific land use problems.

The five combined land resource units delineated as examples in Figure 5 have the following general characteristics:

1. Nearly level to gently sloping alluvial flood plains and terraces with deep, well-drained medium textured soils. Minor poorly drained soils may be alkaline. Soils on terraces may be moderately deep to indurated hardpans. This land is used for irrigated cropland, meadowland, and homesites.
2. Nearly level to gently rolling, lightly dissected volcanic plains with vegetation types including low sagebrush, big sagebrush and sagebrush-juniper on shallow and very shallow, stony and very stony soils, mostly with clayey subsoils. This land is used for grazing and wildlife habitat.
3. Hilly, mixed volcanic, juniper-sagebrush uplands with moderately deep, clayey soils. This land is used for grazing, wildlife habitat and recreation.
4. Steeply sloping mountainous, mixed volcanic terrain with open Ponderosa pine and scattered occurrence of other conifers, on moderately deep, medium and fine textured soils. This land is used for commercial timber, summer grazing, wildlife habitat and recreation.
5. Strongly dissected lava plateaus with low sagebrush on scablands and open Ponderosa pine in the draws. The soils are very shallow and very stony in scabland areas, with moderately deep, medium textured soils on north slopes. This land is used for grazing, wildlife habitat and recreation.

About 12 to 15 of these land resource units are needed to adequately characterize Crook County at this level of generalization. Many of the same units would have wide extent on a state map.

Information shown at this scale and level of generalization is helpful in developing an overview and general understanding of the resources, potentials and problem areas of a county. Information presented on ERTS imagery at this small scale appears to be most appropriate for general planning at state or regional levels. County level and local area planning generally requires more detailed information but the support high-flight imagery is ideal for determining and presenting these higher levels of detail in selected problem areas. ERTS imagery enlarged to a scale of 1:250,000 is well suited for mapping resource and land use information with a degree of generalization useful for broad planning at the county level. Assessment of ERTS imagery in consultation with county planners has supported these preliminary judgments.

5. OTHER APPLICATIONS

Several significant uses of ERTS imagery in land use and resource inventory and monitoring have been demonstrated in other parts of Oregon. The alignment and distribution of faults in much of south-central Oregon has been mapped at 1:1,000,000 on ERTS, band 5 and color reconstituted bands 4,5, and 6. These are shown for the Deschutes Basin on Figure 6. Similar mapping on high flight imagery shows a slight increase in detail, but with very serious geometric fidelity loss. The area is dominated by the west end of the Brothers Fault Zone which crosses the figure just above the Newberry scarp. The juvenile character of this zone is shown by the lack of a single integrated break and by the crossing of the Green Ridge Fault by extensions of this zone. Green Ridge faulting is dated at 2 to 4 million years ago. This relation is not clear on high flight imagery.

Different MSS band combinations and a variation in intensity level in color reconsitutions of ERTS imagery show advantages in identifying delineating, and seasonal monitoring of various vegetation types. For example, bands 4,5,7 seem best for identifying juniper woodland. Bands 4,5,6 appear to be most sensitive for picking up the initial flush of green growth of annual grasses and winter grains. The contrast between dry grasslands and shrub-steppe vegetation is apparently very strongly enhanced by the combination of bands 4,5 and half power 7.

Forest clearcut areas are easily seen and mapped on 1:1,000,000 scale ERTS imagery. Examination of color reconstituted frames indicates that clearcut areas can be visually stratified by age to some degree from the ERTS imagery. Computer classification has been successful for delineating clearcut areas from digital data and will greatly increase capability to discriminate age differences. Tussock moth damage is spreading rapidly in forests of Eastern Oregon. Algoriths are in an intermediate stage of development for detecting forest areas experiencing this insect infestation from digital data.

Irrigation development is rapidly expanding along the Eastern Oregon-Washington border near the Columbia River. ERTS imagery has provided the first up to date and accurate record of this development. Satellite imagery is an excellent means of measuring the extent and rate of increase of this important change in land use.

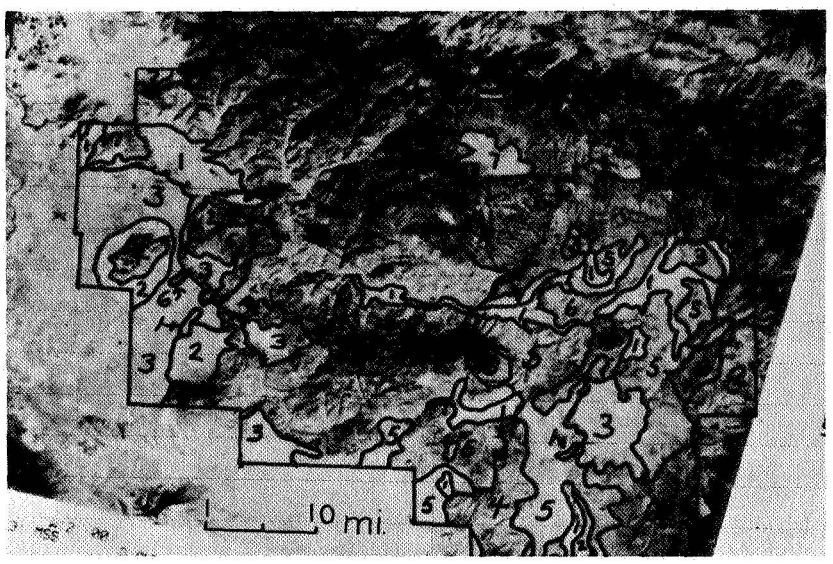

Figure 1. Geology of Crook County, Oregon, showing 8 units.
ERTS frame 1076-18211--4, 5, 6

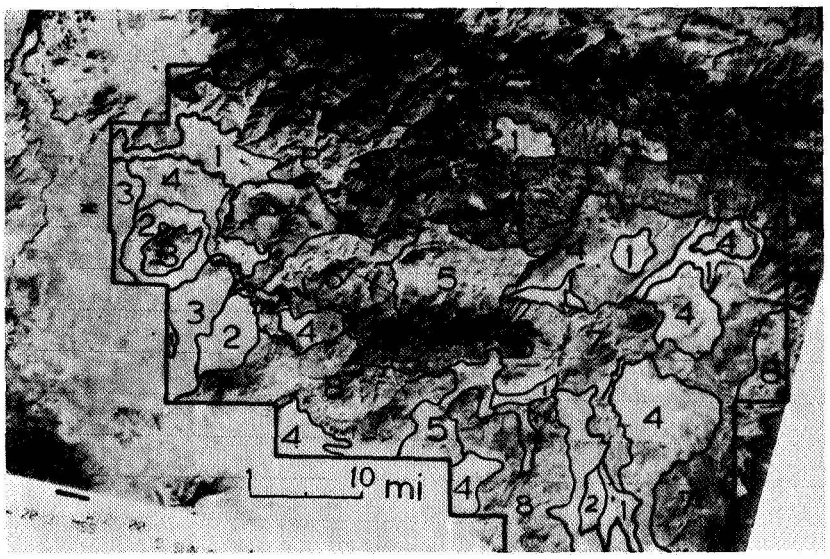

Figure 2. Soil-landscapes in Crook County, Oregon, showing 12 classes.
ERTS frame 1076-18211--4, 5, 6

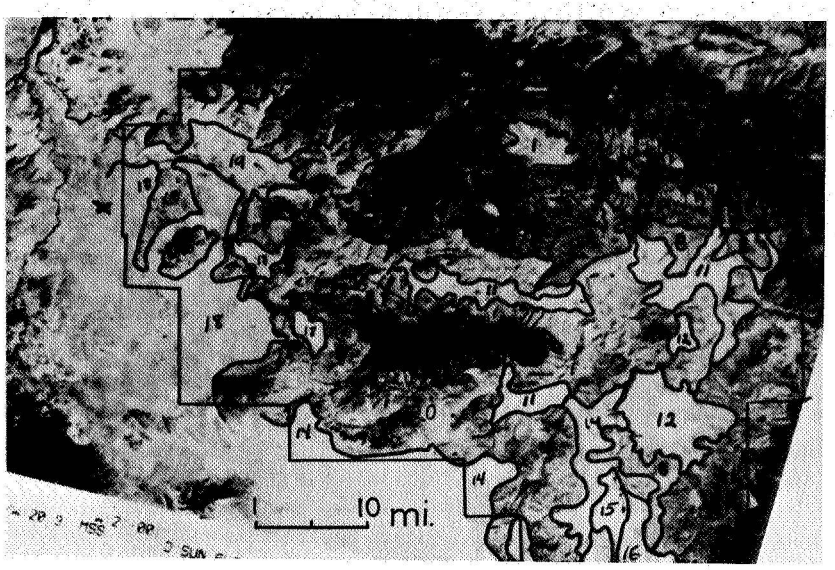

Figure 3. Vegetation and land-use in Crook County, Oregon, showing 17 classes. ERTS frame 1076-18211--4, 5, 6

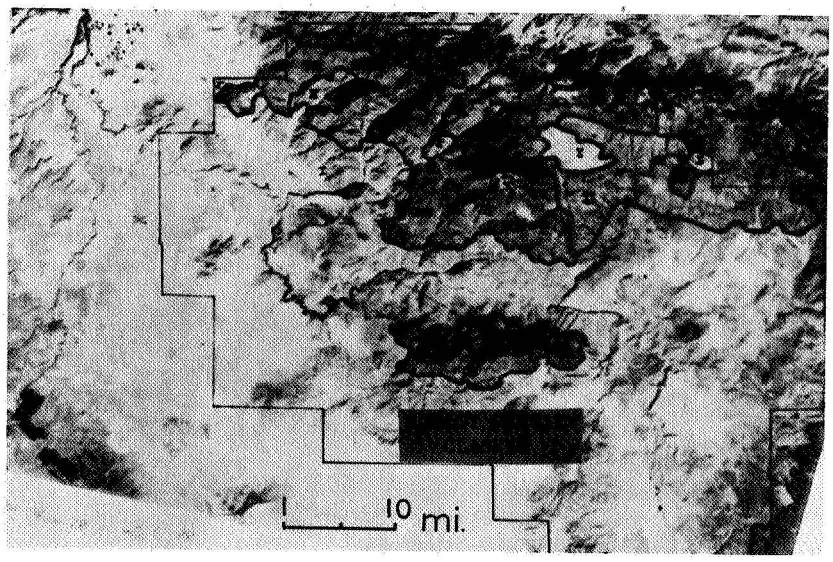

Figure 4. Forest density types in Crook County, Oregon, showing 5 classes. ERTS frame 1076-18211--4, 5, 6

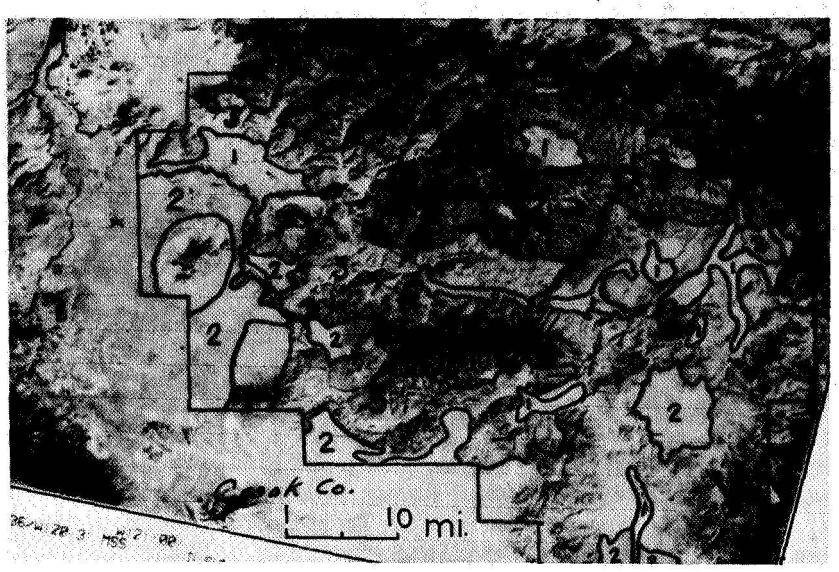

Figure 5. Land resource units for Crook County, Oregon, showing 5 classes. ERTS frame 1076-18211--4, 5, 6 (partial classification shown)

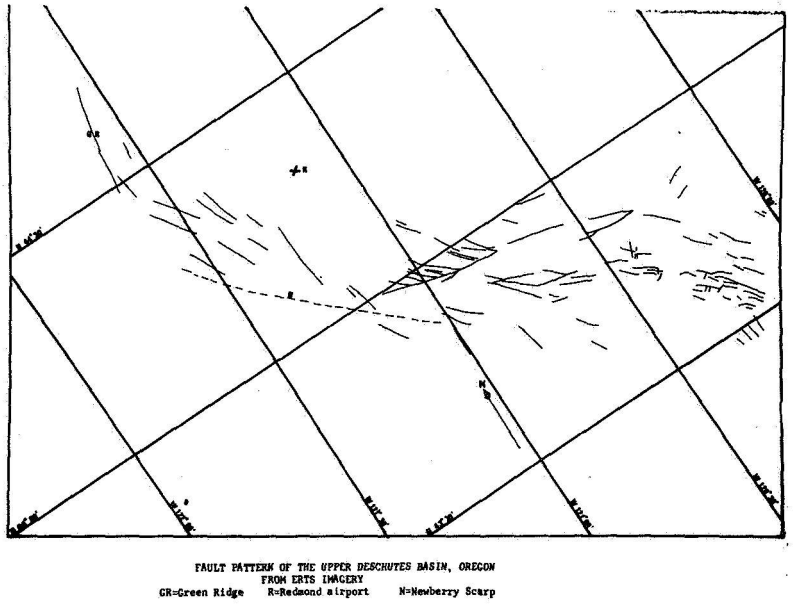

Figure 6. Fault pattern of the upper Deschutes Basin, Oregon.

APPENDIX

Abbreviated Legends for Figures 1 through 4, delineated on ERTS Imagery at 1:1,000,000 scale.

Figure 1. Geology

1. Alluvium and unconsolidated terrace materials
2. Unconsolidated fan gravels
3. Rim basalts, resistant plateau formers
4. Silicic to andesitic, shallow intrusions and domes
5. Weakly consolidated tuffs and tuffaceous sediments
6. Columbia River basalts - resistant bedrock
7. Clarno and John Day Formations, weak, easily eroded bedrock
8. Paleozoic and Mesozoic rocks, mixed bedrock types

Figure 2. Soil-Landscape Units

1. Deep, silty and loamy soils on floodplains and terraces
2. Mod. deep and shallow loamy soils, with hardpan, on alluvial fans
3. Mod. deep and shallow, sandy and loamy soils on lava flows
4. Shallow, stony, loamy soils on gently rolling volcanic plains
5. Mod. deep and shallow clayey soils in rolling uplands
6. Shallow and mod. deep clayey soils and rock, in steeply rolling upland
7. Shallow and very shallow, stony soils, in dissected, rolling uplands
8. Shallow stony soils and mod. deep loamy soils in steeply rolling upland
9. Very shallow stony soils on level to rolling lava plateaus; interspersed with mod. deep, loamy soils on north slopes
10. Mod. deep, loamy and clayey soils in steeply rolling mountains
11. Mod. deep and deep loamy soils, on north slopes, above 4500 ft. elev.
12. Shallow stony soils and cliffs, in major canyons

Figure 3. Vegetation and Land Use Classes

1. Meadows
2. Low Sagebrush/Ponderosa pine
3. Ponderosa pine/Low Sagebrush
4. Ponderosa pine
5. Meadow/Low Sagebrush/Douglas-fir
6. True Fir and Mixed Conifer Types
7. Ponderosa pine/Juniper
8. Low Sagebrush/Big Sagebrush
10. Big Sagebrush/Low Sagebrush
11. Big Sagebrush/Cover Crops
12. Low Sagebrush
14. Tall Sagebrush
15. Rangeland Seedings/Cover Crops/Greasewood
16. Tall Sagebrush
18. Western Juniper
19. Cover Crops
20. Juniper/Low Sagebrush/Tall Sagebrush

Figure 4. Forest Density-Type Classes

1. Less than 10% stocked with commercial trees, or nonstocked
2. Poorly stocked - mostly Ponderosa pine
3. Poor to medium stocked - mixed larch and Ponderosa pine
4. Medium to well stocked - Douglas-fir, larch and true fir
5. Very well stocked - mostly true fir on north facing slopes