Resource Inventory Notes

BLM 7 September, 1977

FOREST SITE INDEX MAPPING AND YIELD MODEL INPUTS TO DETERMINE POTENTIAL SITE PRODUCTIVITY

Submitted by:

James R. Getter

and

Creighton H. Tom[1/]

INTRODUCTION

The U.S. Department of Agriculture recently announced a policy to help keep the Nation's prime agricultural lands from going into nonagricultural uses. An integral part of this effort would be an inventory and evaluation of such farm, range, and forest lands. The Colorado State Forest Service is likewise looking for a quantitative timber assessment process in which potential stand productivity can be mapped economically. Such a process would greatly facilitate both state and federal resource management decision-making.

There have been six previous timber resource inventory appraisals in Colorado, the first of which was conducted in 1937 (Taylor and Hornibrook) and the last being completed in 1972 (Brown and Getter). Each of the six inventories was an appraisal of varying degrees but none to date have mapped forest productivity classes.

Better management decisions and projections will result from the availability of information such as site productivity and its spatial distribution. Such needed data can be currently obtained only through costly, time-consuming field work. This preliminary report describes the initial steps, data sources, results, and conclusions from a prototype computer system to overlay multivariate map and remote sensing data to estimate forest site productivity.

1/ Colorado State Forest Service, and
Colorado State Department of Forest & Wood Sciences, respectively

Published by:

USDI, Bureau of Land Management, D 340
Denver Service Center, Denver Federal Center, Bldg. 50
Denver, Colorado, 80225

A study area was designated on the Eaton Reservoir quadrangle in Larimer County, Colorado as the preliminary step in this study. The reasons for selecting this particular area were twofold: (1) vegetative and topographic diversity, and (2) elevation, slope, and aspect data generated during a previous study (Tom and Getter, 1975). This quadrangle lies adjacent to the Colorado-Wyoming state border (Figure 1).

Site index* was chosen as the "dependent" variable to be measured, and is a quantitative term used to describe how well a timber species grows on a given area. Foresters are concerned with a need to classify forest sites for two main reasons: (1) to identify productivity, and (2) to provide a frame of reference for silvicultural diagnosis and prescription (Jones, 1969). In this study the emphasis is on an area-by-area identification of site productivity classes.

A recent study indicated the feasibility of lodgepole pine site index prediction from selected environmental factors (Mogren and Dolph, 1972). The four variables used included soil, climatic, and topographic characteristics.

An earlier study of topographic slope and aspect factors and their relationship to ponderosa pine site quality in the Black Hills successfully delineated site quality for local areas (Mogren, 1959). This study stratified the site area into the three site area classes (Figure 2) of Harman (1955).

Available inventory data for this study included elevation, slope, aspect, vegetation type, and LANDSAT-1 multispectral line-scanner digital data. As will be explained further in Section II, these nine data sources were spatially overlayed as 2.5-acre cells (Figure 3).

A training area was selected within the study area and stratified by site area classes after Harman. Forest stands were delineated by area class and site index measurements taken at four random points within the stand and averaged. An analysis of variance (Table 1a, 1b) was performed to determine if there was variation of site index within these site area classes. Individual stand characteristics and statistics (Tables 2 and 3) were recorded by timber type, stand size class, stocking class, site area class, site index, and stand area.

*Terminology of Forest Science, Technology Practice and Products. SAF, Washington, D.C. 1971.

SECTION II. LANDSCAPE MODELING

A. General

Landscape modeling provides a quantitative framework wherein three-dimensional map and/or remote sensing data can be spatially merged, overlayed, and registered into a coherent analytical structure. This numerical design represents a multivariate response surface which "models" the landscape. The z-component of map data is not only analytically compatible with the corresponding spectroreflectance vector of remote sensing data, but also symbiotically useful to each other. For example, remote sensing data provides reliable land cover classifications in rapidly changing areas, but ancillary physiographic, socio-economic, and transportation data not normally available to automated image processing can dramatically improve these operations. This useful reciprocal relationship has been demonstrated in an on-going study of the Denver, Colorado metropolitan area (Tom, Miller, Krebs, and Aukerman, 1974; Miller, Tom, and Nualchalwee, 1977).

The LANDSAT-1 and -2 earth resource satellites are widely used as a repetitive source of moderate-resolution (1.1 acres per picture element) multi-spectral data. Each LANDSAT digital image can be visualized as a matrix A of r rows and c columns of four-dimensional spectroreflectance vectors $a_{i,j}$ which represent the spectral pattern of ground picture elements (pixels) as detected and recorded by the multispectral scanner (MSS) sensor system as follows:

$$A_D = \begin{bmatrix} a_{i,i} & \cdots & a_{i,c} \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ a_{r,1} & \cdots & a_{r,c} \end{bmatrix}$$

where A_D = LANDSAT scanner image on date D
and $a_{i,j}$ = pixel in ith row and jth column composed of the four-channel MSS column vector

$$a_{i,j} = \begin{bmatrix} p^4_{i,j} \\ p^5_{i,j} \\ p^6_{i,j} \\ p^7_{i,j} \end{bmatrix}$$

B. Landscape Modeling Data Resources

LANDSAT-1 digital imagery was available for the date of August 15, 1973, (frame number 1388-17131) which covered a 100- by 100-nautical mile area encompassing the Colorado Rockies and eastern plains from Fort Collins to Denver. The Eaton Reservoir quadrangle was identified, rotated, and rectified for 2.5-acre pixels for all four MSS channels. This geometric operation permitted spatial registration with previously existing 2.5-acre elevation, slope, aspect, and vegetation data plans of 137 rows and 102 columns of cellular values generated from a wildfire hazard mapping test project (Tom and Getter, 1975; Tom, 1975). A fifth ancillary variable, near-instantaneous solar radiation, was computed from the slope and aspect data for the time of the LANDSAT-1 overpass to provide data on the area's sunlit/shadowed mountainous terrain.

Field site index measurements were concurrently made on 37 points, and revealed ranges from 25 through 65 (Table 2). These points, as will be shown in the following subsections, provided the dependent variable of site index as a known or "ground-truth" value.

C. Multivariate Site Productivity Classification

The multivariate statistical technique most useful for arraying the data in a meaningful fashion and providing a framework within which each pixel's site index can be located is that of discriminant analysis. The method combines multiple measurements from each sample , i.e., pixel to determine orthogonal axes (discrimant functions) such that each observation can be plotted and classified by means of a single disciminant score. Mathematically, a linear disciminant function is derived such that

$$Y = a_1x_1 + a_2x_2 + \dots + a_nx_n$$

where x_1, x_2, ... , x_n are the n-channel pixel measurements (n=9 in this study) and a_1, a_2, ... , a_n are selected to determine a value for Y (the linear compound) which minimizes the misclassification of the 37 cases falling into the ten classes.

With the BMD07M biomedical computer program used here, not all of the ancillary/LANDSAT-1 variables need appear in the final discriminant function (Dixon, 1968). Using this linear stepwise discriminant analysis program, it is possible to enter at each step that nonincluded variable which produces the greatest improvement in the discriminating power of the function. The program allows for later deletion of variables, as well as program termination if the unentered variables are poor discriminators. The final discriminant function consequently contains only useful variables in distinguishing between the groups. The function is commonly checked by seeing how well it classifies an independent set of known cases. Most usefully, it can be used to classify unknown cases from the mean and covariance statistics compiled from the set of known training cases for each group.

D. Site Productivity Classification Results

BMD07M program classification of the 37 "ground-truth" pixels with four LANDSAT-1 MSS channels and five ancillary variable showed 34 correctly classified cases for an average 92 percent classification rate on the ten site index classes (Table 4). The ancillary variables were generally more useful discriminators, but the LANDSAT-1 MSS channels also contributed to the overall accuracy level.

A second BMD07M run was subsequently made deleting the visible red MSS-5 channel since it did not improve the overall classification as the last variable added. Again, the program correctly classified 34 cases and the eight-variable mean and covariance statistics were saved to classify the entire Eaton Reservoir quadrangle.

Cost-effectiveness considerations required the examination of smaller variable combinations than the preceding eight-and nine-channel runs which yielded a 91.9 percent figure-of-merit. For example, users having only the five ancillary variables (elevation, vegetation, slope, aspect, and insolation) would achieve a 67.6 percent figure-of-merit (Table 5). However, an optimal five-channel combination would delete aspect and insolation for LANDSAT bands MSS-4 and -6 to get 81.1 percent accuracy. Other user groups could find the reduced accuracy of this latter best combination cost-effective with the lowered computation requirements of only five versus eight variables.

In a field inventory mode, site indices would be measured and classified into broader ten-foot height classes. Accordingly, the figures-of-merit reported in Tables 4, 5, and 6 would be revised upward to 100, 70.3, and 86.5 percent, respectively.

The full quadrangle classification was performed and the site indices were both printed and saved on magnetic tape. Ground verification efforts will be mounted shortly to check out a number of these unknown cases for a complete statistical analysis. This final phase will, of course, be the most time-consuming step and no verification results are yet back at this time.

SUMMARY

Because of the considerable costs of field work and limited manpower available CSFS is attempting to generate cost-effective information, normally obtained in the field. The production system will classify site indices to broad classes, i.e., high, moderate or low. This inexpensive approach will not give us discrete values of volume per area but potential volume per area.

Estimates of growth and yield of managed stands can be determined before the managed stands are created. Given site index, age and density we can obtain potential volume estimates, compiled from yield tables, for timber management decision (Myers 1967; 1971). Yield tables are guides to land managers that report probably wood yields that result from a combination of factors such as site quality.

Previous inventories, in tabular form have shown us how much volume per acre of what kind for various administrative boundaries. We now believe we have a procedure for determining its location. With site index information and potential volume per area mapped out we feel the land manager has a good general planning tool as to areas of concern and resource allocation.

This procedure has obvious limitations which are similar to a photointerpretation report written by Lund 1974.

- Classification accuracies of the training sets are moderately high but should be weighted by the limited number of sample points.

- Due to the large number of site index predictions possible in a wildland situation on any given area, an equally large number of sample points will have to be taken.

- Forest stands were stratified to their position on slope causing forest stands to have similar sets index values possible causing a bias.

- Spatial registration of spectral (LANDSAT) data to aerial and ground points can be difficult in a poorly defined wildland area.

With sample field plot data to include elevation, slope, aspect, solar radiation, vegetation type, density, site index and four bands of LANDSAT, predictions of site index and potential productivity can be made for a given area and then mapped out for land management decision making.

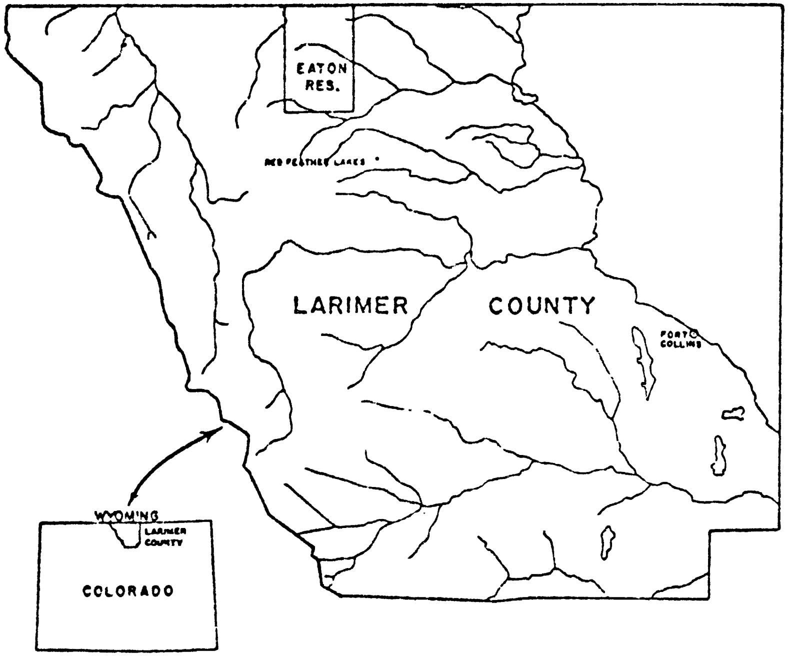
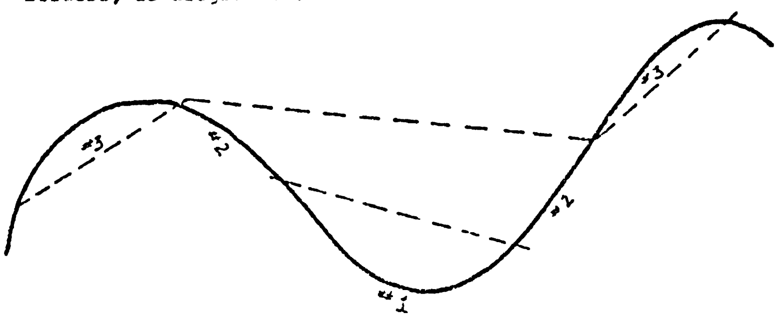


FIGURE 1. MAP OF EATON RESERVOIR QUADRANGLE STUDY SITE. The 7.5-minute USGS quadrangle's location within Larimer County, and that of the county relative to Colorado-Wyoming state borders, is diagrammed.



Area No. 1 (good)

:Bottoms of draws
:and lower south-
:east, east, north-
:east, north, and
:northwest aspects.
:Deep rich soil.
:Soil moisture
:plentiful. Best
:growing sites.

Area No. 2 (average)

:Lower and middle slopes
:on south and west as-
:pects; middle and upper
:slopes, including ridge
:tops with good soil
:depth, on southeast,
:east, northeast, north
:and northwest aspects.
:Soil depth moderate.
:Soil moisture good.
:Average growing site.

Area No. 3 (poor)

:Upper south, west
:and southwest aspects.
:Shallow soils.
:Driest sites.
:Growing conditions
:below average.

Figure 2. Site Area Class System used on Eaton Reservoir Quadrangle after Harman 1955.

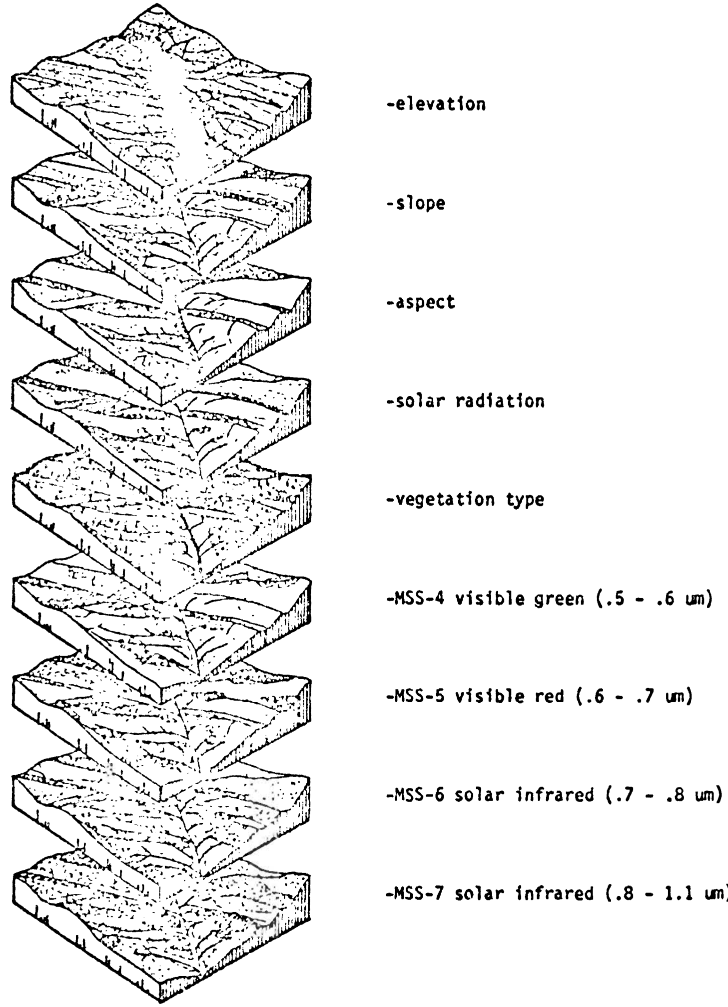


Figure 3. Conceptual diagram of nine ancillary and image planes overlaying the Eaton Reservoir Quadrangle.

Table 1a. EATON RESERVOIR QUADRANGLE ANALYSIS OF VARIANCE. The site index means of sampled stands grouped into Harman's class were significantly different at the α = .10 level (Mendenhall).

	Sum Squares	Degrees of Freedom	Mean Square	F-Value
Treatment	688	2	334	2.90*
Error	1265.5	11	115.05	
Total	1933.5	13		

*Significant at α = .10 level. The tabled value at the α = .05 level was 3.98.

Table 1b. EATON RESERVOIR QUADRANGLE ANALYSIS OF VARIANCE. The site index means of sampled stands grouped into Harman's class good versus average and poor were significantly different at the α = .01 level.

	Sum Squares	Degrees of Freedom	Mean Square	F-Value
Treatment	740.60	1	740.60	10.18*
Error	872.90	12	72.74	
Total	1933.5	13		

*The tabled value at α = .01 level was 4.75.

TABLE 2. EATON RESERVOIR QUADRANGLE SAMPLED TIMBER STAND CHARACTERISTICS. The following fourteen timber stands on the Eaton Reservoir quadrangle were measured for timber type, stand size class, stocking class, Harman's site area class, site index, and stand area.

STAND NUMBER	TIMBER TYPE	STAND SIZE CLASS	STOCKING CLASS	HARMAN'S SITE AREA CLASS	SITE INDEX	STAND AREA, ACRES	COMPUTER TRAINING AREA
1	Ponderosa pine	small sawtimber	medium	poor	46	16	5.0
2	Ponderosa pine	small sawtimber	medium	avg.	40	50	7.5
3	Lodgepole pine	small sawtimber	medium	good	60	33	2.5
4	Douglas fir	small sawtimber	medium	poor	30	31	10.0
5	Douglas fir	small sawtimber	medium	avg.	40	65	10.0
6	Douglas fir	small sawtimber	medium	poor	33	16	7.5
7	Douglas fir	small sawtimber	well	avg.	25	15	7.5
8	Lodgepole pine	small sawtimber	medium	avg.	45	32	15.0
9	Lodgepole pine	pole timber	well	avg.	50	166	10.0
10	Lodgepole pine	pole timber	well	good	55	4	5.0
11	Lodgepole pine	small sawtimber	medium	good	40	27	7.5
12	Lodgepole pine	pole timber	well	avg.	40	29	10.0
13	Lodgepole pine	small sawtimber	medium	good	65	126	15.0
14	Douglas fir	small sawtimber	medium	avg.	40	17	15.0

Table 3. EATON RESERVOIR QUADRANGLE SAMPLED TIMBER STAND STATISTICS.

Site Area Location	Mean Site Index	Standard Error of Mean	Standard Deviation	Coefficient Variation
good	55	5.40	10.8	19
average	40	2.87	7.6	19
poor	36	3.98	6.9	30

Vegetation Type	Site Area Location	Acres in Each Site Area	% of Total Acres Per Site Location
Lodgepole pine	good	190	27.5
Lodgepole pine Douglas-fir Ponderosa pine	average	374	54.2
Ponderosa pine Douglas-fir	poor	126	18.3
Totals		690	100.0

TABLE 4. NINE IMAGE/LANDSCAPE VARIABLE FREE STEPWISE DISCRIMINANT ANALYSIS SUMMARY. Thirty-four 2.5-acre training set points were correctly reclassified into ten site index classes with the first eight variables for a 92 percent average figure-of-merit. The entry order indicates that the ancillary variables were generally the more useful, although MSS bands 6 and 4 were also quite useful. MSS band 5 could probably be deleted without sacrificing classification accuracy.

STEP NUMBER	VARIABLE ENTERED	CLASSIFICATION ACCURACY TOTAL RIGHT	PERCENT RIGHT	F-VALUE TO ENTER
1	TOPOGRAPHIC ELEVATION	16	43.24	7.68
2	LANDSAT-1 MSS-6 (SOLAR INFRARED)	20	54.05	7.16
3	TOPOGRAPHIC SLOPE	26	70.27	4.20
4	LANDSAT-1 MSS-4 (VISIBLE GREEN)	29	78.38	3.52
5	VEGETATION COVER	30	81.08	3.44
6	AUGUST 15, 1973 LANDSAT-1 IMAGE INSOLATION	33	89.19	1.47
7	TOPOGRAPHIC ASPECT	33	89.19	1.74
8	LANDSAT-1 MSS-7 (SOLAR INFRARED)	34	91.89	1.31
9	LANDSAT-1 MSS-5 (VISIBLE RED)	34	91.89	0.64

TABLE 5. FIVE LANDSCAPE VARIABLE FREE STEPWISE DISCRIMINANT ANALYSIS SUMMARY. Twenty-five 2.5-acre training set points were correctly reclassified into ten site index classes using only ancillary variables for a 68 percent average figure-of-merit. Topographic elevation was the most useful single variable, and could classify the 37 total points correctly 43 percent of the time.

STEP NUMBER	VARIABLE ENTERED	CLASSIFICATION ACCURACY TOTAL RIGHT	PERCENT RIGHT	F-VALUE TO ENTER
1	TOPOGRAPHIC ELEVATION	16	43.24	7.68
2	VEGETATION COVER	19	51.35	3.94
3	TOPOGRAPHIC SLOPE	22	59.46	3.58
4	TOPOGRAPHIC ASPECT	24	64.86	1.93
5	AUGUST 15, 1973 LANDSAT-1 IMAGE INSOLATION	25	67.57	1.65

TABLE 6. FIVE IMAGE/LANDSCAPE VARIABLE FREE STEPWISE DISCRIMINANT ANALYSIS SUMMARY. Thirty 2.5-acre training set points were correctly reclassified into ten site index classes using three ancillary and two LANDSAT-1 variables. This five-variable combination is superior to the five ancillary variables tested in Table 5. The entry order is identical to that of Table 4.

STEP NUMBER	VARIABLE ENTERED	CLASSIFICATION ACCURACY TOTAL RIGHT	PERCENT RIGHT	F-VALUE TO ENTER
1	TOPOGRAPHIC ELEVATION	16	43.24	7.68
2	LANDSAT-1 MSS-6 (SOLAR INFRARED)	20	54.05	7.16
3	TOPOGRAPHIC SLOPE	26	70.27	4.20
4	LANDSAT-1 MSS-4 (VISIBLE GREEN)	29	78.38	3.52
5	VEGETATION COVER	30	81.08	3.44

LITERATURE CITED

Brown, Delmer L. and J. R. Getter. 1972. *Summary Report, State & Private Timber Resource Inventory.* Colorado State Forest Service, Colorado State University, Fort Collins, Colorado 80523. 21 pp., illus.

Dixon, W. J. 1967. *BMD, Biomedical Computer Programs.* University of California Publications in Automatic Computation No. 2, University of California Press, Berkeley, California. pp. 214a-214s.

Harman, Wendell H. 1955. *Ponderosa Pine Management in the Black Hills.* Ames Forest 42: 6-8.

Jones, John R. 1969. *Review and Comparison of Site Evaluation Methods.* U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-51. 27 pp., illus.

Lund, H. Gyde. 1974. *So we know what we have, but where is it?* In Monitoring Forest Environment Through Successive Sampling. Symposium Proceedings, Syracuse, New York. pp. 133-141.

Mendenhall, William. 1975. *Introduction to Probability and Statistics, Fourth Edition.* Belmont, California, Duxbury Press, pp. 414-417.

Myers, Clifford A. 1967. *Yield Tables for Managed Stands of Lodgepole Pine in Colorado and Wyoming.* U. S. Forest Service- Rocky Mountain Forest and Range Experiment Station. Research Paper RM-26. 19 pp., illus.

Myers, Clifford A. 1971. *Field and Computer Procedures for Managed-Stand Yield Tables.* USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-79. 24 pp., illus.

Miller, L. D., C. H. Tom and K. Nualchawee. 1977. *Remote Sensing Inputs to Landscape Models which Predict Future Spatial Land Use Patterns for Hydrologic Models.* NASA X-923-77-115 preprint, Goddard Space Flight Center, Greenbelt, Maryland. 41 pp., illus.

Mogren, E. W. and K. P. Dolph. 1972. *Prediction of Site Index of Lodgepole Pine from Selected Environmental Factors.* USDA Forest Service, Volume 18, No. 4, pp. 314-316.

Mogren, E. W. 1959. *Slope and Aspect as Indicators of Site for Ponderosa Pine in the Black Hills.* Research Note #11. College of Forestry and Range Management, Colorado State University, Fort Collins, Colorado 80523.

Taylor, R. F. and E. M. Hornibrook. 1937. *The Forest Resources of Colorado.* U. S. Forest Service.

Tom, Craig and J. R. Getter. 1975. *Computer Mapping of Wildfire Hazard Areas: A User-Oriented Case Study.* Colorado State Forest Service, Colorado State University, Fort Collins, Colorado 80523.

Tom, C. H., L. D. Miller, J. S. Krebs, and R. Aukerman. 1974. *The Design of a model to project Land Uses and Predict Open Space Encroachment Patterns/Denver Metropolitan Area.* U. S. Department of Interior, Bureau of Outdoor Recreation Final Report. Colorado State University, Fort Collins, Colorado 80523. 195 pp., illus.

CURRENT LITERATURE

General

Got multiple resources to inventory? Our draft manual of SIM (Site Inventory Method) outlines an intensive field procedure for gathering basic data for Range, Widlife, Watershed, Soils and Forestry Resources. Drop us a line, (Attention D-330) for a copy.

- - - - - -

Reprint - "A Tool and Method for Extracting Plant-Root-Soil Cores on Remote Sites" by Brown and Thilenius

Res. Note RM-338 "Lighted Collars to Aid Night Observations of Mule Deer"

Res. Paper RM-181 "Weight Scaling for Southwestern Ponderosa Pine" are available from: Rocky Mountain Forest and Range Exp. Sta., 240 West Propect St., Ft. Collins, CO 80521.

- - - - - -

Search Agriculture Vol. 5, No. 6. "Measuring Revegetation Rates and Patterns on Abandoned Agricultural Lands" and Vol. 6 No. 1. "Satellite Sensing of Phenological Events". From: Cornell University, Agricultural Exp. Sta., Ithaca, NY 14853.

- - - - - -

"Land & Survey Records - Record Presentation & Service Through Microfilm" drop us a line (Attention D-532)and we'll send you a copy.

- - - - - -

1976 "ANNALES DE LA RECHERCHE FORESTIERE AU MAROC" Available from: Station De Recherches Forestieres, B.P. 763 Rabat-Agdal, Rabat, Morocco.

- - - - - -

Research Paper PNW-209 (1976)"Code-A-Site: A System for Inventory of Dispersed Recreational Sites in Roaded Areas, Back Country, and Wilderness". From: Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon 97208.

Forestry

Res. Paper SE-154 "Sampling and Analytical Techniques for an Interim Survey in the South Carolina Low Country" From: Southeastern Forest Exp. Sta., P.O. Box 2570, Asheville, NC 28802.

\- - - - - -

DNR Note No. 15 "Measuring and Predicting Growth Response in Unthinned Stands of Douglas-fir by Paired Tree Analysis and Soil Testing" From: Washington DNR, 100 Capital Center Bldg., Olympia, WA 98504.

\- - - - - -

"Tree Nursery Inventory: An Annotated Bibliography", by H. Gyde Lund and Clyde M. Hunt in Tree Planters' Notes, Vol. 28, No. 1, Winter 1977. Available from: Cooperative Forestry, U.S. Dep't. Agriculture, Forest Service, Washington, D.C. 20250.

\- - - - - -

The June 1977 (Vol. 23, No. 2) issue of Forest Science has some interesting articles:

"A Model Relating Merchantable Length to Tree Diameter and Height" by Gideon and Faurot

"Predicting Scenic Beauty of Forest Environments: Some Empirical Tests" by Arthur

"Determination of Optional Growing Stock Levels by Inventory Theory" by Pelz

"Estimating Area in Sampling Forest Populations on Two Successive Occasions" by Hazard

Check your local Forestry Library for a copy.

\- - - - - -

AFRI Research Note No. 24 "DBH from Stump Diameter and Height for Northern Hardwoods" from Applied Forestry Research Institute, State University of New York, Syracuse, NY 13210.

Range & Wildlife

Spec. Sci. Rep. - Wildlife 198 - "Analysis and Machine Mapping of the Distribution of Band Recoveries".

Spec. Sci. Rep. - Wildlife 199. "Computerized Tabulation and Display of Band Recovery Data".

Res. Pub. 92. "Classification of Natural Ponds and Lakes in the Glaciated Prairie Region". From: USDI Fish & Wildlife Service, Northern Prairie Wildlife Res. Ctr., Jamestown, ND 58401.

\- - - - - -

Information Sheet 1266. "The MAFES Individual Animal Weighing Cage" From: Mississippi Agricultural and Forestry Esp. Sta., Mississippi State Univ., Mississippi State, MS 39762.

\- - - - - -

DNR Note #7. "A Survey of Tree Debarking by Black Bear in Capitol Forest" From: Washington Department of Natural Resources, Forest Land Management, Division, Olympia, WA 98504.

\- - - - - -

Drop us a line, (Attention D-360) for a copy of Tech. Note 299 "Collecting Methods for Amphibians and Reptiles", by Thomas G. Balgooyen, May 1977.

\- - - - - -

Protection

MP 897 "The Biological Meaning of Sampling Results and the Development of a Sequential Sampling Scheme to Predict Damaging Levels of Alfalfa Weevil". From: Cooperative Exten. Serv., Bulletin Room, 4910 Calvert Rd., College Park, MD 20742.

\- - - - - -

Ag. Handbook 501 "A Guide to Insect Injury of Conifers in the Lake States" Available from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price is $3.15.

\- - - - - -

"High Altitude Aircraft Data as a Fire Intelligence Tool" in Fire Control Notes No. 36. From: Office of Public Affairs, Department of Forestry, Room 1516, 1416 Ninth Street, Sacramento, CA 95814.

- - - - - -

"Users' Guide to Debris Prediction and Hazard Appraisal" From: Northern Region, Forest Service, Missoula, MT 59806.

- - - - - -

Stream Surveys

Reprint - "Validity of Methodologies to Document Stream Environments for Evaluating Fishery Conditions" by William S. Platts and "QRD - A concept for Today -- and Tomorrow" From: USDA Forest Service, Intermountain Forest and Range Exp. Sta., 507 - 25th St., Ogden, UT 84401.

- - - - - -

"Stream Reach Inventory and Channel Stability Evaluation". From: USFS - R-1, Division of SAW M&G, Missoula, MT 49806

- - - - - -

Remote Sensing

Canada's Forest Appraisal Program, Remote Sensing Program and Integrated Resource Survey Program are discussed in "Program Review 1972-1976". Write the Forest Management Institute Department of the Environment, Ottawa, Ontario, K1A OH3 - Canada, for a copy. It's very interesting.

- - - - - -

Geological Survey Prof. Paper 929 "ERTS-1, A New Window on Our Planet". For sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, price $13.00, Stock No. 024-001-02757-7.

- - - - - -

Reprint - "Forestland Type Identification and Analysis in Western Massachusetts: A Linkage of a LANDSAT Forest Inventory to an Optimization Study" by Rafsnider, Rogers and Morse. Available from: Northeastern Area State and Private Forestry, USDA Forest Service, 6816 Market St., Upper Darby, PA 19082.

* * * * * *

MEETINGS

Remote Sensing, Photo Interpretation, and Forest Sampling: September 6-9, 1977. Field and office procedures developing the practical aspects of efficient data collection and analysis.

Variable Plot Cruising and 3-P Sampling Workshop for Practicing Foresters: September 12-16, 1977. Practical exercises in field and office principles and procedures for instituting and improving variable plot cruising and 3-P sampling techniques.

These courses are sponsored by: The Ohio State University, School of Natural Resources. Contact: Dr. Joseph D. Kasile, Division of Forestry, The Ohio State University, 2001 Fyffe Court, Columbus, Ohio 43210. Phone (614) 422-2816.

\- - - - - -

The SAF Inventory Working Group will hold a business meeting at the national convention in Albuquerque on October 3rd. The meeting place will be posted at the convention. The meeting is open to anyone.

\- - - - - -

Growth Models for Long Term Forcasting of Timber Yields and Forest Resources Management. October 24-28, 1977 to be held at the Donaldson Brown Center for Continuing Education, V.P.I., and SU Blacksburg, VA. Registration is #30. For additional information contact Dr. Timothy A. Max, School of Forestry and Wildlife Resources, V.P.I. & SU., Blacksburg VA 24061. Phone (703) 951-5297.

\- - - - - -

Integrated Inventories of Renewable Natural Resources, A national workshop, sponsored by the University of Arizona's School of Renewable Natural Resources, and the Society of American Forester's Inventory working group in cooperation with the USDA Forest Service, USDI Bureau of Land Management, and the Renewable Natural Resources Foundation will be held Jan. 8-12, 1978 at the Marriott Hotel in Tucson. Copies of the brochure containing the registration material have been sent to all subscribers of Resource Inventory Notes. If you have not received a brochure or need additional copies, drop us a line. (Attention: H. Gyde Lund) Register early as space will be limited.

GPO 842-017

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
DENVER FEDERAL CENTER
BUILDING 50
DENVER, COLORADO 80225

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF THE INTERIOR
Int 415

U.S.MAIL

J C SPACE DIRECTOR   02 000252
COMPUTER APPL STAFF
FOREST SERVICE
PO BOX 2417
WASHINGTON   DC 20013