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annual report

REGIONAL FOREST
NUTRITION RESEARCH
PROJECT: 1969-70

Institute of Forest Products

College of Forest Resources

University of Washington

PARTICIPATING MEMBERS

Boise Cascade Corporation
Borden Chemical, Division of Borden, Inc.
Broughton Lumber Company
Bureau of Land Management
Collier Carbon and Chemical Corporation
Cominco American, Inc.
Crown Zellerbach Corporation
Department of Natural Resources, State of Washington
Georgia Pacific Corporation, Bellingham Division
International Paper Company
ITT Rayonier, Inc.
Longview Fibre Company
Menasha Corporation
Phillips Petroleum Company
Pope & Talbot, Inc.
Publishers Paper Company
Scott Paper Company
Seattle Water Department, City of Seattle
Shell Chemical Company
Simpson Timber Company
St. Regis Paper Company
The Sulphur Institute
Timber Service Company
U.S.F.S. Pacific N.W. Forest and Range Experiment Station
West Tacoma Newsprint Company
Weyerhaeuser Company
Willamette Industries, Inc.
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FOREWARD

James S. Bethel, Dean
College of Forest Resources

The United States faces a growing problem of accommodating a limited forest resource to the needs of a rapidly expanding population. Demands for goods and services from a stable forest land base stem not only from a greater need for forest products but also from growing requirements for land for outdoor recreation, water supply, fish and game production and for many other purposes. Clearly, in the presence of such a land use conflict the only prospect for meeting the general need for goods and services lies in achieving more efficient utilization of each acre of forest land. It is essential that the individuals and organizations that make up this resource complex continually search for effective methods to increase forest productivity. One such procedure is forest fertilization.

Forest fertilization as a cultural manipulation is in its infancy in the United States. The present state of knowledge in the field of forest fertilization does indicate, however, that it has great potential for increasing forest productivity. The full development of this potential requires much more basic research on tree nutrition and growth response and applied research to develop viable fertilization technology. The Northwest Regional Forest Nutrition Research Project represents the response of forest industry and the forest related public agencies to this challenge.

One of the dividends to be declared from a cooperative venture of this kind is the education spin-off. The forest organizations require not only information concerning use of forest fertilization as a tool but also personnel who are competent to understand the technology and to use it effectively. The development of a reservoir of professionals with such competence is an important by-product of this research effort.

The College of Forest Resources is pleased to be able to conduct this research for the sponsoring organizations through its Institute of Forest Products. Although the present program is only scheduled for six years duration, it is apparent that this will just begin large scale coordinated research in this domain. The College looks ahead to a long-term association with the forest organizations of the region in the conduct of this research which should contribute much to increasing the productivity of the forest lands of the Pacific Northwest.

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INTRODUCTION

David P. Thomas, Director
Institute of Forest Products

Fertilizer response research in the Douglas-fir region was initiated about 20 years ago by scientists at the University of Washington and several other research organizations.

These researchers had observed the general chlorotic condition of large areas of Douglas-fir forests, and by greenhouse trials demonstrated that this phenomenon was associated with a general deficiency of nitrogen in the glaciated soils of the region.

This early work was confirmed in field trials by researchers at the University of Washington, as well as in private companies and land management agencies. Approximately 300 fertilizer plots were established by the College of Forest Resources of the University of Washington, and many more by other agencies. Clear indications of response to nitrogen were demonstrated in most cases.

However, most of the field trials were established on glaciated soils of western Washington and confined to limited age and site index classes. Although there was a general feeling of optimism regarding nitrogen fertilizing of Douglas-fir, there were too many gaps in the accumulated knowledge to make sound predictions for the whole of the Douglas-fir region. With the advent of operational aerial fertilization in the Pacific Northwest in 1965, it became all the more essential to have a better quantitative basis for selecting areas and rates of application.

Approximately four years ago the Northwest Forest Soils Council, appreciating the magnitude of the problems to be solved, conceived the idea of a cooperative research project financed by the land and timber managers of the area and administered by a single research team. The Tree Nutrition Committee of this Council drew up a proposal for the project and the Institute of Forest Products of the University of Washington was asked to administer it.

Review of the Program

It seems appropriate that in this introduction to the first annual report, a brief review of the program should be presented so that details in the body of the report might fall more readily into perspective.

The broad goal of this project is to develop information on response to nitrogen fertilizer of Douglas-fir and western hemlock over a wide range of second-growth stands so that sound decisions may be made by forest managers regarding the extensive fertilizing of their forests.

This is to be accomplished in the following steps:

1. Establish and maintain a series of fertilizer field trials appropriately distributed on subscribers' lands in western Washington and Oregon in Douglas-fir and hemlock second-growth forests;
2. collect and analyze growth data from these plots and report results to subscribers;
3. offer additional information to subscribers by holding seminars, discussions, and short courses;
4. conduct associated research to supplement the response data from field trials to assist in diagnosing nutrient problems, soil and physiology studies, and quantitative ecology related to mineral cycling in forest environments;
5. report findings regularly to subscribers and advise them on fertilization problems and practices;
6. cooperate with other programs and research designed to intensify forest management and increase wood production;
7. serve as the mechanism to focus and direct efforts related to solution of forest nutrition problems in west-side forests;
8. and review the entire project at the end of six years to assess needs for any additional research and advise subscribers regarding the conclusions.

In summary, the scope of the overall program includes the following objectives:

1. Examination of response of trees to fertilizer under various conditions of soil, climate, age, and site index;
2. analysis of the effects of fertilizer application on total ecosystems;
3. diagnosis of elemental deficiencies in forest stands;
4. consideration of the economics and logistics of fertilizer application;
5. study of the physiological relationships within trees which give rise to response;
6. and comparison of the efficiencies of various forms of fertilizer.

The following report describes the progress that has been made during the first year towards these objectives.

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DEVELOPMENT OF THE PROJECT

Stanley P. Gessel, Associate Dean
College of Forest Resources and Director of the
Regional Forest Nutrition Research Project

Early in the conception stage of this project, it became apparent that the scope of the needed research in forest fertilization was beyond the financial resources of any single organization. The Northwest Forest Soils Council decided that a large-scale cooperative project based on as wide support as possible was the best solution. Letters were sent to all potentially interested land managing companies and agencies and fertilizer manufacturers requesting that they express their opinion on the worth of such a cooperative venture and their willingness to contribute financially to its support. On the basis of the generally favorable and enthusiastic response, it was decided to proceed with the drafting of a formal proposal.

This was prepared by the Tree Nutrition Committee of the Northwest Forest Soils Council, which was appointed specifically for this task, and several members of the faculty of the College of Forest Resources of the University of Washington. Liaison with the potential cooperators was maintained so that the resulting proposal might best satisfy their needs and represent the most prevalent conditions in the region.

It was decided to restrict the geographical testing area to Washington and Oregon west of the Cascade Crest with the exception of the Siskiyou Mountains in southwest Oregon which represent a unique and extremely complex geological and vegetative area. The entire region was subdivided into six areas distinguished on broad climatic and soil differences. Douglas-fir would be sampled in all areas, and hemlock would be sampled in those areas where it represented an important component of the total forest area. The most common site qualities in each of the six Douglas-fir provinces and three hemlock provinces would be tested.

The chief difficulty in formulating the design was in balancing two divergent viewpoints with respect to the philosophy of future forest management in this region. The one viewpoint looks at the prevalent unmanaged conditions which have been inherited and the immediate management practices relevant to these conditions, while the other viewpoint looks beyond to the day when young stands will be intensively managed to maturity. There are two pertinent implications in the first viewpoint: (1) that uniform stocking density and species composition assume less importance in the establishment of field trials since they are not the prevalent conditions in westside forests today, and (2) that the older second-growth stands assume relative importance since they are so plentiful today and can give more immediate financial return to the owner.

The opposing viewpoint maintains that stands of the future will be intensively managed from youth to maturity and that the unmanaged 40-year old stand will increasingly become a thing of the past. Hence, research oriented to the older stands might not provide the most optimum long-range benefits. This view implies: (1) that uniform normal stocking in the establishment of field trials assumes greater relative importance since it will represent future conditions to a greater extent, and (2) that the younger second-growth stands become more important to sample in the research design.

In balancing these arguments, all of which are valid, it was decided to put an equal number of field trials in each of three age categories: (1) 15-30 years; (2) 31-45 years; (3) 46-60 years. The older stands were given equal weight because much remains to be learned of their response patterns, and they are decidedly of greater immediate economic importance.

However, it was thought to be desirable to restrict the species composition of the field trials to 80 percent in the primary species (either Douglas-fir or hemlock) and to specify that this 80 percent should have a basal area stocking of 80-110 percent of "normal" stocking. This was specified partly because past experience has indicated that fertilizer research plots established in non-uniform stands do not generally provide meaningful results.

Another important consideration in the conception of the project was the interaction between thinning and fertilizing. Since it is expected that the two may often be done simultaneously in future stand management, a number of experimental thinning-fertilizer plots were included in the research design.

When the details of the design were satisfactorily worked out, the result was a minimum six-year project with an annual budget of \$100,000. This budget was necessary to finance the installation, measurement, analysis and reporting of 720 Douglas-fir plots and 288 western hemlock plots and to support graduate student research activities which would supplement the field trials.

In July of 1968 the proposal was approved by the Institute of Forest Products and submitted together with a financing schedule to forest landowners, agencies, and the fertilizer industry. Another six months elapsed before a clear indication of the extent of potential support was obtained.

On March 1969, the proposal and the various organizations attending the meeting of Forest Products Research Institute so that a decision may be made.

By April 1969, the project was secured. The project was to be conducted the following year on a reduced funding, or

This situation was a consensus was reached on the scope of the project. Initially eliminated 10 percent of the project to be reincorporated. The decision was made. The research was the decision

Mr. Ian MacKenzie, a forest manager with a project supervisor background of the State of Columbia and of the world

The list of participants in the project became open to the industry, the project was represented. The list of participants to this cooperation have been very

On March 7, 1969, a meeting was called at the University of Washington to clarify the status of the project funding and to review the research proposal and procedures. Representatives of approximately thirty organizations attended. Encouraged at the outcome of this meeting, the Institute of Forest Products submitted memoranda of agreement to the interested organizations so that a definite commitment of funding could be obtained and a decision made on whether or not to proceed.

By April, 1969, funding to the extent of \$74,000 per annum had been secured. This was \$26,000 short of the \$100,000 per year necessary to conduct the study in its full form. This deficit had been considered inescapable for some time, and a decision had to be made on whether to proceed on a reduced scale, to delay another year and attempt to solicit additional funding, or to scrap the whole project.

This situation had been discussed at the March 7 meeting, and the consensus was that the most desirable of these alternatives was to reduce the scope of the design and that this might most readily be done by temporarily eliminating the thinning component which represented exactly 25 percent of the total number of 1,008 plots. It was anticipated that an attempt to reincorporate the thinning plots into the project at a later time would be made. The decision was made to proceed on this basis since the fertilizer research was considered of paramount importance. Hence, on April 28, 1969, the decision to commence the project was announced.

Mr. Ian G. Morison, who is about to complete his Ph.D. degree in soil and forest nutrition at the College of Forest Resources, was appointed the project supervisor. A native Australian, Mr. Morison has an impressive background of 20 years in forestry. Together with his colleague, Dr. T. N. Stoate, he has conducted a great deal of nutritional research in British Columbia and the three Pacific coast states, as well as various other parts of the world. His report follows in the next chapter.

The list of cooperators, several of whom have joined the project since it became operational, is on the frontispiece of this report. The timber industry, the government agencies and the fertilizer industry are well represented. I wish there was sufficient space to personally acknowledge all the individuals in these and other organizations who have contributed to this cooperative effort. The support and enthusiasm we have received have been very gratifying and most sincerely appreciated.

ANNUAL FIELD PROGRESS REPORT

Ian G. Morison
Senior Scientist and Project Supervisor
College of Forest Resources

With the elimination of the 252 thinning plots, 756 fertilizer plots remained in the design. The field work program called for the establishment of 126 six-plot installations on cooperators' lands before the beginning of the 1971 growing season. Approximately half were to be established in the summer, fall, and winter of 1969-70, and the remainder in the summer, fall, and winter of 1970-71.

After the decision to proceed with the project on April 28, 1969, there remained only a month and a half until the end of the school year, at which time student help would be available to fill the field crews. This interval was spent in purchasing the necessary supplies and equipment, hiring the permanent and temporary crewmen, and organizing vehicles and work schedules. Mr. Steven G. Archie, College of Forest Resources staff forester, assisted the project supervisor in all these activities and spent much of the summer helping to locate suitable candidate areas.

Two recent graduates of Green River Community College's forest technician program were hired to fill the two permanent field positions, David C. Nettin and William M. Bizak. Four first-year students in Everett Community College's forestry technician program were hired for the summer to complete the field crew. These men were Robert W. Gonyea, Larry A. Duren, Michael L. Buchanan, and Gary M. Broughton.

Eight thousand dollars worth of equipment and supplies for the field work were purchased specifically for the project and are the permanent property of the project. Vehicles were provided by the University Motor Pool at a low daily and mileage rate.

The most serious problem was the locating of satisfactory stands of timber for plot installations. Many participating organizations assisted actively in locating suitable areas and the success of the first year's operations was due largely to this assistance. However, cooperation was variable and only 10 percent of the areas inspected by the project supervisor and the staff forester were suitable for the purposes of the study. Uniformity of stand species-composition and stocking density proved to be the most difficult of the specifications to meet. A special candidate area form has been distributed to participants for use in locating future areas, and it is anticipated that this will cut down on inspection of unsuitable areas.

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On June 16, 1969 the six-man crew commenced a 2-week training period. This training stressed the high level of accuracy and precision required in field research work of this nature.

Regarding the installations themselves, each of the six plots in a stand is situated most advantageously with respect to roads, topography, openings, etc., and surveyed in using staff compass (or right angle prism) and chain. The plots are rectangular in shape, being a minimum of 1/10 acre or as large as is necessary to obtain 50 trees per plot. The corners are marked with iron bars painted yellow for better visibility.

The visibility consideration is important in two major respects: (1) good visibility enables the crew to keep their bearings while working inside the plots, greatly increasing efficiency; and (2) it helps insure against accidental destruction of a plot by roadbuilders, loggers, etc. Each plot is further identified by liberal use of yellow paint along the plot boundaries and red paint bands on the site trees.

In addition, a series of 3" x 5" white signs are installed around each plot advising that it is a research area and requesting that it be protected. Each tree on the plot is tagged with numbered aluminum discs at breast height with all tags facing the northeast corner. The corners of the plot are flagged so there is almost no possibility that any one could accidentally move onto a plot without knowing it. However, for the record of the forester in charge of the area, maps of the location and surveys of the plot layout are being forwarded through the Liaison Committee members.

Measurements performed on each plot during the summer period included heights of six site trees and age determination of eight trees. In addition, crown class was recorded, as were any remarks pertinent to the analysis of any individual tree, such as presence of disease symptoms, malformed features or broken tops, etc. Since such notes are vitally important to the analysis of the data, a great deal of time was spent in pointing out relevant peculiarities to the field crew so that they would observe them.

By the end of September 1969, 45 installations (270 plots) had been established and the four temporary field men returned to Everett College, leaving the two permanent crewmen to continue with this work. By the end of November, 55 installations were completed and an additional two were established during the spring vacation giving a total of 57 for the first year's operation. These installations were distributed as follows:

| | | |
|---------------|----|---------------|
| Province I | 8 | installations |
| Province II | 8 | " |
| Province III | 5 | " |
| Province IV | 10 | " |
| Province V | 9 | " |
| Province VI | 5 | " |
| Province VII | 2 | " |
| Province VIII | 8 | " |
| Province IX | 2 | " |

The tariff system of volume determination will be employed in the computer analysis of this data. Diameters and final tariff heights are not taken during the summer growing season because of the obvious effect this would have on the data after the subsequent remeasurements. Hence, these measurements were taken during the months of September to March by the two permanent crewmen. During the dormant season, the breast-height diameter of each tree is recorded and 10 trees are measured for height in order to obtain the tariff number of each plot. These 10 trees include six dominants (which also serve as site trees); two codominants, and two intermediate trees. The trees will be re-measured at 2-year intervals up to the sixth year and growth response calculated at each remeasurement.

On January 26, 1970, the application of the urea nitrogen to the installations was commenced. This work had to be finished by the end of March and this was not a possibility with only our two crewmen. A special appeal was made to participants to cooperate in this operation by providing men to assist with the work. The response was excellent and the fertilizing was completed on March 26. The urea was provided free of charge by four of the participating chemical fertilizer manufacturers: Collier Carbon and Chemical Corporation, Cominco American Inc., Shell Chemical Company, and Wilson and Geo. Meyer & Company.

The University Motor Pool was unable to provide a suitable truck for the transportation of the fertilizer from the various pick-up points to the installations and the project is particularly indebted to the Department of Natural Resources, State of Washington, for providing a truck free of charge for 2 months for this work. It is not intended here to acknowledge the assistance given by individual organizations as this was generally of an excellent nature, but it should be reported that while the State of Oregon is unable to be a financial supporter of the project, it did provide field crew and vehicle assistance in fertilizing some of the Oregon plots.

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Dr. Raymond A. Gilkeson, associate professor of soils at Washington State University, spent a week with project personnel in setting up benchmark soil types and developing a procedure for choosing representative soil types for the installations.

Dr. Charles Driver, professor of forest pathology at the College of Forest Resources, University of Washington, trained the field crew in the recognition of the common tree diseases of the region. Relevant comments are made on the field data sheet for each tree so that anomalous data can be quickly identified.

Several organizations sent their soils men into the field with project personnel to assist in locating representative soils and to become familiar with the field work for future interpretive work on the data.

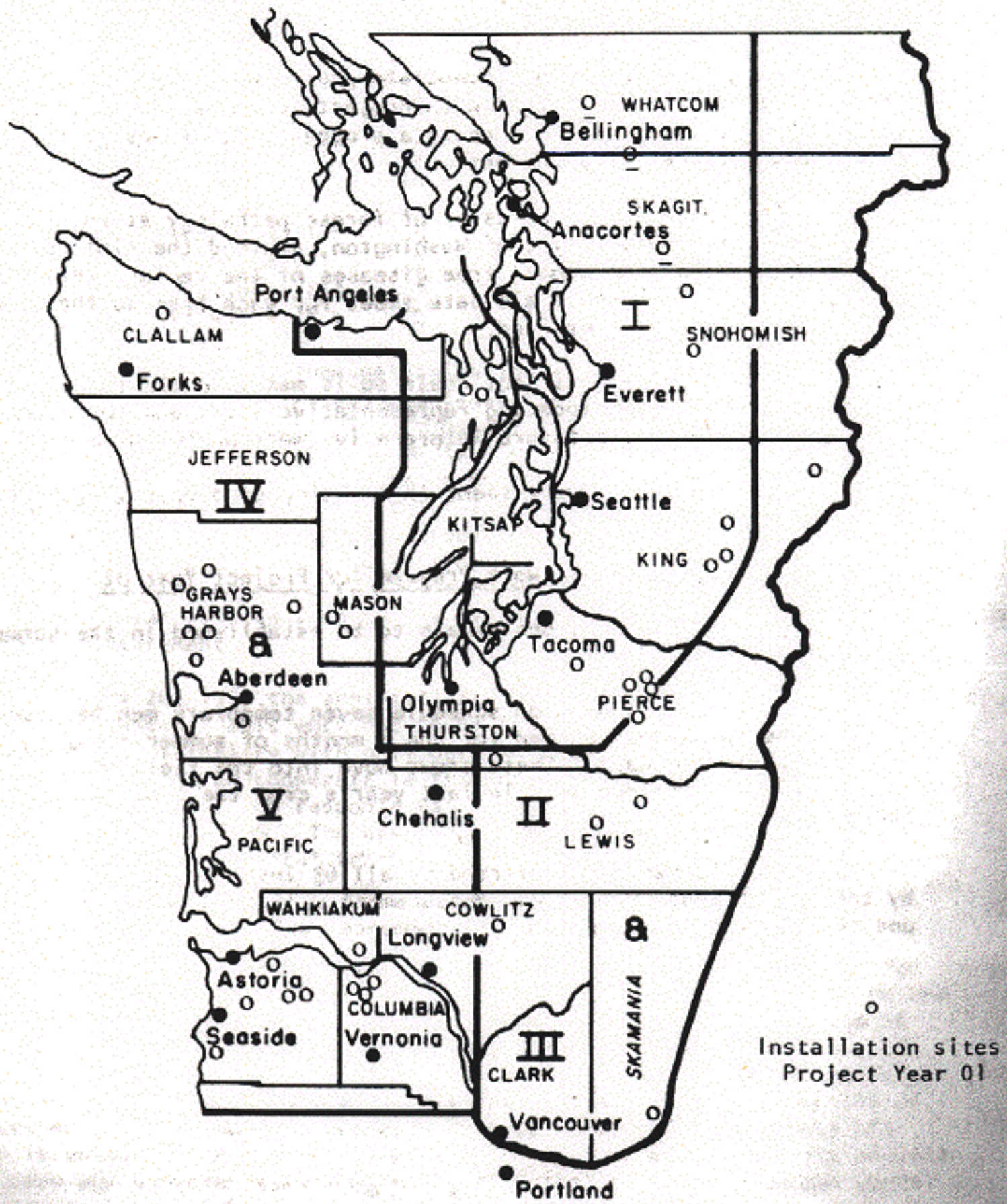
April and May 1970 were spent in locating candidate areas for project year 02 field work.

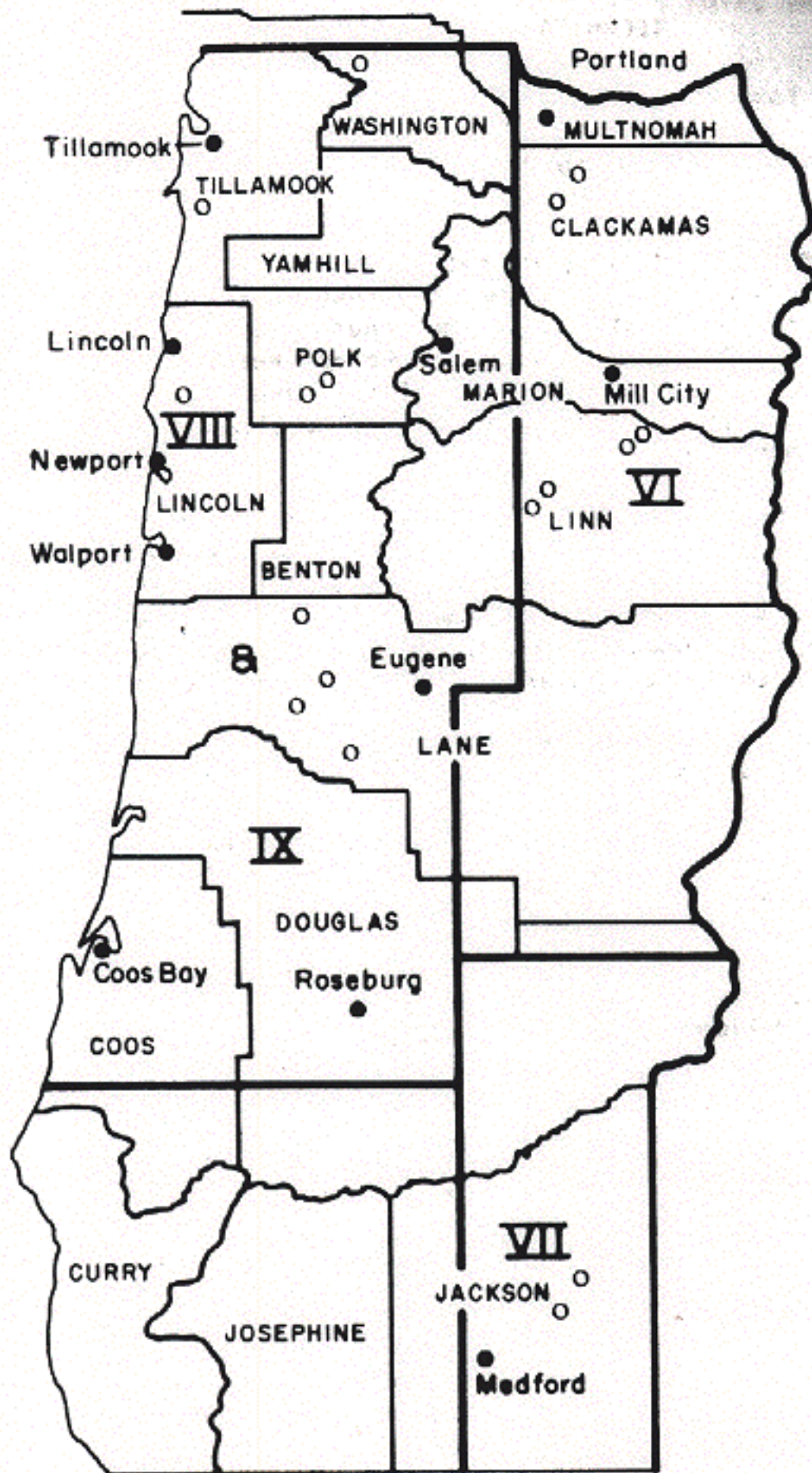
Proposed Field Work Program for Project Year 02

Sixty-nine installations remain to be established in the summer, fall, and winter of 1970-71.

To complete this work on schedule seven temporary men have been selected to join the two permanent men for the 3 months of summer -- making three crews of three men each. These crews move into the field on June 15 and because five of the men were in last year's crew the training period will be reduced.

It is anticipated that virtually all 69 installations will be established by the end of September. Tree measurement will be done in October - December and fertilizing of the plots will commence early in January 1971.





TECHNICAL ADVISORY COMMITTEE

Steven G. Archle, Staff Forester
College of Forest Resources

The wide scope and complex nature of the Regional Forest Nutrition Research Project has dictated that the Institute of Forest Products purposely seek discussion and advice on a number of technical questions. Appropriate faculty of the College of Forest Resources, as well as individuals and groups outside the College have contributed much time and expertise to charting the development of the program and helping to solve its problems.

The Tree Nutrition Committee of the Northwest Forest Soils Council has remained an important component of the project, and it is this group which is known in the project organization as the Technical Advisory Committee. In addition to its normal activities in the Northwest Forest Soils Council, the committee serves in an advisory capacity to the Institute of Forest Products on technical project matters. Its members are:

| | |
|----------------------------|---|
| Dr. Robert Strand | Forestry Supervisor Central Research Division Crown Zellerbach |
| Dr. Richard E. Miller | Project Leader Forestry Science Laboratory Pac. NW For. & Range Expt. Sta. |
| Dr. Paul Heilman | Associate Professor Western Washington Res. & Ext. Cen. Washington State University |
| Dr. Eugene C. Steinbrenner | Forest Soil Specialist Weyerhaeuser Research Center |
| Dr. Dennis P. Lavender | Associate Professor Forest Physiology Oregon State University |
| Mr. Harry Anderson | Forest Scientist - Soils Department of Natural Resources |

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The Technical Advisory Committee's specific roles in the project are the following:

1. To review work accomplished by the project personnel and to assist in determining future work programs;
2. to provide guidance and planning to help anticipate and solve problems;
3. to provide technical assistance in the development of additional research proposals;
4. and to supplement public relations work by the University by providing information about the research project and attempting to gain additional financial support.

The committee meets at the University of Washington every three months. Four meetings were held in the past year, on July 16 and October 15, 1969 and on January 15 and April 15, 1970.

In addition to the regular members, some of the meetings have also been attended by Dr. Charles B. Davey, professor of soil science and forest management, North Carolina State University, and Dr. James E. King, timber management specialist, Weyerhaeuser Research Center. This is in keeping with the general policy of expanding the Advisory Committee to include additional expertise on specific topics as the need arises.

The deliberations of these meetings fill 50 pages of minutes, and a large number of issues have been discussed. Several examples of the recommendations made by the Technical Advisory Committee in the past year are:

1. The optimum time to apply urea-nitrogen fertilizer in the region is generally between the months of January and March, the earlier applications being at the lower elevations and more southerly latitudes;
2. the cooperators should intensify their efforts to assist the project by doing some of the preliminary field work in candidate area selection, and an appropriate form should be submitted to them to facilitate this effort;
3. **In future studies, the appropriate levels of supplemental fertilizer applications in this region would appear to be:

| | | | | |
|------------|-----|------|-----|------|
| phosphorus | 100 | lbs. | per | acre |
| sulphur | 50 | " | " | " |
| potassium | 100 | " | " | " |
| magnesium | 50 | " | " | " |
| calcium | 50 | " | " | " |
| FTE | 25 | " | " | " ** |

4. Plantation stands should be treated on a regular design basis in the formulation of a thinning-fertilizer interaction study since their growth patterns are generally different from those of natural stands, especially in the early stages of stand development.

The discussions and recommendations of the Technical Advisory Committee and others are considered by an in-College executive group, which has the responsibility for the administration and execution of the project. This group consists of:

| | |
|--------------------|---------------------|
| I.F.P. Director | David P. Thomas |
| Associate Dean | Stanley P. Gessel |
| Project Supervisor | Ian G. Morison |
| Forest Biometrist | Kenneth J. Turnbull |
| Forest Pathologist | Charles H. Driver |
| Staff Forester | Steven G. Archie |

In conclusion, the Regional Forest Nutrition Research Project would never have gotten off the ground nor continued to proceed on schedule had it not been for the individual and collective support of the Technical Advisory Committee. The Institute of Forest Products greatly appreciates this assistance and will continue to solicit expert advice on project-related activities in the realization that such exchange is essential to insure the proper direction of this important research effort.

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COOPERATORS LIAISON COMMITTEE

Ian G. Morison

The Cooperators Liaison Committee of the Regional Forest Nutrition Research Project was appointed last November by Institute of Forest Products Director David P. Thomas. It is composed of one representative from each of the 28 participating organizations. It is the body through which contact is maintained between the project administrators of the Institute of Forest Products and the funding organizations.

One regular annual meeting is held each year in January at which time progress reports are presented, financial statements are made, and any aspect of the project can be discussed. Members are encouraged to ask questions, offer suggestions, make criticisms, and in general become personally familiar with the project's activities.

Other meetings of this committee can be called when some major issue must be discussed or when the course of the project might be significantly altered. All important decisions relating to project financing and development are referred to the Liaison Committee for the comment and approval of its members.

Additional efforts to keep the funding organizations familiar with current developments include the dissemination of newsletters, trade journal reprints, and personal correspondence.

The first meeting of the Liaison Committee was held on January 30, 1970, at the University of Washington. Reports were presented to members together with a range of appropriate matters for discussion by the committee. The next regular meeting is scheduled for January 29, 1971.

On the following page is a list of Liaison Committee members and the organizations which they represent.

Name

Organization

| | |
|---------------------|--|
| E. C. Scheider | Boise Cascade Corporation |
| Jerry P. Re | Borden Chemical |
| Karl E. Karlsson | Broughton Lumber Company |
| Charles Thomas | Bureau of Land Management |
| Cecil D. Sterling | Collier Carbon & Chemical Corp. |
| M. E. Switzer | Cominco American, Inc. |
| George H. Schroeder | Crown Zellerbach Corporation |
| Donald R. Hopkins | Department of Natural Resources |
| Reynold V. Dickhaus | Georgia Pacific Corporation |
| David Mote | International Paper Company |
| John P. Hendrickson | ITT Rayonier, Inc. |
| Ralph K. Stryker | Longview Fibre Company |
| William Lansing | Menasha Corporation |
| N. L. Case | Phillips Petroleum Company |
| T. J. Driscoll | Pope & Talbot, Inc. |
| Richard W. Holmes | Publishers Paper Company |
| Kurt Munnich | Scott Paper Company |
| Joe E. Monahan | Seattle Water Department |
| R. E. Wickman | Shell Chemical Company |
| A. O. Petzold | Simpson Timber Company |
| E. S. Sedlacek | St. Regis Paper Company |
| J. D. Beaton | The Sulphur Institute |
| Gilbert M. Bowe | Timber Service Company |
| Richard E. Miller | Pacific Northwest Forest and Range Experiment Station |
| Willard L. Lawson | West Tacoma Newsprint Company |
| E. C. Steinbrenner | Weyerhaeuser Company |
| Morris H. Bergman | Willamette Industries, Inc. |
| R. A. Fulton | Wilson & Geo. Meyer and Company |

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BASIC RESEARCH REPORT

Stanley P. Gessel

The Importance of Related Research

Applied research such as constitutes the major portion of the regional fertilizer program is meaningless without prior information on which to base a design and accompanying necessary investigations. Fortunately, tree nutrition research in the Northwest has had a considerable amount of the necessary prior work as already pointed out. However, there are many unsolved problems which must have attention as this field research progresses in order to enable cooperators to apply the information on their lands. The current example of concern about nitrogen pollution of the environment is an example. Unless we have information on the movement and fate of nitrogen in the forest ecosystem after application, and hopefully can clearly demonstrate that this is not a major problem, then all the response and application information we can generate will be relatively useless.

Use of essential elements in the production of forest crops can be an important tool in the continuing use of non-agricultural lands throughout the world, but only if the principles of use which involve the correct element at the correct time in correct amounts are clearly understood and followed. This regional program can only answer some aspects. The others must proceed with other points of support.

Basic Research Projects Now Being Funded

With the approval of the Cooperators Liaison Committee, project funds have been allocated to the support of three graduate student basic research projects during the present budget period, which extends from April 1, 1970 to March 31, 1971. These projects were approved on the basis that they were directly relevant to the needs of the cooperators and would provide important and timely practical information on forest fertilization.

The first project to be funded, which is already in operation, is in the general area of nitrogenous fertilizer cycling and effects in the soil biosphere. The work is being conducted by Mr. Wilfred J. B. Crane, research assistant, under the direction of Dr. Dale W. Cole, associate professor of forest soils, College of Forest Resources. The field work is being conducted primarily on the Allen E. Thompson Research Center at the City of Seattle's Cedar River Watershed.

The research objectives include:

1. The determination, quantifying, and modeling of the transformations and movement of nitrogenous fertilizer within a forest soil profile;
2. the study of ion interactions following hydrolysis of nitrogenous fertilizer;
3. the investigation of factors controlling gaseous loss of ammonia nitrogen from the soil surface;
4. the interpretation of the overall effect of elemental additions, transformations, interactions, and movement on the total environment of the soil biosphere.

The second project is scheduled to begin this coming summer and is in the general area of disease developments related to forest fertilization and thinning. This is being conducted by Mr. Berlin D. Nelson, Jr., research assistant, under the direction of Dr. Charles H. Driver, professor of forest pathology, College of Forest Resources.

The objectives of the project include:

1. Monitoring and analysis of disease conditions of plots incorporated within the cooperative fertilizer project, particularly with respect to determining the base levels of Fomes annosus infection in western hemlock stands;
2. studying the effects of nitrogen fertilization on the occurrence and progress of root rot diseases of western hemlock and Douglas-fir.

The third project is anticipated to begin in September 1970 and is in the area of design and analysis investigations for research into forest fertilization. The project director will be Dr. Kenneth J. Turnbull, associate professor of forest biometry. At this time an appropriate graduate student has not become available.

The research objectives are as follows:

1. Obtaining from existing data estimates of variance appropriate to design of fertilization trials;
2. testing the robustness of the analysis of variance and covariance models under growth study conditions where it is known that underlying assumptions are not fulfilled.

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The combined cost of these three projects during project year 02 is anticipated to be approximately \$25,000. Additional amounts necessary to support these projects will come from sources other than the regional fertilizer project. Periodic status reports on these basic research projects will be presented to cooperators.

Tree Nutrition Committee Report

On March 11, the Tree Nutrition Committee of the NW Forest Soils Council met to formulate recommendations to present to the Institute of Forest Products on appropriate basic research objectives of the project.

The following were determined to be areas of needed basic research:

1. Mineral cycling studies, including the fate of fertilizer in the ecosystem;
2. environmental effects of extensive fertilization, including pollution aspects;
3. diagnostic techniques for determining where to fertilize;
4. economics and logistics of fertilization;
5. interaction of fertilizer application with disease, insects and genetics;
6. physiological effects of fertilizer application;
7. and mensurational and statistical techniques.

It was judged that the two projects not currently under examination but of considerable importance to cooperators were numbers 3 and 4. Concerning 3, the Tree Nutrition Committee drew up detailed proposals for soil and foliar sampling and analysis based on the level of funding available.

To complete the optimum program would require additional financing from such bodies as the National Science Foundation or from grant funds such as are provided by the McIntire-Stennis program.

The State of Oregon has agreed to finance some foliar analyses to be done at Oregon State University.

Regarding number 4 above, programs for investigation into the economics and logistics of fertilization are being set up by faculty members of the College of Forest Resources, University of Washington, and personnel of the Pacific Northwest Forest & Range Experiment Station, U. S. Forest Service.

Related Research Efforts at the University of Washington and Elsewhere

The regional fertilizer research program is one of a series of integrated research programs either in progress or being initiated at northwestern educational institutions which are aimed to better understand natural ecosystems and therefore forest productivity. For instance, the Coniferous Forest Biome research of the International Biological Program has been approved for funding after July 1, 1970. This will initiate a full-scale research effort by hundreds of scientists throughout the western states. Results will be presented in models of forest ecosystems. The program is being directed from the University of Washington but will eventually involve all major western educational institutions.

The federally supported forest research program known as McIntire-Stennis has already stimulated a great deal of research in the field of forest soils and tree nutrition. More is planned at all participating institutions as total research develops more specific focus. Already the College of Forest Resources has spent about \$50,000 of McIntire-Stennis funds on tree nutrition research. In addition, the Botany Department at the University of Washington continues to have an interest in this field and has at least one graduate student working in this area every year.

Early contributions of this work at the University of Washington were that all native species could be grown under a variety of controlled conditions and all readily demonstrated essential elemental needs. Judgment on foliar elemental levels for normal growth and use of foliar analysis as a diagnostic technique were logical outcomes of this work.

Research on properties of forest soils related to mineral uptake, especially nitrogen studies, has received much attention and has been most helpful in planning the present study as well as providing a starting point for additional basic research. The current research program in mineral cycling in forest ecosystems has many applications to practical tree nutrition, including potential fertilizer pollution. Ultimate nutrient needs of forests under intensive harvest systems will also be partially answered by this program.

The large number of fertilizer field trials established by the College of Forest Resources have provided early and continuing evidence of the field response of forest trees to elemental additions. The large

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array of plots and the combination of elements used clearly demonstrated the dominant effect of nitrogen and formed the basis for recommendations of fertilizer treatment and levels in the present cooperative project. Numerous papers and two Institute bulletins have been published giving results of this work. A third bulletin updating growth response on all plots is now being prepared.

Washington State University has had a continuing interest in forest fertilization, having cooperated extensively on many aspects of forest soils research. Through the Western Washington Experiment Station at Puyallup various programs on fertilizer research have been established. A number of years ago a series of fertilizer plots were established throughout southwestern Washington by individual tree farmers. Dr. Paul Heilman, research scientist at Puyallup, has just completed a study of growth on these plots. This information is most valuable as it includes Douglas-fir response on better sites and under a range of management conditions.

Industrial forest owners and governmental land agencies have also been active in forest tree nutrition and forest fertilizer research. Among others, both Weyerhaeuser Company and Crown Zellerbach have conducted extensive laboratory fertilizer research. In addition, they have expansive field research and operational experience in the use of nitrogen fertilizers. Methods of application have rapidly advanced under the stimulus of this research. The wide range of forest conditions and management practices involved in much of this field application will make the results extremely valuable in additional assessments of the role of fertilizer amendments in forest production.

The Department of Natural Resources of the State of Washington and the United States Forest Service are making similar contributions to the advancement of this field. Their work involves field plot testing under a variety of conditions and some operational applications.

THINNING - FERTILIZER STUDY PROPOSAL

Ian G. Morison

As was indicated earlier in this report, the original project proposal included a study of thinning and fertilizing together as part of the design. This was intended to help determine the independent effects of each and any interactions which might occur where both were used together.

It also proposed studies of growth response to other nutrient elements besides nitrogen, although it did not include funding for them. This original design required an annual funding of \$100,000 as a minimum. When only \$74,000 was tentatively committed to the project in March 1969, a meeting of representatives of those organizations who had made this commitment was called, and it was agreed that, if no additional support was forthcoming, the thinning fertilizer study which represented about one quarter of the total number of plots should be eliminated. Thus, the project would proceed with the fertilizer-only trials.

Following the announcement to proceed on this basis, several organizations, realizing the importance of the thinning-fertilizer study, indicated their willingness to make additional funds available for this component.

This matter was brought forward at the Liaison Committee meeting in January 1970, and there was general agreement among the members that this study was most desirable and that they would urge their organizations to financially support it.

The committee then asked the Institute project administration to draw up a proposal and budget to cover both the thinning-fertilizer study and the supplemental fertilizer study and to present it for consideration in the period from July to September 1970.

A large amount of work has been put into the preparation of this proposal, and it is in an advanced form and will be presented on schedule. The time table then calls for obtaining commitments to participate during the period from September to December 1970 and making a decision on whether or not to proceed in January 1971. If the decision is made to proceed, the contractual agreements would be completed by March 1971, and field operations would commence in June 1971.

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BUDGET REPORT

Project Year 01 (April 1, 1969 - March 31, 1970)

David P. Thomas

A total of \$76,000 was contributed to the support of the project during the first year's operation. The actual field expenditures during this period are as follows:

| | |
|----------------------------------|--------------|
| Salaries and wages | \$34,272 |
| Employee benefits | 4,113 |
| Supplies, equipment and services | 8,705 |
| Travel | 12,420 |
| Indirect costs | <u>8,339</u> |
| TOTAL | \$67,849 |

During this period, an additional total of \$870 was spent on the graduate student research component. This amount was quite small in comparison to the field component because it was the desire of the Institute of Forest Products to present the basic research proposals to the Liaison Committee at its annual meeting in January before funding was authorized.

The combined sum of the field and graduate student research components is \$68,719. Since \$76,000 was available during Project Year 01, the residual amount is \$7,281. This will be carried over into Project Year 02 and set aside for the support of pertinent graduate student research as approved by the Liaison Committee.

REGIONAL FOREST NUTRITION RESEARCH PROJECT

Organization Chart

