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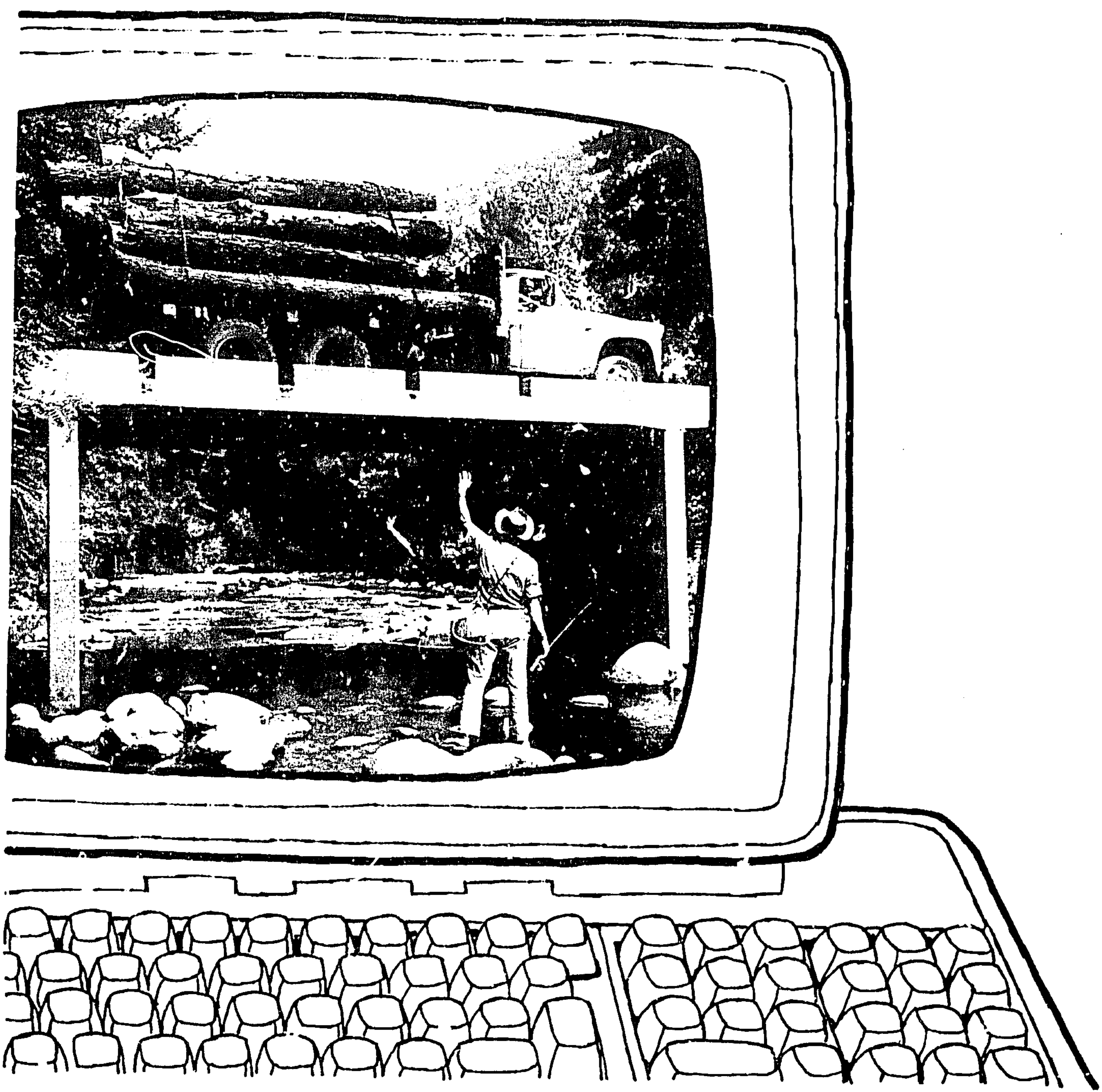
United States
Department of
Agriculture

Forest Service
Southern Region

CASE STUDIES IN FOREST RESOURCE INFORMATION ANALYSIS



CASE STUDIES
IN
FOREST RESOURCE INFORMATION ANALYSIS

Edited by
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May, 1980

The Editor: Dr. R. Rajagopal is an Associate Professor in the department of Geography at The University of Iowa. He has degrees in mathematics, operations research, and resource management. He has spent several years in the study of Management Information Systems, especially those suitable for biological, resource, and environmental management and planning. He teaches resource and environmental management information systems to students of geography, forestry, environmental studies, engineering, and planning. He has successfully motivated and influenced several management and systems analysts, resource and environmental planners, program managers, and other college teachers. Recently, he was sponsored by the American Association for the Advancement of Science to direct short courses on "Information Analysis for Environmental Management" to college and university faculty in the eastern United States. He has also been sponsored by federal agencies, industries, and international organizations to direct courses, seminars, and workshops for managers, scientists, and college professors. His major research contributions are in the area of environmental pollution control systems, land management planning, resource system simulation, gaming, and ecosystems analysis.

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PREFACE

A series of workshops was sponsored by the Computer Science Group of USDA Forest Service, Atlanta, Georgia, for resource professionals in Region 8. Over forty participants attended two one-week workshops--an introductory session in June and a follow-up session in August 1979.

During the first session, the participants were introduced to a variety of mathematical, statistical, computational and systems analytic concepts and their application to the analysis of forest resource management problems. The participants were also provided extensive text material covering these topics. In short, the first session provided an overview of systematic problem solving and information analysis techniques. This gave the participants an opportunity to apply these techniques, if found suitable and useful, to specific Forest Service problems.

For the second session, each participant developed a small project which included some of the systems and procedures acquired in the first session. This project activity reinforced skills gained in the workshop that would be of immediate benefit in the participants' work. It is expected that the completion of the project will be a first step in the application of information analysis and problem solving techniques to their professional activities. The process may enlarge as they utilize not only the computational facilities available in the region, but also those at Fort Collins. Another benefit of the project was that it was a potential stimulant for interdisciplinary activity. It helped the participants to note the interrelatedness of the subject matter and the potential interactions and contributions of the many disciplines and people trained in them to problems confronting the Forest Service and our society. During the second session, the participants also heard and interacted with several information management professionals from industry, government, and consulting organizations. These outside professionals gave seminar presentations on the design, development, and implementation of small and large scale forest resource management information systems.

This book is a collection of some of the short project outlines and case studies prepared by the participants and a few guest speakers. It would not have been possible without the contribution of participants, who prepared the short case studies; those who assisted in the preparation of such case studies; and those who facilitated discussion and dialogue throughout the two workshop sessions. I am indebted to all of them.

My special appreciation goes to Ray Hall, Paul Baerman, Clark Sell, Jim Webb, Jim Sabin, John Vance, John Waters, Katherine Allen, and Ken Barbash for making this effort seem worthwhile; Sotero Muniz, Dick Field, Carol Simmermacher, Steve Pratt, Julian Hofmann, Gary Myers, and Hugh Johnson for presenting thought provoking seminars as guest speakers; and David Kuhn for conducting a professional evaluation of the workshop.

Finally, I wish to express my sincere appreciation to Kris Hirst and Debra Schottman for having launched a marathon effort to organize and produce this final draft in such a short time.

INTRODUCTION

R. Rajagopal
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Currently, many organizations are attempting to use digital computers at various levels. In the last thirty years, there have been tremendous advances in hardware technology and modest gains in software development, but comparatively little research to understand the impact of computer use on organizations and society. Introduction of computer based information systems in any organization produces a myriad of associated events, some of which can be foreseen and planned for, whereas others can only be handled as they arise. For example, in addition to the impact on conceptual, economic, and training matters, the introduction of computers will also affect organizational policy, staffing, communication, and socio-psychological factors [Sanders (1974), Coleman and Riley (1973), Diebold (1973)]. The major difficulty for individuals who have worked in a noncomputer environment seems to be in conceptualizing the computer as a symbolic information processing device. In some situations this problem is further amplified by a manager's belief in a myth that "you cannot teach an old dog new tricks."

The potential of quantitative and information processing techniques in forest resource and environmental management far exceeds actual realization. Incredibly sophisticated information storage, retrieval, and display techniques already exist. But comparable efficiency is not achieved in re-synthesizing, or adapting to real situations, the output of this stored information.

In some instances, the integration of existing technology with an imaginative data monitoring and/or a processing device has increased productivity severalfold. Typical examples can be found in modern-day applications of optical scanning devices and mini-computers in sawmilling and wood processing industries. Therefore, in addition to understanding the development of computer software and knowing about its availability, the resource professional will have to be able to apply the methodology. A selected set of methodology-application linkages that are relevant to forest resource management, planning, and control are shown in Figure 1.

The U. S. Forest Service administers and manages over 180 million acres of national forest lands. The use of large-scale computer technology and information systems is and will be indispensable in the management and planning for the judicious use of such a vast national resource. Most forest service professionals are trained in the fields of forestry, hydrology, wildlife, soils, recreation, pathology, entomology, forest engineering and economics, and a few other resource related subjects. To efficiently manage the vast national forests it has become necessary for these professionals to incorporate information processing concepts, technology, and management in the administration of the national forest system. There is no doubt that these professionals have spent substantial amounts of time, both in the classroom and on the job, in mastering and practicing the subject matter of their chosen fields. But currently advances in information processing technology--and its application to almost any field of human endeavor--is being made with tremendous rapidity. Software development and hardware technology of today become obsolete within a few years. If current trends in computer technology are any indication of what the future

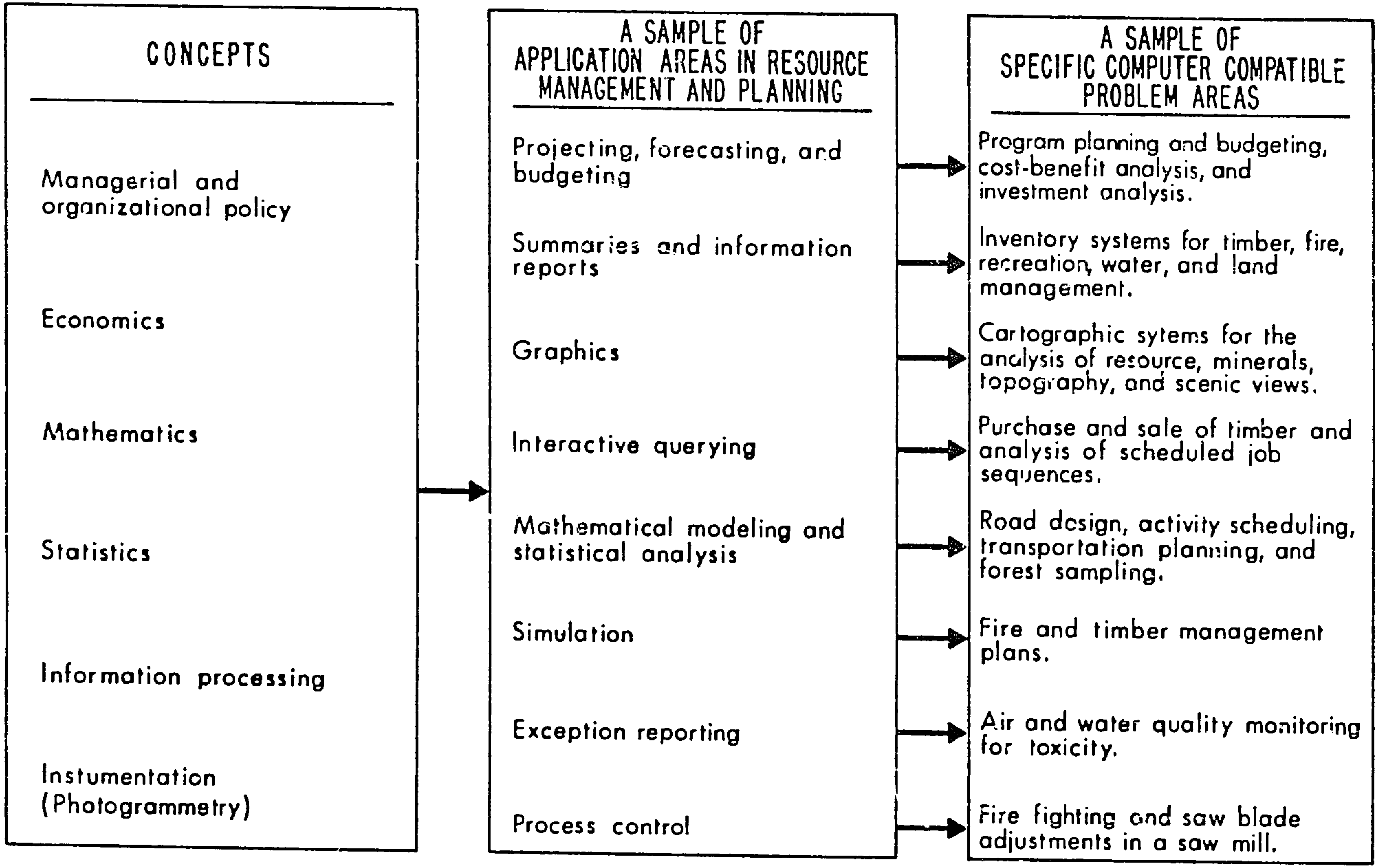

Figure 1: Concepts and generic application areas leading to a set of computer-compatible resource management problem areas.

has to offer, it is almost certain that the use of large-scale computer based information systems will pose a variety of new challenges in the field of forest resource management. Therefore, it will be of substantial benefit to resource management agencies to embark on a coordinated program to educate its professionals to face the challenges of tomorrow.

With this perspective in mind, a series of workshops was offered to resource professionals in Region 8 of the U. S. Forest Service. The workshops provided the following:

- Mathematical and logical framework governing the structure of certain selected forest resource and environmental problems. Included an introduction to the summation of series, the theory of equations, differential equations, and optimization.

- Statistical methods useful in the synthesis of forest resource and environmental information and the analysis of observed variations. Included an introduction to descriptive and inferential statistics and graphical applications for spatial analysis.

- Computer based information processing concepts that are invaluable in the extension of the above-mentioned techniques to real world problem solving. Included an introduction to FORTRAN and a variety of other statistical and optimization software codes.

- An opportunity to hear and interact with successful information management professionals from industry, government, and consulting organizations who delivered short seminar presentations.

The main thrust of the workshop was to magnify the understanding of analytical tools within a framework of problem solving, and thus promote their acceptance and subsequent use in forest resource and environmental management. In the workshops, a variety of problem scenarios were considered, including those from: land use planning, population dynamics, nutrient cycling, systems ecology, facility siting, pollution control systems, financial analysis, forest management, and resource allocation. On the basis of such an exposure it was hoped that the participants would be able to identify and formulate problems and use relevant computational tools, if necessary, in their analysis. This expectation has led to the case studies that are briefly described in this book. For organizational convenience, these case studies have been grouped to form the following parts.

Part I: Design and Development of Data Bases

In today's world various forms of record keeping have become a major activity in almost every public and private organization. The Forest Service is no exception. The need to methodically collect, store, and process data, and retreive information in a form suitable for use in decision making is a very basic one. This need is strongly recognized by our various participant authors who have outlined data base systems for accident statistics, mineral lease files, public issues, renewable resource information, mailing labels, progeny evaluation data, land acquisition files and ADP equipment inventory.

Part II: Sampling, Statistics and Simulation

Forest resource information such as stand density, species and tree size distribution; environmental information such as wildlife habitats, aquatic life, ambient temperature and stream flow; and productivity measures such as profit, cost, time and efficiency are all governed by natural and man-made variations. Therefore it is necessary to study such resource systems under conditions of uncertainty. Recognizing this need, some of our participant authors have ventured into the analysis of mortality, productivity, water quality, diversity, and efficiency data by the methods of sampling, statistics and simulation.

Part III: Computational Analysis for Planning, Productivity, and Economics

Certain aspects of cost-benefit analysis, production analysis, and the planning process can be captured within a framework of a computational system. Numerous such systems (INVEST, PAR III, WRAP, etc.) are available to professionals in the region as well as the nation. On the other hand, if the problem is quite small in scope and site-specific, the professional with a modest amount of assistance should be able to develop a program to meet his/her objectives. Our participant authors have developed their own programs or evaluated the use of existing software in the development of timber management plans, timber production analysis, economic analysis for roads and fires and mast production analysis.

Part IV: Optimization and Network Analysis

Scheduling human resources, machinery and operating decisions to accomplish certain planned objectives is a problem that a resource professional must face from time to time. A variety of systems analytic tools such as linear optimization, network analysis, simulation, decision analysis, etc., can be of substantive use to professionals in the resolution of resource allocation and scheduling problems. One of our guest authors and two participants have explored the use of goal programming and network analysis to harvest scheduling, timber sale and resource planning activities respectively.

Part V: Spatial Analysis for Resource Management and Planning

Computer graphics provides a powerful tool for the rapid display and analysis of spatially-oriented data. The simplest form of computer graphics involves digitized map reproductions on the basis of a stable (unchanging) data base. By developing map overlays for specific variables, several relatively simple computer generated maps can be combined to show more complex interactions of resource variables. Two of our participant authors explore the use of such graphics technology for the analysis of wildlife habitats and recreation resources, and finally our guest authors have described the current state of the art in such technology with specific applications.

No book is complete without a few words of wisdom that capture the fervor of the author's intentions in an eloquent fashion than what he himself can express. Here are a few gems:

> I have told you these details of Asteroid B612 and I have given you its number because of grownups. Grownups love numbers. When you speak to them of a new friend, they never inquire about essentials. They never say to you: "What is the sound of his voice? What are his favorite games? Does he collect butterflies?" They ask you: "How old is he? How many brothers does he have? How much does he weigh? How much does his father make?" Only then do they think they know him.
>
> Antoine de Saint Exupery

> The purpose of Forest Resource Information Systems is insight and not numbers.
>
> Anonymous

> .....You can catch phenomena in a logical box or in a mathematical box. The logical box is coarse but strong. The mathematical box is fine grained but flimsy. The mathematical box is a beautiful way of wrapping up a problem, but it will not hold the phenomena unless they have been caught in a logical box to begin with.
>
> John R. Platt

Scientists who only do experiments are as ants, who only gather and use what they gather. Scientists who only theorize are as spiders, who only make cobwebs out of their own substance. But consider the bee, who takes a middle course; he gathers his material from the flowers of the garden and of the field, but transforms and digests it by a power of his own. Not unlike this is the true business of forest resource management.

Adapted from Sir Francis Bacon

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PART I

DESIGN AND DEVELOPMENT OF DATA BASES

A DATA BASE SYSTEM FOR ACCIDENT STATISTICS

Brenda Ayers
Jefferson National Forest
Roanoke, Virginia

Objective

To design a computer data base containing a variety of accident information which can be accurately, easily, and effectively retrieved for analysis and evaluation.

Project

I began developing a data tree from questions used on Form AD-278, the Supervisor's Report of Accident (Figure 1), using a standard naming convention for easier use and in case the program became a Regional Data Base. I also set a limit on characters in the field, to avoid input/output discrepancies. These and other design considerations for the data base took twice as long as the actual "loading" process, due to the need for accuracy and thoroughness.

The data tree and definition tree (Figure 2) were then input into FCCC, beginning the data base establishment on the computer. I used data for April and May 1979 (the latest months of completed AD-278 forms); and put the data in load form (Figure 3), created a tape on ICL, and thus put the data into System 2000. I limited my data input in order to achieve this project without any physical assistance from the Regional Office, as well as control experimental costs. A special file was created to simplify entrance into the system and recovery from system crashes.

After the data base was created and the actual data placed in the system, information could be pulled in a variety of formats and tested for query response and ease of retrieval.

Operation

The data base has proved to be an effective management tool. Accurate figures on accidents can be retrieved quickly and easily; each month's data can be added to the system in a day's time. After several years of information is in the system, the data will be available for comparison on that level as well.

Testing of this program has identified the need for two more elements. These will be quite easy and inexpensive to add, as the effort was made to define a logical data tree and the data base is currently small. Additional elements can be added in the future, if needed.

Editor's Note

National Forests in Regions 5, 6, and 8 are currently pilot testing this data base. With a few modifications and additions, this data base is being considered for service-wide adoption.

Figure 1. Supervisor's Report of Accident.

108 DAY

U.S. DEPARTMENT OF AGRICULTURE

SUPERVISOR'S REPORT OF ACCIDENT

1. REPORT STATUS: 1. ORIGINAL; 2. SUPPLEMENTAL; 3. CORRECTION; 4. DELETE

2. NO. OF EMPLOYEES INJURED IN ACCIDENT — 129

3. NAME OF EMPLOYEE (LAST, FIRST, & MIDDLE INITIAL) — 101 102

4. AGE — 103

5. AGENCY CODE

6. SOCIAL SECURITY NO. — 104

7. EMPLOYMENT GROUP CODE — 105

8. REPORTING OFFICE (CITY AND STATE)

9. KIND OF ACCIDENT — 106 (CODE)

10. DATE AND TIME OF ACCIDENT — YR. MO. DAY HR. MI. — 107 109

11. NO. HRS. ON DUTY — 110

12. WAS OCCURRENCE OUTSIDE REGULAR WORK HOURS — 0-NO 1-YES

13. EMPLOYEE PERSONAL FACTORS — 112 (CODE)

14. TREATMENT BY PHYSICIAN — 111 — 0-NO 1-YES

15. INJURY/ILLNESS CLASS — 106 (CODE)

16. DATE WORK STOPPED — YR. MO. DAY — 114

17. DATE RETURNED TO WORK — YR. MO. DAY — 115

18. NO. FULL WORK DAYS LOST — 113

19. DID INJURY RESULT IN:
A. TRANSFER TO ANOTHER JOB OR TERMINATION OF EMPLOYMENT — 0-NO 1-YES
B. LOSS OF CONSCIOUSNESS OR RESTRICTION OF MOTION — 0-NO 1-YES
C. EMPLOYEE UNABLE TO PERFORM NORMAL ASSIGNMENT — 0-NO 1-YES

20. NO. PRIVATE PERSONS INJURED OR KILLED — 130

21. MOTOR VEHICLE DAMAGE — A. GOVERNMENT $ 116 — B. PRIVATE ON OFFICIAL USE $ 117

22. VEHICLE INFORMATION — A. OWNERSHIP 120 1. GOVT. 121 2. PVT. ON OFF. BUS. (CODE) — B. TYPE 122 (CODE)

23. OTHER PROPERTY DAMAGE — A. GOVERNMENT $ 118 — B. PRIVATE $ 119

24. REPORTING UNIT ORGANIZATION IDENTIFICATION (WRITE IN) — ① ② ③ ④

25. UNSAFE ACT — 123

26. FUNCTIONAL ASSIGNMENT — 124 — 125 MIH

27. SPECIFIC SITE OF ACCIDENT — 132

28. HAZARDOUS CONDITION — 126 — 127 WEATHER — 128 TEMP.

29. ACCIDENT CAUSE — 131

30. COMPLETE DESCRIPTION OF BODILY INJURY AND/OR OCCUPATIONAL ILLNESS (INCLUDE EXACT PART INJURED) — 135 — 30A 133 30B [illegible]

31. COMPLETE DESCRIPTION OF ACCIDENT (WHAT HAPPENED, HOW IT HAPPENED, WHAT WAS INVOLVED, WHAT LED UP TO ACCIDENT) — 136

32. ACTION TAKEN TO PREVENT SIMILAR ACCIDENTS — 138

33. WHAT OTHER ACTION SHOULD BE TAKEN

34. MANAGEMENTS COMMENTS ON CORRECTIVE ACTION — 139

35. MANAGEMENT ORGANIZATIONAL FACTORS — 140 (CODE FROM INSTRUCTIONS)

SIGNATURE OF WORK SUPERVISOR — 137 — DATE

SIGNATURE OF REVIEWING OFFICER — DATE

ORIGINAL - TO BE SENT TO THE CODING OFFICE BY THE REVIEWING OFFICIAL WITHIN 7 DAYS OF THE ACCIDENT. FORM AD-278 (1-74)

EXAMPLES OF ABBREVIATIONS USED FOR FORM AD-278

105 - EMP CD
- YCC
- YAC
- OLD
- PT
- FT
- FCC
- VOL
- CET
- OTH

4 - DIST
- BBRG
- CLIN
- GLWD
- NC
- WYTH
- NRA
- FCCC
- SO

106 - ACC
- M (MEDICAL)
- LT (LOST TIME)
- VN (VEHICLE - NO INJURY)
- VI (VEHICLE - INJURY)
- FA (FATALITY)
- PD (PROPERTY DAMAGE)
- IJ (INJURY ONLY - DIDN'T SEE DOCTOR)

108 - DAY
- SUN
- MON
- TUE
- WED
- THR
- FRI
- SAT

111 - MD
- Y
- N

112 - EMP PERS -
- FATIGUE (01)
- PHY COND (02)
- ALCOHOL (03)
- DRUGS (04)
- EMOT STR (05)
- ILLNESS (06)
- SKIL DEF (07)
- KNOW DEF (08)
- COMM WAY (09)
- ATTN DIV (10)
- SHOT CUT (11)
- UNDES TASK (12)
- NONE (00)

120 - GOV. OWN
- Y
- N

Figure 1. (cont'd.)

EXAMPLES OF ABBREVIATIONS USED FOR FORM AD-278

121 - PVT
- Y
- N

122 - TYP
- VAN
- SED
- TRK (PICKUP)
- 4WD
- TKR (BIG TRUCKS)

123 - UNSAFE ACT

DGR EQUIP	(A)
NO PPE	(B)
WRONG DRESS	(C)
NO WARNING	(D)
HORSEPLAY	(E)
IMP EQUIP	(F)
IMP HANDS	(G)
INATTENTION	(H)
POSITION	(I)
DRIVING	(J)
SPEED	(K)
X SAF DEV	(L)
MIXING	(M)
EQUIPMENT	(N)
OTHER	(O)
NONE	(P)

124 - FUNCTIONAL ASSIGNMENT
- B&F
- TIMBER
- RANGE
- WDLIFE
- ROADS
- TRAILS
- CONST
- REC
- LANDS
- FIRE
- RADIO
- ENG

127 - WEATH -
- CLOUDY
- RAINY
- HAZY
- SUNNY

131 - ACC. CAUSE
- POSITON
- IMP USE HAND
- IMP EQUIP
- NO WARNING
- WRONG DRESS
- NO PPE

Figure . (cont'd.)

EXAMPLES OF ABBREVIATIONS USED FOR FORM AD-278

140 - MGMT FACTOR	INADQ TRAIN (01)
	INADQ EQUIP/SPACE/MAT (02)
	INADQ INSP/MAINT (03)
	LACK OF/FALTY INST (04)
	INSUFF STAFF (05)
	HIRE INCOMP PEOP (06)
	DEF INSP WORK (07)
	DEF PERF HAZ ANAL (08)
	DEF INPL POLICY (09)
	NONE (10)

Figure 2. Data and definition tree.

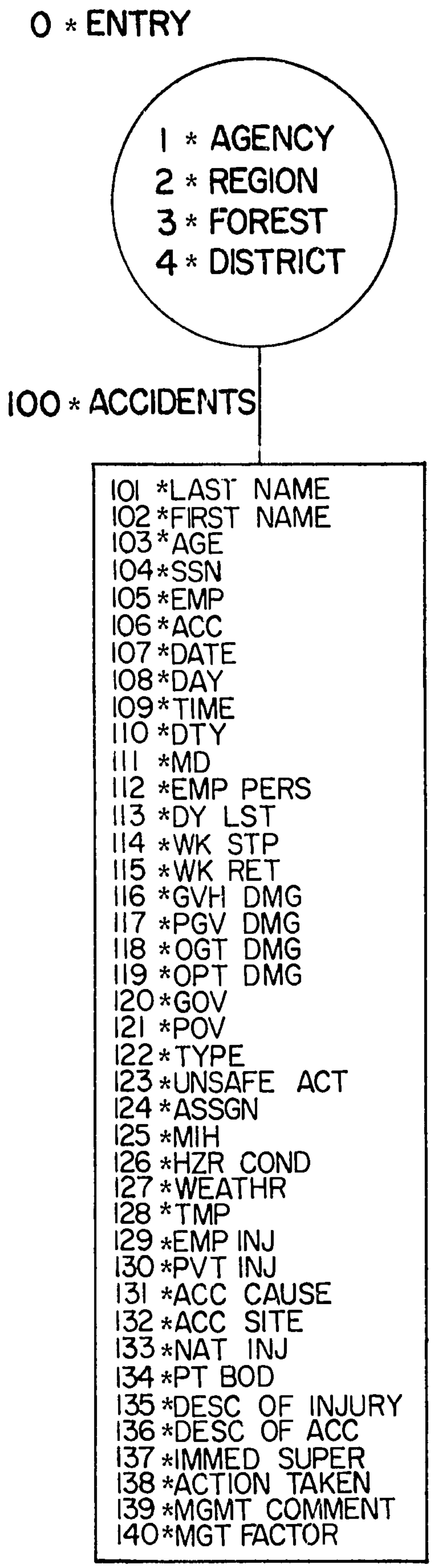
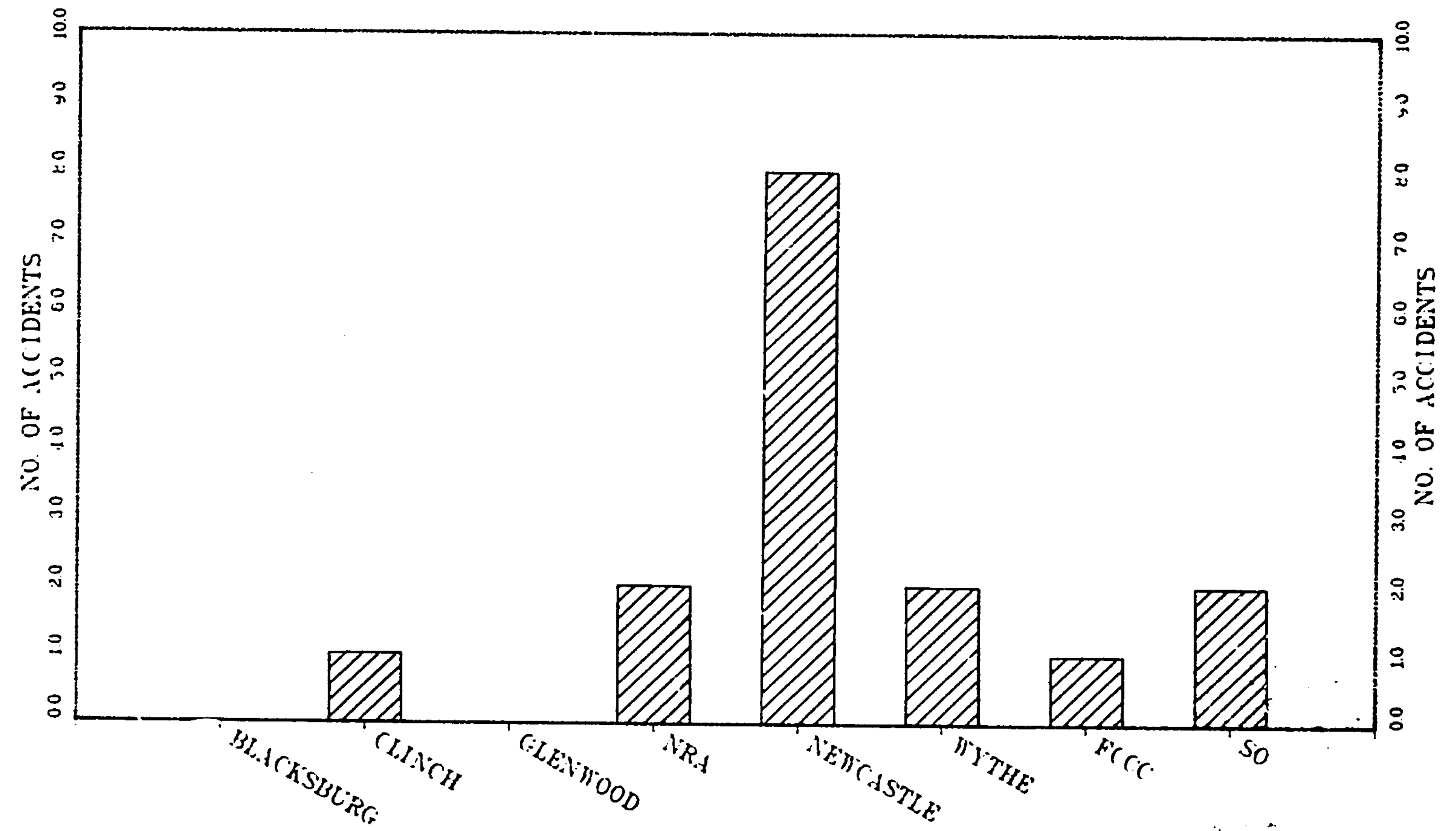


Figure 3. Sample Load Statement (loading form).

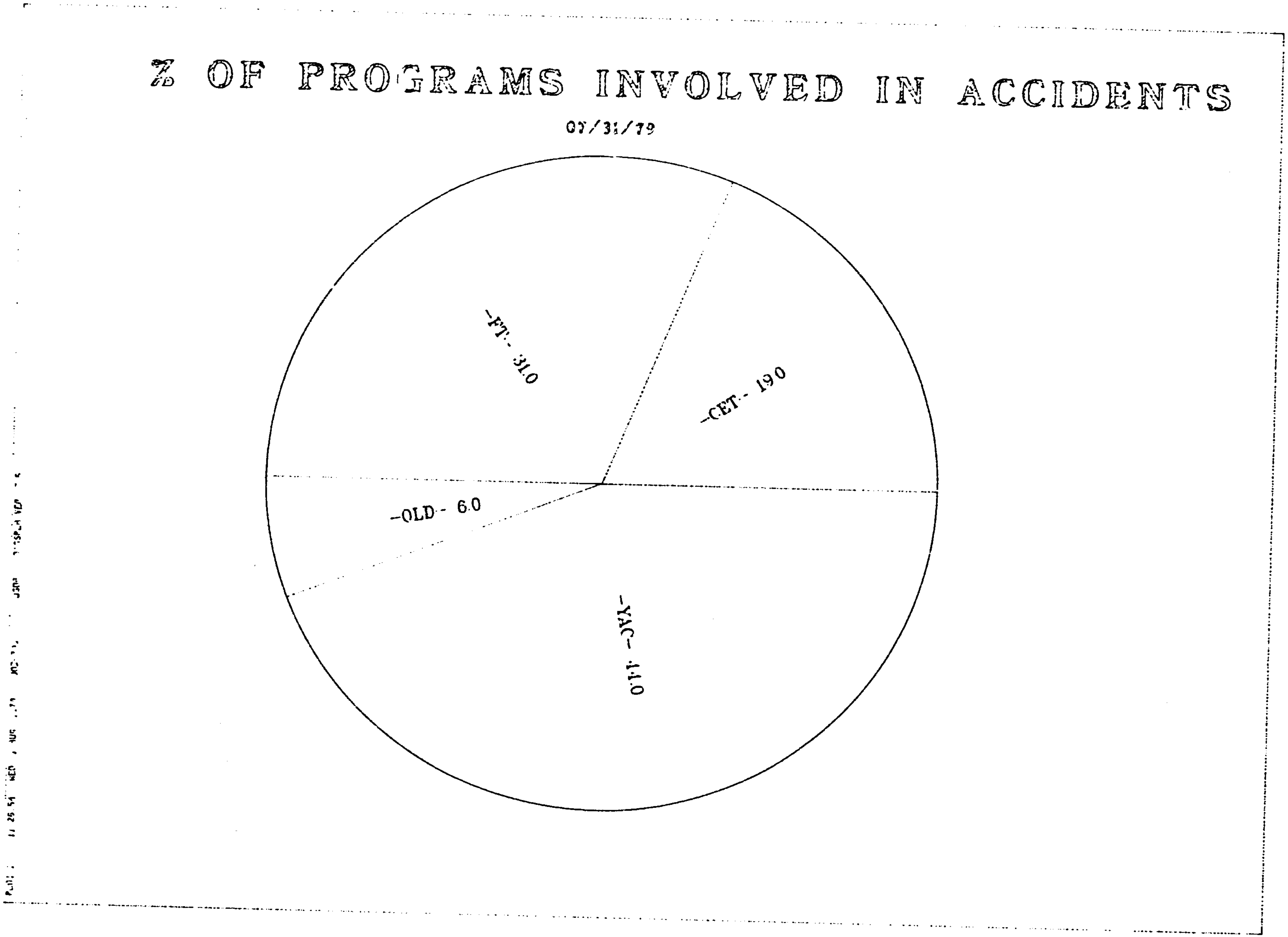
```
1*11*2*08*3*14*4*NC*
100*  101*LAST NAME*102*FIRST,M.I.*103*19*104*     SSN     *
      105*YAC*106*VI*107*04/03/79*108*TUE*109*1430*
      110*006*111*N*112*NONE*116*00250*120*Y*121*N*
      122*VAN*123*NONE*124*WDLIFE*125*633*126*SLIP SURFACE*
      129*06*130*00*131*WET ROADS*                      END*
```

NO. REPORTABLE ACCIDENTS APRIL-MAY

03/01/79

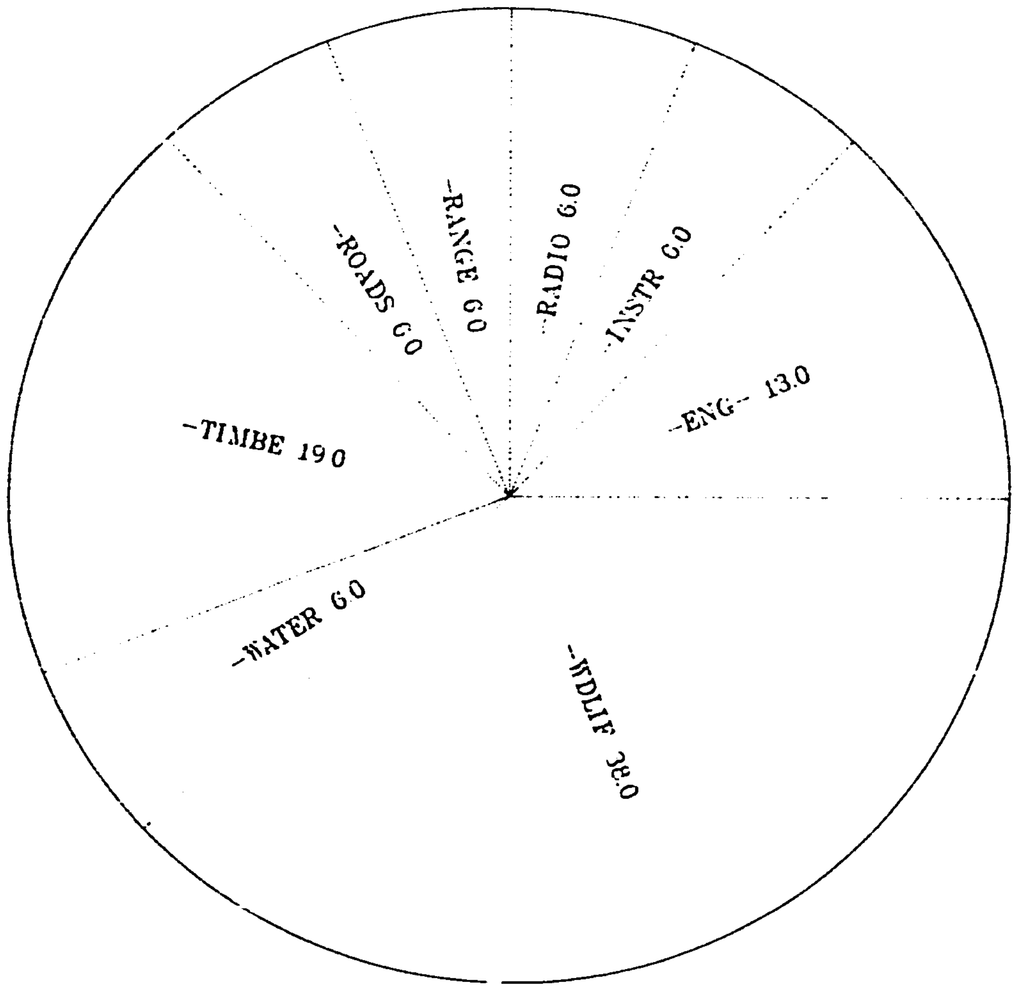


Appendix I. Computer generated graphs.


% OF PROGRAMS INVOLVED IN ACCIDENTS
07/31/79
-FT- 31.0
-CET- 19.0
-OLD- 6.0
-YAC- 44.0

%-FUNCTIONS INVOLVED / ACCIDENTS

07/31/79



Appendix II. Sample output.

```
---
>LIST C4,C107,C106,C131,C113,C105:
*  DIST          DATE     ACC    ACC CAUSE          DY LST   EMP
***
*  FCCC     04/30/1979    LT     IMP USE HAND            3   FT
*  NRA      04/20/1979    M      BARBED WIRE                 YAC
*  NC       04/16/1979    LT     TREE HIT EMP            2   YAC
*  NRA      04/03/1979    M      WASP                        CET
*  NC       04/03/1979    VI     WET ROADS                   CET
*  NC       04/03/1979    VI     WET ROADS                   YAC
*  NC       04/03/1979    VI     WE; ROADS               1   CET
*  NC       04/03/1979    VI     WET ROADS               5   YAC
*  NC       04/03/1979    VI     WET ROADS               1   YAC
*  NC       04/03/1979    VI     WET ROADS               3   YAC
*  NC       05/23/1979    M      WET GRND                    FT
*  SO       05/23/1979    VN     NONE                        FT
*  WYTH     05/14/1979    M      IMP LIFTING                 OLD
*  WYTH     05/18/1979    VN     NONE                        FT
*  CLIN     05/22/1979    VN     IMP BACKING                 YAC
*  SO       05/30/1979    VN     BLIND SPOT                  FT
---
```

```
>TALLY/EACH/C107:
************************
 ELEMENT-      DATE
************************
FREQUENCY   VALUE
------------------------
        7     04/03/1979
        1     04/16/1979
        1     04/20/1979
        1     04/30/1979
        1     05/14/1979
        1     05/18/1979
        1     05/22/1979
        2     05/23/1979
        1     05/30/1979
------------------------
        9 UNIQUE VALUES
------------------------
       16 OCCURRENCES
------------------------
```

```
---
>TALLY/EACH/C103:
TALLY/EACH/C103:
************************
 ELEMENT-      AGE
************************
FREQUENCY   VALUE
------------------------
        1      17
        4      19
        2      20
        1      21
        2      22
        1      30
        1      32
        1      39
        1      44
        1      46
        1      69
------------------------
       11 UNIQUE VALUES
------------------------
       16 OCCURRENCES
------------------------
```

A DATA BASE SYSTEM FOR MINERAL LEASE FILES

Vernon Berger
U.S. Forest Service
Atlanta, Georgia

Since the first oil shortages in 1973, there has been a dramatic increase in energy mineral leasing and production activity in federally controlled lands. As of 1977, there were approximately 20,000 active leases with an additional 7,000 to 15,000 applications per year for new or renewed leases or permits on Forest Service lands in the United States.

Along with increased activity has come increased concerns and regulations concerning surface management and environmental protection. Increased mineral activity and environmental concerns have brought an emphasis on both long-term and large-scale planning. Until recently, there has been no uniform method developed to share the large volume of information associated with mineral leases and to allow immediate retrieval of specific or summarized data on the mineral leases and permits administered by the Forest Service.

The first automated mineral leasing file system was developed on the Custer National Forest in Region 1 in 1975, using FS-GIM. The system was used by the State Office and District Geologist to help them stay on top of a mushrooming oil and gas exploration and development workload. In January 1977, the Custer's "Mineral Lease File" was studied by the Washington Office and the other Regional Offices to determine the feasibility of adapting the system for service-wide use. It was concluded that the National System should be developed so that it could be used with the System 2000 which the Forest Service was planning to purchase at that time.

The planning for the proposed "Lease File" was coordinated with other staff groups to determine areas of conflict and where further coordination was possible with the current needs and systems. It was decided that the system should provide the following:

1) better evaluation of leasing impact on the Forest System Program;

2) closer coordination with the Department of the Interior agencies which share mineral leasing responsibilities;

3) closer supervision of operators;

4) more timely and accurate responses to requests for information from Congress and the Administration;

5) better projection of workloads for budgeting and work-planning purposes;

6) better coordination between mineral leasing and other Forest Service programs; and

7) the ability to determine income from mineral leases and extractions on Forest Service controlled land.

On September 9, 1977, we received a copy of the System Coordinating Council's authorization to begin collecting data for the "Lease File." The Washington Office Minerals and Geology Staff began coordinating the system's implementation immediately and set deadlines for completion of different phases of the plan. The inception of RARE-II in November, 1977 brought the "Lease File" program to a halt until February, 1979.

Prior to RARE-II, special coding forms were developed and distributed to the Regional and State Offices with an instruction package. Limited coding was completed in 1978, but, due to unclear instructions and a form inappropriate for Eastern land uses, was unsatisfactory. In June, 1979, the mineral staff was given a week-long training session covering terminal use and the S2000. The session provided excellent information and background, as well as an opportunity to discuss some of the potential problems.

After the training session, the Region-8 Minerals Group gave first priority to the implementation of the "Lease File" in the Region. From the middle of June, 1979 until mid-August, 1979, three Minerals Group persons worked on the system. The actual time spent during these two months is broken down as follows:

Temporary GS-3, lease coding, 90%
Applications Examiner GS-5, loading data, editing data base, 40%
Geologist GS-11, program changes, instruction to field, 50%

Approximately 7,000 leases were coded in this time, and 2,000 loaded onto the system. Each forest has since been coding its own new applications and leases. The coded leases are then submitted in batches of 200, a workable size for editing and checking once they have been loaded. All leases should be in the system by the end of September, 1979.

From that point until at least January, 1980, we will operate at a maintenance level, familiarizing ourselves with the system's procedures and uses. Then we will begin the coding and loading of data for our Outstanding and Research minerals, which will need unique identifying case numbers. There may be a need for some minor reprogramming to accept these cases.

The entire system should be in use by May 1980. Special training will be needed for the Forest Mineral Staff and assistants in the use and Maintenance of the "Lease File." Each forest will maintain its own data base, to avoid possible damage to the entire data base. Current personnel staffing levels should be adequate to maintain the system if the maintenance is done at the forest level as anticipated.

Major problems that have occurred during the development of the "Lease File" have been:

1. lack of coordination with the field personnel who are to use the system and are familiar with the minerals program;

2. lack of coordination with Regions 8 and 9 concerning the specifics and fundamentals of outstanding and reserved mineral rights and land descriptions;

3. lack of budgeting at the regional level; and

4. inconsistent instructions and priority setting by the Washington and Regional offices.

However, despite the problems in development, the following are only a few of the foreseen benefits:

1. accurate and timely replies to information requests from Congress, the Washington and Regional offices, and the public;

2. analysis of current mineral leasing and permitting program;

3. analysis of current and future status of outstanding and reserved mineral rights;

4. better development of budget and manpower needs; and

5. higher quality Land Management Planning.

Overall, the "Mineral Lease File" as it is being set up on the System 2000, will greatly benefit the Mineral Areas Management Program and the Forest Service and public as a whole.

USDA--FOREST SERVICE
Mineral Lease Coding Form

Lease Number (uncoded)______________ State__________
Prepared by______________ Date__________

Card A 1

1. Lease Number (GS Station Code + BLM Prefix Code + Number)
2 | 3 4 | 5 6 7 8 9 10 11 | 12 13 14 15
2. Region 16 17 Forest 18 19 District 20 21
3. Proclaimed Forest* 22 23 24 25
4. State 26 27 County 28 29 30
5. Acres 31 32 33 34 35 36 37 38
6. Ownership Status 39 40
7. Stage 41 42
8. Leaseholder 43 44 45 46 47 48 49 50 51 52 53 54 55
56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
73 74 75 76 77 78 79
8a. Action 80

Card B 1

1. Lease number (as on Card A)
2 | 3 4 | 5 6 7 8 9 10 11 | 12 13 14 15

9. Effective Date
Y Y | M M | D D
16 17 18 19 20 21

10. Expiration Date
Y Y | M M | D D
22 23 24 25 26 27

11. Commodity 28 29 30 | 31 32 33 | 34 35 36
12. Planning Unit Number* 37 38 39 40 41
13. Date Plan Completed*
Y Y | M M | D D
42 43 44 45 46 47

14. Special Area Management* 48 49 50 51 52

15. Township / Range / Meridian
53 54 55 56 57 58 | 59 60 61 62 63 64 | 65 66
67 68 69 70 71 72 | 73 74 75 76 77 78 | 79 80

Card C 1

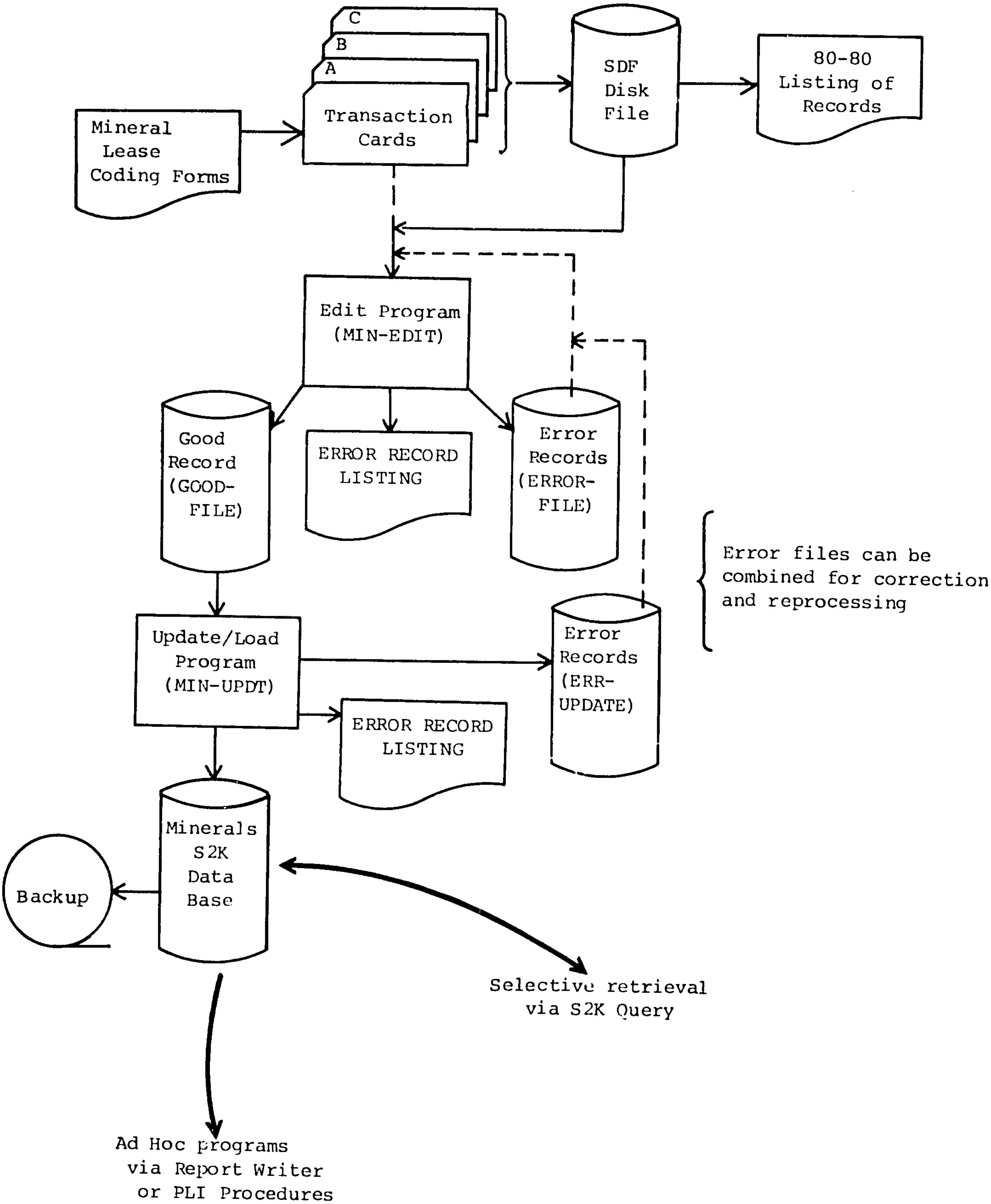
1. Lease Number (as on Card A)
2 | 3 4 | 5 6 7 8 9 10 11 | 12 13 14 15
16. Wells 16 17
17. Bond 18
18. FS Stip. 19 20
19. Reg. Stip. 21 22
20. Rehabilitation 23
21. Latitude* Deg. 24 25 | Min. 26 27 | Sec. 28 29
22. Longitude* Deg. 30 31 32 | Min. 33 34 | Sec. 35 36
23. Legal Description 37 38 39 40 41 42 43 44 45 46 47
48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

---

*Use is Optional with Regional Forester.

T2800-6(2/78)
Revised 3/78 to add 8a.

Figure 1. Minerals Leasing File Systems Flowchart.



Appendix I

Sample Output

```
>DESCRIBE:
DESCRIBE:
SYSTEM RELEASE NUMBER  2.80E
DATA BASE NAME IS MINERALS
DEFINITION NUMBER 2
DATA BASE CYCLE   3
      1*  LEASE NUMBER (NAME X(14))
      2*  REGION (INTEGER NUMBER 99 WITH MANY FUTURE ADDITIONS)
      3*  FOREST (INTEGER NUMBER 99 WITH MANY FUTURE ADDITIONS)
      4*  DISTRICT (INTEGER NUMBER 99)
      5*  PRO FOR (NON-KEY  INTEGER NUMBER 9999)
      6*  STATE (INTEGER NUMBER 99 WITH MANY FUTURE ADDITIONS)
      7*  COUNTY (INTEGER NUMBER 999 WITH SOME FUTURE ADDITIONS)
      8*  ACRES (DECIMAL NUMBER 9(5).99 WITH  FEW FUTURE ADDITIONS)
      9*  STATUS (NAME XX WITH SOME FUTURE ADDITIONS)
     10*  STAGE (INTEGER NUMBER 99 WITH SOME FUTURE ADDITIONS)
     91*  LEASE ABRIV (NAME XXXX WITH MANY FUTURE ADDITIONS)
     11*  LEASHOLDER (NON-KEY  NAME X(30))
     12*  EFFECTIVE (DATE WITH SOME FUTURE ADDITIONS)
     13*  EXPIRATION (DATE WITH FUTURE ADDITIONS)
     14*  PLAN NO (NON-KEY  NAME X(5))
     15*  PLAN COMPLETED (NON-KEY  DATE)
     16*  SPECIAL MGT (NAME X(5) WITH SOME FUTURE ADDITIONS)
     17*  WELLS (INTEGER NUMBER 99 WITH FEW FUTURE ADDITIONS)
     18*  BOND (NAME X WITH FEW FUTURE ADDITIONS)
     19*  FS STIP (NAME XX WITH MANY FUTURE ADDITIONS)
     20*  REG STIP (NAME XX WITH MANY FUTURE ADDITIONS)
     21*  REHAB (NAME X WITH SOME FUTURE ADDITIONS)
     22*  LATITUDE (NON-KEY  INTEGER NUMBER 9(6))
     23*  LONGITUDE (NON-KEY  INTEGER NUMBER 9(7))
     24*  DESCRIPTION (NON-KEY  NAME X (34))
     30*  COMMODITIES (RG)
      301*  COMMODITY (NAME XXX IN 30 WITH MANY FUTURE ADDITIONS)
     40*  TOWNSHIPS (RG)
      401*  TOWNSHIP (NAME X(14) IN 40 WITH FEW  FUTURE ADDITIONS)
     50*  OTHER REGION FOREST ACRES (RG)
      501*  OTHER REGION (NON-KEY  INTEGER NUMBER 99 IN 50)
      502*  OTHER FOREST (INTEGER NUMBER 99 in 50)
      503*  OTHER ACRES (NON-KEY  DECIMAL NUMBER 9(5).99 IN 50)
```

[Rendering of Computer Output]

Appendix II
Sample Output

```
>TALLY/EACH/C301:
TALLY/EACH/C301:
 ***********************
  ELEMENT-      COMMODITY
 ***********************
 FREQUENCY    VALUE
 -----------------------
         1      AG
         3      AR
         1      AU
         1      CLA
         4      COL
         3      DSP
         3      FEL
       881      OG
         1      QTZ
 -----------------------
         9 UNIQUE VALUES
 -----------------------
       898 OCCURRENCES
 -----------------------
```

```
>TALLY/ALL/C301:
TALLY/ALL/C301:
 ***********************
  ELEMENT-      COMMODITY
 ***********************
  MINIMUM-      AG
 -----------------------
  MAXIMUM-      QTZ
 -----------------------
         9 UNIQUE VALUES
 -----------------------
       898 OCCURRENCES
 -----------------------
```

```
>PRINT COUNT C8:
PRINT COUNT C8:
 CNT  8* 902
---
>PRINT SUM C8:
PRINT SUM C8:
 SUM  8* 972278.180
---
>PRINT AVG C8:
PRINT AVG C8:
 AVG  8* 1077.914
---
>PRINT MAX C8:
PRINT MAX C8:
 MAX  8* 13544.00
---
>PRINT MIN C8:
PRINT MIN C8:
 MIN  8*       .00
---
>PRINT SIGMA C8:
PRINT SIGMA C8:
 SIG  8* 1011.095
---
```

[Rendering of Computer Output]

MECHANIZATION OF A TRACKING SYSTEM FOR PUBLIC ISSUES

Henry C. Bullock
Daniel Boone National Forest
Winchester, Kentucky

Introduction

Public involvement provides an integral part in National Forest Management Planning. This involvement requires considerable time on the part of individual participants. It is only common courtesy to notify those persons who have spent their time in meetings, discussion groups, and letter writing, how their issues are being used. Such notification, however, could have the potential of overloading office services and planning personnel in preparation of simple responses.

For this reason, we have prepared an automatic system of responding to participants and notifying them of the disposition of their issues.

The System

We have designed the system around the capabilities of our word processor (IBM 6/452 Office Systems, 6 Information Processor). See Figure 1 for a diagrammed system description.

In actual practice, we have established four lines of record, with 22 fields for information. These lines of record are: 1) name and organization represented and "entry" (signifying 'initial entry' or 'duplicate entry'); 2) address and zip code, and type of contribution (public meeting, letter, etc.); 3) key words, print date (for correspondence mailing), search date, and issue type (planning issue, management issue, disruptive issue, etc.); and 4) issue - usually a direct quote or paraphrase (see Figures 2 and 3 for field definitions and sample listings).

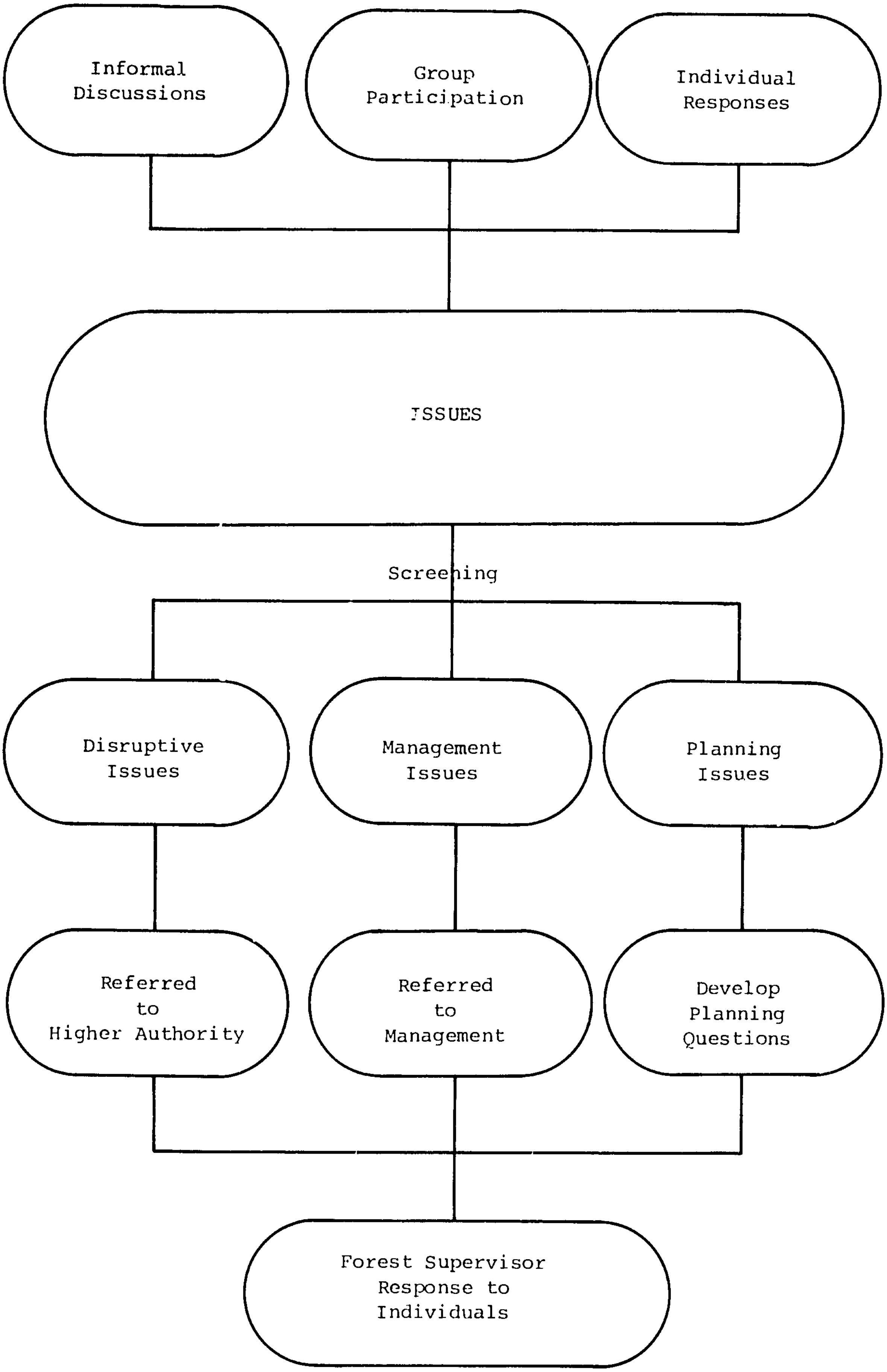


Figure 1. System Diagram.

Figure 2. Issue File Fields

FIELD NUMBER	FIELD SIZE	IDENTIFICATION
1	10	ID
2	5	TITLE
3	15	FIRST NAME
4	2	MIDDLE INITIAL
5	15	LAST NAME
6	5	SUBTITLE
7	35	ORGANIZATION
8	1	ENTRY
SECOND LINE OF RECORD		
9	35	STREET ADDRESS
10	25	STREET ADDRESS
11	20	CITY
12	8	STATE
13	6	ZIP
14	35	CONTRIBUTION TYPE
15	-	-
THIRD LINE OF RECORD		
16	20	KEYWORD 1
17	20	KEYWORD 2
18	20	KEYWORD 3
19	8	PRINT DATE
20	6	DATE (i.e. 790822)
21	35	ISSUE TYPE
FOURTH LINE OF RECORD		
22		ISSUE

Figure 3. Issue File

ID	TITLE/ST ADD/KEY WORD 1	F/N ST ADD/KEY WORD 2	MI/CITY/KEY WORD 3	LN/ST/PDT	ST/Z/DT	ORGANIZATION/CONTRIBUTION TYPE/ISS
1	Ms.	Susan		Herrick		League of Women Voters
	Route 3		Versailles	KY		PM
	Mineral	Multiple-uses		4/30/79	790430	NJ
	Shouldn't the Forest Service be responsible for mineral extraction which could negate other multiple-uses of their land.					
2	Ms.	Susan		Herrick		D
	Timber	Private	Subsidized			
	Will private timber growers be subsidized?					
3	Mr.	William		Meyer		Univ. of Ky.
	School of Biological Sciences	University of Kentucky	Lexington	KY	40506	PM
	Sustained-yield	Timber	Production	4/30/79	790430	NJ
	I think the best principal in forestry is sustained yield. There is too much emphasis on increasing timber production.					
4	Mr.	William		Meyer		D
						PM
	Land	Untouched		4/30/79	790430	NJ
	Could you please leave some land untouched?					
5	Mr.	Philip	W.	Conn		Bureau of Univ. & Reg. Services
	Morehead State University		Morehead	KY	40351	PM
	Developable	Land		4/30/79	790430	NJ
	The Forest Service is taking land out of the realm of developable land.					
6	Mr.	Philip	W.	Conn		D
						PM
	Aesthetics	Tourism		4/30/79	790430	NJ
	I think aesthetics are highly marketable and one of the greatest potentials of the area is tourism.					

Use

To demonstrate the use of the system, we will use "planning issues" and develop planning questions which will address the issue. An issue stated in a public meeting and quoted directly from tape that says, "Shouldn't the Forest Service be responsible for mineral extraction which could negate other multiple-uses of their land?"

The planning question in this case is "Under what conditions will mineral extraction be permitted on the Forest?"

Following the development of the appropriate planning question, we write each participant who used the mineral key word.

The August 7, 1979 letter is an example of the final output from the system. Those portions underlined were automatically supplied from the issue file.

Each letter must, of course, be proofed before mailing; but this system allows us to spend more time on the problem, and less on the simple contact letter.

Summary

The system is not foolproof. However, it does fulfill the needs of the organization and is expected to improve our relationship with other interested parties. It allows for feedback and clarification of problems while freeing us to track each issue to the originators of that issue.

A SYSTEM FOR RENEWABLE RESOURCE MANAGEMENT DECISIONS

Eli J. Giaquinto
National Forest System
U.S. Forest Service
Atlanta, Georgia

Problem Definition

Operations under the Renewable Resources Planning Act (RPA) have made it virtually impossible for management to make comprehensive decisions for production and allocation of renewable resources from National Forest lands. The massive amount of knowledge and supporting information required in the decision-process is overwhelming the decision-makers. Much of this information is available, but appears under various information centers. A system is needed to bring this information to the decision-maker in the form of a physical/biological/social/economic/political matrix. (Refer to Figure 1).

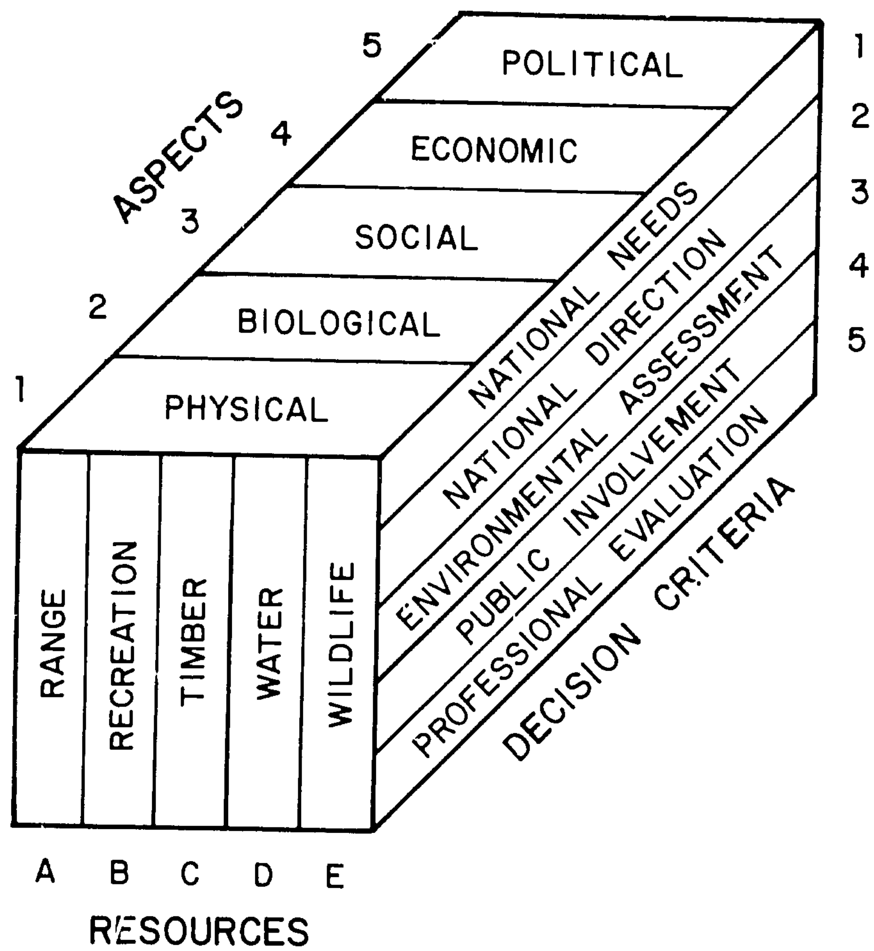
Statement of Objective

To provide management with an information system for improved National Forest land/renewable resources management decisions. Such a system must consider physical, biological, social and economic aspects of the renewable natural resources associated with the National Forest land under management. The decision will be a determination of who gets what, where, when and how they get it--a political decision.

The Model

The RESPOL Model envisions a classification system for rapid location of related information. The matrix represented by the model is built upon three dimensions provided by (1) resource information inherent in the management of the five renewable resources themselves (range, recreation, timber, water and wildlife),[1] (2) decision criteria fundamental to the Resources

FIGURE 1



RESPOL - RESOURCE POLITICS FOR NATIONAL FORESTS RENEWABLE RESOURCES

Planning Act,[2] and (3) consideration of alternatives in the light of physical, biological social, economic and political effects, as required by the National Environmental Policy Act of 1969. Figure 1 is a graphic representation of the model.

Exemplar

As an example, a decision-maker confronted with a problem involving the distribution of timber output to satisfy a national need in behalf of social betterment could refer to the classification system in Figure 1 and isolate the body of information under "timber," "social" and "national needs" in support of a decision. Figure 2 illustrates this procedure.

Decision Tree

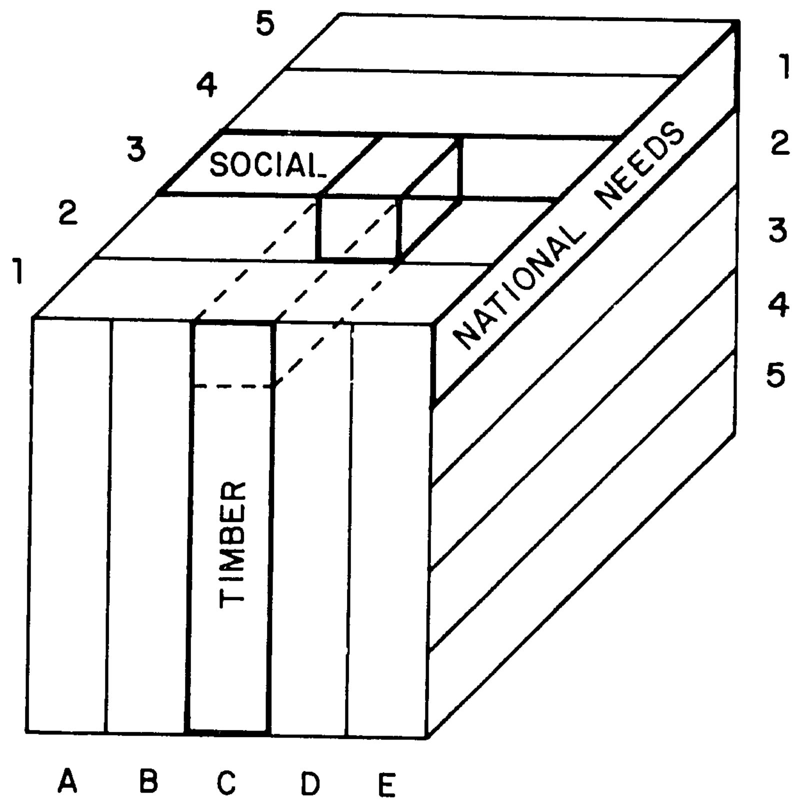
This vast body of knowledge would need to be computerized for quick and ready reference. A typical RESPOL decision tree is graphically designed in Figure 3. Following the example pathway would begin with "timber" at the "resource" level, lead to "social" at the "aspects" level, and finally to "national needs" at the "decision criteria" level of information. The letters in parentheses at the resources level are coordianted with the Forest Service management information handbook, the coordinating instrument for the Forest Service budgeting system.

---

[1] "A Report to Congress on the Nation's Renewable Resources," U.S. Department of Agriculture, March 1979, pp. 18-49.

[2] Ibid., pp. 5-6.

FIGURE 2



TSNN - SOCIAL ASPECTS OF THE TIMBER RESOURCE FOR THE INDICATED NATIONAL NEEDS

T - TIMBER RESOURCE

S - SOCIAL ASPECTS

NN - NATIONAL NEEDS (1980 RPA)

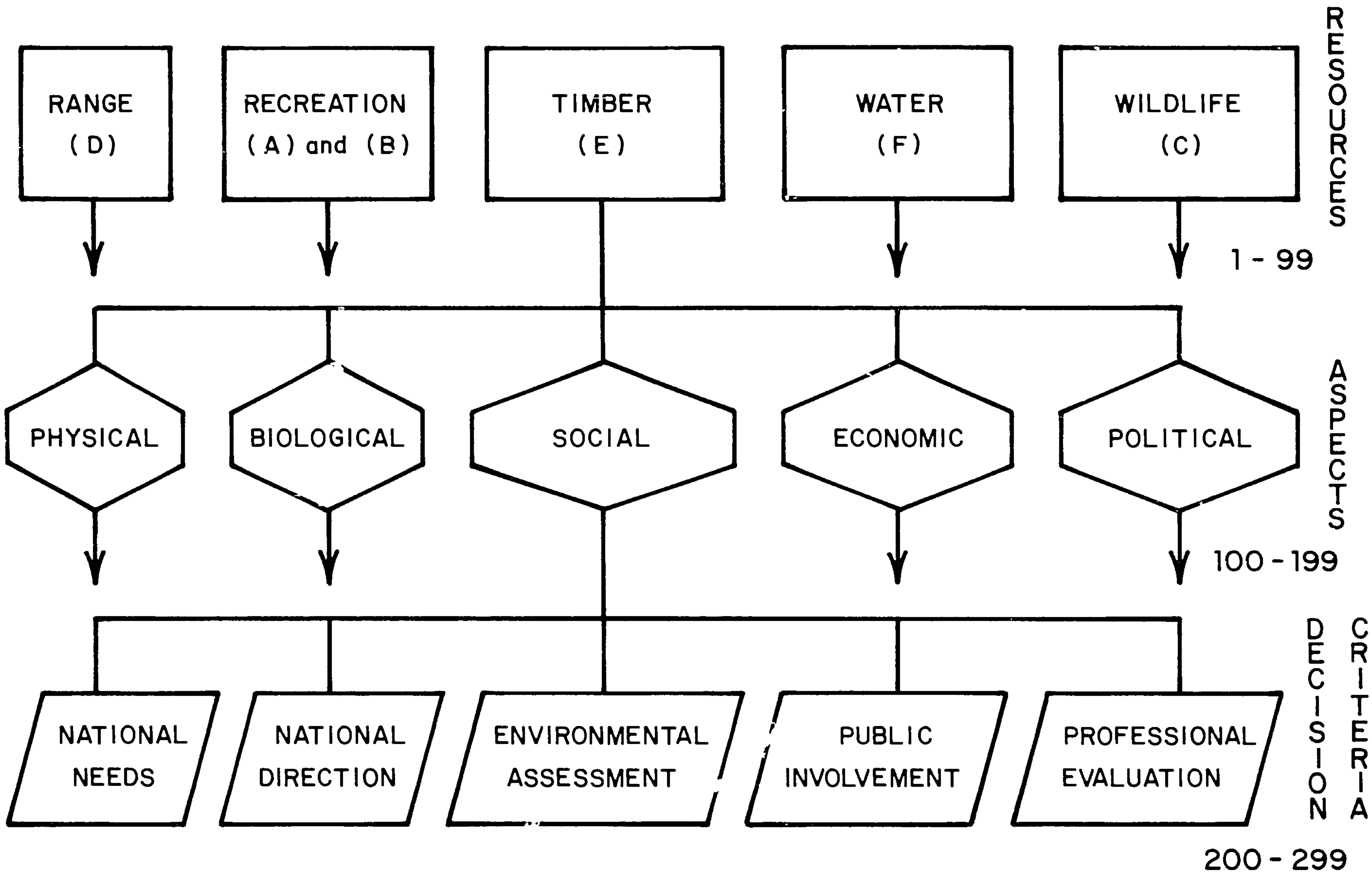

RANGE (D)
RECREATION (A) and (B)
TIMBER (E)
WATER (F)
WILDLIFE (C)
RESOURCES
1 - 99
PHYSICAL
BIOLOGICAL
SOCIAL
ECONOMIC
POLITICAL
ASPECTS
100 - 199
NATIONAL NEEDS
NATIONAL DIRECTION
ENVIRONMENTAL ASSESSMENT
PUBLIC INVOLVEMENT
PROFESSIONAL EVALUATION
DECISION CRITERIA
200 - 299

FIGURE 3

The Data Base

Here is a typical data base for RESPOL:

RESPOL Data Base

E001	State
E002	National Forest
E003	County
E004	CFL in State
E005	CFL in County

E 100	SOCIAL
E 101	Total Population in State, 1970
E 102	Rural Farm Population in State, 1970
E 103	Rural Nonfarm Population in State, 1970
E 104	Urban Population in State, 1970
E 105	Total Population in County, 1970
E 106	Rural Farm Population in County, 1970
E 107	Rural Nonfarm Population in County, 1970
E 108	Urban Population in County, 1970
E 109	Number of Low Income Families in County, 1970
E 110	Number of Low Income Families Occupying Substandard Housing, 1970
E 111	Total Population in State, 1960
E 112	Rural Farm Population in State, 1960
E 113	Rural Nonfarm Population in State, 1960
E 114	Urban Population in State, 1960
E 115	Total Population in County, 1960
E 116	Rural Farm Population in County, 1960
E 117	Rural Nonfarm Population in County, 1960

E 118 Urban Population in County, 1960

E 119 Attitudes Toward National Forest Timber Management and Timber Use

E 200 NATIONAL NEEDS

E 201 Low Income Housing

E 202 Number of Units Needed in County

E 203 Volume of Lumber Needed

E 204 Number of Units Needed, 1980

E 205 Volume of Lumber Needed, 1980

E 206 Number of Units Needed, 1981

E 207 Volume of Lumber Needed, 1981

E 208 (etc.)

E 100 BIOLOGICAL

E 101 Total Growing Stock

E 102 Total Sawtimber Growing Stock

E 103 Net Annual Growth, Total

E 104 Total Softwood Sawtimber Growing Stock

E 105 Total Hardwood Sawtimber Growing Stock

E 106 Total Softwood Poletimber Growing Stock

E 107 Total Hardwood Poletimber Growing Stock

E 108 Net Annual Growth, Softwood

E 109 Net Annual Growth, Hardwood

E 110 Net Annual Growth, Softwood Sawtimber

E 111 Net Annual Growth, Hardwood Sawtimber

E 112 Net Annual Growth, Softwood Poletimber

E 113 Net Annual Growth, Hardwood Poletimber

E 100 ECONOMIC

E 101 Demand, All Species-Products

E 102 Demand, Sawtimber-All Species

E 103 Demand, Softwood Sawtimber

E 104 Demand, Hardwood Sawtimber

E 105 Demand, Softwood Poletimber

E 106 Demand, Hardwood Poletimber

E 107 Supply, All Species-Products

E 108 Supply, Sawtimber-All Species

E 109 Supply, Softwood Sawtimber

E 110 Supply, Hardwood Sawtimber

E 111 Supply, Softwood Poletimber

E 112 Supply, Hardwood Poletimber

The lines of communication to and from the appropriate storage cell can be traced in the decision tree, Figure 3.

An Example

Here is how the system would work. A decision maker gets a Congressional inquiry involving the social aspects of timber for a proclaimed national need. "What is the need for low-income housing in Rabun County, Georgia?" "How can the National Forest contribute to this need in 1980?" Program, using SYSTEM 2000 data base:

```
LIST E202, E204, E205 WH E201 = Low Income Housing,
E200 = NATIONAL NEEDS, E003 = Rabun, E002 = Chattahoochee,
E001 = Georgia; List E110 WH E100 = BIOLOGICAL,
E003 = Rabun, E002 = Chattahoochee, E001 = Georgia;
```

LIST E109, E103 WH E100 = ECONOMIC, E003 = Rabun,

E002 = Chattahoochee, E001 = Georgia. END.

Computer Printout will list:

*

261	SOC/E202	Number of Units Needed
26	SOC/E204	Number of Units Needed, 1980
260 MBF	SOC/E205	Volume of Lumber Needed, 1980
7.7 MMBF	BIO/E110	Net Annual Growth, Softwood Sawtimber
2.7 MMBF	ECO/E103	Demand, Softwood Sawtimber
4.2 MMBF	ECO/E109	Supply, Softwood Sawtimber

PRINT E119 WH E100 = SOCIAL, E003 = Rabun, E002 = Chattahoochee, E001 = Georgia

Computer printout will print:

Local attitude supports timber use from National Forests. Non-local attitude supports Wilderness and non-market uses of the National Forests ...little if any timber use from National Forests.

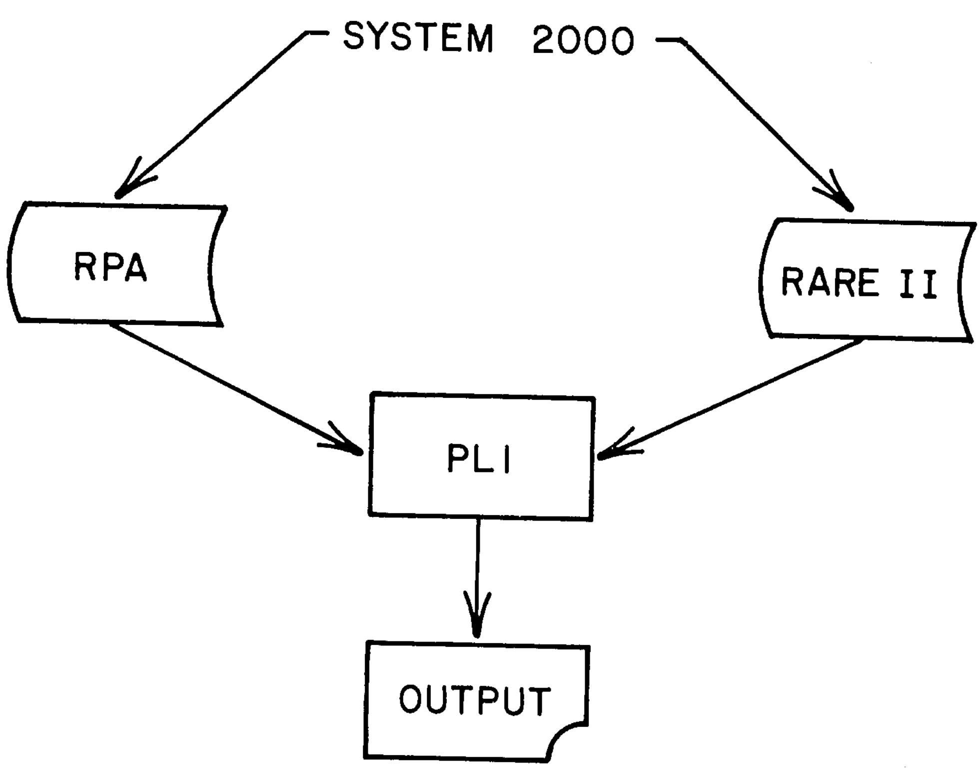
Alternatives:

1. National Forest supplies timber for low-income housing.
   HUD finances logging, milling and construction.
2. National Forest supplies timber for low-income housing.
   YCC logs to mill.
   HUD finances milling, supplies and materials.
   YCC builds housing.
3. National Forest supplies timber.
   HUD finances logging, milling, supplies and materials.
   YCC builds some housing.
   HUD builds housing not built by YCC.

Concluding Remarks

There are many productive uses of the system. As another example, the system could be used to compare programs with a procedural language interface (PLI) as shown in Figure 4. These are merely a few uses for the RESPOL system. The opportunities for use are virtually unlimited.

FIGURE 4



A SYSTEM FOR MAILING LABELS

Bill Henley
Ozark-St. Francis National Forest
Russellville, Arkansas

Problem

At present there are 14 different mailing lists for various plans and environmental statements issued from the Supervisor's Office of Ozark-St. Francis National Forests. The lists contain names of individuals and/or organizations to which mailings have been made. The names are located in card files, on typed lists, or on mag cards, and are identified for each particular mailing. When a new mailing is initiated, the names and addresses are typed on envelopes for each person or organization to receive the document. This job is most time consuming and expensive considering the amount of clerical time that is required.

Analyzing the Problem

The problem was discussed with the Forest Planner and the Environmental Coordinator. We considered using either Mag Card II tape labeling or a computerized mailing label system currently available through the Fort Collins Computer Center. We decided on the latter, since it seemed to be the fastest and most economical method. With the help of John Waters, we planned to implement the project using available computer hardware and software.

Project

The project, which I have called "Oz Labels," uses the existing program, Mailing Label System. The first step was to complete the data entry form, R8 6200-9 (see Attachment #1), with the following information:

Input

1. Set up group codes for the various existing mailing lists (see Attachment #1).

Attachment #1

FOREST COMPUTERIZED MAILING SYSTEM
Data Entry Form

NAME AND ADDRESS CARDS

Card No. — Sequence No.

1
cc 1 2 ______________________________ 33
40 ______________________________ 71 76 ____ 80

2
cc 1 2 ______________________________ 33
40 ______________________________ 71 76 ____ 80

3
cc 1 2 ______________________________ 33
40 ______________________________ 71 76 ____ 80

4
cc 1

GROUP CODES

cc

2 ( ) Press Releases
3 ( ) Mandatory Mailing List
4 ( ) Trail Clubs & Organiza.
5 ( ) RPA List, 1979
6 ( ) St. Francis Unit Plan
7 ( ) Ozone Unit Plan
8 ( ) Lake Wedington U.P.
9 ( ) Lee Creek Unit Plan
10 ( ) Magazine Unit Plan
11 ( ) Mt. Magazine Statement
12 ( ) RARE II
13 ( ) Ozark Timber MGT. Plan
14 ( ) Herbicide Statement
15 ( ) Forest Direction Statement
16 ( ) All
17 ( )
18 ( )
19 ( )
20 ( )
21 ( )
22 ( )
23 ( )
24 ( )
25 ( )
26 ( )

REFERENCE CODES

cc

27 ( ) ZOI - Dailies*
28 ( ) ZOI - Weeklies
29 ( ) ZOI - Radio
30 ( ) ZOI - TV
31 ( ) Major State Dailies
32 ( ) State Dailies & Weeklies
33 ( ) Media - Special
34 ( ) Mandatory (NEPA)
35 ( ) Congressional Delegation
36 ( ) State Delegation
37 ( ) Federal Agencies
38 ( ) State Agencies
39 ( ) Local Government
40 ( ) Groups & Organizations
41 ( ) Individuals - Signature**
42 ( ) Individuals - Letter***
43 ( ) All
44 ( )
45 ( )
46 ( )
47 ( )
48 ( )
49 ( )
50 ( )
51 ( )
52 ( )

REFERENCE CODES

cc

53 ( )
54 ( )
55 ( )
56 ( )
57 ( )
58 ( )
59 ( )
60 ( )
61 ( )
62 ( )
63 ( )
64 ( )
65 ( )
66 ( )
67 ( )
68 ( )
69 ( )
70 ( )
71 ( )
72 ( )
73 ( )
74 ( )
75 ( )

Sequence No.

76 ____ 80

* ZOI - Zone of Influence
** Signature - petition, form letter, etc.
*** Letter - individually written

R8-6200-9 (6/75)

2. Set up reference codes to identify the various categories of the public within the mailing lists shown under group codes (see Attachment #1).

3. Complete the name and address (card 1) for each label. Enter an X in the various group codes and reference codes (card 4), that identify the name on the label.

4. Enter the names and addresses by punch cards into the Fort Collins Computer Center Data Base. (This job was actually done in the Regional Office by John Waters).

Since the combined mailing lists involve several thousand names, only the Press Releases involving 104 names and addresses have been entered into the computer at this time (see Attachment #2).

Output

We have available on the Forest an ICL Batch Terminal (intelligent) with printer. The software needed is gum label paper which we have ordered from Visible Computer Supply Corporation, 3626 Stern Drive, St. Charles, Illinois. The entire project will be operational after the names and addresses have been entered into the computer, properly identified by group and reference codes. Address labels for any or all of the 14 lists will be printed by our terminal upon demand.

Attachment #2

FOREST COMPUTERIZED MAILING SYSTEM
Data Entry Form

NAME AND ADDRESS CARDS

Card No. | **Sequence No.**

1

cc 1 2 - 33

40 - 71 76 - - - - 80

2

cc 1 2 - 33

40 - 71 76 - - - - 80

3

cc 1 2 - 33

40 - 71 76 - - - - 80

4

cc 1

GROUP CODES

cc

2 (X) Press Releases
3 ( ) Mandatory Mailing List
4 ( ) Trail Clubs & Organiza.
5 ( ) RPA List, 1979
6 ( ) St. Francis Unit Plan
7 ( ) Ozone Unit Plan
8 ( ) Lake Wedington U.P.
9 ( ) Lee Creek Unit Plan
10 ( ) Magazine Unit Plan
11 ( ) Mt. Magazine Statement
12 ( ) RARE II
13 ( ) Ozark Timber MGT. Plan
14 ( ) Herbicide Statement
15 ( ) Forest Direction Statement
16 ( ) All
17 ( )
18 ( )
19 ( )
20 ( )
21 ( )
22 ( )
23 ( )
24 ( )
25 ( )
26 ( )

REFERENCE CODES

cc

27 (X) ZOI - Dailies*
28 ( ) ZOI - Weeklies
29 ( ) ZOI - Radio
30 ( ) ZOI - TV
31 (X) Major State Dailies
32 (X) State Dailies & Weeklies
33 ( ) Media - Special
34 ( ) Mandatory (NEPA)
35 ( ) Congressional Delegation
36 ( ) State Delegation
37 ( ) Federal Agencies
38 ( ) State Agencies
39 ( ) Local Government
40 ( ) Groups & Organizations
41 ( ) Individuals - Signature
42 ( ) Individuals- Letter**
43 ( ) All
44 ( )
45 ( )
46 ( )
47 ( )
48 ( )
49 ( )
50 ( )
51 ( )
52 ( )

REFERENCE CODES

cc

53 ( )
54 ( )
55 ( )
56 ( )
57 ( )
58 ( )
59 ( )
60 ( )
61 ( )
62 ( )
63 ( )
64 ( )
65 ( )
66 ( )
67 ( )
68 ( )
69 ( )
70 ( )
71 ( )
72 ( )
73 ( )
74 ( )
75 ( )

Sequence No.

76 - - - - 80

* ZOI - Zone of Influence
* Signature - petition, form letter, etc.
* Letter - individually written

R8-6200-9(6/75)

A COMPUTER SYSTEM FOR PROGENY EVALUATION

Ralph A. Lewis
National Forest System
U.S. Forest Service
Atlanta, Georgia

Introduction

Region 8 of the U.S. Forest Service maintains one of the largest and most varied tree improvement programs in the South. Seven pine species--represented in more than 1200 acres of first generation seed orchards and six hardwood species--have been established in clone banks. Nevertheless, this represents only the first steps in a genetic improvement program. The next phase involves thorough field testing of offspring from select trees propagated in the orchards. Information from these tests is absolutely essential before the program can enter into advanced generation breeding. A large, flexible and readily accessible data system must be established in order to accommodate and analyze the mass of information generated by these tests.

Concepts of Progeny Testing

In order to understand the needs associated with a progeny test data system, some knowledge of the basic purpose and procedures of progeny testing is necessary. First of all, progeny tests have two general functions:

a. To provide pedigreed arrays of trees from which advanced generation selections can be made; and

b. To test the genetic worth of the parentage now residing in the seed orchards.

In order to satisfy these requirements, a large number of well-replicated field tests must be established over a variety of site conditions and in some cases, over a number of years. Each tree in every test will be evaluated at least one time for survival, and all living trees will be evaluated two or more times for a variety of traits. Individual tree data will be pooled into family averages and related families into parental averages. In turn, family performance will be pooled as will data from families with common parentage. From these data, relative genetic worth of the orchard parents can be determined. This will permit a selective removal of poor parents from the seed orchard and an improvement in genetic quality of orchard seed. All performance levels will be used to evaluate individual tree selections for advanced generation orchards, best parents, and best individuals within families.

Objectives of the Computer Program Systems

The entire testing program represents many individual tests with different environmental and genetic conditions. The mass of data generated by these tests must be maintained in a readily accessible state with analytical options available as new data is added to the files. Thus, the following objectives should be met by any computer system.

a. To maintain data in an orderly and accessible state.

b. To permit additions to the data file and their integration into the analytical processes.

c. To provide the analytical capability to meet the basic purposes of progeny testing.

Justification of the Computer Systems

The projected volume of data would seem to preclude any consideration of a manual record-keeping system. Over 25 tests have been installed in the Region over the past two years. This number will rise to at least 15-20 tests per year. In addition, the periodic evaluations will compound the workload in future years. In all, a minimum of 200,000 trees will be required to test all control-cross families in just one planting. Since most families will be planted in two or more locations and some will be planted in more than one year, the number of individual trees that must be evaluated at least once approaches a million. It is reasonable to assume that survival will average around 80%; but this still promises to be a huge file.

System Organization and Functions

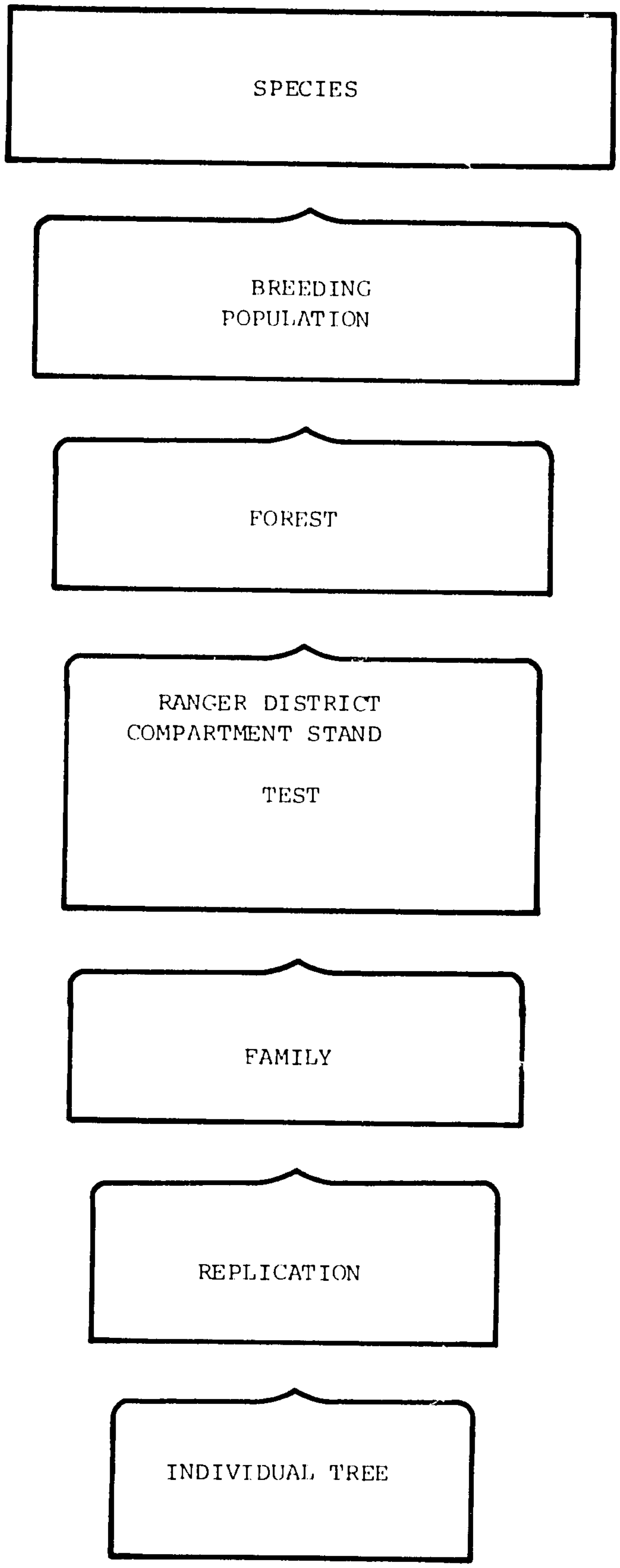
Although there will be differences, the hierarchy of progeny test records and analysis should closely parallel the seed orchard arrangement. The primary division will be species. Next will be breeding population within species. Again, almost all comparisons should be confined to an individual breeding population, but there will be exceptions where more than one breeding group may be involved in a given test. Thus, provisions must be made for pooling and comparison at all levels within species. Nevertheless, most analyses will follow the hierarchy of:

1. Species
2. Breeding population
3. Forest
4. Test number
5. Family
6. Replication
7. Individual tree

Other elements--in addition to the hierarchical elements, year of planting, Ranger District, Compartment and stand--should also be carried. (See Figure 1).

FIGURE 1

Hierarchical Elements of Progeny Test Data Files



A number of different sets of data will be required for each progeny test. All will be interrelated, but each will have discrete and unique categories of information. The following data sets are currently projected.

1. Test Establishment: this data set will contain information on the test location, layout, size and composition. It will serve as a basis for the other data sets by defining the hierarchy of the test.

2. Initial Survival Check: the first evaluation of a test planting will be made at the end of the first growing season. Its primary purpose is to determine whether or not the survival is adequate for a valid test. It will also provide a survival pattern within each family plot and replication since the status of each tree is recorded.

3. First Test Measurement: the exact timing of the first test measurements has not been decided, but it should be either the fourth or fifth year after planting. The items of information to be collected are survival (may be implied by a height value), height, and disease (as designated by species).

4. Subsequent Measurements: as with the first time measurements, the exact timings have yet to be determined. Nevertheless, the major data elements can be defined. They are: survival (implied), height, DBH, straightness, crown and disease infection.

For a given test, the data file will be built over a number of years. All information from each evaluation or measurement should be maintained in order to track development. Although this requirement will significantly increase the record space requirements, it is necessary for a total evaluation.

In addition to the basic record-keeping function, several analytical procedures will be required. All requirements cannot be predicted, but the following list should contain most of the primary ones.

1. Averaging: in order to evaluate a given family, performance must be measured over a variety of environmental influences. This program should be able to search out data in several tests, sum and average it on an individual family basis. Parental evaluations require a further combining of data from all families with the common parent.

   Due to the large environmental component associated with growth and disease parameters, at least some comparisons between tests will require rankings rather than absolute values. Thus, an additional procedure will be required for comparisons of families for height, diameter growth and disease infection. Within each test, families should be ranked for each of these parameters, with "one" being the best family in that test for that particular trait (see Table I).

   There are some obvious problems with such a system--different tests will contain different numbers of families so that rankings for one test may be more valid than for another. Also, small tests contain fewer families so that fewer (and higher) rank values will be associated with the small tests which could significantly bias the relative standings. If this proves to be too much of a problem, provisions should be made for an alternate comparison system as outlined in the next paragraph.

   Without getting into a complex regression or individual value adjustment systems, a ranking index would be set up based on the

TABLE I

Averaging

I. Each test

A. Initial Survival Check

- % of survival by test & family

B. First Measurement

- % survival by test & family
- % disease & total height by test
- % disease and total height-orchard vs. checks
- % disease and total height-individual family within test

C. Second Measurement (all items above plus:)

- diameter
- straightness (scored)
- crown (scored)

II. Between tests

test mean for that parameter. This procedure would require that a set of rank "classes" be set up relative to the mean value. Thus, a given family would be assigned to its absolute value in relation to the test average. More than one family could be assigned the same rank class within the same test and these classes would be relatively free of bias regardless of test size.

All averaging should be done exclusively within the same time frame; i.e., averaging across tests should be done only with data collected when the trees are of comparable ages.

2. Ranking: the ranking function was partially covered under averaging, insofar as its operations with an individual family both within and between tests are concerned. Nevertheless, ranking must be extended to comparisons between families within breeding populations. Rankings for each individual trait (height, diameter, etc). should be made, plus an overall family ranking based upon the combined rank totals. Although every trait probably does not merit equal weight in the combined score, equal weight will be given in the absence of any well defined weighting factors. As more experience with the different species and breeding populations are gained, specific weighting factors may be formulated.

3. Sort: the complex nature of the records will require an extensive sort capability. This should include a user option to specify sort elements from major to minor such as found in the ORCUTL program of the Seed Orchard Inventory System. In addition, there should be user control of data listed. It may not be feasible to do this down to individual columns of data, but groups of columns reflecting specific evaluations or growth trends will be needed.

Sort capabilities should be available for the following elements: breeding population, forest, family, year of planting and Ranger District.

Conclusions

Although the current concept of the system is complex, it will probably not meet all program needs. Nevertheless, it should satisfy the early stages of program development. As more experience is gained in the field of progeny evaluation, program modifications should produce a more efficient system.

A DATA BASE SYSTEM FOR IDENTIFICATION AND SCREENING OF ISSUES

Joseph Metzmeier
National Forests in Texas
Lufkin, Texas

Background

Dealing with issues is not a new idea in resource management. Indeed, the Forest Service and the National Forest System were born out of a need to address issues of the day. The various laws and regulations that govern our operations and set our policies and direction are a response to issues important to the American people. Most Forest managers spend a great deal of time each day dealing with issues of either a short range or long range nature. So dealing with issues is not new for us and is at the core of our everyday behavior. What is new is the requirement--by law and regulations--that the Forest Service deal with public issues in the planning process in a direct and visible way.

Purpose

The purpose of issue oriented planning can be characterized by: focus, public involvement, priority and organization. Focus on issues and management concerns enables us to concentrate limited planning manpower and money to solve specific problems. This eliminates a shot-gun or a planning-for-the-world approach. It gives the rationale for addressing issues and management concerns and the level of detail to which they will be addressed. Public involvement on issues provides a pipeline through which we can communicate with the public. Few members of the public are interested in discussing the broad spectrum of resource management. They can, however, relate to current issues and the need to plan for resolution of those issues. Through the issue development and analysis process the forest or region is able to place some priorities on which issues and management concerns must be handled first, and, just as important, which ones will not be addressed at all. Organization of the various levels of management that must deal with the issues is also important, so the the Chief's Office deals with problems affecting the national level, and the Ranger District deals with problems of a local nature. Issue orientation provides a systematic sorting through of issues and negotiations on which issues must be addressed at which planning level.

Process

To meet requirements by law and regulations, a process for dealing with public issues and management concerns was developed. Several concepts were used which follow the same general steps. These steps are:

- Issue identification, assessment and analysis. This is a continuous process. It is conducted both internally within the organization and externally through the involvement of various interest groups.
- Screening process. This is a method that helps sort out which issues will be addressed, which will not be, which level of the organization will address the issue, and to what degree of detail; and what supporting documentation and rationale are to be provided.
- Development of management strategy. This step involves choosing among alternatives for dealing with identified issues and concerns. The level of detail of the chosen strategy must be fine enough to make visible the Forest Service Program that is to deal with that issue or concern.
- Implementation and monitoring. The best plan is worthless if not implemented. Effort put into issues and concerns is wasted unless suggested strategies can be tried and evaluated. The issues provide a mechanism for evaluating the effectiveness of a planning effort.

The flow chart in Exhibit 1 is a description of the process that will be used to accomplish this task.

Description of the Process

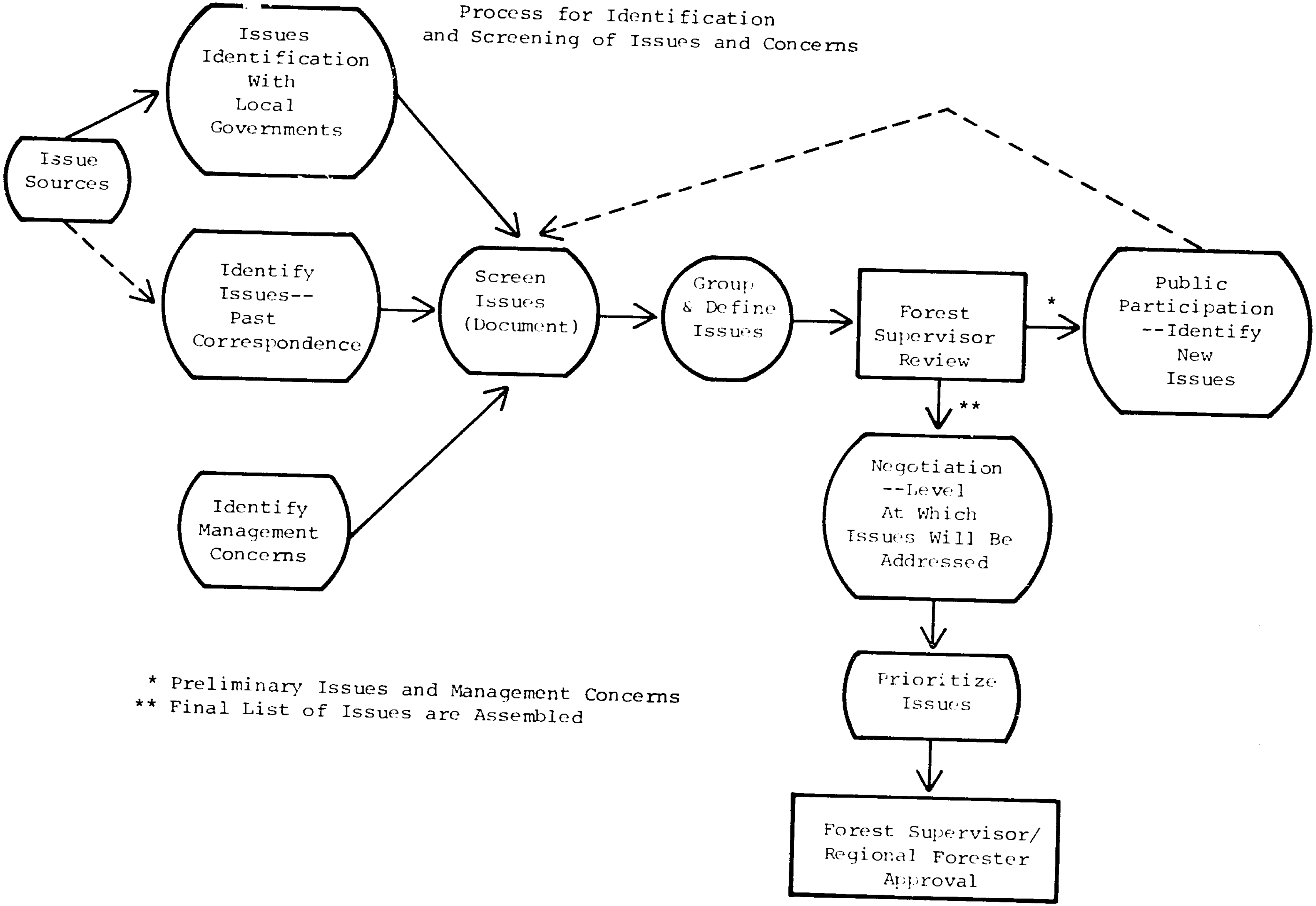
Sources of issues are: past public involvement, written responses to draft EIS, news articles, RARE II, and existing plans. Comments received on past planning efforts should be reviewed to identify areas of public concern. Other possible sources of issues are Congressional members, public contacts, etc. Issues can be identified with local governments, state and federal agencies through preliminary informal meetings. These meetings will serve two functions: first, to inform the local governments of the planning process, and second, to identify issues. Most management concerns can be identified by communicating with Forest Service personnel. Possible approaches are Ranger-Staff meetings, meetings with district and supervisor's office personnel, and memos to all personnel requesting their assistance in identifying management concerns. Inspections, general management reviews, and service trip reports should also be reviewed. Regional input through the regional plan and communications with Regional staff specialists should be incorporated.

After identifying issues, the next step will be to screen issues and management concerns. This step will mean a review of each issue that has been identified and a sorting out of those issues that will be addressed in Land Management Planning regardless of the level--national, regional, or local. Each issue should be trackable through the screening process. Issues that are dropped should be referred to the appropriate individual for consideration so that the reasons for dropping it can be documented.

Following this, the issues should be grouped and defined, each receiving a description that will provide the detail necessary so that the

EXHIBIT 1

Process for Identification and Screening of Issues and Concerns



* Preliminary Issues and Management Concerns
** Final List of Issues are Assembled

reader understands the situation and how it relates to Land Management Planning. Issues and management concerns that survive the screening process should be grouped with related issues. A narrative description should be written.

The Forest Supervisor then reviews the issues and management concerns recommended by the interdisciplinary team before public review takes place. The issues are reviewed by the public using the methods established in the public participation plan. This is to determine if the public feels the preliminary issues are relevant and to identify any new issues from the public sector. If any new issues are identified as a result of public involvement, these will be run through the screening process.

After the final list of issues is assembled, the Forest Supervisor and the Regional Forester will identify at which level or levels they should be addressed. The issues will be prioritized by criteria developed for this purpose. Some issues may be prioritized through public participation. The Forest Supervisor will review the final list of issues and management concerns to be addressed, and recommend for final approval to be given by the Regional Forester.

Screening Criteria

A screening criteria is necessary to work up a preliminary list of issues to be reviewed by the Forest Supervisor. The following criteria are necessary:

- Is it within the legal authority or control of the Forest Service to resolve the issue?
- Is it feasible to resolve the issue, based on the economic, biological, social or political situation?

- Is it significant enough to be resolved in the Land Management Planning process or should it be handled administratively?
- Is there an opportunity to resolve it in the Land Management Plan?
- Is it being handled by another agency or governmental unit?

Narrative Description

A narrative description describing the issues is necessary which should include the following items:

- Issue title: a short statement describing the issue.
- Narrative analysis and assessment: state the problem, how the public views the issue, and how the Forest Service views the issue.
- Scope of the issue: consider all areas affected, whether geographic, political, adminstrative, or socio-economic in determining the scope of the issue. Also note how the issue relates to other agencies and groups as well as the public; who raised the issue; and who is affected and how. Note the impact of the issue on management, other agencies, groups, and the public, whether direct, indirect, or accumulative. Finally, consider whether the issue is existing or emerging, and what its relationship is to the present management direction.
- Intensity of the issue: this includes the amount of input received, and its intensity in terms of the number of people involved, the emotions aroused, the extent of media focus, and the variety of interest.
- How the issue relates to other issues.

Computer Process with System 2000

A computer model was created by selecting some twenty letters received from past planning. A copy of a letter is included in Exhibit 2. Issues that were addressed in these letters were underlined (see Exhibit 2).

EXHIBIT 2

#1

2-5-78
PO Box
San Augustine Tex

U.S. Forrest Service
PO Box 969

Dear Sir:

Please be advised: I believe the Angelina National Forest should be managed in a sensable conservative way — cutting and harvesting in a manner not to destroy but to promote good timber growing practices. I believe it can be harvested in a way to boost the economy of our area and not hurt the forrest. If Clear-cutting is done on a reasonable scale and replanted properly I do not see that it would be a wrong practice.

I do not believe that any private owner should be cut off from his property or his property taken for wilderness purposes. I believe it to be very wrong for the government or anyone else to take private land just to turn it into some thing some one esle can use as a wilderness experience or whatever.

It is necessary to group issues and to categorize on the basis of focal elements and sub-elements. By use of the management information handbook codes, this was accomplished. An issue tree using the criteria and narrative outlined earlier, and the grouping criteria also mentioned, was set up. (See Exhibit 3).

A data form necessary for submission to the computer section was made. A copy is included in Exhibit 4. Some 229 completed forms were used in this computer model.

A list of sorted outputs desired and a list of analytical determinations needed were submitted to the computer science section in the Regional Office (see Exhibits 5 and 6). Copies of the results are included in Exhibit 7.

Conclusion

The computer program, LMP8TX ISSUES, with the use of System 2000, will meet the need for storage of data and has the capability for sorting. This sorting will enable us to focus on each individual issue, plus prioritize them. With this program, the sorting time is reduced, but the time needed for identification of issues and completion of data forms takes approximately five minutes per issue. In the sample twenty letters used there was an average of fourteen issues identified for each, thus taking approximately one hour and ten minutes per letter. Also, it is necessary that someone experienced with the background of Forest Service activities and regulations determine feasibility of addressing the issues.

The final determination of the efficacy of this program will come about through use in the National Forest in Texas planning process.

EXHIBIT 3

Issue Tree Produced by Computer Science Section

1. SOURCE	7. CITY
2. NUMBER	8. STATE
3. DATE	9. ZIP
4. NAME	10. FOREST
5. ORGANIZATION	11. NAME
6. ADDRESS	12. DATE

100. ISSUES	106. POLITICAL
101. ISSUE	107. OPPORTUNITY
102. AUTHORITY	108. OTHER
103. ECONOMICAL	109. AGENCY
104. BIOLOGICAL	110. COMPATIBLE
105. SOCIOLOGICAL	111. UNDERLYING

200. FOCAL ELEMENT	212. DURATION
201. ELEMENT	213. EMOTION
202. LEVEL 1	214. MEDIA
203. LEVEL 2	215. POPULATION
204. SPECIFIC AREA	216. LAND OWNERS
209. IMPACT 1	217. OTHER INDIVIDUAL
210. IMPACT 2	218. POLITICAL GROUPS
211. STATUTE	219. OTHER AGENCIES
220. ADMINISTRATIVE	

300. SOCIO-ECONOMIC
301. COUNTY
302. PRECINCT
303. SCHOOL
304. WATER
305. OTHER AREAS

EXHIBIT 4

ISSUE TREE DATA

C1. Source (Letter, Public Meeting, Petition, Other)
[Underline appropriate entry.]

C2. Number-# ____________ C3. Date [Of Source Document] ____________

C4. Name [Person Providing Input] ____________

C5. Agency, Company, Organization ____________

C6. Address ____________

C7. City or Town ____________

C8. State ____________ C9. Zip ____________

C10. Forest [Issue Directed To] ____________

C11. Initials [Person Filling Out Form] ____________

C12. Date [Form Filled Out] ____________

C101. Issues [Description] ____________

____

____

[Circle Y (Yes) or N (No):]

C102. Y or N (Within the Authority of Forest Service)

C103. Y or N (Economically Feasible)

C104. Y or N (Biologically Feasible)

C105. Y or N (Sociologically Feasible)

C106. Y or N (Politically Feasible)

C107. Y or N (Opportunity to be Resolved in LMP)

If No for C102-C107, give reason ____________

____

C108. Y or N (Is Issue Being Handle by Other Agency) C109. Agency ____________

C110. Y or N (Compatible with Existing Management Direction)

C111. Y or N (Underlying Issues That Should Be Continued in LMP)

C201. Focal Element [Underline appropriate element:] (A Recreation; B Wilderness; C Wildlife and Fish; D Range; E Timber; F Water; G Minerals; H Human and Community Development; J Lands; K Soil; L Facilities; P Protection; ZZ All; or YY None)

C202. Sub-Element: Level #1 [Alpha Level Code + Name] ____________________

____

C203. Sub-Element: Level #2 [Sub Level Alpha Level Code + Name] ____________________

____

C204. Specific Area [Geographic Location Affected] ____________________

[Circle Appropriate Choice Using Question That Follows Each:]

C209. Impact (Reversible, Irreversible) [If Decision is Made and Activity Carried Out, Can It Be Changed Back?]

C210. Impact (Indirect, Direct, Accumulative) [What is the Impact On the Resource?]

C211. Status of Issue (Existing, Emerging) [Is Issue New or Has It Been Around For a While?]

C212. Duration (Short Term, Intermittent, Long Term) [How Long Will the Impact on the Resource Last?]

C213. Emotion (Not Evident, Interested, Excited, Violent) [What do People Think About the Issue?]

C214. Media Focus (Distorted, Factual, Uninformed, Not Evident) [How is the News Media Reacting to the Issue?]

C215. Involved Population <(1-10); (11-100); (101-500); (501-1000); (1000 plus)> [How Many People Are Affected?]

C216. Land Owners Affected (Yes, No) Who? [If Known] ____________________

C217. Other Individuals Affected (Yes, No) Who? [If Known] ____________________

C218. Political Groups Affected (Yes, No) Who? [If Known] ____________________

C219. Other Agencies Affected (Yes, No) Who? [If Known] ____________________

C220. Administrative Level (National, Region, Forest, District, All) [What is Scope of Impact of Issue?]

SOCIO-ECONOMIC AREA AFFECTED

C301. County [Which one/s] ____________________

C302. Precinct [Which one/s] ____________________

C305. Other [Name, if Needed] ____________________

C306. Socio-Economic Area - How Affected? ____________________

____

EXHIBIT 5

A LIST OF SORTED OUTPUTS NEEDED

1. List by Focal Element the Issues that have yes answers for items C102, C103, C104, C105, C106, and C107.

   Print out should show Focal Element, Issue, and # of Letter.

2. List by Focal Element of those issues not economically feasible (No in C103)

   Print out same as 1 above

3. List by Focal Element of those issues not within the authority of the Forest Service (No in C102)

   Print out same as 1 above

4. List by Focal Element of those issues not compatible with existing management directions. (No in C110)

   Print out same as 1 above

5. List of all issue by Focal Elements in which the Media Focus (C214) was labeled distorted

   Print out same as 1 above

6. List of all issues by focal element in which the emotion (C213) was labeled interested.

   Print out same as 1 above

7. List of all issues by Focal Element that have a socio-economic impact (C301) on Trinity County

   Print out same as 1 above

8. Alphabetic Listing by Name and Address of all letters received. Include also date of letter.

   Print out should show items C2, C3, C4, C5, C6, C7, C8, and C9

9. A list of those individual responding with No Comment (Focal Element YY None)

   Print out should show name (C4) and letter (C2)

10. A List of all Agency, Company, and Organization Representative responding by either letter, or petition

Print out show each only once on print out includes letter # also.

11. A List of all issues that have E03 in C202 and 433 in C203

Print out show E03-Silvicultural Examination & Prescription
433-Stand and/or Compartment Prescription Phase

12. A List of all issues that have A14 in C202

Print out show A14-Dispersed Recreation-Full Service Mgmt

13. A List of all issues that have L20 in C202

Print out show L20-Trail Inventory and Planning
List of Issue Letter #

14. A List of all issues that have L01 in C202 and 701 in C203

Print out show L01-Transportation System Planning & Inventory
701-Transportation System Planning
List of Issue Letter #

15. List of all Timber Focal Element Issues that are on the Davy Crockett National Forest (C10)

Print out show Issue (C101) Letter #(C2)

16. List of all issues by Focal Elements in which the impact (C209) was labeled Irreversible

Print out show same as 1 above

17. List of all issues by Focal Element in which the status of issue (C211) was labeled emerging.

Print out show same as 1 above.

EXHIBIT 6

LIST OF ANALYTICAL OUTPUTS NEEDED

1. Total of Issues addressed at each Focal Element (C201)

   Print out should show

   EX:

Focal Element	# of Issues
A. Recreation	35
B. Wilderness	15

2. Total of Issues by Sub Element Level #1 (C202)

   Print out should show

   EX:

Sub Element Level One	# Issues
A01 Recreation Planning & Inventory	6
A02 Cultural Resource Management	2

3. Total of Issues by Sub Element Level #2 (C203)

   Print out should show

   EX:

Sub Element Level Two	# Issues
301 Recreation Planning & Inventory	4
302 Off-Road Vehicle (ORV) Use	2

4. Total of Source Documents

   Print out should show

   EX:

Letter	28
Public Meeting	6
Petition	2
	36

5. Source Documents Received From Each Zip Code

   Print out should show

   EX:

Zip Code	Number
75961	9
75080	2
75656	3
	14

EXHIBIT 7

EXAMPLE OF SORTED OUTPUTS

#2

ISSUES NOT ECONOMICALLY FEASIBLE
08/29/1979

* ELEMENT	ISSUE	NUMBER	NAME
***			
* RG 101-A RECREATION	UNLESS LAKE IS FULL IT IS VERY DIFFICULT FOR BASS BOATS + HE AVY TRAILER LOADS TO USE LETNE Y PARK BOAT RAMP	5	SOLON FEINBERG
* RG 105-E TIMBER	ESTABLISH ONE OR MORE AREAS OF APPROXIMATELY 15,000 ACRES SE LECTED FROM NON-WILDERNESS RID GES WITH LONGLEAF PINE, ANGELI NA N.F., FOR MANAGEMENT OF LO*	6	EDWARD C. FRITX
* RG 112-P PROTECTION	TICKET NOISE VIOLATION OFFENDE RS AT EVERY OPPORTUNITY (ORV)	12	E. D ALLAN

#3

ISSUES NOT WITHIN AUTHORITY
08/29/1979

* ELEMENT	ISSUE	NUMBER	NAME
***			
* RG 101-A RECREATION	UNLESS LAKE IS FULL IT IS VERY DIFFICULT FOR BASS BOATS + HE AVY TRAILER LOADS TO USE LETNE Y PARK BOAT RAMP	5	SOLON FEINBERG
* RG 114-YYNONE	CONCORD CEMETERY SHOULD NEVER BE MOVED AGAIN	19	CONCORD MISSIONARY B APTIST CHURCH

LIST/TITLE(131) D(20) ISSUES NOT COMPATIBLE WITH EXISTING MANAGEMENT DIRECTION/

#5

ISSUES WHICH THE MEDIA FOCUS WAS LABELED DISTORTED
08/29/1979

* ELEMENT	ISSUE	NUMBER	NAME
***			
* RG 102-B WILDERNESS	ANY LAND SUITABLE FOR TIMBER P RODUCTION SHOULD NOT BE CONSID ERED FOR WILDERNESS AREA	3	W F SANDERS
* RG 105-E TIMBER	LIMIT EXTENT OF AREA OF CLEAR- CUTTING	6	EDWARD C. FRITX
* RG 105-E TIMBER	ANY LAND SUITABLE FOR TIMBER P RODUCTION SHOULD NOT BE CONSID ERED FOR WILDERNESS AREA	3	W. F SANDERS
* RG 105-E TIMBER	ANY LAND SUITABLE FOR TIMBER P RODUCTION SHOULD NOT BE CONSID ERED FOR WILDERNESS AREA	3	W. F SANDERS
* RG 105-E TIMBER	SIZE OF CLEARCUT OK IF REASONA BLE	1	MRS RAYE WISE
* RG 105-E TIMBER	SIZE OF CLEARCUT OK IF REASONA BLE	1	MRS RAYE WISE

#12

ALL ISSUES THAT RELATE TO OPERATIONS OF DISPERSED RECREATION-FSM
08/29/1979

* ELEMENT	ISSUE	NUMBER	NAME
***			
* RG 101-A RECREATION	SUPPORT PACK IN/PACK OUT LITTE R PROGRAM	14	JIM VANOVER
* RG 101-A RECREATION	SUPPORT PACK IN/PACK OUT LITTE R PROGRAM	10	FERRIS FAIN
* RG 101-A RECREATION	SUPPORT PACK IN/PACK OUT LITTE R PROGRAM	4	BOB MCKNIGHT

A DATA BASE SYSTEM FOR LAND ACQUISTION FILES

Joseph F. Moore
National Forests in North Carolina
Asheville, North Carolina

Introduction

The National Forest System keeps land records on the Basic Information Sheet (see Exhibit A for example). Other lands data is kept in the final file. Older cases are retained at the Forest and District levels on microfilm with the permanent records being held at the Federal Records Center. The more recent cases are retained in the Forest awaiting microfilming.

Over the past year there have been more than five requests for data from these files which required three to five days research time by a GS-11 grade employee. If the acquisition data had been entered in a data base, these requests could have been satisfied in one day with a minimum of work.

There is no listing of cases showing the status of acquired or outstanding minerals on acquired lands. Any minerals prospecting applications require a research of the Status Atlas to see if minerals are outstanding by tract. The RARE II study took four days of research and listing to provide information that could have been procured from a data base in two hours.

Methodology

System 2000 appeared to be the most likely system to sort the various data requests that have been received over the past year. If the data had been entered on System 2000, the data could have been sorted for a request in one day.

A sample of forty recent acquisitions was selected and data was entered on a data base. The entries were picked to answer the various requests that have been received in the past year, and to provide information

EXHIBIT A

USDA-FOREST SERVICE

BASIC INFORMATION SHEET

1. CASE DESIGNATION	2. CARD CODE (1)

3. IDENTIFICATION

REGION (2-3)	STATE (4-5)	COUNTY (6-8)	POLITICAL SUBDIVISION (9-10)
08	37	Mitchell 121	
ADMIN. UNIT (11-12)	AREA UNIT (13-14)	DISTRICT (15-16)	TRACT OR LOT NO. (17-28)
NFsNC 11	Pisgah 367	Toecane 08	P-59
TOWNSHIP (29-33)	RANGE (34-38)	SECTION (39-41) / MERID. NO. (42-43)	QUADRANGLE NO. (29-36)

4. OWNERSHIP

1. NATIONAL FOREST
2. OTHER FEDERAL
3. PRIVATE
4. OTHER PUBLIC (44)

ACRES (45-51)	ADMIN. RESP. (52)	TITLE METHOD (53-54)	AUTHORITY (55-56)	MONTH (57-58)	DATE (59-60)	YEAR (61-62)
	1	Purchase 15	Weeks Law 3/1/1911	10	22	76

5. VALUATION (Nearest Dollar) (63-69) 12,626

HOW EVALUATED (70): 1. ACQUIRED 2. APPRAISED

6. ENCUMBRANCES

CLASS	TYPE	ACRES	EXP DATE	VESTED INTEREST
1/ (71) O/R	(72) Mineral 1	(73-77)	(78-79)	(80) 3

For each succeeding Encumbrance card needed, use column 1-43 and 51-80 following

CLASS	TYPE	ACRES	EXP DATE	VESTED INTEREST
2/ (51) O/E	(52) R/W 6	(53-57)	(58-59) OX	(60) 4
(61)	(62)	(63-67)	(68-69)	(70)
(71)	(72)	(73-77)	(78-79)	(80)

7. USE RESTRICTIONS

Each Use Restriction card contains 2 restrictions and uses columns 1-43 and 44-80 following

TYPE	AUTHORITY	ACRES: Inside Authorized Reclamation, Flood or Power Projects	Outside Project Boundaries or Other	Check Status 1. Outside 2. Other	TOTAL
(44-45)	(46)	(47-50)	(51-54)	(55)	(56-59)
(60-61)	(62)	(63-66)	(67-70)	(71)	(72-75)

OVERLAP (withdrawals only) - Estimate; show only on last U R card → (76-80)

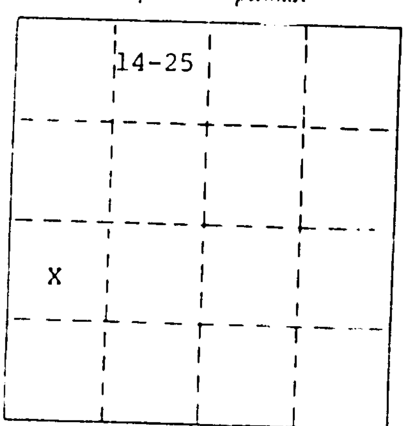
List additional Encumbrances and Use Restrictions on supplemental 5400-21(S)

SPECIAL NOTES:

1/ Mineral rights in Reynolds Mineral Company as contained in mineral exception in 9/9/19 deed recorded in Book 74, page 122, Mitchell County.

2/ Title to portion of tract within bounds of State Highway 266 as shown on survey by Carroll B. Pierce dated 2/17/76.

Map Used Optional



TITLE AND ENCUMBRANCE TABULAR RECORD ENTRY	NO.	DATE	INITIALS
USE RESTRICTION TABULAR RECORD ENTRY	NO.	DATE	INITIALS

GPO 881-423

5400-21 (REV. 6-66)

concerning lands acquisition. The information collected is shown in Exhibit B. Most of the information comes directly from the Basic Information Sheet; however, some items require research into the acquisition file itself.

Paula Barnes, Computer Terminal Coordinator of the National Forests in North Carolina, took the information that was available and designed a data base for System 2000 (Exhibit C).

Cost and Time Involved

There are 5,000 estimated lands transactions in the Forest. However, only a few of those acquired since 1950 would require information that is not already on the Basic Information Sheet. The average time to research an entry from a file is four minutes because most of the information is on the BI Sheet or in a specific part of a purged file.

The estimated cost to enter all the acquisition data on the National Forests in North Carolina would be $2,369 initially. This amount includes using a summer student at the GS-5 level to research the information. Prior to 1950 only that information shown on the BI Sheet would be entered except in cases of information in components 301 and 302. In these cases the microfilm records have to be consulted to complete the data base. The information, when completed, would be key punched at a cost of $1.00 per thousand key strokes. The cost to the Forest for this would be $144.00, estimated. The storage in System 2000 for this data base is $75.00 annually. This is a recurring annual cost. Therefore, the initial cost to the Forest would be as follows:

Cost of Researching Data Base	$2150.00
Cost of Entry	$ 144.00
Cost of System	$ 75.00
TOTAL	$2369.00

EXHIBIT B*

C1 Forest	C2 Tract	C3 Date Acq.	C4 Tot. Ac.	C5 Price/ Acre	C6 Opt/ofr Date	C7 Appr Date	C100 Phys.	C101 For. Name	C102 County

C103 Acres	C200 Acq.	C201 Acq. Method	C202 Authority	C300 Rights	C301 Encumber-ances	C302 Minerals

*Simulation of form to be used to list infoımation to be punched.

EXHIBIT C

Description of Data Base

The Acquisition Data Base consists of 17 components. Of these 17, 14 actually contain data.

The hierarchy of the data base is shown in Exhibit D.

The definition is shown in Exhibit E, which gives the format for the data.

Exhibit F is the actual data as it was loaded into the data base.

Exhibit G is some actual output with explanations of each. Estimated cost for these requests is $.52 in batch mode.

EXHIBIT D

Acquisition Data Base

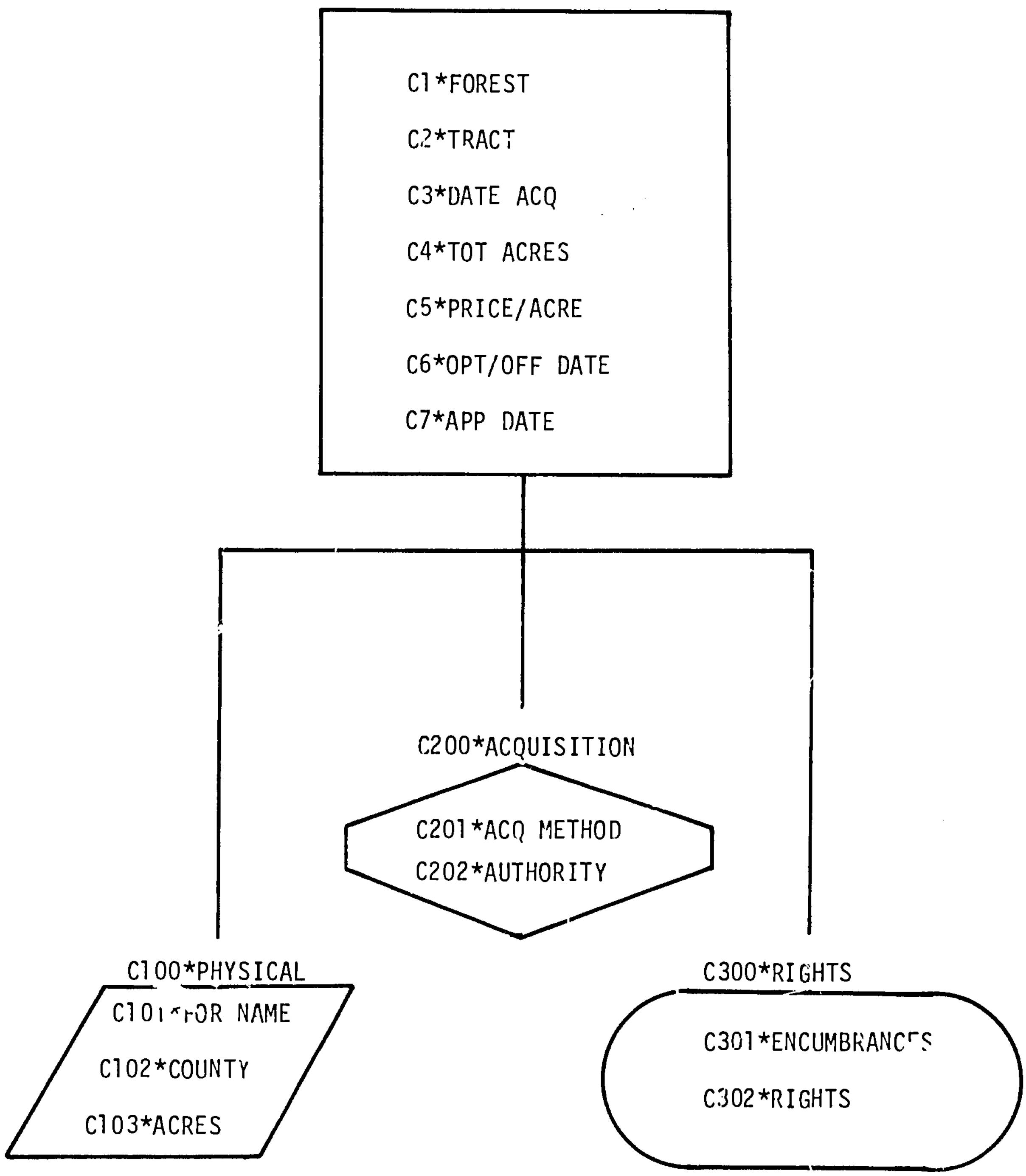


EXHIBIT E

Definition or Data Format

```
Data Base Name is Acquisition:
C1*Forest (Name X(9));
C2*Tract (Name X(15)):
C3*Date Acq. (Date):
C4*Tot. Acres (Dec. 9 (6).99):
C5*Price/Acre (Money $9,999.99):
C6*Opt/off Date (Date):
C7*App. Date (Date):
C100*Physical (RG):
C101*For Name (Name X(9) in 100):
C102*County (Name X(13) in 100).
C103*Acres (Dec. 9 (6).99 in 100):
C200*Acquisition (RG):
C201*Acq. Method (Name X (45)in 200);
C202*Authority (Name X (25) in 200):
C300*Rights (RG):
C301*Encumbrances (Name X (45) in 300):
C302*Minerals (Name X (25) in 300):
Map:
```

EXHIBIT F

```
001-1*NANTAHALA*2*N-563*3*03/17/1977*4*15.79*5*$2500.00*6*11/19/1976
002-*7*10/04/1976*100*101*NANTAHALA*102*JACKSON*103*15.79*200*201*
003-PURCHASE RECEIPT ACT *202*WILD AND SCENIC RIV. ACT*300*301*EASEMENT,ROW-
004-RD AND TRAIL*302*IN US*END*
005-1*NANTAHALA*2*N-522*3*08/21/1969*4*268.72*5*$288.75*6*04/16/1968*7*
006 06/01/1968*100*101*NANTAHALA*102*MACON*103*268.72*200*201*PURCHASE WEEK
```

Example of two cases with a printout of all information stored

EXHIBIT G

Examples of outputs:

```
PR MAX C5:
 MAX  5* $8305.00
```

```
LIST C2, C4, C5, ORDERED BY C5 WH C2 EXISTS:
*  TRACT                    TOT ACRES   PRICE/ACRE
***
*  C-543 (544) (A,B)         704.00      $100.93
*  P-101                      59.30      $119.00
*  P-11                       74.24      $150.00
*  N-607                     124.63      $150.00
*  N-568 (110)                25.00      $152.00
*  P-7                        61.00      $200.00
*  P-9                       161.21      $200.00
*  P-15                      123.39      $200.00
*  N-579                      54.33      $200.00
*  N-604                      51.30      $200.00
*  N-919 (597)                 7.50      $250.00
*  U-1639                     48.74      $250.51
*  U-1620 (U-1621)           205.42      $277.48
*  N-522-A                     6.13      $288.75
*  N-522C                     11.15      $288.75
*  N-522                     268.72      $288.75
*  P-38                       86.89      $300.00
*  N-531                      64.57      $300.00
*  N-654                      32.36      $325.00
*  P-933                      47.60      $325.00
```

"List tract, tot acres, price/acre ordered by price/acre where tract exists;" This gives a list of the three components starting with lowest price/acre.

```
PR C2, C302 WH C302 EXISTS:
2* N-663
  302* IN US
2* N-522
  302* IN US
2* N-522-A
  302* IN US
2* N-522C
  302* IN US
2* U-1639
  302* IN US
2* P-52
  302*OUTSTANDING IN #RD PARTY, ALL MINERALS RESERVED
```

Print tract, minerals where minerals exist.

All acquisitions during a particular year could be entered into the system as they were completed. The estimated time is about 15 minutes per case for an estimated twenty cases, or an annual cost of $20.00, figured at a GS-5 level. Therefore, the annual cost of maintaining the system is:

Entry Cost	$20.00
Storage Cost per year	$75.00
TOTAL PER YEAR	$95.00

The estimated savings of the system could be figured for an average of five requests per year as follows:

Without system:

15 days at GS-11, $95.00/day = $1,425.00 total cost

With system:

3 days at GS-11, $95.00/day = $ 285.00 } $385.00 total cost
2 days at GS-5, $50.00/day = $ 100.00

Estimated savings:

Estimated annual savings	= $1,040.00
Estimated savings on mineral information	= $ 500.00
TOTAL	= $1,540.00

The above total can be added to the intangible benefits of having a mineral information on tap that is not available now and the efficiency of being able to handle information requests being increased tenfold. This would allow the Forest Supervisor to have information with as short as one day turnaround time if necessary.

Another benefit will be in the acquisition system. North Carolina will be able to provide accurate information to proponents based on North Carolina rather than national averages. Attached are examples of information sorting that the system is capable of generating. The average cost is $1.00 per request.

Changes and Refinements

The following changes are needed in the system after use and experimentation: case name (last name to be equated with tract number); mineral outstanding to be refined; acreage information to be refined to include disposed acreage in exchanges. To use the system for ROW acquisition information, the system would have to be changed and redesigned; however, this much needed data base could be used in basically the same way. However, road name, number, length, width, and acreage would have to be added to the data base.

Forest Financing

The initial cost of the system would be financed from the Acquisition and Minerals Fund with update and maintenance to come from the same fund.

A DATA BASE SYSTEM FOR AUTOMATIC DATA PROCESSING EQUIPMENT INVENTORY

Margaret Stephens
U.S. Forest Service
Atlanta, Georgia

Objective

To create and develop a computerized data base in System 2000 for the Automatic Data Processing Equipment (ADPE) Inventory.

Methodology

Using information gathered from Region 8 and State and Private Forestry's latest computer generated ADP/MIS (Automatic Data Processing Management Information System) reports, I wrote a general description of the ADPE Hardware Inventory Subsystem. For this subsystem, I designed data and definition trees, keeping in mind the convenience of future users (see Figure 1).

The information from the reports was then coded on specially prepared forms (see Figure 2) and keypunched on cards. Batch mode was chosen over demand because of cost and ease of handling. Cards were then loaded onto the system, and a printout retrieved, at which time we tested the program for reliability and versatility.

General Description

The computerized ADPE Inventory data base created for Region 8 and State and Private Forestry is a useful tool that has made possible the storage and easy access of ADPE data. Information concerning a certain machine is gathered, coded, and stored within the computer. Whenever the need arises, the information can be retrieved in some assimilated form

Figure 1

R8/SA ADPE Inventory Definition Tree

C1 1*Region Code

C100 (RG) Item

C101*Serial No
C102*Eq Cat
C103*Func Un#
C104*Trans Code
C105*Class Code
C106*Mach Mftr
C107*Type
C108*Model
C109*Supplr
C110*Acq
C111*Own or Lease
C112*Disp
C113*Maint
C114*Acq Date FG
C115*Acq Date FU
C116*Act Purchase Date FU
C117*FU Rel Dte
C118*PPrice
C119*MRental
C120*RMMaint
C121*FSS
C122*Economic Life
C123*Trans Dte

Abbreviations for the above are as follows:

C101-Serial Number
C102-Equipment Category
C103-Functional Unit Code
C104-Transaction Code
C106-Machine Manufacturer
C107-Machine Type
C109-Supplier
C110-Acquisition Code
C112-Disposal
C113-Mainenance Code
C114-Acquisition Code Federal Government
C115-Acquisition Code Functional Unit
C116-Actual Purchase Date Function Unit
C117-Functional Unit Release Date
C118-Purchase Price
C119-Monthly Rental
C120-Recurring Monthly Maintenance
C121-Federal Supply Schedule Procurement Code
C123-Transaction Date

Figure 2

REGION 8 or S&PF/SA ADPE INVENTORY

Form Used For Keypunching ADPE Inventory For Additions, Deletions, or Other Changes.

	1*08*100* (or) 1*41*100*
Serial Number	101*_ _ _ _ _ _*
Equip. Category	102*_ _ _ _*
Functional Unit	103*_ _*
Transaction Code	104*_*
Class Code	105*_ _*
Machine Manufacturer	106*_ _ _*
Type	107*_ _ _ _ _*
Model	108*_ _ _*
Supplier (if leased)	109*_ _ _*
Acquisition Code	110*_*
Owned or Leased	111*_*
Disposition Code	112*_*
Maintenance Code	113*_*
Gov't Acq. Date	114*_ _/_ _*
Unit Acq. Date	115*_ _/_ _*
Purchase Date	116*_ _/_ _*
Unit Release Date	117*_ _/_ _*
Purchase Price	118*_ _ _ _ _ _ _ _ _*
Monthly Rental	119*_ _ _ _ _ _ _*
Recurring Mnth Maint	120*_ _ _ _ _ _ _*
FSS Procurement Code	121*_*
Economic Life	122*_*
Transaction Prep Date	123*_ _/_ _/_ _ _ _
	END*

that will be useful to computer science managers, the resource planner or to any other concerned parties (see Appendix I).

This subsystem is derived from the existing major federal ADP Inventory Management Data System. It is based on a set of federal agency reports which feed the computer-based ADPE inventory management bank maintained by the Automated Data and Telecommunications Service (GSA) for the use of all federal agencies (see Appendix II). The computer science ADP/MIS coordinator has been responsible for this required reporting since June 1971, for Region 8 and State and Private Forestry. The advantages of the new data file is that the data can be easily stored and updated; retrieval time for information is drastically reduced; and records are easily combined for specialized reporting.

Plans are being made to expand this subsystem, to cover the comprehensive A-11 data requirements, thus making it a complete system geared to contain automatic data processing related utilization, system functions, manpower, man hours, and cost data such as telecommunications costs.

Appendix I.

Sample Output

REPORT 5 U S FOREST SERVICE ADP MANAGEMENT INFORMATION SYSTEM REPORT AS OF 9-30-78

** TERMINAL INVENTORY ** REPORTED BY: REGION 8 ATLANTA GEORGIA ADP UNIT NO: 1108

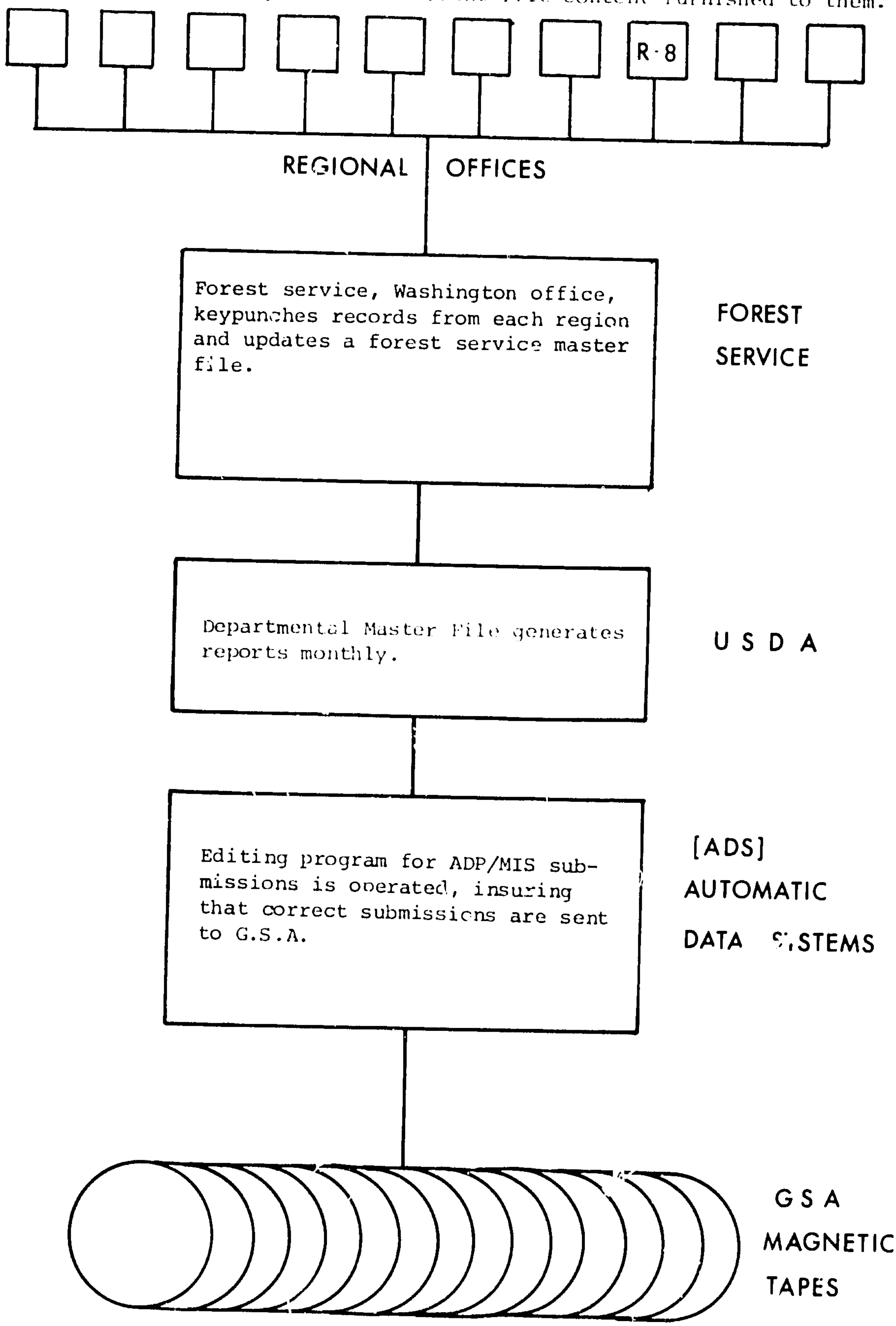
= MA CARD = TRANSACTION PREPARATION DATE: 78-09

(1-2) (77-80)

T C	SYS ID NUM	CLASS CODE	MFR	TYPE	MODEL	SERIAL NO	SUB-UNIT	SUPPLR (LEASE)	ACQ CODE	OWN CODE	DISP CODE	MAINT CODE	GOVT ACQ YR-MO	UNIT ACQ YR-MO	PURCH DATE YR-MO	ACT RELSE YR-MO	PURCH PRICE	BASIC MONTHLY RENTAL	RECURR MONTHLY MAINT	FSS PRO CODE
3	11-12	13-14	15-17	18-22	23-25	26-31	32-33	34-36	37	38	39	40	41-44	45-46	49-52	53-56	57-63	64-69	70-74	75
1	Y4	20	DTA	303	78	493	33		3	4		2	7310	7310			5746	129		0
1	Y4	28	DTA	409	78	8340	33		3	4		2	7310	7310			29484	823		C
1	Y4	56	DTA	702	78	1681	33		3	4		2	7310	7310			3213	29		0
1	Y4	02	DTA	8202	78	2113	33		3	4		2	7310	7310			5859	142		0
1	Y4	31	DTA	8711	78	764	33		3	4		2	7310	7310			2268	56		C
2 (1)	Y3	54	CDE	1132	P	30975	(33) 01		3	4		1	7612	7612			3365	129		F
1	[illegible]	54	COT	[illegible]	P	N 1274	33		3	1		1	7812	7812	7812		3932			[illegible]
1	Y3	56	CDE	3600		6070	33		3	4		1	7610	7610			1250	54		F
2 (1)	Y3	55	ICL	1502		175033	33		3	4		3	7708	7708			17040	(355) 326		F
2 (1)	Y3	28	ICL	15515		110267	33		3	4		3	7708	7708			11760	(245) 239		F
1	Y3	54	INY	STERM		780884	33		3	1		3	7709	7709	7706		1895			F
1	Y8	20	UNI	2009	1	679	33		3	1		1	6404	6404	6410		17600		150	F
1	Y9	33	UNI	2010	94	1387	33		3	1		1	6404	6404	6410		72600		370	F
1	YC	54	CDE	1030		75817	33		3	1		3	7606	7606	7408		1500			0
1	YI	54	DEC	LA36		06135	33		3	1		3	7502	7502	7502		1925			0
1	YK	54	DEC	LA36		05467	33		3	1		3	7505	7505	7505		1925			0
1	YN	54	COT	320C	300	50827	33		3	1		3	7408	7408	7408		2878			0
1	YP	54	COT	320C	300	50847	33		3	1		3	7408	7408	7408		2878			0.

Appendix II. ADP/MIS Information Reporting System.

Each region establishes new ADP equipment records and updates the computer generated reports from current file content furnished to them.



GSA ADPE Inventory Data Base, as prescribed by FMC 74-2

PART II

SAMPLING, STATISTICS AND SIMULATION

AN ANALYSIS OF PLANTING DATA FOR FISCAL YEAR 1979

Bruce L. Baldwin
Y-LT Flood Prevention Project
U.S. Forest Service
Oxford, Mississippi

Problem Statement

For the past three years prior to 1979, the Y-LT had experienced severe mortality of pine seedlings. The mortality was attributed to unfavorable weather conditions during the November to April planting season followed by severe drought in July and August.

In FY-1979, the weather pattern changed. Temperatures remained moderate and sufficient precipitation occurred often enough to keep the planting sites moist throughout the planting season.

It was felt that with ideal weather conditions, 1979 mortality should be minimal. As the planting season drew to a close, reports began to come in of tree mortality which exceeded expectations.

Objectives

In the absence of temperature extremes and drought, identify those factors which influence mortality and rank them in order of importance. Also identify those factors that are significant and those which should be disregarded.

Methodology

An assignment was given to the field offices to measures survival-mortality on each farm which had been planted during FY-1979. A sample of 10 plots was to be taken on each farm. In cases where one farm had received trees from more than one shipment (a rare occurance), 10 plots were taken in each shipment area.

The following historical information on independent variables was determined for each series of 10 plots (farm or portion of farm planted):

1. Species planted.
2. Nursery which grew and packaged the seedlings.
3. Shipment number.
4. Administrative unit which planted the trees.
5. Maximum ambient temperature on the date shipped.
6. Temperature in the pine bales at point of delivery.
7. Number of days from receipt of trees until they were planted.
8. Shipping distance from the nursery.
9. Quality control measurements from the week the trees were planted.
10. Maximum and minimum temperature during planting.

Usable information was obtained for a total of 212 cases. Each case represented a mean of 10 sample plots.

A sample of forty of the 212 cases was used to test curve fits of independent variables against the dependent variable, mortality. This was done with a programmable hand calculator. There was no significant difference in the R^2 for a linear, logarithmic, power or exponential curve fit.

After consulting with Ted Lacher, Regional Office, and Lew Purcell, Batesville Unit, it was decided to use SPSS to construct a correlation matrix and a stepwise linear regression of the above variables. Two additional variables were constructed by multiplying the shipping distance by the ambient haul temperature and the bale temperature respectively. A dependent variable, mortality, was constructed by subtracting the survival rate from 100%.

Implementation

An SPSS run of all 212 cases was run on the Ole Miss Dec 10 computer in Oxford, Mississippi. Nonscaled variables such as species, administrative unit, and nursery were treated as dummy variables and mixed with scaled variables such as temperature or distance.

This initial run proved discouraging since only 12.3% of the variation in mortality was accounted for by some 20 variables.

The raw data was placed on file in the Fort Collins computer and a second run was made. This time cases of mortality greater than 70% were excluded since many of these were disasters related to random acts of man and nature such as fires, floods, grazing, etc. Nonscaled variables were cross tabulated. Slash pine composed 39.4% of the sample. A significant difference was found between slash pine mortality and loblolly mortality.

TABLE I

Variable	Number of Cases	Mean	Standard Deviation	Standard Error	F Value	2 Tail Prob.
Slash Pine	80	20.80	18.11	2.025	1.76	
Loblolly Pine	123	12.37	13.66	1.232		

Variable	Pooled T Value	Variance Degrees of Freedom	Est. 2 Tail Prob.	Separate T Value	Variance Degrees of Freedom	Est. 2 Tail Prob.
Slash Pine	3.77	2.01	.000	3.56	136.21	.001
Loblolly Pine						

Since the loblolly pine showed exceptional survival, it was decided to limit the study to slash pine. The final run analyzed slash pine for each administrative unit. Since all the slash pine came from the same nursery in Florida, all variables such as nursery and distance were dropped. The variables remaining were: mortality, delay from shipment to planting, minimum temperatures during planting, maximum temperature during planting, temperature in bales at time of delivery, and maximum temperature on date hauled.

A step-wise regression was used to pick the most important variables which contributed to mortality by administrative unit. Only two administrative units produced prediction equations which were significant at the 95% level of probability.

TABLE II

Lexington Unit

Variable	B	F	DF	F	Confidence Level
Days Lag	.887	9.99	2	7.81	99.7
Min. Planting Temp.	.477	5.70	25		
(Constant)	-6.328				

Note the additional variables: maximum planting temperature, bale temperature and temperature on date hauled were significant at the 95% level of confidence. They were ignored for the prediction equation because they added 1% or less to the R square value.

Multiple R	.62
R Square	.38
Adjusted R Square	.33
Standard Error	15.54

TABLE III

Holly Springs Unit

Variable	B	F	DF	F	Confidence Level
Maximum Planting Temp.	-1.037	8.762	2	4.59	97.34
Bale Temp.	- .947	3.564	16		
(Constant)	140.778				

Additional variables were not significant.

Multiple R	.603
R Square	.364
Adjusted R Square	.285
Standard Error	14.812

Prediction equations for other administrative units were not significant.

Summary Statement

The major finding of this study was that slash pine transported from Florida to Mississippi showed 8.4% poorer survival than loblolly pine from Mississippi, Alabama, Tennessee or North Carolina.

Based on analysis of slash pine planted on the southern-most unit of the Y-LT Project, mortality was increased by approximately 1% for each day of delay from shipment arrival until the last tree was planted and 1% for each 2° rise in the minimum planting temperature during planting. These two factors accounted for approximately 38% of the variation in mortality.

A second analysis of slash pine planted on the northern-most unit of the Y-LT Project showed an increase of approximately 1% in mortality for each degree of decrease in the maximum planting temperature or bale temperature. These two factors accounted for approximately 36% of the variation in mortality.

These findings are logical and expected, except for the relationship of bale temperature on the northern unit.

AN ANALYSIS OF PLANTING DATA FOR FISCAL YEAR 1978

Tony Durkas
Chattahoochee-Oconee National Forest
Gainesville, Georgia

Each April, our districts report on the survival of seedlings planted the previous year. The districts are required to explain the cause of failure for any plantings that have a survival of less than sixty percent. Most often, the reasons given for failure are weather and work-force.

In reality, there are a myriad of variables that can and do affect seedling survival. However, for this project, I selected temperatures and work-force and the correlation they have with survival percent.

The data for this analysis consisted of observations on 113 individual planting sites on five Districts. Planting on most areas took more than one day to complete, therefore, an average low temperature for the period was used in the data. Days on which the temperature remained below 40° F were considered as "freezing." Weather records show only six days during the planting season where temperatures never rose above freezing and no planting was done on these days. The work-force was divided into Forest Service employees and contractors, each planting separate areas.

A regression analysis of the data run through STATJOB indicates there is no significant correlation between survival percent and work-force or temperature.

Although this project was not successful in identifying the factors that affect seedling survival, it is believed that with controlled conditions and greater detail, a successful analysis could be performed.

```
@STJ$. REGAN2MAPPED
                         MADISON ACADEMIC COMPUTING CENTER PROGRAM REGAN2

                                      DATA INPUT SUMMARY

     BEGINDATA*******

 ***** ELAPSED TIME RESET TO ZERO

 INPUT RECORD      1

  BEFORE TRANSFORMATION

    VAR.  NO.       1          2          3          4          5
    NAME     DISTRICT     AREA        TEMP      WFORCE      SPCT
     DATA        1.00        1.00       64.0       2.00       67.0

  AFTER TRANSFORMATION

    VAR.  NO.       1          2          3          4          5
    NAME     DISTRICT     AREA        TEMP      WFORCE      SPCT
     DATA        1.00        1.00       64.0       2.00       67.0

 LAST (   113TH) INPUT RECORD

  BEFORE TRANSFORMATION

    VAR.  NO.       1          2          3          4          5
    NAME     DISTRICT     AREA        TEMP      WFORCE      SPCT
     DATA        4.00        113.       71.0       2.00       45.0

  AFTER TRANSFORMATION

    VAR.  NO.       1          2          3          4          5
    NAME     DISTRICT     AREA        TEMP      WFORCE      SPCT
     DATA        4.00        113.       71.0       2.00       45.0

     ENDOFDATA*******

***** ELAPSED TIME AT END OF INPUT PHASE     0.-00   SEC.
```

Figure 1. Data Input Summary.

```
TJ*STJ. STJ

ERSION 10. 01
              MADISON ACADEMIC COMPUTING CENTER PROGRAM REGAN2

                                 LISTING OF CONTROL CARDS


              BEGINPROG*******REGAN2

              RUN  INPUT      *NVARS(5)

              RUN  I/FORMAT   *(F1. 0, F3. 0, F2. 0, F1. 0, F2. 0)

              RUN  VNAMES     *V1 IS DISTRICT, AREA, TEMP, WFORCE, SPCT

              RUN  TRANSFRM1 *NTVARS = 5,
              RUN  TRANSFRM2 *FOR (I=1,5) TV(I) = V(I)
                   1:   NTVARS = 5,
                   2:   FOR (I=1,5) TV(I) = V(I)


              RUN  MODEL1     *DEPVAR(5), INDEPVAR(1,3)

              RUN  MODEL2     *DEPVAR(5), INDEPVAR(3,4)


CONTROL CARD LISTING COMPLETE

              S U M M A R Y   O F   I N P U T   R E C O R D

                    INPUT RECORD CONSISTS OF    1 OBSERVATIONS OF
                                                5 VARIABLES ON
                                                1 LOGICAL RECORDS

           VARIABLE
```

NUMBER	NAME	FIELD TYPE	LOGICAL RECORD	COLUMNS	FORMAT
1	DISTRICT	NUMERIC	1	1 - 1	F1. 0
2	AREA	NUMERIC	1	2 - 4	F3. 0
3	TEMP	NUMERIC	1	5 - 6	F2. 0
4	WFORCE	NUMERIC	1	7 - 7	F1. 0
5	SPCT	NUMERIC	1	8 - 9	F2. 0

Figure 2. Listing of Control Cards.

C O R R E L A T I O N MATRIX

VARIABLE NO. NO. NAME	1 DISTRICT	2 AREA	3 TEMP	4 WFORCE	5 SPCT
1 DISTRICT	1.000				
2 AREA	.816	1.000			
3 TEMP	-.369	-.401	1.000		
4 WFORCE	.367	.386	-.386	1.000	
5 SPCT	-.094	-.086	.110	-.122	1.000

DESCRIPTIVE STATISTICS PACKAGE
UNBIASED ESTIMATES

VARIABLE NOS. NAMES	SUM	MEAN	STANDARD DEVIATION	VARIANCE	RELATIVE ERROR BOUND	MINIMUM	MAXIMUM
1 DISTRICT	.34200+003	.30265+001	.15380+001	.23654+001	.96192-15	.10000+001	.50000+001
2 AREA	.64410+004	.57000+002	.32764+002	.10735+004	.79460-15	.10000+001	.11300+003
3 TEMP	.64070+004	.56699+002	.13679+002	.18712+003	.35938-14	.32000+002	.78000+002
4 WFORCE	.18800+003	.16637+001	.47454+000	.22519+000	.26270-14	.10000+001	.20000+001
5 SPCT	.70080+004	.62018+002	.24190+002	.58514+003	.14960-14	.60000+001	.99000+002

NUMBER OF OBSERVATIONS 113.

***** ELAPSED TIME AT END OF OUTPUT OF BASIC STATISTICS 0.-00 SEC.

Figure 3. Correlation Matrix.

MADISON ACADEMIC COMPUTING CENTER PROGRAM REGAN2   79/08/27

B A S I C   R E G R E S S I O N   S T A T I S T I C S

STANDARD ERROR OF ESTIMATE................	24. 2191
MULTIPLE CORRELATION COEFFICIENT.........	. 1244
COEFFICIENT OF DETERMINATION...........	. 0155
CORRECTED COEFFICIENT OF DETERMINATION.	- 0024

VARIABLE	TYPE	REGRESSION COEFFICIENT	STD. ERROR OF REGRESSION COEFFICIENT	STANDARDIZED REGRESSION COEFFICIENT	PARTIAL CORRELATION COEFFICIENT	T-VALUE WITH 110 DEG. FREEDOM	PARTIAL F VALUE WITH 1 AND 110 DEG. FREEDOM	SIG LEVEL
5 SPCT	DEPENDENT							
	CONSTANT	56. 1388	13. 0109		380	4. 31476	18. 61711	0000
1 DISTRICT	INDEPENDENT	-. 9667	1 6009	-. 0615	-. 057	-. 60385	. 36464	547.
3 TEMP	INDEPENDENT	. 1553	. 1800	0878	. 082	86277	. 74437	[illegible]

A N A L Y S I S   O F   V A R I A N C E   S U M M A R Y   T A B L E

SOURCE OF VARIATION	SUM OF SQUARES	DEG. FREEDOM	MEAN SQUARE
LINEAR REGRESSION	1013. 86099	2	506. 93049
RESIDUALS FROM REGRESSION	64522. 10362	110	586. 56458
CORRECTED TOTAL	65535. 96460	112	

F-RATIO =   86 WITH   2 AND   110 DEG. FREEDOM
SIGNIFICANCE LEVEL OF F-RATIO =   4242

CORRECTION FOR MEAN	434620. 03540	1
UNCORRECTED TOTAL	500156. 00000	113

***** ELAPSED TIME AT END OF ANALYSIS OF THIS MODEL   0. -00   SEC.

Figure 4. Basic Regression Statistics.

MADISON ACADEMIC COMPUTING CENTER PROGRAM REGAN2

MODEL [illegible] PAGE [illegible]
DEPVAR 5 [illegible]

B A S I C   R E G R E S S I O N   S T A T I S T I C S

STANDARD ERROR OF ESTIMATE	24.1691
MULTIPLE CORRELATION COEFFICIENT.........	.1398
COEFFICIENT OF DETERMINATION	.0195
CORRECTED COEFFICIENT OF DETERMINATION ..	.0017

VARIABLE	TYPE	REGRESSION COEFFICIENT	STD ERROR OF REGRESSION COEFFICIENT	STANDARDIZED REGRESSION COEFFICIENT	PARTIAL CORRELATION COEFFICIENT	T-VALUE WITH 110 DEG FREEDOM	PARTIAL F VALUE WITH 1 AND 110 DEG FREEDOM	[illegible]
5 SPCT	DEPENDENT							
	CONSTANT	62.3971	15.9511		.349	3.91178	15.30205	[illegible]
3 TEMP	INDEPENDENT	.1321	.1810	.0747	.069	.72996	.53284	[illegible]
4 WFORCE	INDEPENDENT	-4.7296	5.2162	-.0928	-.086	-.90670	.82211	[illegible]

A N A L Y S I S   O F   V A R I A N C E   S U M M A R Y   T A B L E

SOURCE OF VARIATION	SUM OF SQUARES	DEG. FREEDOM	MEAN SQUARE
LINEAR REGRESSION	1280.20902	2	640.10451
RESIDUALS FROM REGRESSION	64255.75559	110	584.14323
CORRECTED TOTAL	65535.96460	112	

F-RATIO = 1.10 WITH 2 AND 110 DEG. FREEDOM
SIGNIFICANCE LEVEL OF F-RATIO = .3379

CORRECTION FOR MEAN	434620.03540	1
UNCORRECTED TOTAL	500156.00000	113

***** ELAPSED TIME AT END OF ANALYSIS OF THIS MODEL 0.00 SEC

END OF ANALYSIS

STATJOB TERMINATED BY END OF FILE ON INPUT STREAM

@FIN

Figure 4. Basic Regression Statistics. (continued)

INFORMATION ANALYSIS FOR SHORT-LEAF PINE MANAGEMENT

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Background Statement

Region 8 of the Forest Service has in the past relied mainly on empirical projections of timber yields often based upon the cut volumes derived from timber sales. The harvest volumes are based upon area control. Stocking levels have been taken from research data and are displayed as basal area guides based upon height, average stand diameter, and/or age and occasionally site index (see exhibits 1 and 2). Managed yield tables for different management regimes have not been extensively used by the Forest Service.

Presently there is a general lack of understanding or trust in the few existing computer programs for yield tables of southern pine. This is partly due to a lack of understanding of precisely what specifics are included in the program, or in other words, what "drives" the program. In addition, many of the programs are not readily available.

Presently programs do not cover all the major species managed on the National Forest and do not appear to give reasonable yields to the field users. Technical data for longer rotations to support management assumptions is often lacking, particularly for regimes such as fertilization and genetics. In addition, most present models are based upon pure stands which are not generally a reality in the field. This paper, though not dealing directly with this specific issue, should provide for recognition of "holes" in a stand. Exhibits 1 and 2 are examples of existing data. They do not reflect the effects of site or time other than indirectly. The tables

*-TABLE 3 - Pine Spacing Guide

Prevailing DBH (inches)	Number of Trees	Desired Spacing Between Leave Trees (Grid Centers) in Feet	BA*
6	300	12 x 12	60
7	220	14 x 14	60
8	200	15 x 15	70
9	170	16 x 16	80
10	150	17 x 17	80
11	120	19 x 19	80
12	110	20 x 20	90
14	90	22 x 22	100

These are guides only and may vary between Forests and sites.

*Rounded to nearest 10.

*-TABLE 4 - Leave Basal Area, All Trees 4" DBH and Over by Height.

Total Height	Southern Yellow Pine BA*
36 - 45	70
46 - 55	80
56 - 65	80
66 - 75	90
76 - 85	100
86 - 95	100
96 -105	100
106 -115	110
116 -125	110
126 -130	110

Adapted from Morriss, D. J., "Basal Area Thinning Guides for Thinning in South", Journal of Forestry, Vol. 56, No. 12. -*

*Rounded

are not directly tied to predicted growth rates or yields. Although prevailing diameter is tied to a recommended basal area, the recommended basal area can be obtained for a stand by several different arrangements of sizes. As such, it is difficult to measure the performance of a given stand against the predicted stand.

Several reviews and inspections, (including those by GAO, a National inservice review of reforestation, and TSI.5,6,) have indicated that Region 8 and the Forest Service as a whole needs to develop stocking level curves and managed yield tables. A National Task Force has recommended that minimum standards be developed for managed yield tables.

Problem Statement

This paper will develop and display a standard format for stocking level curves and managed yield tables that can be adapted for different species, management regimes and Forests or areas. The stocking level curve will reflect the management regime of the yield table. The shortleaf pine (*Pinus echinata*) will be used for this exercise.

Procedure

A review of some of the existing programs such as TIMHAB (Meyers), and Variable Density Yield Tables for Loblolly Pine Plantations (Meyers, Exhibit 5) indicate these programs do not include all the items needed for today's management. They do not display culmination of mean annual increment, or readily display how results are obtained. The Density Yield Tables may be modified but additional information concerning yield will have to be determined.

There are several technical reports for yield and stand tables for second growth southern pines and plantations (Meyers, 1977). However, these reports are for unmanaged or unthinned stands. Included in this group of reports are volume, yield, and stand tables for second growth Southern Pines and yields of unthinned Loblolly Pine plantations on cutover sites in the West Gulf Region (Fields, 1979). These reports are valuable as a basis against which to measure intensive management treatments. Other work in the same field is continuing at the University of Georgia, Southern Forest Experiment Station, Southeastern Forest Experiment Station and at other universities and Forest Stations. Other Regions and Stations of the Forest Service also have developed computer programs. An example of this is the paper, "Timber Harvest Scheduling with Multiple Decision Criteria" by Fields (1979).

Summary

A preliminary stocking level curve similar to Exhibit 3 has been developed for use in conjunction with managed yield tables similar to Exhibit 4. The stocking level curve displays as the recommended stocking level the managed levels in the yield table. The stocking level curve also displays a maximum stocking level beyond which one may expect a reduction in growth rates acceptable to management. In addition, a minimum acceptable stocking level is displayed to show at approximately what limit a decision needs to be made concerning the future management of a stand.

An age growth curve by site index is displayed at the bottom of the stocking level curve so that an estimate of tree size and growth rate by age and site can be made. Examples of managed yield tables for shortleaf pine are included; these tables are based upon individual tree data.

Work Remaining

As with most projects, much remains to be done to make this system operational. Some, but not necessarily all items, are noted below:

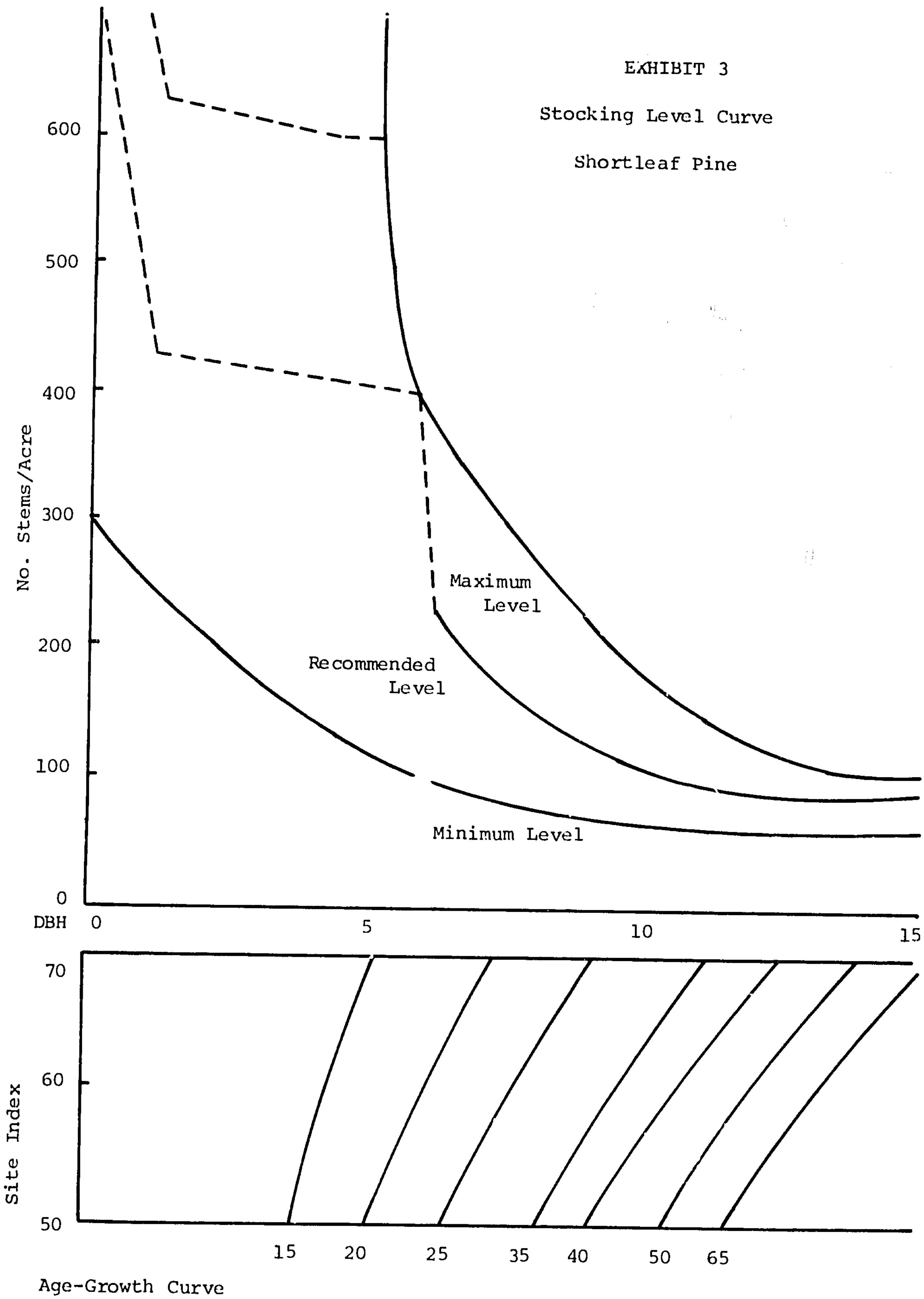
EXHIBIT 3
Stocking Level Curve
Shortleaf Pine
No. Stems/Acre
600
500
400
300
200
100
0
DBH
0
5
10
15
Maximum Level
Recommended Level
Minimum Level
Site Index
70
60
50
15
20
25
35
40
50
65
Age-Growth Curve

EXHIBIT 4

Species Shortleaf
Site 60
Rotation 70

Date 4/79

Managed Yield Table

Stand "Per Acre"								Harvest "Per Acre"					
					Stand Volume						"Cut" Volume		
Stand age	# of trees	Basal area	Avg. DBH	Stand ht.	PT CCF	ST CCF	ST MBFSCR	# of trees	Basal area	Avg. DBH	PT CCF	ST CCF	ST MBFSCR
15	60	74	4.8	-	-	-	-	-	-	-	-	-	-
20*	600	110	5.8	30	12.4	-	-	-	-	-	-	-	-
20**	249	60	6.6	30	6.8	-	-	351	50	5.1	5.6	-	-
25*	249	89	8.1	36	8.1	4.5	1.7	-	-	-	-	-	-
25**	178	70	8.5	36	5.4	4.5	1.7	71	19	7.0	2.7	-	-
35	178	108	10.5	47	-	20.6	9.4	-	-	-	-	-	-
40*	178	120	11.1	52	-	25.6	12.1	-	-	-	-	-	-
40**	103	80	11.9	52	-	16.9	8.4	75	40	9.9	-	8.7	3.7
50	103	98	13.2	60	-	24.4	12.7	-	-	-	-	-	-
65*	103	119	14.6	69	-	35.3	18.5	-	-	-	-	-	-
65**	-	-	-	-	-	-	-	103	119	14.6	-	35.3	18.5
								TOTALS			8.3	40.0	22.2

* before "cut"
** after "cut"

EXHIBIT 5

Yields per Acre of Stand Number
Loblolly Pine Plantation

Site Index 65
Residual Basal Area:
Initial 68
Subsequent 68

Swampy Compartment of the Piney Woods Tract, Inventories 1976

Characteristics of Standing Trees								Periodic Reductions				
Stand Age (Yrs.)	Trees No.	Basal Area Sq. Ft.	Avg. DBH In.	Avg. Ht. Ft.	Vol. Cu. ft.	Vol. Cords	Vol. Bd.Ft.	Trees No.	Basal Area Sq. Ft.	Vol. Cu. Ft.	Vol. Cords	Vol. Bd. Ft.
20	490	139	9.2	50	2020	26.5	2500					
20	235	68	7.0	30	1010	13.2	1000	235	71	1010	13.3	1500
25	251	92	8.2	54	1580	20.7	4000					
25	167	68	8.7	54	1200	15.8	3500	84	24	380	4.9	500
30	165	88	9.9	63	1850	24.3	7300					
30	117	68	10.3	63	1450	19.0	6100	48	20	400	5.3	1200
35	116	84	11.6	70	2040	26.8	9900					
35	88	68	11.9	71	1670	21.9	8300	28	16	370	4.8	1600
40	87	83	13.2	77	2210	29.0	12000					
40	68	68	13.5	77	1830	24.0	10100	19	15	380	5.0	1000
45	68	81	14.8	82	2320	30.4	13400					
45	55	68	15.1	82	1980	26.0	11500	13	13	340	4.4	1900
50	55	80	16.3	86	2430	31.8	14500					
					Total Yields					5310	69.5	22600

* Meyers, "A Computer Program for Variable Density Yield Tables for Loblolly Pine Plantations"

Cord and Board-foot volume included in cubic volume; board-foot volume included in cords. Minimum cuts for inclusion in total yields: 229, cubic feet and 1000, board feet.

- The data for the managed yield table will need to be field verified as representative of existing stands.
- Additional data will have to be reviewed for the development of other management regimes.
- Volume equations for different management regimes will need to be developed to be included either in a new Region 8 managed yield table computer program or to modify existing programs.
- Existing programs would need to be modified to meet agreed upon national minimum standards.
- The stocking level curve will need an illustrated explanation on its use and some refinement.
- Additional growth data will need to be reviewed to check age growth relationships.

References

Feduccia, D.P., T.R. Dell, W.F. Maner, Jr., T.E. Campbell, and B.H. Polmer. 1979. "Yields of Unthinned Loblolly Pine Plantations on Cutover Sites in the West Gulf Region." U.S. Department of Agriculture Forest Service Research Paper SO-048.

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GAO. 1978. "Need to Concentrate Intensive Timber Management on High Productive Lands." Report to the Congress by the Comptroller General of the United States.

Meyers, Clifford A. 1977. "Simulating Timber and Deer Food Potential in Loblolly Pine Plantations." U.S. Department of Agriculture, Forest Service General Technical Report SO-12.

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Smith, E.A. 1979. "Managed Yield Table for Ouachita Shortleaf Pine." U.S. Forest Service, unpublished.

AN ANALYSIS OF TIMBER SALE WATER QUALITY DATA

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Introduction

This is a simple example of the analysis of water quality data from the Bee Gum Gap Timber Sale on the Chattahoochee National Forest. Two computer programs were used, S.T.O.R.E.T. and SPSS.

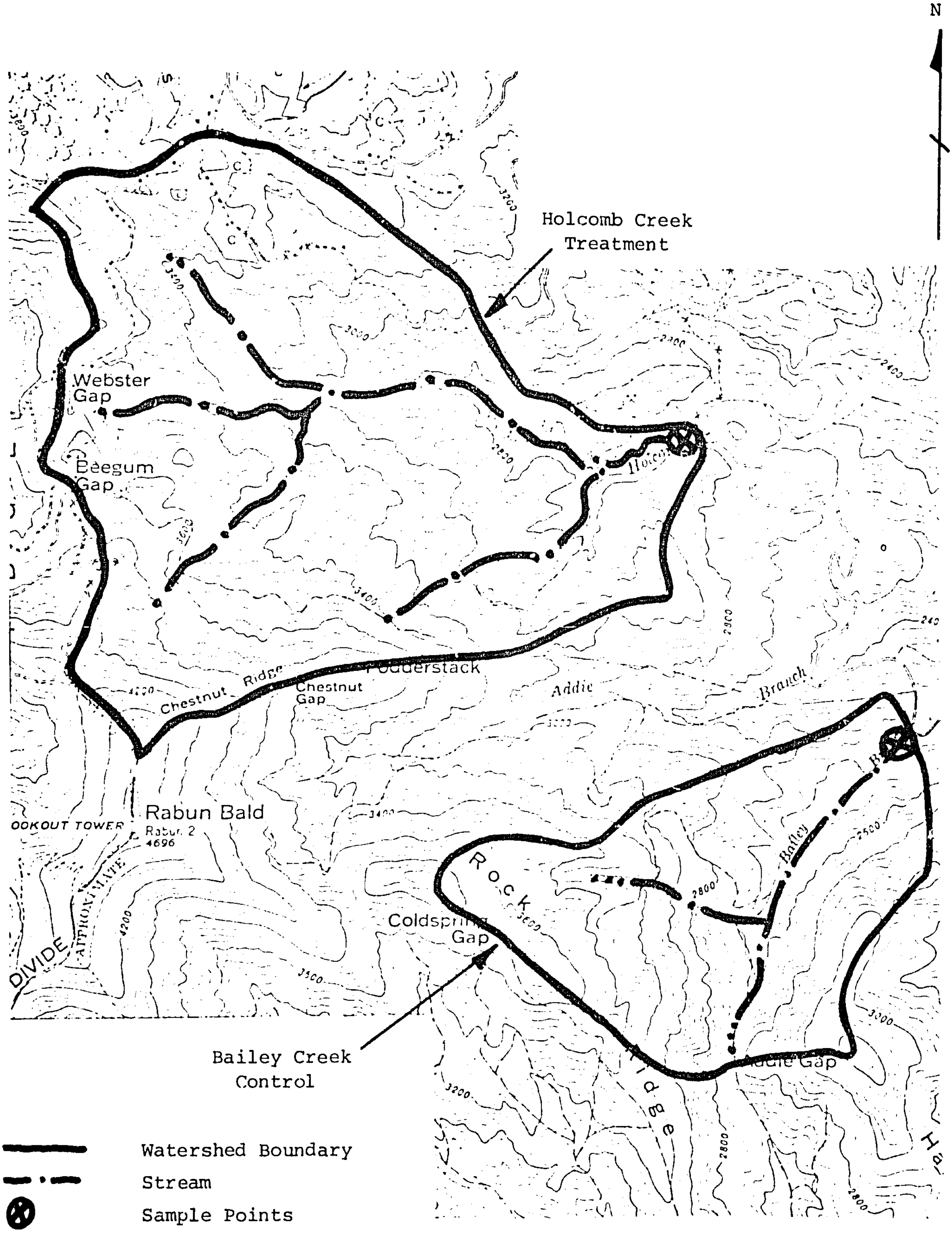
Statement of the Problem

The Bee Gum Gap Timber Sale took place in the Holcomb Creek Watershed, located in Rabun County, Georgia. This watershed is in the extreme northeast corner of the state, and is on the slopes of Rabun Bald, the second highest peak in Georgia (see Map 1). Concern is often expressed that timber cutting and road building lower water quality through erosion and subsequent sedimentation of stream waters.

A water quality monitoring program was initiated to monitor the quality of water leaving the timber sale area using the paired watershed method. Holcomb Creek was the treatment watershed, while Bailey Creek, a similar but uncut watershed, was used as the control. Water samples were taken twice monthly, once at base flow and once during a storm, at the mouth of each watershed during the life of the sale. (However, data used in this example are hypothetical, created for this problem.)

This water quality data was analyzed with the help of two computer program packages available for use at the Supervisor's Office. S.T.O.R.E.T. is a Storage and Retrieval program for water information, and is administered through the Environmental Protection Agency in Washington, D.C. Water

Map 1 Location of Holcomb Creek and Bailey Creek, Bee Gum Gap Timber Sale, Tallulah Ranger District, Chattahoochee National Forest, Georgia.



Scale = 1=24000
Contour Interval = 40 feet
Rabun Bald Quadrangle Sheet

quality and quantity data are stored in the system, then can be retrieved and manipulated following storage. Data is stored by individual sample sites. Once stored, data can be analyzed for only one station, or data at several stations can be compared and analyzed at one time. In this example, S.T.O.R.E.T. was used to store the basic data, then to do some simple statistical work using one retrieval mode. This was done for both watersheds.

The second package used was SPSS, the Statistical Package for the Social Sciences. In this example, SPSS was used to compare several water quality parameters and print scattergrams of this data. To save time and needless repetition, only the Bailey Creek data was used in the SPSS analysis.

The remainder of this paper will deal with the tables that follow, giving brief explanations of each table and what each means.

S.T.O.R.E.T.

Each station in the S.T.O.R.E.T. system has a unique Station Code. All data for that station is stored by using this 6-digit code, and all retrieval and analysis of data begin with this code.

Tables 1 and 2 are Station Description Information Tables, and were constructed when the Stations were first established. These tables are printed with each retrieval for the respective station, unless suppressed by using special commands during the retrieval. The information in the upper right corner of the description sheet has the S.T.O.R.E.T. code, latitude and longitude, the station name, state codes, river basin names and codes, depth of the sample, and other information. The upper left hand corner shows that all data is taken from streams in ambient conditions.

Table 1 - Station Description Information, Holcomb Creek

STORET RETRIEVAL DATE 79/09/05

030504 031001000104 0901100104
34 58 50.0 083 16 25.0 2
BEE GUM GAP1 HOLCOMB CR
13241 GEORGIA
SAVANNAH R
W CHATTOOGA R
1118ATLB 760827
0000 FEET DEPTH CLASS 00

/TYPA/AMBNT/STREAM

DESCRIPTION

BEE GUM GAP STA 1,TALLULAH RANGER DISTRICT,MONITORS TIMBER HARVESTING IN THE HOLCOMB CR WATERSHED,SAMPLES ARE COLLECTED SEMIMONTHLY,ONCE AFTER RAINFALL

Table 2 - Station Description Information, Bailey Creek

STORET RETRIEVAL DATE 79/09/05

/TYPA/AMBNT/STREAM

030505 031001000105 0900100105
34 58 15.0 083 16 06.0 2
BEE GUM GAP2 BAILEY BR CONTROL
13241 GEORGIA
SAVANNAH R
- CHATTOOGA R
11IMATLB 760827
0000 FEET DEPTH CLASS 00

DESCRIPTION

BEE GUM GAP STA 2,TALLULAH RANGER DISTRICT,MONITORS BAILEY BR AS A
CONTROL FOR 030504,SAMPLES ARE COLLECTED SEMIMONTHLY,ONCE AFTER RAINFALL

The descriptive paragraph in the center of the page gives the station name, the Ranger District name, what purpose the monitoring serves, frequency of sampling, and other special conditions or information. This paragraph is of a free form format, and may also contain what parameters are being sampled, who is responsible for the data, and any other relevant information. If properly constructed, the descriptive paragraph will give an unfamiliar data retriever a brief but concise explanation of the station.

Tables 3 and 4 are the result of the retrieval commands printed in the lower central portion of the page. PGM=RET gives a printout of all data stored for that station. This program sorts the data and prints it in time sequence, from earliest to latest sample taken. Dates are given in a year/month/day mode, so that 76/02/01 indicates February 1, 1976. The four parameters sampled were: 00061-Stream Flow in cubic feet per second (CFS); 00065-Stream Stage, or the depth of water in inches; 00070-Turbidity measured in Jackson Turbidity Units (JTU's), a measure of cloudiness of the water; and 00095-Specific Conductivity, measured in Micromhos per square centimeter, what amount of foreign matter is present in the water sampled. BD=760101, ED=761015 lists Beginning and Ending Dates for the project. PRT=BOTH asks for a printout of the data given here as well as the Descriptive paragraph from Tables 1 and 2. RMT=72 instructs the computer to route the printout to a remote, high speed printer.

Tables 5 and 6 are the result of the retrieval command PGM=INVENT. It provides a brief summary table for all parameters listed for that station and a few basic statistics computed from the data stored for each parameter. During the specified beginning and ending dates, note that twenty samples were taken at Bailey Creek, and nineteen at Holcomb Creek. This is confirmed by Tables 3 and 4, as no sample is listed as taken for February 1, 1976.

Table 3 - Data Stored for Holcomb Creek

```
STORET RETRIEVAL DATE 79/09/05
                                         030504                                    031001000104 0901100104
                                         34 58 50.0 083 16 25.0 2
                                         BEE GUM GAP1 HOLCOMB CR
                                         13241   GEORGIA
                                         SAVANNAH R
                                         W CHATTOOGA R
/TYPA/AMBNT/STREAM                       1118ATL8  760827
                                          0000 FEET  DEPTH  CLASS 00
```

DATE FROM TO	TIME OF DAY	DEPTH FEET	00061 STREAM FLOW, INST-CFS	00065 STREAM STAGE FEET	00070 TURB JKSN JTU	00095 CNDUCTVY AT 25C MICROMHO
76/01/01			25	2.1	12.0	13
76/01/15			55	4.2	70.0	45
76/02/15			67	5.0	110.0	80
76/03/01			49	3.9	58.0	37
76/03/15			18	1.8	9.0	8
76/04/01			70	5.3	126.0	72
76/04/15			13	1.5	7.0	6
76/05/01			28	2.5	19.0	14
76/05/15			37	3.2	29.0	23
76/06/01			34	2.9	24.0	19
76/06/15			53	4.1	64.0	44
76/07/01			67	4.8	93.0	67
76/07/15			50	3.9	54.0	36
76/08/01			27	2.3	17.0	14
76/08/15			31	2.7	21.0	18
76/09/01			17	1.9	10.0	10
76/09/15			26	2.5	24.0	16
76/10/01			57	4.3	80.0	51
76/10/15			53	4.0	66.0	57

```
PGM=RET,
PURP=305/USFS,A=1118ATL8,
S=030504,S=030505,
P=61,P=65,P=70,P=95,
BD=760101,ED=761016,
PRT=BOTH,RMT=72,
./EPACHA   JOB (A320,MCHA,,STORET,B),MSGCLASS=P,TIME=5
**JOBPARM LINES=10
```

Table 4 - Data Stored for Bailey Creek

```
STORET RETRIEVAL DATE 79/09/05
```

```
 030505                                        031001000105 090010n105
34 58 15.0 083 16 06.0 2
HEE GUM GAP2 BAILEY BR CONTROL
13241   GEORGIA
SAVANNAH R
W CHATTOOGA R
1118ATLB  760827
 0000 FEET  DEPTH  CLASS 00
```

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	00061 STREAM FLOW, INST-CFS	00065 STREAM STAGE FEET	00070 TURB JKSN JTU	00095 CNDUCTVY AT 25C MICROMHO
76/01/01			17	1.9	4.0	4
76/01/15			40	4.1	17.0	.4
76/02/01			37	3.6	12.0	11
76/02/15			47	4.8	24.0	14
76/03/01			37	3.7	13.0	10
76/03/15			15	1.6	3.0	3
76/04/01			50	5.0	18.0	17
76/04/15			13	1.2	2.0	2
76/05/01			20	2.1	7.0	6
76/05/15			32	3.0	12.0	9
76/06/01			25	2.7	8.0	6
76/06/15			38	3.9	15.0	12
76/07/01			44	4.5	20.0	15
76/07/15			34	3.6	14.0	11
76/08/01			21	2.0	6.0	6
76/08/15			26	2.5	7.0	7
76/09/01			12	1.4	4.0	3
76/09/15			25	2.3	6.0	7
76/10/01			40	4.1	18.0	14
76/10/15			36	3.7	14.0	12

```
PGM=RET,
PURP=305/USFS,A=1118ATLB,
S=030504,S=030505,
P=61,P=65,P=70,P=95,
BD=760101,ED=761016,
PRT=BOTH,RMT=72,
./EPACHA   JOB (A320,MCHA,,STORET,B),MSGCLASS=P,TIME=5
**JOBPARM LINES=10
```

Table 5 - Basic Statistics for Holcomb Creek

```
STORET  DATE 79/09/05
                                                    030504                    031001000104 0901100104
                                                    34 58 50.0 083 16 25.0  2
                                                    HEE GUM GAP1 HOLCOMB CR
                                                    13241 GEORGIA
                                                    SAVANNAH R
                                                    W CHATTOOGA R
/TYPA/AMBNT/STREAM                                  1118ATL8  760827
                                                     0000  CLASS 00
```

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00061 STREAM	FLOW,	INST-CFS	19	40.6947	332.100	18.2235	.445623	4.18078	70.0000	15.0000	76/01/01	76/10/15
00065 STREAM	STAGE	FEET	19	3.31052	1.36102	1.16663	.352400	.267643	5.50000	1.50000	76/01/01	76/10/15
00070 TURB	JKSN	JTU	19	47.0000	1341.33	36.6242	.779234	8.40217	120.000	7.00000	76/01/01	76/10/15
00095 CNDUCTVY	AT 25C	MICROMHO	19	33.1579	549.475	23.4409	.706947	5.37770	80.0000	6.00000	76/01/01	76/10/15

```
PGM=INVENT,PURP=208/USFS,
A=1118ATL8,
S=030504,S=030505,
P=61,P=65,P=70,P=95,
BD=760101,,ED=761016,
PRT=BOTH,RMT=72,
,/EPACHA   JOB (4320,MCHA,,STORET,8),MSGCLASS=P,TIME=5
**JOBPARM LINES=10
```

Table 6 - Basic Statistics for Bailey Creek

```
STORET  DATE 79/09/05

                                  030505
                                  34 58 15.0 083 16 06.0  2        031001000105 0900100105
                                  BFE GUM GAP2 BAILEY BR CONTROL
                                  13241 GEORGIA
                                  SAVANNAH R
/TYPA/AMBNT/STREAM                W CHATTOOGA R
                                  1118ATLB  760827
                                  0000  CLASS 00
```

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00061 STREAM	FLOW,	INST-CFS	20	30.4500	134.366	11.5917	.380678	2.59197	50.0000	12.0000	76/01/01	76/10/15
00065 STREAM	STAGE	FEET	20	3.08500	1.36242	1.16723	.378356	.261000	5.00000	1.20000	76/01/01	76/10/15
00070 TURB	JKSN	JTU	20	11.2000	39.8526	6.31289	.563651	1.41161	24.0000	2.00000	76/01/01	76/10/15
00095 CNDUCTVY	AT 25C	MICROMHO	20	9.15000	20.1342	4.48712	.490395	1.00335	17.0000	2.00000	76/01/01	76/10/15

```
PGM=INVENT,PURP=208/USFS,
A=1118ATLB,
S=030504,S=030505,
P=61,P=65,P=70,P=95,
BD=760101,,ED=761016,
PRT=BOTH,RMT=72,
./EPACHA   JOB (A320,MCHA,,STORET,B),'SGCLASS=P,TIME=5
**JOBPARM LINES=10
```

Statistics computed in PGM=INVENT are Mean, Variance, Standard Deviation, Coefficient of Variation, and Standard Error. Also shown are Maximum and Minimum values. These statistics provide a means of comparison between the treatment and control watersheds. Holcomb Creek drains a substantially larger area than does Bailey Creek. This would imply that Holcomb Creek is larger than Bailey Creek; the data bears this out. Both the Flow and Stage of Holcomb Creek are larger than we find at Bailey Creek, as expected. However, both Turbidity and Conductivity at Holcomb are much larger than at Bailey Creek. The water coming from the treated (cut) watershed is cloudier and contains more particles on a per-unit basis than that coming from the control (uncut) watershed, probably because of timber harvesting in the Holcomb Creek watershed.

SPSS

To find the correlation between data gathered for various parameters at the Bailey Creek Station, the data was taken from the S.T.O.R.E.T. files, coded for use on SPSS, and analyzed on that system via the Fort Collins Computer Center.

Table 7 shows the set-up and format used to analyze the Bailey Creek data. All four parameters were used, Stage requiring three columns, and Flow, Turbidity, and Conductivity using two each. It also notes the need for scattergrams for three comparisons of parameters: Flow with Stage; Turbidity with Stage; and Turbidity with Conductivity.

Tables 8, 9, and 10 are three scattergrams and accompanying correlation statistics, giving a more complete picture of the uncut watershed of Bailey Creek. The 'across' parameters are X-axis or independent variables; the 'down' parameters Y-axis or dependent variables. All three comparisons in these tables are very highly correlated, with all correlations (R)

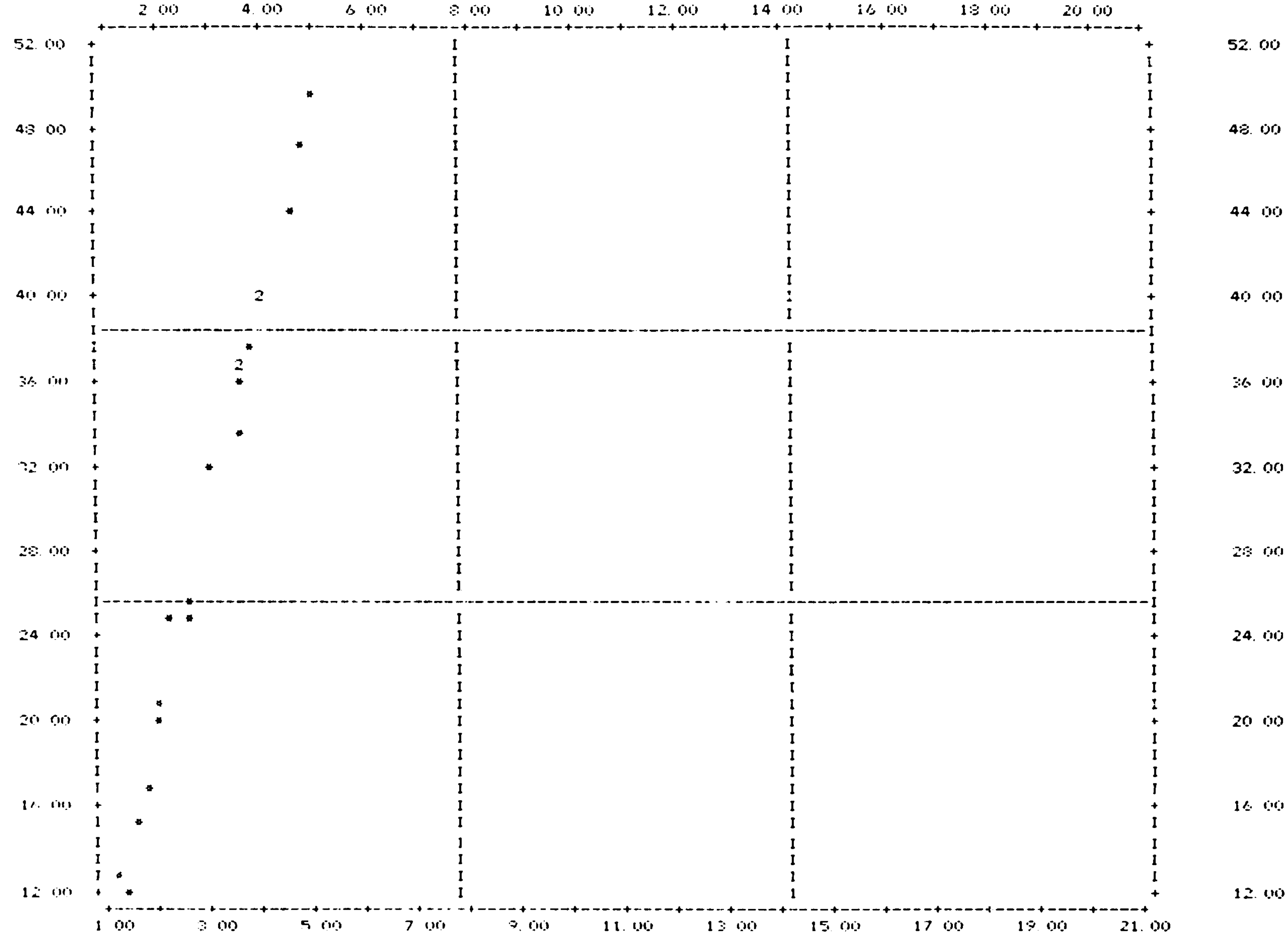
Table 7 - Set-up of run on SPSS for Correlations and Scattergrams

```
STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES                              09/19/79         PAGE    1

SPSS FOR SPERRY UNIVAC 1100 EXEC 8, VERSION H, RELEASE 7.2-UW1.0, SEPTEMBER 1978

SPACE ALLOCATION                 ALLOWS FOR        37 TRANSFORMATIONS
WORKSPACE       7875 WORDS                        150 RECODE VALUES + LAG VARIABLES
TRANSPACE       1125 WORDS                        300 IF/COMPUTE OPERATIONS

                    RUN NAME        BAILEY CREEK CONTROL
                    VARIABLE LIST   STAGE,FLOW,TURB,CONDUCT
                    INPUT MEDIUM    TAPE
                    N OF CASES      20
                    INPUT FORMAT    FIXED (F3.0,F2.0,F2.0,F2.0)

                   ACCORDING TO YOUR INPUT FORMAT, VARIABLES ARE TO BE READ AS FOLLOWS

                   VARIABLE  FORMAT  RECORD    COLUMNS

                   STAGE     F 3. 0     1       1-  3
                   FLOW      F 2. 0     1       4-  5
                   TURB      F 2. 0     1       6-  7
                   CONDUCT   F 2. 0     1       8-  9

THE INPUT FORMAT PROVIDES FOR   4 VARIABLES     4 WILL BE READ
IT PROVIDES FOR  1 RECORDS ('CARDS') PER CASE   A MAXIMUM OF    9 'COLUMNS' ARE USED ON A RECORD.

                    VAR LABELS      STAGE,STAGE IN FT/
                                    FLOW,FLOW IN CFS/
                                    TURB,TURBIDITY IN JTU/
                                    CONDUCT,CONDUCTIVITY IN MMHOS
                    SCATTERGRAM     FLOW WITH STAGE/ TURB WITH STAGE/ TURB WITH CONDUCT
                    OPTIONS         7
                    STATISTICS      ALL

**** GIVEN WORKSPACE ALLOWS FOR   1573 CASES FOR SCATTERGRAM PROBLEM *****

                    READ INPUT DATA
```

Table 8 - Stage versus Flow on Bailey Creek

BAILEY CREEK CONTROL 09/19/79 PAGE 2

FILE NONAME (CREATION DATE = 09/19/79)
SCATTERGRAM OF (DOWN) FLOW FLOW IN CFS (ACROSS) STAGE STAGE IN FT



STATISTICS

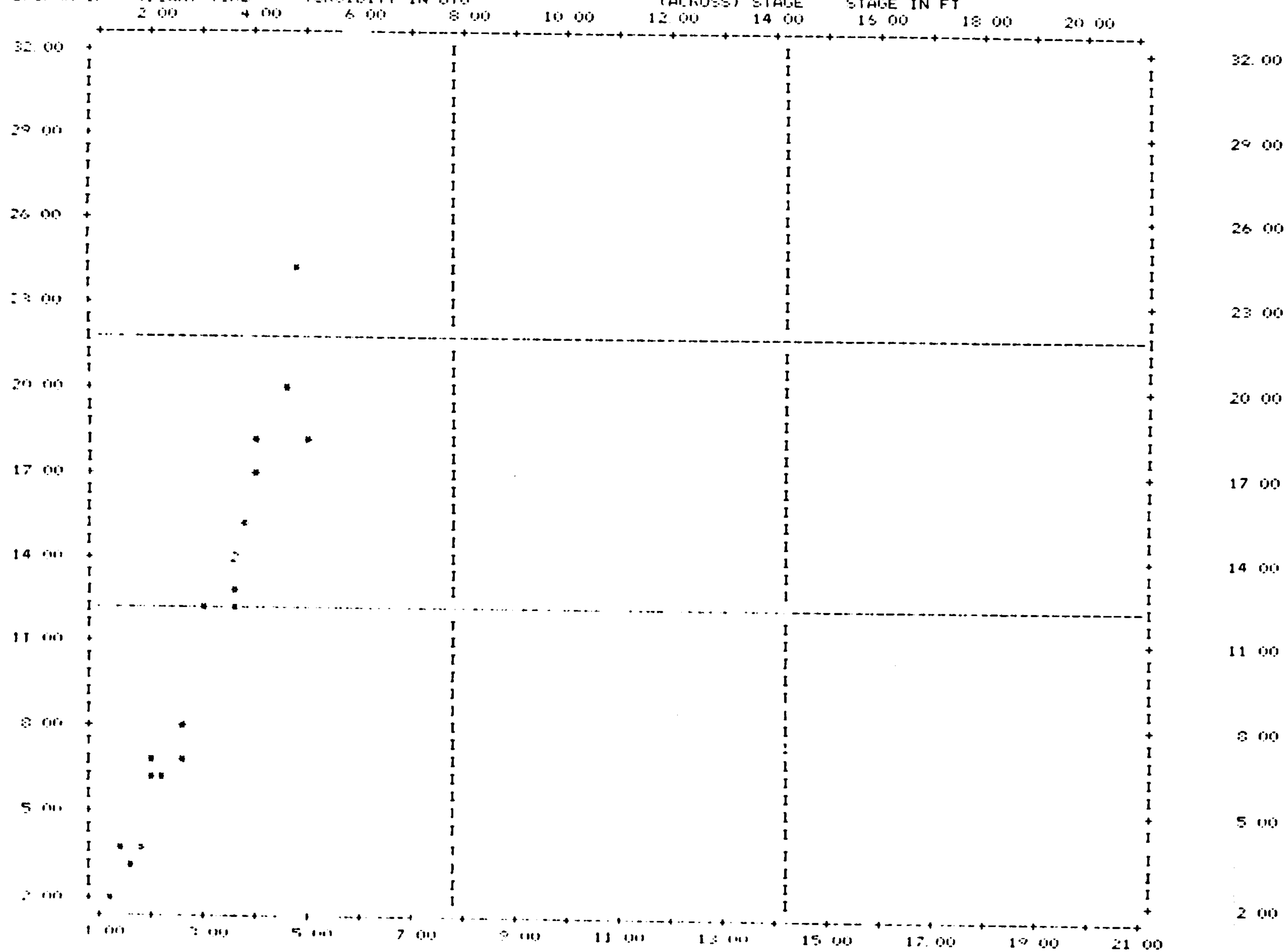
CORRELATION (R)-	.99364	R SQUARED -	.98733	SIGNIFICANCE -	.00001
STD ERR OF EST -	1.34057	INTERCEPT (A) -	.00759	SLOPE (B) -	9.86788
PLOTTED VALUES -	20	EXCLUDED VALUES-	0	MISSING VALUES -	0

Table 9 - Stage versus Turbidity on Bailey Creek

BAILEY CREEK CONTROL 09/19/79 PAGE 4

FILE NONAME (CREATION DATE = 09/19/79)

SCATTERGRAM OF (DOWN) TURB TURBIDITY IN JTU (ACROSS) STAGE STAGE IN FT



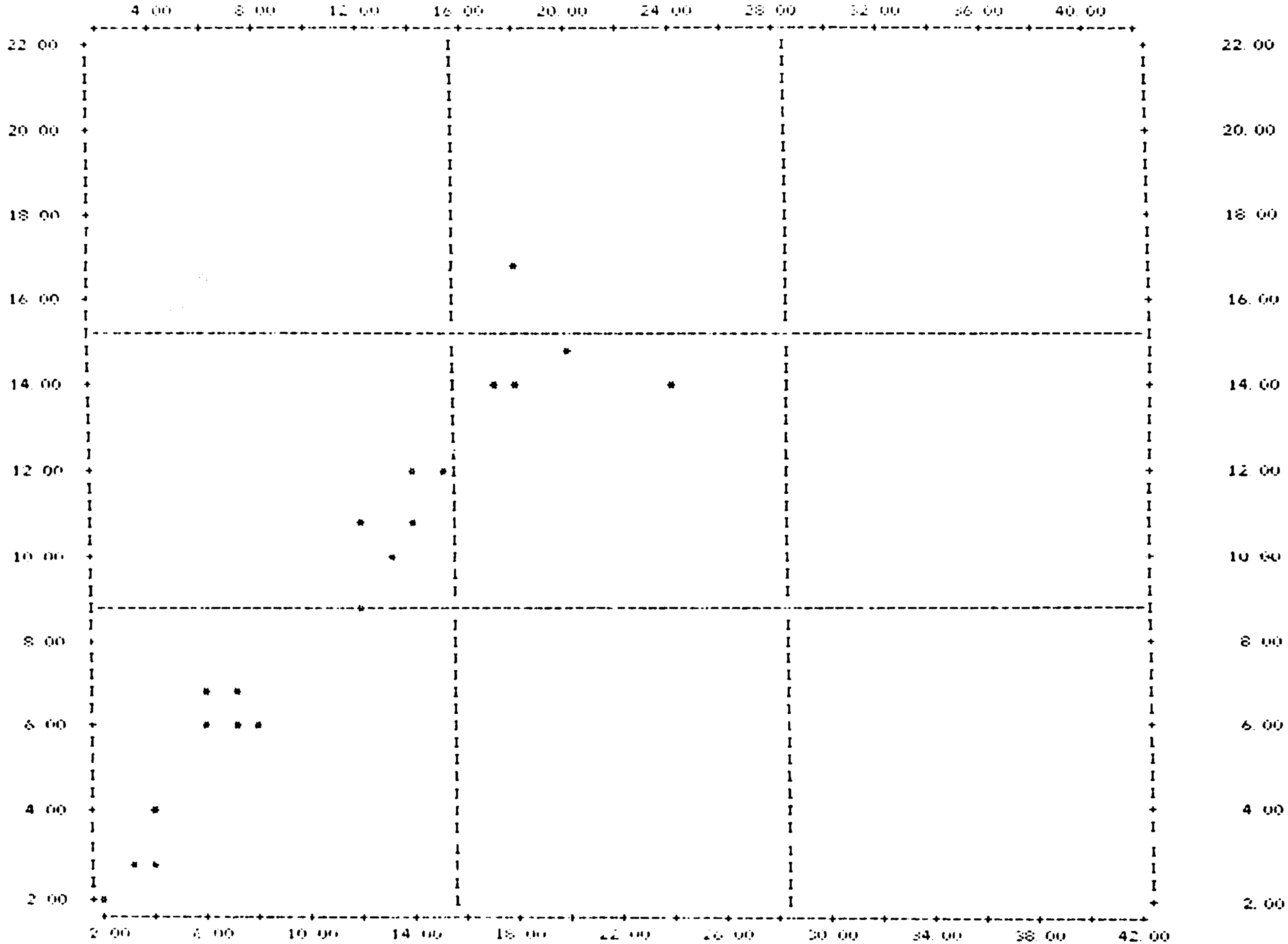
STATISTICS

CORRELATION (R) -	.96899	R SQUARED -	.93894	SIGNIFICANCE -	.00001
STD ERR OF EST -	1.60272	INTERCEPT (A) -	-4.96778	SLOPE (B) -	5.24077
PLOTTED VALUES -	20	EXCLUDED VALUES-	0	MISSING VALUES -	0

Table 10 - Turbidity versus Conductivity [redacted]

BAILEY CREEK CONTROL 10/23/79 PAGE 2

FILE NONAME (CREATION DATE = 10/23/79)
SCATTERGRAM OF (DOWN) CONDUCT CONDUCTIVITY IN MMHOS (ACROSS) TURB TURBIDITY IN JTU



STATISTICS

CORRELATION (R)-	.95205	R SQUARED -	.90640	SIGNIFICANCE -	00001
STD ERR OF EST -	1.41042	INTERCEPT (A) -	1.57092	SLOPE (B) -	67670
PLOTTED VALUES -	20	EXCLUDED VALUES-	0	MISSING VALUES -	0

positive and all R-squared values well above 0.9. All are highly significant, and the correlation between Stage and Flow is very close. As the water rises in the creek, more water must be flowing past the sample station, and less water flows past when the water level drops. The correlation between Stage and Turbidity, while still very close, is not quite as close as Stage and Flow (0.98733 and 0.93894). Less close, but still quite good, is the correlation between Turbidity and Conductivity (0.90640). This was expected, and is born out in research findings, since not all material dissolved in water counted in the Conductivity readings will cause the cloudiness shown by Turbidity values.

Also computed with Tables 8, 9, and 10 are Standard Error of the Estimate, Intercept, and Slope. It lists any excluded or missing values, and the number of points plotted. In the scattergram itself, a point is usually shown with an asterisk (*), but when two values are to be plotted at the same point, a number is shown to indicate how many values were to be counted at the same point (see Tables 8 and 9).

Conclusions

This is only a brief example of how two computer packages can be used to analyze watershed data. Both packages will do much more than this example here, and can be of considerable help to the hydrologist or watershed scientist. As the amount of data taken at each station increases, and as the number of stations increases, the assistance of computers in data analysis will become more and more important.

AN ANALYSIS OF CHANGES IN FOREST DIVERSITY

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Introduction

The Forest and Rangeland Renewable Resources Planning Act of 1974 (88 Stat. 476), as amended by the National Forest Management Act of 1976 (90 Stat. 2949; 16 USC 1600), requires that the National Forest System provide for and maintain diversity of plant and animal communities to meet overall multi-use objectives. In addition, where appropriate and practicable, management that preserves endemic and naturalized plant and animal species similar to those already existing should be practiced.

The National Forests in North Carolina were named as Lead Forest in Region 8, and assigned a task having the objective of field testing a planning process that fulfills the requirements of the National Forest Management Act. This Lead Forest effort was called the Nantahala-Pisgah Land Management Plan. Different interdisciplinary teams were formed to identify issues and concerns, collect inventory data, evaluate alternatives, etc. After the final EIS and LMP are formulated, then implementation of the Nantahala-Pisgah Plan will proceed. The interdisciplinary team may recommend a revision of this plan at any time. However, at least every ten years or more, the Forest Plan will be revised whenever the Forest Supervisor determines that the conditions or demands of the public in the area covered by the plan have changed significantly. In addition, the Forest Supervisor shall review the conditions on the land covered by the Nantahala-Pisgah Plan at least every five years.

Methods

The "Diversity" interdisciplinary teams for the Nantahala-Pisgah Plan met in early June and attempted to develop criteria by which diversity could be defined and illustrated using existing data. It was decided that forest cover types would be usable, since their distribution and condition are indicators of existing and potential plant and animal communities. In addition, forest cover types with their acreage and age class distribution are readily available from Continuous Inventory of Stand Conditions (or CISC).

The Southeastern Forest Experiment Station is currently examining forest diversity determined basically by timber rotations using DYNAST (Boyce, 1977, 1978a, 1978b; Boyce and Cost, 1978). DYNAST is an acronym for "Dynamically Analytic Silviculture Techniques." It consists of three complementary models adapted to different management purposes (Boyce, 1977). Due to the nearness of the Southeastern Forest Experiment Station and their software availability (Sperry-Univac BC/7), cooperation was sought from them for developing alternatives for diversity using CISC as a data input.

Using current CISC data and information from the North Carolina Natural Heritage Program, 36 major plant communities were determined for the Nantahala-Pisgah National Forests. Of these, the sphagnum bogs, grassy balds and shrub balds were excluded from further analysis. CISC data reveals (Table I) that the majority (84 percent) of the forest cover types in the Nantahala-Pisgah Forests are hardwood or hardwood-pine. Also, almost one-half (46 percent) of the Nantahala-Pisgah Forests are in the 41-60 year age class, indicating prior cutting practices.

Hardwood-pine and pine-hardwood acreages were combined to simplify analysis. They are very similar in percentages of crowns in the dominant and codominant position. Hereafter, this combination of forest cover types will be referred to as mixed. Data gathered from the recent Continuous Forest Inventory (CFI) in South Carolina (McClure, Cost, and Knight, 1979) were

TABLE I

Acreages and Their Proportions for the Four Major Cover Types in the Nantahala-Pisgah National Forests

Forest Cover Types		Age Classes									Totals
		0 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	80 +	
Hardwood	1*	19,906	19,423	15,985	35,563	126,301	149,036	92,175	59,655	52,738	570,782 (72.4%)
Pine	2*	20,386	9,926	2,996	3,520	9,563	23,190	12,418	5,716	6,348	94,063 (11.9%)
Hardwood-Pine	3*	2,944	2,084	3,544	5,941	15,711	22,489	21,888	8,990	9,716	93,306 (11.8%)
Pine-Hardwood	4*	563	608	1,607	1,434	4,487	8,772	7,049	2,865	2,717	30,098 (3.9%)
COLUMN TOTAL		43,799 (5.6%)	32,041 (4.1%)	24,132 (3.1%)	46,458 (5.9%)	156,062 (19.8%)	203,487 (25.8%)	133,530 (16.9%)	77,226 (9.8%)	71,519 (9.0%)	
GRAND TOTAL											788,249 (100%)

1* Stands in which 70% or > of the crowns in the dominant and codominant position are hardwood species.

2* Stands in which 70% or more of the crowns in the dominant and codominant position are softwoods.

3* Stands in which 51 to 69% of the crowns in the dominant and codominant position are hardwood species.

4* Stands in which 51 to 69% of the crowns in the dominant and codominant position are softwood species.

used in supplying timber volume information for the hardwood, softwood (pine) and mixed groups used in the DYNAST-MB program. It is beyond the scope and intent of this paper to explain the DYNAST-MB computer program. Dr. Stephen Boyce of the Southeastern Forest Experiment Station, who developed and implemented DYNAST-MB, has explained it fully in recent publications (Boyce, 1977, 1978a, 1978b; Boyce and Cost, 1979). Therefore, only major forest diversity alternatives and their feasibility under potential future management schemes will be discussed.

Based on input from the timber section, a period of 110 years was chosen for looking at timber growth and changes in forest diversity. Multiple rotations for the three forest cover types were 65 and 80 years, 100 and 280 years, and 80 and 280 years respectively for softwood, hardwood, and mixed. For example, the first cut of mature softwood would occur at 65 years with all the old growth cut at 80 years. Sizes of timber were estimated from age classes in the CISC data and placed in seven categories. These were: seedling, sapling, pole-6", pole-8", pole-10", mature, and old growth. The 0-10 year age class was divided equally between seedling and sapling (See Boyce 1977 for exact dimensions of timber size categories).

Initial runs of the CISC and CFI data for the hardwood cover types are shown in Figures 1 and 2. Figure 1 shows that as the large proportion (46 percent) of pole-10" timber (present status) increases in size, a subsequent proportional increase in mature timber is apparent. In approximately 25 years, the mature timber will become old growth resulting in a proportional increase of that timber age class. Under the rotation described earlier for hardwoods, the forest approaches a state of regulation at about 90 years. There will always be a certain proportion of old growth as well as the other age classes.

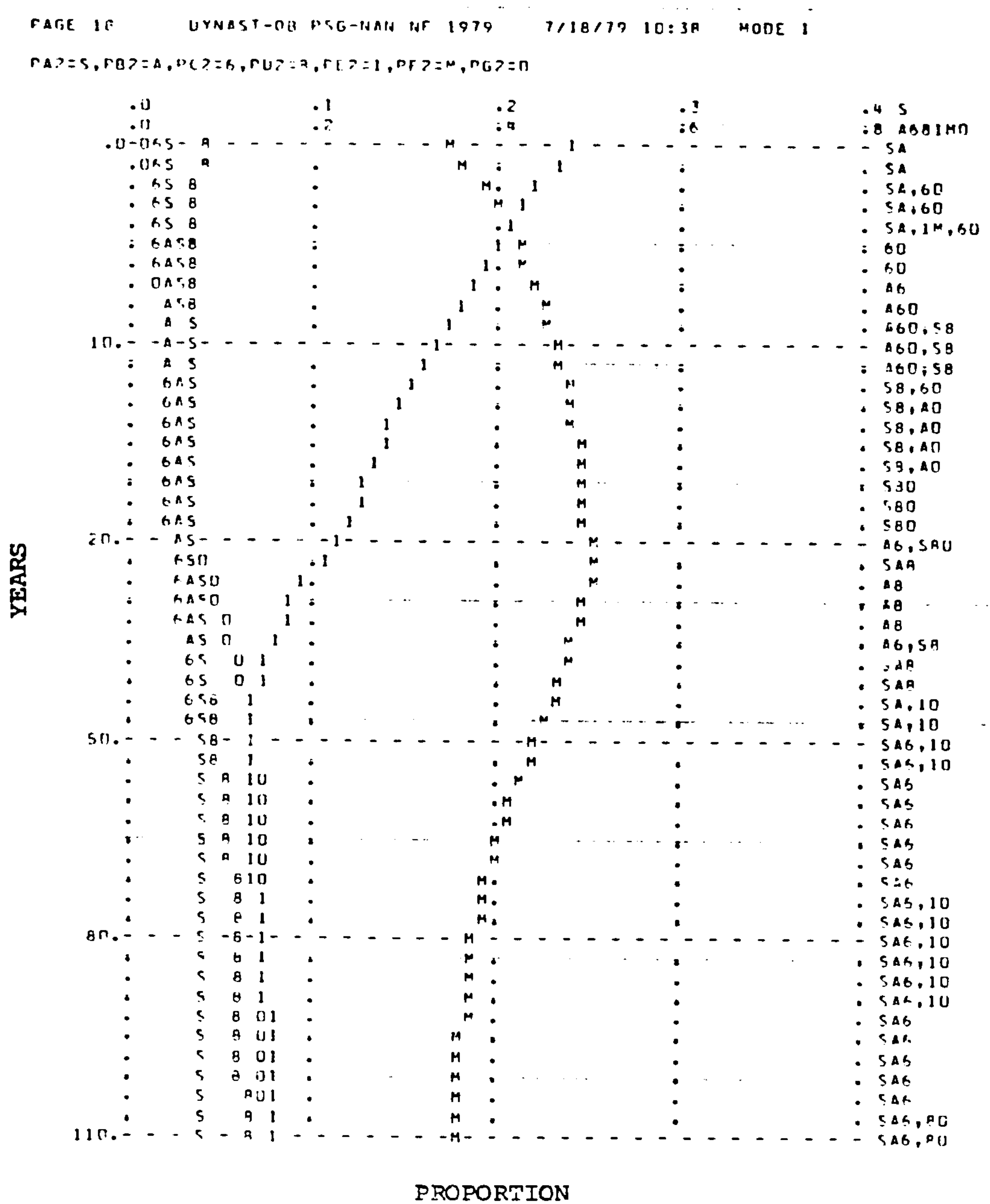

Figure 1. Mode 1. The distribution of seedlings (S), saplings (A), 6-inch poles (6), 8-inch poles (8), 10-inch poles (1), mature timber (M), and old growth (O) in the hardwood forest cover type.

PAGE 10 DYNAST-OB PSG-NAN NF 1979 7/18/79 10:38 WILDERNESS

PA2=S,PB2=A,PC2=6,PD2=8,PE2=1,PF2=M,PG2=O

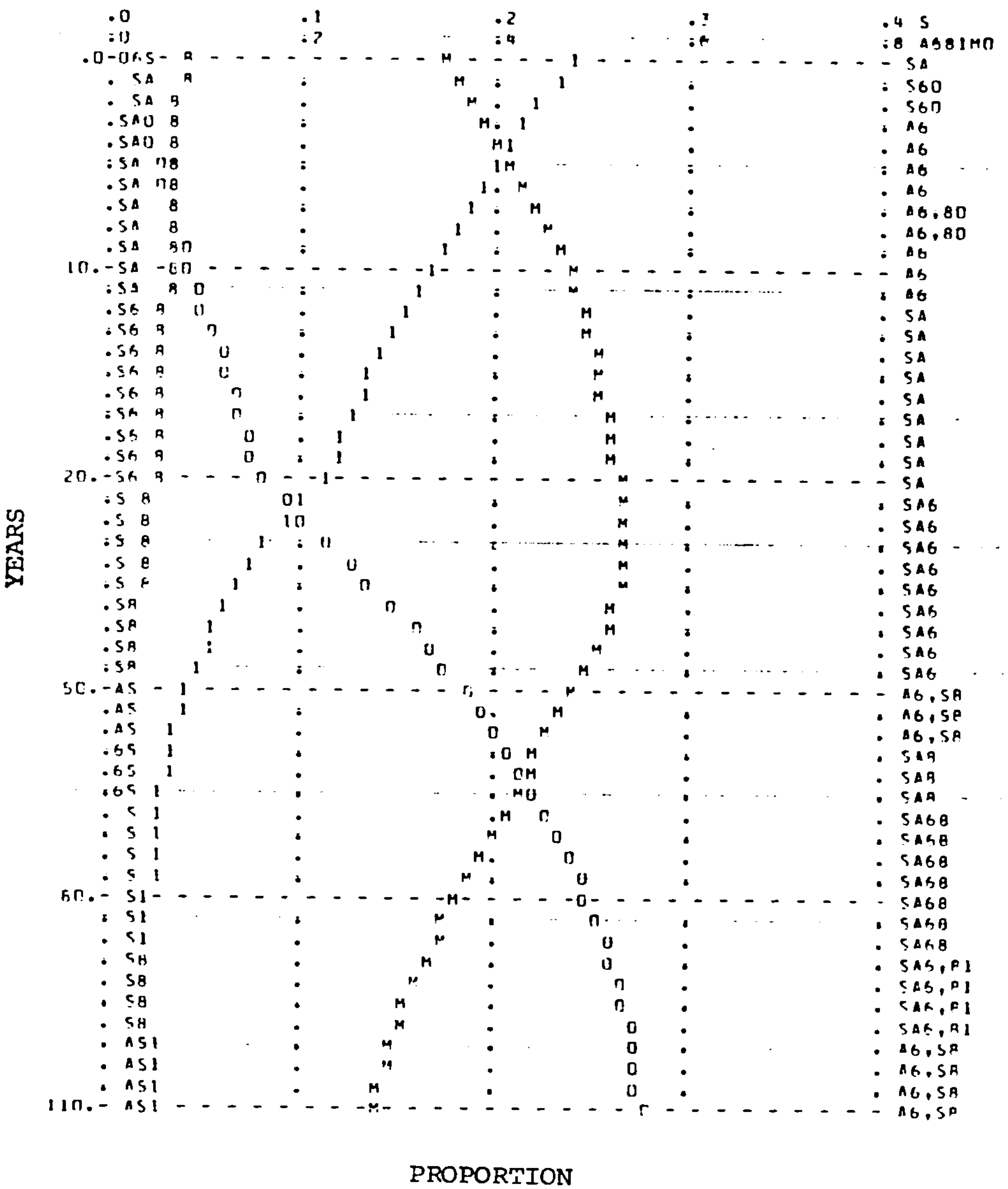

Figure 2. Wilderness. The distribution of seedlings (S), saplings (A), 6-inch poles (6), 8-inch poles (8), 10-inch poles (1), mature timber (M), and old growth (O) in the hardwood forest cover type under wilderness management.

Because of the interest in and the land base involved in wilderness in the Nantahala-Pisgah National Forest, a wilderness forest diversity scheme was examined (fig.2). As one would expect the pole-10" timber decreases rapidly and becomes mature timber. The mature timber in approximately 40 years becomes old growth. The proportion of old growth steadily increases until the vast majority of timber is in this age category. The amount of sapling, pole-6" and pole-8" timber decreases because under wilderness management there is no timber harvest. A small increase in seedling growth begins to appear at 75 years due to the mortality of old growth and subsequent canopy opening. This will provide some openings in the forest due to the natural mortality of trees. Gallinaceous birds, such as turkeys and grouse, deer, and songbirds, (e.g. bluebirds, indigo buntings, etc.) will be adversely affected and their populations decline under wilderness management. Schoenfield and Hendee (1978) and McCallum and Corban (1978) have discussed the effect of wilderness and the concurrent wildlife habitat changes.

To better illustrate how wildlife populations change under various forest diversity schemes, grouse was used as an example. Grouse are birds of early stages of forest succession, but require an interspersion and variety of age classes and forest cover types. Nesting, brooding and winter cover are also essential for yearly habitat needs (USDA 1971).

Algorithms as constructed in the DYNAST-MB model express how a particular benefit depends on the distribution of habitats. It states a relationship between the distribution of age classes in the forest and the species habitat requirements (Boyce, 1977). Further explanation of the development and utilization of algorithms can be found in Boyce (1977).

Figures 3, 4, and 5 depict the relationship of grouse habitat (benefit) and the proportion of pole-6" and 8" (hardwood), mature and old growth

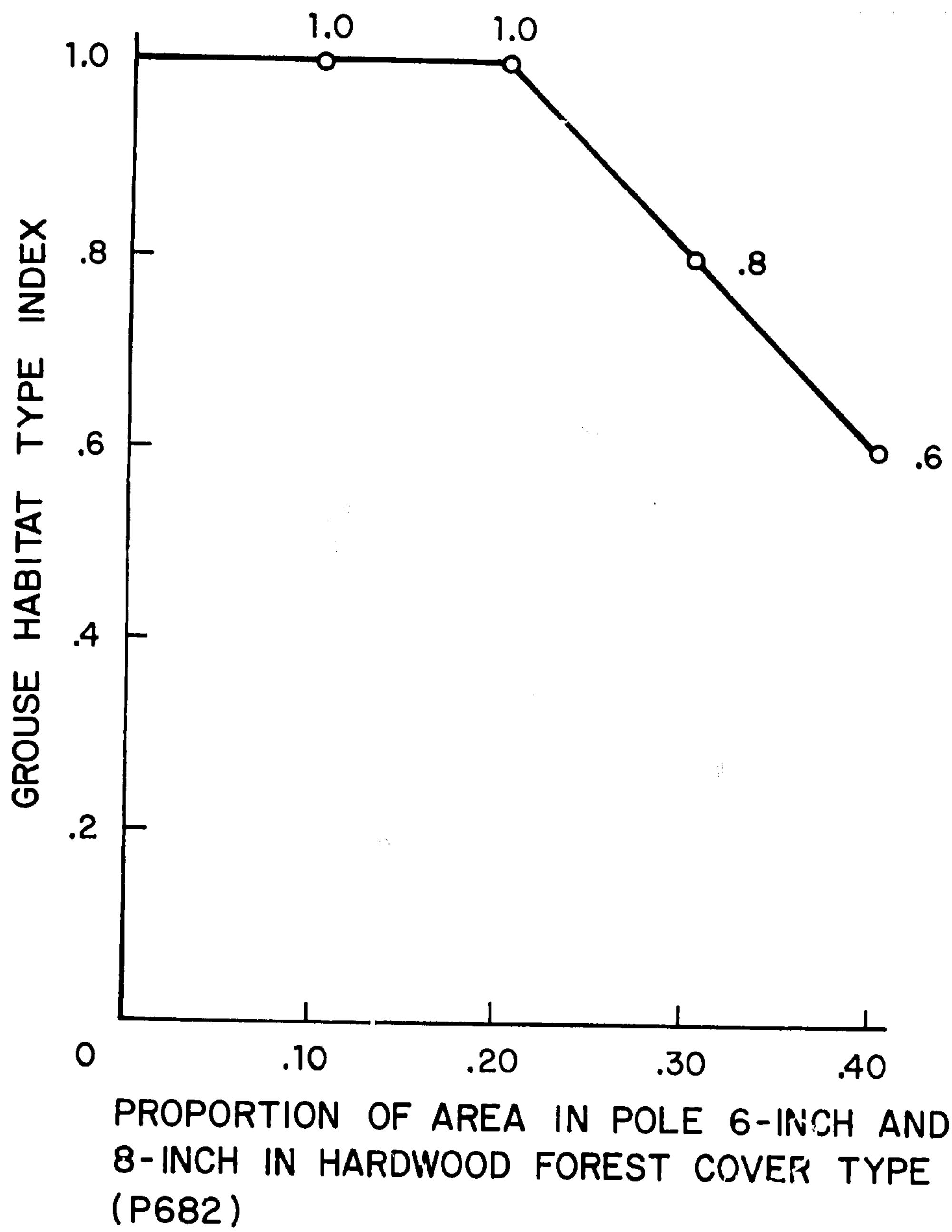

FIGURE 3. Grouse habitat type index versus the proportion of area in pole 6-inch and 8-inch hardwood forest cover type.

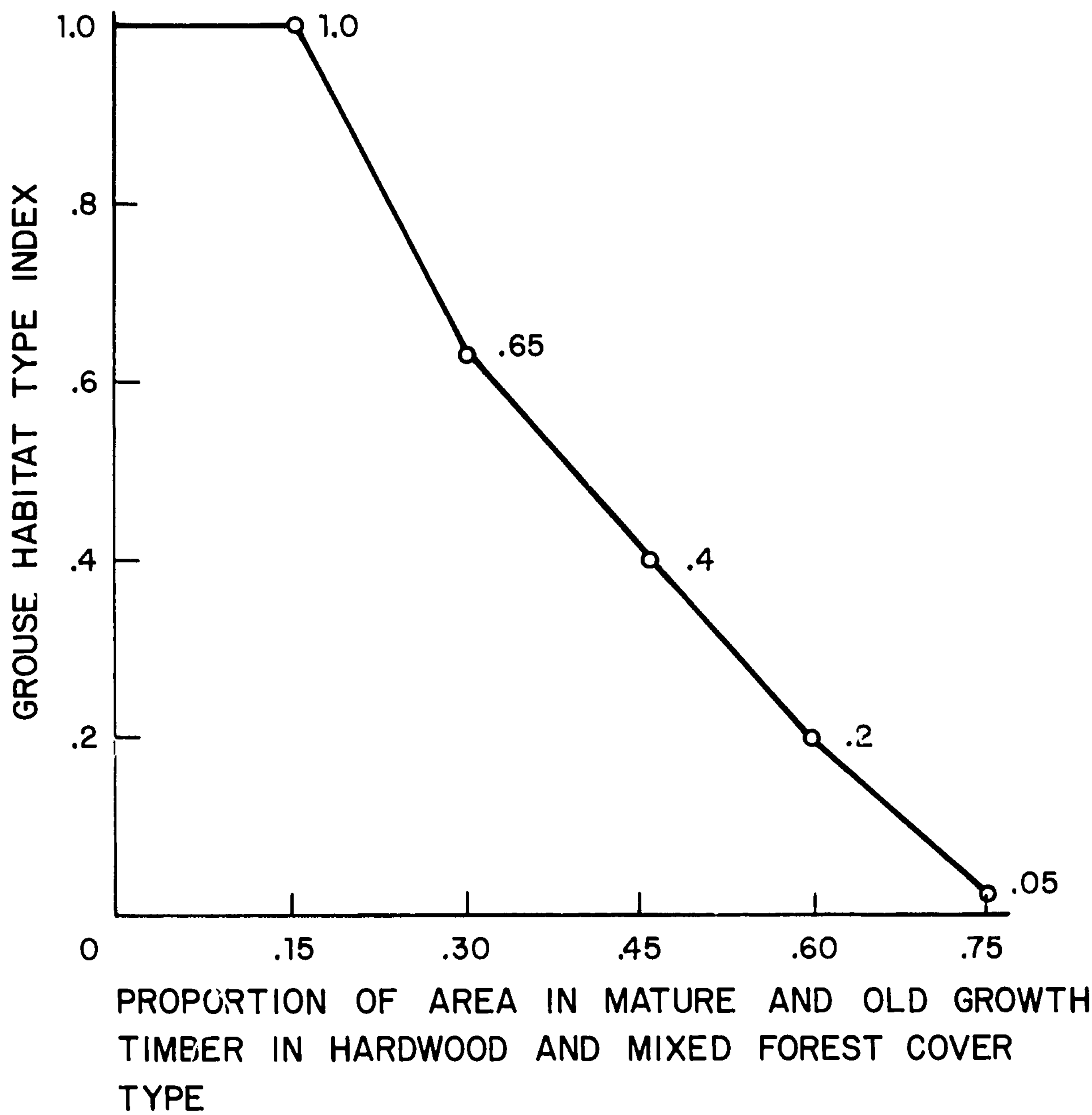

FIGURE 4. Grouse habitat type index versus the proportion of area in mature and old growth timber in the hardwood and mixed forest cover types.

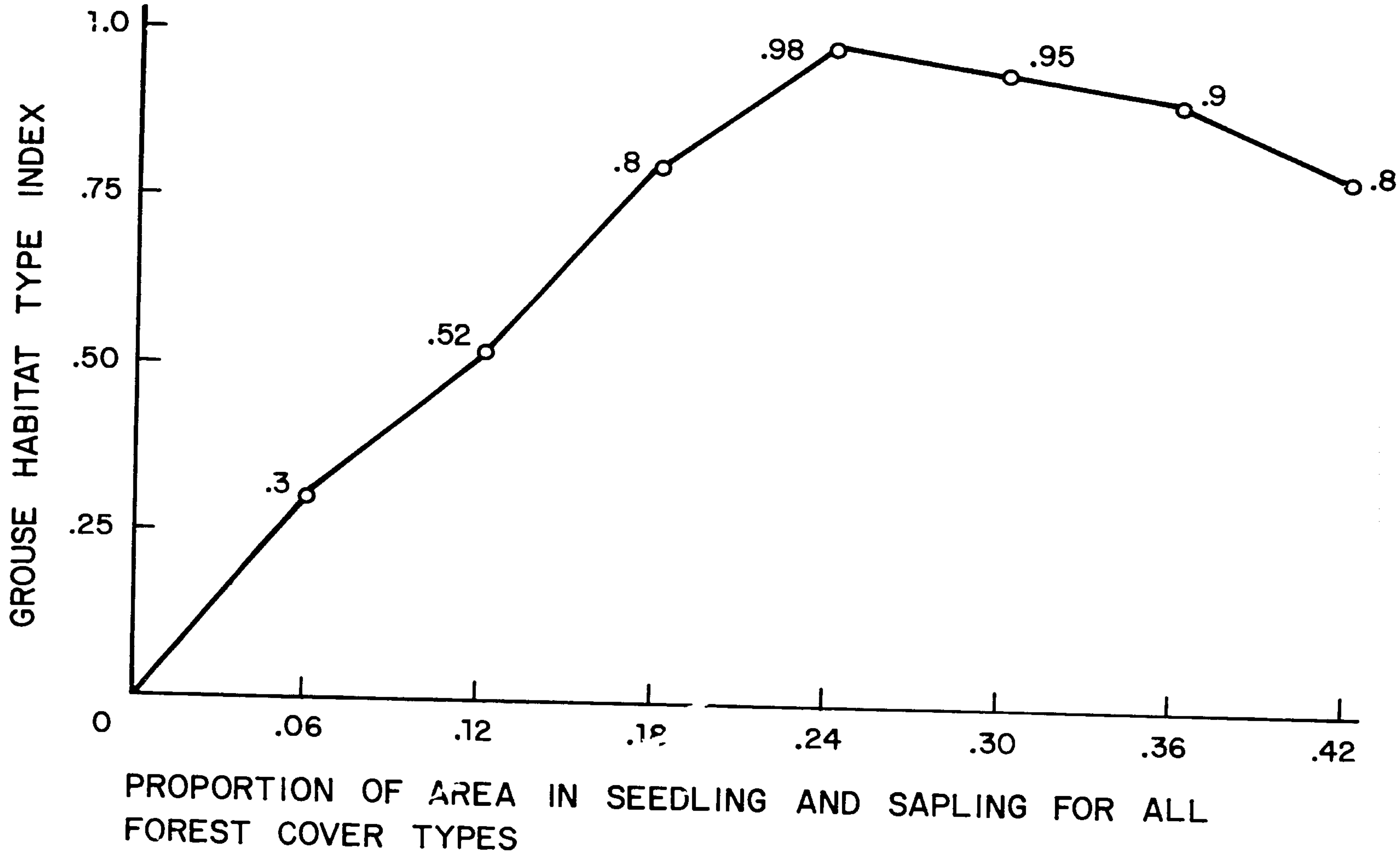

FIGURE 5. Grouse habitat type index versus the proportion of area in seedling and sapling for all three forest cover types.

(hardwood and mixed), and seedling-sapling respectively. The algorithms used to develop these graphs were part of the data input and the subsequent plots shown in Figures 6 and 7. Figure 6 shows an increase in the grouse habitat index resulting from a reduction on old growth and an increase in the proportion of habitat in the seedling and sapling stage. The grouse habitat index approaches its maximum under this type of forest management. Deer and other early successional species will respond well to these conditions. However, species like bear and squirrel lacking dens and cavities in old growth will not fare as well.

The change in the grouse habitat index under wilderness management is shown in Figure 7. A correlation can easily be seen in the increase of old growth, due to a lack of timber harvest, and a decline in grouse habitat index. Seedling growth occurs as some of the old growth dies making small openings in the forest canopy. However, there is not enough to cause a proportional increase in the grouse habitat index.

Feasibility and Potential for Future Use

Public demands on National Forests are becoming more numerous and complicated as each group or cause expresses its interests. Management of National Forests is further complicated by the national direction to harvest more timber and yet concurrently insure diversity of plant and animal communities and tree species. DYNAST-MB allows one to look at changes in forest diversity. It is flexible enough so that algorithms which are introduced into the program act independently of each other, thereby avoiding interaction with other resources. Resource managers, planners, district rangers, and other personnel with the Forest Service will need access to models that predict potential timber yields and the affect on forest diversity.

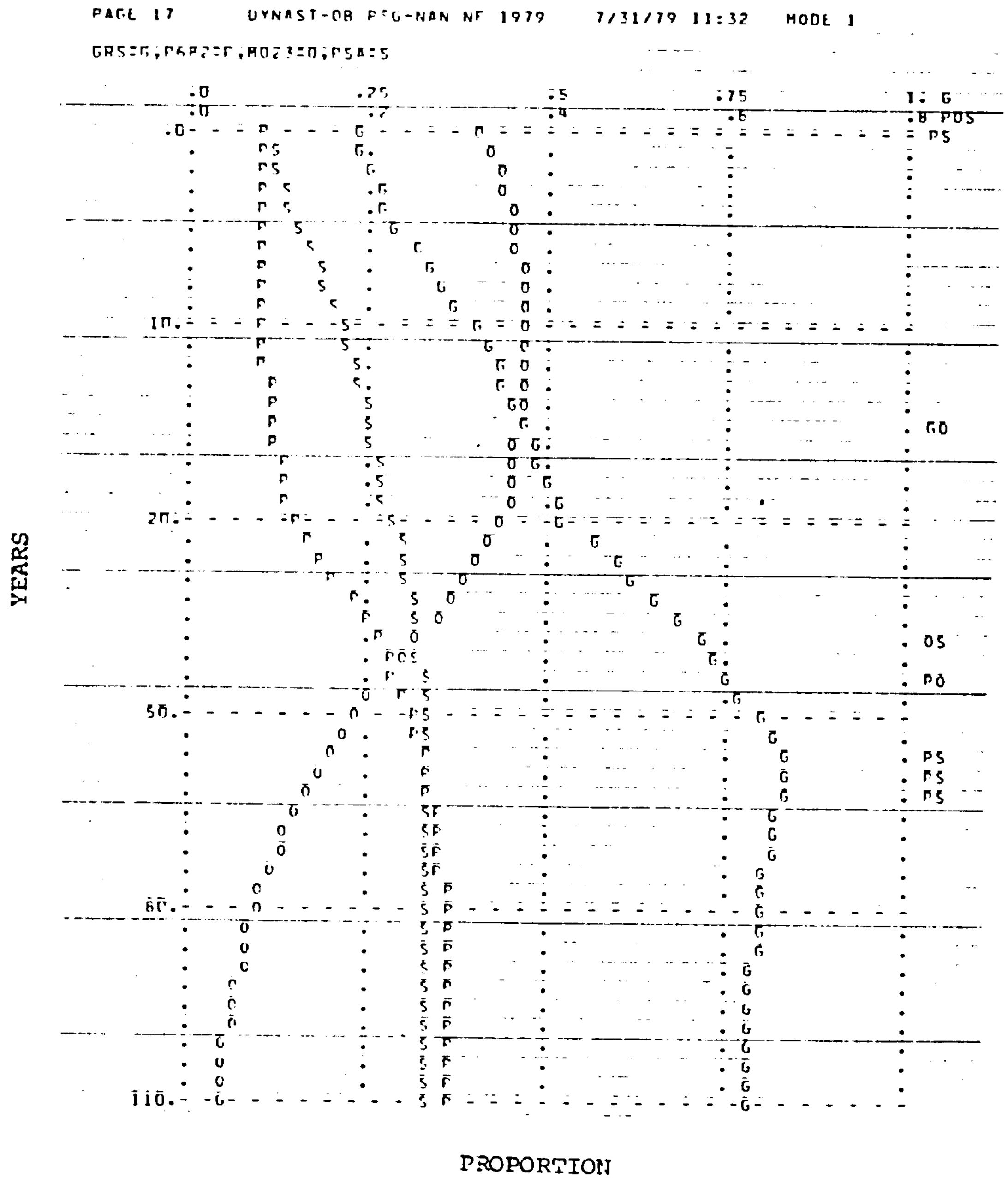

Figure 6. Mode 1. Changes in the indices for grouse and the distribution of 6-inch pole and 8-inch hardwood, mature and old growth hardwood and mixed, and seedling and sapling for forest cover types.

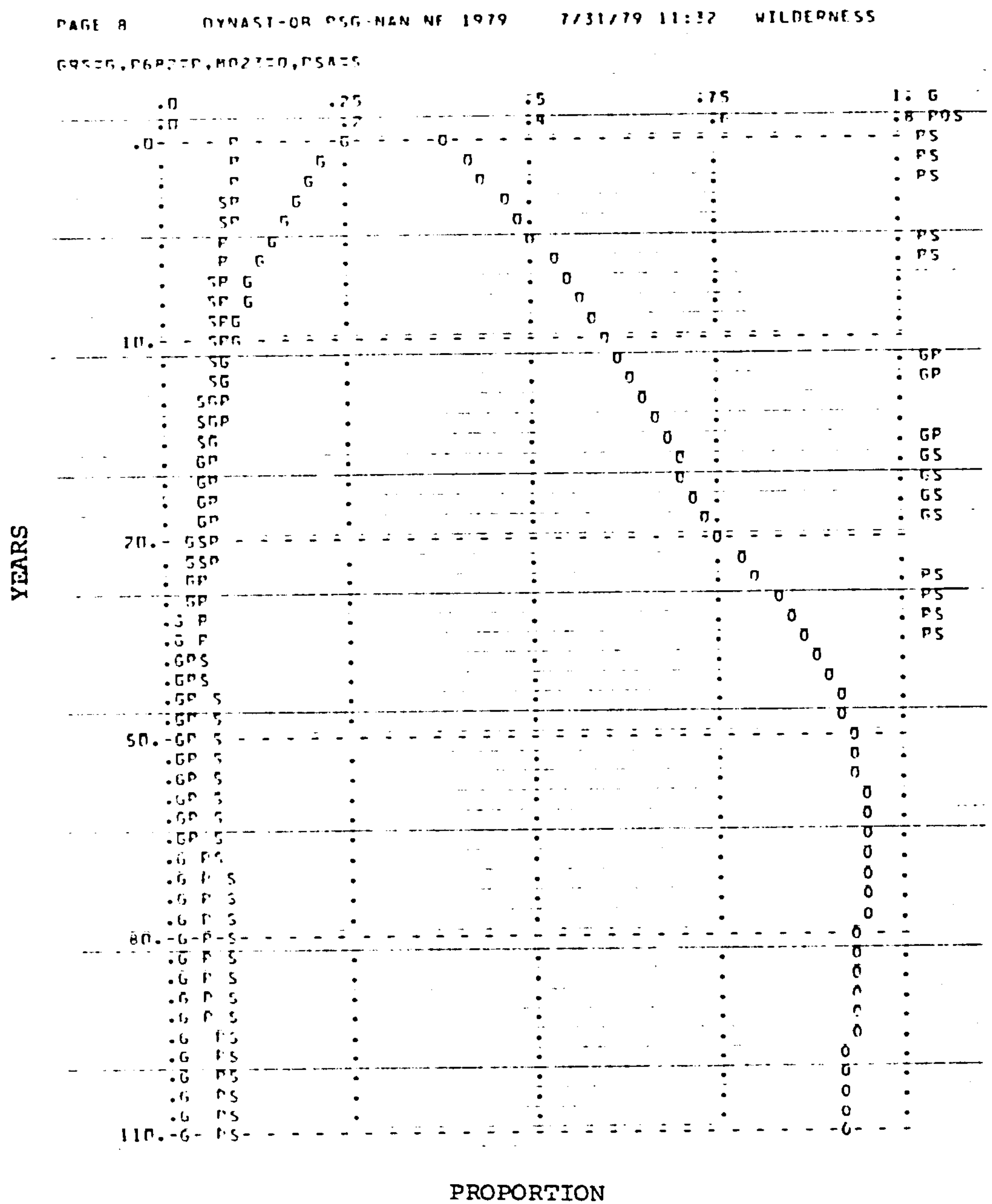

Figure 7. Wilderness. Changes in the indices for grouse, and the distribution of 6-inch pole and 8-inch hardwood, mature and old growth hardwood and mixed, and seedling and sapling for all forest cover types.

Acknowledgements

Dr. Stephen Boyce, Chief Forest Ecologist at the Southeastern Forest Experiment Station, developed the DYNAST-MB program used in this report. He also allowed me to have access to the facilities at the Station and gave freely of his time and knowledge in assisting me with this project.

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AN ANALYSIS OF WORD PROCESSOR UTILIZATION

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Introduction

As part of the FY 79 Clerical Support Study, an evaluation of the use of Regional Office word processing equipment was conducted for a two-week period. This sample period (as recommended by G.S.A.) provides a base from which over-all typing volumes can be determined and utilization calculated. While a cost-analysis would be included in justification of any new WP equipment, it is not included in this study, which concentrates instead on workload data.

Utilization Study

The utilization study consisted of briefing the chief clerks and interested supervisory personnel about the data collection forms. For the study, all typed documents, whether prepared by word processor or manual typing, were to be attached to a "Typing Task Data Sheet" unless they were confidential material. The A.M. group completed coding of the form by classifying the type of document (narrative, form, etc.) and the number of lines typed. These items for confidential material were coded by the typist. The forms were sent out for keypunching and verification. The data records were then loaded onto the Fort Collins' Computer system. The data was summarized and analyzed using the "Statistical Package for the Social Sciences" (S.P.S.S.) program available at Fort Collins.

Expanded calculations show that the annual amount of typed material produced by the Regional Office is 67,240 pages. A standard of 28 lines per page was used to convert lines to pages. A recognized standard which is used by G.S.A. and the Army requires an output of 25 pages per day per work station. This is equivalent to 700 lines/day/work station using the above conversion factor. The WP summary indicates that at this standard less than four input stations would be required for the sample workload. Combining the work volumes as shown in the WP configuration yields the results found in Table I.

Analysis

The figures generated in Table I present a very poor efficiency picture. The word processing equipment in this office is only being used 36.4 percent of its capacity. This is based on two assumptions. The first is that the two week sample was representative of the annual workload. Each staff will have to examine the study data and supply correction factors to adjust for non-normalcy of the workload and cyclical work not appearing in the work sample. Secondly that the 25/page/day/workstation (or 700 lines) is a valid standard or guideline. The Army, at its Word Processing Center in Washington, D.C., has achieved an operating level of 1065 lines/day/station after less than a year's operation. The 700 lines appears to be a valid standard. Another factor that will eventually contribute to a higher standard is a workday longer than 8 hours (7 hours productive time). With the possibility of four ten-hour workdays and proper scheduling the standard could be increased 25 percent to 875 lines (31.5 pages)/day/workstation.

Table II presents the same picture except that it is expressed in (equipment) utilization. The average system utilization is less than 30 percent. Both performance indicators show that there is not sufficient work volume for the number of work stations presently in the system.

TABLE I

WP Work Station Requirements

Staff	Lines/Day	Present No. of Work Stations	Work Stations at Standard	% Capacity
Engineering (E)	287	2	.410	20.5
Lands & Watershed (LW)	317	2	.453	22.7
Planning, Programming, Budgeting (PPB)	333	1	.475	47.5
Admin.Mgt. (AM)	265		.378	
Admin. Services (AS)	226	2	.322	41.1
Human Resource Programs (HRP)	84		.121	
Personnel Mgt. (PM)	61	1	.087	8.7
Fiscal Mgt. (FM)	309	1	.441	44.1
Timber (TM)	197	1	.282	28.2
Fire & Aviation (FA)	184	1	.263	78.3
Recreation, Range, & Wildlife (RRWL)	364		.520	
Total (Average)	2627	11		36.4

TABLE II

WP Actual Typing Minutes*

Staff	Min/Day	Present No. of Work Stations	Min/Day/ Unit	% Utilization*
E	184.3	2	92.2	21.9
LW	160.2	2	80.1	19.0
PPB	117.5	1	117.5	28.1
AM	113.4			
AS	106.6	2	129.4	30.8
HRP	38.7			
PM	30.5	1	30.5	7.1
FM	163.2	1	163.2	38.9
TM	196.2	1	196.2	46.7
FA	107.2	1	240.4	57.2
RRWL	133.2			
Total (Average)		11	1349.5	29.2

(In the original, arrows link AM, AS and HRP to the one shared "2" row, and FA and RRWL to the shared "1" row.)

*See TABLE I for abbreviations

*Based on a 7-hour day

TABLE III

Document Queue Distribution

	Same Day	1-Day	2-Day	3-Day	4-Day	5-Day	More Than 5
No. of Documents	1048	188	90	56	50	15	34
Percent	70.8	12.7	6.1	3.8	3.4	1.0	2.2
Cumulative Percent	70.8	83.5	89.6	93.4	96.8	97.8	100.

This is further substantiated by Table III, which shows the effectiveness of the typing function. Queue time is defined as the time difference between when the document is received and when typing was begun. This table indicates that approximately 90 percent of all typing is begun within two working days of its receipt, and only 2 percent is held longer than 5 days.

It is important to note that the proportion of WP typing is only 36.3 percent of the total pages produced. There appears to be an opportunity to shift some of the workload to the WP. A review of Table IV would suggest that some or all of the typed copy of two or more pages should be on the WP. The "Less than 1 page" column of the table essentially represents for the WP entry the number of revisions. Revision typing is the retyping of a document containing a mixture of changed and unchanged lines. On the average all staffs are doing 31 percent revision work on the WP.

Another prime choice for the WP would be the longhand material of two or more pages. These two sources would supply an additional 18,000 lines of typing or a 70 percent increase in WP workload.

However, while an increase in volume would improve the capacity indicator, it might not result in any greater efficiency. The WP will increase productivity only when used for its editing capability. Short documents of 1, 2 or 3 pages which will not require future editing should be done on a manual typewriter. A review of the manually typed documents that were either typed from longhand or typed copy and that were produced as rough draft is shown in Table V. Efficiency would likely be improved on only 3,000 lines of the possible 18,000 generated, or a possible 12 percent increase. An additional 5 percent could be produced by WP if the one or two page category is included, although this material, as mentioned

TABLE IV

Typing Job Size*

	Less Than 1 Page	1-2	2-3	3-10	10 or More Pages	Total
Manual	767	216	56	66	8	1113
Manual Percent	6	19	5	6	1	100
WP	115	133	43	59	18	368
WP Percent	31	36	12	16	5	100

*Number of documents is 9-day sample

TABLE V

Input Form of Manual Documents*

	Less Than 1 Page	1-2	2-3	3-10	10 or More Pages
Typed Copy	174	68	15	28	14
Longhand	440	129	36	27	0
Machine Dictation	0	0	0	0	0

*9-day sample

Output Form of Manual Documents*

	Less Than 1 Page	1-2	2-3	3-10	10 or More Pages
Typed Copy	8	10	7	3	0
Longhand	42	25	9	6	0

*9-day sample

previously, is not particularly suited to the WP, nor is material which must remain in a specific location (e.g., personnel or pay records, and fiscal statistics).

The Work Sampling

After a review of the draft report with the Regional Office Staffs, the staffs contended that the Word Processor (WP) is in heavy use normally and in constant use during peak periods. The test period showed less than 30 percent utilization. Three areas which might influence WP effectiveness are: first the amount of time spent archiving (storing information on a portable recording device), de-archiving, logging jobs, picking up work, consulting with a supervisor or author. According to the manufacturer's literature the allowance for these activities should be 5-10 minutes per job. Second is the amount of time spent printing the document While it is true that the workstation is free for use while the document is printing, the operator is not. Since the WP is de-centralized in this office, the operator is responsible for monitoring the printer. A productivity decrease up to 1/3 may result. It is dependent on the number of times a printwheel is changed, the type of paper (e.g., single sheets, non-continuous special forms), the location of the printer to the workstation, and the location of storage facilities. Both of these areas have been adjusted, and are included in Tables VI and VII. A comparison of the old versus the revised tables shows an average of 50 percent improvement in the performance indicators. While this is good, it still conflicts with the opinions of the users who believe their utilization to be near 100 percent. The third area questions the appropriateness of the two-week study period. Most staff members attributed the poor performance to the low ebb in their work cycle during the selected sample period, due to numerous factors not accounted for in the study.

TABLE VI

Revised WP Workstation Requirements*

Staff	Lines/Day	Pages/Day	Present No. of Workstations	W.S.@ STD	% Capacity
E	542	19.4	2	.774	38.7
LWM	356	12.7	2	.509	50.9
PPB	341	12.2	1	.487	48.7
AM	289	10.3		.414	
AS	412	14.7	2	.588	59.3
HRP	128	4.6		.183	
PM	71	2.5	1	.102	10.2
FM	322	11.5	1	.460	46.0
TM	221	7.9	1	.316	31.6
FA	184	6.6	1	.263	89.5
RRWL	442	15.8		.632	

*See TABLE I for abbreviations, and for previous Workstation Requirements

TABLE VII

Revised WP Actual Typing Minutes*

Staff	Units	Min/Day	Hr/Day/Unit	Min/Day/Unit	Utilization
E	2	277	2.3	138.5	33.0
LWM	2	256	4.3	128.0	61.0
PPB	1	184	3.1	184.0	43.8
AM		169			
AS	2	194	3.5	212.5	50.6
HRP		62			
PM	1	43	.7	43.0	10.2
FM	1	269	4.5	269.0	64.0
TM	1	240	4.0	240.0	51.1
FA	1	125	4.9	293.0	69.8
RRWL		168			

*See TABLE I for abbreviations,
TABLE II for previous Actual Typing Minutes

Revised Performance Sampling

Unless there is a measurement system, there can not be an effective means of judging productivity. If workload data are not captured, there is no means to justify the creation of new systems or make modifications to old ones. The literature suggests that unmeasured clerical type work is only 50 percent efficient. So after stimulating interest and support for productivity improvement, a measurement system must be developed. The Document Summary (see Exhibit 1) appears to be part of the solution for discovering Word Processor effectiveness. This document can provide management with an effective tool in evaluating over-all system performance. The preliminary results of the January, 1979 Clerical Study indicated that WP typing utilization was poor. Part of this was due to the lack of consideration given to the areas of system operations and the printing functions. An even more significant factor was the inability to adjust the sample period for non-normalcy of workload. All staffs were interviewed for their evaluation and interpretation of the report's results and conclusions. Most felt that the sample period was inappropriate due to either professional travel or leave, clerk's leave and vacancies, or priority work being done while WP typing was being backlogged.

To correct this, another approach is being used to verify a normal level of WP utilization. All staffs agreed that a more appropriate time could be found for a random sampling procedure to be administered to gain a more accurate view of the actual time and keystrokes used in preparing WP documents. This would include creation, revision, and printing workloads. These data have not been recorded or collected since the WP was installed.

EXHIBIT 1

Document Summary

Document ID: 5107A
Document Name: Management YCC Property
Operator: dk
Author: Curtis

Comments:

STATISTICS

Operation	Date	Time	Worktime	Keystrokes
Created	1/23/79	12:52	:09	1335
Last Revised				
Last Printed	1/23/79	13:04		
Last Archived			onto Diskette	

Total Pages:	1	Total Worktime:	:09
Total Lines:	20	Total Keystrokes:	1335

Pages to be printed: 2

Wang Laboratories, Inc., maker of the WP in use in the Regional Office, was contacted as to the availability of a feature to add document summaries together automatically. This feature would allow the user to produce daily, weekly, or any specified frequency reports. Although the request is not new and Wang Laboratories has been investigating it for the past two years, no foreseeable support will be available. Therefore the interim solution will be to produce a summary whenever a document is created, revised, or printed (or any combination). These summaries will be forwarded to keypunch and the resulting cards will be used as input to a computer program at F.C.C.C. to generate current operating statistics. A historical data base will also be built to generate management reports. This data base should eliminate any need for future WP sampling and provide accurate statistics on system utilization with a minimum of manual effort.

An Alternative Approach

With appropriate definitions, the Word Processor system can also be viewed as a Waiting Line system with job arrivals, service times and priorities for service. The system considered in our study consists of several subsystems of staffs or combination of staffs. One such subsystem, for example, could be the pooling of the Administrative Management, Administrative Services and the Human Resources Program Staffs. A Waiting Line model (using existing software such as GPSS, SIMSCRIPT, etc.) could be developed for such systems and then integrated so that we can evaluate the Word Processing system as a whole. An attempt in this direction was initiated in Region 9 but a detailed description of the model and the program are beyond the scope of this report.

GROWTH AND YIELD PRODUCTION FOR UPLAND OAK STANDS

Walter E. Smith
National Forests in North Carolina
Asheville, North Carolina

Background

This is a program developed by Dr. Martin E. Dale of the Northeastern Forest Experiment Station. He is located at Delaware, Ohio. The program was published as U.S. Forest Service Research Paper NE 241-1972. It is also a FORTRAN program at FCCC, although we were unable to locate it there.

The Program

The program is based on studies of upland oak growth plots. The data varies from 5-12 years of growth. A total of 154 plots--varying in size from 0.2 to 1 acre--were established and the data collected. The initial age of the plots varies from an average of 20 to 90 years old. Stands younger than twenty years cannot be projected accurately because of the lack of data in the younger age classes.

Cubic foot volumes are based on the two independent variables of diameter and height. Two height factors were used, one for the white oak group and one for the red oak group.

Merchantable cubic foot volume and board foot volume estimates are obtained by multiplying the total cubic foot volume by the ratio of merchantable cubic foot volume or board foot volume to total cubic foot volume for each diameter class. The merchantable volume ratios increase with the increase in average stand diameter.

After the initial basal area data is entered, the new basal areas are calculated on a per acre basis for all trees over 2.5 inches D.B.H. instead of on an individual tree basis.

The program is based on a regression formula which determined average stand diameter as a function of site index and age. The average stand diameter is adjusted for each site index and age class to reflect changes in average stand diameter due to the intensity of cutting. Included are ingrowth and mortality functions which are used to adjust the number of trees annually.

The input data for the program are: stand age, basal area, number of trees over 2.5 inches D.B.H., and site index. In addition, control data to be entered are: number of year, when to view the stand, the interval of time for printout data in years, stand number, and starting date (year) that the stand is begun. With this program we can project the present known stand to rotation by different cutting intensities and produce volumes that are removed at each cutting point. This data could then be analyzed for economic returns under different intensities of cuts using another program.

Example

An example of the data this program will produce is as follows:

Given: 20 year old stand

75 site index

30 initial basal area

272 number of trees per acre over 2.5" D.B.H.

Production data per acre:

Current annual basal area increase	3.5 sq. ft.
Net basal area growth in 10 years	31.5 sq. ft.
Total cubic ft. volume in trees over 2.5" D.B.H. at start of period	554.0 cu. ft.
Net cubic ft. volume growth in 10 years	1067.0 cu. ft.

Production data per acre (cont.):

Total cordwood volume in trees over 4.5" D.B.H. at start of period	2.9 cds.
Net cordwood volume in 10 years	10.5 cds.
Total board ft. volume in trees over 8.5" D.B.H. at start of period	0.0 bd. ft.
Net board ft. volume in 10 years	483.0 bd. ft.
Average stand diameter in trees over 2.5" D.B.H. at start of period	4.5" D.B.H.
Average stand diameter increase in 10 years	1.7" D.B.H.

By the time a stand is 50 years old, if nothing else has been done to reduce the stand basal area, the following would result according to Dr. Martin E. Dale's program:

50 year-old stand

75 site index

30 initial basal area at 20 years

95 basal area

3356 cubic feet total

35 cords

4300 boardfeet

*The above data was taken from tables produced by the program.

PART III

COMPUTATIONAL ANALYSIS FOR PLANNING, PRODUCTIVITY, AND ECONOMICS

USE OF WRAP IN TIMBER MANAGEMENT PLANNING

Larry Bishop
U.S. Forest Service
Atlanta, Georgia

Objective

The objective of this study was to use the Woodland Resource Analysis Program (WRAP) to facilitate the preparation of the Yazoo-Little Tallahatchie Flood Prevention Project timber management plans.

WRAP, a software package developed by the Tennessee Valley Authority (TVA) in cooperation with the U.S. Forest Service and the Alabama Forestry Commission, is a computerized system for timber management planning incorporating multiple use objectives for use on private forest properties.

The Yazoo-Little Tallahatchie Flood Prevention Project (Y-LT) was established through the Flood Control Act of 1944. This act authorized the U.S. Department of Agriculture to install upstream flood prevention measures in the Yazoo and Little Tallahatchie River watersheds in north Mississippi. The Soil Conservation Service and the Forest Service are responsible for providing on-the-ground leadership, technical assistance, and financial help to local landowners in the project area. Some of the services the Forest Service provide to private landowners include: planting pine seedlings on eroded land to reduce situation of streams, rivers and lakes; releasing pine from undesirable hardwood competition; and preparing timber management plans.

Project

Timber management planning on the Y-LT is a fairly simple process. After receiving a request from a qualified landowner, a forester or forestry technician delineates the landowner's individual timber stands on an aerial photograph. Then he visits the property and cruises each stand, rarely taking more than ten plots per stand. Following this, he prepares a stand summary with management guidelines for the next ten to thirty years or so, which with a map and cover letter, is then mailed to the landowner. These plans are not highly detailed (averaging six to eight pages, including map and cover letter), but they have been generally well received by the landowners. Total time spent in preparing the plan averages about two days - one day in the office and one in the field. On many occasions personal contact with the landowner is never made because many are absentee landowners.

I used a Yazoo-Little Tallahatchie timber management plan that had been prepared for a 610 acre farm near Oxford, Mississippi, and entered the data on the WRAP input forms. (WRAP uses three basic forms for data input: (1) WRAP Input - Landowner Information/Objective Form, (2) WRAP Input - Tract Inventory Form, and (3) Refining the Objective Form. A copy of each is included at the end of this report.) Some conversion of data and approximation was nescessary since the two systems require slightly different data.

I mailed the completed forms to TVA to be processed through WRAP, and received a 91-page printout within 10 days. Among other things, the printout contained: a ten-year cutting schedule with anticipated income and cost; a fifty-year harvesting schedule based on multiple resource objectives; wildlife population projections; a rate of return analysis for each individual stand (referred to as "tracts" in WRAP); a retirement analysis; a loan schedule; naratives on various timber management systems, timber sale contracts, watershed protection, fire control, site preparation, planting, hardwood control, fuel wood and pruning; silvical characteristics and management guidelines for yellow poplar, white oak, and yellow pine; narratives on establishing and maintaining ecological stability; wildflower management; deer, turkey, cottontail rabbit, bobwhite quail, beaver, mourning dove, small game, song bird, waterfowl, pond, and recreation and fishing management narratives; government assistance programs, and the tree farm system. In short, I was overwhelmed with information. See Appendices II and III for sample outputs and excerpts from WRAP.

Conclusions

Is it practical to use WRAP in preparing the Yazoo-Little Tallahatchie timber management plans? I would have to say no. WRAP demands direct contacts with the landowner for the completion and refining of information/objectives form; some of the landowners are absentee. WRAP requires much more data than is needed for Y-LT management plans. WRAP requires a forester to take two to four working days just to collect field data for the average size ownership; then another day to assimilate the data and enter it on the input forms. This is about 2 1/2 times more than is required for a Y-LT plan. WRAP's printout format then requires the forester to take several hours to read and explain to the landowner; and the reception of that computer printout by the average landowner is questionable, especially if she/he is unfamilar with the nature and content of such explanations.

In my opinion, WRAP, in the present form, is too complicated and unwieldy a system for the use on the Yazoo-Little Tallahatchie Flood Prevention Project.

Appendix I.

COMPUTER RUN [ ][ ][ ][ ][0][0][ ]

WRAP INPUT
LANDOWNER INFORMATION/OBJECTIVES FORM

This questionnaire is authorized by the Tennessee Valley Authority Act of 1933 (16 U.S.C. § § 831-831dd). While you are not required to respond, your cooperation is appreciated in order to make this survey comprehensive, adequate, and timely.

OMB 074R0084
Expiration Date 7/81

I
LANDOWNER INFORMATION SECTION

Mo. Day Yr. 07 09 79

STATE AND COUNTY CODES 28 071

A. UNIT NAME DOWNER FARM

TOTAL ACRES IN UNIT 600 Acres

B. INTERVIEWEE RUTH KRISTOE

TITLE OWNER

ADDRESS 3579 SHADY DRIVE

CITY, STATE, AND ZIP KILBURN GA 30247

AGE (If Corp. Omit) 48 Years

C. PER ACRE MARKET VALUE EXCLUDING TIMBER 200

D. AD VALOREM TAXES PER ACRE 1.20

E. ALTERNATIVE INVESTMENT RATE ___ %

F. ANNUAL EXPECTED INFLATION RATE ___ %

G. NEED CASH AT SOME FUTURE DATE? YES [ ] NO [X]

YEAR NEEDED ____ AMOUNT ____

II
LANDOWNER OBJECTIVES SECTION

INSTRUCTIONS: Enter the relative value for each of the following objectives or goals. Use a scale 0 to 10, 0 = no degree or not to be considered, 10 = very desirable or high priority. Remember the economic premise that everything costs! A high rank for one objective may mean sacrificing benefits in another area. Therefore, carefully weigh your rank.

1. How interested are you in obtaining income from periodic timber harvests? 10
2. Are you interested in providing outdoor recreation opportunities for family and friends exclusive of hunting and fishing? 4
3. What is your interest in the following species of wildlife on your property?

a. Gray squirrel	5	d. Grouse	1
b. Deer	9	e. Quail	7
c. Turkey	8	f. Rabbit	6

INSTRUCTIONS: Check the following YES or NO

	YES	NO
1. Would you like to reinvest your timber income to provide an annual income?	X	
2. Are you interested in building a retirement income?	X	
3. Is an estate for your heirs important?		X
4. Does the ecological health and stability of your lands concern you?	X	
5. Would you like to practice multiple use land management?	X	
6. Are you interested in Christmas tree production?		X
7. Are you interested in realizing income from naval stores and/or stumping?		X
8. Are any of the following tree species of special interest to you?	X	

___ Black walnut ___ White oak
___ Yellow poplar ___ Yellow pines
___ Black cherry ___ Black locust

	YES	NO
9. Does the development of a fee recreation enterprise other than hunting or fishing interest you?		X
10. Will you provide recreational hunting for your family?	X	
11. Would you like to profit from fee hunting?		X
12. Is your land adjacent to extensive forest land? If YES, circle one. <100, (100-5,000), 5,000+ acres	X	
13. Are you interested in bear management on your property?		X
14. Are you interested in raccoons on your property?		X
15. Are you interested in beaver management (encouragement or control)?	X	
16. Would you like to encourage doves?	X	
17. Does the development of waterfowl potential interest you?	X	
18. Are family fishing opportunities important?	X	
19. Are you interested in fee fishing to produce income?		X
20. Would you like to construct a fishing pond?	X	
21. Are you interested in catfish farming as a source of income?		X
22. Would you like to enhance the fall colors on your property?		X
23. Are you interested in increasing the numbers and variety of songbirds?	X	
Would you like to increase the diversity of wildflowers?	X	
Do you want to set aside any special use areas?		X

LOG RULE: (Check one)

[X] Doyle
[ ] International
[ ] Scribner

INTERVIEWER ...OY BISHOA

TITLE FORESTER

ADDRESS RM 300 1720 PEACHTREE ST

CITY, STATE, AND ZIP ATLANTA GA 30309

TELEPHONE AREA CODE 404 NUMBER 881-3611

INVENTORY PROCESSOR: Data Sheets enclosed? Yes [ ] No [X]

TVA 5599 (FF&WD-1-78)

2.01

COMPUTER RUN

This questionnaire is authorized by the Tennessee Valley Authority Act of 1933 (16 U.S.C. §§ 831-831dd). While you are not required to respond, your cooperation is appreciated in order to make this survey comprehensive, adequate, and timely.

TRACT

1. NAME OF UNIT: DONNER FARM
2. NAME OF TRACT: WILT PLANTATION NUMBER 1
3. TRACT NUMBER: 01 ACRES: 430
4. PRESENT LAND OR WATER USE CODE: 151

(If 600 series is used, no further inputs are required; check with landowner for interest in 700 series.)

WATER — YES / NO

5. If tract is water, is pollution present? (If tract is water or potential water site, no further inputs required.) — NO
6. Is tract adjacent to pond or stream? — NO
7. Is pollution present in adjacent pond or stream? — NO

TIMBER (NOTE: The following questions are divided into two parts referring either to the present stand or future stand.)

SECTION I

INFORMATION FOR EXISTING STAND

- DENSITY — Basal area (if natural) / Stems/acre (if planted): 86
- Stocking percent (if no measurable basal area exists)
- SITE INDEX — Ht. @ 50 (if natural) / Ht. @ 25 (if planted): 55
- AGE — Av. of dominant and codominant: 21
- VOLUME — Merchantable sawtimber per acre, board ft.
- Percent poles and piling
- Merchantable pulpwood per acre, standard cords: 4.0
- VALUE (Fill in even if no merchantable volume exists in any category) — Sawtimber (dollars/MBF): 100.00; Poles and piling (dollars/MBF); Pulpwood (dollars/cd): 4.00
- HARVESTS — No. of intermediate cuts before final harvest (up to three): 3
- INTERVAL — Minimum no. of years between cuts: 5
- RESIDUAL — Basal Area: 1st cut 80; 2nd cut 80; 3rd cut 80

INFORMATION FOR FUTURE STANDS

- Is future stand type different from present? Yes / No: No
- If yes, what is future Land Use Code?
- DENSITY — If planted stand, give stems/acre: 680
- SITE INDEX — Ht. @ 50 (if natural) / Ht. @ 25 (if planted) (Omit if Land Use Code is same as present): 55
- VOLUME — Percent poles and piling
- VALUE — Probable stumpage value (Give in terms of today's prices) — Sawtimber (dollars/MBF): 120.00; Poles and piling (dollars/MBF); Pulpwood (dollars/cd): 4.00
- HARVESTS — No. of intermediate cuts before final harvest (up to three): 3
- INTERVAL — Minimum no. of years between cuts: 5
- RESIDUAL — Basal Area: 1st cut 80; 2nd cut 80; 3rd cut 80

SECTION II

Management Recommendations

Tract Management Treatments and Expenses (See Appendix A for codes)

(NOTE: Fill in treatments you feel will be needed on future stands as well as existing stands even if stand conversion is not planned. If code 20 is used give description in Section III.)

INFORMATION FOR EXISTING STAND

(a) Annual treatment: 05.1
Amount of expense: 2.00 per acre
(b) One time treatment
Amount of expense — per acre
Gov't assistance payment — per acre
Age incurred — years
(c) Periodic treatment
Amount of expense — per acre
Age first incurred — years
Time interval of expense—every — years
Number of treatments

TVA 5599A (PF&WD 1-78)

INFORMATION FOR FUTURE STANDS

(a) Annual treatment: 05.1
Amount of expense: 2.00 per acre
(b) One time treatment: 05.3
Amount of expense: 9.00 per acre
Gov't assistance payment: 3.00 per acre
Age incurred: 40 years
(c) Periodic treatment
Amount of expense — per acre
Age first incurred — years
Time interval of expense—every — years
Number of treatments
(d) Establishment treatment: 06.1
Amount of expense: 50.00 per acre
Gov't assistance payment: 37.50 per acre

SECTION III

Tract Specific Treatments

Description of treatment for Code 20 (if used in Section II)

(Use no more than 24 letters including spaces; abbreviate if necessary.)

CODE

200

201

202

203

204

Resource Manager: [signature] Date: 7/3/79

NOTES

Appendix I. (cont'd.) One of these forms is filled out for each tract. A <u>tract</u> is a distinctly identifiable subdivision of the farm with fairly uniform characteristics. The sample above is for tract number 1. There were 14 tracts on the Donner farm; therefore, 14 of these forms were required.

REFINING THE OBJECTIVE RANKS

. . . TO THE RESOURCE MANAGER

To make sure the landowner has ranked his objectives according to his true feelings, the objectives are refined or "reranked" before being input into the WRAP program. This refining of the "ranks" reflects the landowner's wishes and makes them arithmetically consistent so the computer can deal with them.*

When the WRAP input and tract inventory forms are completed, the resource manager should develop a questionnaire according to the instructions below and present it to the landowner for completion.

Step 1: Arrange objectives 1; 2; and 3a, b, c, d, e, and f in order according to the ranks given by the landowner on the WRAP input form. If there are objectives with the same rank, the order in which they are placed is unimportant. If any objective or objectives are given a rank of zero, then the order in which they come at the end of the program is unimportant.

Step 2: Place the objective with the highest rank in the single blank on the left of Objective Refining Form I. Do this for all of the blanks on the left side.

Step 3: Place the rest of the objectives, in order of rank, in the blanks on the right side as indicated by the order number. Drop the last objective from the list in the second group on the right side. Drop the last two objectives from the list in the third group on the right side. Continue this procedure until there are only two remaining objectives, then proceed to Objective Refining Form II.

Step 4: Place the second-ranked objective in the blank on the left side of Form II. Do this for all blanks on the left side.

Step 5: Place all the lower-ranked objectives, in order, in the blanks on the right side. Proceed as in step 3.

*This procedure is based on a concept developed by Churchman and Ackoff (1953).

Step 6: Fill out Objective Refining Forms III, IV, V, and VI repeating steps 4 and 5- removing the next highest-ranked objective each time you proceed to the next form. Continue until there are only three objectives remaining. Then staple the instruction sheet to the constructed forms and have the landowner answer the questions. Include the completed questionnaire with the rest of the WRAP input.

Example: Suppose the landowner ranked the objectives in the following order:

Fill in Objectives and Ranks from Landowner/Objectives Form (from highest to lowest rank).

Order	Objective	Objective Number	Rank
1	Timber income	1	10
2	Quail	3e	8
3	Recreation	2	5
4	Squirrel	3a	5
5	Deer	3b	4
6	Turkey	3c	2
7	Grouse	3d	1
8	Rabbit	3f	0

. . . INSTRUCTIONS FOR LANDOWNERS

Refining the objective ranks is a procedure to reflect more precisely your original objectives. On forms I through VI (see Exhibit I in this section of the manual), compare the objective or benefit on the left with the list of benefits on the right. Choose which you would rather have, the one on the left or the group on the right. After making your decision, put a check mark in the appropriate space. Once you have checked an item on the left, all succeeding items on that side of that page should be checked also. Proceed in this manner to complete each page of the forms.

Your answers should not be ponderous decisions. Use your instinctive feeling. Do not be concerned with your original ranking sequence.

Appendix I. (cont'd.)

Appendix I. (cont'd.)

REFINING THE OBJECTIVE RANKS

FORM I

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation
4. Squirrel
5. Deer
6. Turkey
7. Grouse
8. Rabbit

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation
4. Squirrel
5. Deer
6. Turkey
7. Grouse

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation
4. Squirrel
5. Deer
6. Turkey

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation
4. Squirrel
5. Deer

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation
4. Squirrel

(x) 1. Timber Income — ( ) 2. Quail
3. Recreation

SAMPLE

TVA 55998 (FF&WD 6-77) Form I

FORM II

( ) 2. Quail — (x) 3. Recreation
4. Squirrel
5. Deer
6. Turkey
7. Grouse
8. Rabbit

( ) 2. Quail — (x) 3. Recreation
4. Squirrel
5. Deer
6. Turkey
7. Grouse

( ) 2. Quail — (x) 3. Recreation
4. Squirrel
5. Deer
6. Turkey

( ) 2. Quail — (x) 3. Recreation
4. Squirrel
5. Deer

(x) 2. Quail — ( ) 3. Recreation
4. Squirrel

SAMPLE

TVA 55998 (FF&WD 6-77) Form II

FORM III

( ) 3. Recreation — (x) 4. Squirrel
5. Deer
6. Turkey
7. Grouse
8. Rabbit

( ) 3. Recreation — (x) 4. Squirrel
5. Deer
6. Turkey
7. Grouse

( ) 3. Recreation — (x) 4. Squirrel
5. Deer
6. Turkey

( ) 3. Recreation — (x) 4. Squirrel
5. Deer

SAMPLE

TVA 55998 (FF&WD 6-77) Form III

FORM IV

(x) 4. Squirrel — ( ) 5. Deer
6. Turkey
7. Grouse
8. Rabbit

(x) 4. Squirrel — ( ) 5. Deer
6. Turkey
7. Grouse

(x) 4. Squirrel — ( ) 5. Deer
6. Turkey

SAMPLE

TVA 55998 (FF&WD 6-77) Form IV

FORM V

(x) 5. Deer — ( ) 6. Turkey
7. Grouse
8. Rabbit

(x) 5. Deer — ( ) 6. Turkey
7. Grouse

SAMPLE

TVA 55998 (FF&WD 6-77) Form V

FORM VI

(x) 6. Turkey — ( ) 7. Grouse
8. Rabbit

SAMPLE

TVA 55998 (FF&WD 6-77) Form VI

Appendix II.

```
xxx        xxx   xxxxxxxxxxxxx     xxxxxxxxxxxxxxxx    xxxxxxxxxxxx
xxx        xxx   xxx      xxx      xxx          xxx    xxx      xxx
xxx        xxx   xxx       xxx     xxx          xxx    xxx       xxx
xxx        xxx   xxx        xxx    xxx          xxx    xxx        xxx
xxx        xxx   xxx       xxx     xxx          xxx    xxx       xxx
xxx        xxx   xxx      xxx      xxx          xxx    xxx      xxx
xxx  xxxx  xxx   xxxxxxxxxxxxx     xxxxxxxxxxxxxxxx    xxxxxxxxxxxx
xxx xxxxxx xxx   xxx     xxx       xxx          xxx    xxx
xxx xxx  xxx xxx xxx      xxx      xxx          xxx    xxx
xxxxxx   xxxxxx  xxx       xxx     xxx          xxx    xxx
xxxxx     xxxxx  xxx        xxx    xxx          xxx    xxx
```

A WOODLAND RESOURCE ANALYSIS PROGRAM
DEVELOPED BY
THE TENNESSEE VALLEY AUTHORITY
IN COOPERATION WITH
UNITED STATES FOREST SERVICE   ALABAMA FORESTRY COMMISSION

DONNER FARM

PROCESSED FOR:

RUTH CRISTOE
OWNER
3979 SHADY DR
LILBURN GA 30247

RESOURCE DATA COLLECTED 7/09/79

RESOURCE DATA ANALYZED 7/17/79

FOR ADDITIONAL INFORMATION CONTACT:

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INTRODUCTION

YOU HAVE BEFORE YOU A WRAP PRINT-OUT--A COMPUTER GENERATED SERIES OF INFORMATIONAL RESOURCE MESSAGES AND TABLES, EACH INITIATED BY THE INFORMATION SUPPLIED BY YOU AND YOUR FORESTER. IT IS BASED ON YOUR STATED GOALS AND OBJECTIVES, IN ADDITION TO HIS ANALYSIS OF YOUR EXISTING RESOURCES AND LAND CAPABILITIES.

WRAP IS DESIGNED TO AID YOU IN MAKING INTELLIGENT CHOICES FROM AMONG THE MANY OPTIONS FACING YOU IN THE ESTABLISHMENT AND MANAGEMENT OF A SUCCESSFUL MULTIPLE-USE PROGRAM ON YOUR WOODLANDS. WRAP DOES NOT MAKE DECISIONS. IT DOES MAKE THE COMPLEX OPTIMIZING CALCULATIONS NEEDED TO DETERMINE MANAGEMENT STRATEGIES BEST SUITED TO YOUR SITUATION; IN THIS WAY, WRAP PROVIDES A MANAGEMENT PLAN FOR YOUR CONSIDERATION. SINCE IT IS IMPOSSIBLE TO INCORPORATE ALL OF THE VARIABLES AFFECTING YOUR DECISIONS IN THE PROGRAM, YOU AND YOUR FORESTER SHOULD PLAN TO AUGMENT THIS REPORT WITH YOUR OWN MORE DETAILED DATA, PROFESSIONAL EXPERTISE, AND FIRSTHAND KNOWLEDGE OF THE PROPERTY.

WRAP DOES NOT DEAL WITH INTENSIVE COMMERCIAL ENTERPRISES SUCH AS SKI AREAS OR HUNTING PRESERVES. IT DEALS WITH WOODLAND OPERATIONS ONLY. NOR ARE POSSIBLE COSTS AND RETURNS FOR AGRICULTURAL ACTIVITIES INCLUDED. HOWEVER, THESE MAY BE ADDED TO THE WRAP RESULTS TO OBTAIN A MORE ACCURATE AND REALISTIC REPRESENTATION OF THE POTENTIAL OF YOUR TOTAL OWNERSHIP.

THIS PROGRAM IS UNIQUE IN THAT IT DEALS WITH YOUR OBJECTIVES, WHAT YOU WANT FROM YOUR LAND. BY UTILIZING YOUR OBJECTIVES, YOUR RESOURCE DATA, LAND CAPABILITIES, AND BY COMBINING THEM WITH THE VOLUMES OF STORED DATA, ALONG WITH THE MATHEMATICAL CAPABILITIES OF THE COMPUTER, WE HAVE BEEN ABLE TO SELECT AN OPTIMUM COURSE OF ACTION FOR YOU. WE FEEL THAT THIS PLAN OFFERS YOU THE BEST OPPORTUNITY OF REACHING YOUR STATED GOALS AS RELATED TO YOUR FORESTER.

STUDY THIS INFORMATION CAREFULLY, BOTH ALONE AND WITH YOUR FORESTER. IF AFTER A CAREFUL STUDY, YOU FEEL THAT THERE ARE INACCURACIES--OR IF YOU ALTER YOUR OBJECTIVES AS A RESULT OF THE INFORMATION PRESENTED, CONTACT US (AT YOUR FORESTER'S ADDRESS FOUND ON THE COVER PAGE), AND ADJUSTMENTS AND RECALCULATIONS CAN BE MADE.

Appendix II. (cont'd.)

TRACT AND LAND USE SUMMARY

TRACT NUMBER	TRACT NAME	ACREAGE	PRESENT LAND USE	STAND AGE (IF TIMBER)	FUTURE LAND USE (IF DIFFERENT FROM PRESENT)
1	YLT PLANTATION NUMBER 1	43.0	LOBLOLLY PINE PLANTATION	21	
2	YLT PLANTATION NUMBER 2	68.0	LOBLOLLY PINE PLANTATION	20	
3	YLT PLANTATION NUMBER 3	102.0	LOBLOLLY PINE PLANTATION	20	
4	YLT PLANTATION NUMBER 4	35.0	LOBLOLLY PINE PLANTATION	19	
5	YLT PLANTATION NUMBER 5	26.0	LOBLOLLY PINE PLANTATION	18	
6	RUTHS WOODS	63.0	UPPER SLOPES AND RIDGES	70	LOBLOLLY PINE PLANTATION
7	TOMS WOODS	6.0	UPPER SLOPES AND RIDGES	70	LOBLOLLY PINE PLANTATION
8	SWAMP	14.0	BOTTOMLAND	80	
9	HARDWOOD DRAW	15.0	UPPER SLOPES AND RIDGES	25	
10	DRY RIDGE	32.0	UPPER SLOPES AND RIDGES	80	LOBLOLLY PINE PLANTATION
11	WOODLOT	3.0	WOOD LOT		
12	CEMETARY	4.0	EXCLUDED AREA		
13	FISHING POND	4.0	WARMWATER LAKES OR PONDS		
14	OLD FIELDS	195.0	FALLOW OR IDLE		
	TOTAL ACRES	610.0			

Appendix II. (cont'd.)

LONG-RANGE (50-YEAR) HARVESTING SCHEDULE RESULTING IN MAXIMUM MULTIPLE-RESOURCE BENEFITS

(MULTIPLE-RESOURCE OPTIMIZED)

TRACT NO	ACRES	TYPE	YEAR	STAND AGE	-HARVEST VOLUME- POLETIMBER (MBF-DOYLE)	SAWTIMBER (MBF-DOYLE)	PULPWOOD (STD-CDS)	HARVEST VALUE	-RESIDUAL STAND (PER ACRE)- SAWTIMBER (BF-DOYLE)	PULPWOOD (STD-CDS)	BA (SQ FT)
1	43.0	LOBLOLLY PINE PLANTATION	1981	23			1,660	16,602		24.0	80
			1986	28		153	412	20,956	3,989	11.0	80
			1991	33		158	98	16,328	6,761	4.0	80
			1996	38		498	146	56,192			
		* STAND REGENERATED									
			2011	15			888	8,884		22.0	80
			2016	20		115	298	15,590	3,830	10.0	80
			2021	25		137	89	15,925	6,480	4.0	80
			2026	30		477	148	53,967			
		* STAND REGENERATED									
2	68.0	LOBLOLLY PINE PLANTATION	1979	20			697	6,974		21.0	80
			1984	25			754	7,536		25.0	80
			1989	30		98	183	12,597	4,264	8.0	80
			1994	35		497	403	58,737			
		* STAND REGENERATED									
			2011	17			521	5,208		18.0	80
			2016	22			798	7,981		23.0	80
			2021	27		88	268	12,587	3,223	11.0	80
			2026	32		440	574	54,125			
		* STAND REGENERATED									
3	102.0	LOBLOLLY PINE PLANTATION	1979	20			2,071	20,708		21.0	80
			1984	25		203	1,060	32,971	2,572	13.0	80
			1989	30		277	343	33,922	5,273	7.0	80
			1994	35		997	461	114,275			
		* STAND REGENERATED									
			2009	15			1,428	14,283		20.0	80
			2014	20		175	608	27,302	2,678	12.0	80
			2019	25		252	298	30,745	5,254	6.0	80
			2024	30		976	452	111,882			
		* STAND REGENERATED									
4	35.0	LOBLOLLY PINE PLANTATION	1979	19			226	2,261		18.0	80
			1984	24			397	3,971		24.0	80
			1989	29		58	116	7,506	4,097	8.0	80
			1994	34		275	205	32,305			
		* STAND REGENERATED									
			2009	15			298	2,981		18.0	80

Appendix II. (cont'd.)

THE FOLLOWING TABLE PRESENTS ESTIMATES OF THE RELATIVE LEVELS OF WILDLIFE POPULATIONS AND RECREATION ACTIVITY THAT MAY BE SUPPORTED IN YOUR WOODLANDS FOR THE NEXT FIFTY YEARS. THESE ARE POTENTIAL LEVELS AND ARE EXPRESSED AS LOW, MEDIUM, HIGH, OR NOT POSSIBLE (BLANK). HARVESTING ACTIVITIES, AS WELL AS STAND AGE AND OTHER VARIABLES, AFFECT THESE LEVELS AND MAY PRODUCE VARIATION IN POTENTIAL LEVELS THAT CAN BE SUPPORTED.

AT THE BOTTOM OF THE PAGE, IS A TABLE WHICH INDICATES RANGES FOR THE VARIOUS WILDLIFE POPULATIONS AS WELL AS RECREATION. IF, FOR EXAMPLE, THE FOLLOWING TABLE INDICATES THAT, IN A GIVEN YEAR, MEDIUM (M) LEVELS OF DEER ARE POSSIBLE, THERE MAY BE FROM FOUR TO EIGHT DEER PER 100 ACRES OF WOODLAND. IT IS VERY IMPORTANT TO NOTE THAT THESE ARE ESTIMATES AND YOUR PARTICULAR PROPERTY MAY VARY FROM THE NORM. HOWEVER, THE TABLE DOES PROVIDE A REASONABLE BASIS FOR COMPARISON PURPOSES.

THERE IS ALSO A TABLE BELOW WHICH SHOWS THE TIMBER MANAGEMENT CASH FLOW FOR YOUR PROPERTY AT INTERVALS OF FIVE YEARS. VALUES IN THE TABLE ARE EXPRESSED IN TODAY'S DOLLARS AND DO NOT INCLUDE INFLATION. IT SHOWS PERIODIC INCOMES AND EXPENDITURES, AS WELL AS THE NET ACCUMULATED INCOME THROUGH THE YEAR INDICATED. A MINUS (-) SIGN TO THE RIGHT OF THE LAST COLUMN INDICATES THAT THERE HAVE BEEN MORE COSTS THAN INCOMES TO THAT YEAR.

POTENTIAL RESULTS OF THE PRECEDING HARVESTING STRATEGY BY FIVE-YEAR INCREMENTS

(MULTIPLE-RESOURCE OPTIMIZED)

W I L D L I F E	P O P U L A T I O N S	A C H I E V E D				RECREATION	TIMBER MANAGEMENT CASH FLOW		
EAR	SQUIRREL	DEER	TURKEY	GROUSE	QUAIL	RABBIT	USE-DAYS	INCOME (DOLLARS)	EXPENDITURES (DOLLARS)	NET ACCUMULATED INCOME TO DATE (DOLLARS)
979	M	M			L	L	M	50,701	9,382	41,319
984	L	M			L	L	L	67,361	5,372	103,307
989	L	H			L	L	M	82,004	4,687	180,624
994	L	M			L	L	M	265,566	15,082	431,108
999	L	M			L	M	M	71,880	6,622	496,366
004	L	H			M	M	L	23,937	4,687	515,616
009	L	H			L	M	L	119,335	12,965	621,987
014	L	M			L	L	L	49,781	4,687	667,081
019	L	H			L	L	L	74,880	5,137	736,824
024	L	H			L	L	L	211,059	12,022	935,861
029	L	M			L	L	M	125,727	9,682	1,051,906

LOW (L), MEDIUM (M), HIGH (H) WILDLIFE POPULATIONS AND RECREATION USE-DAYS ARE DEFINED AS FOLLOWS:

	LOW	MEDIUM	HIGH
SQUIRREL	LESS THAN 5 PER 10 ACRES	5 TO 10 PER 10 ACRES	MORE THAN 10 PER 10 ACRES
DEER	LESS THAN 4 PER 100 ACRES	4 TO 8 PER 100 ACRES	MORE THAN 8 PER 100 ACRES
TURKEY	LESS THAN 2 PER 1000 ACRES	2 TO 3 PER 1000 ACRES	MORE THAN 3 PER 1000 ACRES
GROUSE	LESS THAN 8 PER 100 ACRES	8 TO 11 PER 100 ACRES	MORE THAN 11 PER 100 ACRES
QUAIL	LESS THAN 4 PER 10 ACRES	4 TO 6 PER 10 ACRES	MORE THAN 6 PER 10 ACRES
RABBIT	LESS THAN 5 PER 10 ACRES	5 TO 10 PER 10 ACRES	MORE THAN 10 PER 10 ACRES
RECREATION (USE-DAYS/YEAR)	LESS THAN 2 PER ACRE	2 TO 4 PER ACRE	MORE THAN 4 PER ACRE

Appendix II. (cont'd.)

RATE OF RETURN ANALYSIS

A RATE OF RETURN ANALYSIS IS PROVIDED TO ASSIST YOU IN EVALUATING YOUR INVESTMENT IN WOODLAND MANAGEMENT ACTIVITIES. RATE OF RETURN MAY BE DEFINED AS THE INTEREST RATE THAT EQUATES THE NET PRESENT VALUE OF ALL FUTURE INCOMES AND EXPENSES WITH ZERO. IT IS IMPORTANT TO NOTE THAT THE FIGURE WE USE FOR THE INITIAL INVESTMENT IN THE TRACT IS THE CURRENT VALUE OF YOUR TIMBER AS IT STANDS UNCUT IN THE WOODS. WE DO NOT CONSIDER THE PRICE YOU PAID FOR YOUR LAND IN THE ANALYSIS, OR ANY OTHER EXPENSES ON THE TRACT BEFORE THIS YEAR.

RATE OF RETURN MAY BE THOUGHT OF AS THE INTEREST RATE YOU ARE EARNING FOR EACH TRACT. KEEP IN MIND THAT THIS INTEREST RATE IS BASED ON THE INCOMES AND EXPENSES PROVIDED TO WRAP BY YOU AND YOUR FORESTER. THIS RATE IS ALSO BASED ON THE RESULTS OF YOUR WRAP HARVESTING SCHEDULES.

THIS ANALYSIS IS BASED ON WOODLAND MANAGEMENT ACTIVITIES, THUS THE VALUE OF YOUR LAND BASE IS NOT INCLUDED. A RATE OF RETURN BY TRACT ENABLES YOU TO SEE WHICH TRACT IS YIELDING A HIGHER RETURN. THIS ALLOWS YOU TO FOCUS YOUR MANAGEMENT ACTIVITIES ON THE TRACTS THAT ARE YIELDING A HIGHER RETURN. IF TAXES AND MANAGEMENT EXPENSES ARE NOT REFLECTED AS COSTS THE RATE OF RETURN FOR A SPECIFIC TRACT MAY APPEAR UNUSUALLY HIGH. THESE RETURNS MAY ALSO BE HIGHER THAN EXPECTED IF THE LANDOWNER CARRIES OUT CERTAIN MANAGEMENT TREATMENTS HIMSELF.

THE FOLLOWING TABLE CONTAINS THE PERCENTAGE RATE OF RETURN FOR EACH TIMBERED TRACT ON YOUR PROPERTY. THE RATE IS GIVEN FOR BOTH EXISTING AND FUTURE STANDS ON EACH TRACT, BASED ON THE TIMBER-OPTIMIZED AND MULTIPLE-RESOURCE OPTIMIZED HARVESTING SCHEDULES.

THE SYMBOL N/A WILL APPEAR IF A STAND INCURS A FINAL HARVEST IN THE CURRENT YEAR BECAUSE A RATE OF RETURN CANNOT BE CALCULATED. THE SYMBOL N/T WILL APPEAR FOR NON-TIMBERED TRACTS. ASTERISKS (***) WILL APPEAR IF THE RETURN IS LESS THAN THE INFLATION RATE. DOLLAR SIGNS ($$$) WILL APPEAR IF THE RATE OF RETURN IS GREATER THAN 300 PERCENT. THE SYMBOL I/D WILL APPEAR IF AN EXISTING YOUNG STAND HAS NO SAWTIMBER OR PULPWOOD VALUE.

I/D - INSUFFICIENT DATA
N/A - RETURN NOT APPLICABLE
N/T - NON-TIMBERED
*** - LESS THAN INFLATION RATE
$$$ - GREATER THAN 300 PERCENT

INTERNAL RATE OF RETURN

TRACT NO	EXISTING STAND TIMBER	EXISTING STAND MULTIPLE	FUTURE STAND TIMBER	FUTURE STAND MULTIPLE
1	27 %	27 %	29 %	29 %
2	20 %	20 %	21 %	21 %
3	29 %	29 %	27 %	27 %
4	23 %	23 %	24 %	24 %
5	26 %	26 %	24 %	24 %
6	N/A	N/A	22 %	22 %
7	N/A	N/A	22 %	22 %
8	N/A	N/A	16 %	16 %
9	11 %	11 %	11 %	11 %
10	N/A	N/A	22 %	22 %
11	N/T	N/T	N/T	N/T
12	N/T	N/T	N/T	N/T
13	N/T	N/T	N/T	N/T

Appendix III. Excerpts from WRAP

1. BORROWING MONEY TO DEVELOP YOUR LAND

   MAJOR RESOURCE DEVELOPMENT PROGRAMS USUALLY REQUIRE ADDITIONAL CAPITAL OUTLAY BY THE LANDOWNER. THIS IN TURN REQUIRES A MAJOR DECISION, OR SERIES OF DECISIONS. PROBABLY THE FIRST DECISION TO BE MADE IS THE ECONOMIC FEASIBILITY OF THE PROGRAM....

   ....THE FOLLOWING TABLES ARE DESIGNED TO SHOW YOU AT A GLANCE HOW MUCH MONEY YOU CAN BORROW, AT DIFFERENT INTEREST RATES AND TIME PERIODS, WITHIN YOUR AVAILABLE INCOME LEVEL....

2. PRUNING

   PRUNING SELECTED CROP TREES OF HIGH-VALUE SPECIES, SUCH AS BLACK WALNUT, BLACK CHERRY, YELLOW-POPLAR AND POSSIBLY WHITE OAK, CAN POSSIBLY INCREASE YOUR EVENTUAL INCOME THROUGH THE PRODUCTION OF MORE HIGH-VALUE PRODUCTS AS VENEER LOGS, STAVE AND HEADING BOLTS, ETC....

3. YELLOW-POPLAR (LIRIODENDRON TULIPFERA L.) HAS A WIDE BOTANICAL RANGE.... IT REQUIRES A MOIST, WELL-DRAINED, AND LOOSE-TEXTURED SOIL....PRODUCES AN AVERAGE OF TWO MILLION SEEDS PER ACRE EACH YEAR....HARVESTING METHOD.... POST-LOGGING TREATMENT....PROTECTION....ARTIFICIAL REGENERATION....

   WHITE OAK....

   YELLOWPINES....

4. FOLLOWING IS A PARTIAL LIST, BY LIKELY HABITATS, OF THE WILDFLOWERS YOU MIGHT EXPECT TO FIND IN YOUR GENERAL AREA....

5. BECAUSE OF YOUR HIGH INTEREST IN GRAY SQUIRRELS, A TIMBER MANAGEMENT PROGRAM HAS BEEN DEVELOPED FOR YOUR PROPERTY THAT SHOULD RESULT IN THE GREATEST NUMBER OF SQUIRRELS CONSISTENT WITH YOUR OTHER OBJECTIVES....

   ...WHITE-TAILED DEER....

   ...WILD TURKEY....

   ...COTTONTAIL RABBIT....

   ...BOBWHITE QUAIL....

COMPUTATIONAL APPLICATIONS FOR TIMBER PRODUCTION ANALYSIS

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The need for certain basic information is common in every evaluation of timber production. A program which provides this information in a readily usable form, with a minimum of input, has been developed to assist in forest resource planning.

The final output of the program consists of seven tables. By looking at these seven tables, the planner knows the current growth of timber in the state, the amount of timber that could be grown under intensive management conditions, and the amount of timber that will be needed at different times in the future. The program provides a quick way of getting a general view of forestry conditions in the state.

The following information is needed to run this program: 1) acreage of each site class, by ownership; 2) average growth, by ownership; and 3) acreage of each area condition class, by ownership. This information is published for each state by the Renewable Resources Evaluation Unit (Forest Survey) of the Forest Service Research Branch. It is available in a number of combinations: acreage of forestland by forest-type and ownership class is one such combination.

The program will develop other information such as potential productivity, potential productivity per acre, and average growth per acre. OBERS demand projections can also be read in for the years 1962, 1980, 1985, 2000, and 2020.

A more detailed explanation of what the program does, and how the same information can be obtained manually, follows.

<u>Program</u>

The first step in the evaluation is to derive potential productivity. In order to do this, it is necessary to know the acreage by site-class, as in Table 1.

Table 1.

Acreage of Commercial Forestland
by Site-Class and Ownership

Site Class	All Ownerships*	National Forests*	Other Public*	Forest Industry*	Farmer & Misc. Private*
165 cu. ft. or more	507.8	15.0	18.8	137.1	336.9
120-165 cu. ft.	2542.6	205.4	94.4	440.5	1802.3
85-120 cu. ft.	8230.2	613.1	231.3	1462.4	5873.4
50-85 cu. ft.	4877.8	277.1	131.5	885.7	3583.5
Less than 50 cu. ft.	345.9	11.4	28.4	70.4	235.7
Total	16504.3	1122.0	504.4	2996.1	11831.8

* figures given in 1000 acres.

The next step is to determine the average production per acre by site-class.

For the site-class "165 cu. ft. or more," assuming 220 cubic feet is the highest production expected:

1. 220 - 165 = 55
2. 55 ÷ 2 = 27.50
3. 165 + 27.50 192.50 cubic feet = average

The same method is used to compute the average of the remaining site classes:

Site-class "120 - 165 cu. ft.:"

1. 165 - 120 = 45
2. 45 ÷ 2 = 22.50
3. 120 + 22.50 = 142.50 cubic feet

Site-class "85 - 120 cu. ft.:"

1. 120 - 85 = 35
2. 35 ÷ 2 = 17.50
3. 85 + 17.50 = 102.50 cubic feet

Site-class "50 - 85 cu. ft.:"

1. 85 - 50 = 35
2. 35 ÷ 2 = 17.50
3. 50 + 17.50 = 67.50 cubic feet

For the site-class "Less than 50 cu. ft.," it will be necessary to assume a minimum production per acre. In this case, it is assumed to be 25 cubic feet per acre. Therefore, the average would be:

1. 50 - 25 = 25
2. 25 ÷ 2 = 12.50
3. 25 + 12.50 = 37.50 cubic feet

This procedure would be the same in all cases, although you might wish to change the highest figure (220 cu. ft.) or the lowest (25 cu. ft.), depending on conditions in a particular area.

The third step would be to multiply the number of acres in each site-class (step 1) by the average productivity derived in step 2.

Table 1 shows that there are 507,800 acres in all ownerships in site-class "165 cu. ft. or more." In step 2, it was determined that 192.50 cubic feet per acre is the average productivity in this site-class. To derive total productivity, multiply 507,800 acres by 192.50 cu. ft./acre. This gives a total production of 97,751,500 cubic feet for this site-class. If this is completed for every site-class and ownership, the results can be shown in tabular form, as in Table 2.

Table 2.

Potential Production, By Ownership

Mid-Point of Site-Class	All Ownerships*	National Forest*	Other Public*	Forest Industry*	Farmer & Misc. Private*
192.5 cu. ft.	97751.5	2887.5	3619.1	26391.7	64853.2
142.5 cu. ft.	362320.5	29269.5	13452.0	62771.3	256827.7
102.5 cu. ft.	843595.5	62842.8	28833.2	149896.0	602023.5
67.5 cu. ft.	329251.5	18704.2	8876.2	59784.7	241886.4
37.5 cu. ft.	12971.2	427.5	1065.0	2640.0	8838.7
Total	1645890.2	114131.5	55845.5	301483.7	1174429.5

* figures given in 1000 cubic feet.

The total amount of 1,645,890.2 in the "All ownerships" column represents the total cubic feet of timber which could be produced in the state if every acre of forestland produced its fullest potential. Although it is unrealistic to think that this will ever happen, this total can be used to derive and average potential production per acre.

In step 4, the total potential production from Table 2 is divided by the total acreage from Table 1 to obtain this average potential production per acre. Thus the average for all ownerships would be 1,645,890,200 feet (Table 2) ÷ 16,504,300 acres (Table 1) = 99.7 cubic feet/acre. Table 3 shows the result of this procedure.

Table 3.

Potential Production per Acre

	All Ownerships*	National Forest*	Other Public*	Forest Industry*	Farmer & Misc. Private*
Potential Production/ Acre/Year	99.7	101.7	100.7	100.6	99.3

* figures given in cubic feet.

Table 3 indicates that the average quality of lands in all ownerships is about the same. National Forest lands are capable of producing more than other categories, but the difference is slight.

A look at the actual growth will help to determine how well the different ownerships are managing their forest lands. Actual growth of growing stock as reported in Mississippi Forests: Trends and Outlook, is listed in Table 4.

Table 4.

Actual Growth per Year, By Ownership

	All Ownerships	National Forest	Other Public	Forest Industry	Farmer & Misc. Private
Million cubic feet	1013.0	78.5	33.3	185.6	715.6

To obtain an average growth per acre, divide the volumes in Table 4 by the acres in Table 1. For example, average growth per acre in all ownerships is 1,013,200,000 cubic feet (Table 4), divided by 16,504,300 acres (Table 1), or 61.4 cubic feet per acre. The averages for all ownership classes are listed in Table 5.

Table 5.

Average Growth per Acre, By Ownership

	All Ownerships	National Forest	Other Public	Forest Industry	Farmer & Misc. Private
Cubic feet	61.4	70.0	60.1	62.0	60.5

Table 5 indicates that the growth rate is about the same on all ownerships, except National Forest. It also shows that none of the ownership classes is managing its lands well enough to achieve maximum production.

A knowledge of the number of acres in each area-condition class will help to indicate why actual growth is so much lower than potential. Area-condition class is based upon stocking of desirable trees and other conditions affecting timber growth. The area-condition classes are as follows:

Class 10 - Areas 100 percent or more stocked with desirable trees and not overstocked.

Class 20 - Areas 100 percent or more stocked with desirable trees and overstocked with all live trees.

Class 30 - Areas 60 to 100 percent stocked with desirable trees and with less than 30 percent of the area controlled by other trees, inhibiting vegetation, slash, or nonstockable conditions.

Class 40 - Areas 60 to 100 percent stocked wtih desirable trees and with 30 percent of more of the area controlled by other trees, or conditions that ordinarily prevent occupancy by desirable trees.

Class 50 - Areas less than 60 percent stocked with desirable trees, but with 100 percent or more stocking of growing-stock trees.

Class 60 - Areas less than 60 percent stocked with desirable trees, but with 60 to 100 percent stocking of growing-stock trees.

Class 70 - Areas less than 60 percent stocked with desirable trees, and with less than 60 percent stocking of growing-stock trees.

The acreages of commercial forestland by area-condition and ownership classes are listed in Table 6.

Table 6.

Area-Condition Class

Area Condition Class	All Ownerships*	National Forest*	Other Public*	Forest Industry*	Farmer & Misc. Private*
10	101.7	--	--	67.7	34.0
20	30.5	--	--	11.1	19.4
30	332.6	40.9	27.7	79.0	185.0
40	905.4	90.7	21.9	306.7	486.1
50	2632.9	249.5	69.9	550.9	1762.6
60	9185.1	625.9	345.4	1498.8	6715.0
70	3316.1	115.0	89.5	481.9	2629.7
Total†	16504.3	1122.0	554.4	2996.1	11831.8

* Figures in 1000 acres.

† Totals may not add to 100 due to rounding.

This analysis indicates that growth could be increased considerably. But, there is no need to spend money to increase the production of timber if there is no demand for additional products. The long time periods involved in producing timber require that future demand be considered as well as current demand. Predicting what will happen in the future is one of the most difficult tasks in any economic analysis, but it is essential. Although a prediction will never be absolutely correct, it does give an idea of the direction which an organization needs to take.

A set of projections of demands for agricultural and forestry products has been prepared by the Office of Business Economics (now known as the Bureau of Economic Analysis) of the Department of Commerce, and the Economics Research Service (now Economics, Statistics, and Cooperatives Service) of the Department of Agriculture. These projections contain estimates of the demand for timber at different times in the future, and are available by state, by Bureau of Economic Analysis area, and by Water Resource area and subarea.

Table 7 lists the estimates for the state of Mississippi.

Table 7.

Demand for Roundwood Production*

	1962	1980	1985	2000	2020
Million Cubic Feet	364	600	662	850	1150

* Source: 1972 OBERS projections, Vol. I., pp. 106-107.

A comparison of Table 7 with Table 2 indicates that the amount of roundwood demanded in the year 2020 does not exceed the production capability of the state's forest land (1,150,000,000 cu. ft. versus 1,645,890.200 cu. ft.); however, a comparison of Table 7 with Table 4 shows that actual production will have to be increased moderately in order to meet demands (current production = 1,013,200,000 cubic feet; demand = 1,150,000,000 cubic feet).

A word of caution: OBERS projections are based on a given set of assumptions. For example, it was assumed that price trends for timber products will be about the same as the price trends for competing materials. Therefore the substitution between timber products and other products would be limited. It was also assumed that there would be enough supplies to satisfy demands for timber products, and that technology in forest industires would improve at the same rate as in industries which produce competing materials.

If these assumptions do not fit the expected situation in a given state, there are other sources of projections. Many state universities, state planning agencies, and others make estimates of future population and industrial levels for the state. A check with these sources, and a comparison of the available estimates will help in selecting the one which "fits" best.

It is also possible to make timber demand projections. Timber demand projections are usually based on population, income, and per capita consumption of the different timber products, such as timber for housing, paper and pulp, etc. This can become a very involved procedure, requiring a great deal of time and money, and is not really necessary if reasonable estimates are already available.

Summary

I plan to continue working on this project. I hope to combine this system with something like PAR III. Given growth rates, costs, and prices, PAR III computes present net worth, benefit-cost ratios, and internal rates of return for forestry investments. With the proper forms, a planner could spend a couple of hours putting data on forms, rather than several days performing routine mathematical calculations.

I would also like to store this program in a file, so that it can be used on a demand terminal. A planner could then have a set of tables within minutes.

There is a tendency in planning to spend far too much time gathering data that is never used. The planner then has little time to plan. I think this system will help to eliminate some of this waste.

Although I spent more time working on the program than it would have taken me to do all the calculations for the thirteen southern states, I think the time was well spent. The program will help people who are not familiar with the necessary calculations. It can also be used in sub-state planning, with only minor modifications.

ECONOMIC ANALYSIS FOR FOREST DEVELOPMENT ROADS

Charlton S. Lewis
Jefferson National Forest
Roanoke, Virginia

Objective

To develop a procedure for economic analysis for road projects and thus satisfy the requirements of the Forest Service Manual Region 8 Supplement 48, which says in part, "...all capital investment projects estimated to be over $50,000 in construction costs submitted to the Regional Office for fiscal year programming, shall contain an economic analysis that includes present net worth and internal rate of return." "DISCOUNT" is a computer program developed in Region 5 that helps perform such economic analysis. Using a specially designed form to expedite calculations of benefits and costs and the computer program "DISCOUNT," we performed an economic analysis for Apple Tree Road #3034 on the Jefferson National Forest (see Exhibit I).

Project

The first step in performing an economic analysis is the determination of benefits and costs and their values. To aid in this determination, a form was constructed after study to determine what the major costs and benefits associated with a Forest Service road were. The most likely costs are preconstruction, construction, reconstruction, and maintenance. The most likely benefits are timber, wildlife (hunting, fishing, etc.), dispersed recreation (hiking, etc.), and firewood recreation. An example of the form used in this project is shown in Figure 1. Values of benefits and costs were from sources on the Forest and from RPA in the <u>FY 1981-82 Program Development Instructions</u>, Appendix A, 1978.

Exhibit I.

VICINITY MAP

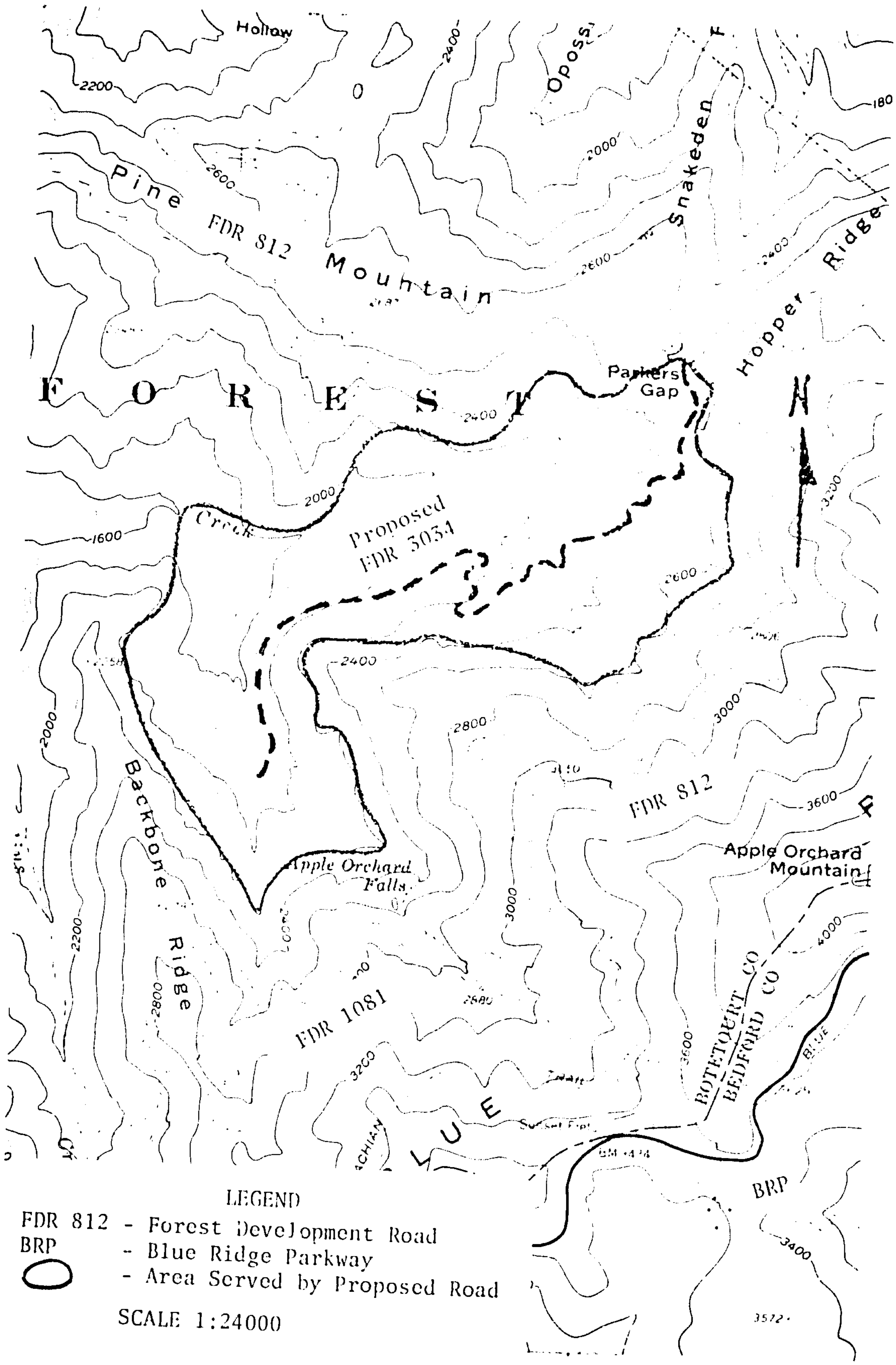


Figure 1. Form constructed to assist in the calculations of costs and benefits associated with a Forest Service road (portion of form).

ECONOMIC ANALYSIS

Apple Tree ROAD NO. *3034*

Glenwood RANGER DISTRICT ALT. *C*

ROAD SEGMENTS

MILEAGE CONST.	MILEAGE RECONST.	YEAR
2.113 MI.	MI.	0
0.5 MI.	MI.	10
MI.	2.613 MI.	20
MI.	MI.	
MI.	MI.	
MI.	MI.	
MI.	MI.	

MILEAGE	YEARS	MAINT. LEVEL
2.113 MI.	1-10	2
2.613 MI.	11-20	2
MI.		
MI.		
MI.		
MI.		
MI.		

ROTATION: *80* YEARS TOTAL AREA: *580* ACRES

TIMBER VOLUMES (PER CUTTING CYCLE)

	% CUT/CYCLE (80 YR.)		% CUT/CYCLE (100 YR.)		VOLUME/ACRE*	
	REGEN.	THINN.	REGEN.	THINN.	REGEN.	THINN.
SAWTIMBER	12%	24%	10%	20%	8 MBF/AC.	2 MBF/AC.
ROUNDWOOD	12%		10%		13 CUNITS/AC.	
FIREWOOD	12%	24%	10%	20%	3 CORDS/AC.	1.5 CORDS/AC.

REGENERATION

12% X *580* AC. = *70* AC.

THINNING

24% X *580* AC. = *140* AC.

	AREA	VOLUME/AC.*	VOLUME
SAWTIMBER	70 AC.	8 MBF/AC.	560 MBF
ROUNDWOOD	70 AC.	13 CUNITS/AC.	910 CUNITS
FIREWOOD	70 AC.	3 CORDS/AC.	210 CORDS
SAWTIMBER	140 AC.	2 MBF/AC.	280 MBF
FIREWOOD	140 AC.	1.5 CORDS/AC.	210 CORDS

COSTS

PRECONSTRUCTION: RATE: $3000/MI. (FOR EA. MI. OF CONST.)

MILEAGE	RATE	COST	YEAR
2.113 MI.	$ 3000/MI.	$ 6339	0
0.5 MI.	$ 3000/MI.	$ 1500	10
MI.	$ 3000/MI.	$	
MI.	$ 3000/MI.	$	
MI.	$ 3000/MI.	$	
MI.	$ 3000/MI.	$	

*GET FROM DISTRICT.

Figure 1. (cont'd.)

CONSTRUCTION: RATE: $ 52,615.45 /MI. (from contract)

MILEAGE	RATE	COST	YEAR
2.113 MI.	$52,615/MI.	$ 111,175	0
0.5 MI.	$52,615/MI.	$ 26,308	10
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	

RECONSTRUCTION: RATE: $ 20,000 /MI.

MILEAGE	RATE	COST	YEAR
2.613 MI.	$20,000/MI.	$52,260	20
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	
MI.	$ /MI.	$	

MAINTENANCE:

MAINT. LEVEL	$/MI./YR.
1	56
2	225
3	729
4	873
5	1121

MILEAGE	RATE	COST	YEARS
2.113 MI.	$ 225 /MI./YR.	$ 475 /YR.	1-10
2.613 MI.	$ 225 /MI./YR.	$ 588 /YR.	11-20
MI.	$ /MI./YR.	$ /YR.	
MI.	$ /MI./YR.	$ /YR.	
MI.	$ /MI./YR.	$ /YR.	

The purpose for developing "DISCOUNT" was to meet a need for analyzing future cash flows that could be accomplished on a low-speed terminal, and would be easier to use than earlier programs. Part of the resultant "DISCOUNT" is a program designed to calculate internal rates of return, net present values, and benefit-cost ratios quickly and easily. "DISCOUNT" is designed to handle sets of cash flows with a maximum of 100 costs or returns occurring only once, and a maximum of 30 annual amounts. The maximum number of years for each annual amount is 100.

The cash flows for Apple Tree Road #3034, combined, are as follows:

Cash Flow	Undiscounted $	Year(s)
Single Payment Preconstruction Costs	- $ 6,340	0
	- $ 1,500	10
Single Payment Construction Costs	- $111,200	0
	- $ 26,300	10
Single Payment Reconstruction Costs	- $ 52,000	20
Uniform Series Maintenance Costs	- $ 480	1-10
	- $ 590	11-20
Single Payment Timber Benefits	$ 79,800	1,11,21
Uniform Series Wildlife Benefits (Hunting)	$ 1,150	1-10
	$ 1,420	11-20
Uniform Series Dispersed Rec. Benefits	$ 3,990	1-20
Single Payment Firewood Rec. Benefits	$ 7,270	2
	$ 1,720	12

The preceding cash flows were used as input to program "DISCOUNT" and for the discount rates shown, the results are:

Discount Rate	Present Worth Costs	Present Worth Benefits	Net Present Worth	B/C Ratio
6%	- $155,459	$208,315	$52,856	1.34[illegible]
8%	- 146,669	182,163	35,494	1.242
10%	- 140,224	162,099	21,875	1.156
12%	- 135,802	146,802	11,000	1.081
14%	- 135,687	137,858	2,171	1.016
16%	- 131,051	125,940	- 5,111	0.961

Internal Rate of Return = 14.56%.

Present worth of costs and benefits are not calculated directly by "DISCOUNT," but as follows:

Present Net Worth = PNW
Benefit/Cost Ratio = BCR
Present Worth of Costs = PWC
Present Worth of Benefits = PWB

$$PWB - PWC = PNW$$

$$\frac{PWB}{PWC} = BCR$$

$$PWB = PNW + PWC$$

$$\frac{PNW + PWC}{PWC} = BCR$$

$$PNW + PWC = (BCR)(PWC)$$

$$(BCR)(PWC) - PWC = PNW$$

$$PWC(BCR - 1) = PNW$$

$$\boxed{PWC \quad \frac{PNW}{BCR - 1}}$$

$$PWB - PWC = PNW$$

$$PWB = PNW + PWC$$

$$PWB = PNW + \frac{PNW}{BCR-1}$$

$$= PNW \left(1 + \frac{1}{BCR - 1} \right)$$

$$= PNW \left(\frac{BCR - 1 + 1}{BCR - 1} \right)$$

$$\boxed{PWB = \frac{(PNW)(BCR)}{BCR - 1}}$$

Note: Selected features of running "DISCOUNT" on FCCC and ICL1502 are shown in Figures 2 and 3.

Future Use

There is much potential for this program. Already, the Forest Service Manual in the Region 8 Supplement requires an economic analysis for construction projects estimated to cost over $50,000. This is not to say that only economics and not environmental, social, and other concerns should be examined, but that economics definitely cannot be ignored. "DISCOUNT" is a tool that can quickly and easily aid in performing such economic analyses for any alternative.

REFERENCES

(1) INVEST 111. An Analytical Aid for Program Planning and Evaluation. Region 5. April 1972. Revised January 1974.

(2) Grant & Ireson. Principles of Engineering Economy. Ronald Press Co., Prentice-Hall, Inc., 1971. Appendix C.

(3) Van Horne, James C. Financial Management and Policy. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971. Appendix 3B: "Multiple Internal Rates of Return." pp. 79-81.

(4) Bell, Loren " 'DISCOUNT' A Conversational Discounting Program" Region 5.

Figure 2. Part of "DISCOUNT" demand run, showing the input tables and results.

```
FOLLOWING IS A SUMMARY OF YOUR INPUT DATA

 #        COST(-)              NO. OF YEARS UNTIL
         OR RETURN               COST OR RETURN

 1           $-6340.00                 0
 2           $-1500.00                10
 3         $-111200.00                 0
 4          $-26300.00                10
 5          $-52300.00                20
 6           $79800.00                 1
 7           $79800.00                11
 8           $79800.00                21
 9            $7270.00                 2
10            $1720.00                12

 #     ANNUAL COST(-)      NO. OF YEARS UNTIL          NO. OF YEARS UNTIL
         OR RETURN         1ST ANNUAL AMOUNT          LAST ANNUAL AMOUNT
 1        $-480.00                  1                          10
 2        $-590.00                 11                          20
 3        $1150.00                  1                          10
 4        $1420.00                 11                          20
 5        $3990.00                  1                          20

ARE THE ABOVE INPUTS CORRECT(YES OR NO);
?>YES


AN INTERNAL RATE OR RETURN EQUALS  14.56 PERCENT
```

Figure 2. (cont'd.)

```
WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>6.
WHEN THE DISCOUNT RATE IS   6.000 PERCENT,

THE NET PRESENT VALUE IS          $52855.97

AND THE BENEFIT-COST RATIO IS        1.340

WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>8.
WHEN THE DISCOUNT RATE IS   8.000 PERCENT,

THE NET PRESENT VALUE IS          $35494.57

AND THE BENEFIT-COST RATIO IS        1.242

WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>10.
WHEN THE DISCOUNT RATE IS  10.000 PERCENT,

THE NET PRESENT VALUE IS          $21874.68

AND THE BENEFIT-COST RATIO IS        1.156

WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>12.
WHEN THE DISCOUNT RATE IS  12.000 PERCENT,

THE NET PRESENT VALUE IS          $10999.99

AND THE BENEFIT-COST RATIO IS        1.081

WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>14.
WHEN THE DISCOUNT RATE IS  14.000 PERCENT,

THE NET PRESENT VALUE IS          $2171.[illegible]2

AND THE BENEFIT-COST RATIO IS        1.016

WHEN NO MORE DISCOUNT RATES ARE DESIRED ENTER STOP
DISCOUNT RATE(10% WOULD BE ENTERED AS 10.)?>16.
WHEN THE DISCOUNT RATE IS  16.000 PERCENT,

THE NET PRESENT VALUE IS          $-5110.68

AND THE BENEFIT-COST RATIO IS         .961
```

Figure 3. Runstream to run "DISCOUNT" on ICL1502.

```
@RUN,L/N F59CSL,                    ,STP,1,100
@ASG,A BASPROG.
@BASIC BASPROG.
OLD:DISCOUNT
RUN
YES
10
-6340
0
-1500
10
-111200
0
-26300
10
-52300
20
79800
1
79800
11
79800
21
7270
2
1720
12
5
-480
1
10
-590
11
20
1150
1
10
1420
11
20
3990
1
20
YES
6.
8.
10.
12.
14.
16.
STOP
BYE
@FIN
@@@@
```

INFORMATION ANALYSIS FOR MAST PRODUCTION

Rex Mann
U.S. Forest Service
Jackson, Mississippi

Purpose

The purpose of this project was to study annual hardwood mast production for several different timber rotations on the Holly Springs Ranger District in Mississippi. "Mast" is fruit from trees that is used to support wildlife. In this study, the "mast" being considered is acorns from oak trees.

Mast Production

The Holly Springs District has a total acreage of approximately 118,000 acres, of which approximately 20,000 acres are classed as upland hardwood. The remaining acreage is classified as pine type but does have a large mast producing hardwood component. However, for this study, only the mast produced from the hardwood stands was considered.

The hardwood stands are composed of a variety of mast producing species. Some species produce good crops on three to five year cycles, while others produce fairly stable annual crops. Exhibit 1 charts mast production by DBH for the various species on the Holly Springs District and Exhibit 2 shows the composite mast production versus age. Mast production data is very limited and what is available applies only to upland hardwoods. The only data found came from the Region 8 Wildlife Habitat Management Handbook. Mast production was given in pounds per square foot of basal area by diameter class for several different species.

Since the mast production data was by species, the first step was to determine an average species composition for the Holly Springs District.

EXHIBIT 1

LBS. ACORN YIELDS LBS./SQ. FT BA

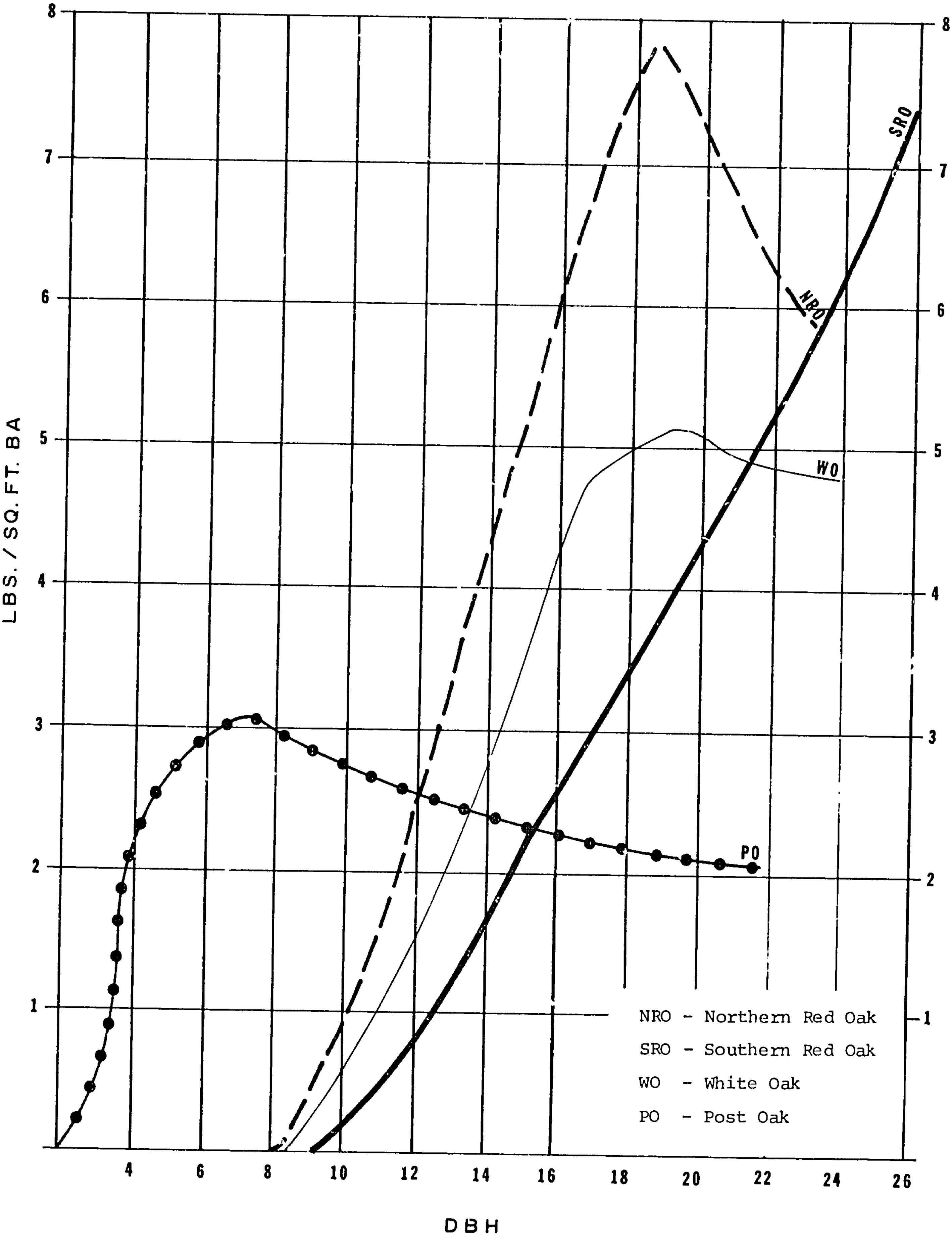
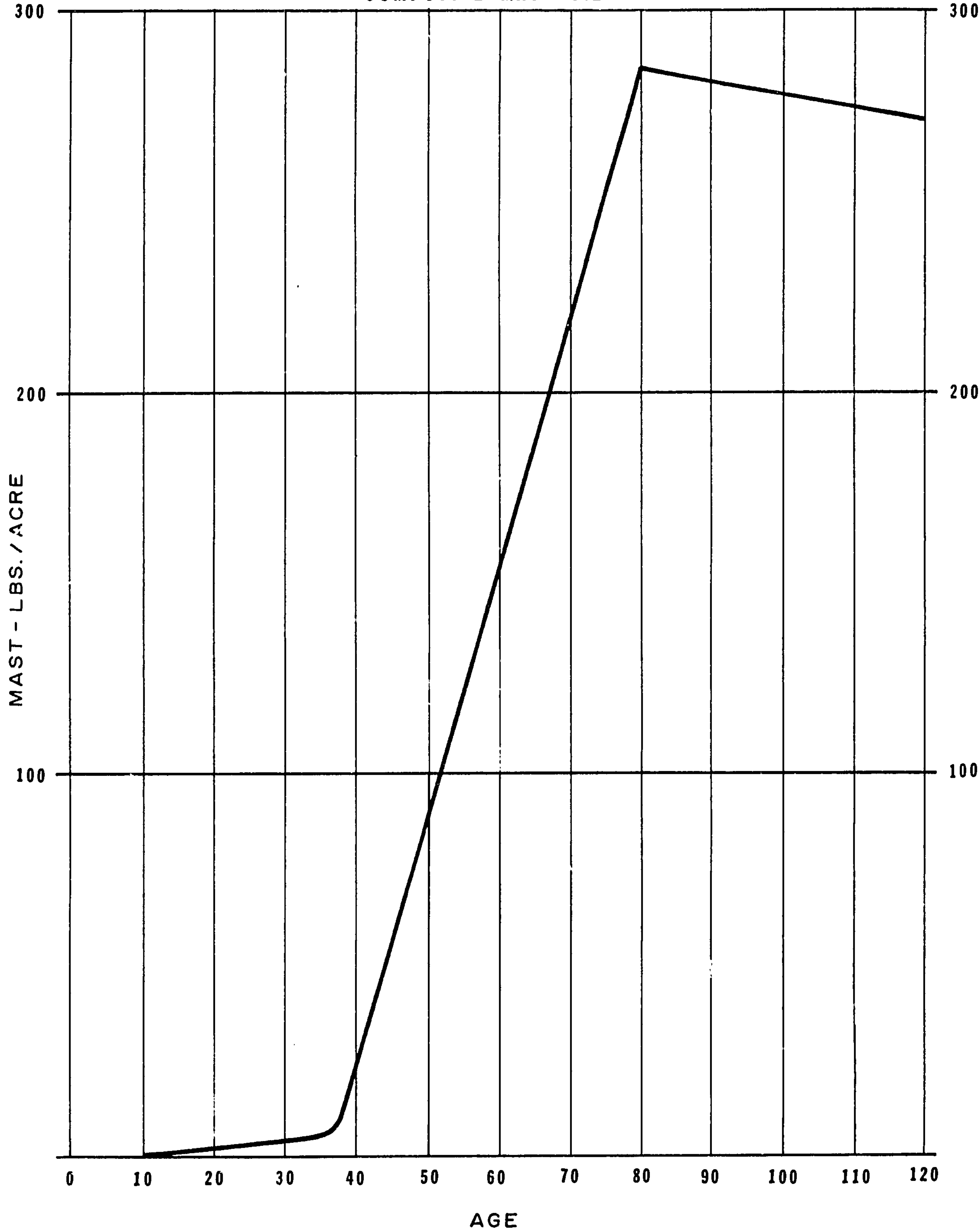


EXHIBIT 2

COMPOSITE MAST YIELD



This was done by consulting with district personnel and was determined to be as follows: 50% white oak, 20% Southern Red Oak, 5% Northern Red Oak, and 5% Post Oak, with the remainder being non-mast producing species.

Since the data gave pounds of mast per square foot of basal area by diameter class, the next step was to determine the age (in ten year classes) that each diameter was reached. To do this, an average site index had to be determined. A CISC (Continuous Inventory of Stand Conditions--an automated system) printout listing all the hardwood stands on the district was obtained, and an analysis of this showed the average site index to be 75. Using Table 13 from the publication, Growth and Yield Predictions for Upland Oak Stands, by Martin E. Dale, the age/diameter class relationship was obtained.

The next step was to determine what the basal area would be for each age class. In doing this, the assumption was made that all stands were stocked at desirable levels and would remain so. The recommended basal areas in the Forest Service Thinnning Guidelines for Mississippi were used for each age class.

By multiplying these basal area figures by mast production, a total mast production figure per acre was arrived at. This is shown in Exhibit 3.

A breakdown of acres in each ten year age class was obtained from CISC, using the UTIL Program. A FORTRAN computer program was then set up to take the existing age class distribution and project it through several different rotations (80, 90, 100, 110 and 120 years). The assumption was made that for each rotation, a specified acreage would be clearcut each year (Total Acres/Years in Rotation, or A/R). The final output was a printout which gave the age class distribution and a total mast production figure for each ten year cutting cycle. These results are given in Exhibit 4.

EXHIBIT 3

Mast Production/Acre by Age Class

Age	DBH	BA	Mast Production (Pounds/Acre)
10	2	-	0
20	4	46	3
30	6	59	9
40	8	64	10
50	11	72	85
60	13	75	124
70	16	80	193
80	19	80	294
90	21	80	281
100	23	80	279
110	24	80	279
120	25	80	274
130	26	80	269

EXHIBIT 4

	80 Years	90 Years	100 Years	110 Years	120 Years
Mast (pounds)/ Yr. of rotation	2.6 million	2.8 million	3.0 million	3.2 million	3.3 million
Avg./ Yr. for next 100 years	2.5 million	2.7 million	3.0 million	3.2 million	3.4 million

From Exhibit 4, it is apparent that annual mast production increases significantly with increases in the length of rotation. It should be emphasized that these results apply only to the Holly Springs District and a different species composition would likely give completely different results.

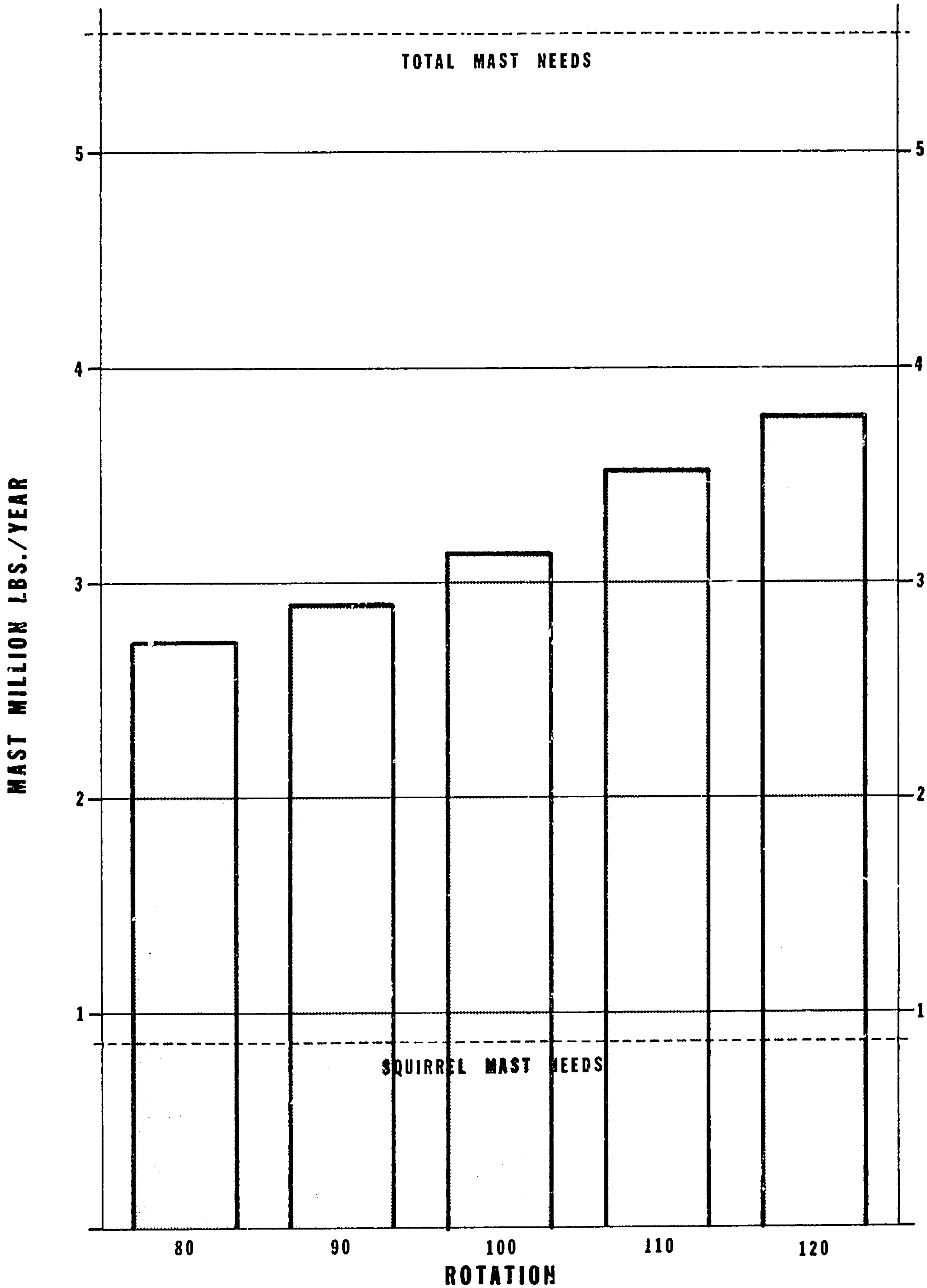
Mast Requirements

Data on wildlife mast requirements is even more lacking than data on production. The three primary mast consumers are squirrel, deer and turkey. According to the Region 8 Wildlife Habitat Management Handbook, a squirrel requires from 30 to 40 pounds of mast per year. Our population goals for squirrels would require a total annual mast production of less than 1 million pounds. This would be met by any of the proposed rotations. However, when the combined needs of all wildlife are considered, there are no firm figures.

The Wildlife Habitat Management Handbook does give a figure of 30,800 pounds per square mile (640 acres) required to support a population of ten turkeys per square mile with average populations of deer and squirrel. If this figure was used, a total annual production of 5.67 million pounds would be required on the Holly Springs District (see Exhibit 5). None of the rotations would supply mast in this quantity. The deficit is currently being made up by the hardwood component in the pine stands. As we get further along in our timber management program, this hardwood component in the pine stands can be expected to decrease.

To meet the annual production figure of 5.67 million pounds, an additional 18,000 acres of hardwood is needed if we keep the 100 year rotation. This would have to be hardwood inclusions in the pine stands and would work out to be approximately 185 acres of inclusions per 1,000 acre compartment.

EXHIBIT 5


TOTAL MAST NEEDS
SQUIRREL MAST NEEDS
MAST MILLION LBS./YEAR
5
4
3
2
1
80
90
100
110
120
ROTATION

Growth figures could be plugged into this program to determine the timber volume that should should be given up in order to produce a given quantity of mast.

A METHOD FOR PREDICTING ALLOWABLE BURN ACRES FOR VALUES AT RISK*

Robert W. McCallum, Jr.
National Forests in Alabama
Montgomery, Alabama

Methods

In this paper, a method for developing allowable burn acres for varying classes of fire day that are responsive to values-at-risk is proposed. The methodology is built around site-specific suppression cost data and lends itself to computer modeling. While not attempting to analyze the entire fire management program on a cost-effective basis, the paper does conclude that suppression activities can be cost effective when they are carried out commensurate with the values to be protected.

Introduction

In a recent evaluation of fire management activities on National Forest System lands[1], the following findings were promulgated concerning resource values:

- systems presently used to assess values equate values with damages;
- benefits from fire are not recognized;

---

*Acknowledgement: the author wishes to express his appreciation to the Computer Science Field Support Unit, Regional Office, Region 8; and in particular, to Mr. John Waters, for his help in the application of computer techniques found in this paper.

[1] USDA, Forest Service, 1977, Evaluation of Fire Management Activities on the National Forests, Policy Analysis Staff Report (November, 1977).

- the validity of existing value data is questionable;
- values do not play a significant role in establishing fire management activity;
- fire management values are neither representative of nor related to other resource systems.

The study also recognized shortcomings in the areas of policy, planning, managerial control and evaluation. The outgrowth of this study was a revised Fire Management policy whereby Fire Management Areas (units of National Forest land) would be established; and in which fire management practices within these areas would be responsive to land and resource management goals established through the land management planning process.[2] In developing these practices for the Fire Management Area, maximum fire size and allowable burn acreage would be established for various fire intensity levels commensurate with the values to be protected.

In determining "values," not only should damages resulting from fire be considered, but also the benefits that are gained. As Crosby states, "Forest and other wildlands are valuable because they serve human needs. Valu is thus a cultural characteristic of wildland resources rather than intrinsic property. Regardless of the functions served by wildlands, value derives from the supply of products and services and the demand for them."[3] Values then are derived from the use of and plans for the use of National Forest production of goods and services, and these values change as the goals and objectives of the Forest change.

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[2] USDA, Forest Service, 1978, _Fire Management_, Forest Service Manual 5100. (Amendment 56, February 1978).

[3] USDA, Forest Service, 1977, _A Guide to the Appraisal of: Wildlife Damages, Benefits, and Resource Values Protected_, by John S. Crosby. Research Paper NC-142. (Washington, D.C.)

The least-cost-plus-loss theory has met with varying degrees of success in considering fire management economics.[4] Most analysis deals with the total fire management spectrum--fuels management, pre-suppression, prevention, detection, and suppression. It is this author's belief that the Forest Management Area will be funded for pre-suppression, prevention and detection activities in order to maintain a ready posture for fire control. The potential for greatest dollar savings can be recognized in the area of suppression activities, if suppression activities are commensurate with resource values. This paper will focus on this area of fire management.

A Suggested Hypothesis

The author wishes to propose the following hypothesis: there is a relationship between class of fire day, suppression costs and value at risk that, when considered together, will result in an acceptable allowable burn acreage.

Methodology

Value-at-risk is a probabilistic determination of those values that would be lost without any protective action; and as Crosby summarizes, is characterized as (a) forest or wildland resource values--values derived from forest resources and forest resource products; (b) nonforest resource values--values independent of forest values but influenced by fires; and (c) environmental values-at-risk--values related to the environment that overlap both of the foregoing. The problem becomes one of quantifying these values-at-risk--of determining the dollar value of resource loss and resource benefits gained from fire.

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[4] USDA, Forest Service, 1979, Application of Economic Techniques to Fire Management - A Status Review and Evaluation, by Julie K. Gorte and Ross W. Gorte. (General Technical Report INT-53.)

Class of fire day is a descriptive rating that represents levels of fire intensity as determined by the burning index.[5] The burning index is composed of energy release and spread components, and is related to the effort required to contain or control a fire. As the burning index increases numerically, the potential intensity of the fire increases. The relationship of class of fire day to burning index is shown in Table I.

TABLE I

Class of Fire Day and Relationship to Burning Index
Fuel Model "E" of NFDRS

Class of Fire Day	Burning Index
A	0 - 9
B	10 - 18
C	19 - 37
D	38 - 45
E	46 +

Suppression costs are those costs incurred as a result of suppression activities on a fire. Allowable burn acreage is a measure of acceptable loss acreage based on the goals and objectives of the Fire Management Area, either on an annual or long-term basis; and developed through an analysis of the physical, biological, social and economic values of the area.

For the Talladega Division, Talladega National Forest, fire size and suppression cost by class of fire day for fiscal year 1978 were tabulated as shown in Table II.

[5] Taken from a conversation with Lou Brossy, Fire Management Staff Officer, National Forests in Alabama.

TABLE II

Wildfire Size and Costs of Suppression, Talladega Division, Talladega National Forest for FY 1978.[6]

Class of Fire Day	Size (Ac)	Suppression Costs ($)	Class of Fire Day	Size (Ac)	Suppression Costs ($)
C	2	200	E	38	1200
C	19	1800	E	22	500
E	2	220	C	1	210
E	3	400	E	56	600
C	7	400	C	1	300
C	3	350	C	15	700
C	1	150	C	26	600
C	16	600	C	8	600
C	205	4000	C	35	600
C	20	500	C	1	300
C	35	1600	C	1	300
C	41	800	C	5	600
C	1	250	C	3	200
A	8	400	C	1	116
C	3	200	C	4	700
C	3	400	C	1	100
C	1	150	C	1	150
C	1	150	C	34	250
C	3	250	D	2	250
C	1	50	C	1	100
C	1	50	C	6	200
C	1	100	C	9	250
C	4	250	C	4	150
C	2	300	C	4	200
C	12	150	E	6	150
E	15	300	E	3	250
E	5	200	D	80	500
D	3	250	C	1	300
C	1	300	C	7	300
B	5	150	B	1	100
A	5	150	B	1	150
B	1	100	C	1	50
C	1	50	C	15	100
B	1	100	B	1	100
C	68	350	C	6	300
C	45	350	C	15	250
C	4	250	C	1	50
C	1	200	C	4	200
C	1	100	C	33	250
C	1	200	D	55	300
D	40	300	C	10	350
C	40	350	C	8	250
C	3	250	C	2	250
C	9	300	C	9	300
C	1	200	C	3	200
C	3	250	C	7	200
C	17	250	C	8	300
C	2	250	C	52	500
C	27	400	C	14	400
C	8	400	C	1050	22250
C	4	300	C	3	500
C	2	300	C	1	350
C	1	400	C	1	300
C	3	250	C	9	300
C	2	300	C	2	300
C	1	300	C	1	400
C	1	50	C	1	50
C	6	350	B	6	300
B	1	150	B	1	200
B	2	200	B	3	200
C	1	150	C	3	150
C	11	150	C	2	150

Source: 5100-29 for Shoal Creek RD and Talladega RD

[6]Data taken from Form 5100-29, Individual Fire Report. Maintained in office of FMO, National Forests in Alabama, based on estimates rather than actual measures.

Using the computer modeling software for Statistical Package for the Social Sciences (SPSS), an analysis was made between class of fire day and size of fire. This analysis showed that there was no significant difference between these two variables--in other words, a more severe burning index did not necessarily result in a larger fire. Next, the computer was asked to develop suppression cost per acre and to print a scattergram where the y-axis was equated to suppression cost per acre and the x-axis to the size of fire. The result is shown in Figure 1; and as expected, it shows a downward sloping curve. As the size of fire increases, the suppression cost per acre decreases. A schematic diagram of the suppression cost curve is given in Figure 2 and will be used throughout the remainder of this paper.

As discussed previously, quantifying value-at-risk is difficult at best. For application in this paper, the author developed a value-at-risk for pine immature sawtimber, and this "value" is based on the following assumption: for some timber types and condition classes, the dollar value of the timber as reflected in the timber appraisal may become an indication of the value-at-risk.

Convery offers some insight into this assumption.[7] He states that the timber appraisal takes into consideration the effects that timber harvest may have on soil, water, aesthetics, wildlife, etc.; and these effects are reflected in the degrees of difficulty assessed in the timber appraisal and charged as costs to the timber operator. The mitigation measures for soil erosion, landscape management principles, wildlife coordination, etc. are also reflected in the sale layout and appraisal. In other words, the damages (potential or actual) to the resource are counted as "costs" and the mitigation measures as "benefits." The externalities of the effects are

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[7] Convery, Frank J., 1976., Applying Economics in the Forest Land-Use Planning Process, (Duke University, under contract to USFS).

Figure 1. Scattergram of Suppression Costs Per Acre and Size of Fire

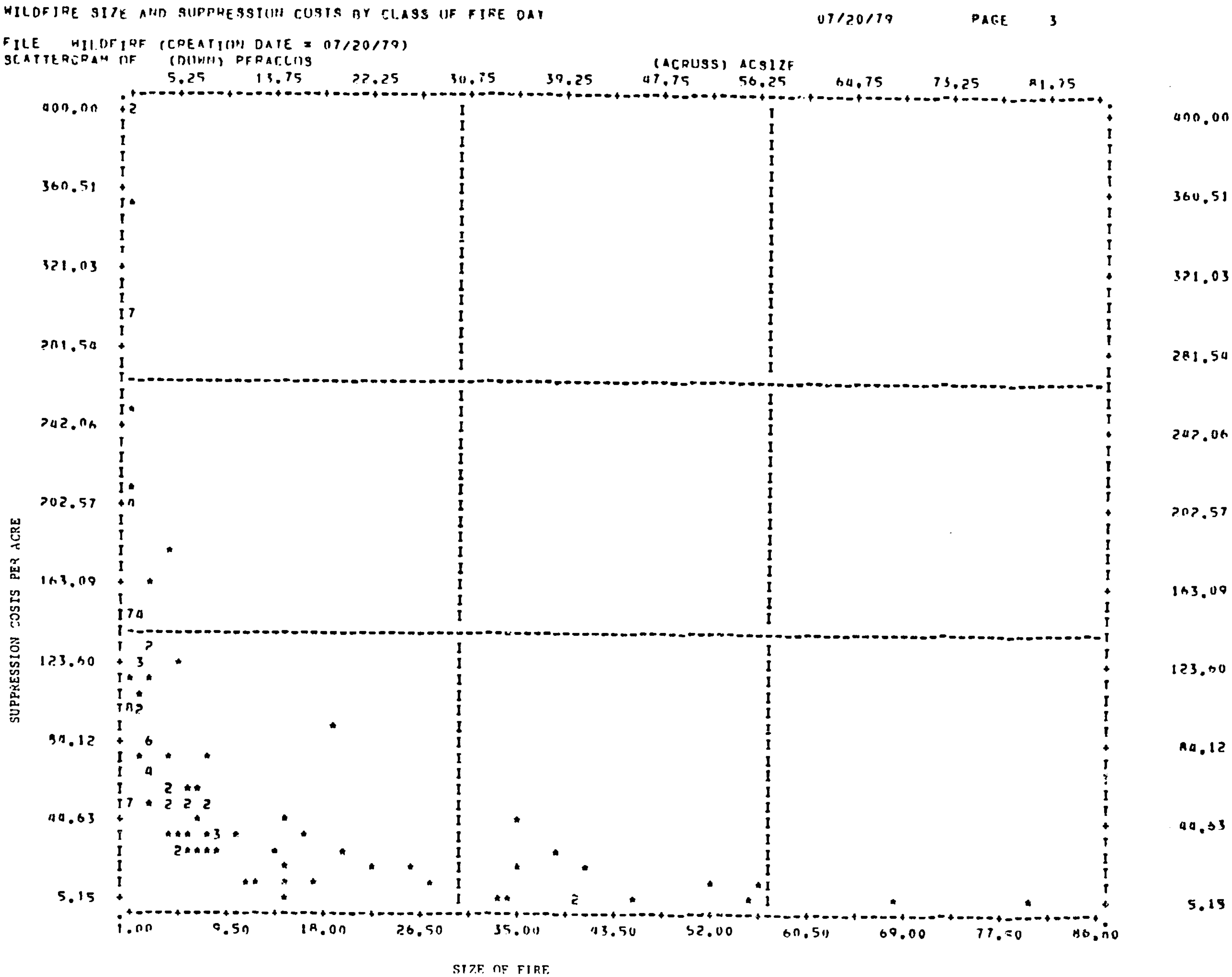
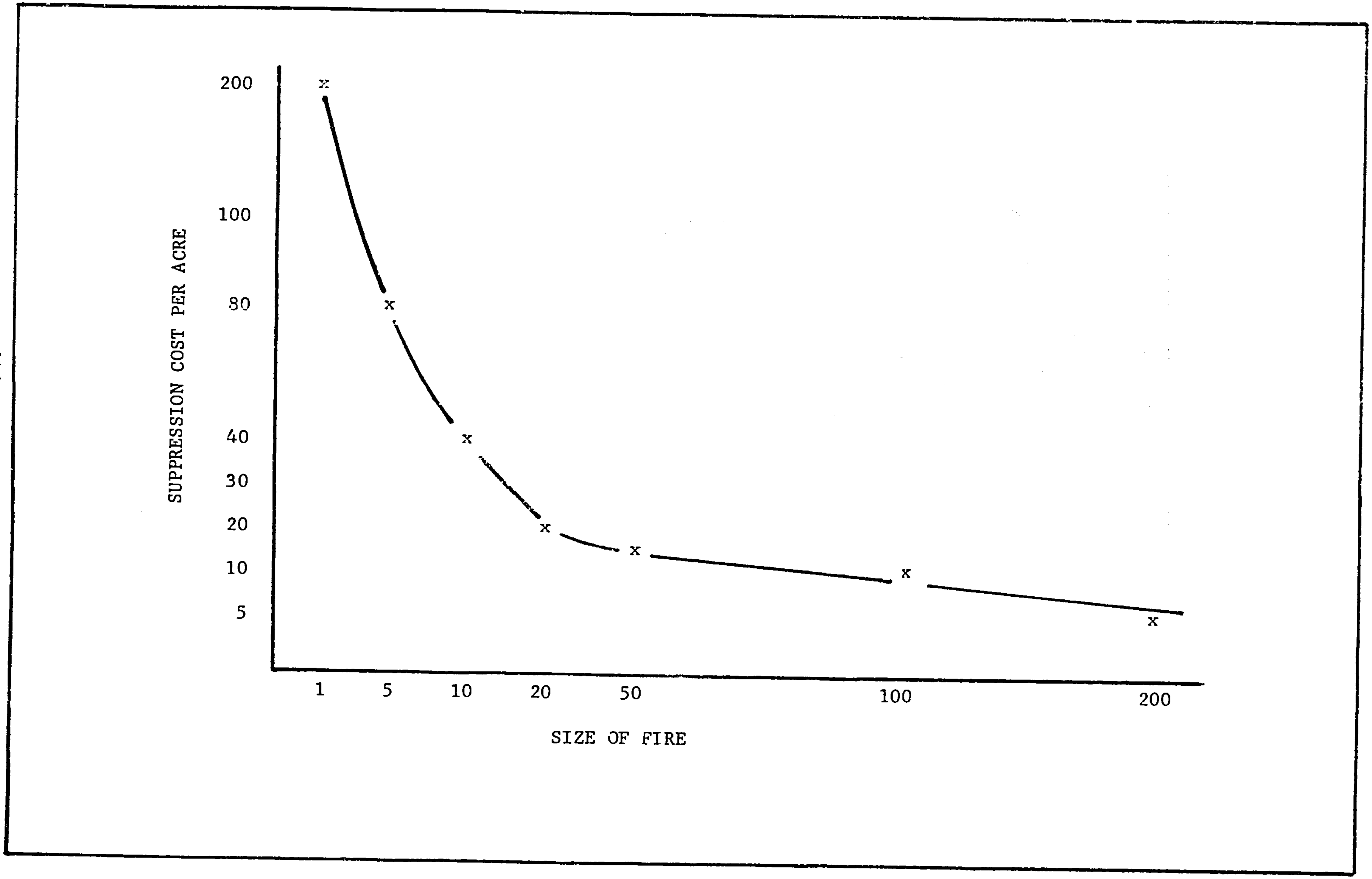


Figure 2. Suppression Cost Curve (Schematic).



internalized in the timber appraisal and sale layout. If this is true, then the value of appraised timber may become a basis for determining value-at-risk.

On the Talladega Division, a clear cut of pine immature sawtimber yields an average of 2.0 MBF per acre with an average appraised value of $65.00 per MBF.[8] For pine immature sawtimber then, our value-at-risk on a per acre basis is $130.00. Recognizing that losses to timber are dependent upon class of fire day (potential intensity of fire) and other considerations, estimated loss percentages per acre were developed and shown in Table III. The result is an adjusted value-at-risk based on the class of fire day. Actual percentages can be developed by on-the-ground inspections.

TABLE III

Adjusted Value-at-Risk by Class of Fire Day for Pine Immature Sawtimber

Class of Fire Day	Estimated Percent Loss	Per Acre Adjusted Value-at-Risk
A	2	$ 2.60
B	5	6.50
C	10	13.00
D	15	19.50
E	20	26.00

*Total Value-at-Risk/Acre - $130.00.

For purposes of further explanation, this writer assumed an adjusted value at risk of $ 20.00. When the value-at-risk for any class of fire day (adjusted VAR) is plotted on the y-axis of the suppression cost curve (from Figure 2) and carried to the x-axis, an allowable burn acreage is developed

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[8]In 1977 dollars.

where suppression cost is equal to the value-at-risk. Figure 3 shows that, on a per acre basis, costs incurred for suppression activities prior to this point are in excess of expected resource losses; and resource losses after this point are in excess of suppression costs.

In Table IV, on a cumulative basis, the differences between suppression cost and value-at-risk are even more pronounced. At the lower fire size limit shown in Table IV, suppression costs are ten times the expected loss; and at the upper limit of fire size, the expected losses from a fire can be four-fold over suppression cost (see Figure 4).

Conclusion

Developing a cost-effective fire management policy for fire management areas that is responsive to Forest goals and objectives will be a function of the land management planning process. Considering the entire spectrum of fire management--fuels management, prevention, pre-suppression, detection and suppression--suppression activities appear to offer an opportunity to decrease costs commensurate with values, provided that the methodology for quantifying these values-at-risk is rationally conceived. Once value-at-risk has been quantified, allowable burn acres for varying classes of fire days can be predicted based on historic suppression cost data, and these allowable burn acres will reflect costs of suppression activities in relation to the values protected.

This method of developing allowable burn acres has these advantages:

- It is area specific. All fire data can be taken from existing records or be developed by on-the-ground inspection. Value-at-risk can be developed for specific fire management areas (it is conceivable that different areas may have different "values").
- It can equate allowable burn acres to class of fire days. This can allow fire management personnel to pre-position their initial attack

Figure 3. Suppression Cost Curve with Value-at-Risk and Allowable Burn Acres (Schematic).

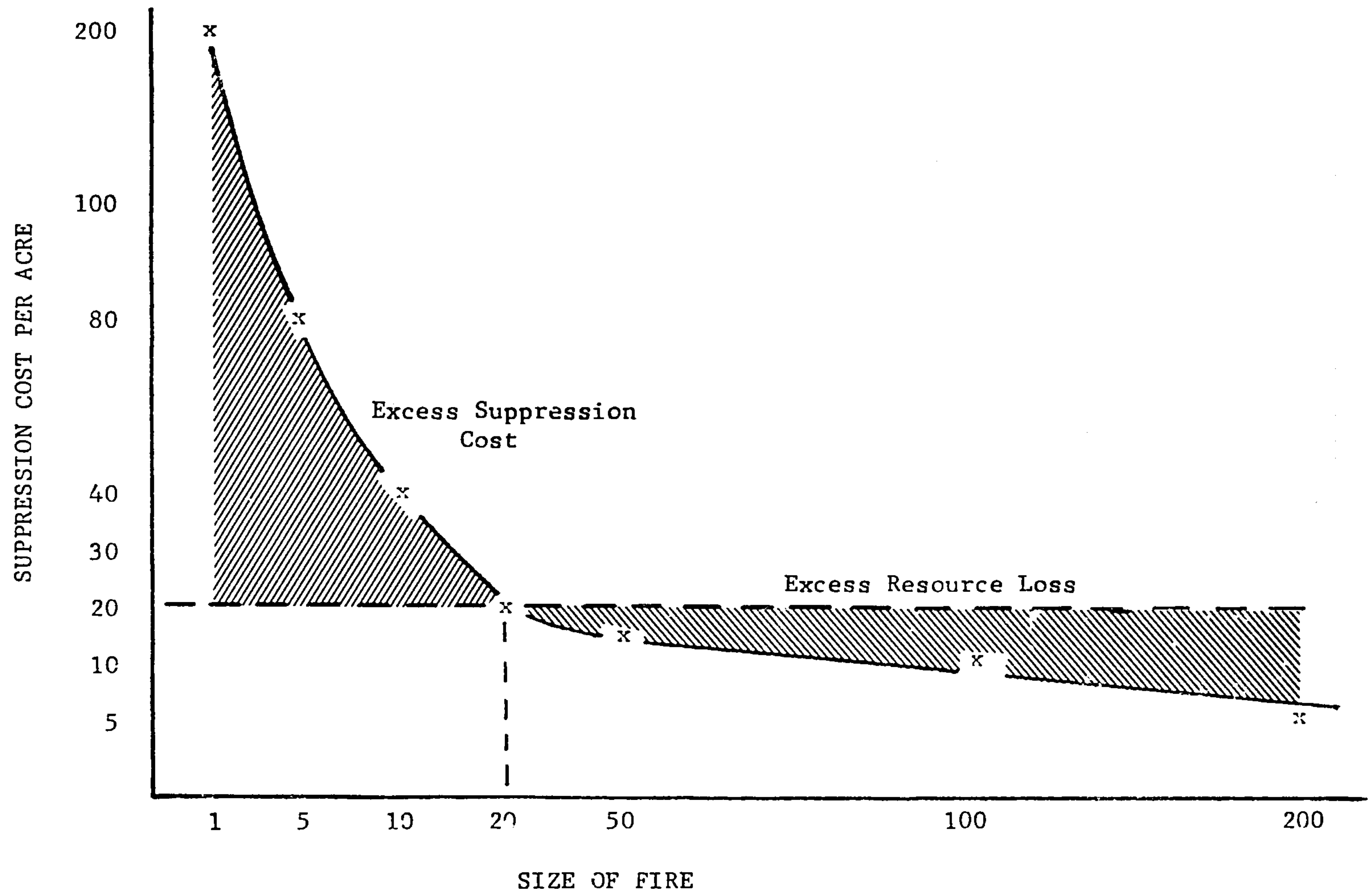


TABLE IV

Comparison of Suppression Cost and Value-at-Risk
Where Value-at-Risk is Assumed at $20.00

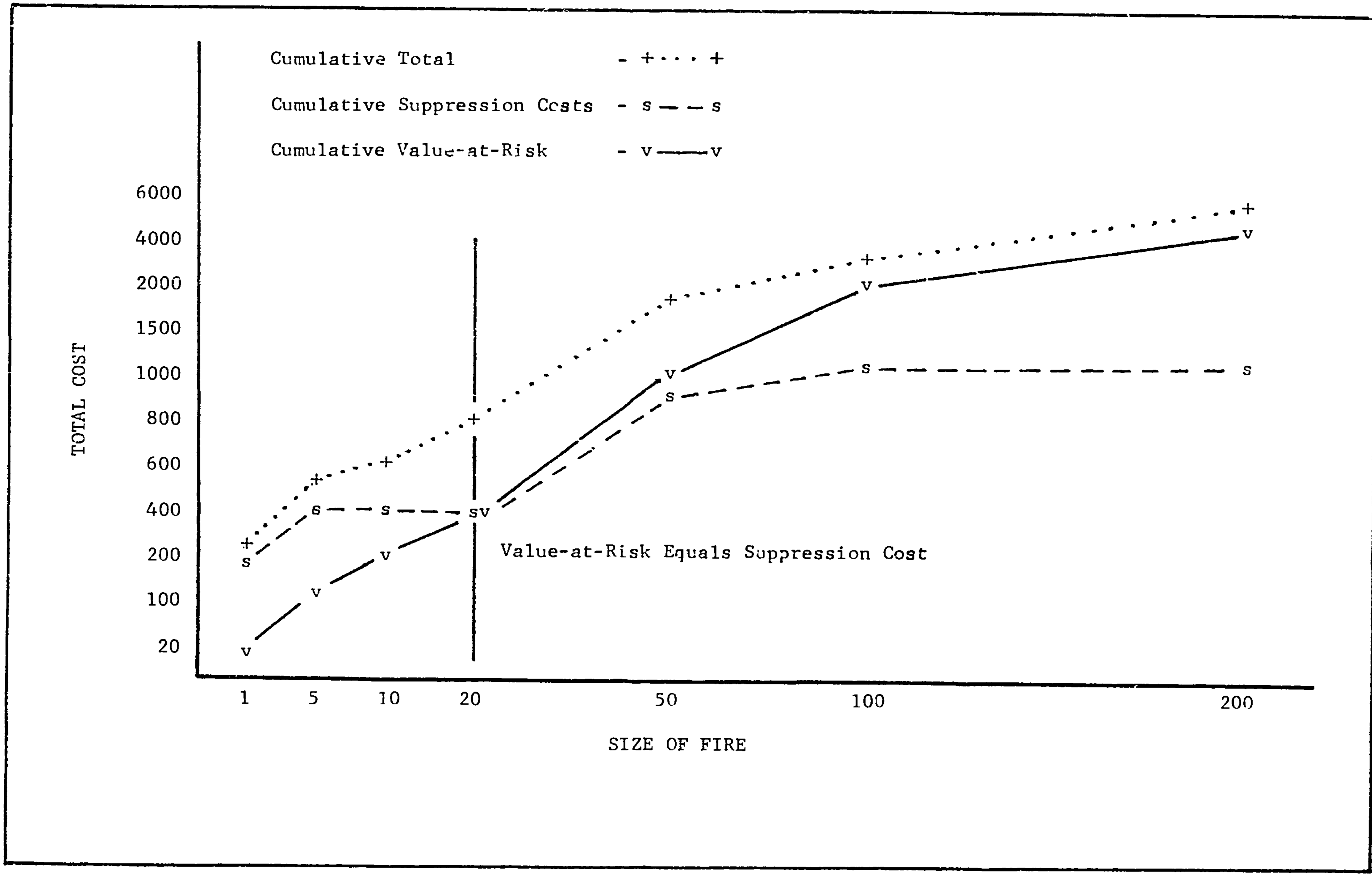
(Acres) Size of Fire	Per Acre Basis Suppression Cost	Value-at-Risk	Total
1	200	20	220
5	80	20	100
10	40	20	60
20*	20	20	40
50	15	20	35
100	10	20	30
200	5	20	25

*Point where Suppression Cost Equals Value-at-Risk

(Acres) Size of Fire	Cumulative Basis Suppression Cost	Value-at-Risk	Total
1	200	20	220
5	400	100	500
10	400	200	600
20*	400	400	800
50	750	1000	1750
100	1000	2000	3000
200	1000	4000	5000

*Point where Suppression Cost Equals Value-at-Risk

Figure 4. Cumulative Cost Curves for Value-at-Risk and Suppression Cost (from Table 4).



forces in those areas of high values-at-risk on higher class fire days.

- Where allowable burn acreage permits, benefits and/or costs may be charged to the benefiting function as prescribed burn acreage.
- Although not utilized to its fullest extent in this paper, the computer software of the SPSS program exists; and with little modification, this entire procedure can be developed for ready access.

PART IV

OPTIMIZATION AND NETWORK ANALYSIS

TIMBER HARVEST SCHEDULING
WITH MULTIPLE DECISION CRITERIA

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This paper presents the concepts of optimal harvest scheduling and the quantitative treatment of multiple decision criteria or multiple objectives. Both of these subjects have been relatively ignored in managing the national forests of the South. New legislation and regulations no longer permit us the luxury of this ignorance. Furthermore, the knowledge you should be gaining in this training session can provide the basic information necessary to apply these modern methods of forest management.

Timber Management Planning - Current Policies

Let us first look at the way timber management activites are currently being planned in Region 8. Planning is based on a stand inventory/prescription and on management guidelines which are supposed to reflect the objectives and constraints governing the management of the entire forest. The prescription process describes existing stand characteristics then specifies the types of immediate treatments and the composition of the timber stand which will occupy the site in the future. Management guidelines dictate the range of treatments to be considered and the future structure of the forest. For example, a prescription may call for an upland hardwood stand of site productivity II, age 50, to be commercially thinned in five years. Then, at some undetermined future date, it is to be converted to an even-aged cove hardwood stand with rotation age of 80 years. The periodic and annual harvest areas are determined by the application of area control using the future allocation of the forest by management type and the policy-specified rotation ages. Individual stands or stand segments are selected for harvesting in order to meet the regeneration area requirement. The selection criteria is based on stand condition and is generally "worst first" followed by oldest.

There are, of course, many other objectives and constraints which influence the selection of each combination of stand, treatment, and timing. It is typically assumed, however, that merely achieving the periodic regeneration area requirement while simultaneously satisfying the constraints will produce the 'ultimate' schedule of treatments. While arriving at such a feasible solution is admittedly a difficult task, it does not necessarily produce a unique, optimal schedule. There are likely many different schedules which can meet these constraints (including regeneration area), but which produce vastly different results when other measures of performance are considered.

One example is harvest volume. Region 8's forest regulation-harvest scheduling procedure ignores volume; it is not measured in the stand inventory, does not influence the regulation procedure, and appears neither as an objective nor as a constraint. But consider the requirement, "...limit the sale of timber from each national forest to a quantity equal to or less than a quantity which can be removed from such forest annually in perpetuity on a sustained-yield basis..." (RPA, Sec. 13[a] [NFMA Sec. 11]). Because we cannot very easily 'remove' regeneration area, 'quantity' must refer to volume. And note the additional multiple resource requirement, "...secure the maximum benefits of multiple use sustained yield management" (RPA, Sec. 2[d][1]). Together these requirements call for an optimizing approach to forest planning which incorporates constraints on periodic harvest volumes.

Although Region 8's timber management planning procedures cannot comply precisely with these requirements, the techniques of timber harvest scheduling available elsewhere in the Forest Service can be combined with the experience in multiple resource planning to provide the basis for a quantitative analysis of alternative plans for the entire forest.

Optimal Timber Harvest Scheduling

Linear programming (LP) is the most widely used technique for optimal timber harvest scheduling. 'Canned packages' such as Timber RAM (Navon, 1971) and MAX-MILLION (Clutter, 1968) have been used on public and industrial forests for about ten years and second generations of these packages are currently being installed. A number of other optimization techniques such as dynamic programming, quadratic programming and optimal control have been applied to harvest scheduling but with limited success; complicated solution procedures generally make them computationally inefficient for the size of problems encountered here. A more widely applied technique, second only to LP, is simulation; but simulation in its simplest and most efficient form is not an optimizing technique. To perform simple tests of feasibility may require the introduction of iterative procedures which can greatly increase solution times; and searching for an optimal solution would take even longer. Thus, LP continues to be the most popular automated approach to timber harvest scheduling because of its availability and its computational efficiency. It has an added plus in its relationship to goal programming which we will note later.

Linear Programming, as applied to the scheduling problem, is merely an allocation of a limited amount of resources to a specified set of uses which, at the same time, meets certain restrictions and optimizes some decision criterion. Thus timber stands (or stand classes) may be assigned to certain management regimes so that such constraints as non-declining even-flow and maximum periodic regeneration area are met while decision criterion, say harvest volume, is optimized. Mathmetically, the LP problem is expressed as:

$$\text{Maximize} \quad z = c_1x_1 + c_2x_2 + \ldots + c_nx_n \quad ,$$

$$\text{subject to} \quad a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \leq b_2$$

$$\vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n \leq b_m$$

$$\text{and} \quad x_1 \geq 0,\ x_2 \geq 0,\ \ldots,\ x_n \geq 0$$

where x_i are the decision or activity variables, c_i are specified constants (typically weights or costs), a_{ij} are technical coefficients, and b_j are available resource amounts or production requirements. Note that both the objective function and the set of constraints are linear, hence the name, LP. This gives rise to the proportionality, additivity, divisibility, and deterministic assumptions of the procedure.

In a timber harvest scheduling problem, x_1 would be the area of the first stand class allocated to the first management regime, x_2 to the second and so on until no more than all of that stand class (area b_1) is allocated. Other constraint rows relate other stand classes and their management activities. In another row, the a_{ij} could be the volume per acre produced by the management activity on the area represented by the i index during the period represented by the j index. The sum of the volumes in the period i must be less than or equal to b_j. Finally, the objective may be to maximize the volume produced during the first four decades of the planning horizon. The per acre contribution to this objective from each activity is represented by c_1.

Typically LP packages such as Timber RAM and MAX-MILLION permit the creation of alternative objective functions, say maximize present net value or minimize present value of cost. However, it is mathematically impossible to solve the LP problem using more than one of these objective functions at a time. Although Gifford Pinchot noted that it would be desirable to simultaneously satisfy interrelated and possibly conflicting optimality criteria, most people, can intuitively see this is impossible. This, in effect, replaces the single-valued objective function z with a string of objectives, z1, z2, z3,...zp. This string is called a vector in the notation of linear algebra and the body of solution techniques that address problems with such an objective function is called vector optimization.

The simplest way to solve multiple criteria or multiple objective problems is to form a linear combination of the several criteria, then use the standard single criteria procedures. This is often undesirable because the criteria are not of the same form or measured in the same units and thus are not amenable to combination. Vector optimization techniques, in general, seek to sidestep this problem in a number of different ways. But, ultimately, the solution that is selected represents some combination (usually a subjective weighting) of the several criteria and provides an allocation that achieves the conflicting objectives to varying degrees. It was in the context of timber harvest scheduling with multiple decision criteria and extension to multiple resource planning that I explored the use of goal programming as a solution technique for vector optimization.

Essentials of Goal Programming

Goal Programming (GP) is a special form of LP designed to address multiple criteria problems. It has the same basic structure as LP and can use the same solution procedures. Thus, any LP problem can be quickly converted to a GP and solved with commercially available algorithms. These tremendous advantages are the principle selling points for GP and are generally ignored by its proponents - especially those who have devised specialized matrix generators and solution algorithms. In general, such packages rely on a model form which is seldom appropriate, leads to inferior and often incorrect solutions and is unnecessarily limited in the size of problem that may be solved. This will be further discussed later in the paper.

GP attacks the multiple criteria problem indirectly by forming a linear combination of departures from the several objectives. It then seeks to minimize the sum of these departures which may be individually weighed to reflect the preference set of the decision maker. The problem is formulated by setting target levels for each desired objective or criterion. Under- and over-achievements of these targets are introduced as a new set of decision variables. These variables are added to the rows which related the former decision variables (the x_i's) to the objective function (z) or constraint levels (b_j). These new equations constitute the set of goal constraint rows. The other constraint rows remain unchanged.

The GP model may be expressed mathematically as:

$$\text{Minimize} \quad z = w_1^-d_1^- + w_1^+d_1^+ + w_2^-d_2^- + w_2^+d_2^+ + \ldots + w_p^-d_p^- + w_p^+d_p^+$$

$$\text{subject to} \quad c_{11}x_1 + c_{12}x_2 + \ldots + c_{1n}x_n + d_1^- - d_1^+ = g_1$$

$$c_{21}x_1 + c_{22}x_2 + \ldots + c_{2n}x_n + d_2^- - d_2^+ = g_2$$

$$\vdots$$

$$c_{p1}x_1 + c_{p2}x_2 + \ldots + c_{pn}x_n + d_p^- - d_p^+ = g_p$$

$$\text{and} \quad a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \leq b_2$$

$$\vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n \leq b_m$$

and $$x_1, x_2, \ldots, x_n, d_1^-, d_1^+, d_2^-, d_2^+, \ldots, d_p^-, d_p^+ \geq 0$$

$$d_1^- \cdot d_1^+ = 0, \quad d_2^- \cdot d_2^+ = 0, \ldots, d_p^- \cdot d_p^+ = 0$$

where d_i^- and d_i^+ are goal under- and over-achievements, w_i^- and w_i^+ are associated weights, g_k are the goals, x_i are the former activity variables, c_{ik} are coefficients relating the former activity variables to the goals, a_{ij} are technical coefficients for the constraints b_j. Note that the last line of the formulation prevents under- and over-achievements of the same goal from occurring simultaneously in a solution. The solution algorithm guarantees this automatically.

GP has a number of strong points as well as some weak ones. Its principle advantage is the joint consideration of noncommensurate objectives without an explicit definition of the trade-offs between these objectives. GP can, however, display the implicit trade-offs by ranging the weights and obtaining several solutions. Such a procedure can also overcome a major difficulty with GP - the initial determination of the set of weights.

We have already noted that a GP model can be easily formed from an existing LP model. This advantage can be further exploited to address another difficulty of GP - the setting of goal levels. GP solutions can be inferior (that is, improved solutions - "more of at least one goal and less of none" - are available), if the goal levels are not properly set. By using as goals the single objective LP optima obtainable from previous solutions of the LP model, the possibility of inferior GP solutions is largely eliminated. We have also noted that GP's relationship to LP permits the use of standard algorithms for solution.

GP has other weaknesses, the seriousness of which may also be reduced by employing it jointly with LP. The form of the GP model virtually ensures feasibility, often cited as an advantage. Because most infeasibilities are due to incorrect problem formulation or binding constraints, these are not something the analyst wants to ignore - which is, in effect, what GP does. If feasibility is assured by LP analysis first, then the analyst may be confident that the GP solutions will 'float'. Another failure of GP is the lack of marginal information about resources and activities. However, an accompanying LP model can show the contribution of additional resource inputs or the effects of following strategies that are not in the optimal solution.

These remarks all apply to the form of GP presented above, more properly termed cardinally-weighted GP. There is a more general form which can employ ordinal weights as well as cardinal weights and is called preemptive GP. In other words, goals are grouped by priority classes and the departures from higher priority goals are minimized before lower priority ones are considered. The solution procedure is like running a series of cardinally-weighted GP models where the solutions of all higher order models become binding constraints on the next lower model. As may be expected, the formulation and solution of preemptive GP problems require procedures that are not available in standard LP packages. There have been several special packages written to handle such problems. One such package is owned by the Forest Service. Caution is recommended in the use of such models because of the assumptions and the disadvantages noted above. Also such packages do not have provisions for complementary use of LP. Furthermore, there are serious theoretical questions about the interpretation of preemptive GP solutions. Finally, the preemptive model generation and solution procedures are much more limited in size than standard LP procedures. Selected references on the use of GP can be found in Field (1973), Bell (1976), and Field et al. (to be published).

A Procedure for the Complementary Use of LP and GP

The following is a description and an example of the joint use of LP and GP in timber harvest scheduling. This procedure can easily be extended to other applications including multiple-use planning. The idea is to begin with LP and perform certain analyses; then, if necessary, reformulate the planning problem as a GP model and perform additional analyses while continuing to check the acceptability and efficiency of the results with LP.

The specific steps in this procedure are as follows:

1) Formulate the planning problem as an LP model (or other mathematical programming model, if desired). Such formulation involves specifying problem parameters, decision variables, activities, constraints, and suitable decision criteria.

2) Optimize several objective functions serially under appropriate constraints. If the model is quite large and costly to solve, reduce it by deleting some of the alternative activities and use the reduced model to make the initial trials. Continue to use the reduced model to provide initial bases for solving the full model. Study the solutions and associated strategies for suitability in application. If possible, make changes in the model to eliminate undesirable consequences such as sharp increases in harvests or the treatment of large portions of the forest in a single period.

3) Compare the several solutions and strategies. Note the trade-offs among certain indices of performance as the objectives and constraints change. Observe the values of the dual variables and the reduced costs of

the nonbasis variables and make the appropriate marginal interpretation. Look for the presence of alternative optima. Even though these alternative solutions produce the same value for the objective function, they may differ in many other ways that are within the problem constraints. Thus it may be desirable to add or combine certain criteria in order to select a unique optimal strategy. Perform postoptimal analyses to test the sensitivity of attractive solutions and strategies to changes in parameters and response data: a reduced model may be sufficient for this testing. If the plan that is supported by a particular solution is completely satisfactory, provides a unique strategy, and is unlikely to be improved by slight reductions in the value of the model's objective function, complete the analysis with this step. If any of these conditions are not met, continue the analysis with the next three steps.

4) Reformulate the problem as a cardinally-weighted GP model. Include as goal levels the various single-objective optima from the individual LP solutions. This inclusion will gurantee an internally consistent goal set and lead to noninferior solutions. Give a large enough weight to the most favored goal to ensure a high level of achievement. Other weights should generally reflect the decision maker's preferences. If the model or reduced version is small enough to allow efficient multiple runs, use parametric procedures to range the goal weights and refine the preference structure. Obtain several solutions to one of more forms of the goal model that best describe the decision maker's preference.

5) Study the several solutions and strategies and compare them to the LP solutions in order to measure enhancements; or, if nonoptimal goals are used, to ensure that the solutions are noninferior. If new, unsatisfactory conditions are present in the preferred solutions and strategies, it may be necessary to return to the second step and reformulate the entire model.

6) Select the preferred solution to be used as a basis for the timber management plan and begin the action or tactical planning necessary to implement it.

The following case study illustrates the joint use of LP and GP in timber harvest scheduling.

Case Study (See ** Page 237)

Forest Situation. An analysis of the timber data form the Oconee National Forest in Georgia, preparatory to the writing of a new ten year timber management plan, provides an example. The Oconee contains approximately 35,000 ha of commercial forest land, predominantly in natural stands of southern pine on good to excellent sites. The age-class distribution has a sizeable bulge in the 40 to 60 year range; and the forest is generally understocked and managed at moderate intensity.

Forest Service policies regarding land classification, timber product objectives, permissible management strategies, and other managerial constraints were used as guidelines in formulating the LP model. Response data were based on suitable growth and yield relationships and past timber sales. An LP matrix covering a planning horizon of 150 years was generated with Timber RAM (Resources Allocation Method; Navon, 1971). Specific constraints included nondeclining harvest volumes by decade beginning with the current cut of 1,132,685 m^3 and continuing through a conversion period of 100 years. An even flow of havest volume was required for the five remaining decades, and periodic constraints were also imposed on budget and regeneration area.

Management activities included clearcutting existing stands of pine up to age 100 with or without prior thinnings. This clearcutting was followed by a cycle of 50-year rotations, each employing one of several thinning options followed by a clearcut. Certain pine classes, if treated, were required to be converted to hardwoods in order to attain a desired forest composition. Unstocked pine sites were reforested in the first decade to meet legal requirements, but the treatment of existing stands was optional.

Model Forms. Three sets of differently sized models were used in this case study. A small test model containing one site class of pine with clearcuts only as management options was used to try out model forms and solution procedures and to conduct sensitivity analysis on the most promising formulations. Knowledge gained with this model led to the selection of forms for the large model that included all stand classes, constraints and activities. This model is generally called the fully constrained model. Starting bases for the large model were obtained by solving a reduced model which contained all the stand classes but only a limited number of activities and greatly relaxed constraints. This substantially reduced overall solution time for the large model. (Univac's Functional Mathematical Programming Systems [FMPS] was the LP solution package used for the analysis.) Some solutions to the large model were obtained under relaxed constraints sets.

Separate solutions to the LP problem were based on three alternative objectives or measures of performance: maximize harvest volume, maximize net present value (MPV), and minimize present value of costs (PC). These could generally be regarded as silvicultural, fiscally efficient, and austerity objectives, respectively. In all cases, the optimization period was the entire 150 year planning horizon and economic objectives were expressed in present values with a discounting rate of 6 percent.

LP Results. The levels of harvest volume, NPV, and PC under the optimum solution to six variations of the large LP model are shown in Table 1. The

Table 1. Levels of performance under various LP objectives and constraint sets. Planning period totals in thousands of units.

	Indices of Performance		
	Volume (m^3)	Net Present Value (dollars)	Present Cost (dollars)
1. Full Constraints			
a. maximize total volume	37,738*	26,718	10,266
b. maximize net present value	36,869	31,740*	12,186
c. minimize present cost	20,587	10,744	3,196*
2. No flow constraints			
a. maximize total volume	39,046*	26,363	9,050
b. maximize net present value	36,523	34,159*	13,721
3. No flow, regeneration or budget constraints -- maximize total volume	39,695*	23,333	7,107

* Objective function.

** Case Study (from Field, et. al. 1980. Developed in cooperation with the University of Georgia School of Forest Resources, and the Southern Region.)

first three involve alternative objective criteria for the fully constrained model. In comparing these solutions, we note that an 18.7 percent increase in NPV accompanies a 2.3 percent decrease in total volume as the decision criterion is changed from volume to value. The cost minimization solution gives sharply reduced levels for all indices because it treats only enough area to meet the nondeclining yield constraints. Figure 1 shows that the periodic harvests of the three fully constrained solutions meet the requiremnet for nondeclining yield.

To determine the opportunity costs of the harvest flow and the regeneration and budget constraints, solutions were obtained in which these constraints were relaxed. The increases in total volume and NPV would be relatively small (Table 1), but Figure 2 shows that the accompanying fluctuations in periodic harvests are not inconsequential. Increased fluctuation in periodic treatment costs and regeneration areas also occurred when these constraints were relaxed.

Discussion. Given that the decision maker must choose a solution from among the fully constrained alternatives, the 'present cost' minimization is likely to be eliminated because it fails to utilize all of the resources. In retrospect, a formulation requiring treatment of all stands under minimization might have been more appropriate. While severe budgetary constraints and a desire for increased economic efficiency could make the minimum cost solution more desirable, the particular formulation of the minimum cost alternative used here (and probably any others) poses implementation problems that will be subsequently discussed. The NPV maximization solution might also be unattractive because of the Forest Service's reluctance to use profit as the single decision criterion for public land management.

Figure 1. Periodic harvests with the fully constrained LP solutions.

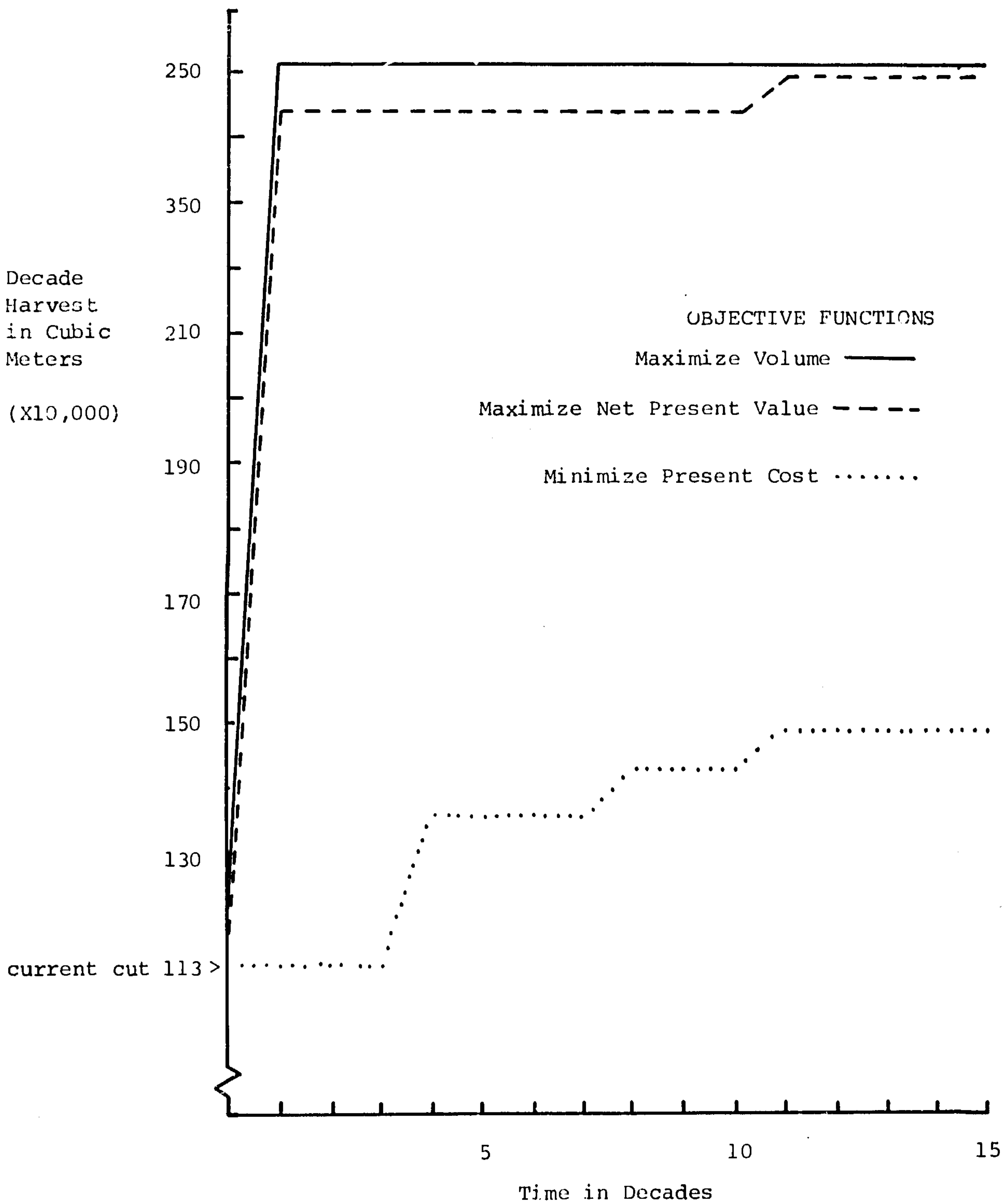
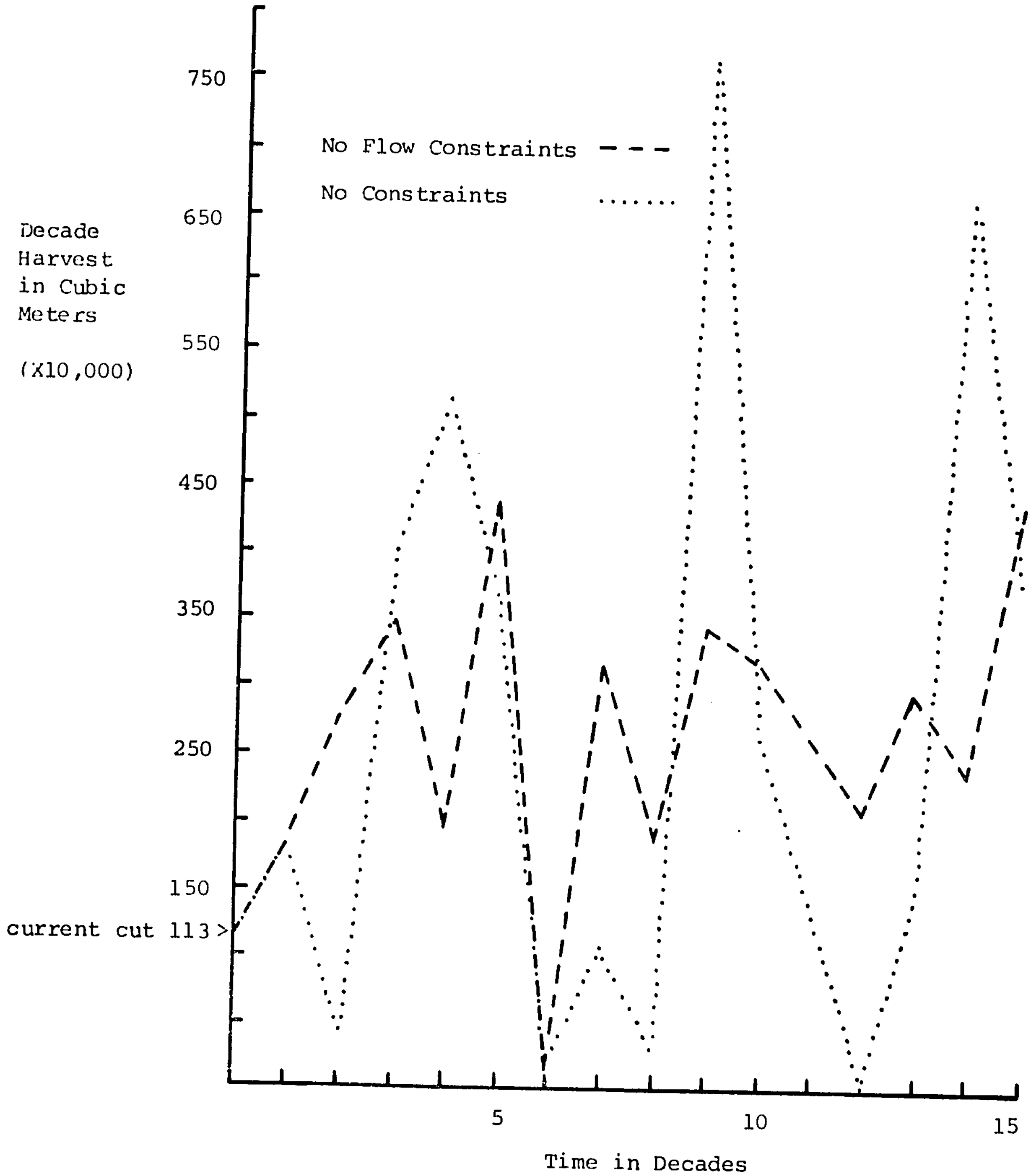


Figure 2. Periodic harvests with a maximum volume objective and reduced contraint sets.



The strategy based on the solution to the volume maximization problem indicates that alternative optima exist. This is a common occurrence with volume maximization problems, more especially those with short optimization periods. Even if volume is accepted as the singularly important criterion, it would behoove the decision maker to seek an alternative strategy with other admirable qualities such as a high NPV as well as maximum volume. Thus, additional criteria beyond that included in the model must be employed to determine a unique strategy, if such a strategy exists and its discovery is desirable.

As with strategies which provide alternative optima, the decision maker may also wish to explore slightly suboptimal strategies, as might be possible with certain nonbasis activities that have low reduced costs. The LP dual output may also provide useful information on the relative value of the several stand classes. For example, it would be most advantageous from a total volume standpoint if the manager could acquire more area in age 30 pine plantations on site class I. Alternatively, if withdrawals are necessary, they will reduce volume the least if they can be made in the site class III hardwood areas. Such interpretations can only be made with the LP model because the GP dual variables are based on the departures and cannot provide any marginal information about the resources or activities.

Reformulation as GP Models. Choosing from among alternative optimal strategies or satisfying a manager's desire to consider multiple-decision criteria simultaneously may be achieved by reformulating the problem as a GP model. This reformulation was easily accomplished in this example by employing certain FMPS options to make a few simple changes in the LP matrix generated by Timber RAM. The optimal values for harvest volume, NPV, and PC were placed on the right-hand sides of their respective function rows. At the same time, the rows were designated as equality constraints with over- and under-achievement variables included in each row. Then a new objective function was created to include the under-achievements for volume and NPV and the over-achievement for PC. Several solutions were obtained by minimizing variously weighted forms of this function. These matrix modifications and solutions were all handled within FMPS.

A model that represented 'normalized' or 'relative' goals was more difficult to formulate. In this form of the model, all the new goals are equal to unity while the elements of the new $\underline{C}$ matrix are equal to $c_{kj} \div g_k$; thus, the added departure variables become relative or percentage departures from the original goals. Such an approach is often recommended to overcome an inherent bias in favor of goals of large magnitudes. It will be noted, however, that in this example the bias is merely reversed, not eliminated. Such a result may not generally occur, but instead be dependent upon the structure of the model. Because FMPS lacks the ability to form entire new rows based on existing rows, a FORTRAN program was used to rewrite the Timber RAM matrix, dividing the desired goal row coefficients by the goal.[1] Then, as in the procedure described above, FMPS was used to set up and solve the GP model.

GP Results. The original analysis used cunits (100 ft^3) as the volume measure instead of the cubic meters displayed in this paper. Thus, the volume goal was originally about half the magnitude of the NPV goal. This disproportion produced a solution based on equally-weighted, absolute goals which favored the NPV goal and an equally-weighted, normalized-goals solution which favored the PC goal (Table 2). To present what was presumed to

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[1]This operation may be accomplished more directly with IBM's MPSX solution package. MPSX handles the other steps in converting from LP to a GP model in much the same manner as FMPS.

Table 2. Levels of performance under various GP weighting schemes. Planning period totals in thousands of units.

	Indices of Performance		
	Volume (m^3)	Net Present Value (dollars)	Present Cost (dollars)
1. Equal weights	36,388	30,372	10,129
2. Relative weights	31,548	17,762	4,236
3. Volume weight = 10	37,478	30,121	10,911

be the manager's preference, a second model with absolute goals was formed with the volume goal departure having a weight of 10 while the other weights remained at unity. Comparing the solution of this model to the solution with equally-weighted, absolute goals showed a 3 percent increase in volume production with less than a 1 percent decrease in NPV. Or, comparing this solution to the LP maximum volume solution, NPV was increased by 13 percent at the expense of a 1 percent reduction in volume.

The pattern of harvest volumes for the differentially-weighted GP solution (Figure 3) is similar to the LP solution for volume maximization (Figure 1). However, the strategies for the first decade are quite different for the two solutions (see Table 3, items 1a and 2c). Not only is the GP strategy unique in that there are no alternative optima, but considerably fewer hectares are treated to achieve virtually the same yields. This was, indeed, a fortuitous result, and while it was made possible by GP, it was certainly not guaranteed by it. In fact, Table 3 also shows that the 'normalized' model resulted in an unsatisfactory optimal strategy in which 62 percent

Figure 3. Periodic harvests with the differently weighted GP solutions.

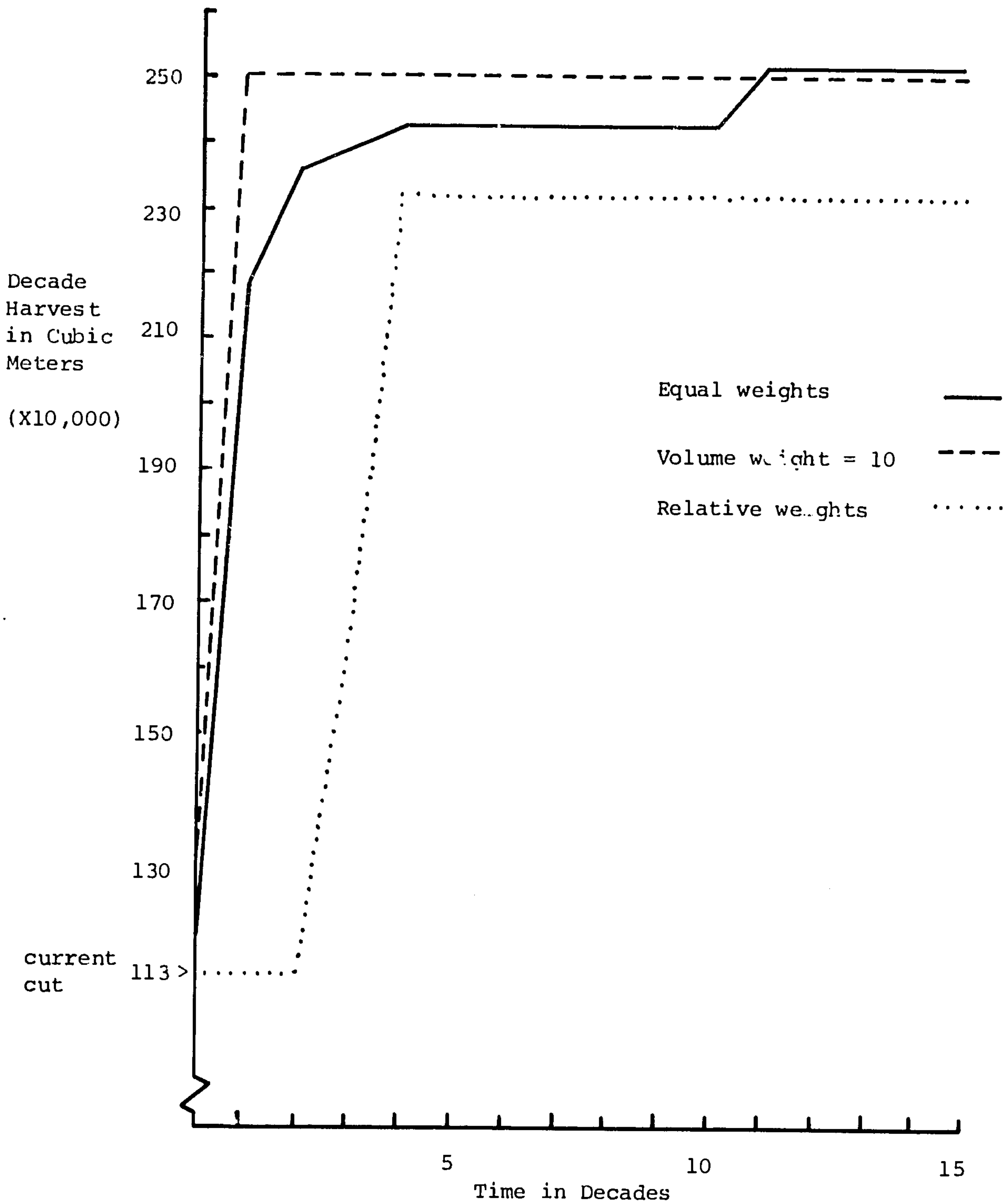

Table 3. Optimal first decade strategies under various fully constrained LP and GP formulations. Forest hectares by management activity.

	Activity					
	Pine					
	Harvest	Thin	Plant*	Convert†	Hardwood Cut	Total Treated
1. LP						
a. maximize volume	5,956	1,970	591	2,906	3,007	14,430
b. maximize net present value	5,995	3,556	591	4,044	754	14,941
c. minimize present cost	--	12,930	591	--	3,007	16,528
2. GP						
a. equal weights	2,348	8,730	591	5,492	--	17,161
b. relative weights	--	19,951	591	--	1,888	22,430
c. volume weight = 10	4,392	234	591	5,713	198	11,128

* Unstocked areas only; pine harvest areas also require planting in this decade.

† Pine that is harvested and converted to hardwood, not included under pine harvest.

of the forest would receive treatments in the first decade, none of which would be a final harvest. This strategy is even worse than the strategy produced by the LP model that minimzed PC. In both cases, early harvest constraints are met by intermediate cuttings, thus delaying the sizeable regeneration costs until later, more heavily discounted periods. The several figures and tables show that the solution with differentially-weighted goals also compares favorably with the NPV solution and the solution with equally-weighted goals. Given the available information described here, the analysis would likely be terminated at this point and implementation of the final model's solution strategy would proceed.

Discussion. In this example, we have been able to overcome the inadequacy of LP to produce a satisfactory solution in the face of conflicting criteria by judicious use of GP. We were also able to avoid some of the possible pitfalls of GP by basing it on the LP solutions and comparing the solutions and strategies it produced to its LP counterparts. The sensitivity analyses performed with the small test model could have been made with the large model if desired. The opportunity costs of relaxing constraints with a GP formulation would not be very useful, even though it may be easily accomplished.

While this example is based on a Forest Service planning problem and was used as an LP package designed for such planning, the technique is not limited to application in the public sector. GP can just as easily be appended to industrially oriented LP packages patterned after Ware and Clutter (1971) in order to analyze the harvest scheduling of a privately owned forest. Similar improvements in sensitivity testing and strategy selection would be possible.

Conclusions

For single-objective management planning commonly analyzed with LP, GP can be valuable as a postoptimal analysis technique. If alternative optima or multiple-criteria questions arise during such analysis, GP can be used to assist in the efficient selection of a unique strategy or compromise solution. Formulating the GP model from the LP model and subsequent LP checks of the solutions can ensure noninferior GP solutions, a condition not guaranteed when this technique is used independently to solve multiple-objective problems. Thus, the analysis of such problems may also be enhanced through the joint use of GP and LP. If a forest manager employs the technique described here, then the framework for more efficient multiple-use planning will be established.

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A NETWORK ANALYSIS OF TIMBER SALE ACTIVITIES

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Problem

Each year, approximately sixty timber sales take place in the Francis Marion and Sumter National Forests. Each of these sales, as in other forest timber sale programs, must be carefully studied by soil scientists and archaeologists for possible problems or conflicts that come up in the office or in the field. These reviews consider numerous activities, such as possible road locations, archaeological surveys, and sale appraisals, as well as time constraints. For the past several years, scheduling problems have set the sale programs behind schedule. This paper proposes a schedule of activities for time allowed.

Program Selected

The RAMUS program available at Fort Collins was selected to schedule and evaluate the timber sale activities. This program calculates the critical path, assigns dates to specific activities and provides a graphic display of the activities and events in the form of a bar chart.

Application

A portion of the timber sale program on the Enoree Ranger District for fiscal year 1980 was used to test the program. Nine activities (areas) were selected to be monitored:

01, Road Location
02, Timber Marking
03, Soil and Water Surveys
04, Archaeological Survey
05, Road Survey
06, Road Design
07, Sale Volume Computation
08, Sale Appraisal
09, Sale Advertisement - Award

In other districts, additional activities may be added, i.e., Rights-of-Way, and others.

Each activity on each timber sale was given an I-Node number showing when it is to begin in relation to other activities, a J-Node number to show when it must be completed in relation to other activities, and the number of days required for completion. Some activities are planned to be completed before the beginning of the fiscal year, and thus were not shown.

A critical path is developed by the program showing the critical jobs that must be completed before the next job is to begin. This is the control over the time required to do the total project.

Results

The first run of the program shows the same problems encountered in the timber sale program. By assigning a reasonable number of days to each activity, the total project was not to be completed until November 27, 1980, almost two months after the end of the fiscal year. In actual practice, the activities are rushed toward the end of the fiscal year to complete the sale program on time.

The activities must be reviewed to see which ones can be completed in less time. The program can then be run again to achieve a schedule of activities that can be completed in the time allowed.

EDITED DATA READY TO BE ENTERED

```
 1:ENOREE TIMBER SALE PROGRAM
 2:9
 3:01,ROAD LOCATION
 4:02,TIMBER MARKING
 5:03,SOIL WATER SUR
 6:04,ARCHEOLOGICAL SUR
 7:05,ROAD SURVEY
 8:06,ROAD DESIGN
 9:07,SALE VOLUME
10:08,SALE APPRAISAL
11:09,SALE ADV. AWARD
12:9
13:100879
14:111179
15:112279
16:122079
17:010180
18:021180
19:052680
20:070480
21:090180
22:100179
23:1,1,1,1,1,1,0,0
24:EN 94 VOL COMP    7   1   2 20
25:EN 94 SOIL-WAT    3   1   2  5
26:EN 94 ARCH SUR    4   1   2  5
27:EN 94 SALE APP    8   2   3 20
28:EN 94 ADV-AWD     9   3   4 40
29:EN 117 TBR MARK   2   1   2 25
30:EN 117 SOIL-WAT   3   2   3  5
31:EN 117 ARCH SUR   4   2   3  5
32:EN 117 VOL COMP   7   2   3 20
33:EN 117 ROAD DES   6   2   4 30
34:EN 117 SALE APP   8   4   5 20
35:EN 117 ADV AWD    9   5   6 40
36:EN 165 TBR MARK   2   2   3 15
37:EN 165 SOIL-WAT   3   3   4  5
38:EN 165 ARCH SUR   4   3   4  5
39:EN 165 VOL COMP   7   2   3 20
40:EN 165 ROAD DES   6   3   4 30
41:EN 165 SALE APP   8   5   6 20
42:EN 165 ADV AWD    9   6   7 40
43:EN 147 ROAD LOC   1   1   2  5
44:EN 147 TBR MARK   2   3   4 20
45:EN 147 SOIL WAT   3   2   4  5
46:EN 147 ARCH SUR   4   2   4  5
47:EN 147 ROAD SUR   5   3   4 20
48:EN 147 ROAD DES   6   4   5 30
49:EN 147 VOL COMP   7   4   5 20
50:EN 147 SALE APP   8   5   6 20
51:EN 147 ADV AWD    9   7   8 40
52:EN 122 ROAD LOC   1   2   3  5
53:EN 122 TBR MARK   2   4   5 28
54:EN 122 SOIL WAT   3   3   5  5
55:EN 122 ARCH SUR   4   3   5  5
56:EN 122 ROAD SUR   5   4   5 25
57:EN 122 ROAD DES   6   5   6 30
58:EN 122 VOL COMP   7   5   6 20
59:EN 122 SALE APP   8   6   7 20
60:EN 122 ADV AWD    9   7   8 40
61:EN 160 ROAD LOC   1   3   4  5
62:EN 160 TBR MARK   2   6   7 28
63:EN 160 SOIL WAT   3   4   6  5
64:EN 160 ARCH SUR   4   4   6  5
65:EN 160 ROAD SUR   5   6   7 25
66:EN 160 ROAD DES   6   7   8 30
67:EN 160 VOL COMP   7   7   8 20
68:EN 160 SALE APP   8   8   9 20
69:EN 160 ADV AWD    9   9  10 40
```

ALL JOBS BY TIME UNITS

AUG 8, 1979

ENOREE TIMBER SALE PROGRAM

CRITICAL PATH BY TIME UNITS

C P	AREA ACTIVITY	I NODE	J NODE	JOB TIME	EARLY START	EARLY FIN.	LATE START	LATE FIN.	TOTAL SLACK	FREE SLACK
	1 EN 147 ROAD LOC	1	2	5	1	6	21	26	20	20
*	2 EN 117 TBR MARK	1	2	25	1	26	1	26	0	0
	4 EN 94 ARCH SUR	1	2	5	1	6	21	26	20	20
	3 EN 94 SOIL-WAT	1	2	5	1	6	21	26	20	20
	7 EN 94 VOL COMP	1	2	20	1	21	6	26	5	5
	3 EN 117 SOIL WAT	2	3	5	26	31	41	46	15	15
*	8 EN 94 SALE APP	2	3	20	26	46	26	46	0	0
	2 EN 165 TBR MARK	2	3	15	26	41	31	46	5	5
	6 EN 117 ROAD DES	2	4	30	26	56	56	86	30	30
*	7 EN 117 VOL COMP	2	3	20	26	46	26	46	0	0
	4 EN 117 ARCH SUR	2	3	5	26	31	41	46	15	15
	4 EN 147 ARCH SUR	2	4	5	26	31	81	86	55	55
	3 EN 147 SOIL WAT	2	4	5	26	31	81	86	55	55
*	7 EN 165 VOL COMP	2	3	20	26	46	26	46	0	0
	1 EN 122 ROAD LOC	2	3	5	26	31	41	46	15	15
	3 EN 122 SOIL WAT	3	5	5	46	51	111	116	65	65
	5 EN 147 ROAD SUR	3	4	20	46	66	66	86	20	20
	6 EN 165 ROAD DES	3	4	30	46	76	56	86	10	10
	2 EN 147 TBR MARK	3	4	20	46	66	66	86	20	20
	4 EN 165 ARCH SUR	3	4	5	46	51	81	86	35	35
	3 EN 165 SOIL WAT	3	4	5	46	51	81	86	35	35
*	9 EN 94 ADV-AWD	3	4	40	46	86	46	86	0	0
	1 EN 160 ROAD LOC	3	4	5	46	51	81	86	35	35
	4 EN 122 ARCH SUR	3	5	5	46	51	111	116	65	65
	5 EN 122 ROAD SUR	4	5	25	86	111	91	116	5	5
	4 EN 160 ARCH SUR	4	6	5	86	91	151	156	65	65
	3 EN 160 SOIL WAT	4	6	5	86	91	151	156	65	65
	8 EN 117 SALE APP	4	5	20	86	106	96	116	10	10
*	6 EN 147 ROAD DES	4	5	30	86	116	86	116	0	0
	7 EN 147 VOL COMP	4	5	20	86	106	96	116	10	10
	2 EN 122 TBR MARK	4	5	28	86	114	88	116	2	2
	8 EN 147 SALE APP	5	6	20	116	136	136	156	20	20
	8 EN 165 SALE APP	5	6	20	116	136	136	156	20	20
*	9 EN 117 ADV AWD	5	6	40	116	156	116	156	0	0
	7 EN 122 VOL COMP	5	6	20	116	136	136	156	20	20
	6 EN 122 ROAD DES	5	6	30	116	146	126	156	10	10
	2 EN 160 TBR MARK	6	7	28	156	184	168	196	12	12
	8 EN 122 SALE APP	6	7	20	156	176	176	196	20	20
	5 EN 160 ROAD SUR	6	7	25	156	181	171	196	15	15
*	9 EN 165 ADV AWD	6	7	40	156	196	156	196	0	0
*	9 EN 147 ADV AWD	7	8	40	196	236	196	236	0	0
	6 EN 160 ROAD DES	7	8	30	196	226	206	236	10	10
	7 EN 160 VOL COMP	7	8	20	196	216	216	236	20	20
*	9 EN 122 ADV AWD	7	8	40	196	236	196	236	0	0
*	8 EN 160 SALE APP	8	9	20	236	256	236	256	0	0
*	9 EN 160 ADV AWD	9	10	40	256	296	256	296	0	0

ALL JOBS BY DATE

ENOREE TIMBER SALE PROGRAM

CRITICAL PATH BY DATES

C P	AR	ACTIVITY	I NODE	J NODE	JOB TIME	*****EARLY***** START	FIN.	*****LATE***** START	FIN.	**SLACK** TOT.	FREE
	1	EN 147 ROAD LOC	1	2	5	1OCT79	9OCT79	30OCT79	6NOV79	20	20
*	2	EN 117 TBR MARK	1	2	25	1OCT79	6NOV79	1OCT79	6NOV79	0	0
	4	EN 94 ARCH SUR	1	2	5	1OCT79	9OCT79	30OCT79	6NOV79	20	20
	3	EN 94 SOIL-WAT	1	2	5	1OCT79	9OCT79	30OCT79	6NOV79	20	20
	7	EN 94 VOL COMP	1	2	20	1OCT79	30OCT79	9OCT79	6NOV79	5	5
	3	EN 117 SOIL-WAT	2	3	5	6NOV79	13NOV79	28NOV79	5DEC79	15	15
*	8	EN 94 SALE APP	2	3	20	6NOV79	5DEC79	6NOV79	5DEC79	0	0
	2	EN 165 TBR MARK	2	3	15	6NOV79	28NOV79	13NOV79	5DEC79	5	5
	6	EN 117 ROAD DES	2	4	30	6NOV79	19DEC79	19DEC79	3FEB80	30	30
*	7	EN 117 VOL COMP	2	3	20	6NOV79	5DEC79	6NOV79	5DEC79	0	0
	4	EN 117 ARCH SUR	2	3	5	6NOV79	13NOV79	28NOV79	5DEC79	15	15
	4	EN 147 ARCH SUR	2	4	5	6NOV79	13NOV79	27JAN80	3FEB80	55	55
	3	EN 147 SOIL WAT	2	4	5	6NOV79	13NOV79	27JAN80	3FEB80	55	55
*	7	EN 165 VOL COMP	2	3	20	6NOV79	5DEC79	6NOV79	5DEC79	0	0
	1	EN 122 ROAD LOC	2	3	5	6NOV79	13NOV79	28NOV79	5DEC79	15	15
	3	EN 122 SOIL WAT	3	5	5	5DEC79	12DEC79	10MAR80	17MAR80	65	65
	5	EN 147 ROAD SUR	3	4	20	5DEC79	6JAN80	6JAN80	3FEB80	20	20
	6	EN 165 ROAD DES	3	4	30	5DEC79	20JAN80	19DEC79	3FEB80	10	10
	2	EN 147 TBR MARK	3	4	20	5DEC79	6JAN80	6JAN80	3FEB80	20	20
	4	EN 165 ARCH SUR	3	4	5	5DEC79	12DEC79	27JAN80	3FEB80	35	35
	3	EN 165 SOIL-WAT	3	4	5	5DEC79	12DEC79	27JAN80	3FEB80	35	35
*	9	EN 94 ADV-AWD	3	4	40	5DEC79	3FEB80	5DEC79	3FEB80	0	0
	1	EN 160 ROAD LOC	3	4	5	5DEC79	12DEC79	27JAN80	3FEB80	35	35
	4	EN 122 ARCH SUR	3	5	5	5DEC79	12DEC79	10MAR80	17MAR80	65	65
	5	EN 122 ROAD SUR	4	5	25	3FEB80	10MAR80	11FEB80	17MAR80	5	5
	4	EN 160 ARCH SUR	4	6	5	3FEB80	11FEB80	5MAY80	12MAY80	65	65
	3	EN 160 SOIL WAT	4	6	5	3FEB80	11FEB80	5MAY80	12MAY80	65	65
	8	EN 117 SALE APP	4	5	20	3FEB80	3MAR80	18FEB80	17MAR80	10	10
*	6	EN 147 ROAD DES	4	5	30	3FEB80	17MAR80	3FEB80	17MAR80	0	0
	7	EN 147 VOL COMP	4	5	20	3FEB80	3MAR80	18FEB80	17MAR80	10	10
	2	EN 122 TBR MARK	4	5	28	3FEB80	13MAR80	5FEB80	17MAR80	2	2
	8	EN 147 SALE APP	5	6	20	17MAR80	14APR80	14APR80	12MAY80	20	20
	8	EN 165 SALE APP	5	6	20	17MAR80	14APR80	14APR80	12MAY80	20	20
*	9	EN 117 ADV AWD	5	6	40	17MAR80	12MAY80	17MAR80	12MAY80	0	0
	7	EN 122 VOL COMP	5	6	20	17MAR80	14APR80	14APR80	12MAY80	20	20
	6	EN 122 ROAD DES	5	6	30	17MAR80	28APR80	31MAR80	12MAY80	10	10
	2	EN 160 TBR MARK	6	7	28	12MAY80	22JUN80	29MAY80	9JUL80	12	12
	8	EN 122 SALE APP	6	7	20	12MAY80	10JUN80	10JUN80	9JUL80	20	20
	5	EN 160 ROAD SUR	6	7	25	12MAY80	17JUN80	3JUN80	9JUL80	15	15
*	9	EN 165 ADV AWD	6	7	40	12MAY80	9JUL80	12MAY80	9JUL80	0	0
*	9	EN 147 ADV AWD	7	8	40	9JUL80	4SEP80	9JUL80	4SEP80	0	0
	6	EN 160 ROAD DES	7	8	30	9JUL80	20AUG80	23JUL80	4SEP80	10	10
	7	EN 160 VOL COMP	7	8	20	9JUL80	6AUG80	6AUG80	4SEP80	20	20
*	9	EN 122 ADV AWD	7	8	40	9JUL80	4SEP80	9JUL80	4SEP80	0	0
*	8	EN 160 SALE APP	8	9	20	4SEP80	2OCT80	4SEP80	2OCT80	0	0
*	9	EN 160 ADV AWD	9	10	40	2OCT80	27NOV80	2OCT80	27NOV80	0	0

ALL JOBS ON A BAR CHART

15 ENCREE TIMBER SALE PROGRAM AUG 9, 1977

BAR CHART

SCALE FACTOR: 1 UNIT = 40 WORK DAYS

C P	START NODE	END NODE	JOB DESCRIPTION
	1	2	EN 147 ROAD LOC
X	1	2	EN 117 TBR MARK
	1	2	EN 94 ARCH SUR
	1	2	EN 94 SOIL-WAT
	1	2	EN 94 VOL COMP
	2	3	EN 117 SOIL-WAT
X	2	3	EN 94 SALE APP
	2	3	EN 165 TBR MARK
	2	4	EN 117 ROAD DES
X	2	3	EN 117 VOL COMP
	2	3	EN 117 ARCH SUR
	2	4	EN 147 ARCH SUR
	2	4	EN 147 SOIL WAT
X	2	3	EN 165 VOL COMP
	2	3	EN 122 ROAD LOC
	3	5	EN 122 SOIL WAT
	3	4	EN 147 ROAD SUR
	3	4	EN 165 ROAD DES
	3	4	EN 147 TBR MARK
	3	4	EN 165 ARCH SUR
	3	4	EN 165 SOIL-WAT
X	3	4	EN 94 ADV-AWD
	3	4	EN 160 ROAD LOC
	3	5	EN 122 ARCH SUR
	4	5	EN 122 ROAD SUR
	4	6	EN 160 ARCH SUR
	4	6	EN 160 SOIL WAT
	4	5	EN 117 SALE APP
X	4	5	EN 147 ROAD DES
	4	5	EN 147 VOL COMP
	4	5	EN 122 TBR MARK
	5	6	EN 147 SALE APP
	5	6	EN 165 SALE APP
X	5	6	EN 117 ADV AWD
	5	6	EN 122 VOL COMP
	5	6	EN 122 ROAD DES
	6	7	EN 160 TBR MARK
	6	7	EN 122 SALE APP
	6	7	EN 160 ROAD SUR
X	6	7	EN 165 ADV AWD
X	7	8	EN 147 ADV AWD
	7	8	EN 160 ROAD DES
	7	8	EN 160 VOL COMP
X	7	8	EN 122 ADV AWD
X	8	9	EN 160 SALE APP
X	9	10	EN 160 ADV AWD

* = EARLY TIME
\- LATE TIME
X = CRITICAL PATH

END OF FISCAL YEAR

CRITICAL PATH BY TIME UNITS, DATE AND BAR CHART

 AUG 8, 1979

~~ENDFEE TIMBER SALE PROGRAM~~

CRITICAL PATH BY TIME UNITS

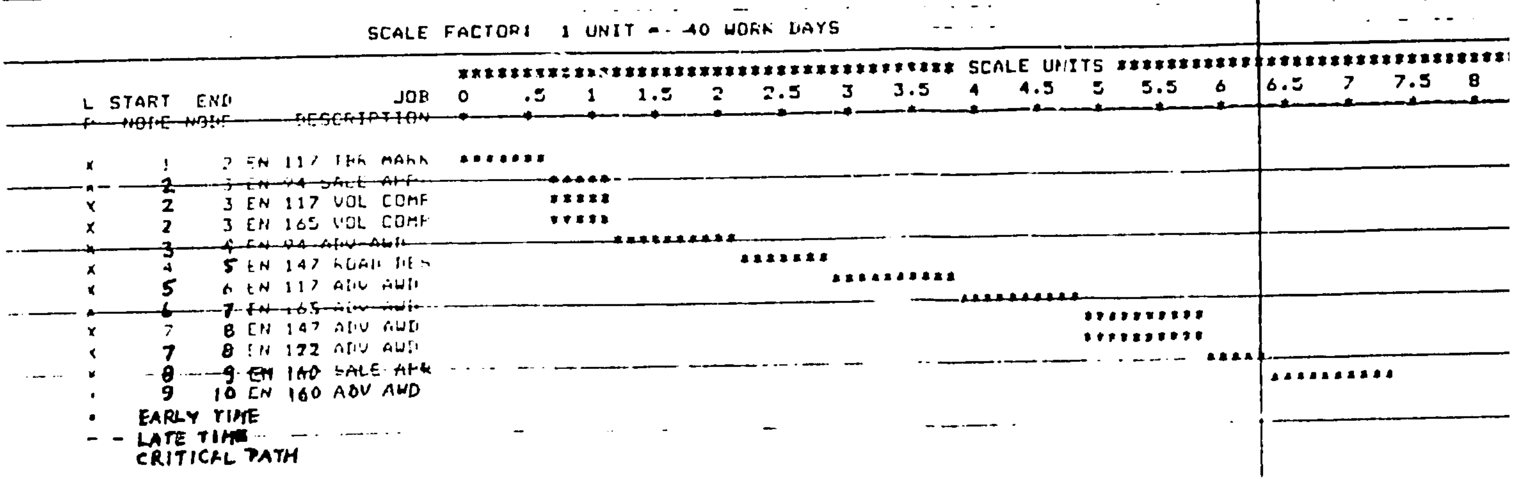
C F	AREA ACTIVITY	I NODE	J NODE	JOB TIME	EARLY START	EARLY FIN.	LATE START	LATE FIN.	TOTAL SLACK	FREE SLACK
*	2 EN 117 TBR MARK	1	2	25	1	26	1	26	0	0
*	~~9 EN 94 SALE APP~~	~~2~~	~~3~~	~~20~~	~~26~~	~~46~~	~~26~~	~~46~~	~~0~~	~~0~~
*	7 EN 117 VOL COMP	2	3	20	26	46	26	46	0	0
*	7 EN 165 VOL COMP	2	3	20	26	46	26	46	0	0
*	~~8 EN 94 ADV-AWD~~	~~3~~	~~4~~	~~40~~	~~46~~	~~86~~	~~46~~	~~86~~	~~0~~	~~0~~
*	6 EN 147 ROAD DES	4	5	30	86	116	86	116	0	0
*	9 EN 117 ADV AWD	5	6	40	116	156	116	156	0	0
*	9 EN 165 ADV AWD	6	7	40	156	196	156	196	0	0
*	~~9 EN 147 ADV AWD~~	~~7~~	~~8~~	~~40~~	~~196~~	~~236~~	~~196~~	~~236~~	~~0~~	~~0~~
*	9 EN 122 ADV AWD	7	8	40	196	236	196	236	0	0
*	8 EN 160 SALE APP	8	9	20	236	256	236	256	0	0
*	9 EN 160 ADV AWD	9	10	40	256	296	256	296	0	0

CRITICAL PATH BY DATES

C F	AR ACTIVITY	I NODE	J NODE	JOB TIME	EARLY START	EARLY FIN.	LATE START	LATE FIN.	SLACK TOT.	SLACK FREE
*	~~2 EN 117 TBR MARK~~	~~1~~	~~2~~	~~25~~	~~1OCT79~~	~~6NOV79~~	~~1OCT79~~	~~6NOV79~~	~~0~~	~~0~~
*	8 EN 94 SALE APP	2	3	20	6NOV79	5DEC79	6NOV79	5DEC79	0	0
*	7 EN 117 VOL COMP	2	3	20	6NOV79	5DEC79	6NOV79	5DEC79	0	0
*	~~7 EN 165 VOL COMP~~	~~2~~	~~3~~	~~20~~	~~6NOV79~~	~~5DEC79~~	~~6NOV79~~	~~5DEC79~~	~~0~~	~~0~~
*	9 EN 94 ADV-AWD	3	4	40	5DEC79	3FEB80	5DEC79	3FEB80	0	0
*	6 EN 147 ROAD DES	4	5	30	3FEB80	17MAR80	3FEB80	17MAR80	0	0
*	~~9 EN 117 ADV AWD~~	~~5~~	~~6~~	~~40~~	~~17MAR80~~	~~12MAY80~~	~~17MAR80~~	~~12MAY80~~	~~0~~	~~0~~
*	9 EN 165 ADV AWD	6	7	40	12MAY80	9JUL80	12MAY80	9JUL80	0	0
*	9 EN 147 ADV AWD	7	8	40	9JUL80	4SEP80	9JUL80	4SEP80	0	0
*	~~9 EN 122 ADV AWD~~	~~7~~	~~8~~	~~40~~	~~9JUL80~~	~~4SEP80~~	~~9JUL80~~	~~4SEP80~~	~~0~~	~~0~~
*	3 EN 160 SALE APP	8	9	20	4SEP80	2OCT80	4SEP80	2OCT80	0	0
*	9 EN 160 ADV AWD	9	10	40	2OCT80	27NOV80	2OCT80	27NOV80	0	0

BAR CHART

SCALE FACTOR: 1 UNIT = 40 WORK DAYS



EXAMPLE OF ONE ACTIVITY (AREA) - ADVERTISE AND AWARD OF TIMBER SALES - BY TIME UNIT, DATE AND BAR CHART

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ENOREE TIMBER SALE PROGRAM AUG 9, 1979

Advertise-Award BY TIME UNITS

C F	AREA ACTIVITY	I NODE	J NODE	JOB TIME	EARLY START	EARLY FIN.	LATE START	LATE FIN.	TOTAL SLACK	FREE SLACK
*	9 EN 94 ADV-AWD	3	4	40	46	86	46	86	0	0
*	9 EN 117 ADV AWD	5	6	40	116	156	116	156	0	0
*	9 EN 165 ADV AWD	6	7	40	156	196	156	196	0	0
*	9 EN 147 ADV AWD	7	8	40	196	236	196	236	0	0
*	9 EN 122 ADV AWD	7	[illegible]	40	196	236	196	236	0	0
*	9 EN 160 ADV AWD	9	10	40	256	296	256	296	0	0

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ENOREE TIMBER SALE PROGRAM AUG 9, 1979

BY DATES

C F	AR ACTIVITY	I NODE	J NODE	JOB TIME	EARLY START	EARLY FIN.	LATE START	LATE FIN.	SLACK TOT.	SLACK FREE
*	9 EN 94 ADV-AWD	3	4	40	5DEC79	3FEB80	5DEC79	3FEB80	0	0
*	9 EN 117 ADV AWD	5	6	40	17MAR80	12MAY80	17MAR80	12MAY80	0	0
*	9 EN 165 ADV AWD	6	7	40	12MAY80	9JUL80	12MAY80	9JUL80	0	0
*	9 EN 147 ADV AWD	7	8	40	9JUL80	4SEP80	9JUL80	4SEP80	0	0
*	9 EN 122 ADV AWD	7	8	40	9JUL80	4SEP80	9JUL80	4SEP80	0	0
*	9 EN 160 ADV AWD	9	10	40	2OCT80	27NOV80	2OCT80	27NOV80	0	0

END OF FISCAL YEAR

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ENOREE TIMBER SALE PROGRAM AUG 9, 1979

BAR CHART

SCALE FACTOR: 1 UNIT = 40 WORK DAYS

JOB SCALE UNITS: 0 .5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8

C P	START NODE	END NODE	JOB DESCRIPTION	BAR
X	3	4	EN 94 ADV-AWD	**********
X	5	6	EN 117 ADV AWD	**********
X	6	7	EN 165 ADV AWD	**********
X	7	8	EN 147 ADV AWD	**********
X	7	8	EN 122 ADV AWD	**********
X	9	10	EN 160 ADV AWD	**********

* - EARLY TIME
\- - LATE TIME
* - CRITICAL PATH

A NETWORK ANALYSIS OF FOREST RESOURCE PLANNING ACTIVITIES

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Definition of Problem

The Forest Resources Planning section of the Northeastern Area, State and Private Forestry, administers planning grants to ten state forestry organizations. The planning grants are used to assist the states in developing Statewide Forest Resources Plans. The relative lack of data concerning the resources (time, personnel, and dollars) needed to complete a State Planning Program makes it difficult to determine necessary funding levels.

Methodology

As a part of initiating the search for a computer assisted management program, the Forest Resources Planning Section contacted the Planning Systems Application Liaison for State and Private Forestry. Our liaison suggested that our section try the PAC II Software System, a CPM/PERT (Critical Path/Program Evaluation and Review Technique) program which is already operational at Fort Collins and is specifically designed to assist in project management. It was agreed that the Systems Application Liaison and a representative from our office would meet in the Regional Office (R9) to experiment with PAC II.

Previous to the week at Region 9's offices, the Northeastern Area's Forest Resources Planning section went through their planning process to determine data for the following variables:

1. number of resources,
2. number of hours per week per resource,

3. efficiency of resources,
4. rates per hour per resource,
5. beginning and end date of project,
6. non-linear planning process.

The values given to the above variables are as in Tables I and II and III which follow:

TABLE I

Data for Statewide Resource Planning Programs

No. of resources	No. hrs./wk.	Efficiency	Rate/hr.
line officer	4	90%	$12.00
state forester	8	80%	$10.00
assistant state forester	16	80%	$ 9.00
planner	30	75%	$ 7.00
assistant planner	30	75%	$ 6.00
clerical	20	90%	$ 3.00

TABLE II

Dates for Runs of the Programs

	Beginning Date	End Date
First Run	10/1/79	7/1/81
Second Run	10/1/79	7/1/82
Third Run	10/1/79	7/1/83

TABLE III

Non-linear Planning Process for Programs*

PHASE I

TAG		DEP
100	Draft of Planning Concept Document	-
110	I & I Agency Personnel	100
120	I & I Key People	100
130	Revise and Finalize Concept Document	120
140	Organize Work and Review Committees	100

PHASE II

TAG		DEP
200	Inform Public	130
210	List of Issues	200
220	Screen Issues	210
230	Aggregate and Refine Issues	210
240	Review and Revise Management Goals	130

PHASE III

TAG		DEP
300	Refocus Process	230
310	Issue Assessment	210
320	List Issue Strategies	240
330	Program Select Criteria	230
340	Screen Issue Strategies	320

PHASE IV

TAG		DEP
400	Issue Priority Alternatives	320
410	Aggregate Issue Priority Alternatives	400
420	Issue Strategy Priority	340
430	Final Program Alternatives	420
440	Effects of Alternatives	430

*See Critical Path Chart (Exhibit 1)

TABLE III (cont.)

TAG	PHASE V	DEP
500	Alternative Differences	440
510	Select Recommended Program	500
520	Public Review	510
530	Final Program	520

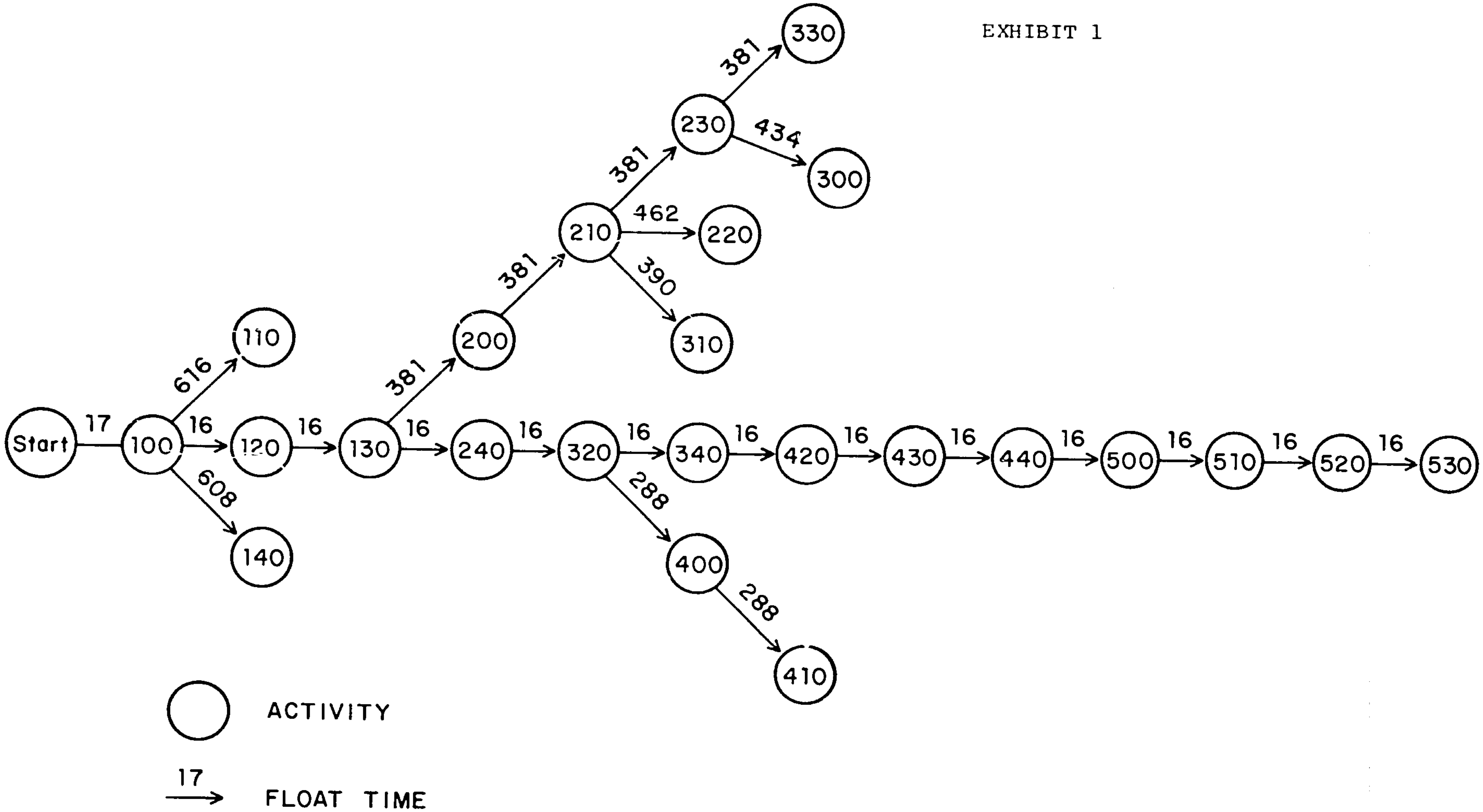
Implementation

Using the information formulated in the methodology section, an input data display was constructed. The PAC II Data Base contains three major subsets of data: user data, resource data, and project data. Information is added to and changed on the PAC II Input Display through the use of seven different types of input cards. The same input cards are used to establish information and to change it. The seven input card types are: (1) table entries, (2) resource entries, (3) project-phase entries, (4) activity entries, (5) direct expense/event entries, (6) progress entries, (7) comment entries. For the purposes of our case study, 203 lines of input entries were made using only the first four input cards. Cards are designated by the number appearing in Column 1 of the Input Display (see Figure 1).

Table entries are used to establish default values (a substituted value if the input entries were in error or data was omitted) and user specifications of the program. It includes those variables that are most likely to change (i.e., time units/week, holidays, user comments).

Resource entries are placed on the second card. They include resource identification, description, regular salary rate, and the availability of the resource. Card Number 3 is used to add, change, or delete project/phase entries to the PAC II Input Display. A project I.D. is required; however, a project description is optional. Project start and end dates are also included with project/phase entries.

EXHIBIT 1



CPM/PERT CHART

FIGURE 1

```
@TASG,T   ISPAC2F4,1000
READY

@TASG,T   ISPAC2F20,1000
READY

@TASG,T   ISPAC2F21,1000
READY

@XQT      USR*FILE-IS1.PAC210

@ASG      USB*FILE-ISI.PAC212
```

1982

```
STATE FOREST PLANNING                PACII INPUT DISPLAY                       PAGE   1
                                        OCT  1,79

SEQ
0001   1D400                         055                          **
0002   1H1979010102190528070409031008111211221225
0003   1H1980010102200529070409041009111311231225
0004   1H1981010102210530070409051010111411241225
0005   1H1982010102210530070409051010111411241225
0006   101      STATE FOREST PLANNING
0007   2NDEPTDEPARTMENT STAFF           1200      040
0008   2NSTFRSTATE FORESTER             1000      080
0009   2NSFRSST. FOR. STAFF             0900      160
0010   2NPLANPLANNER                    0700      300
0011   2NPLSTPLANNING STAFF             0600      300
0012   2NCLRKCLERICAL                    300      200
0013   3NSFRP-PLAN PLANSFRP BUDGET DETERMINATION                    D3100179070182
0014   3NSFRP-PLAN PLANPHASE-I PREPLANNING      1
0015   3NSFRP-PLAN PLANPHASE-II PROCESS         2
0016   3NSFRP-PLAN PLANPHASE-III PROCESS        3
0017   3NSFRP-PLAN PLANPHASE-IV PROCESS         4
0018   3NSFRP-PLAN PLANPHASE-V PROCESS          5
0019   4NSFRP-PLAN DEPTPLANNING CONCEPT DOC.  1001 A01     16        090
0020   4NSFRP-PLAN STFRPLANNING CONCEPT DOC.  1001 A02     64        080
0021   4NSFRP-PLAN SFRSPLANNING CONCEPT DOC.  1001 A03     80        080
0022   4NSFRP-PLAN PLANPLANNING CONCEPT DOC.  1001 A04    320        075
0023   4NSFRP-PLAN PLSTPLANNING CONCEPT DOC.  1001 A05    320        075
0024   4NSFRP-PLAN CLRKPLANNING CONCEPT DOC.  1001 A06    160        090
0025   4NSFRP-PLAN DEPT  1X1 AGENCY PEOPLE    1101 B01***  8         090
0026                                               ***A01A02A03A04A05A06
```

Activity entries (card 4) make up the bulk of the PAC II Input Display (see Figure 1). The card indicates project and resource I.D., in addition to an activity I.D. This is followed by a tag to link the activity to the resource. The time estimate for the activity follows with a variable indicating the percent of the standard work-week or resource availability.

Three separate runs were made using the same data for the variables with the exception of the project's end date. The start date was October 1, 1979. End dates used were July 1, 1981, 1982, and 1983 (see Table II).

Of the eighteen planning reports available from PAC II, our case study specified the Critical Path Report. The concept behind the Critical Path Method and the Program Evaluation and Review Technique is to represent a complex project as a series of dependent activities or jobs that must be completed. The process is used to answer the following questions:

1. How long will the project take?
2. Which activities are the most critical to the project's scheduled completion?
3. How should the project be scheduled?

The program will answer the time question by designating the Critical Path. The Critical Path is defined as the series of dependent activities or jobs that take the longest amount of time to complete. Any reduction in the project's total time must consider these activities. The Critical Path can be determined from the program's output by noting the lowest float time (latest start time of the activity minus the earliest start time of the same activity) in the project's initial activity and comparing it against float times in the remaining activities. If the float times in the remaining activities are equal to or less than the lowest float time in the initial activity, the activity is on the Critical Path (see Critical Path Chart).

The first run, ending in 1981, indicated that given the resources, tasks, and time frame (21 months), the required end date could not be met. The project could not meet its completion date as evidenced by the negative float times (see Figure 2). The end date was adjusted to 1983 (45 months) with the result that float times indicated an adjustment in activity length was needed (see Figure 3). The end date was lowered to 1982 (33 months) which resulted in a more realistic Critical Path (see Figure 4).

Potential

The potential of the PAC II Software System as a management tool for forest resources planning cannot be accurately assessed at this time. However, some benefits of the program are:

1. By submitting state planning processes into the PAC II system, state planners will be forced to scrutinize their methodology.
2. It offers a way to match dollars to the time allotted to the planning process.
3. It can examine the amount of time for the total process in relation to time for the individual planning phases (i.e., are some phases too long, too short?).
4. Once a file is constructed for an individual state, PAC II allows for easy update and quick response to changing time, dollars, and resources.
5. It offers a computerized method to allow our FRP section to quickly examine and compare alternatives to our present FRP planning process.

There are also circumstances where benefits derived from a computerized CPM/PERT program do not justify the costs, such as:

FIGURE 2

STATE FOREST PLANNING — CRITICAL PATH REPORT — PAGE 1

SFRP BUDGET DETERMINATION SFRP-PLAN PLANNER

DEPARTMENT RUN

	RESOURCE COST	EQUIPMENT COST	DIRECT COST	TOTAL COST	STARTING / ENDING DATES	RESOURCE / EQUIPMENT TIME	
PROJECT TOTAL	66,828.00	.00	.00	66,828.00	OCT 1,79 JUN 8,82	10,211.0	.0
PHASE-I PREPLANNING 1	13,616.00	.00	.00	13,616.00	OCT 1,79 APR 8,80	1,992.(	.0

ACTIVITY DESCRIPTION	IDENT	RESOURCE	TOTAL COST	RES TIME	EQUIP TIME	SCH FORM	TAG/DEP	EARLY START	EARLY FINISH	LATE START	LATE FINISH	FLOAT
PLANNING CONCEPT DOC.	100	CLERICAL	480.00	160.0	.0	90	A06 RES	OCT 1,79	DEC 5,79	NOV 28,78	JAN 30,79	-214
PLANNING CONCEPT DOC.	100	DEPARTMENT STAFF	192.00	16.0	.0	90	A01 RES	OCT 1,79	NOV 1,79	DEC 20,78	JAN 30,79	-192
PLANNING CONCEPT DOC.	100	PLANNER	2,240.00	320.0	.0	75	A04 RES	OCT 1,79	JAN 15,80	OCT 20,78	JAN 30,79	-241
PLANNING CONCEPT DOC.	100	PLANNING STAFF	1,920.00	320.0	.0	75	A05 RES	OCT 1,79	JAN 15,80	OCT 20,78	JAN 30,79	-241
PLANNING CONCEPT DOC.	100	ST. FOR. STAFF	720.00	80.0	.0	80	A03 RES	OCT 1,79	NOV 15,79	DEC 15,78	JAN 30,79	-201
PLANNING CONCEPT DOC.	100	STATE FORESTER	640.00	64.0	.0	80	A02 RES	OCT 1,79	DEC 12,79	NOV 21,78	JAN 30,79	-219
I&I AGENCY PEOPLE	110	CLERICAL	64.00	28.0	.0	90	B06 A04	JAN 15,80	JAN 24,80	JUN 23,81	JUL 1,81	+366
I&I AGENCY PEOPLE	110	DEPARTMENT STAFF	96.00	8.0	.0	90	B01 A04	JAN 15,80	JAN 30,80	JUN 16,81	JUL 1,81	+362
I&I AGENCY PEOPLE	110	PLANNER	392.00	56.0	.0	75	B04 A04	JAN 15,80	JAN 31,80	JUN 15,81	JUL 1,81	+361
I&I AGENCY PEOPLE	110	PLANNING STAFF	336.00	56.0	.0	75	B05 A04	JAN 15,80	JAN 31,80	JUN 15,81	JUL 1,81	+361
I&I AGENCY PEOPLE	110	ST. FOR. STAFF	360.00	40.0	.0	80	B03 A04	JAN 15,80	FEB 5,80	JUN 10,81	JUL 1,81	+358
I&I AGENCY PEOPLE	110	STATE FORESTER	160.00	16.0	.0	80	B02 A04	JAN 15,80	JAN 31,80	JUN 15,81	JUL 1,81	+361
I&I KEY PEOPLE	120	CLERICAL	72.00	24.0	.0	90	C06 A04	JAN 17,80	JAN 31,80	JUN 17,81	JUL 1,81	+361
I&I KEY PEOPLE	120	DEPARTMENT STAFF	192.00	16.0	.0	90	C01 A04	JAN 17,80	FEB 27,80	MAY 22,81	JUL 1,81	+343
I&I KEY PEOPLE	120	PLANNER	336.00	48.0	.0	75	C04 A04	JAN 17,80	FEB 8,80	JAN 31,79	FEB 23,79	-242

PARITY ERROR

PARITY ERROR

FIGURE 3

STATE FOREST PLANNING

CRITICAL PATH REPORT

SFRP BUDGET DETERMINATION SFRP-PLAN PLANNER

DEPARTMENT RUN

	RESOURCE COST	EQUIPMENT COST	DIRECT COST	TOTAL COST	STARTING / ENDING DATES	RESOURCE TIME	/ EQUIPMENT TIME
PROJECT TOTAL	66,828.00	.00	.00	66,828.00	OCT 1,79 JUN 9,82	10,211.0	.0
PHASE-I PREPLANNING 1	13,616.00	.00	.00	13,616.00	OCT 1,79 APR 8,80	1,992.0	.0

ACTIVITY DESCRIPTION	IDENT	RESOURCE	TOTAL COST	RES TIME	EQUIP TIME	SCH FORM	TAG/DEP		EARLY START	EARLY FINISH	LATE START	LATE FINISH	FLOAT
PLANNING CONCEPT DOC.	100	CLERICAL	480.00	160.0	.0	90	A06	RES	OCT 1,79	DEC 5,79	DEC 11,80	FEB 13,81	+302
PLANNING CONCEPT DOC.	100	DEPARTMENT STAFF	192.00	16.0	.0	90	A01	RES	OCT 1,79	NOV 1,79	JAN 14,81	FEB 13,81	+324
PLANNING CONCEPT DOC.	100	PLANNER	2,240.00	320.0	.0	75	A04	RES	OCT 1,79	JAN 15,80	NOV 3,80	FEB 13,81	+275
PLANNING CONCEPT DOC.	100	PLANNING STAFF	1,920.00	320.0	.0	75	A05	RES	OCT 1,79	JAN 15,80	NOV 3,80	FEB 13,81	+275
PLANNING CONCEPT DOC.	100	ST. FOR. STAFF	720.00	80.0	.0	80	A03	RES	OCT 1,79	NOV 15,79	DEC 31,80	FEB 13,81	+315
PLANNING CONCEPT DOC.	100	STATE FORESTER	640.00	64.0	.0	80	A02	RES	OCT 1,79	DEC 12,79	DEC 4,80	FEB 13,81	+277
I&I AGENCY PEOPLE	110	CLERICAL	84.00	28.0	.0	90	B06	A04	JAN 15,80	JAN 24,80	JUN 22,83	JUL 1,83	+882
I&I AGENCY PEOPLE	110	DEPARTMENT STAFF	96.00	8.0	.0	90	B01	A04	JAN 15,80	JAN 30,80	JUN 16,83	JUL 1,83	+878
I&I AGENCY PEOPLE	110	PLANNER	392.00	56.0	.0	75	B04	A04	JAN 15,80	JAN 31,80	JUN 15,83	JUL 1,83	+877
I&I AGENCY PEOPLE	110	PLANNING STAFF	336.00	56.0	.0	75	B05	A04	JAN 15,80	JAN 31,80	JUN 15,83	JUL 1,83	+877
I&I AGENCY PEOPLE	110	ST. FOR. STAFF	360.00	40.0	.0	80	B03	A04	JAN 15,80	FEB 5,80	JUN 10,83	JUL 1,83	+874
I&I AGENCY PEOPLE	110	STATE FORESTER	160.00	16.0	.0	80	B02	A04	JAN 15,80	JAN 31,80	JUN 15,83	JUL 1,83	+877
I&I KEY PEOPLE	120	CLERICAL	72.00	24.0	.0	90	C06	A04	JAN 17,80	JAN 31,80	JUN 17,83	JUL 1,83	+877
I&I KEY PEOPLE	120	DEPARTMENT STAFF	192.00	16.0	.0	90	C01	A04	JAN 17,80	FEB 27,80	MAY 23,83	JUL 1,83	+859
I&I KEY PEOPLE	120	PLANNER	336.00	48.0	.0	75	C04	A04	JAN 17,80	FEB 8,80	FEB 16,81	MAR 10,81	+274

FIGURE 4

STATE FOREST PLANNING | P A G E 1.

C R I T I C A L   P A T H   R E P O R T

SFRP BUDGET DETERMINATION .SFRP-PLAN PLANNER

DEPARTMENT RUN

	RESOURCE COST	EQUIPMENT COST	DIRECT COST	TOTAL COST	STARTING / ENDING DATES		RESOURCE TIME	/ EQUIPMENT TIME
PROJECT TOTAL	66,828.00	.00	.00	66,828.00	OCT 1,79	JUN 9,82	10,211.0	.0
PHASE-I PREPLANNING 1	13,616.00	.00	.00	13,616.00	OCT 1,79	APR 8,80	1,992.0	.0

ACTIVITY DESCRIPTION	IDENT	RESOURCE	TOTAL COST	RES TIME	EQUIP TIME	SCH FORM	TAG	DEP	EARLY START	EARLY FINISH	LATE START	LATE FINISH	FLOAT
PLANNING CONCEPT DOC.	100	CLERICAL	400.00	160.0	.0	90	A06	RES	OCT 1,79	DEC 5,79	DEC 5,79	FEB 7,80	+44
PLANNING CONCEPT DOC.	100	DEPARTMENT STAFF	192.00	16.0	.0	90	A01	RES	OCT 1,79	NOV 1,79	JAN 8,80	FEB 7,80	+66
PLANNING CONCEPT DOC.	100	PLANNER	2,240.00	320.0	.0	75	A04	RES	OCT 1,79	JAN 15,80	OCT 25,79	FEB 7,80	+17
PLANNING CONCEPT DOC.	100	PLANNING STAFF	1,920.00	320.0	.0	75	A05	RES	OCT 1,79	JAN 15,80	OCT 25,79	FEB 7,80	+17
PLANNING CONCEPT DOC.	100	ST. FOR. STAFF	720.00	80.0	.0	80	A03	RES	OCT 1,79	NOV 15,79	DEC 24,79	FEB 7,80	+37
PLANNING CONCEPT DOC.	100	STATE FORESTER	640.00	64.0	.0	80	A02	RES	OCT 1,79	DEC 12,79	NOV 26,79	FEB 7,80	+39
I&I AGENCY PEOPLE	110	CLERICAL	84.00	28.0	.0	90	B06	A04	JAN 15,80	JAN 24,80	JUN 22,82	JUL 1,82	+624
I&I AGENCY PEOPLE	110	DEPARTMENT STAFF	96.00	8.0	.0	90	B01	A04	JAN 15,80	JAN 30,80	JUN 16,82	JUL 1,82	+620
I&I AGENCY PEOPLE	110	PLANNER	392.00	56.0	.0	75	B04	A04	JAN 15,80	JAN 31,80	JUN 15,82	JUL 1,82	+619
I&I AGENCY PEOPLE	110	PLANNING STAFF	336.00	56.0	.0	75	B05	A04	JAN 15,80	JAN 31,80	JUN 15,82	JUL 1,82	+619
I&I AGENCY PEOPLE	110	ST. FOR. STAFF	360.00	40.0	.0	80	B03	A04	JAN 15,80	FEB 5,80	JUN 10,82	JUL 1,82	+616
I&I AGENCY PEOPLE	110	STATE FORESTER	160.00	16.0	.0	80	B02	A04	JAN 15,80	JAN 31,80	JUN 15,82	JUL 1,82	+619
I&I KEY PEOPLE	120	CLERICAL	72.00	24.0	.0	90	C06	A04	JAN 17,80	JAN 31,80	JUN 17,82	JUL 1,82	+619
I&I KEY PEOPLE	120	DEPARTMENT STAFF	192.00	16.0	.0	90	C01	A04	JAN 17,80	FEB 27,80	MAY 24,82	JUL 1,82	+601
I&I KEY PEOPLE	120	PLANNER	336.00	48.0	.0	75	C04	A04	JAN 17,80	FEB 8,80	FEB 8,80	MAR 4,80	+16

1. In some smaller states the planning program can be evaluated. just as rapidly through a manually done CPM/PERT diagram.
2. There is resistance by states to computerized management techniques.
3. The time expenditure to build input files for ten states would be great.

Before a final evaluation, the NA Forest Resources Planning Section has scheduled a PAC II case study with the State of Maryland.

PART V

SPATIAL ANALYSIS FOR RESOURCE MANAGEMENT AND PLANNING

THE USE OF COMPUTER GRAPHICS IN
PLANNING WILDLIFE HABITAT IMPROVEMENTS

Joseph M. Dabney
Jefferson National Forest
Roanoke Virginia

Objective

Traditionally, Forest Service budgets for wildlife habitat improvements have been quite small, and even though the situation has improved significantly in the past three years, funding still falls far short of what is needed to accomplish the total wildlife job. Therefore, it is important that we utilize our wildlife monies as efficiently as possible. This project is an attempt to utilize computer technologies to increase the efficiency of our wildlife planning.

A large percentage of Jefferson National Forest in southwest Virginia is steep, rocky and infertile, and therefore not conducive to the establishment of the traditional types of wildlife habitat improvements. The most time-consuming and most expensive aspect of wildlife habitat work is often the location of suitable areas, scattered throughout the forest.

In the past, when wildlife budgets were so small as to preclude any direct habitat improvements, the location of sites was not a signficant problem. However, now that budgets have increased to the point that we must plan and accomplish a considerable amount of work each year, a quick method for locating areas which need habitat improvements and pin-pointing suitable sites within these areas is definitely needed.

Methodology

The quality of wildlife habitat is primarily a function of the vegetation within the area. The greater the diversity of plant species, age classes, and successional stages, the better the quality of the habitat for a variety of wildlife species. Because of this need for diversity in their habitat, large, unbroken stands of timber 40 years of age or older are usually poor habitat for most species.

The location, size, species composition, age, and quality of all timber stands on the Forest is currently available. The availability of this data, coupled with soils data which is also available for the Forest, provides practically all the information necessary to locate areas which need habitat improvements and to pin-point suitable sites.

For this project, I have chosen the Poverty Creek Wildlife Unit, located on the Blacksburg Ranger District. This unit consists of 5,300 acres (Fig. 1), primarily forested, with a few widely scattered open fields. Data covering forest type, stand age, existing wildlife improvements, soil series, and land use patterns on private lands within one-half mile of the unit boundary will be mapped, utilizing a Tektronik 4051 with graphic table and file manager. An existing program "HABAN" (Habitat Analysis), developed by James Teaford[1] to analyze wildlife habitat, will be used on at least a portion of the study area. Use of this program will require the collection of additional wildlife-related data such as the availability and utilization of forage, soft mast, edges, etc.

In theory, after the above data has been put into the computer, it will be a simple task to "ask" the computer to print a map of all areas where the Forest is 40+ years old and the soils are suitable for agricultural type habitat improvements. To provide additional information to help us in our planning efforts, we could also ask the computer to show existing wildlife improvements and open fields on adjacent private property, enabling us to locate our improvements where they will do the most good.

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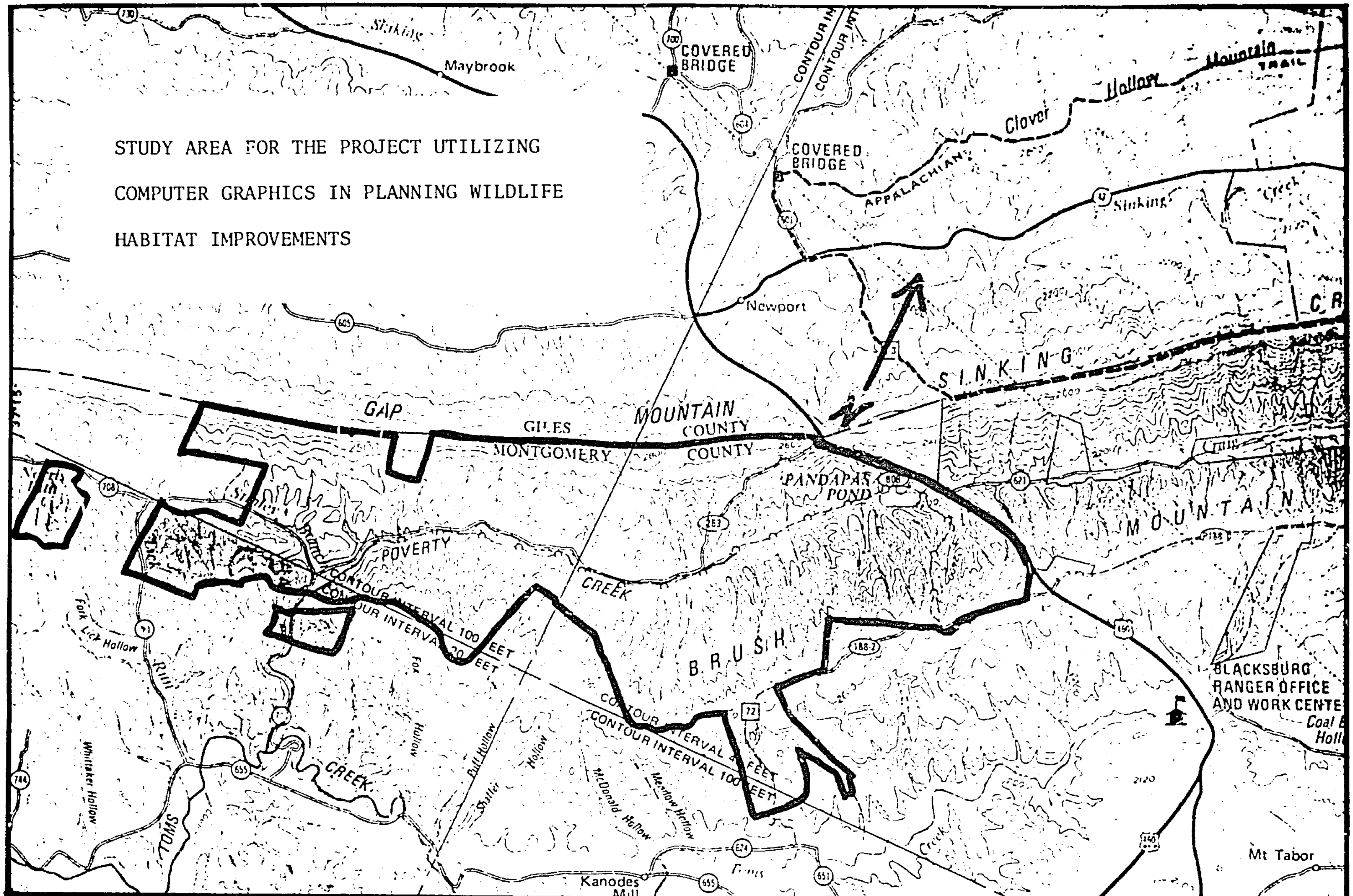
[1]Teaford, J.W. 1977. MAST AND HABAN: A Forest Wildlife Management Decision Aid. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg. 155 pp.

Figure 1.



Blacksburg
1 Mile

Since timber harvests are usually beneficial to most wildlife species, the stored data could also be used to locate timber sales where they will provide the most benefit to wildlife. Sites for water developments could also be located with this system by simply asking the computer to print all our soils which are suitable for pond construction, then determining which of these areas are greater than one-half mile from a permanent source of water.

The "HABAN" program which will be utilized on a portion of the area uses standard timber data in conjunction with several other wildlife-related variables to determine the quality of habitat for a given species or group of species. It can also be used to project how successional changes will affect the habitat quality in any given number of years. This could be very helpful when making plans which cover ten or more years.

Implementation

Implementation of this project will begin in early October, 1979. Technical assistance and equipment is being provided by Dr. Robert H. Giles, Jr., Professor of Wildlife at Virginia Polytechnic Institute and State University, Blacksburg, Va., and John Zack, Graduate Assistant, V.P.I.& S.U., is providing programming and operation expertise. Joe Coggin, Research Biologist, Virginia Commission of Game and Inland Fisheries, provided input in planning the project and will assist in the study. The project should be completed by January, 1980.

Potential

As stated in the objective, Forest Service wildlife budgets, as well as those of state game and fish agencies, are too small to be wasted on unnecessary habitat work. This project is a pilot which, hopefully, will prove that computer mapping of existing timber and soils data can greatly benefit our wildlife planning efforts by enabling us to quickly and accurately locate improvements and timber sales where they will provide the maximum benefit to wildlife. This system should greatly reduce the field time needed to locate suitable sites; thus reducing cost and allowing more work to be accomplished with a given amount of money.

Once this data has been computerized, the potential for its use by other resource groups such as timber, watershed, and range is almost unlimited.

RECREATION RESOURCE ANALYSIS

Steve Hendricks
National Forests in North Carolina
Asheville, North Cariolina

Background

Several congressional acts of recent years, including RPA (1974), the National Forest Management Act of 1976, and the regulations written to implement these acts, call for the integrated management of public lands to provide and enhance a broad spectrum of recreation opportunities to meet the needs of the American people.

Outdoor recreation resource management planning in the Forest Service will be conducted as an integral part of the land management planning process specified in the Regulations for the National Forest Management Act of 1976. In the planning process, it is essential that the recreation resource receive equal consideration with the other basic resources of the land. A nation-wide task force is in the process of developing a system to deal with recreation resource planning needs, such as classification, inventory, analysis, and management of the recreation resource, in keeping with these acts. This system is currently titled the Outdoor Recreation Opportunity Spectrum (O.R.O.S.).

The Nantahala and Pisgah National Forests of North Carolina are the lead forests for Region 8 in the current land management planning process. As part of the lead forest planning effort, the National Forests in North Carolina are searching for a way to integrate the outdoor recreation resource into the land management planning process. The O.R.O.S. is undergoing trial use and evaluation as part of this planning effort.

The Outdoor Recreation Opportunity Spectrum (O.R.O.S.)

Essentially, the O.R.O.S. is a method of classifying land by the opportunity for recreation experiences (see the appendix for a detailed explanation of the system). O.R.O.S. zone delineation is based on four criteria of physical features, with physical setting as the unit of analysis. These four criteria are: a) remoteness from sites and sounds of man; b) size of area; c) residual evidence of man; and d) renewable resource modification. The spectrum itself is best described as follows:

/ P / SPNM / SPM / RN / R / MU /

S P E C T R U M

with P - primitive; SPNM - semi-primitive, non-motorized; SPM - semi-primitive, motorized; RN - roaded natural; R - rural; and MU - modern-urban.

The O.R.O.S. is a straightforward and relatively simple improvement upon a number of previous recreation inventory and analysis systems. Using both physical and sociological criteria, the system promotes planning by demand for various activities and experiences, by locating appropriate sites for specific activities, rather than the reverse. This system does not require a large amount of inventory information, and most information required for it should be readily available. Additional improvements, such as capability units and attractiveness ratings, can be gradually added once the "experience" zones are delineated.

The Project

The project presented here is the initial portion of a feasibility study and trial use of the Outdoor Recreation Opportunity Spectrum system. If the system fully meets our needs in the planning process, the O.R.O.S. will be meshed with the computer-based inventory and evaluation of the Lead Forest planning effort.

For inventory data storage in the planning effort, the forests utilized the computer facilities of the Land Resources Information Service (LRIS) in Raleigh, North Carolina. Using the extensive graphic plotting capabilities of the COMARC system of the LRIS, the O.R.O.S. can lend itself to computer applications at a large scale.

Primary objectives for the complete feasibility study are as follows:

1. to test the ease of implementation and suitability of the O.R.O.S. for use as part of the Lead Forest/LMP process;
2. to recognize potential problems and become familiar with the COMARC computer system by working with the system;
3. to test O.R.O.S. criteria developed on a nationwide basis for its applicability to conditions in North Carolina;
4. to identify any additional inventory data that might be needed as part of the LMP; and
5. to begin to put together a 'package' that will aid in the explanation and field testing of the O.R.O.S.

Methodology

One Ranger District, the Pisgah District of the Pisgah National Forest, was chosen as a study area, primarily because of its diverse recreational activities and conditions, and because portions of needed inventory data were already complete.

Using data gathered from the Pisgah District, and digitizing equipment at the LRIS, we began digitizing information for the first step in our problem. Updated road information, taken from four B-maps (Scale 1" = 2000'), was digitized; each road labeled and coded for Forest/Non-Forest Service control (Non-Forest Service roads are coded with a minus sign). Each map was scaled and latitude and longitude changed to the state coordinate grid.

After input, this digitized information was edited, using the graphics display screen to clear up stray lines and points. Then, a proximity program was run to establish distance zones from roads. This step is time-consuming, as each road must be run individually, with special editing for each intersection.

Next, soils information (in the form of Ecological Management Units) was digitized for a portion of Unit 5 in the Pisgah District. When the zoning delineation is completed, Ecological Management Units can be over laid with O.R.O.S. zones to produce capability units.

Finally, graphic plots of O.R.O.S. zones were produced. Examples of these O.R.O.S. zones and Special Use Area plots are included in the Appendix.

Accomplishments and Conclusions

Aside from the obvious advantages of becoming familiar with digitizing processes and of the resultant bank of data, we discovered certain problems with the program as is, and became aware of how useful the combination of COMARC and the O.R.O.S. will be in the future.

As the work progressed, it became evident that the proximity program will need revising, unless O.R.O.S. zones are delineated manually and then digitized. It also became apparent that the boundaries for overlays will need to be coordinated to prevent extensive editing.

Because of the combination of COMARC and O.R.O.S., information from many resources can be permanently stored, and easily extracted as needed. This information may be plotted at any scale, and updated as situations change. Finally, overlays of many of the resources and allied factors can be produced for visual support.

Future Possibilities

If the O.R.O.S. system is successfully implemented, additional information can be used to build on the system as it is collected. Much of the following information can be used to produce overlays for various purposes:

Visual Management Zones - to produce attractiveness ratings;

Timber information (CISC data and digitized data) for use in determining renewable resource modification;

Hunting/Fishing Areas;

Floodplains;

Prime Agricultural Land;

Existing Forest Service Facilities;

Special Interest Areas.

Much of this information can be used to develop a procedure for recreation site suitability analysis. Several universities are conducting research closely related to the work we are doing--some of their research should enable us to refine the analysis.

Postscript

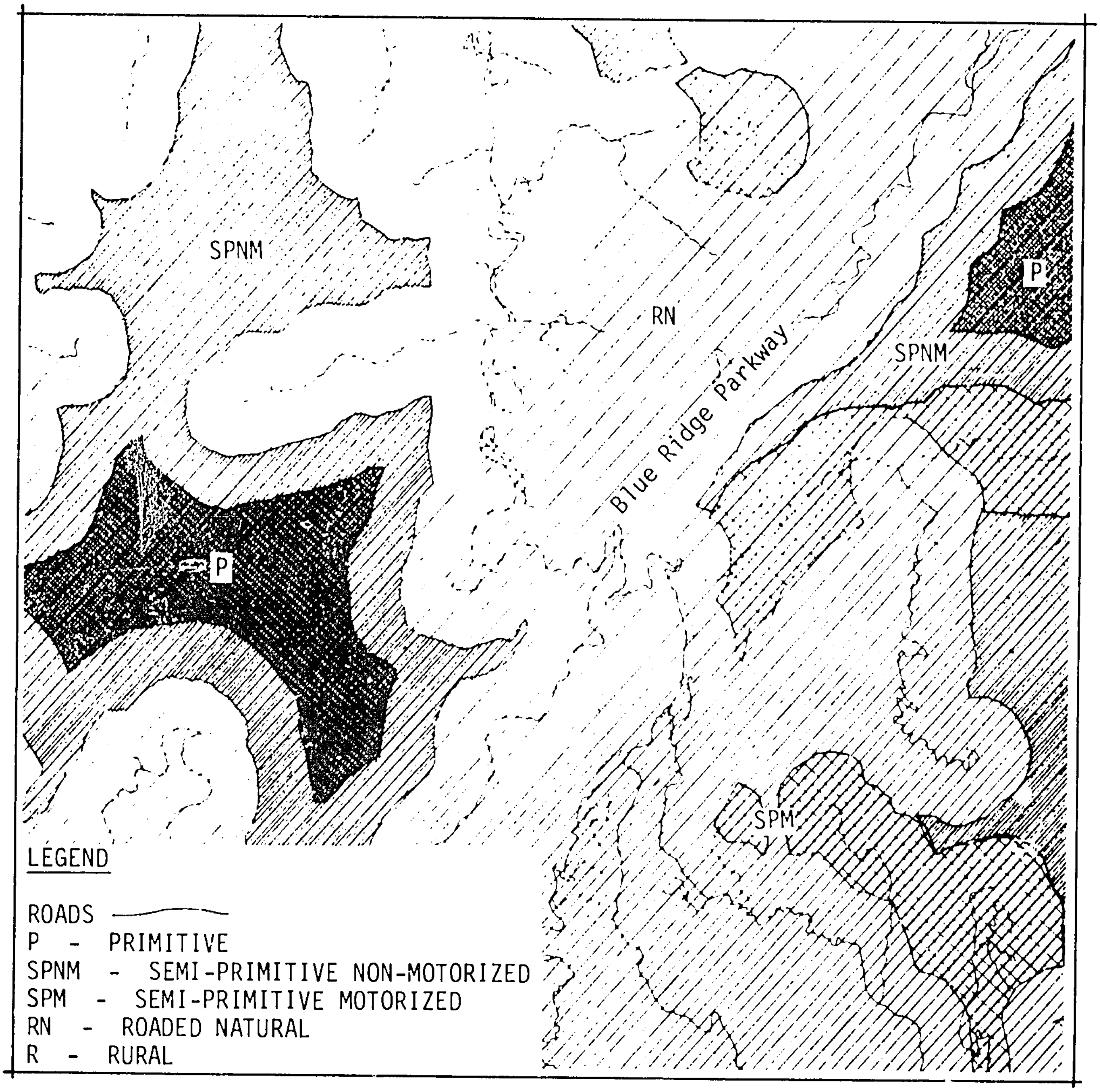
This project was the starting point for the development of one of the first automated applications of the O.R.O.S. in the Forest Service. Mapping of recreation potential is complete now for the Pisgah District. The mapping process will be applied to all Ranger Districts. In the alternatives formulation portion of the Land Management Planning Process, the savings of time and manpower (through reduced mapping and calculation time) should be significant. Detailed work on computer applications of the O.R.O.S. are currently (Spring 1980) in progress. Tom Everly, a graduate student at North Carolina State University is helping to work out the mechanics of the COMARC system for its application to the O.R.O.S.

ROS REMOTENESS CRITERIA

ROS Class	Freedom from Sights and Sounds	Distance Guidelines
Primitive	Most	1+ miles from roads, railroads, or trails with motorized use. 1/2+ miles from major powerlines.
Semi-primitive, non-motorized		1/2 + miles from roads, railroads, or trails with motorized use, or major powerlines.
Semi-primitive, motorized		Same as SPNM except can include areas and trails providing ORV motorized use.
Roaded natural		0 - 1/2 mile from roads, railroads, and trails with motorized use, or major powerlines.
Rural		No remoteness criteria.
Modern-urban	Least	No remoteness criteria.

SIZE CRITERIA

ROS Class	Self-reliance in Natural Setting	Size Criteria
Primitive	Most	5,000+ acres
Semi-primitive, non-motorized		2,500+ acres
Semi-primitive, motorized		2,500+ acres
Roaded natural		No size criteria
Rural		No size criteria
Modern-Urban	Least	No size criteria



OROS RECREATION POTENTIAL

PISGAH RANGER DISTRICT

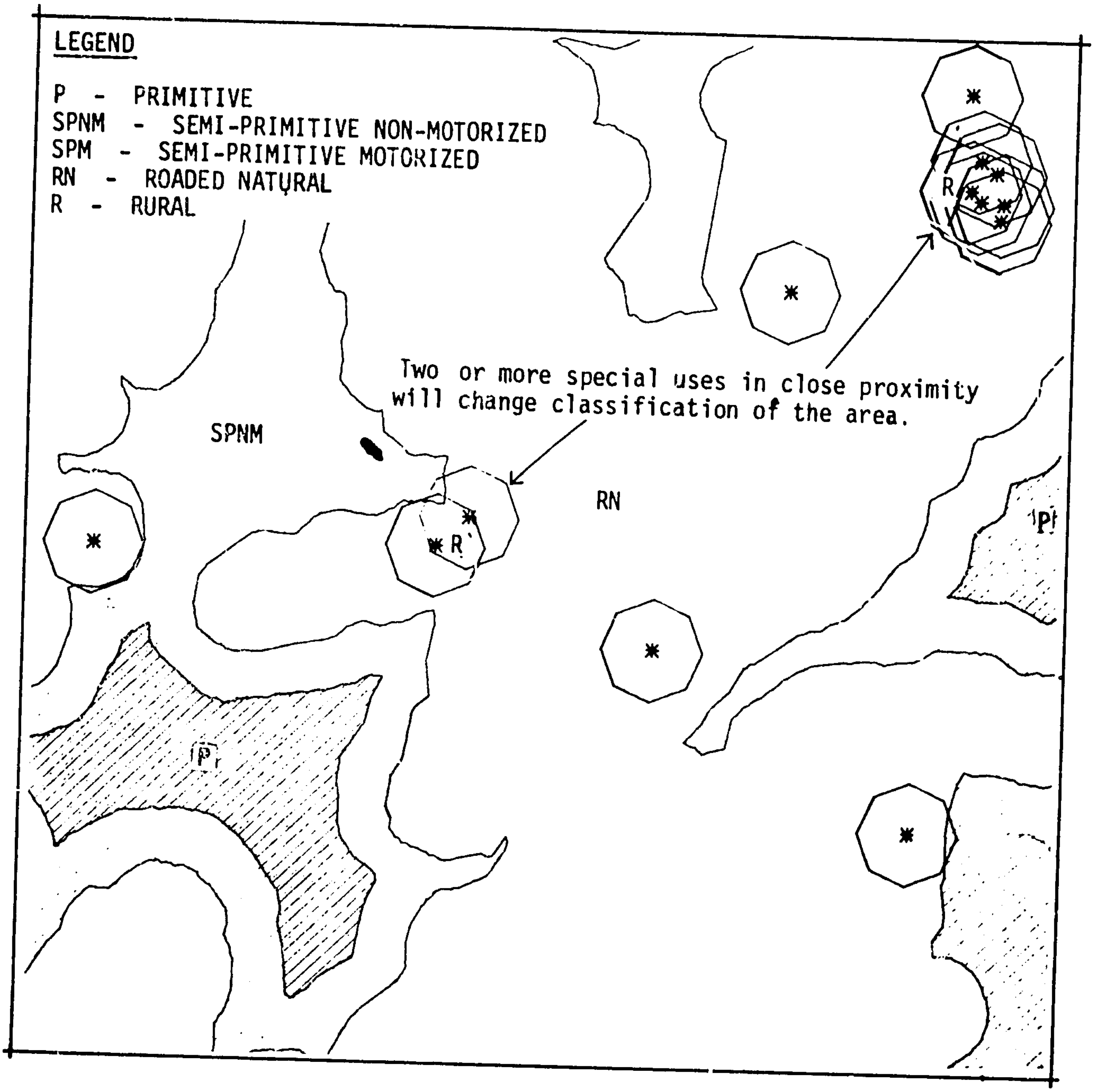
LRIS

LAND RESOURCES
INFORMATION SERVICE
NC DEPT OF NR&CD
919/733-2090

SCALE 1: 100000
1 INCH = 8333 FT
1 12 1980

ORIG SCALE 1: 100000

NORTH



OROS PROXIMITY TO SPECIAL USES

PISGAH RANGER DISTRICT

LRIS
LAND RESOURCES
INFORMATION SERVICE
NC DEPT OF NR&CD
919/733-2090

SCALE 1: 100000
1 INCH = 8333 FT
1 82 1980

ORIG SCALE 1: 288080

NORTH

Source of Criteria Listed in Appendix

RECREATION OPPORTUNITY SPECTRUM *

The Recreation Opportunity Spectrum, with associated activity opportunities, recreational setting requirements, and experience opportunities that are highly proable for each spectrum class. This is a table of general descriptors of the three components of the spectrum classes. There might be specific activity exceptions to these general characteristics.

Spectrum Class	Activity Opportunities ______ engaged in	Recreational Setting ______ to realize	Experience Opportunities
Primitive (P)	Viewing Outstanding Scenery Enjoying Unique and/or Unusual Environments Hiking Cross-country ski touring and snowshoeing Horseback Riding Canoeing Sailing Other, nonmotorized watercraft use Swimming Diving (Skin or Scuba) Fishing Photography Camping	Area is characterized by essentially unmodified natural environment of fairly large size. Interaction between users is very low and evidence of other area users is minimal. The area is managed to be essentially free from evidence of man-induced restrictions and controls. Motorized use within the area is not permitted.	Extremely high probability of experiencing considerable isolation from the sights and sounds of man, independence, closeness to nature, tranquility, and self-reliance through the application of woodsman skills in an environment that offers a high degree of challenge and risk.
Semi-primitive non-motorized (SPNM)	Snowplay Hunting (big, small game, upland birds and waterfowl) Nature Study Acquiring General Knowledge/Understanding Unguided Hiking General Information	Area is characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Motorized use is not permitted.	High, but not extremely high, probability of experiencing the above listed natural environment elements.

* Source: Draft of a proposed amendment to Forest Service Manual Section 2310. USDA Forest Service Washington Office, Washington, D.C. 9/27/79. (Their draft changes the O.R.O.S. to the R.O.S. simply dropping "Outdoor" from the name).

Spectrum Class	Activity Opportunities engaged in	Recreational Setting to realize	Experience Opportunities
Semi-primitive motorized (SPM)	All of the activities mentioned in above Classes plus the following: Motor-driven ice and snowcraft ORV touring Power boating	Area is characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Concentration of users is low, but there is often evidence of other area users. The area is managed in such a way that minimum on-site controls and restrictions may be present, but are subtle. Motorized use is permitted.	Moderate probability of experiencing the above listed natural environment elements, except that there is a high degree of interaction with the natural environment. Explicit opportunity is available to use motorized equipment while in the area.
Roaded Natural	All of the activities mentioned in above Classes plus the following: Picnicking Gathering Forest Products Auto Touring Water Skiing & Other Water Sports Automobile Camping Trailer Camping Viewing Interpretive Signs Organization Camping Lodger Power Boating Resort-Commercial Public Services Resort-Lodging	Area is characterized by predominantly natural appearing environments with moderate evidences of the sights and sounds of man. Such evidences usually harmonize with the natural environment. Interaction between users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities.	About equal probability to experience affiliation with other user groups and for isolation from sights and sounds of man. Opportunity to have a high degree of interaction with the natural environment. Challenge and risk opportunities associated with more primitive type of recreation are not very important. Practice and testing of outdoor skills might be important. Opportunities for both motorized and non-motorized forms of recreation are possible.

Spectrum Class	Activity Opportunities engaged in	Recreational Setting to realize	Experience Opportunities
Rural (R)	All of the activities mentioned in above classes plus the following: Competion Games Ice Skating Scooter-Motorcycle Use Bicycling Spectator Sports Jogging Passive use of developed parks and open space Picnicking Outdoor concerts	Area is characterized by substantially modified natural environment. Resource modification and utilization practices are primarily to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of man are readily evident, and the interaction between users is often moderate to high. A considerable number of facilities are designed for use by a large number of people. Facilities are often provided for special activities. Moderate densities are provided for away from developed sites. Facilities for intensified motorized use and parking are available.	Probability for experiencing affiliation with individuals and groups is prevalent as is the convenience of sites and opportunities. These factors are generally more important than the setting of the physical environment. Opportunities for wildland challenges, risk-taking, and testing of outdoor skills are generally unimportant except for specific activities like downhill skiing, for which challenge and risk-taking are important elements.
Modern-urban (MU)	All of the activities mentioned in above Classes.	Area is characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Sights and sounds of man, on-site, are predominant. Large numbers of users can be expected, both on-site and in nearby areas. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site.	Probability for experiencing affiliation with individuals and groups is prevalent, as is the convenience of sites and opportunities. Experiencing natural environments, having challenges and risks afforded by the natural environment, and the use of outdoor skills are relatively unimportant. Opportunities for competetive and spectator sports and for passive uses of highly man-influenced parks and open spaces are common.

THE LAND RESOURCES INFORMATION SERVICE OF NORTH CAROLINA

Carol Simmermacher
and
John Higgins
Land Resources Information Service
Raleigh, North Carolina

Information

This document is divided into two sections. The first section describes the broad objectives and functional capabilities of the North Carolina Land Resources Information Service (LRIS), and is intended to provide a context for the specific applications example described in Section II. The application example selected for Section II is a project of the Soil Conservation Service performed as part of the North Carolina program to control non-point source pollution from various land uses, and illustrates the LRIS objectives and capabilities in operation.

Section I

The Land Resources Information Service is a facility of the Division of Land Resources, North Carolina Department of Natural Resources and Community Development. The Service had its formal inception in the Land Policy Act passed by the General Assembly in 1974. One of the provisions of this legislation was the authorization to establish an information service for the "systematic collection, classification, application, and exchange of land use information" that would facilitate informed land use decisions at state, regional and local levels.

Through the subsequent efforts of a task force of the Land Policy Council, the data characteristics and functional capabilities necessary to realize the objectives of the Act were defined and incroporated into bid specifications for a turn-key system which would provide the hardware and software resources for the information service.

The system selected was configured by Comarch Design Systems, and the hardware in its present state consists of a Data General Eclipse S230 16 bit minicomputer with 448 KB main memory which is timeshared by two 44" x 60" digitizing tables, two graphics display terminals with attached hard copy unit, two alphanumeric CRT's one operator console, a four-pen 36" incremental drum plotter, a 300 LPM line printer, a 96 MB disk storage unit, and a 800 BPI tape drive.

The software is a combination of Data General Advanced Operating System and utilities, coupled with Comarc's interactive analysis and graphics display routines. A partial list of software capabilities which have been utilized in applications to date would include:

- Simultaneous handling of data in point, line, polygon, or grid format;
- Extraction of data by label, polygon, window, minimum and/or maximum area;
- Performance of overlays and sieve analysis of any combination of point, line, polygon, or grid information;
- Calculation of acreage, distance, percentage, or volume under a surface;
- Conversion of polygon data to grid cells, and grid cells data to polygons;
- Calculation of slope, aspect, and view exposure;
- Production of maps at any scale with title block, border, and options for shading in four colors;

• Production of perspective plots.

Data can be digitized in point, line, or polygon form. Detailed information for soils, land use, topography, roads, streams, etc., is being captured for specific areas of the state where planning projects are currently active. On a more general level, comprehensive statewide information is being captured for general soils, topography, population, county boundaries, subbasin boundaries, and enumeration district boundaries. Through the use of software, this information can be accessed singularly, or in combination with any other data set or sets, where scale, analysis criteria, geographic area, and form of output are defined interactively by the user.

The data capture efforts and organization of the geo-coded data base upon which the system operates has been guided by three primary considerations. The first consideration was to capture geo-coded data that would have the greatest utility for a broad range of applications. For example, rather than digitize a map containing specialized, interpretive information, such as septic tank suitability for a given area, the approach at LRIS has been to digitize basic data, such as detailed soils and contours for the area, from which a multiplicity of interpretations could be derived. Through the use of the system's analytic functions, not only could an analysis of septic tank suitability be derived from the soil and contour data, but also interpretations of soil erosion, conservation treatments, agricultural capabilities, flood zones, and many others.

A second consideration with regard to the nature of the data base has been to use a single coordinate reference system to integrate the data collected for different agency projects, where variation in the scale of data reflect the variety of uses and levels of detail to which it is put. By tying all its data to one common geo-referencing structure (the North Carolina State Plane system), the operational integration of the digitized data had been achieved, Thus soils information that was collected at a scale of 1:15840 can be analyzed in combination with land use information at 1:24000, and the country road network at 1:63360. In this manner. the user is provided great flexibility in both the analysis of combinations of different data sets and the level of detail (scale) desired.

A third consideration regarding data capture is a consequence of the financial status of LRIS. While the General Assembly authorized the organization and established the broad objectives of the information service, it did not appropriate any startup funds or operating budget. Thus the service is obligated to recover its initial captial costs and operating costs from a chargeout structure which is applied to agency clients for the use of the Service's staff and system resources on their projects. Not having funds allocated specifically for statewide data capture efforts, data collection has proceeded primarily on a project by project basis for those areas under study by various agencies. By virtue of the use of a single coordinate reference system, the data captured incrementally will form, over time, contiguous statewide coverages. Descriptions of a sample of past and current projects would include work done for North Carolina Cultural Resources, Archaelogy Section (site and find inventory, distribution analysis, probable site location prediction); North Carolina Geologic Survey (plotting and spatial analysis of bougea values, subsurface strata, cross sections, and contours of various geologic beds); United States Geologic Survey (14 USGS land use/land cover maps); North Carolina Parks and Recreation (site suitability analysis, recreational needs analysis, identification and mapping of significant plant and animal species); North Carolina Division of Community Assistance (development of a data set profiling the social, economic, and natural resource characteristics of North Carolina's communities); and the U. S. Forest Service and School of Forest Resources, North Carolina State University (a cooperative project to develop forest resource inventory data bases, data base management procedures, and analytical management decision procedures).

A current major concern is the optimization of hardware and software with respect to the data handling (I/O) associated with simultaneous, time-shared users of the system. Achievement of system optimization is of particular importance in view of the indications that a new phase of service expansion may be beginning.

At the request of project users, a 1200 BPS modem and a 300/1200 BPS modem have been installed to support their needs for remote, dial-up access to the LRIS data and system resources. Coupled with the known plans of system users to acquire intelligent terminals with communication capabilities, and recent inquiries from current and prospective users as to the system's ability to communicate with such equipment, a new direction for the future growth of LRIS is beginning to emerge.

The picture that is emerging is one in which the State LRIS could become the central facility for a network of regional and municipal land use information subsystems. Within that framework, the remote sites could contribute to and retrieve from LRIS's statewide data files the 'basic' data with their specialized data files collected for their specific planning or land use needs, and perform their analysis at their local sites.

Such a system with integrated statewide and local geo-coded data, and accessible analytic tools, would seem to provide an even greater realization of the mandate of the 1974 Land Policy Act for the foundation of an Information Service for the "systematic collection, classification, application, and exchange of land use information" to facilitate informed land use decisions at state, regional, and local levels.

Section II[1]

Section 208 of Public Law 92-500 requires that a plan be developed that will include a process to identify, to the extent feasible, methods to control non-point source pollution from various land use activities, including agriculture.

The Act states: " It is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983 (40CFR, Part 130)."

The North Carolina Soil and Water Conservation Commission was designated responsible for developing the agricultural portion of the state's 208 Water Quality Management Plan by the North Carolina Department of Natural Resources and Community Development, Division of Environmental Management. The Commission serves as a coordinator for the agricultural task force composed of several agencies and groups. The agricultural task force determined that sediment from eroding cropland, nutrients from cropland, and applied pesticides were the suspected agricultural pollutants in North Carolina. They elected to develop the 208 Plan to reduce within practical and feasible limits sedimentation, nutrients, and pesticides transported to the state's streams and waterways.

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[1]This section was written by S. Taylor Currin, Engineering Specialist of the U. S. D. A.; and Karen Siderelis, Systems Analyst, LRIS.

The 208 Plan in North Carolina was developed to include a continuing process of identifying problems, developing additional Best Management Practices (BMP's), assessing adequacy and modifying existing BMP's. The agricultural task force developed the agricultural portion of the statewide 208 detailed plan of study to include research, field trials, and evaluation and application of potential BMP's. These BMP's would eventually identify feasible methods of correcting existing problems and obtain the desired water quality standards (when determined by the state) without forcing unreasonable economic restraints on the North Carolina farmer.

As required by Section 208, PL 92-500, the agricultural task force identified priorities for addressing particular non-point source control and solving water quality problems. The task force sought to develop necessary programs for the continuing process of planning, research, and evaluations. This included research and quantitative study to identify agricultural pollutants.

The Commission delegated responsibility for erosion and sedimentation to the U.S.D.A. Soil Conservation Service. The planning was divided into three phases:

Phase I - Identify areas in North Carolina with high potential for having agricultural-related water problems resulting from erosion and sedimentation.

Phase II - Develop best management practices for the control of erosion and sediment non-point source pollution from agricultural land.

Phase III - Develop the implementation approach to control pollution problems related to sediment from agriculture.

To accomplish Phase I, a state-wide erosion and sedimentation study was made. The survey identified areas with high potential for having water quality problems resulting from erosion and sedimentation.

The remainder of this document describes the use of the LRIS computer system in its application to assist in the accomplishment of tasks associated with the completion of Phase II. For the area under analysis, these tasks included:

1. Estimate the potential soil loss from erodable cropland.
2. Summarize and construct a map showing the location of cropland that needs conservation treatment.
3. Determine the cost of applying conservation treatment for each increment and summarize the cost for each watershed.
4. Compare the rate of erosion between farms with and without conservation plans.
5. Determine the cost differential of application of conservation treatment in coastal plain and piedmont land resource areas.
6. Construct maps to determine location of erodable, wet, and stable land and rates of erosion occurring on erodable lands by land capability subclass.

For the purpose of illustrating in this paper the procedures used to accomplish the task above, a 3,254.67 acre area in northwestern Wayne County, in the Coastal Plain hydrologic area (Subbasin 03-07-14), has been used to demonstrate the analysis.

Procedure

The data collected and subjected to the above analysis included the detailed soils, land use, and treatment needs of the demonstration area.

The soil survey (Exhibit A) was digitized at a scale of 1:20000 but was converted by the computer to a scale of 1 in. = 2000 ft. (Exhibit B). A trained conservationist made an on-site survey and coded land use and treatment needs on an orthophotoquad sheet (Exhibit C). This data was digitized into the computer at a scale of 1:24000, 1 in. = 2000 ft. (Exhibit D).

The detailed soils data were interpreted to reflect the soil capability unit. Each detailed soil type on the map was assigned a value, either stable land ("I"), erodable land ("E"), wet land ("W"), or shallow land ("S"). An acre summary report of these lands was printed (Exhibit E) and a map produced to show the locations of E, W, and S lands (Exhibit F).

The field data recorded on the orthophotoquad sheets were interpreted by the computer to reflect various land use classifications. An acre summary report was produced to display the number of acres on each map dedicated to a certain land use (Exhibit G).

The detailed soils data were examined by the polygon extract functions of the software to produce a new file of data containing only E lands. These E lands were then overlayed with the field data from the orthophotoquad sheet, producing a file that contained the intersections of E lands and field data (Exhibit H). Every polygon in the new file contained both a value representing a soil type and a four-digit code representing the land use and treatment need.

The overlay file was used to compute the amount of erosion occuring in the demonstration area. The universal soil loss equation was solved for every polygon as follows:

Soil Loss = R + K + LS + C + P

where R = Rainfall factor for this county;

K = Erodibility factor which was derived by the computer from the detailed soils type;

LS = Slope-length factor which was estimated and input to the computer as a variable by detailed soils type;

C = Cover factor which was encoded as the first digit of the four-digit code; and

P = Practice factor which was encoded as the second digit of the four-digit code.

The erosion was grouped by rates to indicate a continuum of severity. Data was summarized by erosion and the corresponding land uses (cropland, hayland, pastureland, and idle land - Exhibit I). A map was produced showing the locations of erosion occurring on E land (Exhibit J).

The overlay file was also used to determine the cost of treatment to reduce erosion on E lands to acceptable limits (five tons per acre per year). Costs of installing certain treatments and annual cost to maintain treatments were computed for every polygon on the map. Costs per acre were input to the computer as a variable by recommended treatment.

The sample area contains 3255.67 acres; 1642 acres were cropland, 1278 acres were woodland, 44 acres were pastureland, and 247 acres were other land. Of the 1642 acres of cropland, 210 acres were E cropland. Another 173 acres were eroding at a rate of five to ten tons; 10.75 acres at a rate of ten to fifteen tons; and 27 acres at a rate of greater than fifteen tons. The average cost of applying the needed conservation treatment is $26 per acre.

The demonstration area included 571 acres of land having conservation plans. Of this acreage 369 acres are cropland, 6.57 acres pastureland, 6.29 acres other land, and 188 acres are woodland. Of the 369 acres of cropland, there were 57 acres of E cropland. Forty-three acres were eroding at a rate of five to ten tons; 1.06 acres at ten to fifteen tons; and 13.48 acres at a rate greater than fifteen tons. The average cost of applying the needed conservation treatment is $33 per acre. The increased cost of treating the E cropland with conservation plans can be attributed to the fact that a higher percentage of the land is in the greater-than-fiteen tons per acre class.

Evaluation

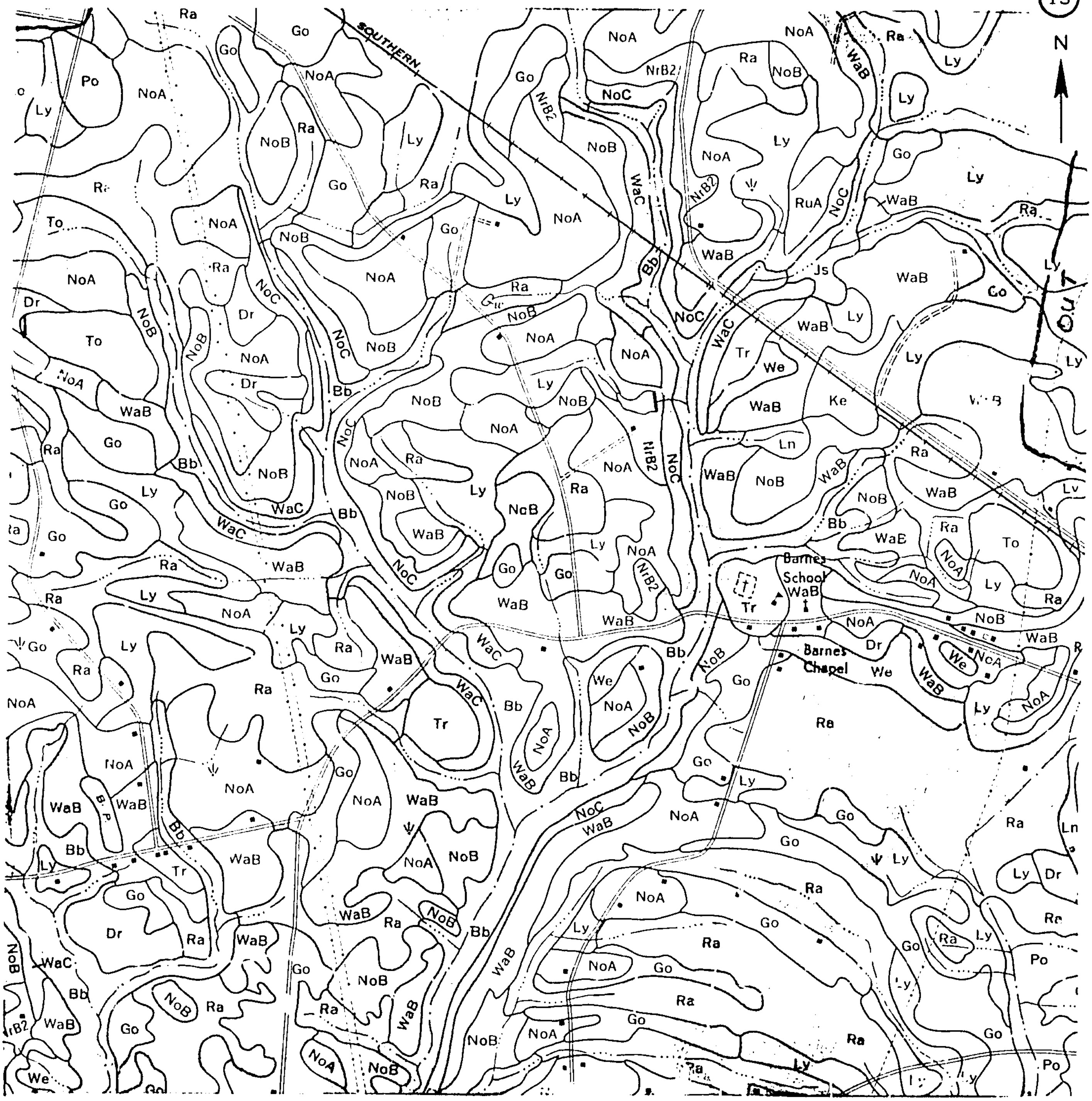
This method of survey and analysis is adequate to make erosion surveys to determine the cost of applying conservation treatments. It is an excellent technique for managing a land treatment program when progress is required. The cost of making the analysis and producing the outputs illustrated is between 10 and 12 cents per acre.

Potential Uses

This method could be used to monitor the effects of land treatment on stream sedimentation. There is a need to determine the effectiveness of applied conservation treatment over the "long run" and the rate that maintenance is applied to conservation practices. Several key agricultural subbasins within a major land resource area could be surveyed and digitized into a historical data base. Each year planning and application rates could be updated and entered with the previous records using additional codes without requiring additional digitizing of land area.

The procedures used in this demonstration could also be used to produce map displays similar to those exhibited and used by planners and engineers to evaluate areas for developing sewage disposal systems; industrial, business, or recreational sites; and by soil conservationists to locate eroding areas in need of conservation treatment.

EXHIBIT A

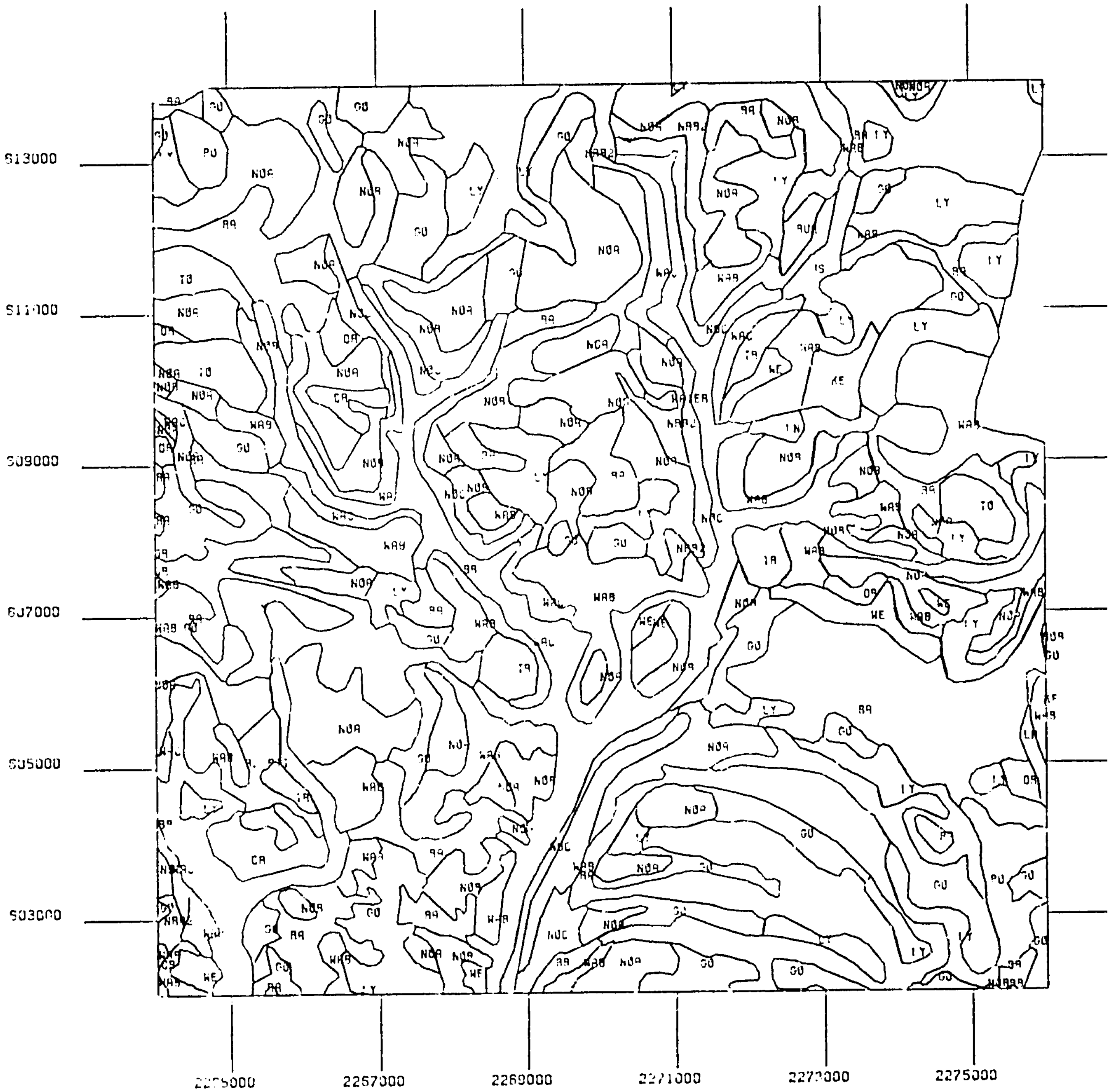


1 ¾ ½ ¼ 0 1 Mile
5000 4000 3000 2000 1000 0 5000 Feet
Scale 1:20000

SOIL SURVEY OF WAYNE COUNTY, NORTH CAROLINA

Exhibit B

SOIL SURVEY



SCALE 1: 24000
1 INCH = 2000 FT
1 8 1979
DEMOWYDSOI.P1
ORIG SCALE 1: 20000
NORTH

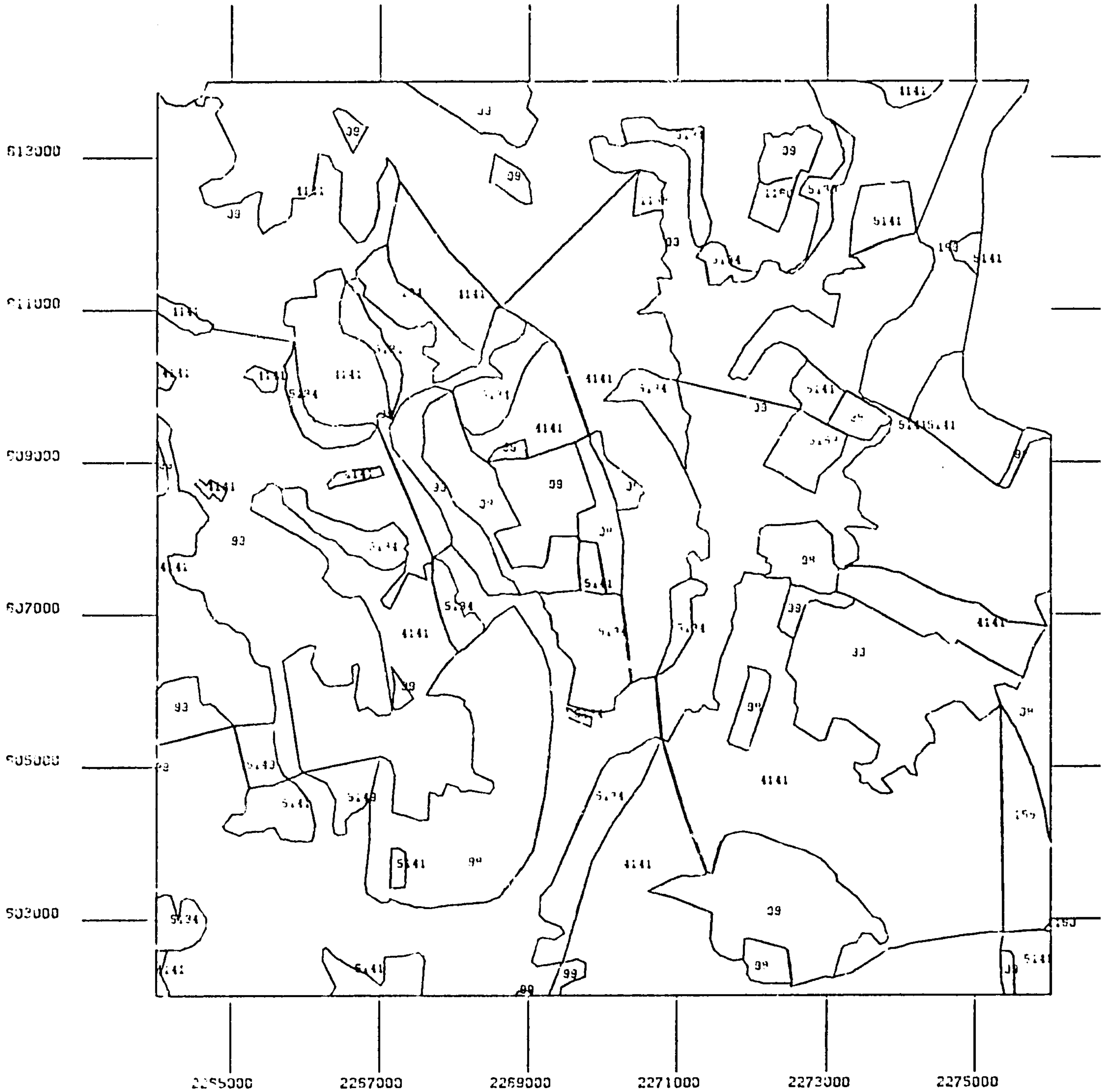
FIELD CODING OF LAND USE AND TREATMENT NEEDS

Legend:

________	Green	Boundaries of Conservation Plans
________	Red	Land Use Delineation
2310		Code to Indicate 1st digit - Cover-management factor "C" 2nd digit - Support practice "P" 3rd and 4th digits - Treatment needs

EXHIBIT D

LAND USE AND TREATMENT NEEDS



SCALE 1: 24000
1 INCH = 2000 FT
1 10 1979
DEMOLANU.PiđT.Pi
ORIG SCALE 1: 24000

NORTH

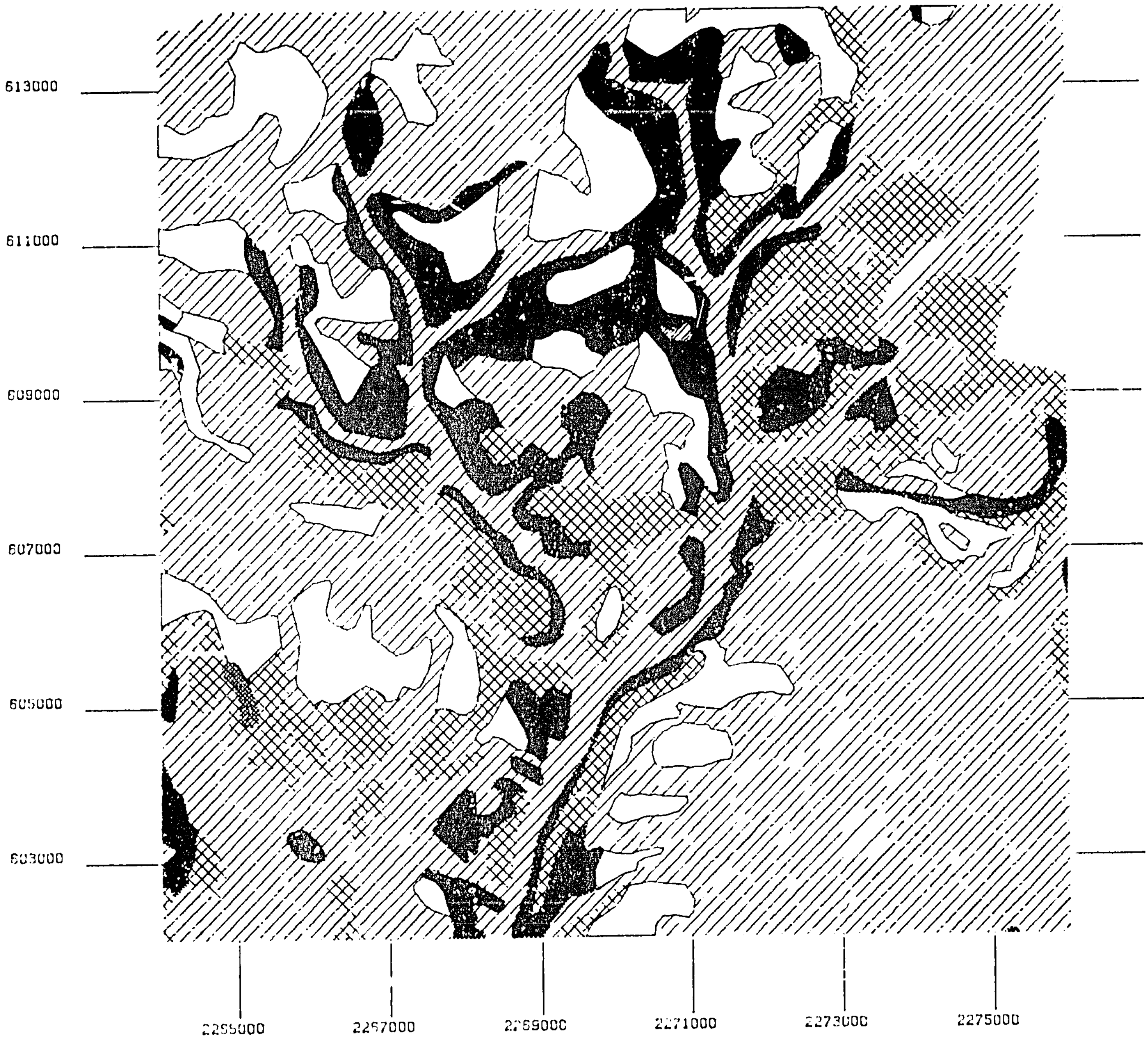
SUMMARY OF "E," "W," AND "S" LAND IN DEMONSTRATION AREA


```
**********************************************************************
*     ACRES OF E, W, AND S LAND IN WAYNE COUNTY              PAGE  1 *
*                                                                    *
*     PREPARED BY LAND RESOURCES INFORMATION SERVICE      1  8 1979  *
*                                                                    *
*     FOR USE BY SOIL CONSERVATION SERVICE                           *
**********************************************************************
* CLIENT NO. =     1      FILE NAME = DEMOEWS.P1     XMIN  =2264000 *
* PROJECT NO.=    10      DATA TYPE     = PSOI       XMAX  =2276000 *
* MAP TYPE    =   13      # OF LABELS  =       8     YMIN  = 602000 *
* MAP NO.     =  .13      # OF POLYGONS=     230     YMAX  = 614000 *
* FILE TYPE   =   55      TOTAL ACRES  =    3254     SCALE =  24000 *
**********************************************************************
*  LAB      LABEL          TOTAL     # OF          PERCENT OF        *
*  NUM      NAME           ACRES     POLYS        ACRES    POLYS     *
*                                                                    *
*    1   E LAND            442.75      45         13.60    19.57     *
*    2   W LAND           1887.37     112         57.99    48.70     *
*    3   S LAND            447.78      35         13.76    15.22     *
*    4   CLASS I LAND      470.92      36         14.47    15.65     *
*    5   WATER               1.65       1           .05      .43     *
*    6   B.PIT               4.21       1           .13      .43     *
*                                                                    *
*        230 POLYGONS ON MAP TOTALING TO     3254.670 ACRES          *
**********************************************************************
```

EXHIBIT E

EXHIBIT F

"E," "W," AND "S" LAND



CLASS ' LAND
S LAND
W LAND
WATER
B.PIT
E LAND

WAYNE COUNTY DEMO AREA

E, W, AND S LANDS

SCS PROJECT NO 10

LRIS

LAND RESOURCES
INFORMATION SERVICE
NC DEPT OF NR&CD
919/733-2090

SCALE 1: 24000
1 INCH = 2000 FT
1 15 1979
DEMOEWS.P1
ORIG SCALE 1: 20000

NORTH

LAND USE
IN DEMONSTRATION AREA

ACRES OF LANDUSE CLASSES IN WAYNE COUNTY — PAGE 1

PREPARED BY LAND RESOURCES INFORMATION SERVICE — 1 6 1979

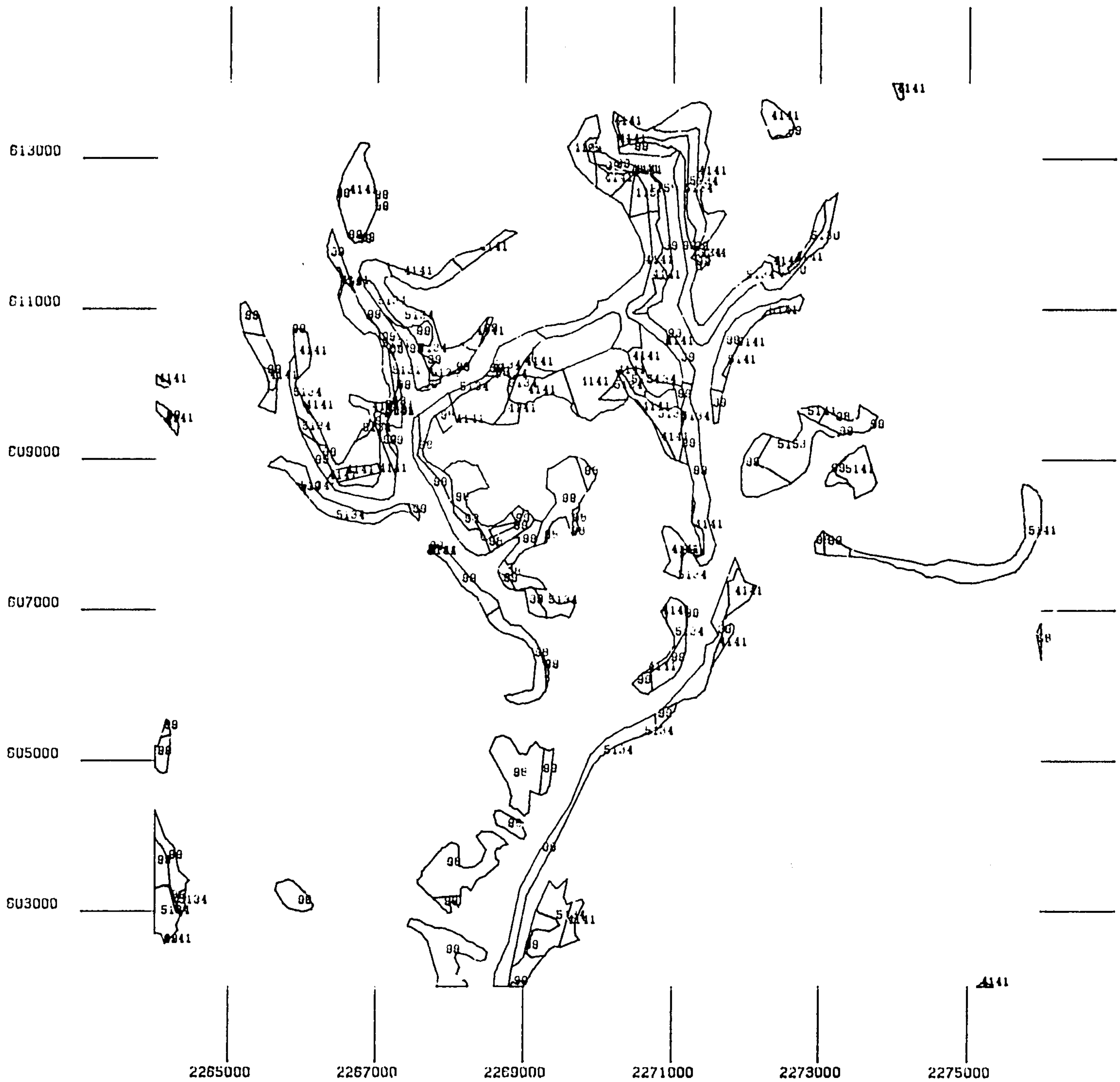
FOR USE BY SOIL CONSERVATION SERVICE

CLIENT NO. =	1	FILE NAME =	DEMOLU.P1	XMIN	=2264000
PROJECT NO.=	10	DATA TYPE =	SCSLAN	XMAX	=2275000
MAP TYPE =	10	# OF LABELS =	12	YMIN	= 602000
MAP NO. =	.00	# OF POLYGONS=	82	YMAX	= 614000
FILE TYPE =	82	TOTAL ACRES =	3212	SCALE =	24000

LAB NUM	LABEL NAME	LAB NUM	LABEL NAME	TOTAL ACRES	# OF POLYS	PERCENT OF ACRES	PERCENT OF POLYS
1	CROPLAND	8	------------	1622.88	43	50.52	52.44
1	CROPLAND	2	ADEQ PROTECT	19.49	2	.61	2.44
2	PASTURELAND	6	------------	37.34	2	1.15	2.44
2	PASTURELAND	2	ADEQ PROTECT	6.70	2	.21	2.44
6	OTHER LAND	8	------------	247.67	10	7.71	12.20
7	WOODLAND	8	------------	1278.05	23	39.79	28.05

82 POLYGONS ON MAP TOTALING TO 3212.124ACRES

EXHIBIT G



SCALE 1: 24000
1 INCH = 2000 FT
6 11 1979
DEMOOVERLAY.P1
ORIG SCALE 1: 24000

NORTH

EROSION CLASSES FOR DEMONSTRATION AREA

ACRES OF EROSION IN WAYNE COUNTY — PAGE 1

PREPARED BY LAND RESOURCES INFORMATION SERVICE — 1 8 1979

FOR USE BY SOIL CONSERVATION SERVICE

CLIENT NO. =	1	FILE NAME =	DEMOERO.PI	XMIN	=2264000
PROJECT NO.=	10	DATA TYPE =	SCSLAN	XMAX	=2276000
MAP TYPE =	10	# OF LABELS =	12	YMIN	= 602000
MAP NO. =	.00	# OF POLYGONS=	198	YMAX	= 614000
FILE TYPE =	82	TOTAL ACRES =	446	SCALE =	24000

LAB NUM	LABEL NAME	LAB NUM	LABEL NAME	TOTAL ACRES	# OF POLYS	PERCENT OF ACRES	PERCENT OF POLYS
1	0-5 TONS	2	PASTURELAND	4.26	2	.95	1.01
2	5-10 TONS	1	CROPLAND	173.12	52	38.79	26.26
3	10-15 TONS	1	CROPLAND	10.75	16	2.41	8.08
4	>15 TONS	1	CROPLAND	27.09	26	6.07	13.13
5	NOT COMPUTED	5	NON-FARMLAND	231.13	102	51.78	51.52

198 POLYGONS ON MAP TOTALING TO 446.338ACRES

EXHIBIT I

EXHIBIT J

EROSION ON LAND IN DEMONSTRATION AREA