GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL

[ ] REVISION NO. ____

Project No. E-24-633 DATE: 6/5/81

Project Director: Dr. W. R. Fey School/~~XXX~~ ISyE

Sponsor: USDA, Forest Service; Asheville, NC 28802

Type Agreement: Agreement No. 18-849

Award Period: From 3/15/81 To 3/30/82 (Performance) 3/31/82 (Reports)

Sponsor Amount: $10,000 Contracted through:

Cost Sharing: $2,500 (E-24-348) GTRI/~~XXX~~

Title: Range Sector of the Regional Forest Resources Assessment Model

ADMINISTRATIVE DATA OCA CONTACT Duane Hutchison x 4820

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Reports: See Deliverable Schedule Security Classification: None

Defense Priority Rating: None

RESTRICTIONS

See Attached Government Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with the Forest Service; however, none authorized/proposed.

COMMENTS:

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 7/6/83

Project Title: "Range Sector of the Regional Forest Resources Assessment Model"

Project No: E-24-633

Project Director: Dr. W. R. Fey

Sponsor: USDA; Forest Service, Ashville, North Carolina

Effective Termination Date: 3/30/82

Clearance of Accounting Charges: 3/30/82

Grant/Contract Closeout Actions Remaining:

None

- ☐ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

Final Invoice Prepared 9/2/82

Assigned to: ISyE (School/Laboratory)

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FORM OCA 10:781

E-24.633
Final Report

RANGE SECTOR OF THE REGIONAL FOREST RESOURCES ASSESSMENT MODEL

Final Report

USDA, Forest Service
Grant No. 18-849

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1982

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INTRODUCTION

Forest management systems are composed of many biological, human and financial accumulations and relationships that are organized into feedback loops that control the operation of the system parts and determine the performance pattern through time of the system variables [ ]. The top managers in the Forest Service need a model which treats the interactions between different decisions, between different biological systems and between those decisions and biological sub/systems. These interactions create the time histories (performance patterns) of cash balance, timber, biomass, number of people participating in recreation, herbage biomass, populations of different wild animals and etc. [ ]. That's why on understanding of such interactions is very important for a manager who must take appropriate actions to bring different components of the forest system under control.

System Dynamics is a method of modeling the complex interactions that characterize our biological, engineering, managerial, organizational, and social systems. The system Dynamics method provides for the analysis and synthesis of dynamic feedback systems of all types. This is accomplished by carrying out certain activities in a prescribed logical sequence [ ].

The application of the System Dynamics method to forest management systems (FMS) is difficult because the biological/human/financial interactions are so complex, reliable data is so limited, and the long forest life cycle is not synchronized with the much shorter political and organizational budget and administrative control cycles. Nevertheless, it can be done by following the sequence described in [ ].

Since the FMS is composed of many interrelated, but organizationally distinct, entities, there is no single objective for forest management or concensus on priorities for the multiple uses in the short and long run. The resulting conflicts, compromises, and competition among the groups are important determinants of system performance and must be included in the hypothesis and model despite the difficulties in determining their nature. Biological data are limited in what has been measures and the length of the historical records. Government and private organization data is also limited in extend and duration. But enough is available to establish a general picture [ ].

Using this System Dynamics approach, Willard R. Fey and Yaman Barlas [ ] developed a "preliminary model" of the overall FMS on regional levels. Vernon L. Robinson and Willard R. Fey [ ] suggested that such a "total" model will be very useful to improve the forest management. They point out that modeling such a big and complex system will not be easy and will take some time. Yet, such an effort will be worthwhile by providing the top managers with a very useful tool in understanding and managing the FMS.

By "preliminary model mean that the model is built at an aggregate level. By preparing influence diagrams of the FMS at an aggregate level, they provided a starting point for potential future studies which will be directed to build a detailed overall model of the FMS. They have decided that the most reasonable way of dividing the FMS into sub-systems is to divide it by "resource elements" mentioned in most Forest Service publications. Among the seven resource elements which they used in their model, this report is mostly concerned about range sector.

Range study is the quest for basic information about rangelands and the development of guides and procedures for their management, improvement, and efficient use. Its primary function is to provide a firm foundation for range management. Rangelands frequently have products other than livestock which must be considered in range study. They may provide game and fish for the sportsman, recreation for campers and sightseers, and timber and minerals for commercial production. Range study must consider these multiple uses where they are implicated and develop management techniques advantageous to all land functions.

The objective of this study is to describe and quantitatively represent the dynamic behavior of the range portion of the Forest Service system, the influence of Forest Service policy on it and influence of congressional appropriations on FS policy.

The south has 323.4 million acres of forest and rangeland of which about 12.5 million is administered by the Forest Service. Of the 12.5 million acres, approximately 2 million acres are suitable for grazing. These lie in the Piedmont and Coastal Plain. Of this acreage, only about 38,000 acres are considered rangeland (grassland,prairies, wet grasslands and savannah).

Most of the opportunities for grazing on National Forests occur in regeneration areas and openings within the timber stands. Thus, the range program is closely tied to the other resource programs and must intergrate and coordinate operations accordingly.

The number of livestock grazed has decreased since 1970 and is currently about 25,000. They use approximately 206,000 Animal Unit Months of forage from forests and rangelands. By permitting more acreage for

controlled grazing, National Forests in the South can sustain an increase from the present level to 293,000 AUM by the year 1982 and to 320,000 AUM by the year 2030. This increase can be achieved without lasting harm to the environment or the forest resource.

As the purpose and procedures are already mentioned in the semi-annual progress report, in this final report, the more detailed parts of the range sector is described and the flow diagram is shown in Figure 1 based upon the influence diagram drawn in the last progress report.

This study of the range sector has included biological, managerial and financial considerations. And the description of the range sector of regional forest resources is made in terms of range development sector, Forest Service decision-making sector, budget sector and cattle industry sector.

RANGE DEVELOPMENT SECTOR

Ranges that are properly stocked and are grazed under well designed grazing systems will improve in productivity, ecological condition, and soil stability.

In contrast, overstocking or poorly designed systems will lead to adverse impacts upon all parts of the range environment including soils, vegetation, wildlife, and streams.

Grazing systems are one means for getting the kind of grazing desired throughout a management area. Some simple systems entail no more than twining livestock into a fenced area, providing them with water and salt, and removing the animals when the vegetation has been grazed

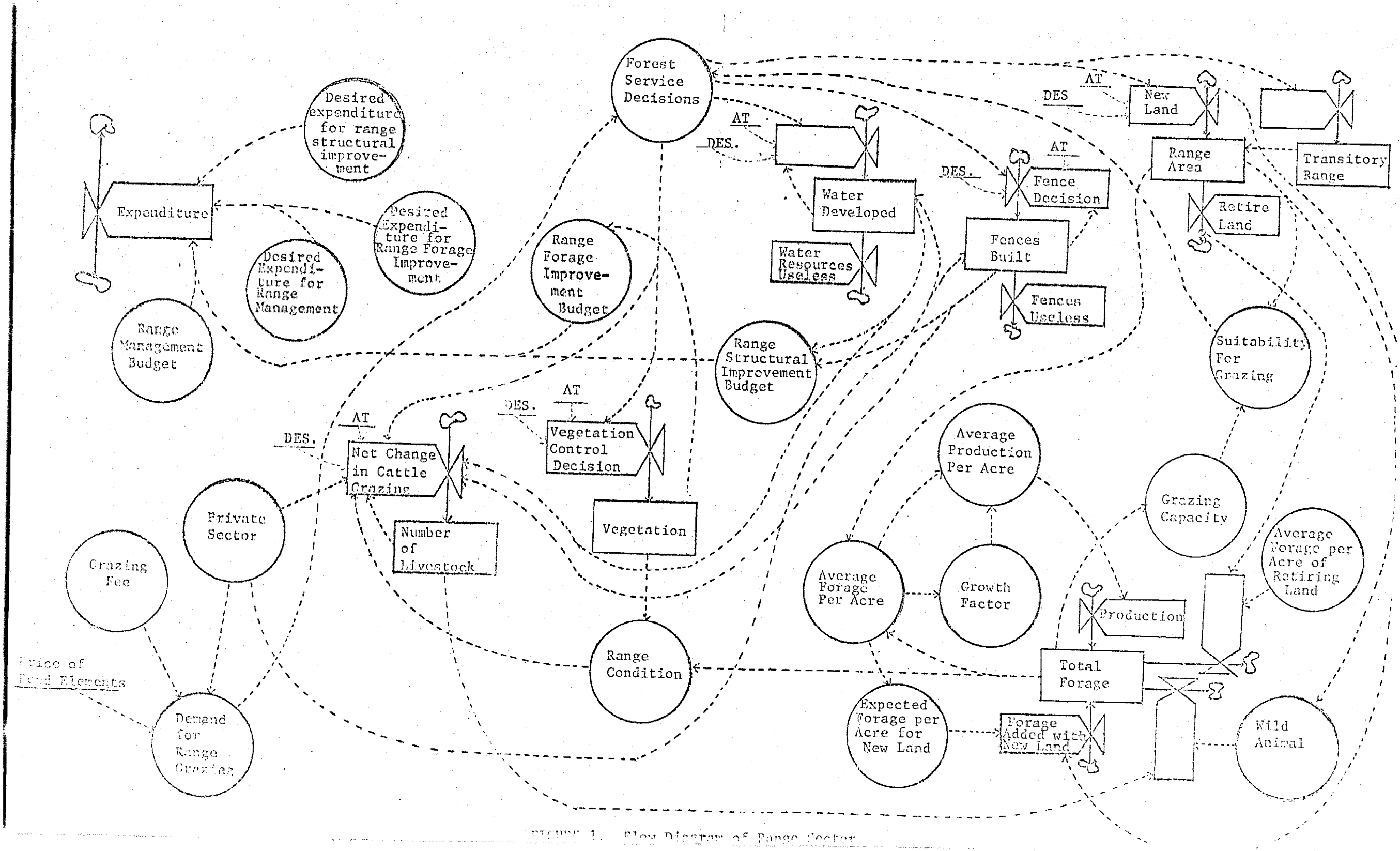

FIGURE 1. Flow Diagram of Range Sector

to a desired amount. Other systems are quite complex and involve rotating livestock among several pasture units during a given grazing season with the order of rotation varied between years.

The amount of range grazing can be expanded by improving grazing management systems, installing structural and nonstructural range improvements and plant control.

Improved grazing systems designed to consider the multiple requirements of soil, vegetation, livestock, and wildlife usually will support more grazing use over time than the grazing management currently practiced in most areas.

Grazing systems and related improvements must be designed to meet specific site requirements and must be applied to economic feasibility, site production potential and vegetation needs.

Structural improvements, such as fences and water developments, are designed to control the movement and distribution of livestock and facilitate their handling. Nonstructural improvements are such practices as seeding, prescribed burning and plant control to increase forage production, nutritional quality and availability of forage.

In the range development sector, as shown in the flow diagram of Figure 1, important variables are vegetation, range condition, grass biomass, fences, and water development.

VEGETATION

Quantitative characteristics of the vegetation which can be observed or measured directly have received much attention recently in testing, comparing, and refining measurement methods devised in earlier years.

Some characteristics of range vegetation lend themselves more readily to measurement techniques while others are more suited to ocular estimation. Brown ( ) gives four criteria as the essence of all methods for expression, assessment, or measurement of a plant species. There are: frequency number, area covered, and weight.

The frequency refers to the degree of uniformity that a species of plants shows in its distribution over an area. It is used when a list of species of one area is being compared with that of another. Frequency is determined by noting the presence or absence of each species in sample plots that are distributed within the study area. The number of individuals in a plant community is expressed as abundance or population density. A classification system is frequently used for estimation of abundance, such as very scarce, scarce, infrequent, frequent and aboundant. A more definite meaning may be given to these general classes by attaching numerical values to them.

In solving many problems connected with range seeding, control of weeds, and effects of burning, the counting of plants gives an adequate basis for making comparisons.

The area covered by vegetation is perhaps the most widely used measurement of the quantity of vegetation. Terms used to denote area covered, especially density, have been used to demote many different specific measurements. Density has been defined as the exact ration between the number of individuals of the same species observed on a certain surface and the extent of the surface.

Weight of herbage produced (pounds) is one of the most important characteristics of range plants and it is probably the best single measure of growth ( ). It is a most convenient term to express forage production and likewise can be used to indicate and measure ecological trend and range condition. Weight is used to express amount of "herbage" and "forage." Herbage is defined ( ) as "harbaceous vegetation considered as a collective unit." Forage is defined in range movement ( ) as "unharvested plant material of any kind available for animal consumption. It may either be used for grazing or cut for feeding. When cut it becomes feed." Forage is the product of herbage and available browse produced time permissible utilization (in per cent), so forage is always less than the total of herbage and browse. Measurement of these characteristics makes it possible to assess vegetation changes due to time, place, or treatments applied, and to define plant communities and permit ecological comparisons. It also permits analysis and interpretation of plant vigor and forage production.

RANGE CONDITION

Range condition is the state of health of both soil and vegetation, and is based upon ecological relatonships.

This term covers the assessment of the status of a particular area of range in relation to its potential. An area rated in excellent condition will be one in which forage production, both in quantity and quality, approaches an optimum for the site in that soils and vegetation are stable and conditions are favorable for continued high productivity.

Condition classes are commonly classified as "Excellent," "Good," "Fair," "Poor," with sometimes a "Very Poor" condition also recognized. Assessment of range condition depends upon ability to recognize and classify the various species of plants, and to recognize their successional position in the vegetation and their value to the class of animals being considered. Perhaps even more, it depends on ability to recognize the symptoms of site deterioration as revealed by the amount of ground covered by various types of vegetation (e.g., trees, shrubs, perennial grasses, annual grasses, forbs, etc.), the amount of bare ground and of dead plant material, and by evidences of erosion.

A comparison measurement that must accompany the assessment of range condition is that concerning range trend, This states, in effect, whether a particular area of range is deteriorating , improving or holding its own, under classified in "Excellent" condition but noted to have a deteriorating trend is an area for management concern. An area in "Fair" condition, but noted to have an improving trend is evidence of good recent management.

Measurements of range trend are based upon an assessment of evidence

of changes in vegetation - whether or not seedlings are becoming established and of which species or vegetation, and of changes in soil condition - whether or not erosion is active and accelerating, or whether or not evidence of past erosion is being "healed over" by plant growth. Among the decisions faced by the manager is the selection of remedies that will reverse the trend and improve range condition. Remedial rangeland management practices include control of animal numbers, distribution, species, and seasons of use.

WATER DEVELOPMENT

Water development usually involves dams, wells, stock ponds and live streams.

The location of drinking-water governs the distribution and movements of most species of grazing animals during the dry seasons of the year. If suitable watering points are well distributed over a rangeland, range use will be more even and local concentrations of animals are less likely to develop. It has long been apparent that development of new watering points in dry areas is a means of achieving a better distribution of animals.

Water development should not be attempted in a region in which overgrazing already exists and in which no control can be exercised over the numbers of distribution of grazing animals. In such circumstances, development of new watering-points in areas which could scarcely be used before due to lack of water, can only lead to the overgrazing and deterioration of those areas.

If the full cooperation of those who control numbers and distribution of animals can be obtained, however, water development is an important means of increasing the productive capacity of the land.

Particularly useful is the provision of temporary watering-points, able to be closed down with the first signs of overuse and range deterioration. A series of such points opened in rotation can be used to shift animal concentrations from one area to another and achieve more uniform use of the rangeland.

FOREST SERVICE DECISION MAKING SECTOR

Forest Service decision making responsibilities require both managerial and professional competence. To efficiently carry out the reaponsibilities assigned to the Forest Service by the Secretary of Agriculture, activities are conducted in accordance with good management practices designed to ensure efficient, economical, and satisfactory new programs or jobs are assigned from time to time, or a specific area of an assigned function may require more intensive consideration. When this happens, the Chief may require specific Washington Office review and approval until experience has been gained by responsible field officers and appropriate policy and procedural guides have been prepared.

Regional Foresters, State and Private Forest Area Directors, and Experiment Station Directors provide policy and direction in accordance with the Chief's national direction and submit program proposals annually to the Washington Office to ensure that environmental, social, and economic factors are fully considered in the decision making process.

A Forest Supervisor has overall responsibility at the Forest level in very much the same way as described for the Chief and for a Regional Forester at those levels. However, since District Rangers do most of the work and conduct almost all National Forest business, a Forest Supervisor properly devotes much time to review and approval of program and project plans and to functional supervision designed to ensure compliance with Forest Service policy and procedural work standards.

Line Officers make decisions for every management problem. Long-range decisions must be made and successfully carried out to ensure future generations a reasonable supply of rangelands and other resources on the National Forests.

As shown in the flow diagram of Figure 1, the management variables are grazing fee decision, vegetation control decision, water development decison, fence decision, decision on grazing permit and designation of range area. These decisions except grazing fee decision are made by Forest Supervisor with advice and veto by region Range Manager and Budget Manager.

The need for many of these decisions is recognized well in advance of program action. The brief descriptions of the decision variables are as follows:

Grazing Fee

Charges for grazing were first made on the National Forests in 1906, and on BLM-administered lands in 1936. The objectives of the grazing fee system have been developed through Federal Legislation, Federal executive policy, and agency studies and guidelines. These objectives which apply to both BLM and FS, are descirbed below [ ] :

- The fee system should collect fair market value for use of the forage resources:
- The fee system must be fair in its treatment of interested groups and individuals.
- The fee system should include regular adjustments that would account for changes in values.
- The fee system must be administratively feasible and use available data series which are uniform and historical.

As a result of the 1966 survey and the 1968 analysis, an FMV fee of $1.23 for AUM was established for the 1966 base year. On November 15, 1968 the Secretaries of Agriculture and Interior proposed a new fee formula and schedule. The fee formula contained the $1.23 FMV base level with adjustments annually to reflect the relative changes in private grazing land lease rates for the eleven Western States.

The grazing fee study in the Western States should be helpful and applicable to National Forests in Region 8.

It is evident that grazing fees for private and corporate lands in Region 8 were developed without any apparent adherence to cattle economics or land values[ ]. Fees have maintained their present value more through long existing custom than through the value of grazing itself or the value of the land.

Vegetation Control

The direct manipulation of vegetation is available to the Forest Service. Increased production of forage for wildlife and grazing animals can be attained with such practices as prescribed burning, seeding better species , controlling undesirable plants, fertilizing, and conserving soil and

water.

Fence and Water Development

Fencing is the total solution, but it is expensive and is usually unnecessary with controlled numbers and proper management. The purposes of constructing fences is to confine livestock or control their movements. The owner will be better off to put the fence money into devision fencing of the range area and adopt a rotation system of grazing that avoids use of the plantation area. In the application of deferred and rotation grazing systems on the range, the expense of fencing and watering should be balanced against possible increased favorable animal responses and benefits to the soil and vegetation.

The decision to develop new watering points on the range is made by the Forest Service. That affects the capital available and total drinking-water inventory. And total water inventory will partly affect the number of livestock that can graze. Similar dynamic behavior can be applied to fence decision process.

Controlling Livestock Numbers

Unless control can be obtained over the number of animals grazing or browsing in an area very little can be done to improve the condition of the rangeland. If numbers of animals are uncontrolled, any improvements that can possibly be brought about will have only the most temporary effects, since grazing animals will concentrate in or around them to create as much or greater damage than existed before.

Control may be brought out by an agreement with permitees and operators to remove excess stock, or it may involve only an agreement to hold livestock off the area to be improved through herding or fencing. For reseeding, removal of undesirable vegetation or any other forms of range improvements there must be an agreement to hold animal numbers below the actual carrying capacity of the area involved. With wild grazing animals it is sometimes exceedingly difficult to control numbers or reduce overstocking without an intensive hunting effort.

Designation of Range Area

The Forest Service designates some land to be range area directly based upon size, shape and range condition. Hard and fast rules for the determination of range area cannot be establashed. Only general guidelines can be provided within which each inspector must exercise individual judgement. Desirable range is that area which produces forage, or has inherent forage-producing capabilities, and can be grazed on a sustained-yield basis under reasonable management goals [1].

Transitory range is defined as areas which become forage-producing and accessible as a result of timber-management practices, fire or other reasons. It is land which has the potential to be suitable for livestock use from the standpoint or accessibility, slope, soils, and forage production, but which is not used at all under existing management and improvement levels.

Budget Sector

The Forest Service's program budgeting process is part of the Department of Agriculture and the Office of Management and Budget's (OMB) 5-year

program budgeting process. The program budget is a 5-year plan, but the number of years for which proposals are asked varies from year to year, depending upon the need for information.

Data for planning are submitted upward by the originating units and must be based upon objectives achievable during the program budget targeted years.

Program budget planning action is the initial step in budget formulation. Proposals from Regions, Areas, and Stations (R/A/S) are the bases for developing national proposals for Department of Agriculture inclusion in the Presidential budget through OMB. R/A/S proposals provide the basis for allocation.

The objective of program budgeting is to allocate federal funds, manpower, and output targets among agency programs and objectives so as to best serve the public interest. The program budgeting process provides an opportunity to reflect current conditions and changes that may have occured since the RPA Program was developed. Program budget proposals are developed within the context of national direction established in the long-term Resources Planning Act program, which is updated annually by the Chief's Presidential, and Department policy guidelines and land management and resource constraints contained in land management plans.

Budget proposals represent firm commitments by Regions, Research Stations, and State and Private Forestry areas to achieve a certain level of output targets at a specified cost. Therefore, costs estimates are updated annually to reflect current conditions and the details for a specific set of project proposals.

The federal budget-appropriation-expenditure process is too slow, too combersome, too unresponsive to changed conditions, and discourages the long-term planning, investment, and management which is so important for forestry[ ].

The amount and form of new capital investment in national forest management and other improvements on the national forests are arrived at by both political and economic process.

Funds provided in appropriation acts are not available for obligation until the appropriation acts are passed by the Congress and approved by the President and until allotments or allocations are made to obligating units. Therefore, officers do not incur any obligations against newly appropriated funds until formally authorized through channels.

The money appropriated by the Washington office will be managed by regional office managers with some flexabilities. One cannot be certain to what extent operating and investment expenditures by functions are wise at this stage, given the data and analytical deficiencies.

CATTLE INDUSTRY SECTOR

Livestock production is a mainstay of economic activity on the family-size farm in the South. The cattle industry in many sections of the South is significantly dependent on the increment of grazing acreage available on National Forests.

The characteristics of farm and ranch operations, the use of National Forest for grazing, the requirements for expansion of the cattle industry are described as follows..

Characteristics of Farm and Ranch Operations

The characteristics widespread use of woodland for grazing is significant because woodland grazing land comprises the major grazing resource available on the National Forests. The woodland grazing acreage was further classified as piney woods and pine-oak-hickory forests. Yearlong grazing is the common utilization period for both woodland and open land grazing acreage. Because of this pracitce, the U.S. Forest Service might consider the wider adoption of a 12 month grazing season in issuing grazing permits.

The Use of National Forests for Grazing

The analysis of the reasons offered by farm operators who previously held grazing permits for discontinuing grazing on National Forests provides certain guidelines that can make the National Forest grazing program more acceptable to all farm operators.

The reasons operators gage for being unwilling to graze cattle on National Forests are mostly susceptible to correction by the U.S. Forest Service. Three reasons - poor quality of forage, inadequate funding, and excessive loss of cattle - accounted for 45.9 percent of negative responses by operators [ ].

The ranking of certain proposed improvements on National Forests by permittees and operators capsules the significance of efforts that might be undertaken by the U.S. Forest Service to upgrade the acceptance and to expand the utilization of the National Forest grazing resource.

Four major improvements were suggested: upgrade the quality of forage, authorize yearlong grazing, provide adequate fencing, and grant long-term (10-year) permits

The Requirements for Expansion of the Cattle Industry

In order to determine the improvements required before herd operations could be expanded significantly, an analysis was made of the factors listed by permittees and operators which limit the expansion of the cattle industry. Those factors that are highly significant in limiting the expansion of the cattle industry are as follows[ ].

High cost of farm land, not enough grazing land, lack of winter feed and not enough profit in raising cattle.

The expansion of the grazing program on the National Forests can compensate for the major limiting factors cited by both permittees and operators.

The conversion of acreage on National Forests to grazing land and the improvement of forage can help alleviate at minimal cost the limitations associated with the insufficiency and high cost of private grazing land. Similarly, winter feed supplies could be expanded by spring and summer grazing on National Forests and by the concurrent expansion of hay production on private land.

Finally, the expansion of herd size through the utilization of National Forests for grazing might spread the overhead costs of cattle operations and increase total profits.

RELATIONSHIPS BETWEEN SECTORS

Range management can provide many outputs in addition to grazing and can be used to meet other management goals, such as vegetative manipulation. Grazing can cause conflicts with other resource used-particularly with timber and wildlife interests-and increased use of the range resource could highten these conflicts.

If the grazing and timber programs are compared, future grazing opportunities essentially coincide with the volume of timber to be harvested (and regenerated).

Since regeneration areas comprise a major portion of these potential grazing opportunities, environmental impacts will be limited to damage to tree seedlings and competition for food with wildlife species such as deer. Where good control of animal density is maintained through rotational systems of grazing, impacts will be insignificant.

Therefore, it is essential to examine the multiple use management of range and possible conflict with other resource uses. Management of rangelands for multiple use is highly complex because of variability among rangelands and the many socialand economic problems involved in allocating the valuable resource in accordance with its capabilities and the demands upon it. Grazing by domestic livestock and wildlife, timber management, watersheds, and recreation management should be based upon the sound knowledge of multiple land use obtained through research rather than land use decisions based on emotions.

FURTHER STUDIES

Planning and decision-making in the range management are extremely complex. Managers, decision-makers,and researchers need a means of bringing together the diverse system components into a usable form. Modeling can help do this, however, the diversity of imputs will require careful scrutiny of outputs until the many gaps in sound research information can be filled.

Once developed, models must be tested in order to know how well they predict outputs, and testing requires the comparison of predicted outputs with actually observed results.

The biological, human, and financial aspects of this regional forest range sector model are related through coupled feedback loops that operate continuously through time to create the patterns of change of the systems variables[ ].

Therefore, it is necessary to conduct both theoretical and experimental research to quantify those biological, managerial, and financial components in dynamic mathmatical terms to permit satisfactory of total-system behavior under a wide variety of practical management alternatives.

Given good models, the performance of grazing systems under widely varying input situations can be predicted to form the basis for: firstly, optimizing new systems without having to perform new experiments whenever changed management practices or range sites are involved,

secondly, demostrating the total long run impact of policies, particularly in budget areas[ ].

thirdly, training Forest Service staff, state forest managers, private forest owners, timber company managers, legislators, financial institution managers, environmentalists or the interested public.