USE OF REMOTE SENSING DATA IN A WILDFIRE REHABILITATION PROJECT

by

V. L. Saxeasone, R. G. Smith, and L. R. Spina

ABSTRACT

A variety of remotely sensed data proved useful in the rehabilitation of an area in central Oregon damaged by a forest fire. A team of U.S. Forest Service specialists used these data in developing an overview of burn severities, site capability, and severity of vegetation damage. Large-scale aerial photography taken from a light plane, small-scale infrared U-2 photography, and Landsat digital data were all used in planning and implementing the re-establishment of vegetation cover, the construction of drainage control structures, and the salvage and removal of debris. Rehabilitation actions were completed in time to successfully avoid damage from summer thunderstorms and winter precipitation.

INTRODUCTION

Wildfire-damaged areas are extremely vulnerable to overland flow of water. Heavy rains and runoff cause loss of soil, degradation of water quality, and threats to life and property from flooding. Restoration of vegetation cover, construction of structures for drainage control, and residue treatment are among the actions which fire rehabilitation personnel must plan and implement before the first damaging precipitation. The immediate and short-term actions must be

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Classification - Remote Sensing - Inventory - Analysis

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cost-effective, and must not interfere with the long-term management objectives for the area. On July 24, 1979, a fire began on the eastern slopes of Oregon’s Cascade Range within the Deschutes National Forest. Before the fire was controlled on July 24, 4,500 acres on steep terrain with highly erodible pumice/ash-derived soils were left without protective cover. A rehabilitation project was organized because: 1) there were extensive downstream capital improvements, 2) the area was a municipal watershed, 3) there was a predominance of hydrophobic soil types which would cause increased rates of runoff, 4) the steepness of the area would aggravate erosion, and 5) areas of relatively high inherent timber productivity were involved.

This paper describes the acquisition, analysis, and application of remotely sensed data in planning and implementing rehabilitation of the burned areas.

METHODS

Pre-Fire Condition Analysis

An immediate inventory of the available remotely sensed data over the fire area was conducted. Three types of aerial photography were available: 1) high altitude, 1:10,000 900° color infrared (CIR) positive transparency acquired by a NASA U-2 flight on August 2, 1978; 2) 1:60,000 CIR 1:92,000 positives acquired by a NASA U-2 flight on August 7, 1972; and 3) black and white 1:32,000 diazo positives from original coverage contracted by the Oregon Department of Forestry. In many cases, the larger-scale CIR coverage provided enough detail for updates determination, and the more recently acquired small-scale CIR coverage served to update the older coverage for timber harvesting, road building, and the establishment and growth of reproduction stands during the 1972-78 interim. The black and white diazo positives served as inexpensive (30¢ each) copies for flight route mapping and field notes. Landsat multispectral scanner (MSS) digital data were
also on hand from a June 8, 1978, overflight. Processing of these data commenced immediately, and was completed 36 hours later. Most of the pre-fire condition analysis was completed prior to final control of the fire.

The aerial photography was interpreted to determine type, condition, and structure of pre-fire vegetation. Management practices and cultural features were noted, tree species or species groups were outlined, and vegetation densities were estimated. The complexity of cover was examined, and the presence or absence of understory vegetation was determined for most forested areas. Satellite data were analyzed to develop a quantitative overview of the extent and location of various cover classes. An overlay incorporating cultural features to aid in the location of specific ground areas on the digital printout was also constructed. Interpretation of these materials permitted the delineation of the distribution, abundance, and condition of various indicator species before the burn (Vollard 1978; Franklin and Byrness 1973) and allowed inferred inferences to be drawn about such site characteristics as soil depth, texture, and waterholding capacity.

Post-Fire Analysis

To obtain a detailed record of the extent and severity of the burn, photographic data were acquired at the earliest possible date after the fire. Three days after the fire was controlled, complete coverage of the burned area was acquired on 35-mm film. Photographic prints were used in assessing the condition of vegetation and, in particular, for identifying likelihood of tree survivor. Vertical 35-mm natural color photography was obtained during the survey. Black-and-white prints were used to produce large-scale mosaics of the entire burned area.

USE OF EXTRACTED INFORMATION

Project results were put to use immediately. Some emergency rehabilitation work began utilizing fire control crews before demobilization. Some fire equipment was immediately available for rehabilitation work. Planning for contract labor and specialized tasks was also initiated immediately upon control of the fire. Since the fire site was within a zone where parallel thunderstorms are common, there was no time to waste in completing the required rehabilitation work before the first damaging rainfall. Information essential to the planning and direction of this work had to be supplied quickly.

At the same time that photography was being exposed and processed, ground crews were obtaining data on sample plots, measuring vegetation survival, amounts of litter left on the soil surface, fire effects on the humus layer, and soil weatherability. Guided by pre-fire condition data, site descriptions were developed for homogeneous regions within the fire. Canopy layers of damaged trees were examined to determine whether sap was flowing. This permitted direct observation of the extent and severity of damage. Ground-checker trees were located on the CN photographic prints, and their signatures were used in predicting survival of damaged trees. Surviving trees were considered merchantable stock; dead trees were salvaged or treated as required.

Many standing dead snags were left after the fire. Where logging methods compatible with minimal disturbance of soils could be employed, considerable volumes of marketable wood were found to be salvagable. In some areas snags represented potential hazards, an material for stream jamming and subsequent flooding, or as waterborne debris which would damage control equipment or downstream capital improvements. In other areas, snags were used as the primary material for construction of contour terraces to break up flow and collect silt deposits. Areas with standing dead snags were easily located on natural color 35-mm prints. By examining topographic maps on USGS quadrangle sheet, species composition on pre-fire photography and satellite digital images, and the extent of homogeneous areas, plans were made for logging, snag felling, and snag removal. Salvage sale units for logging of snags by helicopter were delineated. Assignment of snag-felling crews of a size appropriate to the areas to be felled was made. Channel units where snags and debris showed a potential for jamming were located. The material was then burned or otherwise removed. The combined use of pre- and post-condition information, information quickly generated, and heavy equipment quickly mobilized the area extent of homogeneous areas from digital images, facilitated the efficient planning and allocation of the work effort in snag treatment.

Grass seeding was required on most sites which had burned with high intensity. In general, this type of burn occurred within dense stands, most of which were mixed conifer. To identify and quantify the extent of areas to be seeded, the pre-fire digital image was used as the primary information source. By studying acreage tables, the pre-fire vegetation map, and the density of grass-seeding acreage were calculated and used in contracting for custom helicopter seeding. Contract seeding of 1,600 burned acres began eight days after control of the fire.

Basins to capture larger volumes of silt and debris than could be held by snag terraces were required along ravines and intermittent streams. The location of these improvements was aided by the use of materials mentioned above. More efficient assignments of tractors and crews were made possible by pre-identifying potential basin sites.
CONCLUSION

A series of potentially damaging thunderstorms passed over the fire area during the late summer and fall of 1977. At the Beni municipal water intake, the only measurable effect of the storms was a slight increase in suspended ash particulates, which was not considered significant. Most debris basins filled to capacity but none were breached. Many contour smug terraces filled to capacity and diversion of flows were successful in avoiding significant damage to trails, roads, and other improvements. By the time of the storm, grass seedings had established sufficiently to protect the soil surface. In short, all emergency action was completed in time to avert any significant damage.

ACKNOWLEDGMENT

This project was supported by NASA Office of University Affairs under contract NGL-58-002-005.

REFERENCES


Volland, Leonard A. 1976. Plant Communities of the Central Oregon Pumice Zone. USDA Forest Service Pacific Northwest Region, Region 6

ABSTRACT

A FORTRAN computer program is provided to give per-acre and tract estimates of total and merchantable green and dry biomass with sampling errors for point-sample cruises of Appalachian hardwood stands. Coarsewood estimates are included also. Field work requires only the recording by species of heights of point-sample-selected trees.

INTRODUCTION

Biomass factors for point sampling of Appalachian hardwoods have recently been developed by Wiant and Wingard (in press). That report gives the rationale and methodology used and point-sampling biomass factors for northern red oak (MO), black oak (BO), scarlet oak (SO), white oak (WO), chestnut oak (CO), hickories (HC), yellow-poplar (YP), black cherry (BC), red maple (M), and all of these species combined (OTHERS). Field work involves recording, total heights of point-sample-selected trees. (Although not preferred as the predictions are not as reliable, merchantable height to a 4-inch diameter outside bark may be recorded if the canopy obscures the total height.) Heights are recorded by species, unless OTHERS for miscellaneous species unless they are included in the tally of a similar species (as cedarmontree with YP). Table 1 gives a listing of the FORTRAN program, and details on use of this system are given in the following sections.

Table 1. FORTRAN program listing.

Technical Article 2

COMPUTER PROGRAM FOR POINT-SAMPLE BIOMASS CURVING OF APPALACHIAN HARDWOODS

by

Harry V. Wiant, Jr.
and
Don E. Wingard

The authors are professors of forestry and graduate student, respectively, Division of Forestry, West Virginia University, Morgantown, WV 26506.

One card is used to indicate options desired, as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAf used, right justified if no decimal included. (If blank or zero, BAf = 10 assumed.)</td>
<td>1-4</td>
</tr>
<tr>
<td>Total number of point samples in cruise, right justified. (An error message is given if this value is not input or is zero.)</td>
<td>5-9</td>
</tr>
<tr>
<td>Total acres in tract, right justified if no decimal included.</td>
<td>10-15</td>
</tr>
<tr>
<td>If output for each individual point is desired, punch &quot;1&quot;, if not desired, leave blank.</td>
<td>17</td>
</tr>
</tbody>
</table>

General Instructions

The order of the cards to use this program is:

1. JCL REQUIRED AT INSTALLATION
2. FORTRAN PROGRAM
3. OPTION CARDS
4. POINT SAMPLE DATA CARDS
5. TWO CARDS PUNCH 9999 IN COLUMNS 1-4

Output

The output is given under the following headings:

TOTAL GREN = fresh-weight biomass (tons) of trees, excluding 4-foot stumps, roots, and leaves.
TOTAL DRY = dry-weight biomass corresponding to TOTAL GREEN.
TOTAL W/O BANK = total dry-weight biomass, excluding bark.
TOTAL BANK = TOTAL DRY MINUS TOTAL W/O BANK.
MERCH. GREN, DRY, W/O BANK, BANK correspond to total values but to a 4-inch diameter outside bark.

Cords are calculated on the basis of 5000 pounds of green weight per cord (Wiant and Wingard, in press). The difference in TOTAL GREN and MERCH. GREN biomass or cords represents an estimate of the increase in yield of whole-tree chipping over conventional pulpwood harvesting.

Table 2 shows the optional output which can be printed for each point sample. Table 3 gives

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Fields with no data are left blank.
Table 3. Total biomass estimates (t/ha) for point sample no. 3

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Table 5. Marketable biomass estimates for the tract.

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</table>

5
The standard error ($S_c$) for the tract is calculated as:

$$S_c = \left[ \left( S_X^2 - (S_X^2/n) \right)/n(n-1) \right]^{1/2}$$

where:  
- $X =$ per-acre biomass estimate at a given point sample  
- $n =$ number of point samples  
- $A =$ acres in tract

The standard error is expressed as a percent of the tract estimates also.

The coefficient of variation (CO VAR) is useful for estimating the sample size required for a specified standard error in future cruises. It is calculated as:

$$CO \ VAR = \left[ \left( S_X^2 - (S_X^2/n) \right)/\bar{X} \right] \times 100$$

where:  
- $\bar{X} =$ average

It should be noted that an unrealistically small point sample, with $n = 1$, was used for illustrations in tables 2-5. If point sampling factors are derived which are more appropriate in a given locality than those used here or are developed for other species, the PORTDLM program can be modified easily in the DATA FACTOR, DATA FACTR2, and DATA LABEL statements.

Literature Cited

Want, H. V., Jr., and D. E. Waagek. Biomass factors for point sampling in Appalachian hardwoods. (In press in J. For.)

THE NATIONAL RESOURCE INVENTORY TECHNIQUES PROJECT

One of the purposes of this newsletter is to report on the status of various research projects around the Nation involved in resources evaluation. The National Resource Inventory Techniques (NRIT) Project is one of the four research projects making up the Resources Evaluation Techniques (RRT) Research and Development Program headquartered at the USDA Forest Service's Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado. The mission of NRIT is to develop improved techniques for inventorying renewable natural resources, and to transfer these techniques to appropriate users who generate state, regional, and national assessments. The project leader is H. Clyde Lund.

The current project problems include how to efficiently measure, sample, and aggregate soil, vegetation, and wildlife variables. The variables have been identified through information needs assessments for input to state, regional, and national assessments and corresponding analyses.

The short-range goals are to:

1. Develop by December 1981 criteria for evaluating the combinability of data from diverse sources for assessment purposes.
2. Evaluate by December 1981 alternative measurement and sampling techniques for soil and vegetation to improve ongoing renewable resource inventories for the National Assessment and Appraisals.

Our immediate research is to provide cooperating agencies with techniques that can be used to augment, strengthen, or modify their current procedures which will insure reliable and compatible data bases for national assessments.

The first goal has been partially completed through study 4154-1-2 on Aggregating Inventories. The preliminary results were published in Resources Evaluating Newsletter No. 4, Technical Article 1, p. 1-5, entitled "Aggregating Inventories," by Lund and Schreuder.

A series of active studies are being conducted by project scientists to accomplish the second goal.

Study 4154-1-2, Plant Community Structure as an Ecological Base for Vegetation Inventory, will develop and evaluate techniques to measure vegetation variables required for national assessments. The lead scientist on this study is Richard E. Francis. The end product will be a list and explanation of techniques for measuring non-timber vegetation attributes.

Development and evaluation of techniques to obtain soil information for input to national assessments is in the theme of Study NR-4154-1-3. The Project will draw upon the talents of Dale E. Snyder, Soil Conservation Service, assigned to the National Classification Project within the RRT Program. The objectives of the study will be to determine the extent of soil surveys, the usefulness of soil survey data for national assessments, and how to obtain soil data in areas not surveyed.

Flor and Subplot Configurations for Resource Inventories are being explored by Meredith J. Norris under Study 4154-1-4. Norris is conducting an intensive literature review to evaluate and list the efficiency of alternative plot designs to capture the wide gamut of vegetation information required for national assessments.

Different sample designs have different advantages for assessments, land use planning, or single use. Lund, under study 4154-1-5, will
evaluate the efficiencies and considerations of grid (point) and area (polygon) sampling frames for use as input to national assessments.

Hans T. Schreuder, Leader of the Statistical Research and Support Group in the RFG Program, is working with the NRIT to develop Sampling Strategies for Multiresource Inventories. Schreuder, through Study 4841-6, will develop sampling designs and estimators that are likely to be useful to agencies and also allow for measurement of additional needed variables for national assessments.

Goal three is new. Stephen A. Miller, recently assigned to the Project through the Interagency Personnel Agreement with the USDA Forest Service from the State of Maryland, is developing a state-of-the-art paper and problem analysis for animal census techniques. This will include procedures for estimating population numbers, age and sex composition, and mortality and natality rates.

Support is provided by Roger Kees, Range Technician, and Wally Greenstreet, Forest Technician. Anyone wishing to correspond with the scientists on any of the above studies should write them directly c/o USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 Prospect Street, Fort Collins, CO 80521.

INTERAGENCY WILDLIFE GROUP (IWG) ACTIVITIES

Cliff Hawken, Dave Chalk, and Jim Whelan completed a problem analysis on Ecological Land Classification Techniques for National Assessments of Wildlife and Fish for the National Resource Analysis project. Comments and suggestions from the Forest Service, Fish and Wildlife Service, Soil Conservation Service, Bureau of Land Management, university faculty, and state wildlife and fish agency personnel were solicited, evaluated objectively, and incorporated into the final document. This problem analysis (1) describes the major wildlife and fish problem areas of national concern to federal and state natural resource agencies, (2) identifies the major wildlife and fish problem areas of national concern to federal and state natural resource agencies, (3) describes the state-of-the-art for methodologies available to deal with the problems, and (3) identifies research needs and recommends research studies, in order of priority, which address each problem area.

In addition, the relationship between the wildlife/fish problem analysis and other problem analyses developed by the NRIT which deal with timber and range is described briefly. Each problem analysis constitutes an important part of an integrated resource analysis approach consistent with the cooperative nature of the Resource Evaluation Techniques Program and the Interagency (3-Way) Agreement related to Classification and Inventories of Natural Resources. The wildlife/fish problem analysis provides guidance in the selection and development of inventories procedures for collecting wildlife/fish information to be used in evaluating and monitoring the status of habitats and populations for national assessments.

A study plan for conducting an inventory of fish information needs for national and state wildlife and fish resource planning was completed by Dave Chalk, Cliff Hawken, Steve Miller, and Jim Whelan. This study will identify and define common interagency wildlife/fish resource information needs which will meet national and state level planning requirements of the cooperating federal and state agencies. The interagency information needs assessment will (1) define planning questions to be addressed by the 3-Way Agencies and the International Association of Fish and Wildlife Agencies (IAFWA), through the National Governor's Association/Council of State Planning Agencies, (2) determine information items and data elements needed to address the questions, and (3) develop definitions and standards for each information item and data element.

The chairman of the recently organized Wildlife Working Group of the Canada Committee on Ecological Land Classification contacted the IWG and expressed an interest in our work. This Wildlife Working Group is the Canadian counterpart of the IWG. We are establishing good lines of communication between the two wildlife groups to improve cooperation in developing a hierarchical/ecological system for the classification, inventory, and analysis of wildlife and fish resources.


CALL FOR PRESENTATIONS
1981 JST OR AIN/VIA NATIONAL WORKSHOP

The Association of Interpretative Naturalists and the Western Interpreters Association are calling for presentations for the 1981 Joint 1981 National Workshop to be held September 21-24 in Estes Park, Colorado.

Please consider the following areas for submission and review:

1. Education/Interpretation Experiences
2. Interpretative Techniques
3. Interpretative Practices
4. Interpretative Experiences
5. Interpretative Interpretation
6. Interpretative Techniques
7. Interpretative Practices
8. Interpretative Experiences
9. Interpretative Interpretation
10. Interpretative Techniques
11. Interpretative Practices
12. Interpretative Experiences
13. Interpretative Interpretation
14. Interpretative Techniques
15. Interpretative Practices
16. Interpretative Experiences
A. Papers describing empirical research in the area of interpretation, including relevant research in communications, landscape perception, human ecology, marketing/ advertisng, environmental psychology, and related fields. Papers should include an application of findings.

Submit papers no later than March 31 to:

Maureen McDonough
Department of Parks and Recreation Resources
131 Natural Resources Bldg.
Michigan State University
East Lansing, MI 48824
(517) 353-2790

B. Abstracts (250 words or less) related to all aspects of interpretation (natural, recreational, historical, etc.) at all levels (field operations, management, techniques). Specify the style of your presentation from the list below:

1) General: Presentation normally 30 minutes
2) Poster Board Demonstration - to be exhibited
3) Short Comment - less than 5 minute presentation
4) Panel Discussion - submit names and abstracts of each participant

Submit abstracts for review no later than March 31 to:

Peggy Van Ness
AIR
6700 Needwood Road
Wayne, MI 48055
(313) 945-8604

SEVENTH CANADIAN SYMPOSIUM ON REMOTE SENSING, WINNIPEG, MANITOBA, CANADA
September 8-11, 1981

THEME: Data to Earth Management
Techniques, planning, and poster sessions, exhibits, and social events are planned. Deadline for technical paper abstracts is May 15, 1981.

Further information is available from the General Chairman, Mr. W. G. Best, c/o Department of Natural Resources, Manitoba Centre for Remote Sensing, 1907 Century Street, Winnipeg, Manitoba, Canada, R3E 0W4.

This symposium is sponsored by the Canadian Remote Sensing Society of the Canadian Aeronautical

Space Institute, and organized by the Manitoba Branch of the Canadian Institute of Surveying.

PURDUE HOSTS EDUCATORS' CONFERENCE

CORSE-81, Conference on Remote Sensing Education, will be held May 19-21, 1981, at Purdue University. Co-sponsored by NASA and AROA, the conference is being organized and conducted by the Laboratory for Applications of Remote Sensing (LARS).

The goal of the conference is to bring together remote sensing educators from across the country to exchange information on establishing and improving remote sensing curricula in institutions of higher education.

A panel presentation during the opening session will seek to identify the kinds of skills and knowledge that will be needed by those involved in remote sensing in the years ahead. The remainder of the conference will explore ways for education to meet this challenge.

An honest look at resources needed for effective teaching of remote sensing and also at strategies for teaching in various disciplines will lead into concurrent, discipline-oriented sessions where educators can tackle specific problems in small groups. Several presentations and discussions will address critical questions about obtaining and using digital image-processing capabilities for education.

Several tutorial workshops will be held in conjunction with the conference. These workshops, on the days preceding and following the conference, will strive to acquaint relative newcomers with the basics of remote sensing, and will be a means for others to keep abreast of new technological developments.

Attendance at CORSE-81 is limited to approximately 200 educators, with room and meals provided for many who attend. For additional information contact Shirley Davis, Laboratory for Applications of Remote Sensing, Purdue University, 1220 Potter Drive, West Lafayette, Indiana 47906, Phone (317) 742-2052.

CURRENT LITERATURE

Please order directly from sources given in (). In case of Journal articles, contact your local library for availability.
REMOTE SENSING


Hoffer, R. R., et al. 1979. Digital processing of Landsat MSS and topographic data to improve capabilities for computerized mapping of forest cover types. LARS Technical Report 01579. 159 p. (Contact LARS, Purdue University, West Lafayette, IN 47906, for availability).


INVENTORY

Johnson, Thomas R., and Dietzel R. Pelz. 1979. Tree polygony in forest sampling. Forest Research Laboratory (Agricultural Experiment Station, University of Illinois at Urbana-Champaign, Champaign, IL 61801).


CLASSIFICATION

tional Forest in northwestern Colorado: A habitat type classification. USDA Forest
Service Research Paper RM-221. 41 p. (Publication Distribution, Rocky Mountain Forest

* * * * *

MEETINGS, WORKSHOPS, AND SYMPOSIA

Global Resource Applications: Principles and

Course Contact: Continuing Engineering Education, George Washington University, Wash-
ington, D. C. 20052. Phone (202) 675-6161.

April 6-10, 1981. Digital Image Processing of
Earth Observation Sensor Data. Course No.
307. $695. Contact: Continuing Engineering Education, George Washington University, Wash-
ington, D. C. 20052. Phone (202) 675-6161.

April 6-11, 1981. Perspectives in Landscape
Ecology: Contributions to Research, Planning,
and Management of Our Environment. (Kend-
brown, The Netherlands). Contact: Mrs. W. J. M.
von Gierse, Congress Bureau of the In-
formation Dept. TNO, 144, Juliand van Stol-
berglaan, 2595 CF The Hague - The Nether-
lands.

(Los Angeles, CA) Held in conjunction with
Seventy-First Annual Meeting of Association
of American Geographers. Contact: Ronald
A. Weishaar, Dept. of Geography and Earth
Science, Univ. of Wisconsin, La Crosse, WI
54601. Phone (608) 785-8356.

April 20-21, 1981. Energy and Ecological
Modelling - An International Symposium.
Contact: Dr. William J. Mitch or Dr. Robert
W. Boorseus, Systems Science Institute, Univ. of Louisville, Louisville, KY 40292.
Phone (502) 588-6482.

April 21-23, 1981. Eighth Biennial Workshop on
Color Aerial Photography in the Plant
Sciences and Related Fields. (Shandrah
National For., Virginia). Contact: Dr. Roy
A. Read, Program Chairman, VPI and State
Univ., Blacksburg, VA 24061. Phone (703)
691-5841.

April 22-24, 1981. Forest Sampling Short Course.
(R1015). Sponsored by Forestry Off-Campus
Programs, University of British Columbia and
Continuing Forestry Education, University of
Alberta. Contact: Forestry Off-Campus Programs, Room 72, 2357 Main Mall, Univer-
sity of British Columbia, Vancouver, B.C. V6T 1W5 Canada. Phone (604) 228-6108.

April 23, 1981. Methods for Controlling Devel-
opment of Crowns, Scales, and Stands (F8106).
Sponsored by Forestry Off-Campus Programs.
Contact: Forestry Off-Campus Programs, Room 72, 2357 Main Mall, University of British
Columbia, Vancouver, B.C. V6T 1W5 Canada.
Phone (604) 228-6108/228-6821.

May 3-6, 1981. Wildlife Management on Private
Lands. Milwaukee, WI. Contact: Robert T.
Goun, 3931 Fish Hatchery Rd., Madison, WI
53711. Phone (608) 266-9607.

May 4-15, 1981. Forest Industries Management
Development Program. $1,400. Includes all
fees, meals, and lodging. Contact: Manage-
ment Development Programs, 708 Stickey Man-
agement Center, Univ. of Tennessee, Knox-
vil, TN 37916.

May 11-15, 1981. Fifteenth International Sym-
posium on Remote Sensing of Environment.
Contact: Dr. Jared J. Cook, ERIM, P. O. Box
916, Ann Arbor, MI 48107. Phone (313)
994-1200.

May 26-28, 1981. The Ninth Annual Hardwood
Symposium, "Research Today is the Key to
Profitability Tomorrow." (Pippus, West Vir-
ginia). Contact: Hardwood Research Council, 0 Box 333, Asheville, NC 28802.
Phone (704) 254-2852.

June 1-5, 1981. Remote Sensing Techniques in
Geology. Contact: Branch of Applications, ERIM Data Center, Sioux Falls, SD 57198.
Phone (605) 994-6214.

courses are available on The Natural Phen-
omena of the Yellowstone Area. For more
information, contact Rick Reese, Director, The Yellowstone Institute, 555 South
第二批的地区, ME 54461. Phone (406)
436-0866.

June 22-26, 1981. Dynamics and Management
of Mediterranean-type Ecosystems: An Inter-
national Symposium. (San Diego, California).
Contact: Chairman, Dynamics and Management of Mediterranean-type Ecosystems: An
International Symposium, Pacific Southwest Forest and Range Exp. Stn., USDA Forest,
Service, 4955 Canyon Crest Drive, Riverside, CA 92507.


July 7-10, 1981. Use of Programmable Calculators in Forestry. $400.


July 20-24, 1981. Multilevel Sampling. $400. For information on all three of the above short courses, contact Offices of Conferences and Institutes, 11 Rockwell Hall, Colorado State University, Fort Collins, CO 80523.


** **

WANTED - Material for the Newsletter - feature articles, news items, current literature, and meeting notices. All articles received are to be grammatically and technically correct. Send your material to Resources Evaluation Newsletter, Rocky Mountain Forest and Range Exp. Sta., 240 West Prospect Street, Ft. Collins, CO 80526. Phone: (303) 221-4390, ext. 202 or FTS 223-1202.

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Views expressed in this Newsletter may not necessarily reflect the position of some of the sponsoring agencies.

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