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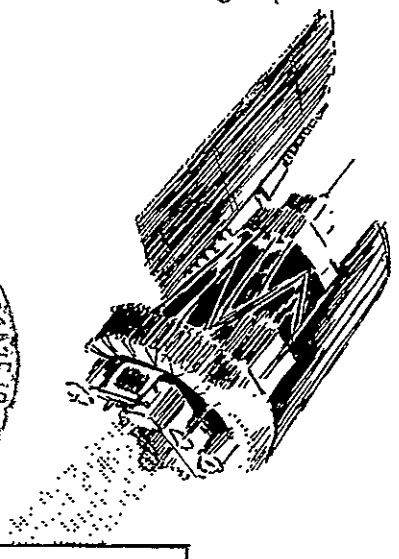
Remote Sensing Research and Applications in Oregon



SEVENTH YEAR PROJECTS AND ACTIVITIES

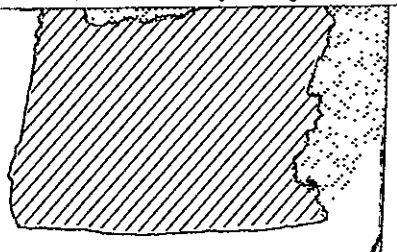
OF THE

ENVIRONMENTAL REMOTE SENSING APPLICATIONS LABORATORY

(ERSAL)

by

Gary L. Benson and Barry J. Schrumpf



COORDINATED BY THE ENVIRONMENTAL REMOTE SENSING APPLICATIONS LABORATORY.

OREGON STATE UNIVERSITY

Environmental Remote Sensing Applications Laboratory
Oregon State University
Corvallis, Oregon
97331

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ANNUAL PROGRESS REPORT TO:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF UNIVERSITY AFFAIRS
WASHINGTON, D. C. 20546

For the Period
1 April 1978 through 31 March 1979
Under NASA Contract No. NGL 38-002-053

In cooperation with State, County, and Municipal Governments, with Councils of Government, and with Federal Agencies in the State of Oregon.

ACKNOWLEDGEMENTS

The work reported in this document is the result of contributions by many people at the Environmental Remote Sensing Applications Laboratory and various state and county agencies, as well as NASA and other federal agencies. Acknowledgement of specific agencies by name is made in the text. ERSAL staff members who have contributed to this report include the following:

C. J. Alexander
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M. J. Hall
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Environmental Remote

Sensing Applications Laboratory

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SUMMARY

The purpose of ERSAL is to work in cooperation with the public agencies in Oregon to develop applications utilizing remote sensing technology so decisions can be made and acted upon directly by those agencies, resulting in regulatory activity or on-the-ground activity. ERSAL helps familiarize public agency personnel with this technology so they may more effectively utilize it for ground-based decision-making now and in the future.

The long-term objectives of ERSAL are to:

1. Extend remote sensing applications information, and technology to new potential users and beneficiaries for use as a key decision-making tool.

2. Use remote sensing technology to solve practical problems in:

    a. resource management
    b. resource allocation
    c. urban development
    d. agricultural practices

3. Maintain a center and browse file of NASA imagery in Oregon.

4. Provide consultation and instruction to those seeking advice on image analysis and remote sensing.

5. Identify and investigate research needs that are oriented to remote sensing applications.

6. Help coordinate remote sensing activities and projects among local, state, and federal agencies within the State of Oregon.

ERSAL has continued to orient its project development and application work toward those projects that result in applications and decisions made directly by the user agency in a relatively short period of time. ERSAL is maintaining a working relationship with those state and federal agencies in Oregon having strong regulatory functions and extensive resource management functions. ERSAL is also developing a working relationship with the new personnel in the above agencies as administrations change and personnel transfer within these agencies.

Project development work with these agencies has been and is being conducted to identify those projects where decisions can be derived using remote sensing technology and determining those agencies that can implement directly upon those decisions.

The following are the more significant accomplishments during the reporting period:

ERSAL Projects for the NASA Office of University Affairs

1. Western Oregon Timber Clearcut Monitoring Project -- The Timber Assessment Division of the Oregon Department of Revenue is utilizing LANDSAT enlargements to monitor new clearcuts on privately-owned lands in Western Oregon. The Timber Division will be using the LANDSAT information to maintain its new responsibility of enforcing a new timber tax law that went into effect January 1978. Positive and negative LANDSAT images from different dates are being compared to detect the new clearcuts. Staff in the Timber Division will be trained to interpret and map data from the LANDSAT images for possible use as an operational system.

2. Columbia River Water Policy Project -- NASA U-2 photography and LANDSAT false color composites were used to map four categories of land use over a 7,000 square mile area in northeast Oregon. This information has been used in an economic analysis to project future water uses for this area. This information is being used by the Oregon Water Policy Review Board so they can adopt a formal Water Policy that would regulate withdrawals from wells and streams, establish minimum streamflow regulation, and enforce water rights. This project demonstrated to the Water Resources Department how remote sensing could be used to map current land use for large areas of land. As a result, the Department has contracted ERSAL to map seven categories of land use for the entire State of Oregon.

3. Land Use Monitoring Projects for Tax Assessment -- Landsat Return Beam Vidicon (RBV) and Multispectral Scanner (MSS) imagery is being utilized by three County Assessors Offices to monitor agricultural land use changes and to update their tax assessment, on an annual basis. Map overlays provided by ERSAL are being used in combination with 4X Landsat image enlargements primarily to follow changes in land use from range land or dry farmland to irrigated cropland. The map overlays enable the Assessors to continue to monitor agricultural developments on Landsat images acquired in the future.

4. Oregon Fire District Map Updating Project -- Landsat-3 RBV imagery is being provided to the Mapping Division of the Oregon Department of Forestry to update fire protection maps. The imagery is being composited with Forest District Maps to show new roads and current vegetation patterns. These composite maps will be used for fire control purposes, forest insect and disease control work, as well as recreational usage.

Cooperative Projects Funded by Agencies other than NASA

1. State-wide Land-use Inventory -- NASA U-2 color infrared photography and multi-date Landsat false color composites are being used to map seven categories of land use in 15 of Oregon's 18 drainage basins. The results of this mapping will be used for irrigation feasibility studies. These studies are needed to establish formal water policies which are used to regulate the water use in each basin. This work is being done for the Oregon Water Resources Department.

2. Columbia Basin 208 Study -- ERSAL is conducting a surface cover/land use inventory of a 6.2 million acre region in North-central Oregon for the U.S. Soil Conservation Service. The information from this study will be used in a non-point source pollution study. The primary data source is Landsat MSS digital data, with secondary data sources being: Landsat false color composites, Landsat-3 RBV enlargements, NASA U-2 color infrared photography, standard orthophotography, and ground surveys.

I. THE ERSAL PROGRAM

INTRODUCTION

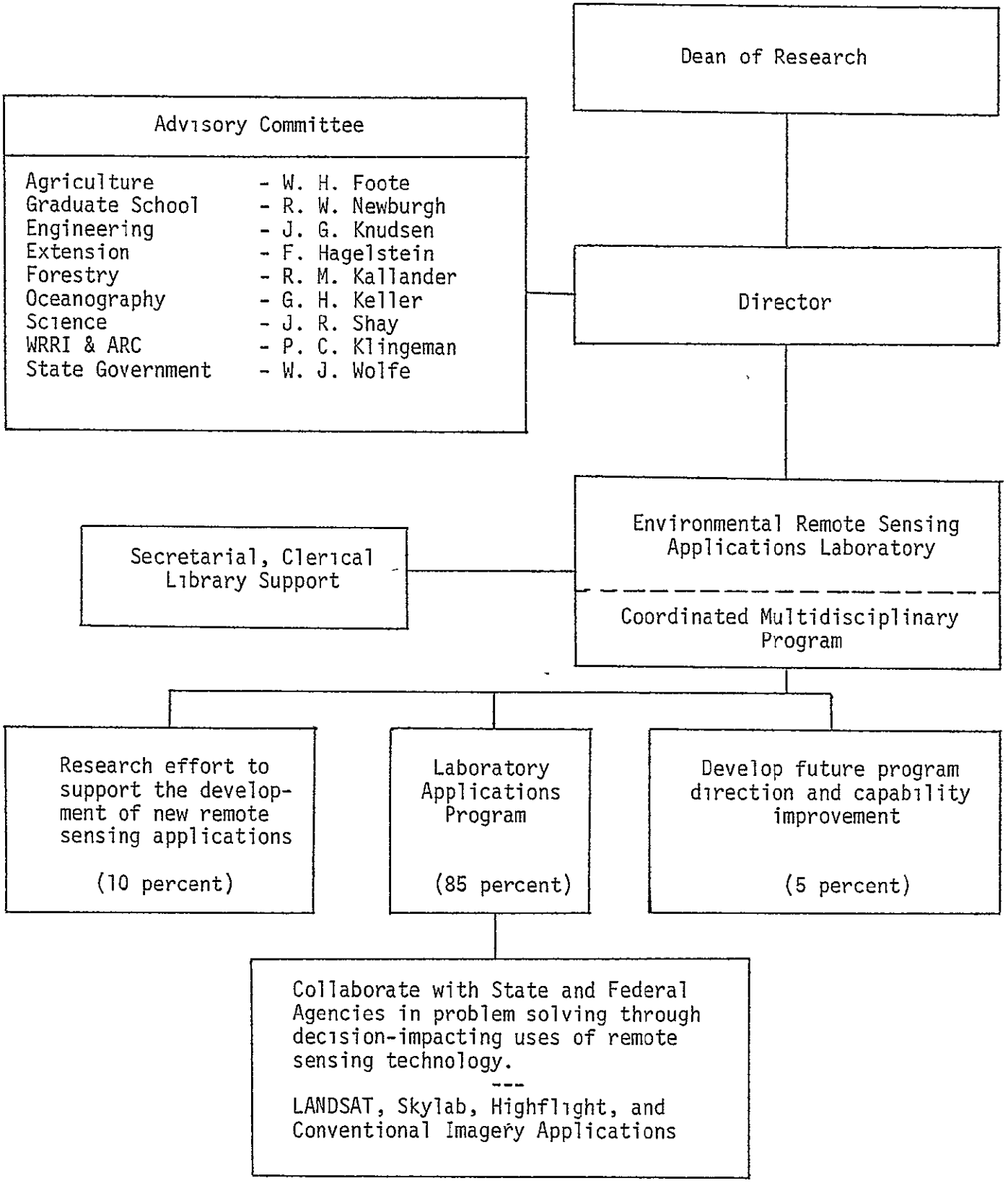
The Environmental Remote Sensing Applications Laboratory has been acquainting federal, state, county, and local agencies with remote sensing technology and its applications since 1972. Since that time, the personnel of ERSAL have been conducting applications projects with many of these agencies demonstrating the utility and effectiveness of remote sensing to provide the information necessary to make decisions. ERSAL is now orienting its applications project development with those agencies that can make decisions within their own agency and bring about on-the-ground effects due to remote sensing input.

ERSAL has conducted application projects that have involved many disciplines with the primary emphasis on management of natural resources. The personnel of ERSAL have also discussed the various aspects of remote sensing and its application with agencies, groups, and private individuals so they can become more knowledgeable about remote sensing and help in the development of new applications. This report deals primarily with the projects and activities that have taken place at the Environmental Remote Sensing Applications Laboratory during the period 1 April 1978 through 31 March 1979.

ORGANIZATION

The Environmental Remote Sensing Applications Laboratory is organized as a unit under the Office of the Dean of Research giving ERSAL the status of a university-wide laboratory (see Figure 1). The organizational plan of ERSAL allows much interaction of its personnel with Oregon State University faculty members from many disciplines. This input has provided many ideas for applications work or improvement of techniques currently used.

FIGURE 1: ORGANIZATIONAL PLAN AND FUNCTIONAL OPERATIONS CHART FOR THE ENVIRONMENTAL REMOTE SENSING APPLICATIONS LABORATORY AT OREGON STATE UNIVERSITY.



FACILITIES AND PERSONNEL

The physical facilities from which the ERSAL staff operate are: a main work room, a computer analysis and office room, a photographic copying and darkroom, and a main office including the Director's office, the reference library and secretarial-administrative office space.

The main workroom of the Laboratory is equipped with large tables and light tables which provide centralized work surfaces. The main workroom and a drafting table in the reference library are equipped with cartographic equipment so mapping and cartographic work can be carried out. The main workroom houses the film library which consists of all the NASA-flown aerial photography over Oregon, and files of Landsat imagery (both 70mm and 9"x9" four-band positive transparencies).

Eight map cases in the main workroom hold imagery enlargements, photomosaics, and topographic and planimetric maps used for general reference and project preparation. They also hold project results such as Landsat computer maps, NASA U-2 photointerpretation maps, and associated project results which are used for reference and demonstration to user agencies as examples of remote sensing utilization. A large supply storeroom off the main laboratory provides for additional map and project materials storage with easy accessibility.

Image viewing and analysis is facilitated by several stereoscopes, including three Old Delft stereoscopic scanners and a Bausch and Lomb zoom transferscope. ERSAL has acquired two Federal surplus photointerpreter units which have the capacity for viewing aerial roll film stereoscopically. These units provide additional training and analysis space for user agency personnel when they are conducting projects with ERSAL.

The computer analysis and office room has a magnetic tape drive and a paper tape reader interacting with the Varian 71 minicomputer, Hazeltine 2000 visual

display terminal and Statos electrostatic printer/plotter at our facility. This combination of equipment has greatly improved the quality and increased the variety of output products which can be developed by computer mapping from Landsat data. This equipment has enabled ERSAL to produce computer maps that closely approximate conventional maps. This approach results in better utilization of the maps by the user agencies. The equipment has also provided ERSAL with the capability of producing accurate computer maps at reduced expense which makes utilization of Landsat digital data more practical from the user's standpoint.

The Laboratory is directly linked with the CDC 3300 and the CDC CYBER-73 computers at the Oregon State University Computer Center. ERSAL has ready access to the available digital processing programs and the two computers through the ERSAL display terminal or through an adjoining computer remote terminal room. The Laboratory's direct link with the computers and computer programs provide interactive processing of Landsat digital data using either ERSAL's printer/plotter or on the Computer Center's line printers.

A photographic dark room is available for experimental testing of photographic techniques and for limited production work. The photographic copying room houses a Polaroid MP-3 copy camera for film copying and a GE Ozamatic Ozalid machine which is used to make inexpensive, high-quality color composites of Landsat imagery.

Part of the browse file service to visitors in the file is microfilm Landsat imagery for both U.S. and non U.S. coverage. A microfilm reader is available in the office library along with the Landsat reference catalogs. A growing collection of NASA reprints on microfiche is also available for visitor use.

Mr. Dennis Isaacson (agronomist, statistician) has joined the staff as a full-time Research Assistant. He will assist in project development especially for project design and sampling procedures involved in the applications projects. Dr. John Mairs (geographer) has left his position here as Research Assistant to

assume a remote sensing teaching position on the faculty at Southern Oregon College, Ashland. Mr. Glen Miller also left the staff to work for the Bureau of Indian Affairs in Carlos, Arizona.

Dr. Barry Schrumpf is the ERSAL Director. The following resource analysts: Cassandra Alexander, Gary Benson, Madeline Hall, RJay Murray, and Larry Warnick assist visitors, coordinate project initiation and development, and perform the majority of the project work.

The support staff at ERSAL includes a secretary, a clerk-typist, and technicians skilled in areas such as manual imagery interpretation, computer programming, graphic arts, and photographic and ozalid operations.

Resumes of operational staff are included in the Appendix.

HIGH ALTITUDE FLIGHT COVERAGE

In 1978, the central portion of Oregon State was photographed from the NASA U-2 plane. Figure 2 illustrates the area flown by facilities of the NASA aircraft program.

The 1978 photography is virtually cloud-free and effectively replaces the U-2 photography obtained over the same area during 1973. The 1973 photography was so badly underexposed that it is unusable for applications projects and represented a very large gap in U-2 photographic coverage of the State. The 1978 photography effectively fills this gap and, with the exception of clouded portions of the 1976 U-2 photography, completes U-2 photographic coverage of Oregon.

The 1978 U-2 photography covers large areas of forestland located on the east side of the Oregon Cascade Range and lower mountainous regions of Central Oregon. It also covers the extensive area of rangeland and dry farmland that is typical for this portion of Oregon.

Some of the range and farm areas are marginal, economically, for this type of land use, but have strong potential for subdivision and development

1978 High Altitude Photographic Coverage of Oregon

Figure 2

into vacation and retirement homes. Since there is a tremendous range of recreational possibilities in Central Oregon, the pressure to build recreational home developments has been quite high. Various state, regional and county agencies must monitor and regulate the recreational housing development. The 1978 U-2 photography covers many of these areas of development and will be quite valuable in developing applications projects with the pertinent regulating agencies.

LAB VISITORS

During the reporting period, ERSAL has carried out an analysis of usage and visitation of our facility. Visitors to the lab were requested to voluntarily enter their names and affiliation into a guest book. Since not all visitors remembered, or declined to register, the analysis represents only a portion of the Lab's visitation. The analysis is illustrated in Table 1.

Since its beginning, ERSAL has been visited by many staff members from various county, regional, state and federal agencies. They have become acquainted with the remote sensing materials we possess and our capabilities which include being able to provide information about current remote sensing data availability and remote sensing applications activities occurring within the State. The remote sensing data information provided can include conventional aerial photography, NASA U-2 photography, satellite data and other types of remote sensing imagery such as thermal infrared scanning and side-looking radar imagery.

After becoming familiarized with ERSAL's capabilities and it's staff proficiency, these agency personnel now telephone in their information requests rather than visit ERSAL personally. Agency use of ERSAL's services amounted to approximately 200 telephone information requests during the current reporting period. As a consequence, these requests represent a large portion of Oregon agency usage of ERSAL's service that should be noted along with the visitation totals.

Table 1:

Analysis of Visitors to the Environmental Remote Sensing Applications Laboratory, 1 April 1978 through 31 March 1979*.

Disciplines	University	City or County	State	Federal	Private	TOTAL
Agriculture & Soils	5	1		9		15
Botany	2					2
Environment/Conservation	1	3	2	4	4	14
Engineering & Power	2		1	5	1	9
Fisheries & Wildlife	13		27	10		50
Forestry & Range	10		4	16	1	31
Geography	57					57
Geology & Hydrology	5		1		5	11
Parks & Recreation	1		1			2
Planning		4	2	1	1	8
Remote Sensing Applications	1		14	2	2	19
Water Resources	1		10			11
Biology	3					3
Oceanography	10					10
Landscape Architecture	3					3
Cultural Resources	4			1	1	6
Revenue		1				1
Other	5				15	20
TOTAL	123	9	62	48	30	272

* Based upon voluntary registration in guest book.

INVOLVEMENT WITH OREGON AGENCIES AND ORGANIZATIONS

The form of involvements that ERSAL has with Oregon agencies and organizations varies considerably from one group to another and extends from providing short responses to single inquiries to engaging in long term, complex projects. The following summary provides some insight into the forms of involvement that have developed with specific agencies. Minor assistance usually involves providing help with imagery, explanation of remote sensing techniques and satellite systems, or direction regarding where to turn for additional help other than that which ERSAL can provide. A significant contact goes beyond minor assistance and usually involves initial levels of training, some use of ERSAL facilities (1 day to 2 weeks), and use of imagery by the visitor to gather information for some specific purpose. A cooperative project involves work with the agency to identify a resource management/regulatory problem that will meet the criteria for project assistance from ERSAL and then to conduct the project. These levels of involvement have caused some agencies to provide funding from their own budgets for conducting remote sensing projects. In some cases ERSAL has served as the contractor. A summary table of contracted projects supported by sources other than the NASA University Program is presented later in this report in the section titled "ERSAL Projects Funded through Outside Agency Support".

Agencies/organizations in Oregon with whom ERSAL has had or provided:

	Cooperative Projects	Significant Contact	Minor Assistance
Federal			
Dept. of Agriculture			
Agricultural Stabilization & Conservation Service			X
Forest Service			
Region 6 Headquarters		X	X
State & Private Forestry	X		

Federal, cont'd.	Cooperative Projects	Significant Contact	Minor Assistance
Fremont National Forest			X
Malheur " "		X	X
Mount Hood " "		X	X
Ochoco " "	X		
Siskiyou " "			X
Umpqua " "	X		X
Willamette " "			X
Winema " "			X
Pacific Northwest Forest and Range Experiment Station			
Wildlife Habitat Lab			X
Forest Sciences Lab		X	X
Soil Conservation Service			X
Dept. of Army			
Corps of Engineers	X	X	X
Dept. of Commerce			
National Oceanic & Atmospheric Administration			
National Marine Fisheries Service			X
Dept. of Energy			
Bonneville Power Administration	X	X	X
Environmental Protection Agency			
Corvallis Environmental Research Lab		X	X
Dept. of Interior			
Fish & Wildlife Service			
Biological Services			X
Ecological Services	X		X
Finley Wildlife Refuge			X
Sheldon-Hart Mountain Wildlife Refuge			X

	Cooperative Projects	Significant Contact	Minor Assistance
Federal cont'd.			
Geological Survey			
Water Resources Division	X		X
Bureau of Indian Affairs			X
Bureau of Land Management			X
Bureau of Mines			X
National Park Service		X	X
Bureau of Reclamation		X	
Pacific Northwest River Basins Commission		X	X
Interstate/regional			
Columbia Region Council of Governments			X
Pacific Northwest Regional Commission		X	X
State			
Dept. of Agriculture	X	X	X
" " Energy			X
" " Environmental Quality	X	X	X
" " Fish & Wildlife		X	X
" " Forestry	X	X	X
" " Geology & Mineral Industries		X	X
" " Land Conservation & Development		X	X
" " Revenue	X	X	X
" " Transportation			
Environmental Section	X	X	X
Highway Division	X	X	X
State Parks		X	X
Dept. of Water Resources	X	X	X
Dept. of State Police			X

	Cooperative Projects	Significant Contact	Minor Assistance
State, cont'd.			
Division of State Lands			X
" " Emergency Services			X
" " State Health			X
Executive Department			
Budget Division		X	
Natural Resources Assistant			X
Coastal Conservation & Development Comm.		X	X
Military Department			X
Natural Area Preserves Advisory Committee	X	X	X
Soil & Water Conservation Commission			X
State Fair		X	
Intercounty			
Mid-Willamette Council of Governments		X	X
Umpqua Regional " " "			X
Lane " " "			X
Benton-Linn Counties Council of Gov.			X
Central Oregon " "	X		
Counties			
Baker Co. Extension Office			X
Benton Co. Assessor's Office			X
Health Dept.			X
Mountain Rescue			X
Planning Dept.	X		
Vector Control			X
Clackamas Co. Dept. of Public Works		X	X
Clatsop Co. Planning Dept.			X
Clatsop Plains Study Task Force	X		

Counties, cont'd.	Cooperative Projects	Significant Contact	Minor Assistance
Coos Co. Planning Dept.			X
Crook Co. " "	X	X	X
Curry Co. Assessor's Office			X
Deschutes Co. Assessor's Office	X		X
Douglas Co. Engineer's Office			X
Soil Scientist			X
Gilliam Co. Assessor's Office			X
Grant Co. Extension Office		X	X
Natural Resource Council		X	
Hood River Co. Forest Dept.			X
Jackson Co. Extension Office		X	
Jefferson Co. Planning Dept.	X		
Josephine Co. Assessor's Office			X
Extension Office			X
Klamath Co. Assessor's Office			X
Planning Dept.		X	
Lake Co. Assessor's Office	X		
Planning Commission	X		
Lane Co. Environmental Health Dept.			X
Vector Control			X
Water Pollution Control			X
Lincoln Co. Planning Dept.		X	X
Linn Co. " "		X	X
Morrow Co. Assessor's Office	X		
Polk Co. " "			X
Planning Dept.			X
Tillamook Co. Extension Office			X

	Cooperative Projects	Significant Contact	Minor Assistance
Counties, cont'd.			
Umatilla Co. Assessor's Office	X		X
Planning Dept.			X
Wasco Co. Assessor's Office			X
Washington Co. Assessor's Office			X
Planning Dept.	X		
Yamhill Co. " "			X
Cities			
Corvallis Fire Dept.			X
Eugene Water & Electric Board			X
Lincoln City Planning Dept.			X
Portland Planning Dept.	X		
Educational			
Oregon State University, incl.:		X	X
Agricultural Experiment Station			
Air Resources Center, Agronomic			
Crop Science, Agricultural			
Chemistry, Agric. & Resource			
Economics, Agric. Engineering			
Technology, Anthropology,			
Atmospheric Sciences,			
Biochemistry/Biophysics,			
Botany & Plan Pathology,			
Business, Civil Engineering,			
Computer Center, Cooperative			
Wildlife Research Unit, Dean of			
Research, Economics, Electrical			
& Computer Engineering, Fish &			
Wildlife, Forest Management,			

	Cooperative Projects	Significant Contact	Minor Assistance
Educational, cont'd.			
Oregon State University, cont'd.			
Forest Research Lab, Geography, Geology, Herbarium, Landscape Architecture, Library, Microbiology, Oceanography, Rangeland Resources, Recreational Resource Management, Science Education, Seed Certification, Soil Science, Statistics, Water Resources Research Institute, Zoology			
University of Oregon		X	X
Portland State University			X
Oregon College of Education			X
Oregon Institute of Technology			X
Southern Oregon State College		X	X
Central Oregon Community College			X
Clatsop Community College			X
Linn-Benton " "			X
Southwest Oregon Community College			X
Treasure Valley " "		X	X
Umpqua " "			X
Private			
Albany Democrat-Herald		X	
Bohemea Realty			X
Boise Cascade Corp.	X		
Brooks-Scanlon			X
CH_2M-Hill			X

Private cont'd.	Cooperative Projects	Significant Contact	Minor Assistance
Consumers Power, Inc.			X
Corvallis Gazette Times		X	
Crop Protection, Inc.		X	
Dick White - Consulting Geologist			X
Foundation Sciences, Inc.			X
Hewlett Packard Corp.			X
Insight Reconnaisance			X
John Hook - Consulting Geologist		X	X
Larry Wilkinson - Consulting Engineer			X
Montagne-Bierly Assoc.		X	X
Moreland, Unruh, & Smith			X
Nature Conservancy		X	X
Oregon Archaeological Society			X
Oregon Farmer-Stockman		X	X
Oregon Natural Heritage Program		X	X
Pacific Northwest Bell			X
Portland Power & Light Co.		X	X
Professional Timber Management			X
Seton, Johnson, & Odell, Inc.			X
Spectrum Color Lab			X
Western Ways		X	X
Wilsey & Ham Consultants			X
Woodward-Envicon Portland			X
ZX Ranch		X	

NEWSLETTER PUBLICATION

A newsletter is prepared at ERSAL and distributed to organizations within Oregon. The content includes an explanation of the NASA supported program conducted at ERSAL, brief descriptions of completed applications projects, updates on remote sensing data gathering systems, and lists of important dates and happenings in remote sensing. The distribution list of over 650 addresses is quite comprehensive and includes:

a) in each of Oregon's 36 counties (120 addresses)
   - Cooperative Extension Service
   - County Tax Assessor
   - County Planning Office
   - County Parks and Recreation
   - County Soil Scientist
   - County Forester

b) several divisions, sections, etc., of each of the following state agencies/organizations in offices throughout the state (213 addresses)
   - Department of Agriculture
   - " " Energy
   - " " Environmental Quality
   - " " Fish and Wildlife
   - " " Forestry
   - " " Geology and Mineral Industries
   - " " Land Conservation and Development
   - " " Revenue
   - " " Transportation
   - " " Water Resources

- Division of State Lands
- " " Emergency Services
- " " Intergovernmental Relations
- State of Oregon Military Department
- Office of Intergovernmental and Public Affairs
- Information and Program Analysis Section
- State Health Planning and Development Agency
- " Librarian
- " Soil and Water Conservation Commission
- " Tax Commission
- Port of Portland Commission
- Pacific Marine Fisheries Commission
- Columbia River Gorge Commission
- Oregon Nuclear and Thermal Energy Council
- " Environmental Council
- " State Marine Board
- Board of Geologists
- Columbia Region Association of Governments
- Mapping Committee on Natural Resources

c) several divisions, etc., of federal agencies in offices throughout the state (185 addresses)

- Agricultural Marketing Service
- " Research Service
- " Stabilization and Conservation Service
- Army Corps of Engineers
- Bureau of Indian Affairs

- Bureau of Land Management
- " " Mines
- " " Reclamation
- Environmental Protection Agency
- Federal Highway Administration, Region 10
- Fish and Wildlife Service
- Forest Service

  Region 6 Headquarters

  National Forests Headquarters

  Ranger Districts

  Pacific Northwest Forest and Range Experiment Station
- Geological Survey
- National Marine Fisheries Service
- " Park Service
- " Recreational Areas
- Soil Conservation Service

d) state and federal government (69 addresses)

- Governor
- Executive Department
- Several state legislators
- Legislative Administration Committee
- " Research
- " Committee on Trade
- Secretary of State
- Governor's Assistant for Natural Resources
- Oregon's Congressional Delegation to the U.S. Congress

e) additional recipients (79 addresses)

- Individuals teaching remote sensing/photointerpretation/photogrammetry throughout Oregon
- Oregon Museum of Science and Industry
- State Councils of Governments
- State Economic Districts
- Oregon Agricultural Experiment Stations
- Commodity Commissions
- Pacific Northwest River Basins Commission

PROJECT INITIATION AND OPERATION

ERSAL has established and maintained effective communication with federal, state, and local agencies in the State of Oregon. Contact is maintained by meetings at their offices, at the Lab, or via phone conversations so continuity is maintained regarding projects they may have underway. During the last year, ERSAL has continued to make potential users aware of the current technology and practical applications of remote sensing. A concerted effort has been made to acquaint potential user agencies with the higher resolution return beam vidicon (RBV) imagery now available from Landsat 3, and explore application possibilities using this new information source.

ERSAL has developed applications projects by first acquainting the potential user agency with remote sensing and how it could be applied. Involvement in an applications project can only begin after considerable consultation between ERSAL staff and the user agency. ERSAL then proceeds with an applications project only if the user agency can demonstrate a direct application from the remote sensing input and the user agency has a strong potential to implement upon the application results.

Projects engaged in by the laboratory have to have a very high potential for direct application, and the agency must agree to several conditions prior to project initiation. Agreement must be reached regarding initiation and termination dates, scale of investigation, types of resources analyzed, what the product(s) will be used for, and how soon application results would be implemented. Following receipt of the product, agencies are expected to indicate the use(s) to which they were put.

In line with ERSAL's current attitude toward project development, ERSAL has elected to become involved only in projects where the user agency would utilize the remote sensing information directly and because of the agencies' capability to regulate or implement, reach a decision to bring about or cause to bring about on-the-ground activity or enforcement.

II. ERSAL PROJECTS

A. COMPLETED PROJECTS FOR THE NASA OFFICE OF UNIVERSITY AFFAIRS

The following are reports on projects that have been completed by ERSAL, primarily during the period between 1 April 1978 and 31 March 1979. The locations of the completed NASA projects are indicated on Figure 3.

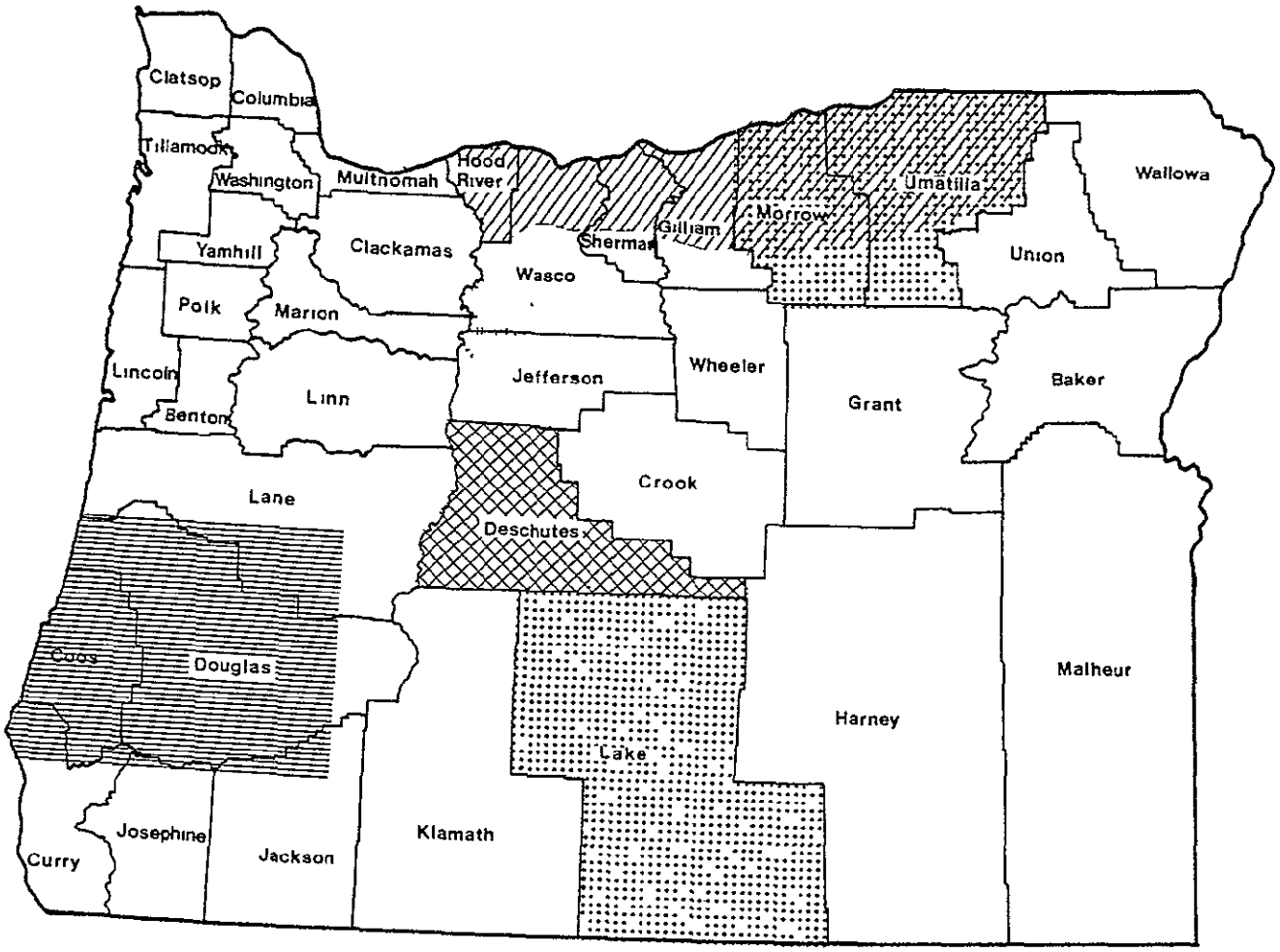
Columbia River Water Policy Project

This project has been described in detail in the Fifth and Sixth Annual ERSAL Report. This project has been carried out in cooperation with the Oregon Department of Water Resources (ODWR) to determine the agricultural land use in several northeast Oregon drainage basins for the purpose of regulating the surface water use of the Columbia River and its tributaries.

The Oregon Water Policy Review Board has been mandated by the Oregon Legislature to formulate a coordinated, integrated state water resources policy and provide for the enforcement of those policies adopted. Information and recommendations needed to form a water policy regarding a drainage basin (or basins) is provided by the Policy and Planning Division of the Oregon Department of Water Resources. When a Drainage Basin Water Policy is adopted by the Review Board, it has the effect of law regarding water rights and water usage for all land use categories. The Enforcement Division of the ODWR carries out the regulation and enforcement of the Water Policy provisions. Normally this involves maintenance of minimum streamflows, regulating withdrawals from wells and streams and enforcing established water rights.

The Water Policy Review Board had asked that the Policy and Planning Division carry out an evaluation of the present and projected land use of north-central and northeastern Oregon along the Columbia River and in the adjacent tributary basins. This area involved seven entire drainage basins, portion of two other drainage basins, and encompassed approximately 7,000

Sites of Projects being conducted for
NASA Office of University Affairs



- Columbia River Water Policy Project
- Assessors Office Land Use Monitoring Project
- Western Oregon Timber Clearcut Monitoring Project
- Warm Springs Indian Reservation Project
- Deschutes County Housing Monitoring Project

Figure 3

square miles. NASA U-2 color infrared photography and LANDSAT false color composites were used to map four categories of land use over this area. This information was combined with soil, hydrologic, and economic data to derive an economic analysis of the projected water needs for this area. The information from the economic analysis has been utilized by the Water Policy and Planning Division to develop a formal water policy for this area. The formal water policy includes all the information regarding future water use, maximum allowable surface water pumping, minimum stream flows, etc. This water policy was submitted to the Water Policy Review Board during Fall, 1978 for their examination, possible amendment and adoption as a formal Columbia River Water Policy.

The Water Policy Review Board has subsequently met and discussed the Water Policy submitted, and made amendments to it. They have prepared several draft versions of the policy for further consideration and possible adoption. The Board is currently deliberating formal water policies for several drainage basins throughout the state in addition to the seven basins analyzed in this project. Therefore, the Water Policy Review Board is likely to adopt formal water policies for only some of the individual drainage basins in the project area during 1979 and 1980. It is highly unlikely that the Board would adopt an overall Water Policy for the Columbia River in the near future except for the purpose of making a claim for a specified amount of Columbia River water for agricultural irrigation purposes. Rather the information derived from this project will be used by the Water Policy Review Board for Water Compact discussions and agreements with the States of Washington and Idaho, and the U.S. Army Corps of Engineers for use of Columbia and Snake River water.

Cottage Grove Watershed Project

This project has been described in detail in the Sixth Annual ERSAL Report. This project developed into two separate tasks using two different

types of remote sensing imagery for different objectives. The first task involved photointerpretation of aerial photography to locate and map log debris jams and areas of soil slippage. The second task involved computer assisted classification of Landsat digital data covering a specified watershed to show different cover classes and land use.

The location of this project was the 34,000 acre Layng Creek Watershed near Cottage Grove, Oregon. The Layng Creek Watershed is the water supply for the city of Cottage Grove, and the watershed is under the jurisdiction of the U.S. Forest Service. As a consequence, the Forest Service must regulate activities in the watershed (including logging) under the multipurpose doctrine while, at the same time, maintaining the water quality of the streams for use as a domestic water supply.

Logging has been allowed in this watershed since 1952 and, as a result, the logging activities have resulted in large amounts of waste or slash timber being washed into the streams forming log debris jams. Often these jams act as intermittent dams that cause localized flooding during high rainfall periods. This area is also subject to a great deal of soil erosion due to the heavy rainfall and runoff typical of this area.

As originally proposed, the Forest Service would have obtained shadow-less aerial photography during early Spring, 1979 just prior to leaf development of the deciduous tree and shrub species. This photography would then be used to locate log debris jams in stream bottoms and to map areas of road or soil slippage. Because the Forest Service had both the financial support and field crew ready to take immediate action based on remote sensing, ERSAL supported this portion of the project as originally proposed.

Shadow-less aerial photography (acquired under continuous overcast sky) could not be obtained because the proper weather condition did not develop during

the period the Forest Service had contracted for photography acquisition. Consequently the Forest Service decided to have conventional 1:5,000 scale (no overcast) color aerial photography flown just before leaf development of the deciduous plant species. The timing of the flight still allowed good visual interpretation of smaller stream bottoms normally obscured by the stream bottom plant species.

Photointerpretation of the color photography was carried out and the locations of log debris jams and soil slippage were mapped. The maps were forwarded to the Forest Service during Summer, 1978. Some of the log jams were field-checked by Forest Service personnel and it was determined that the aerial photography was not suitable for locating log jams in the smaller, more narrow streams in the watershed. In these streams, photointerpretation was not possible due to the steepness of the stream banks and over-hanging coniferous tree species which blocked any overhead view throughout the year.

The results of the photointerpretation study demonstrated that the magnitude of the log debris jam problem was far larger than they had anticipated. As a result of the study, the Forest Service is revising its log jam removal plan and the order in which specific log jams would be removed. One of the log jams located by photointerpretation was removed during Fall 1978. The work was done under a $2,000 contract issued by the Forest Service. Also several areas of soil slippage determined by photo-interpretation are going to be stabilized by re-seeding and replanting. This work is to be completed by October 1979 at an approximate cost of $ 6,000 and funded by the Forest Service. Other log jam removal and soil stabilization efforts based on ERSAL's information are planned for the work season in 1980.

The Forest Service also wanted to conduct a comprehensive examination of its management scheme for the Layng, Brice, and Sharps Creek Watersheds and from that study derive the optimal placement and size of timber sales in addition to determining the optimal number of years between timber cuts (timber rotation) in the same area. In the original proposal, ERSAL recommended that a Landsat MSS digital data analysis should be conducted for the watersheds using a late date of Landsat coverage (e.g. 1978) to be compared with historical photography over these watersheds.

After a series of meetings and discussions, it was decided that the Cottage Grove District Office would not be able to take action on information provided by LANDSAT analysis for at least two years. As a consequence, ERSAL could not support this phase of the project. However, the Cottage Grove District Office was quite interested in examining the potential utility of Landsat digital data analysis and, if they found it to be useful, would seek out and provide financial support for the project. ERSAL conducted a low-cost preliminary classification of one of the watersheds using one of the Landsat MSS digital tapes already in the ERSAL library. The preliminary classification was carried out without benefit of prior ground truth information. The results of the classification were later checked against actual ground site inspection and the two information sources were in good agreement considering the preliminary nature and rapid processing of the Landsat classification. A copy of the U.S. Forest Service comparison report is included in the Appendix of this report.

The Cottage Grove District Office was very impressed by the results and have submitted a proposal to the Washington, D.C. Office of the U.S. Forest Service to gain financial support for the project. The Washington, D.C. Office is currently selecting several "test" National Forests scattered throughout the U.S. for which financial support would be provided to conduct computer-assisted classifications of these forests using Landsat digital data. The results

from these studies would be examined to determine the potential use of Landsat data for all the National Forests.

The proposal submitted by the Cottage Grove District Office is one of the "test" forests being considered for project support. We are told that the "test" forests to be classified will probably be selected during 1979.

B. CONTINUING PROJECTS FOR THE NASA OFFICE OF UNIVERSITY AFFAIRS

The following are reports on projects that are continuing beyond the period 1 April 1978 through 31 March 1979. The locations of the continuing NASA projects are indicated on Figure 3.

Western Oregon Timber Clearcut Monitoring Project

This is a project with the Timber Assessment Division of the Oregon Department of Revenue (ODR) using comparisons of positive and negative single-band Landsat enlargements from different dates to monitor new timber clearcuts on privately-owned land. This project was reported in detail in the Sixth Annual ERSAL Report.

The State Department of Revenue is responsible for the assessment and taxation of all privately-owned forest lands. A tax law went into effect in Oregon on January 1, 1978 which states that timber on privately-owned land in Western Oregon will not be taxed until it is harvested, while the land on which timber is grown will be taxed annually according to a specified formula.

This change in the tax law has required the Timber Assessment and Taxation Division of the Department of Revenue to completely change their method of operation. The new lax law also places the responsibility of monitoring new timber cuts in Western Oregon on this division. This responsibility is being partially met by examining copies of harvest permits that landowners must file with the Oregon Department of Forestry when timber harvests are conducted. However, this system does not work effectively when contractors purchase standing timber from a property-owner, harvest and sell it, then move on to another state within a few months. In this case, it is the contractor, not the land-owner, who is responsible for taxes assessed on the timber. Also many land-owners with some farm operations will convert forest lands to meadow by cutting the timber but do not bother to obtain a harvest permit.

ERSAL and personnel from the Timber Assessment Division have been working together to examine the potential for an operational monitoring system in the Division that will use comparisons of positive and negative single-band Landsat multispectral scanning (MSS) images from different dates. By using this system, changes from year-to-year or for shorter intervals (as necessary) would be used to maintain the Division's monitoring responsibility.

A test area has been established for this project in the southwestern area of Oregon. This area was selected due to the extensive private timber land holdings and highly active timber industry present there. ERSAL personnel have compared late 1977 and mid-year 1978 Landsat MSS images and mapped the new timber clearcuts present on privately-owned lands. The timber division has related the new timber clearcuts to ownerships and checked their records to see if harvest permits have been issued for the timber cuts. Approximately 20 out of 83 new clearcut areas did not have harvest permits issued for them.

At present field personnel from the Department of Revenue are beginning to check the individual clearcut areas where no permit was issued. Initial responses from a few field checks indicate most of the cuts are of 10-20 acres in size and are conducted as field-clearing operations or small wood-lot cuttings. Most of the field checks have been conducted in the more easily accessible valley areas where a great deal of timber and agricultural practices intermix. Field checks in the less accessible high altitude pure timber areas will occur during summer 1979.

The results of the clearcut mapping have been well received by the Timber Division. Considering the small scale of the Landsat MSS images, the mapping accuracy has been quite good and most of the clearcuts with issued permits were detected, along with those having no permit.

The Timber Division is continuing to examine the results of the initial mapping effort as well as examining Landsat-3 Return Beam Vidicon (RBV) imagery

for more refined mapping detail. Due to higher resolving capability of the RBV imagery, the locations and boundaries of clearcuts can be delineated more accurately. This increased mapping accuracy would be quite helpful to the Division to ascribe the size and location of specific clearcuts to their ownership.

The Timber Division wants to continue with its examination of Landsat data for timber clearcut monitoring activities and obtain further information on the reliability of this approach. It is also examining the accuracy that is obtainable with this approach and the turn-around time involved between receiving mapped timber clearcut information and when the satellite obtained the raw data initially.

Forest Management Project for the Warm Springs Indian Reservation.

ERSAL is currently working with the Forestry Branch of the Bureau of Indian Affairs to develop applications using Landsat imagery and NASA U-2 photography. The Warm Springs Indian Reservation is a 650,000 acre reserve of land for the confederation of the Wasco, Warm Springs, and Paiute Indian Tribes. This reservation is located in north-central Oregon to the northwest of Madras, Oregon and is characterized by range and forestlands typical of the eastern slopes of the Oregon Cascades. Approximately 300,000 acres of the reservation is commercial timberland while the remainder is mixed forest and rangeland. Management of the commercial timberland is maintained by the Branch of Forestry, Warm Springs Agency of the Bureau of Indian Affairs (BIA). The Branch of Forestry formulates and carries out the forest management decisions and activities, hence, remote sensing information provided to this Branch can be implemented by them directly.

Portions of the reservation forest have been subjected to high winds during winter 1978, and several areas now exist where trees have either been broken off or toppled (known as blowdown areas). These areas become highly

susceptible to insect attack and, as the foliage and wood of the toppled trees desiccates, the fire danger for these areas increases.

ERSAL and Forestry Branch personnel are currently examining Landsat-3 RBV imagery and comparing it with 1978 NASA U-2 photography to determine if the location and extent of the timber blowdowns are apparent on the RBV imagery. If the blowdowns are readily seen, then the Forestry Branch will relate the locations of these areas to the nearest logging roads so salvage timber sales can be arranged for quick removal. The Forest Branch will determine if there is any detectable patterns to the blowdown areas, for example where certain sizes or orientation of clearcuts would make the trees bordering clearcuts susceptible to blowdown by strong prevailing winds. This information would be used to design future timber sales in a manner that would reduce the hazard of blowdown and their location. This information would then be used to design salvage timber sales that usually involve thousands of dollars.

Some members of the Forestry Branch will use the RBV imagery to update the fire protection maps within the reservation. Because the information from the RBV imagery is current, all new logging roads can be noted and added to the map, saving considerably on aerial photography costs for mapping purposes.

Portions of the reservation forest are being infested with the western spruce budworm, Choristoneura occidentalis, a forest insect pest which is the most destructive forest defoliator in Western North America (Furniss, R.L. and V.M. Carolin. 1977. Western Forest Insects. U.S. Department of Agriculture Miscellaneous Publication No. 1339). Approximately 25,000 acres of the reservation forest have been infested by the spruce budworm, and the Forestry Branch is conducting a spray program to bring the budworm under control. NASA U-2 color infrared photography was examined thoroughly by Forestry Branch personnel for use in the spraying program. However, the photography was not appropriate for demonstrating the boundaries between areas of light infestation

(seen by defoliation) and no infestation. This was the information needed to delineate the areas to be sprayed. Instead, ground inspection and insect trapping in sampling areas was required to delineate the spray area.

Land Use Monitoring Projects for Tax Assessment - Umatilla, Lake, and Morrow County Assessors' Offices.

Several County Assessors groups became interested in utilizing Landsat imagery when ERSAL personnel demonstrated the new RBV imagery available from Landsat-3. Since the RBV imagery has twice the resolving capability of the MSS imagery and provided more mapping potential, the Assessors became far more receptive to utilizing Landsat imagery. This receptivity was increased when it was demonstrated that combinations of Landsat-3 RBV and multi-year MSS false-color composites (FCC's) could be used for detecting and mapping:

a) new irrigated agricultural development,

b) continued year to year production on circle pivot irrigation systems (discontinued production can occur due to financial reasons, change of ownership, loss of water sources, excessive wind erosion, etc.),

c) conversion of rangeland to dryland agriculture,

d) reversion of dryland agriculture to rangeland, and

e) conversion of agricultural land to light industrial use.

The counties that had the greatest amount of interest were those that had rather rapid and large scale changes occurring in the agricultural areas of their county. These counties consisted of Umatilla, Lake and Morrow Counties. ERSAL provided Landsat imagery with mapping aids and assistance to these counties to acquaint them with the use and application of Landsat materials. Descriptions of the activities are provided below.

Umatilla County

The Umatilla County Assessor was provided with RBV 4X enlargements covering the county during the 1978 growing season. Transparencies with township-section grids were prepared to overlay with the RBV 4X enlargements. These transparencies facilitate locating agricultural land use change by ownership as well as being usable for current and future 4X RBV enlargements Also 4X enlargements of 1977 MSS images were provided along with mapping aids so new irrigation established between the 1977 and 1978 growing seasons could be detected. Personnel in the Assessor's office compared the Landsat data with their records during February 1979 and discovered that 40 new central pivot irrigation circles (approx. 130 acres each) had been established that they were not aware of. This was an area they had not planned to field check during 1979. As a consequence, they would not have been aware of these new circles except through the use of the Landsat data. These new circles represent dry rangeland being converted to intensive irrigated agriculture for the production of potatoes, small grains, corn and alfalfa. The assessed value of these circles changed from $2/acre to $650/acre. These circles represent an agricultural land use change for approximately 4,900 acres and an increased assessed valuation in the county of approximately 3.2 million dollars.

Personnel in the Assessor's Office also noted many new small areas of irrigation where more conventional methods of irrigating are used, e.g. wheel lines, or hand set lines. The Assessor's Office is currently locating and tabulating these smaller areas of irrigation, as well as examining the Landsat data for other types of agricultural land use changes.

Lake County

In a manner similar to the Umatilla County Assessor, the Lake County Assessor was provided with mapping aids and RBV 4X enlargements that covered

Lake County during the 1978 growing season. By comparing the County tax records with the 1978 RBV enlargements, the County Assessor determined that eleven new irrigation circles, approximately 130 acres in size, had been established during 1978.

Lake County is higher in elevation than Umatilla County and is more subject to frost during the growing season. As a result, irrigated crops in this county consist primarily of hay, with little or no grain crops. The assessed value of irrigated land is also lower in value at $220/acre. The Assessor noted that approximately 1500 acres had been placed under irrigation during 1978 and this represented an increased valuation in the county of $325,000.

The Assessor used the 4X RBV enlargements to physically locate the new circles, then survey them for an accurate acreage determination. He also noted some areas of newly irrigated land where wheel line irrigation was being used.

Morrow County

Staff of the Morrow County Assessor's Office had already utilized Landsat MSS images and recognized the considerable improvement in resolution present in the RBV images. When 1978 RBV images were demonstrated to them, they noted there was no significant addition of irrigated agriculture in the county that year. However, they did note the establishment and approximate acreage of a cooling pond for a newly established power plant. The RBV images provided them with information about the location, ownership and acreage of the pond. This represented a land use change from agricultural land under farm use to a light industrial use. The assessment function for this type of land use is handled by the Oregon Department of Revenue, so all pertinent facts were forwarded to the Department so they could take appropriate action.

The Morrow County Assessors staff rapidly recognized the utility of the RBV data when they compared it with the MSS imagery. However they could not take advantage of the 1978 RBV coverage when they determined that there were no significant land use changes that year except for the cooling pond. They were aware that new circular pivot irrigation was to be installed in West Morrow County during 1979, and welcomed ERSAL's assistance in learning how to obtain and interpret RBV imagery in the future.

All three counties were able to apply information obtained from Landsat imagery. Two counties applied Landsat information for assessment activities within a year of examining the Landsat data. In both counties, some follow-up field checking is being carried out to survey the exact amount of irrigated acreage involved, but in many cases the location, ownership and acreages of irrigated lands were determined directly through the use of Landsat data.

Forest and Range Fire Rehabilitation Project with the U.S. Forest Service

This project involves the use of Landsat RBV images and computer-assisted classification of MSS digital data to locate areas of wildfire occurrence and provide information about the vegetation occupying burn areas prior to the actual burn. ERSAL is currently establishing procedures and lines of communication with the U.S. Forest Service for the purpose of utilizing Landsat imagery for their wildfire rehabilitation programs.

When wildfires occur, the attendant removal of vegetation results in increased rates of water runoff and increased soil erosion. Where such fires damage substantial portions of watersheds, the damage potential to downstream resources by flooding and erosion often requires the immediate initiation of emergency rehabilitation efforts. The success of these efforts is highly variable, and in large part depends upon timely access to information. The time frame for action is short. The fires occur during the summer months

(July and August are most critical) and rehabilitation must be completed prior to the late fall and winter rains.

Funding for emergency rehabilitation programs is handled at the national level. Procedures for requests have been streamlined so that monies can be allocated quickly, but the nationwide demand for funding is considerable, and adequate documentation of the nature of a given emergency is an important step in the review of funding proposals. The regular and comprehensive coverage Landsat provides can be used to substantiate such proposals since MSS and RBV imagery is now available to ERSAL as soon as five days after Landsat overflights through Integrated Satellite Information Services, Ltd. (ISIS) in Prince Albert, Saskatchewan.

From one to three wildfires located on critical watersheds and large enough to require emergency rehabilitation are expected each average fire season in Oregon. The accurate delimitation, location, and measuring of burned areas is a critical first step in organizing these projects which typically require several hundred thousands of dollars for implementation.

In order to utilize Landsat imagery for applications in the wildfire rehabilitation program, ERSAL Personnel have established communications with ISIS and determined that Landsat data could be delivered on a timely basis. ERSAL staff members have worked with Forest Service Personnel to determine the types of information that need to be extracted from imagery for wildfire damage descriptions and how that information must be arranged for damage assessment reports.

ERSAL is currently developing a formal work agreement with the U.S. Forest Service Regional Forester for fire damage assessment efforts. After this is completed, the following activities will occur:

1) Through the fire season, ERSAL will maintain frequent and regular contact with Forest Service personnel to immediately identify those wildfires which may result in damage sufficient to warrant action.
2) When a candidate fire occurs, ERSAL will order and interpret data for the Forest Service Damage Assessment Report to accompany their emergency funding request.
3) ERSAL will continue analysis for extraction of information required in rehabilitation planning.

Personnel from ERSAL and the Forest Service have examined imagery covering previous wildfires and have concluded that RBV imagery would be suitable to show the location and extent of the fire damage, while Landsat digital data would probably be needed to determine the vegetation recovery potential, burn intensity, plus soil condition and exposure.

Because of these needs, ERSAL is currently preparing new computer programs that would handle Landsat digital data from ISIS and is developing procedures to streamline digital data analysis. If these procedures can be successfully implemented, Landsat data would be the information source upon which actions would be taken on the ground within a few months of data acquisition.

Applications Projects using Oregon Air National Guard Thermal Infrared Scanning Data.

These projects would apply thermal infrared scanning data obtained by Oregon Air National Guard aircraft. The thermal infrared data can be acquired by this state agency during training missions. Two projects were proposed for the reporting year that would utilize that form of data. One involved a study of recreational use (from nighttime detection of campfires) on the Deschutes River, central Oregon, for the Office of State Parks, Department of Transportation. This project was titled "Deschutes River Recreational Use

Project" and was described in detail in the Sixth Annual ERSAL Report. The second project would utilize thermal data for detecting leakage from earthen dams in the southern Willamette Valley for the Corps of Engineers. The Air National Guard failed to acquire usable data for either project during the summer. Because of the training nature of these flights, acquiring good usable data is less certain than from commercial sources.

ERSAL has place requests again for thermal scanning data for these two projects, so data for these projects should be obtained during summer, 1979.

Deschutes County Land Use and Housing Development Monitoring Project.

This is an applications project being developed with the Deschutes County Assessor's Office to utilize NASA U-2 aerial photography, multiple dates of Landsat MSS false color composties, and Landsat-3 RBV imagery. Changes in agricultural land use to forest land or to new housing developments would be mapped from the above remote sensing imagery so the Assessor's Office can detect land use changes within the county and carry out the appropriate assessment activity.

Deschutes county is located in central Oregon on the east side of the Oregon Cascades. It is renowned for its beautiful mountain scenery, numerous clear, sunny days and recreation potential including skiing, hunting, fishing, and general vacationing. The attributes of the county have attracted large numbers of people who have come to live and work there permanently, or who have come to retire there. Many people also purchase land and build vacation homes in this area. There has been a 53% increase in the county population and a 37% increase in the county revenues since 1970. This development has been accompanied by a strong demand for land, for vacation or permanent housing, and has resulted in rapid subdividing of land and construction of subdivisions,

condominiums and widely scattered individual homes. As an example, sixty new subdivisions were constructed during 1977 representing a land use change for approximately 6,300 acres.

The Deschutes County Assessor's Office is having difficulty keeping up with these dynamic land use changes. Most of the land that is converted to subdivisions is derived from farm use or marginal forestlands. Often the farm use land is withdrawn from production for several years before the subdivided lots are sold and housing construction is actually started. However, the assessed value of potential recreation land (land for housing development) is about ten times the assessed value of farm use land under production. The Deschutes County Assessor was seeking ways to monitor when farm use land is withdrawn from production and determine what the new land use is, such as subdivision for housing or reversion to marginal forest land. The Assessor was also seeking effective methods to locate and map new subdivisions or new housing in the county as well as describing the type of access to the new developments. Subdivisions having poor access (temporary dirt roads, jeep tracks, etc.) are assessed at lower value than subdivisions having good access, i.e. paved roads.

After conferring with ERSAL personnel, the County Assessor noted several usages of remote sensing information that would improve the efficiency and streamline the procedures of his office, and would be direct assessment applications based on remote sensing imagery.

One application would be the use of Landsat RBV imagery and NASA U-2 photography to locate and map the new subdivisions present in the county, as well as defining the roads or type of access to the subdivisions. The scale and clarity of the Landsat-3 RBV imagery is quite suitable for mapping the subdivisions and housing present in the forested land where most of the

development activity is occurring. The information derived from the imagery would be used directly to note any parcels of land converted from farm use to improved recreational land, so the assessed value of the land would be changed accordingly. The RBV imagery would also be used to check the irrigated agricultural lands and verify that those lands have not changed in their use, e.g., from irrigated farm land to dryland farming or range. Changes of this nature would also change the assessed value of the land.

The advantage of using both the RBV imagery and the 1978 NASA U-2 photography is that it enables personnel from the Assessor's Office to become accustomed to working with RBV imagery while being able to verify their work with the aerial photography, an information source they are familiar with. Then they will feel competent in using the RBV imagery in their work in future years when current photography is not available.

Another application possibility being explored is the photointerpretation of multiple dates of Landsat multispectral scanner (MSS) false color composites to detect changes of farm use land under production to some other type of land use. These areas could then be located, mapped, and field-checked to determine the new land use and the assessed value for that land would then be changed.

These applications possibilities, as well as others, are currently being discussed and developed with the Deschutes County Assessor with most of the project work being planned for summer or fall, 1979.

Oregon Fire District Map Updating Project.

This project involves the use of Landsat RBV imagery for the purpose of updating Oregon Department of Forestry Fire District maps, as well as use of RBV imagery for forest insect and disease control applications. ERSAL is providing RBV imagery and interpretation assistance to the Mapping Division

of the Oregon Department of Forestry as well as technical assistance to the Oregon Forestry District Offices.

The State Department of Forestry has prepared maps for the state's several fire protection districts since 1948. Approximately 60% of the state is included on these maps which are published at a scale of ½" equals 1 mile. Fire protection districts include land that is for the most part outside of the National Forests, and include forested, range, and some agricultural land. The maps are used not only for the purpose of providing response to, and protection from fires, but the maps are also popular among recreationists and are frequently the mapping products utilized by several other state agencies. The normal cycle for updating maps is 5-7 years, however, a substantial need exists in many districts to have the maps be even more current. The update is accomplished through the use of 1:62,500 or 1:80,000 black and white aerial photography.

ERSAL has provided the Department's Mapping Supervisor with Landsat-3 RBV images and he feels that this new image base could be used routinely for the process of map update. The ground detail, particularly road networks in the forested areas, is available in the imagery and the imagery is free of the tilt, crab, and displacements that are usually present in aerial photography. The Mapping Supervisor has prepared composites of the RBV enlargements and some Forest District Maps. These have been demonstrated to, and examined by, many State Forestry personnel. The receptivity to these products has been quite high because the composites show all political boundaries as well as current road networks and the current vegetation/land use patterns.

Personnel in the Insect and Disease Control Section of the Northeast Oregon Forest District are quite enthusiastic about use of these products because:

1) areas of diseased or insect-attacked trees can readily be noted and located.
2) the composites can be used directly to mark boundaries for salvage timber sales to remove diseased or insect-killed tree stands.
3) the composites can be used to directly map and designate areas for thinning operations in dense, stagnant timber stands.
4) the composites would improve aerial surveys for insect damage by approximately 75% because the person in the aircraft can readily associate the vegetation pattern seen on the ground with the vegetation pattern represented on the map composite, consequently improving his mapping accuracy of insect attack sites.
5) new roads, especially smaller logging roads, are apparent on the RBV images.

Several Districts have expressed an interest in obtaining Fire District Maps for their district that incorporates current RBV imagery, and many new applications should be forthcoming when the Forest Districts have an opportunity to work with these composites.

The Forestry Mapping Supervisor also anticipates that the incorporation of the RBV images with the Fire District maps will considerably reduce drafting time, and will permit updating maps on a schedule that may be two or three times as frequent as present.

C. ERSAL PROJECTS FUNDED THROUGH OUTSIDE AGENCY SUPPORT

The following are projects that have been or are being conducted by ERSAL through funding other than ERSAL's NASA grant during the reporting period 1 April 1978 to 31 March 1979. These projects have been conducted with various federal and state agencies in Oregon using their funds to support the projects. These projects do not meet the criteria of utilizing remote sensing as the sole information base for decision-making and of being short-term projects having high impact. Usually these projects involve longer term decision-making or are demonstration projects for the state and federal agencies to indicate the applicability of LANDSAT imagery and U-2 photography for decision-making procedures.

These agencies became aware of NASA-sponsored applications projects being conducted at ERSAL, and were interested in utilizing remote sensing technology. Upon consultation and advisement from ERSAL, several agencies decided to conduct remote sensing applications projects. The following are example projects conducted by ERSAL and funded by agencies other than NASA.

State-wide Land Use Inventory

This project is being funded by the Oregon Department of Water Resources. The project involves inventorying and mapping the acreages for seven categories of land use in 15 of Oregon's 18 basins. The land use categories of greatest interest are irrigated and potentially irrigable lands. The data for these categories are used in irrigation feasibility studies that form the basis of formal water policies which serve as law in determining the permitted use of water in each basin.

NASA U-2 color infrared photography is being used for spatial detail mapping while Landsat false color composites (FCC) are being used to provide

temporal detail. The Landsat FCC's are providing the necessary information for accurate recognition of many occurences of irrigated lands. The availability of two or more dates of imagery within a single growing season has permitted the additional advantage of conducting the inventory at any time of the year. Prior to the availability of Landsat temporal data the work was done primarily during the irrigation season. This project began in September 1978 and will continue for a two-year period. This project is a direct continuation of the NASA supported project, "Columbia River Water Policy Project" that was conducted through ERSAL with the same state agency.

Columbia Basin 208 Study. ERSAL is conducting a surface cover/land use inventory for the U.S. Soil Conservation Service (SCS) over a 6.2 million acre area. The maps and acreage summaries will be used in a non-point source pollution study. Several forms of remote sensing imagery are needed to gather all the required information. The imagery forms are: Landsat MSS computer compatible tapes (CCT's) and FCC's, Landsat-3 RBV enlargements, NASA U-2 1:125,000 CIR photography, and standard orthophotography. The Landsat imagery is the primary source. This project is one in a series that have been funded by the SCS or U.S. Forest Service and that have gathered information needed for watershed management planning. They all occurred because of Forest Service participation in an early ERSAL project entitled COVEDS.

PIXSYS Work Manual and User's Guide. The U.S. Forest Service has provided funding to ERSAL for the preparation of a manual and guide to the use of the Oregon State University computer software (PIXSYS) that is used at ERSAL for the analysis of Landsat MSS data. The work manual is based on the techniques used in, and the results produced by, four projects in which the Forest Service has participated with ERSAL since 1974. The manual/guide will provide local foresters with an insight to mapping and inventory problems that can be

addressed with remote sensing techniques that employ Landsat data.

Landsat Data Analysis Workshop

Oregon participants in the Pacific Northwest Regional Commission (PNRC) Land Resource Inventory Demonstration Project (LRIDP) utilized data analysis facilities and personnel from outside Oregon for most work completed during the LRIDP (1975 - 1978). The extensive travel this required, and the limitations this imposed on communications between analysts and participating users were of primary importance in the Oregon participants' recommending, in April 1978, that ERSAL at Oregon State University be considered the primary provider for future analysis to be undertaken during the PNRC Landsat Applications Project (LAP). Since several Oregon LAP participants have had limited exposure to remote sensing technology applied to resource analysis, and since OSU's PIXSYS digital data analysis system will be used by most participants, a workshop aimed at familiarizing them with PIXSYS specifically, and ERSAL capabilities in remote sensing resource analysis generally, was conducted March 19 through March 21, 1979. Further workshops are planned for Fall 1979 and Summer 1980.

Through lectures, demonstrations, "hands-on" experience, examination of case studies and discussions of recent developments in remote sensing technology, 22 workshop attendees became acquainted with the potential to incorporate the use of remotely sensed data in their resource management activities. Emphasis was placed on integrating the use of Landsat data with other data sources in order to maximize flexibility of extracting information suited to specific information needs. Content areas encompassed by the workshops include: 1) identification of resource information needs, 2) determining approach to remote sensing technology, 3) procurement of data, 4) processing of data, 5) pattern recognition techniques, 6) grouping and labelling of spectral classes, 7) verification and evaluation of output, and 8) discussions of "state of the art" in LANDSAT applications.

Remote Sensing Project Development Assistance to the Pacific Northwest Regional Commission

ERSAL provided assistance and project development aid to Oregon participants in the Pacific Northwest Regional Commission (PNRC) Landsat Applications Project (LAP). LAP is a remote sensing applications project with Pacific Northwest State agencies as a follow-up to the Land Resource Inventory Demonstration Project (LRIDP). The LAP is being supported by the PNRC in cooperation with NASA-Ames and the U.S. Geological Survey.

As indicated in the previous report on the Landsat workshop, the Oregon participants in LAP recommended that ERSAL be the primary source for data analysis for the Oregon projects. ERSAL personnel provided assistance and suggestions for various projects and how they would best be organized and conducted. These project development discussions involved several Oregon State agencies, personnel from Oregon county agencies, and some federal agencies in Oregon. Three projects were identified, then methods of conducting the projects were analyzed, discussed, and adopted. An additional project is now being planned.

These activities demonstrate ERSAL's capability to respond to state agency needs for aid in working with remote sensing and the confidence expressed by these agencies in ERSAL's expertise.

Summary of Projects Funded by Sources other than NASA Office of University Affairs

Since its beginning in 1972, ERSAL has engaged in several projects that have been funded by agencies other than the NASA Office of University Affairs. Table 2 shows all of these types of projects engaged in since the inception of ERSAL. This table indicates the general nature of each project, the type of imagery utilized and the level of support provided.

Table 2 PROJECTS FUNDED BY SOURCES OTHER THAN NASA UNIVERSITY PROGRAMS

Project Title	Agency	Imagery Used	Financing
Natural Area Preserves	Natural Area Preserves Advisory Committee, State Division of Lands	U-2 color IR 1:125,000	$21,500
Douglas Co. Timber Inventory	Oregon Dept. of Forestry	Landsat MSS CCT, aerial photography: 1:125,000 CIR, 1:60,000 B & W, 1:4,000 color	$20,550
Tansy Ragwort Plotting and Mapping	Oregon Dept. of Agriculture	Landsat MSS CCT, 35 mm color a/p	$10,850
Water Resources State-wide Inventory	Oregon Dept. of Water Resources	Landsat MSS FCC, 1:125,000 CIR, 1:24,000 orthophoto sheets	$26,408
Oregon Land Use Maps	Pacific Northwest Regional Commission (PNRC)	Landsat MSS FCC	$ 2,024
Landsat Data Analysis Workshop	PNRC	Landsat MSS CCT	$ 5,280
Remote Sensing in Resource Analysis (Univ. course)	PNRC	Landsat MSS CCT	$11,387
Crump Lake Veg. Inventory	U.S. Fish & Wildlife Service (USFWS)	1:125,000 CIR	$ 1,690
Days Creek Inventory	USFWS	Landsat MSS CCT	$ 2,495
Malheur Lake Inventory	USFWS	Landsat MSS CCT 1:6,000 CIR a/p	$14,980

Table 2 PROJECTS FUNDED BY SOURCES OTHER THAN NASA UNIVERSITY PROGRAMS(cont'd.)

Project Title	Agency	Imagery Used	Financing
Eel Grass Mapping	USFWS	Landsat MSS CCT 1:20,000 color a/p	$12,320
Western Oregon Wetlands Inventory	USFWS	1:80,000 B & W a/p	$46,940
Calapooia Inventory	Soil Conservation Service (SCS)	Landsat MSS CCT	$ 6,500
Thomas-Cottonwood Watershed Management Planning	SCS	Landsat MSS CCT, 1:6,000 CIR a/p	$ 8,500
Columbia Basin 208 Study	SCS	Landsat MSS CCT, 1:125,000 CIR a/p 1:24,000 orthophoto sheets	$77,794
Tillamook Watershed Management Planning	U.S. Forest Service (USFS)	Landsat MSS CCT, 1:125,000 CIR a/p	$ 7,000
Thomas-Cottonwood Documentation	USFS	Landsat MSS CCT, 1:6,000 CIR a/p	$ 1,500
Landsat Analysis Handbook	USFS	Landsat MSS CCT	$14,996
Landsat Analysis Assistance	USFS	Landsat MSS CCT, 1:6,000 CIR a/p	$13,906
Polygon Plotting (software development)	ESL, Inc.	Landsat MSS CCT	$ 3,960
Northeast Oregon Elk Habitat Analysis	Oregon Dept. of Fish and Wildlife	Landsat MSS CCT 1:6,000 CIR a/p	$15,619

D. FUTURE PROJECTS

ERSAL will complete the previously-mentioned continuing projects and will be developing projects through the next reporting period.

Project development work at ERSAL will continue to emphasize use of Landsat imagery. ERSAL may now be able to engage in projects with Oregon agencies that were not previously possible because the turnaround time between Landsat data acquisition and actual receipt of data has been considerably shortened. Also due to the addition of the improved RBV system on Landsat-3, ERSAL can develop new types of applications projects.

Special emphasis has been placed on applications project development using Landsat-3 RBV data for several reasons:

A. The applications potential for this higher resolution imagery is just beginning to be explored and agencies of different disciplines may be able to generate new applications that were previously not feasible.

B. The digital form of RBV data will become available shortly which represents another form of the high resolution data the potential of which is yet to be examined. Several possibilities for use of the digital data include: a) edge-enhancement and contrast-stretching of the data to emphasize border features, i.e. roads, timber clearcut boundaries, water-land boundaries, urban road networks, and b) stratifying the data to enhance surface features characterized by specific reflectance values.

C. The potential for use of RBV imagery in combination with other data forms is just beginning to be explored. RBV imagery could potentially be combined or composited with Landsat MSS or thermal infrared imagery, Heat Capacity Mapping Satellite imagery, other satellite imagery, various aerial photography, and map bases that require updating. The RBV imagery provides a planimetric image of the earth's surface that is virtually free of tilt, tip and crab

commonly found in aerial photography. As a result, the RBV imagery can act as a planimetric map base and locating device when combined with other forms of data.

D. The scale of Landsat-3 RBV data is very similar to the scale projected for Landsat-D Thematic Mapper data. Consequently, agency personnel that are accustomed to working with the current scale of Landsat-3 RBV data should have no trouble in adapting to and applying Landsat-D Thematic Mapper data that will also have more wavelengths of data available for applications.

ERSAL is also exploring the project possibilities for development and use of the thermal infrared data now available from Landsat-3 and the Heat Capacity Mapper.

III. CONCLUSION

COOPERATIVE ACTIVITIES

The Environmental Remote Sensing Applications Laboratory welcomes agency personnel to visit the laboratory and discuss ways that remote sensing can be applied in the case of each particular agency. The ERSAL staff readily provides viewing of pertinent remote sensing imagery, information about applications, and advice to those visiting agencies. In many instances, however, the visiting agencies have application projects that ERSAL cannot become involved in due to some or all of the following:

1. The project would use remote sensing as only one among many sources of information.
2. The project does not have high potential of an operational decision forthcoming in a short time frame following project completion.
3. Implementation of project information cannot be made directly by that agency.

In cases such as these, ERSAL invites the agency to utilize the ERSAL facility with the agency personnel carrying out the work in the lab. This arrangement can be carried out as long as the visiting agency does not interfere with any of the on-going ERSAL project work.

Staff members of the Oregon Department of Geology and Mineral Industries (ODGMI) utilized laboratory space to analyze Landsat digital data classification output over Northeast Oregon. This analysis was being carried out as part of the Land Resources and Inventory Demonstration Project funded through the Pacific Northwest Regional Commission. They were examining the utility of Landsat digital data to detect and delineate new mining activities. Other staff members from the ODGMI utilized NASA U-2 photography to map enlargements of gravel pit and surface mining operations. All such operations must file a reclamation plan and post a bond for this reclamation with ODGMI if their

operations are expanded after 1972. Personnel from the ODGMI spent several days at the ERSAL facility comparing different dates of photographic coverage over these operations to insure that they were in compliance with the reclamation laws.

Another example of ERSAL's informal consulting assistance was with staff members of Oregon Department of Fish and Wildlife. They utilized NASA U-2 and NASA/Houston aerial photography to map fish and wildlife habitat in the Oregon estuaries as well as new building construction and housing development along estuaries. The maps were prepared for use by coastal counties to aid them in forming their comprehensive land-use plans and zoning ordinancies.

Agency usage of ERSAL facilities also includes county and federal agency use. Lane County personnel spent 2-3 days mapping land-use in portions of their county using NASA U-2 photography for a water pollution study. U.S. Fish and Wildlife Service personnel have also utilized ERSAL's facilities to carry out comprehensive mapping of vegetation/wildlife habitat for three wildlife refuges in the Willamette Valley.

APPENDIX

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Cottage Grove Ranger Station
P. O. Box 38
Cottage Grove, Oregon 97424

REPLY TO. 2510 Watershed Surveys

January 16, 1979

SUBJECT. ERSAL Project

TO. Jim DeLapp

Attached is a report on the ERSAL Project, computer mapping of the Layng Creek Watershed by satellite.

Jim Golden

JIM GOLDEN
Forester

ERSAL PROJECT REPORT

Objective

The objective of this report is to confirm the computer classification of vegetative cover types from data collected from the Layng Creek Watershed in June of 1974, submitted by the ERSAL lab of Oregon State University.

Procedure

The printout from the satellite scan consists of 13 symbols (called "pixels"), representing various intensities of wavelengths, picked up in the scanning process. Each vegetative type has a distinct spectral reflectance (or "signature"). These 13 types of pixels, each representing an area of approximately 2 acres, were combined and grouped from an original 33 characters.

One problem encountered initially was a slight difference of scale between the printout and the map overlay used for locating sample points. Though the difference was less than two percent, when coupled with the slight inaccuracies of the map overlay, pinpointing a true location of a pixel proved to be unreliable. Therefore, homogenous groups were located (minimum of 6 pixels) on the map and then onto aerial photos to insure an accurate location. Areas that have been cutover in the last 5-10 years were difficult to sample because of

the time lag between the 1974 satellite scan and the 1976 photos. However, using information that was available in the TRI system and by "interpolating" the development of the vegetation over time, reasonably accurate predictions could be made.

Each sample point was described according to vegetative cover in each of the following classifications:

CO	Old growth conifer (200 yrs. +)
CY	Second growth conifer (40-200 yrs.)
CR	Conifer regeneration (pre-commercial)
HD	Hardwoods
SH	Shrubs
HB	Herbaceous plants
NV	Non-vegetated

In addition each point was classified as to the number of years since cutting or burning, if any. Most information was obtained from recent aerial photos and from the TRI system, when records were available.

The printout used from the satellite scan consists of 13 symbols which resulted from the grouping of an original 33 symbols, representing various intensities of wavelengths picked up in the scanning process (i.e., bare ground has different reflective properties than a brushfield).

Results

The following table shows the plot summary of the percent of coverage by vegetative type for each printout symbol. This is followed by a table which shows the ERSAL interpretation and whether this was confirmed by this study.

PLOT SUMMARY

Symbol	No. Plots	CO	CY	CR	HD	SH	HB	NV	Years Cut	Years Burned
$	10	82	14			2			NO	NO
0	10	8	62	5	2	10	10			
U	10		92	1	4	3				
D	10		12	62	21	3	2		22	
-	10			5	4	12	16	63	3	
)	10					11	24	58	3	
T	10			69	5	16	8	2	24	
B	10			38	10	36	12	2	12	
=	10			8	8	28	46	8	8	
4	9			21	4	28	27	22	10	
1	1*		5			10	85			
.	3*							100	0	NO
%	4*	12	5	5		12	16	46		

* Too few pixels groups to sample adequately.

SUMMARY

SYMBOL	ERSAL DESCRIPTION	COMMENT
$	Mature conifer, dense	Confirmed, but found mostly as old growth.
0	Mature conifer, medium to dense.	Confirmed. Mostly second growth of moderate density (not overstocked).
U	Mature conifer/hardwood light to medium.	Confirmed. Hardwood not always present. Conifer always very dense, overstocked.
D	Conifer/hardwood	Confirmed. Pre-commercial size conifers with significant hardwood component.
-	Disturbed area	Confirmed. Mostly non-vegetated with varying amounts of SH, HB.
)	Reprod. (older clearcuts)	Mostly non-vegetated clearcuts with HB, SH. No regeneration was apparent on the photos.
T	Regrowth/brush	Immature conifer regeneration, well stocked. Minor amounts of SH.
B	Regrowth/brush	Immature conifer regeneration with moderate to dense SH cover.
=	Older disturbed	Older (age = 8) clearcuts with predominant coverage in HB. Trace amounts of CR.
4	"?"	Older clearcuts. No other reliable description.
1	Brush, dense grass	Single sample showed wet meadow. Too few pixels to sample adequately.
.	Bare soil	Too few pixels to sample adequately, but the three areas sampled were all freshly YUM logged and not burned.
%	Unclassified	Too few pixels to sample. Results not conclusive.

These results show the ERSAL interpretations are generally correct and may be further refined with more datailed study.

Many possible applications of vegetation mapping with satellite data exist.

- determining size and location of unvegetated land to pinpoint sources of turbidity and sedimentation.
- location and distribution of big game habitat.
- brushfield inventory and release opportunities.
- timber harvest scheduling.
- limited in-place resource inventory.
- monitoring of vegetative changes over time through repeated scans.

RG 1/79

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Degrees: B.S., 1975, Oregon State University, Corvallis, Oregon

Positions: Laboratory Assistant, Environmental Remote Sensing Applications Laboratory, Oregon State University, 1973 - 1975.
Remote Sensing Applications Assistant Scientist (Research Assistant), Environmental Remote Sensing Applications Laboratory, Oregon State University, 1976 - present.

Professional Field: Botany, Vegetation Ecology, Remote Sensing.

Selected Publications:

Walsh, Stephen J., John W. Mairs, and Cassandra J. Alexander. 1976. Vegetation inventory of certain state-owned lands in selected Oregon counties (Northwest Oregon). A report to the Natural Area Preserves Advisory Committee, Oregon State Land Board. Submitted by the Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, 60 pp.

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Benson, Gary L.

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Degrees: B.A., 1968, San Jose State College, California
M.S., 1970, State University of New York, Plattsburgh
Ph.D., 1974, Washington State University, Pullman

Positions: Seasonal State Park Naturalist, Prairie Creek Redwoods State Park, Orick, California, 1968;
Teaching Assistant, Department of Biological Sciences, State University of New York at Plattsburgh, 1968-1970;
Teaching Assistant, Biology Program, Washington State University, Pullman, 1970-1974;
Graduate Research Assistant, Environmental Research Center, Washington State University, Pullman, Summer 1971, 1973;
Research Associate, Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, 1974-present.

Professional Field: Plant ecology, biology, remote sensing, resource analysis.

Professional Recognition: Ecological Society of America; British Ecological Society; Society of Sigma Xi; American Society of Photogrammetry; National Wildlife Federation.

Selected Publications:

Benson, Gary L. and Barry J. Schrumpf. 1975, 1976, 1977, and 1978. Third, Fourth, Fifth, and Sixth Year Project and Activities of the Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, Oregon.

Benson, Gary L. 1975. Vegetation/Land Use, soil associations, and road maps for the South Umpqua River watershed near Days Creek, Oregon. Report submitted to Mr. Ron Weaver, Ecological Services, Portland Field Office, U.S. Fish and Wildlife Service.

Benson, Gary L. 1975. Report on soil series, roads and vegetation/bare area transparency maps for the Jumpoff Joe Creek Watershed draining into the proposed Merlin Reservoir near Merlin, Oregon. Submitted to Mr. Ron Weaver, Ecological Services, Portland Field Office, U.S. Fish and Wildlife Service.

Benson, Gary L. 1974. Some comparisons of the autecology of Agropyron spicatum, Sporobolus cryptandrus, and Stipa comata. Ph.D. Thesis. Botany Department, Washington State University, Pullman.

Benson, Gary L., continued

Selected Publications:

Benson, Gary L. 1973. Emission factors of certain high energy-consuming industries and health effects of emissions produced. Environmental Research Center Technical Bulletin No. 10, Washington State University, Pullman. 115 pp.

Benson, Gary L. 1970. Allometry in (plant) embryos in three species of Galium. M.S. Thesis, State University of New York, Plattsburgh.

Papers Presented:

Benson, Gary L. 1979. Remote sensing applications for resource inventory in Oregon. Paper presented at Oregon Society of Soil Scientists; February 1979; Salem, Oregon.

Benson, Gary L. 1970. Allometry in (plant) embryos in three species of Galium. Paper presented at the Twenty-first Annual American Institute of Biological Sciences meeting; August 1970; Indianapolis, Indiana.

Hall, Madeline J.

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Degrees: B.S., 1974, Macalester College, St. Paul, Minnesota
M.S., 1976, Oregon State University, Corvallis

Positions: Graduate Teaching Assistant, Department of Geography, Oregon State University, Corvallis, Oregon, Maps and Map Interpretation, Sep. 1974 - Jun. 1975;
Geographer, U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Land Use Section, Corvallis, Oregon, Aug. 1975 - Sep. 1976;
Research Assistant, Environmental Remote Sensing Applications Laboratory, Corvallis, Oregon, Nov. 1976 - present.

Professional Field: Physical Geography, Geomorphology, Biogeography, Land Use Analysis, Natural Resource Inventory and Management, Air Photointerpretation/Remote Sensing.

Professional Recognition: Oregon Academy of Science.

Selected Publications:

Hall, M.J. 1977. Inventory of Potential Natural Areas on State Lands: Part 5. A report to the Natural Area Preserves Advisory Committee to the State Land Board. 141 pp.

Hall, M.J. 1976. Preliminary Inventory and Analysis: Santiam Bar Proposed Natural Area Preserve. The Natural Area Preserves Advisory Committee, Oregon State Land Board. 93 pp.

Starr, R., R. Marston, and M. Hall. 1976. Environmental Sensitivity of Oregon's Coastal Sand Areas. Department of Geography, Oregon State University, Corvallis, Resource Paper Number 7. 38 pp.

Isaacson, Dennis L.

Born: 5 May 1942

Degrees: B.S., 1969, Portland State University, Oregon
M.S., 1972, Oregon State University, Corvallis
M.Ag., 1974, Oregon State University, Corvallis

Positions: Research Assistant, Department of Entomology, Oregon State University, Corvallis, 1970-1974;
Weed Control Supervisor, Oregon Department of Agriculture, Salem, Oregon, 1974-1978;
Research Assistant, Environmental Remote Sensing Applications Laboratory, Corvallis, 1978-present.

Professional Field: Population Biology, Herbivore-Plant Interactions, Vegetation Management.

Professional Recognition: American Registry of Professional Entomologists, Western Society of Weed Science, Entomological Society of American, International Congress of Entomology, International Organization for Biological Control, NSF Undergraduate Fellow-1968, NSF Graduate Fellow 1970-1972.

Selected Publications:

Isaacson, D.L. and B.J. Schrumpf. 1979. Distribution of Tansy Ragwort in Western Oregon. In Press IN: Proceedings of the Symposium on Tansy Ragwort Toxicity. Nutrition Institute, Oregon State University, Corvallis, Oregon, February 1979.

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Isaacson, Dennis L., continued

Papers Presented:

Crenshaw, R.D. and D.L. Isaacson. 1977. Remote sensing survey of tansy ragwort in Western Oregon. Paper presented at Society for Range Management; February, 1977; Portland, Oregon.

Isaacson, D.L. 1976b. Use of computer-processed satellite data in an integrated weed control program. Paper presented at International Congress of Entomology; August, 1976; Washington, D.C.

Murray, RJay

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Degrees: B.S., 1957, University of Utah, Salt Lake City
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Positions: Research Chemist, Shell Oil Company, 1957-1962;
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Graduate Research Assistant, Computer Center, Auburn University, Alabama, 1963-1966;
Research Associate, Computer Center, Oregon State University, 1966 - present.

Professional Field: Computer Science, Numerical Analysis, Physical and Organic Chemistry, Rheology of Polymers, Remote Sensing.

Professional Recognition: American Chemical Society; Association for Computing Machinery.

Selected Publications:

Simonson, G.H., RJay Murray, et al. 1974. The comparative evaluation of ERTS-1 imagery for resource inventory in land use planning. A multidiscipline research investigation. Final report to NASA Goddard Space Flight Center, Greenbelt, Maryland. Conducted at Oregon State University, Corvallis, Oregon. July 1972 - January 1974. 311 pp.

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Kruse, R.B., and RJay Murray. 1963. Comment on "Stresses and Strains in Solid Propellants During Storage". AIAA,1. pp. 246-247.

Schrumpf, Barry J.

Born: 13 July 1943

Degrees: B.A., 1966, Willamette University, Oregon
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Ph.D., 1975, Oregon State University, Corvallis

Positions: Graduate Research Assistant, Range Management Program, Oregon State University, 1966-1970;
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Principal Investigator, NASA Funded ERTS-1 Project, Oregon State University, 1972-1975;
Acting Director, Environmental Remote Sensing Applications Laboratory, Oregon State University. 1974-1975;
Director, Environmental Remote Sensing Applications Laboratory, Oregon State University, 1975-present.

Professional Field: Range Ecology, Remote Sensing, Resource Inventory and Analysis.

Professional Recognition: Society for Range Management, American Society of Photogrammetry.

Selected Publications:

Isaacson, D.L., R.D. Crenshaw and B.J. Schrumpf. 1978. Inventory of the distribution and abundance of Tansy Ragwort in Western Oregon. Final Report. ERSAL, Oregon State University, Corvallis. 52 pp.

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Schrumpf, Barry J., continued

Selected Publications:

Schrumpf, Barry J., James R. Johnson, and David A. Mouat. 1973. Inventory and monitoring of natural vegetation and related resources in an arid environment. Type II Progress Report No. 1. Rangeland Resources Program, Oregon State University, Corvallis.

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Positions: Cartographic Aid, U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Land Use Section, Corvallis, Oregon, Oct. 1975 - Sept. 1976; Physical Science Aid, U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Land Use Section, Corvallis, Oregon, Sept. 1976 - Aug. 1977; Research Assistant, Environmental Remote Sensing Applications Laboratory, Corvallis, Oregon, Oct. 1977 - present.

Professional Field: Water Resource Geography, Land Use Analysis, Flood Plain Management, Cartography, Air Photointerpretation/Remote Sensing, Resource Inventory and Management.

Professional Recognition: Oregon Academy of Science.

Papers Presented: An Analysis of Residential Land Values On and Near the Regulated Flood Plain, Oregon Academy of Sciences, Linfield College, McMinnville, Oregon. Jan. 21, 1978.


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