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FOREWORD

In April of 1953 the Lake States Forest Tree Improvement Committee was formed, following a regional conference sponsored by the Lake States Forest Experiment Station. Since that time there has been a marked increase in the amount of tree improvement work done in this region, and the Committee has performed a valuable service in encouraging and coordinating such activities.

Since that first conference, the Lake States Forest Tree Improvement Committee has conducted regional tree improvement conferences biennially. For each conference there has been a proceedings, and the Station has published each of them. We are happy to continue this contribution to the Committee's success and to publish the 1963 Proceedings, thus marking a decade of the Committee's activity.

M. B. Dickerman, Director
Lake States Forest Experiment Station*

* Maintained by the Forest Service, U.S. Department of Agriculture, in cooperation with the University of Minnesota.

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ACKNOWLEDGMENTS

The Sixth Lake States Forest Tree Improvement Conference culminated a decade's activity of the Lake States Forest Tree Improvement Committee. It provided the 125 registrants an opportunity to get some up-to-date information on tree improvement and related matters through the papers presented on the first half day, the field trips for the succeeding day and a half, and through numerous informal contacts throughout the two days. The Conference served as the technical session for the Upper Mississippi Valley Section of the Society of American Foresters' fall meeting. It also provided the time and facilities for a meeting of the Tree Improvement Committee (NC-51) of the North Central Land Grant Colleges.

The Proceedings makes a record of the Conference available to all. The Committee hereby extends its thanks to the Lake States Forest Experiment Station for publishing this and past Proceedings.

The Committee members, both past and present, desire to express special recognition for the untiring effort and hard work faithfully carried out by Paul O. Rudolf. His counsel and chairmanship in the organization and direction throughout the first two years, and continued effort since then as our Executive Secretary have earned him our sincere thanks for a job well done.

To plan, arrange, and conduct a Conference such as this is a lot of work. On behalf of the Committee, I should like to thank all who helped in the task. Scott Pauley was Program Chairman. He was assisted by a number of people, of whom the following merit special mention: William Cromell and William Matalamaki of the University of Minnesota North Central Experiment Station, M. J. Latimer of the Blandin Paper Company, and Robert Buckman of the Lake States Forest Experiment Station. I should like to express appreciation also to the officers and members of the Upper Mississippi Valley Section of the Society of American Foresters (particularly those of the Northwest Chapter) who joined with us in one of the best attended of our Regional Tree Improvement Conferences; to Roger Bay, Lake States Forest Experiment Station, who was toastmaster at the banquet; to Ernest Swift, who gave the banquet address; to Dr. Wolfgang Knigge, who prepared a paper for the conference but was forced by illness to return to Germany before he could meet with us; to all those who participated in the technical program; and to all those who came from other regions to meet with us. All contributed to the success of the Conference.

F. J. HODGE, Chairman
Lake States Forest Tree Improvement Committee

FOREST TREE IMPROVEMENT IN THE LAKE STATES 1953 - 1963

by

Paul O. Rudolf[1]

Nineteen fifty-three represented a turning point in forest tree improvement activities in the Lake States. True, there had been activity in this field for a number of years by several agencies in the region. But, up to that time, there had been little formal recognition of forest tree improvement either by research or administrative agencies. Prior to 1953, a number of groups had carried on such work as seed-source studies, the planting of exotics, and other such activities as parts of regeneration or related work. Except for one unsuccessful controlled pollination series made by the Lake States Forest Experiment Station in 1928, only the University of Wisconsin had actually begun work directly aimed toward tree breeding activities.

In the early spring of 1953, the Lake States Forest Genetics Conference was held at Eagle River, Wis. This meeting, which was actually the first Lake States Forest Tree Improvement Conference, was planned and sponsored by the Lake States Forest Experiment Station, but the response indicated widespread interest in and awareness of the importance of forest tree improvement. All agencies within the region that were known to have some interest in tree improvement had been invited to attend, and there were representatives of the Universities of Michigan, Minnesota, Wisconsin; Michigan State University; Beloit College at Appleton, Wis.; the Conservation Departments of Michigan, Minnesota, and Wisconsin; several forest industries; the Forest Products Laboratory; the North Central Region of the U.S. Forest Service; and the Lake States Forest Experiment Station. In addition, there were a number of distinguished visitors from regions outside the Lake States. This group assembled, took a look at what had been done in the past in the general field of forest tree improvement in the Lake States, and then made suggestions for activities in the future.

SETTING THE STAGE - THE SITUATION IN 1953

Although the term had scarcely been heard in the region prior to 1953 a solid basis for advancement of forest tree improvement in the Lake States had been built. A brief rundown by agencies shapes up about like this:

1/ Research Forester, Lake States Forest Experiment Station, St. Paul, Minn., and Executive Secretary, Lake States Forest Tree Improvement Committee.

The Lake States Forest Experiment Station, under the leadership of Carlos Bates and the encouragement of its Director, Raphael Zon, began seed-source studies in 1928. Up to 1953 the Station had made seed-source studies of eight forest tree species and field tests of a score of exotic tree species. It had made some early attempts at breeding sugar maple, had field-planted 31 hybrid poplars, and had assembled 10 hybrid pines for field testing. These tests had demonstrated racial variations in red pine, Scotch pine, ponderosa pine, white spruce, Norway spruce, and green ash. They had illustrated the unsuitability of a number of hybrid poplars for the region, and they had emphasized the need for replication of field tests in a number of localities to avoid unpredictable losses. Results of the studies had been issued in 25 publications.

The University of Wisconsin began breeding forest trees for disease resistance under the direction of Dr. A.J. Riker in 1935 and started a program directed by R.A. Brink in the Genetics Department in 1948. Up to 1953 more than 220 eastern white pines had been selected and tested for blister rust resistance. In addition, more than 400 poplar selections were under test in various places for growth and resistance to diseases caused primarily by *Septoria*, *Cytospora*, and *Hypoxylon*. Several hundred additional trees had been selected to test the progeny for special traits and to build up breeding collections. Controlled pollination, particularly of red pine, had been undertaken, and specialized studies of vegetative propagation and flowering had been started preparatory to developing seed production areas and seed orchards in cooperation with the Wisconsin Conservation Department.

At the University of Minnesota, T. Schantz-Hansen in 1939 began a rangewide seed-source study of jack pine involving 38 sources. (Tests of exotic tree species had begun about 15 years earlier.) In 1947 work was started on poplars and involved about 150 selections, including a number of hybrids that were being field tested. Work was also underway to test various species and selections of elm for hardiness and resistance to the Dutch elm disease and phloem necrosis. Finally seed had been collected for a blue spruce seed-source study in the hope of finding trees hardy in Minnesota and resistant to *Cytospora* canker.

At Michigan State University Professor Bogue began testing exotic tree species about 1904. This was followed later on by trials of hybrid poplars, the breeding of nut-producing trees, and the study of variation in sap production by sugar maple trees.

The University of Michigan began a program of developing chestnuts resistant to the chestnut blight in 1930, under the direction of Dow V. Baxter. The testing of exotic tree species had begun under Filibert Roth in 1904. Studies that followed concerned the testing of ponderosa pine for resistance to a Cronartium rust, the development of a Norway spruce strain resistant to the spruce gall aphid, and the testing of various European strains of Scotch pine.

In 1948 the Nekoosa-Edwards Paper Company, under Robert Dosen's direction, began the cross-pollination of local central Wisconsin jack pines with lodgepole pine pollen from California and field-planted progeny in 1951-1953. In 1950, under B.L. Berklund's direction, they assembled seed of 25 sources each of red pine and jack pine for a regional seed-source study.

At Beloit College in Appleton, Wis., Philip N. Joranson in 1952 initiated a project for breeding native aspens. It was aimed primarily at locating and developing polyploid individuals of quaking aspen and bigtooth aspen in the hope that they would yield more and larger fibers than normal diploid trees.

Most of the research projects mentioned had been aided by cooperators such as the state conservation departments, some pulp and paper companies, and the National Forests.

FORMATION OF THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE

The Lake States Forest Genetics Conference at its conclusion on April 1, 1953, unanimously adopted a set of resolutions, the first of which was as follows: "That there be established a Lake States Forest Tree Improvement Committee for the purpose of encouraging and coordinating forest genetics activities in this region. That a nominating committee, consisting of Messrs. M.B. Dickerman, R.A. Brink, E.J. Adams, and J.B. Millar, appoint a 6- to 10-man tree improvement committee representative of the interested agencies, geographical areas, and subject matter interests in the region."

The initial committee consisted of nine members representing three state conservation departments, four universities, forest industry, and the Lake States Forest Experiment Station. Two years later membership was enlarged to 14, at which number it has remained. The additional five members were representatives of the Forest Products Laboratory, the North Central Region of the U.S. Forest Service, the Institute of Paper Chemistry, and the fields of forest entomology and forest pathology (see Appendix I).

To carry out the mandates issued upon its inception, the Lake States Forest Tree Improvement Committee has operated on three broad fronts; preparation of guides, convening of regional conferences, and periodic dissemination of news (see Appendix II).

1. At the outset, there appeared to be a need for guides that might foster comparability in the conduct of certain tree improvement activities in the region. Accordingly several subcommittees were formed, each charged with a specific task. These groups prepared and had published an annotated bibliography of forest genetics in the Lake States, a guide for selecting superior trees and stands in the Lake States, a delineation of forest tree seed collection zones for the Lake States, a survey of forest tree improvement activities in the region, suggestions for registering and marking selections in the Lake States, and a survey of forest tree seed certification activities in the United States with suggestions for application in the Lake States.

2. Biennial tree improvement conferences have been held in 1955 at Wisconsin Rapids, Wis.; 1957 at Grand Rapids, Minn.; 1959 at Ann Arbor, Mich.; 1961 at Rhinelander, Wis.; and again at Grand Rapids, Minn. in 1963. These conferences have provided opportunities for those engaged in forest tree improvement research to report briefly on what they have done and what they have learned and to compare notes with other workers, and for those interested to learn the status of such research in the Lake States and to point out problems needing study. The conferences have been attended by from 60 to 150 people. In addition to work within the Lake States, tree improvement activities have been reported by speakers from the Northeast, California, the South, the Central States, the Pacific Northwest, and Canada.

3. A newsletter, Lake States Trebredinews, has been issued annually and now has a mailing list of about 300. It carries between-conferences news of tree improvement activities of all Lake States agencies, notices of important meetings, interim reports on subcommittee activities, and tree improvement items from other regions.

THE NC-51 COMMITTEE

In October 1958 representatives of several land grant colleges in the North Central Region met to discuss the advisability of developing a regional project in forest tree improvement. Such a project was subsequently formulated and approved.

The technical committee guiding the project (designated NC-51) operates under an organizational framework developed by the Cooperative State Experiment Station Service (CSESS) of the U.S. Department of Agriculture. One of the State Agricultural Experiment Station directors or assistant directors acts as advisor. In addition to the State Agricultural Experiment Station members, and the CSESS representative, a member of the U.S. Forest Service also is on the Committee (see Appendix III). Federal cooperative regional research funds are made available to the participating state experiment stations to supplement state funds in support of the work.

The Committee meets annually at which time it discusses and acts on studies proposed for inclusion in the regional project, hears progress reports from the various participants in the approved studies, and plans an annual report to the directors. Present approved studies all concern seed-source investigations. One station acts as a leader for a given study. Its representatives assemble seed, grow stock, prepare work plans, and distribute stock. Such other stations as wish to participate can obtain stock and can (but need not) follow the initiating station work plan. The initiating station is expected to take the lead in preparing regional reports, but other participating stations may make analyses and report upon their own data as they see fit.

Current (1963) approved racial variation studies under the regional tree improvement project are as follows, listing the initiating station first (* = poor survival; ** = failure): Scotch pine (Mich., Ill., Ind., Kans., LSFES, Minn., Mo., Nebr., Wis.), Austrian pine (Mich., Ill.*, Ind.*, Ia., Kans., Minn.**, Nebr., Wis.**), red pine (Mich., Ind., Kans., Minn., Nebr., Wis.), eastern white pine (Mich., Kans., Minn.), red oak (Ohio, Ill., Ind., Kans., Minn., Nebr., Wis.), Japanese larch (Mich., Ill., Ia., LSFES, Minn., Nebr., Wis.), tamarack (Minn., LSFES, Mich., Wis.), Douglas-fir (Mich., Ind., Kans.**, Minn., Nebr., Wis.), grand fir (Mich., Ind., Kans.**, Minn., Wis.), and white fir (Mich., Ind., Kans.**, Minn., Wis.). Some of these cooperators are doing related work on other species or on material of the listed species that is in addition to the regional project material. In addition, studies have been approved for the following species, and seed collections for them have been started or arranged: balsam fir (Wis.), ponderosa pine (USFS, Nebr.), and eastern cottonwood (Ill.).

A DECADE'S DEVELOPMENT

Since 1953 there has been substantial progress in forest tree improvement in the Lake States. Most of the agencies that were engaged in such work then have increased their staffs, facilities, and projects, and some additional agencies have entered the field. Perhaps this can best be summarized first by agency and then by field of work.

The Agencies Doing Forest Tree Improvement Work in the Lake States

Lake States Forest Experiment Station.--In 1954 the Station received its first allotment of funds definitely earmarked for forest genetics research. The following year Hans Nienstaedt, a trained geneticist, joined the staff and has since become leader of the Station's genetics project. A field center was established adjacent to the Hugo Sauer State Nursery near Rhinelander, Wis., and the first building was dedicated in 1957. Facilities now available at the Institute of Forest Genetics at Rhinelander include two buildings with office space for a dozen scientists and their supporting personnel, several well-equipped laboratories, four growth control chambers, four greenhouse sections (20' x 50') with automatic controls and necessary headhouse facilities; a lath house; cold frames with bottom heating; and good nursery facilities. Reserved outplanting sites are available on the nearby Nicolet National Forest and on all the other National Forests of the Lake States. Within a few miles, trees of almost all species native to the northern Lake States are available for study and as a source of materials.

The Institute is responsible for the basic forest genetics research of the U.S. Forest Service in the northeastern quarter of the United States and for applied genetics research within the Lake States. First emphasis has been placed on improvement of the spruces, and similar work recently has been started on the birches.

The Institute has been given national responsibility for radiation-genetics studies to be conducted by the U.S. Forest Service and has prepared a site for a radiation facility to be established under the approved standards of the Atomic Energy Commission. Some radiation studies are already underway in cooperation with the Brookhaven National Laboratory.

In 1961 the second Pioneering Research Unit in the Forest Service was established at Rhinelander, with Philip R. Larson in charge. He will devote full time to physiological studies of wood formation.

In 1962 the Station assigned a full-time scientist (David Dawson) to tree improvement studies in the Northern Great Plains with headquarters at the Shelterbelt Laboratory in Bottineau, N. Dak. Initial studies largely concern variation in conifers of possible use in northern plains shelterbelts. Currently, the Station has six scientists assigned full time to tree improvement research.

University of Wisconsin[2/].--The program at the University of Wisconsin was already well established in 1953 and was receiving substantial financial support from the Wisconsin Conservation Department. During the past decade, however, studies were expanded to search also for insect-resistant trees and for resistance to the cedar-apple rust, oak wilt, and maple blight. A summer field headquarters was established in 1954 near Sayner in northeastern Wisconsin with WCD support. Nursery facilities are available at Conservation Department Nurseries, particularly at Wisconsin Rapids and Trout Lake.

Currently, five scientists are devoting full or part time to tree improvement studies. Reduction in Conservation Department financial support has curtailed expansion of the work for the present.

University of Minnesota[2/].--In 1954 the School of Forestry made plans to add forest genetics to its curriculum, and in 1955 Scott Pauley came from Harvard University to head up the program. In 1955 also the Blandin Foundation gave the University a grant of funds for forest tree improvement work. The first formal course in forest genetics was offered in the fall of 1956. Nursery facilities were provided at the North Central Experiment Station and in the nursery of the Blandin Paper Company near Grand Rapids. Outplanting facilities were developed at the Gunn Memorial Park near Grand Rapids and on state-owned land near Grand Rapids, St. Paul, Rice Creek, and elsewhere.

Resources for the Future, Inc. made a grant to the University for the 1956-57 academic year to strengthen graduate training in forest genetics.

Beginning in 1956 staff members in entomology and plant pathology began to study variations in insect and disease development in jack pines of diverse seed origins.

Currently, one staff member is devoting full time to forest genetics work, and five graduate students are working on tree improvement problems in residence and five *in absentia*.

2/ A special function of the Universities is to train scientists, and the universities in the Lake States during the past decade have awarded a considerable number of M.S. and Ph.D. degrees to students specializing in forest genetics and in related fields. Because information from the various schools was given in varying ways, no attempt has been made here to present separate statistics for each one.

University of Michigan[3/].--In 1954 the School of Natural Resources initiated graduate training in forest genetics, with emphasis on the silvical aspects of tree improvement. The University added a course in forest genetics in 1959. They have developed outplanting sites at the University's Biological Station at Douglas Lake and on University properties near Ann Arbor. Currently, one staff member is devoting full time to tree improvement work and some graduate students are doing research in this area.

Michigan State University[3/].--In 1957 Jonathan Wright came to Michigan State University from the Northeastern Forest Experiment Station and initiated both graduate and undergraduate courses in forest genetics. With his arrival the University launched an ambitious program concerned primarily with racial and individual tree variation and statistical bases for determining plot size for tree improvement research.

MSU has a nursery devoted primarily to growing tree improvement stock, has developed outplanting sites on college properties such as the Kellogg, Ruse, and Dunbar Forests, on several state forests, and on some National Forest land.

Currently, one professional staff member is devoting full time to tree improvement work, four others are devoting part time, and four graduate students are carrying on research in this field.

Institute of Paper Chemistry.--In 1954 the Institute initiated a forest tree improvement research program and brought in Philip N. Joranson to continue and expand the program he had started at Beloit College. Since then the Institute has added specialists in plant physiology and cytology to its staff, established laboratory and greenhouse facilities, and developed several outplanting sites on the lands of cooperating industries and of public agencies.

In 1961 Dr. Joranson left the Institute and Dean Einspahr assumed direction of the forest tree improvement program. Presently three full-time scientists are carrying out the research work dealing primarily with the aspens in the North and southern pines in the South.

3/ See footnote 2 on page 7.

Forest Products Laboratory.--Although the Laboratory planned a study on the causes of bird's-eye figure in sugar maple in cooperation with the Lake States Forest Experiment Station in 1928 (and since reactivated), its active tree improvement research program really began in 1958. Since the Laboratory is a national institution, much of its research concerns localities and species of no direct interest to many people in the Lake States. Some studies, however, deal with species native to the Lake States, and basic research on other species may have applicability here also. It initiated a program for obtaining wood quality data from Forest Survey plots as they are established.

The Laboratory has highly specialized facilities for studying wood structure, especially from small wood samples. Currently four scientists are spending full time on research related to tree improvement under the direction of Harold L. Mitchell.

Nekoosa-Edwards Paper Company.--In continuation of work started earlier, the company field-planted additional jack pine-lodgepole pine hybrids from its own pollinations in 1954 and established its own seed-source studies in 1954 and subsequent years. Currently one technical man devotes part time to these studies. The company has its own nursery and outplanting sites.

Consolidated Water Power and Paper Company.--Under John Macon's direction, the company in 1950 and again in 1956, made selections in white spruce transplant beds of the company nursery and field-tested the progeny on their own outplanting areas. Currently, one technical man spends part time on tree improvement work.

Quetico-Superior Wilderness Research Center.--Under C. E. Ahlgren's direction, the Center began a series of vegetative propagation tests in 1952 aimed specifically at tree improvement objectives. Since then it has also conducted work on flower stimulation, controlled pollination, blister rust resistance, and seed orchard development. The Center has its own outplanting areas and has made them available to cooperators. It has had the use of greenhouse facilities on the Duluth Campus of the University of Minnesota. Currently, one technical man spends part time on tree improvement projects.

Minnesota Conservation Department.--In 1962 the Forestry Division established, under Emil Kukachka's direction, a study of factors affecting cone production in white spruce and red pine; the Lake States Forest Experiment Station is a cooperator in this study. Currently, about four technical men spend part time on the project.

Tree Improvement Research Work by Subject Matter Categories

To give a bird's-eye view of tree improvement activities in the region since 1953, I have grouped them into five broad classes suggested by Scott Pauley several years ago. Needless to say, the coverage cannot be detailed or complete in the space available, but it should provide a reasonably accurate impression of what has been and is being done.

Selection and Testing of Variation.--Logically a high proportion of the tree improvement studies initiated in the Lake States since 1953 are concerned with selection and variation. Most numerous are studies of varying scope and intensity on natural variation within speeies. They concern such species as jack pine (LSFES, U. Minn., U. Mich., MSU, NEPCo, WCD, MPP, Mn CD, Mh CD)[4/], red pine (NEPCo, MSU, UW, U. Minn.), eastern white pine (LSFES, MSU), Scotch pine (LSFES, MSU, U. Mich., U. Minn., UW), ponderosa pine (LSFES, MSU), Austrian pine (MSU, U. Mich., U. Minn., UW), limber pine (MSU), Virginia pine (MSU), white spruce (LSFES, MSU, U. Minn., NEPCo, CWPP), black spruce (NEPCo), red spruce (LSFES), blue spruce (LSFES, U. Minn.), Siberian spruce (LSFES), balsam fir (UW), tamarack (U. Minn.), Japanese larch (LSFES, MSU, U. Mich., U. Minn., UW), Siberian larch (LSFES), European larch (IPC, MSU, U. Mich.), eastern hemlock (LSFES), Douglas-fir (MSU), paper birch (U. Minn.), and red oak (MSU, U. Minn., UW). A high proportion of this research involves racial variation or seed-source studies. An increasing number of studies, however, are designed to assess variation among individual trees within a species. This is a necessary forerunner to intelligent breeding work.

An increasing number of studies, however, concern variation induced by recombination or mutation. Included are a number of studies to locate and analyze natural hybrids and to develop interspecific hybrids. These involve several species of spruces (LSFES, U. Minn.), pines, both soft and hard (MSU, UW), birches (U. Minn., LSFES), aspens and other poplars (U. Minn., UW, IPC), and elms (U. Minn.). Some of the poplar trials have already yielded F_2 and F_3 generations. Other controlled pollinations have been made within species, primarily in white spruce (LSFES), black spruce (LSFES), Norway spruce (UW), red pine (UW), jack pine (LSFES), and eastern white pine (UW). Included among these trials are a number of tests of selfing. Knowledge of self-compatibility or incompatibility is, of course, of prime value in such diverse activities as developing seed orchards and establishing pure lines for breeding purposes.

4/ Abbreviations for agencies are as follows: CWPP = Consolidated Water Power and Paper Co., FPL = Forest Products Laboratory, IPC = Institute of Paper Chemistry, LSFES = Lake States Forest Experiment Station, Mh CD = Michigan Conservation Dept., Mn CD = Minnesota Conservation Dept., MSU = Michigan State University, NEPCo = Nekoosa-Edwards Paper Co., QSWRC = Quetico-Superior Wilderness Research Center, USARS = U.S. Agricultural Research Service, U. Mich. = University of Michigan, U. Minn. = University of Minnesota, UW = University of Wisconsin, WCD = Wisconsin Conservation Dept.

The study of mutations is just getting underway in the region. The bulk of the work is being done with jack pine (LSFES). Involved so far are determinations of naturally occurring mutations among plants grown from seed (1) from untreated normal trees, (2) produced in witches brooms, and (3) subjected to X-rays. Other material is under study after exposure to Cobalt-60 irradiation. Related work includes controlled crosses between jack pines grown from X-rayed seed and the use of irradiated pollen in controlled pollinations on white spruce.

Utilization of Selected Variants for Planting.--A major practical application of tree improvement is to utilize selected and specially bred material in forestation work. This may involve either vegetatively propagated clones or seeds from specially treated and cultured areas or both. The practical use of clonal lines in this region is limited largely to aspens and poplars. Research in the use of such material is being pursued by several agencies (U. Mich., U. Minn., MSU, IPC, UW).

A highly encouraging development during the past few years has been the establishment of seed production areas by several agencies. In 1959 the Wisconsin Conservation Department began acquiring and setting aside superior red pine stands for seed production purposes, and shortly thereafter the U.S. Forest Service began similar activities. These selected stands have been cultured to remove undesirable trees and give the selected trees abundant growing space. Since then the Minnesota Conservation Department and several industries have followed suit. There are now in the Lake States 23 established seed production areas, involving about 900 acres of land and with a potential annual production of 3900 bushels of cones (see Appendix IV). The number of established and treated seed production areas includes 14 red pine, 7 white spruce, and 2 eastern white pine. In addition several other areas have been selected but have not yet been completely treated for seed production purposes; these include some for jack pine and black spruce.

The next step, the development of seed orchards, has also been initiated. The University of Wisconsin established a grafted red pine seed orchard for the Wisconsin Conservation Department in 1955 and has continued this activity in subsequent years. The U.S. Forest Service has also begun the development of grafted red pine, black spruce, and white spruce seed orchards, several of which will be established by 1967. Michigan State University has initiated the development of seedling red pine seed orchards in cooperation with the U.S. Forest Service and the Michigan Conservation Department (Appendix IV).

As increasing amounts of seed become available from seed production areas, seed orchards, and other sources where the ultimate geographic origin or the parentage are known, there will be more and more need to identify such seed. So long as the seed does not enter commerce, a records system that satisfies the needs of the producer-user is all that is necessary. If, however, the seed does enter commerce some method of certification by a reputable organization or a legally constituted agency may be required. For this reason the LSFTIC Seed Certification Subcommittee has been developing guidelines that will be available if and when forest tree seed certification is needed in the Lake States. It has been cooperating with a national committee of the Society of American Foresters in this endeavor.

Application of Genetics in Silviculture and Management of Naturally Reproduced Stands.--I am aware of no premeditated applications of genetics in the handling of naturally reproduced stands. The simplest and most direct applications obviously come through artificial regeneration. Nevertheless, I suspect that something has rubbed off on the rather large number of forest managers in the region who have helped in the search for superior trees and who have marked and cut seed production areas. I would guess that closer attention is now given to such features as stem form, branch angle, branch thickness, and relative crown width (along with the standard features of size and vigor) in selecting crop trees or potential crop trees.

Fundamental Genetics Studies.--It is natural that the forest tree improvement work first initiated in the Lake States should emphasize variation and selection since they provide the basis for genetic improvement. Eventually, however, continued good progress requires that we know the "why" of the improvement we get or fail to get. We should know something about the mode of inheritance, the reaction range, the taxonomy, and the evolution of the species with which we deal.

Some of these fundamental studies have been started and have provided evidence of such facts as these: (1) the probable manner in which the closed-cone and open-cone character is inherited in jack pine (Univ. Minn.), (2) modes of inheritance of sex and photoperiodic response in Populus (Univ. Minn.), (3) the heritability of seed coat color in Austrian pine (Univ. Wis.), (4) the probable method of inheritance of resistance to winter injury in lodgepole pine-jack pine hybrids (LSFES), and (5) the heritability of forking in forest trees (Univ. Wis.).

Studies of natural hybrids between paper birch and bog birch and between black spruce and white spruce (Univ. Minn.) are yielding some information on experimental taxonomy. Furthermore, collections have been started of all spruce species (LSFES) and all elm species and varieties in the world (Univ. Wis.); this material should add information of taxonomic value. As progeny from recent controlled pollinations develop, more information on the nature of species will become available.

Current studies have not yet yielded much information concerning the evolution of our Lake States forest tree species. However, as comprehensive racial variation studies begin to provide data on the performance of sources within species, valuable clues to the migration history and evolution of several species should develop to supplement other data from pollen profile and geological research.

Supporting Sciences and Special Techniques.--Although genetics is the keystone of tree improvement, work in several other sciences also is required. Mostly involved are the botanical sciences, but zoology and biometry also make important contributions.

Many of the studies in this category undertaken during the past decade in the Lake States concern plant physiology. Among them are: (1) effects of photoperiod on springwood-summerwood growth of red pine (LSFES), fall grafting of spruce (LSFES), growth of northern conifers in southern and northern nurseries (LSFES, U. Minn.), breaking of bud dormancy in white spruce (LSFES), incidence of lammas growth and prolepsis in jack pine (U. Minn., LSFES), and response of paper birch of various seed origins (U. Minn., LSFES); (2) effects of growth substances (such as gibberellic acid and auxins) on growth, wood properties, and flowering of some hardwoods and conifers (IPC, LSFES); (3) effects of chilling on fall grafting and breaking of bud dormancy in white spruce (LSFES); (4) the anatomical and biochemical changes related to rooting behavior of stem cuttings (IPC); (5) the effects of interspecific and intergeneric grafting, phloem inversion, and mechanical treatments on primary growth and flowering of forest trees (QSWRC, UW); (6) the effectiveness of vegetative propagation techniques such as grafting, budding, stem cuttings, stem splitting, root cuttings, and air layering for reproducing pines, elms, basswood, bird's-eye maple, hackberry, and aspens (MSU, U. Mich., U. Minn., UW, LSFES); (7) the phenology of white spruce from flower initiation to seed production (LSFES); and (8) a study of the physiological bases for vegetative reproduction (LSFES).

A number of cytological studies have been initiated. These have largely concerned the location of triploid aspens (IPC) and polyploid black and white spruces (U. Minn.), the determination of the probable makeup of natural birch hybrids (U. Minn.), and the relation of external appearance to meiotic stages in male spruce flowers (U. Minn.).

It is extremely important to know when the flower primordia are first formed, if treatments to stimulate flowering can be assured of success. (Obviously, treatments made after the die is cast can have little real influence.) Two studies of this nature are underway, one for red pine (UW, U. Minn., LSFES), and one for white spruce (LSFES).

The major end product of most forestry enterprises still is wood. Many tree improvement practices are aimed at increasing the quantity of wood produced. But wood quality also is highly important, and a variety of qualities are required for different products. A number of research projects concerning wood quality are active in the Lake States. They include studies to determine (1) the anatomical, chemical, and physical properties of aspen wood from small samples (IPC), (2) variation of wood qualities between and within aspen clones (IPC), (3) variation in and heritability of specific gravity and other wood characteristics according to seed origin in red pine, white ash, and various species and hybrids of poplars (FPL), (4) springwood-summerwood transition in red pine (LSFES), and (5) auxin-summerwood relationships in red pine (LSFES).

Disease resistance in forest tree species in the Lake States is also being studied. Included are artificial inoculation tests. The aim is to improve the resistance of the more important species to serious diseases. Studies underway concern resistance of white pine to the blister rust fungus (QSWRC, UW, LSFES), jack pine to the eastern gall rust and other rusts (U. Minn., UW), American elm to Dutch elm disease (U. Minn., UW), eastern redcedar to the cedar-apple rust (UW), poplars to Hypoxylon, Septoria, Dothichiza, and Napicladium cankers (UW), oaks to oak wilt (UW), and sugar maple to maple blight (UW). Many of these studies are aimed at screening young seedlings for resistance. A special study aims to determine racial variation within the blister rust fungus (LSFES).

Several other supporting studies are in the realm of ecology, entomology, and biometry. These include studies of (1) the relative effects of site and heredity on the volume and quality of wood produced by diploid and triploid aspens (IPC), (2) selection of poplars resistant to the poplar weevil (UW), (3) effect of fertilizers on the ability of pines to withstand insect attacks (LSFES), (4) effects of insects on cone production (LSFES), (5) variation in insect attacks according to seed origin in jack pine (U. Minn., UW, LSFES), and (6) the most efficient plot sizes and shapes for use in forest genetics field tests (MSU, U. Minn.).

Tree improvement work involves the use of many special techniques. A number of studies have been made in the Lake States during the past decade to test and improve such techniques. Included are tests of (1) various field and bench grafting techniques for conifers (QSWRC, LSFES, UW, U. Minn.), (2) vacuum and other methods of storing tree pollen (USARS, U. Minn.), (3) extended photoperiod to grow northern conifers in southern nurseries (LSFES, U. Minn.), (4) various types of bags for pollination use (LSFES), (5) seedling propagation methods for aspens (U. Minn.), (6) pine pollination techniques (UW), (7) methods of propagating conifers from cuttings and leaf bundles (LSFES, UW), (8) paper chromatography for sexing mature aspens (U. Minn.) (9) tissue culture of Lake States trees (LSFES, IPC), and (10) the development of a small aerial camera to take color photos to help delineate aspen clones (U. Minn.).

Activities of Action Agencies

In addition to the research activities in the region a number of agencies are applying tree improvement practices on their own lands or are facilitating research work by providing land, stands, planting stock, funds, or other materials to research agencies. Some examples of such activities are as follows:

1. The Wisconsin Conservation Department gave financial support to much of the tree improvement research conducted by the University of Wisconsin and also supplied land, stock, and nursery facilities, and built field stations to aid this work. It also provides nursery facilities to the Lake States Forest Experiment Station, and has assisted several agencies in obtaining tree seed.

2. The Michigan Conservation Department has provided outplanting sites and collected seed for Michigan State University and the Lake States Forest Experiment Station, and provided some financial support for genetics research at Michigan State University.

3. The Minnesota Conservation Department has provided outplanting sites to the University of Minnesota, and planting stock and seed to the University of Minnesota and the Lake States Forest Experiment Station. Many of its field men have been trained by Lake States Station specialists in selecting superior trees and have reported such trees.

4. The National Forests have provided outplanting sites, stock, and seed to the Lake States Station and Michigan State University and have given their men training in recognizing superior trees and stands and in tree climbing.

5. Several forest industries (Kimberly-Clark, Marathon Division of American Can Company, Mosinee Paper Co., Rhinelander Paper Co.) have provided plant material and outplanting sites to the Institute of Paper Chemistry, the University of Minnesota, and other agencies, and are cooperating in their field tests.

6. Most of the Lake States industries are getting their seed primarily from better-than-average stands or trees (Blandin Paper Co., Consolidated, Kimberly-Clark, Marathon Division of American Can Company, Northwest Paper Co., Rhinelander Paper Co.) or from specific districts (M&O, Kimberly-Clark), or are grafting their best trees (M&O).

7. The Blandin Paper Co. and the Diamond Match Division-Diamond Gardner Corporation cooperate with the University of Minnesota in field tests; Kimberly-Clark, Marathon Division of American Can Company, and Rhinelander Paper Co. do likewise with the University of Wisconsin; and Mosinee Paper Mills Co. and Nekoosa-Edwards Co. cooperate with the Lake States Station in a regional jack pine seed-source study.

LOOKING AHEAD

Tree improvement developments during the past decade in the Lake States have been noteworthy. Several research agencies now have the nucleus of strong programs, and increasingly valuable results can be expected. Throughout this period there has been a good spirit of cooperation among the agencies and individual workers involved in tree improvement in the region. This has helped provide good informal coordination of the work. Most action forestry agencies in the region have been interested in tree improvement work and have helped to advance it in several ways.

As programs expand, both in research and in application, there is a normal tendency for each group to become more self-sufficient and inward-looking. This tendency doubtless will appear in the Lake States. I hope and believe that the well-established background of cooperation among agencies in the Lake States will help to offset this tendency and that informal regional coordination will continue as in the past. I believe the Lake States Forest Tree Improvement Committee can continue to be a focal point for such regional cooperation.

With increasing staffs, greater numbers of specialists, and improved facilities, I look for the tree improvement research in the Lake States to make much more progress in the ensuing decade than it has in the past 10 years. By 1973, there should be much better evidence as to the extent and nature of variation among our important tree species; breeding possibilities for our principal species ought to be in clearer perspective; and there should be a considerable increase in emphasis on fundamental studies that will tell the "why" of the nature of our species, their reproduction both vegetatively and by seed, their resistance to several important insects and diseases, and the heritability of important traits. I would think, too, that there would be an increasing advance in applied tree improvement which might include almost exclusive use of selected stands for seed production, general establishment of seed orchards, and general consideration of genetic factors in marking and cutting natural stands.

Crystal ball gazing is fun, but only time can decide how good it is. Suffice it to say that tree improvement has made encouraging progress in the Lake States during the past 10 years, and I feel confident that we shall do even better in the future.

THREE YEARS' PERFORMANCE OF THE K/G BLADE IN SITE PREPARATION

by M. J. Latimer[1/]

For the past three years, the Blandin Paper Company has carried out a number of site preparation projects involving the use of a K/G blade (fig. 1). The main features of this blade are the sharp angled cutting edge and the stinger or sharp projection used for ripping trees too large to be cut by the movement of the angle blade alone.

Although we have a K/G blade for our company D-4C caterpillar, most of our projects have involved the use of contract equipment, and to date we have been limited to the D-7 and D-7E caterpillar. Areas with trees under 8 inches d.b.h. can be sheared with the D-4C and K/G blade but at a slower rate than with larger equipment.

In operation the vegetation is sheared off at ground level as the "cat" makes long straight passes. Each time, a strip varying up to 11 feet in width is cut off. Theoretically, motion is continuous, but pile-ups generally occur and the equipment proceeds in a sequence of cutting, pushing material clear of the blade, and then cutting again. Most material up to 10 to 12 inches in diameter can be sheared without stopping (depending upon species, soil, etc.), but trees larger than this must be split and cut. This takes about four passes, each involving no more than 30 seconds of time. Piling or windrowing can be done either with the K/G blade or with a straight dozer blade. The intervals between windrows vary, depending on the capacity of the equipment or amount of vegetation to be pushed together. With the D-7 we generally find the interval to be about 165 feet. Typical windrows will average 15 to 20 feet in width and 5 to 10 feet in height. Generally, there is not a great deal of soil in the windrows compared to conventional land clearing where roots are pushed out.

The extent of clearing accomplished by the operation of the K/G blade alone or in conjunction with some other blade in windrowing is generally more than sufficient to make planting quite easy.

To date we have completed 10 projects involving 564 acres. Another 175 acres has been cut but not windrowed.

Most of our efforts have been directed toward converting residual stands of unmerchantable trees and brush left after cutting, or mixed northern hardwood stands (primarily sugar maple saplings) with little or no commercial potential. We treat primarily those areas that have suitable soil and moisture conditions for planting spruce.

1/ Forester, Blandin Paper Co., Grand Rapids, Minn.

Many factors influence the costs of clearing and windrowing with the K/G blade. Obviously there are situations where machines of a particular horsepower rating are most economical to use. Whether machines are contracted or owned may affect the rate charged per hour of operation. The time of the year affects the ease of shearing and varies with species according to their root-holding capacity. Topography, number and soundness of stumps, and weight of materials to be cut and piled have significant effects on costs. In most cases shearing and windrowing has been applied to areas which are difficult or impossible to convert by other methods. Thus, we need machines in the D-7 or D-8 power range. We have been moving large amounts of vegetation under difficult situations.

The weighted average costs on completed projects is $18.32 per acre for shearing and $11.29 per acre for windrowing (table 1). No adjustment is made in these figures for acreage in windrows because I feel that modification of the planting pattern can give full utilization of the total area.

In some cases we have burned windrows at an additional cost of between $5 and $8 per acre. This may be higher than necessary. Recent experience shows good results with summer burning, a lesson we have learned from the prescribed-burn people. Burned windrows are easily planted by hand, and the effects of more shade and potash seem to make a significant difference in favor of this area for newly planted spruce.

From our experiences to date we would recommend that shearing be done prior to spring breakup, and windrowing be done during the following summer. This schedule provides for better visibility to the machine operator, less uprooting of trees with increased loads of roots and dirt to be moved, and allows the cut material to dry out before windrowing.

For the most efficient layout of sheared areas we have generally cut parallel to the long axis of the tract. This is an advantage in machine planting. In windrowing, the operator may deviate from this pattern by pushing cut material into wet or nonproductive type edges where this is convenient.

In logging operations on areas to be sheared we insist on low stumps. If possible, recently cut areas should be avoided in favor of areas on which the stumps have had time to deteriorate.

Vegetative regrowth on our sheared areas is predominantly annual weeds. Where aspen has been winter sheared, sprouting is fairly heavy. These areas are generally patchy and are quite easily sprayed with a mist blower. Other hardwoods do not seem to sprout vigorously. Spruce transplants seem to benefit from the shading effects of the regrowth, and survival has been excellent on the sheared areas. It appears that plantations on sheared sites will be easy to establish and maintain.

Several years ago we disced a few small areas after shearing at a cost of approximately $10 per acre. General observations of planted trees indicate a better height growth than on undisced areas. At present we do not contemplate discing of sheared areas as a general practice although this is commonly done in the South.

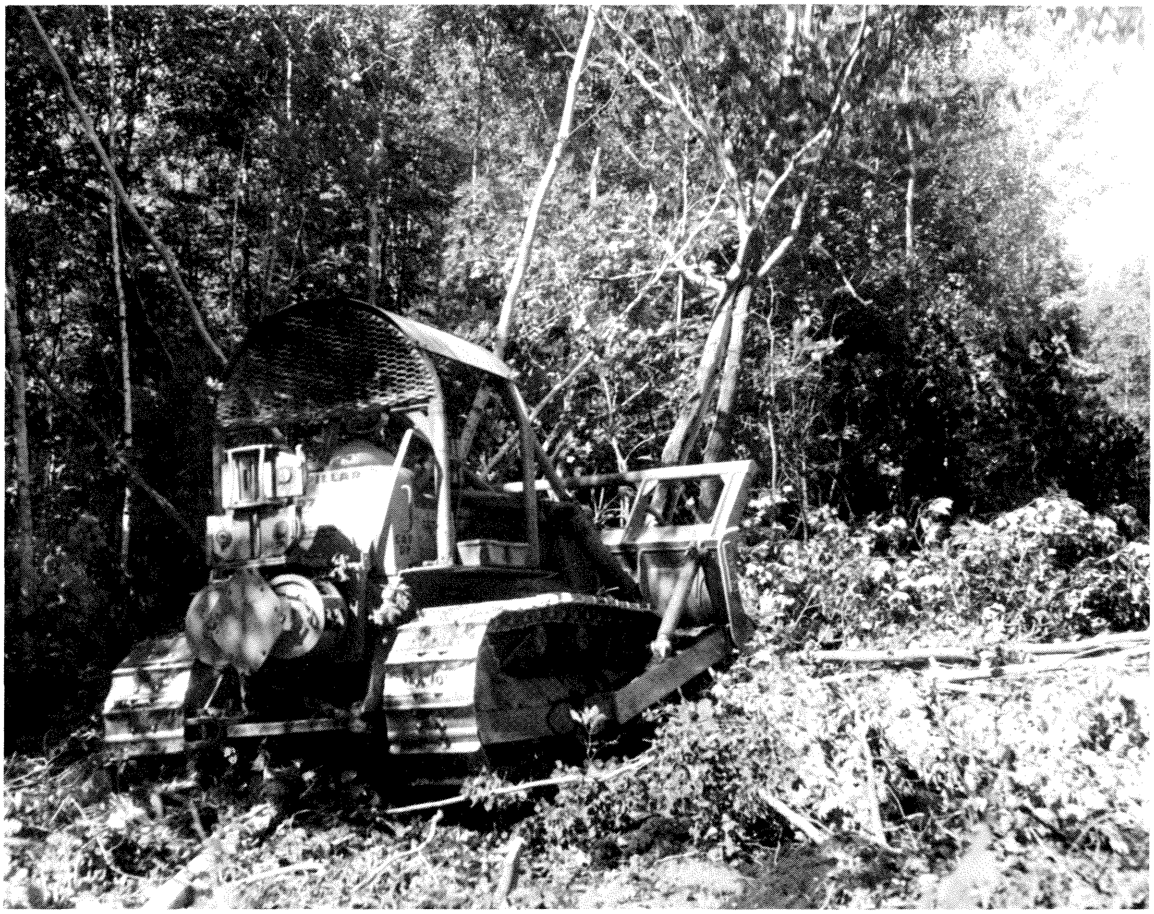

Fig. 1.--Diesel tractor with K/G blade clearing aspen stand to prepare site for planting spruce, Itasca County, Minn. (Photo supplied by M. J. Latimer.)

Some direct seeding plots have been put in on sheared areas. Results have been variable. Conditions ideal for germination of spruce seed are also ideal for annual weeds. Best results have been obtained with jack pine, red pine, and black spruce. I doubt very much, however, that a forester will go to the expense of clearing land and then trust to direct seeding to reforest it.

At the risk of getting into an economic justification of this type of site preparation I will mention that we have found a \$5 to \$8 per acre saving in planting costs. We guess that there may be a saving of \$5 to \$10 per acre on future release costs, depending upon the site cleared and whether you are planting spruce or pine. We do know that we can plant in fairly straight rows on prepared areas, and this may be of some economic benefit at a future harvest date. It is our belief that we can save some money on the cost of planting stock because of better survival and the need for fewer trees per acre in the original planting. Having gained complete control of the site we anticipate that the succeeding crop will be easier to establish and will not require the drastic measures needed to establish the first one.

When all arguments are finished, we find that we do have a method of site preparation which is very well adapted to solving some of our difficult conversion problems. The test of its economic merits will come with time.

Table 1.--Blandin Paper Company K/G Site Preparation Projects 1960-63

Proj. no.	Date	Site conditions	Acres	Equipment used	Cost per acre
33	Aug-Sept 1960	Scattered merch. aspen and dense unmerch. hdwds.	93	Shear D7 & K/G Windrow D7 & Bulldozer TOTAL	$20.84 11.83 $32.67
36	Sept 1960	Cutover aspen and jack pine	25	Shear D7 & K/G Windrow D7 & Bulldozer TOTAL	14.00 9.90 $23.90
58	July 1961	Cutover aspen and brush	63	Shear D7 & K/G Windrow D7 & Bulldozer TOTAL	11.55 15.20 $26.75
59	Aug 1961	Unmerch. hdwds. and brush	84	Shear D7 & K/G Windrow D7 & Bulldozer TOTAL	15.50 13.85 $29.35
60	Oct 1961	Cutover aspen	18	Shear D7 & K/G Windrow D7 & " TOTAL	13.60 14.40 $28.00
64	Mar 1962	Cutover aspen	36	Shear D4 & K/G Windrow D4 & " TOTAL	15.55 9.91 $25.46
83	Nov 1962	Unmerch. hdwds, scattered aspen and brush	175	Shear D7 & K/G Windrow D7 & " TOTAL	21.87 8.70 $30.57
93	Oct 1962	Cutover aspen	28	Shear D7E & K/G Windrow D7E & " TOTAL	20.00 15.72 $35.72
94	Jan 1963	Low density non-merch. hdwds and aspen	7	Shear D4 & K/G Windrow D4 & " TOTAL	12.96 9.64 $22.60
114	Mar 1963	Cutover aspen	35	Shear D7 & K/G Windrow D7 & " TOTAL	21.00 7.50 $28.50
All	1960-1963	Several typical	564	WEIGHTED AVERAGE: Shearing Windrowing TOTAL	 18.32 11.29 $29.61

USE OF FIRE IN PLANTING SITE PREPARATION

by J. H. Dieterich[1/]

INTRODUCTION

Experience has shown that many of our regeneration efforts are doomed to failure even before the seed is sown or the trees are planted, simply because the site has not been properly prepared. In the Lake States, planting site preparation is currently done with mechanical equipment, chemicals, or fire. Each appears to have its advantages and disadvantages, and these three methods will probably continue to be used to achieve satisfactory stand regeneration at a reasonable cost.

Here we shall consider primarily the use of fire for preparing a site for seeding or planting. There is still much to be learned concerning where, when, and how to burn to achieve our objectives, but we know that fire has a definite place in helping to manage some of our Lake States forest types.

HISTORY

For centuries fire has been influential in destroying and establishing timber stands in all parts of the world. In the Lake States, some of the most impressive stands of timber we have today are a result of fire. On the other hand, some of our nonstocked areas or areas of low-quality timber also have resulted from past wildfires.

The wildfires that prepared the sites for some of today's good stands--particularly in the pines--give us a clue to the use of fire in effective management and regeneration of these species. Planting site preparation with prescribed fire is necessarily based on the premise that controlled fire can create the desirable effects of wildfire and at the same time eliminate the undesirable effects that have no place in stand management or regeneration.

Prescribed burning in the Lake States is not new in theory. It is, however, relatively new in practice. There has been a reluctance in the past to use fire for silvicultural purposes, and prescribed burning has been limited for the most part to destroying brush piles and windrowed slash. Broadcast burning has not been an accepted practice for either hazard reduction (except meadow grass) or site preparation. This reluctance to use fire seems to

1/ Research Forester, Lake States Forest Experiment Station, St. Paul, Minn.

derive from questions of control, public relations, benefits, application, and costs.

Complete answers to these questions will not evolve overnight, but with the present cooperative attitude, the States, National Forests, and research organizations should produce some worthwhile results that can be used by all.

PREVIOUS WORK - LAKE STATES

In Michigan, prescribed burning research in jack pine has been directed toward stimulating natural regeneration of cutover areas. Natural seed fall, using seed stored in the cones of residual trees, has provided the medium for regeneration. In Minnesota prescribed burning research is being done at Grand Rapids and Ely. Cliff Ahlgren, working out of Ely with the Quetico-Superior Wilderness Research Center and in cooperation with the Superior National Forest, has been directing his efforts toward the ecological effects of wildfire and prescribed fire on regeneration, plant succession, and stand establishment. Cliff's work will help in establishing guides for prescribed burning in jack pine and indicating what might be expected in the way of seedling survival and effects of competition on seedling survival once germination has taken place.

The Lake States Forest Experiment Station's Northern Conifer Laboratory at Grand Rapids, Minn. is studying the effects of annual and periodic fires on brush mortality, soil nutrient characteristics, and growth of residual stand. One of the principal problems there has been to find ways to regenerate red pine stands--either naturally or artificially--and the prescribed burning trials underway should answer many questions concerning the use of fire in red pine management.

The Chequamegon National Forest in northern Wisconsin is cooperating with us in a prescribed burning program aimed at the difficult job of preparing planting sites in off-site aspen, brush, and low-quality hardwood stands.

PRESCRIBED BURN PLANNING

Planning is one of the most important aspects of using fire for any purpose. Experience is needed in planning the burns and carrying them through to completion. With experience comes a corresponding decrease in the cost of using fire and an increase in the number of opportunities where fire can be used. The prescribed burn should be planned <u>with</u> the timber sale so that the area may be blocked out more effectively and slash along the control lines properly handled. Control lines should be located where they will be most effective and so constructed that they are usable by vehicles or 4-wheel drive pumpers.

ADVANTAGES AND LIMITATIONS OF USING FIRE FOR SITE PREPARATION

To do the most efficient job of site preparation with fire, those doing the burning must be familiar with where, when, and how fire can be used and know its limitations as well as its advantages. The major risk is usually considered to be losing control of the fire. Actually, there is as great a risk in terms of overall economic values if the site is lost to brush and inferior tree species following a successful logging operation.

Comparisons should also be made with either mechanical or chemical methods of site preparation, but more experience will be needed with all methods before this can be done accurately.

Advantages

1. Hazard reduction.--Fire used for site preparation during any season reduces the chances of a severe wildfire occurring on that area. Spring burning removes enough of the fine, flashy material to reduce the hazard for a few years until annual fuel accumulation again builds up. Summer burning also removes flashy material plus some of the larger material that has lost moisture during hot weather. Hazard reduction is an important "fringe benefit" when using fire for site preparation purposes.

2. Nutrient advantage.--Fire used properly for site preparation appears to produce at least a temporary increase in available nutrients in the surface soil layers. This temporary increase in nutrients provides a much needed boost to germinating seedlings or planted stock. Although there are conflicting reports concerning nutrient changes, most evidence indicates that soil structure and fertility are not damaged by a single or even multiple light burns. Continuous severe burning is deterimental to good soil development on certain soils. Changes in nutrient content are being followed closely in the prescribed burning experiments on the Cutfoot Experimental Forest near Grand Rapids, Minn.

3. Costs.--It is difficult to compute prescribed burning costs accurately from the early site preparation work, but there appear to be considerable cost advantages from well-planned and managed prescribed burns. There is always the question of what factors should be included in computing costs--planning, overhead from other areas, equipment use and standby, observer time, mopup, etc. The first burning operations will be the most expensive because there is always a tendency to overman until some experience is gained in handling the fires. Later the costs will be reduced as a result of better prefire planning and more efficient suppression-crew activity.

Size of the area has a direct bearing on cost per acre for burning. Small areas take proportionately more time and money to prepare than larger areas because of the time involved in getting safety strips burned out on the downwind side. With some experience we may reasonably expect to prescribe burn 160 acres in 3 to 4 hours or 40 acres in 1 to 2 hours.

4. Training.--Prescribed burning for any purpose can provide excellent training for fire suppression crews. This on-the-ground training gives inexperienced members of the fire suppression team a chance to observe fire behavior, operate equipment, and test communications as they work around large areas of burning fuel. As a result they are better prepared for wildfires when they occur. Suppression crews should be organized essentially as they would be for a wildfire. The basic fire suppression organization can be put into effect with only minor changes.

Limitations

1. Technical skills.--Using fire for site preparation requires technical skills in (a) choosing the proper day and time to do the job, and (b) igniting the area to attain the desired fire intensity as well as complete the burn in the safest manner in the allotted time. Guides are available that will help pick the first acceptable day on which burning can take place, and local forecasts can help determine the best time of day to start the fires. But there is no substitute for experience in actually doing the firing job. Ignition must proceed at a rate which will accomplish the job as quickly as possible without causing serious fire suppression problems. For example, area ignition, if used improperly in large blocks of dry slash, can create patterns of extreme fire behavior and cause extensive spot fires outside the control line. Fired properly, the fire on this area would be no more difficult to control than one burning on a low-danger day.

2. High surface temperatures.--Soil surface temperatures immediately after burning frequently reach 135° to 150° F. These high temperatures may be lethal to germinating seedlings or planted stock if they last too long and if precipitation is deficient. However, the larger materials not consumed by the fire and the vegetation that returns to the area provide a measure of shade that may prevent some of this heat-caused mortality. Areas burned for site preparation do not remain barren for long; annual vegetation comes in rapidly to provide shade and lower the surface temperatures.

3. Competition.--Preparing a seeding or planting site with fire rarely eliminates all the competing vegetation for any extended length of time. (This is also true for other methods of site preparation.) Sprouting of woody species and invasion of annuals are especially pronounced after a spring burn. However, any effective summer burn will do a satisfactory job of eliminating competing brush species if the litter fuels are dry enough to be removed by a hot ground fire. Site preparation using fire will not completely eliminate the need for release once the seedlings are established. However, from this standpoint, fire compares favorably with other methods of site preparation, and burned areas are easily identifiable from the air when aerial release is planned. Occasionally, where planted stock gets a good start over the competing vegetation, only a small amount of release may be necessary.

4. Determining when to burn.--Although this is not technically a disadvantage or limitation to using fire, it is the most difficult decision to make once it has been decided to burn. The many factors to be considered in determining the day and hour to burn must somehow be consolidated into an index that can be tied directly to expected fire effects and fire behavior. Fuel moisture is the most important single factor to evaluate. The penetration and vertical distribution of moisture in the litter layer or forest floor determine the type of seedbed that results from a prescribed fire.

5. Fire description.--Describing a fire in terms of its thermal and combustion characteristics is a difficult undertaking. We can make rough approximations of fuel volume and arrangement, but it is difficult to use these factors for making meaningful comparisons between burns. About the best we can do at the present time is to describe our prescribed burns (1) in terms of past weather conditions and fuel moisture to obtain a buildup index, and (2) in terms of current weather or weather having a direct effect on the fire to obtain a current burning index. These variables are then subjectively tied into the effects that are achieved from the fire.

OPERATIONAL BURNING FOR SITE PREPARATION

Several successful operational prescribed burns for site preparation have been made during the past few years. A few of them are described here.

Cass Lake District, Chippewa National Forest.--On May 3, 1961, the Cass Lake District burned 37 acres of 2-year-old slash from a jack pine clearcut. The area had an irregular boundary that made firing and control difficult. The job was accomplished in about 4 hours with a burning index of 13 and a buildup index of 22 (6 days without rain). Humidity was 38 to 40 percent; the wind averaged about 6 to 8 m.p.h. Cost was estimated at $12 per acre. The Chippewa N.F. has nearly 600 acres more ready for burning, but because of unsatisfactory conditions during 1963, burning was postponed.

Willow River No. 1, General Andrews State Forest.--On August 20, 1962, the Minnesota Conservation Department burned, with excellent results, 105 acres of clear-cut, defoliated jack pine that had been killed by the pine tussock moth. The area was nearly rectangular, and woods roads were utilized as firebreaks. The last rain, 2.10 inches, had occurred 9 days previously (Buildup Index 25); fuel moisture averaged 8 to 10 percent in small twigs; humidity, 39-44 percent; and wind 12 m.p.h. with gusts to nearly 20 m.p.h. (higher than generally recommended). Most of this area has been successfully planted to red pine. Cost estimates are unavailable, although they were high because of extreme overmanning. This was the first large-scale burn for timber management purposes undertaken by the Division of Forestry.

Willow River No. 3, General Andrews State Forest.--A quarter section of clear-cut jack pine (defoliated by the tussock moth) was burned on July 11, 1963, nearly a year after the Willow River No. 1 burn. It was adjacent to earlier burns. The firing was completed in less than 3 hours, with a realistic use of suppression forces. The costs were computed at $2.38 per acre.

The area had gone 14 days without appreciable rainfall, the buildup index was 48, and the fuel moisture in the small twig material averaged 6 to 8 percent. Humidity dropped to 34 percent, and the wind from the south averaged 12 to 14 m.p.h. with gusts to 18. The morning of the burn was cool, with high humidity and a trace of rain. This helped reduce the possibility of spot fires. The fire burned hot, and much of the large material was consumed because of relatively low moisture content of the fuel. The combination of high buildup (48) and high burning index (28) resulted in more severe burning conditions than would ordinarily be recommended.

Big Falls Experimental Forest, Big Falls, Minn.--During spring 1961, a clear-cut strip of black spruce was burned to determine if natural regeneration would occur from the surrounding stand. A good seedbed was prepared without any trouble from hangover peat fires. The seed catch in 1961 was poor; but with the favorable conditions for seedling germination in 1962, an excellent stand of seedlings is now established. Since then other successful burns have taken place on the Big Falls Experimental Forest in black spruce. No cost estimates are available on this fire.

Minnesota Department of Conservation.--In addition to the burn on the General Andrews State Forest on July 11, 1963, Conservation Department Areas 6 and 7 at Warroad and Baudette each burned jack pine cutover areas to prepare planting sites. Areas 14, 15, and 18 also completed burns for planting site preparation. These were all summer burns. Costs varied from $2.38 per acre to $42.82 per acre; altogether nearly 350 acres was burned at an average cost of $5.40 per acre.

CURRENT FINDINGS AND RECOMMENDATIONS

The following points summarize some of the more significant findings determined from both experimental and operational prescribed burning trials:

1. Fire may be used successfully for site preparation in the following types and stand conditions:

   a) Jack pine clear cut.--For hazard reduction and/or seedbed preparation for ultimate seeding or planting.

   b) Jack pine-hardwood mixture.--For removal of hardwoods for planting site preparation. Clear-cut jack pine before burning to provide fuel.

   c) Black spruce clear cut (strips).--For hazard reduction and seedbed preparation for natural regeneration.

   d) Mature red pine.--For hazard reduction and preparation of seeding or planting sites prior to final harvest cut.

2. Summer burning with proper buildup will do a satisfactory job of planting site preparation with a minimum of control problems and will generally result in a less expensive fire than will either spring or fall burning on the same area.

3. Spring or fall burning not only appears to stimulate sprouting and competition but also comes at a time when wildfires may be a major concern to those doing the burning job. With spring fires, immediate release may be necessary to insure survival of the planted stock.

4. If spring burning is used, a second fire either the 2nd or 3rd year after the first fire will do the best job of site preparation. The first fire will make available some dead fuel but will also cause heavy resprouting. The second fire will clean up the area of dead material, but resprouting will occur again. This technique may have ready application for wildlife purposes to stimulate food and cover. It may also be possible to use this method for forestry purposes if summer burning cannot be done.

5. During spring and fall burning, the time of day for doing the job must be chosen carefully. Starting the fire an hour too early when the humidity is falling and the wind is coming up may result in the fires getting out of control.

6. During summer burning, the choice of time of day is not so critical. Weather is usually not subject to so many unexpected changes, the vegetation is green, and the days are long.

7. There is a close relationship between buildup (moisture deficiency in the fuels) and burning index (current burning conditions). However, it is more important to understand the concept of how these values are related than to attempt to state numerical relationships. When the buildup index is high or on the increase, burning should be done with a relatively low burning index. If the buildup index is low, as it frequently is in the spring, it <u>may</u> be necessary to burn with a higher burning index to accomplish the job (CAUTION!)

8. In burning for site preparation, it is desirable to strive for as high a buildup index (moisture deficiency) and as low a burning index as possible. This will permit maximum fuel consumption by the fire with a minimum of control difficulty.

9. In burning for hazard reduction only, it is not necessary to have a long period without rainfall prior to burning. In fact a burn after 3 days without rain and with a burning index of 10 to 15 will do a satisfactory job of eliminating the fine fuels on a clear-cut slash area.

10. Until we learn more about direct seeding through experimental plots or small-scale tests, we recommend planting as the primary means of getting the area back into production quickly.

11. Based on approximately 20 State and Federal prescribed burning operations to date, costs per acre have varied from a low of \$2.38 (160-acre block) up to \$42.82 (7-acre block). The average for all 20 burns was about \$14 per acre. The Kalamazoo Vegetable Products Co. (KVP) in Canada has obtained prescribed burning costs from \$4 to \$20 per acre for similar areas.

CONCLUSIONS AND RESEARCH NEEDS

Prescribed burning is new in the Lake States but is destined to have a more prominent place in the management of certain northern conifers. For instance, we have seen that fire can be successfully used in jack pine to reduce the fire hazard following logging and at the same time prepare an adequate site for direct seeding or planting. Using fire in red pine and black spruce management also shows a great deal of promise--particularly for site preparation.

Additional research is needed to refine burning practices now being used and to determine for other areas or timber types where fire <u>can</u> and <u>cannot</u> be used, the response of certain stands to controlled fire, and the specific weather and fuel moisture conditions needed to achieve the maximum benefits from fire. Techniques of fire use should be developed to indicate how best to ignite an area so as to take advantage of existing fuel moisture conditions and variations in fire weather. Additional studies may show the need for fuel modification to burn areas that otherwise could not be burned.

Getting an area back into production following logging is at best an expensive process. Costs of getting a new stand established start when the old stand is harvested. Insuring regeneration of the stand costs money; protecting the stand from fire, insects, and disease is expensive; and the timber stand improvement work that follows right up to the time when commercial thinnings are made represents a substantial expense. Improved knowledge on how prescribed burning can be used for hazard reduction or site preparation to reduce these overall costs will be a major contribution to forestry practices.

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HERBICIDES - THEIR LIMITATIONS AND POTENTIALS FOR SITE PREPARATION

by Henry L. Hansen[1/]

HISTORICAL REVIEW

The synthesis of 2,4-D during World War II and its initial recognition as a great potential weed killer marked the beginning of the modern era of chemical silviculture. In 1944 the North Central Weed Control Conference was organized and held its first annual meeting in Omaha, Nebr., to coordinate research, extension, regulatory, and industry efforts on weed control problems. To be sure, this pioneering was done by people with primarily agronomic interests and with a focus on herbaceous weeds. However, during 1945 and 1946 interest developed in the use of 2,4-D in killing woody plants, particularly poison ivy and such alternate hosts of diseases as *Ribes* and the barberries. During that year a Subcommittee on Research in Eradicating Woody Plants was organized under the chairmanship of L. W. Melander. In 1947 a symposium on the chemical control of woody plants was sponsored by this committee, and 52 abstracts of research involving woody plants were published.

While the earliest research on the use of 2,4-D on woody plants was oriented to the problems of rights-of-way maintenance, pasture improvement, poisonous plants, and alternate host eradication, foresters were not long in recognizing the possibility that 2,4-D might help to solve some of the silvicultural problems in Minnesota and the rest of the Lake States. By 1947 research was underway using 2,4-D on hazel, alder, willow, and other common forest brush species. Some of this early work was done in the area in which these meetings are being held, on the Chippewa National Forest and at the Lake Itasca Forestry and Biological Station.

Another milestone in the history of chemical silviculture was the initial testing of aerial applications of 2,4-D for silvicultural purposes in 1951. During that year applications were made on an upland site north of Brainerd and on a swamp site near Effie, Minn. Since that time the airplane has been widely used in connection with forest spraying as the means by which phytocides are applied to the forest.

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EVALUATION OF EXPERIENCE

We now have about 12 years of experience with aerial applications and over 15 years of experience in the use of 2,4-D on forestry related woody weed problems. At this time it is very appropriate that we evaluate the implications of this experience on the problems of site preparation.

Most of the application of 2,4-D and other phytocides has been for the purpose of release. This silvicultural procedure is one of the most costly of all forestry activities when the axe, the brush hook, and the machete are the main tools available. Plantations established in the days of the CCC programs often suffered heavy mortality because funds simply were not available for the expensive job of freeing the planted trees from brush or the competition of sprout hardwoods. Naturally regenerated mixtures of valuable conifers similarly suffered from excessive hardwood competition. It was natural that foresters turned to the new phytocides in some desperation in their search for cheaper release measures. The properties of 2,4-D were explored, and their fortuitous selectivity in favor of the conifers was soon recognized. It became evident that stand mixtures of conifers and hardwoods could be sprayed to give a good measure of control over the hardwoods with relative safety to the conifers. On the drier sites, such as prevail particularly in the western fringes of jack pine distribution in Crow Wing, Hubbard, Wadena, Clearwater, and adjacent counties in Minnesota, it was found that jack pine could be released effectively and at a reasonable cost from intermixed oak by an aerial application of a good phytocide. Similarly pine and spruce understories could be released from aspen overstory competition. These developments made possible more effective and far cheaper release than was possible before the days of 2,4-D.

In connection with the problems of planting site preparation the results of the past in using phytocides are not as widely successful nor as clear-cut in their interpretation. For the purpose of this presentation, site preparation is considered as preliminary to planting or direct seeding or to stimulate natural regeneration.

Little use has been made of phytocides in connection with artificial seeding of areas to secure regeneration. It is probable that the use of selective materials such as 2,4-D would not give as drastic an effect on the seedbed as might be desirable for use preliminary to seeding. Certainly phytocides will not create mineral soil seedbeds, nor will 2,4-D eliminate the herbaceous canopy. It is very possible, however, that chemical treatment may be of considerable help after seeds have germinated to free the young seedlings from competition. However, this is technically a release effect, the value of which has been fully demonstrated and was discussed earlier.

Current interest in planting, even with concomitant expense of site preparation using expensive land clearing methods, raises the question of the possible role of phytocides. Again, heavy equipment or fire are needed if slash, litter, or standing trees and brush are to be removed. Phytocides may be helpful in several ways. First, they may be useful in killing brush in advance of burning to create favorable fuel relationships. While research is underway to test these possibilities in both shrubby and herbaceous fuel types, the potentials are by no means explored. However, there is evidence that fuel drying by chemicals may expedite summer burning when the dangers are low.

A second benefit possible in connection with planting site preparation involves reduction of competing vegetation. Two considerations arise at this point. First, should treatment be made before or after planting, and second, to what extent is such treatment needed and helpful. Certainly there is inadequate experience on which to make judgments contrasting preplanting vs. postplanting applications. This should be the object of considerable testing under a wide range of field conditions and considering it in connection with both mechanical and burning site preparation.

The extent to which phytocides can reduce competition to planted trees depends in a large measure on the nature of the site being planted. Some experience is now being acquired on the Chippewa National Forest and elsewhere. It appears that where planting is being done on sites formerly supporting stands with a heavy brush understory the chemical treatment is most necessary. Pine and aspen sites with dense growths of hazel, prairie willow, cherry, and other aggressive upland brush species tend to produce heavy regrowth following site preparation by mechanical clearing or preburning. Such areas will usually require a phytocidal treatment to carry through the planted trees. On the other hand, sites on which tolerant hardwoods such as maple and basswood grow seldom have heavy brush understories. This explains why current experience in mechanically clearing such sites seems to indicate less need for chemical treatment. Regrowth from the root systems of the hardwood trees is far less aggressive than that from hazel and other brush species. These ecological relationships must be known much more intimately in connection with the site preparation problem.

The use of phytocides as an aid in site preparation on open field plantings where sod and herbaceous weeds is the main problem is being given much attention now because of the more recent availability of some phytocides other than 2,4-D. Such materials as simazine, amizine, diuron, atrazine, and others are being widely tested to improve survival and early growth of Christmas trees as well as farm shelterbelt and windbreak species. Tests in Minnesota have shown that good to excellent weed control was obtained from simazine and atrazine in about 90 percent or more of the statewide trials underway in 1961 and 1962. These materials, applied to the soil in the fall previous to planting or in the spring before emergence of the weeds, do not injure most woody plants being planted because their effect is primarily on germinating seeds and very young seedlings. Amizine, a combination of amino triazole, to control already established grasses and weeds, and simazine, to kill seedlings germinating after the application, also is proving useful in plantings of this type. In the case of amizine, however, sprays must be directed so as not to contact and injure the planted trees.

There has been very little testing of these phytocides as well as of other nonselective soil sterilants in connection with forest type plantings. It is possible that a soil sterilant which is extremely potent in killing all vegetation and which will have low residual toxicity will be developed and may be useful in preplanting site preparation. A number of chemicals are now available which will do a good job of killing everything on a planting site. However, their high cost and the fact that their residual toxicity kills young trees planted the following year makes their utility limited.

Finally, phytocides have been tested to some extent in stimulating natural regeneration of forest stands. Again, the tests are highly inadequate as a basis for determining the potentials of this silviculturally. A few trials seem to indicate limited or little success with red pine. The difficulties of securing abundant reproduction of this species are well known and apparently the phytocides do not offer a cure-all. Where advance regeneration is present, however, 2,4-D applications may be of great assistance in carrying through the young seedlings. This, of course, is again an example of release.

Research at the Lake Itasca Forestry and Biological Stations indicates that 2,4-D sprays may be more useful in encouraging white pine regeneration. This species is far more aggressive than is red pine. Where an adequate seed supply is available, sprays to kill brush and improve light and heat on forest seedbeds have been found to greatly improve white pine regeneration. Even with this species the most striking benefits to be obtained from spraying with 2,4-D are a result of releasing young advance seedling growth from brush competition, greatly increasing the rate of juvenile growth, and assuring a higher ultimate survival percent.

SUMMARY

After more than 15 years of experience and research in the use of selective phytocides and 12 years of using aerial spraying, much has been learned about the potentials and limitations of these materials in silvicultural operations, but a surprising amount still remains to be learned.

In general, excellent results have been obtained where release of conifers from competition of brush or hardwoods has been the problem. This has been true of planted conifers as well as natural regeneration in various stages from initial germination to sapling size. Treatments have been relatively cheap and effective.

Presently available phytocides do not clear rough sites sufficiently for machine planting without the use of fire or heavy mechanical equipment. However, on sites where brush is a problem their use may be an important adjunct to mechanical or burning methods of site preparation. The timing of such applications is a matter requiring further study and testing and must be related to the ecological conditions prevailing.

Soil sterilants of greater potency, lower cost, and less residual toxicity than those presently available may open the way to much wider use of chemicals for site preparation in connection with planting, direct seeding, and natural regeneration.

SOME PRESENT TRENDS IN TREE QUALITY IMPROVEMENT IN GERMANY

by Wolfgang Knigge[1/]

It is with great pleasure that I accept your invitation to take part in the Sixth Lake States Forest Tree Improvement Conference. This gives me a welcome opportunity to renew contacts with American foresters and wood technologists in the field of tree and wood quality improvement. During the past 10 years, American progress in this special research field has been very rapid and successful and has received much attention in Germany. For this reason your leading researchers such as Philip Larson, Harold Mitchell, and Bruce Zobel, to mention only a few, enjoy an excellent reputation in my country.

I consider it a special distinction to fulfill your request for a summary of some present trends in tree quality improvement in Germany. I do this gladly because I believe that much can be learned by comparing experiences in this research area which has recently developed so rapidly.

In an attempt to give a short but pertinent survey of the present status and future goals of research work in my country, it will be necessary for me to limit my comments. I recognize that the major point of discussion at this meeting is primarily the improvement of wood quality through selection of genetically superior trees. This was also the central topic of the World Consultation on Forest Genetics and Tree Improvement held last month in Stockholm. Therefore I would like to limit my own remarks today to two different major working areas of German tree quality research. These two research questions are:

1. What standards can be used to judge wood quality in standing trees?

2. To what degree can wood properties be influenced and improved through forestry practices?

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CRITERIA OF WOOD QUALITY

In searching for criteria for judging wood quality of a single tree, of a tree species, or of a forest stand, forest products research faces a difficult problem. It has to combine its own standards, which are usually absolute and biologically oriented, with those of the forest products industry, which can vary greatly in industrial purpose and changing utilization methods.

For example, the lumber industry is primarily concerned with the length, diameter, taper, and knottiness of logs. The veneer industry, in addition to diameter and knottiness, gives special emphasis to color and grain figure. The pulp and paper industry, however, is more concerned with fiber length, specific gravity, and the suitability of the wood for mechanical or chemical digestion. Other wood consumers have varying utilization requirements by which they judge their raw material. Forest products research has consequently found it necessary to seek theoretical standards which are a compromise attempting to satisfy the varying and changing requirements of the different forest industries.

After long deliberation, German research has placed particular importance on an optimal combination of the external tree characteristics as a useful measure of wood quality. For reasons which I shall discuss later, we prefer these standards to those which evaluate internal wood properties and which we believe are of secondary importance to our wood industries. Therefore, our evaluation of the standing tree is currently based mainly on the following characteristics in descending order of importance:

a) External dimensions of the stem, expressed in terms of diameter and length of the merchantable stem.

b) Branchiness, particularly the number, diameter, and angle of the branches and in addition the proportion of the stem having green, dead, or no branches. A third external standard is

c) Stem form, which is a comparison of the tree axis and cross-section with the ideal form of a geometric cylinder. After these follow internal wood characteristics such as

d) Physical wood properties, particularly specific gravity as an expression of dry weight production and as an indication for swelling and shrinking, and also the elasticity and strength properties. Now follows the

e) Anatomical and chemical composition, particularly fiber length, fiber angle, thickness of the cell wall, and proportion of spring and summer wood within the annual ring; and finally

f) Grain figure and color, which determine attractiveness of the wood in its natural form. It is clear, however, that the importance and practical effect of the standards just enumerated are of secondary importance when the tree is affected by

g) Wood defects: these can be deviations from the ideal stem form, disturbance of normal wood structure, or undesirable changes following tree felling. These wood defects can occur singly or combined. Their individual importance varies according to the special needs of the wood industry involved.

The major importance of tree growth, branching habit, and stem form as criteria for wood quality is due to the fact that these characteristics are easy to measure in standing trees and, when carefully evaluated, make possible a prediction of internal log quality. German foresters are highly interested in American attempts to supplement external measurements by increment borings as a standard inventory procedure, but this procedure is not common in Germany because our commercially important spruce and beech trees are highly inclined to secondary pathological decay following mechanical damage such as boring.

INFLUENCING WOOD CHARACTERISTICS THROUGH FOREST PRACTICES

With these general concepts for judging wood quality, German forest products research during the past decade has subsequently tried to establish how wood quality can be improved during wood production. These attempts are based on the observation that the characteristics of the individual stem are a product of the environment as well as of heredity. The conviction that variations in wood quality very often are a result of specific conditions has led to investigations to determine the degree to which wood properties can be influenced by intensive management practices during stand development. Researchers and many practicing foresters are also convinced that improvement of wood quality can be achieved more rapidly through proper forestry practices than through testing alone in which results become concrete only after a full rotation period. In summary, the conviction has been formulated that the final success of forestry practices should no longer be judged only from the standpoint of maximum forest yield, but equally from the standpoint of high-quality production.

We believe it worthwhile to consider new approaches in the following six areas of forest practices for an improvement of wood quality:

1. Tree species selection
2. Type of stand formation
3. Thinnings
4. Intelligent artificial pruning
5. Forest fertilization and
6. Rotation age

In the remainder of this paper, the results of recent German investigations will be briefly discussed in relation to their significance for the practicing German forester.

CHOICE OF TREE SPECIES

We have to bear in mind that while the number of tree species on the North American Continent numbers several hundred, the number in Central Europe is limited to approximately 60 native species. This difference results largely from the extinction of tree species during the ice age. Furthermore, of the 20 tree species which have practical importance in Germany, the four species--Scots pine, Norway spruce, beech, and oak--constitute 85 percent of our timber harvest. This relatively limited choice has been supplemented somewhat by the successful introduction of foreign tree species, especially those from North America. For example, Douglas-fir, Sitka spruce, grand fir, and white pine have been planted to a considerable extent in Germany.

In the past, German foresters have generally attempted to introduce the largest possible number of tree species which were appropriate for site conditions. It was believed that this procedure would assure in an optimal way many different types of wood for the unpredictable demands of future markets. However, in recent times, it has become quite clear that the continuation of this principle leads to the production of wood having undesirably great variation in quality and usefulness. It also appears that several of these tree species will have no satisfactory usefulness at all in the future. In regard to the increasing mechanization of our wood-using industries, it seemed advisable to limit our commercial tree species to those able to satisfy industries' demands for a uniform and high-quality raw material in quantity and quality. Therefore in the future, two major groups of tree species will be grown in Germany:

a) Those tree species having relatively uniform wood properties and a great number of possible uses, and which in addition, are able to produce rapidly a maximum wood volume and dry wood substance. This group of tree species is designated as the "quantity tree species" and includes mainly conifers, such as Norway spruce, Douglas-fir, and true firs. The most important deciduous tree species of this group are beech and poplar. The second general group includes

b) The so-called "quality tree species." These usually slower growing species produce a high proportion of knot-free wood, large diameter, and usually have favorable color and grain figure. Trees having these favorable wood properties command premium prices. To this group belong carefully raised Scots pine, larch, white (English) oak, and especially ash, maple, walnut, and several types of fruitwood, such as apple, cherry, and pear, which are desired by our furniture industry.

The remaining tree species which either have slower growth rate or do not possess especially favorable wood properties will be grown in the future only on sites unable to support "quantity" or "quality" tree species.

STAND ESTABLISHMENT

It is necessary to mention that in German forestry, artificial regeneration as a form of stand establishment is more common than natural stand regeneration. Furthermore, in most cases, planting is considered more practical than direct seeding. Therefore, in addition to selecting the most suitable tree species and a particular genetically superior provenance of this tree species, the practicing forester must specify the most favorable tree spacing in the stand. Generally the choice of tree spacing strongly influences:

a) The initial cost of founding the plantation.

b) The probable requirements for secondary planting and weeding the plantation.

c) The time of the first commercial thinning.

d) The growth trend of the stand, and in particular

e) The progress of natural pruning, which strongly influences the quality of the mature stand.

By selecting the proper spacing, the forester controls wood quality both through stimulating natural pruning and through modifying the natural growth rate of the tree. Under German silvicultural conditions it appears especially desirable to slow down the natural tendency of the stand for rapid growth in the early years of stand development. Rapid growth at this time, as everybody knows, usually produces loose and structurally weak juvenile wood surrounding the pith. To prevent this, and at the same time to accelerate natural pruning, German foresters have practiced fairly close planting. "Quality tree species"--those which will be used for knot-free lumber or veneer--are therefore usually planted 8,000 to 12,000 trees per acre. The "quantity tree species" of course are planted at a wider spacing; however, this generally does not exceed 5 by 5 feet.

These figures are also used as criteria in judging adequate stocking of natural regeneration. Natural regeneration which is spotty or which lacks a protective canopy or which is uneven-aged seldom produces satisfactory wood quality and therefore often requires premature harvest and replacement.

STAND TENDING

While the form of stand establishment determines the course of tree growth during the first two decades of the stand, the remaining development of individual tree quality until harvest depends greatly upon the methods of stand tending. These silvicultural methods include precommercial and commercial thinnings which are repeated at approximately 3- to 5-year intervals in my country. Under such an intensive management program, the German forester has the possibility to utilize the close correlation between wood quality and crown position of the individual tree. By intelligent use of thinning, the forester can influence tree form, the progress of natural pruning, the width of the annual ring and, within limits, the proportion of spring and summer wood within the annual ring and thus the specific gravity. To a certain degree, he can also modify the fiber length.

In earlier times forest yield researchers in Germany almost unanimously recommended relatively heavy thinning practices. Recently, however, investigations have shown that small- and medium-crowned trees have a relatively higher capacity for wood production and thus show a more efficient space economy than larger crowned trees. Although heavy thinning improves the production of remaining trees, it tends to remove so many of the space-efficient wood producers that the growth of the stand on a per-acre basis does not improve sufficiently over the rotation period. On the basis of recent yield studies, it is now recommended that initial thinnings, especially those during the decades of greater volume production, be relatively conservative.

This newer concept of light and moderate thinning in young stands has decided positive effects on wood quality. First by limiting the explosive juvenile growth rate of the stand, the forester is able to favorably influence the relation between ring width and specific gravity. Thus by increasing the specific gravity in addition to obtaining maximum volume production, the forester can increase the dry weight production of his juvenile stand. Second, light and moderate thinnings have an even more important effect on wood quality because they increase the rate of natural pruning. If one assumes that the optimum production goal for quality wood species should be about 50 percent knot-free wood volume, then white and black knots should be contained within the inner third of the bole diameter. Since the breast-height diameter of economically mature trees in Germany lies between 14 and 20 inches, natural pruning of the lower 12 to 18 feet of the trunk should be completed by the time the tree has a breast-height diameter of 5 to 7 inches or by the time the tree is approximately 30 years of age. It is usually possible for the practicing forester to inspect the progress of natural pruning and callus growth by carefully following the development of branch scars.

It is apparent that in implementing a program of light to moderate thinning in juvenile stands, as jointly advocated by German yield and forest product researchers, a heavier thinning program must occur in later stand development in order to obtain the desired diameter at harvest. By controlling the degree of thinning, we believe the forester can maintain a certain uniformity of annual ring width, even after the normal culmination of tree height and diameter growth. This uniformity of annual ring width is desirable to insure a certain uniformity of structure, spring and summer wood percentage, and wood density and strength properties, and thus to insure homogeneous wood properties.

ARTIFICIAL PRUNING

It is not always possible to obtain satisfactory natural pruning through spacing or thinning. This is especially true for most conifer stands. At least as long as "quality tree species" are to be produced, it is feasible to combine the first precommercial thinnings with artificial pruning.

During the past decades in Germany as well as the United States, there have been many thorough investigations attempting to find the most efficient artificial pruning methods. It is not necessary at this time to mention that the removal of dry branches, green branches, and lateral buds from the terminal leader through mechanical or, more recently, chemical means have all proved advantageous in one way or another.

In Germany, the removal of dry branches has proved to be of the highest practical significance. We found that certain tree species must be pruned in order to produce high-quality wood. For example, spruce and Douglas-fir must always be pruned and pine must often be pruned in order to obtain a reasonable amount of knot-free wood. Among deciduous tree species, pruning has proved necessary, especially for poplar and, to a lesser degree, for oak. According to our experience it is desirable to produce at least an 18- to 24-foot branch-free bole. The number of pruned stems per acre is determined chiefly by site quality. The higher the site quality, the greater the number of stems that should be pruned; and the older the stand, the fewer. As a general average, the number of crop trees to be pruned is about 80 to 160 trees per acre in hardwoods and 120 to 300 trees per acre in conifer stands. Thorough economic investigations have recently shown that under German economic conditions, the costs of artificial pruning are clearly covered by the increased value of higher quality wood.

FOREST FERTILIZATION

During the last 50 years, methods of soil improvement, especially the application of fertilizers, have been used to increase the growth of forest trees. The majority of German forest soils are less fertile than American forest soils due to more intensive land utilization and more generations of continuous cropping. It is, therefore, not surprising that many German investigations have shown a clear increase in forest yield of many tree species and forest types in response to carefully planned and executed fertilizer applications.

However, it still remains difficult to judge completely the effect of fertilization on wood quality. Past investigations attempting to answer this question do not agree. This inconclusiveness is due in part to the wide range of sites, silvicultural conditions, and soil improvement combinations which have been used. In general, a satisfactory increase in wood volume has been reported, providing the fertilizer application has corrected the nutrient deficiency of the site. In addition to significant increases in height growth, 2- to 3-fold increases in annual ring width have been reported. In conifers, this increase in annual ring width, however, is primarily an increase in the spring wood. This results in a decrease in specific gravity following fertilization and leads to the very important question: What is the net effect of forest fertilization on the dry weight production of the stand?

In the wide majority of investigations, the dry weight production appears to be increased. The evidence is particularly convincing in fertilizer application to low-quality sites, where sometimes a doubling of dry weight production occurs. Nevertheless the response of individual tree species, as well as that of investigated sites, has varied greatly in intensity and duration.

The economic benefits of carefully planned and executed soil improvement procedures are today widely accepted in Germany. From a forest product's standpoint, forest fertilization is recommended with certain reservations. Forest fertilization in juvenile stands--just as early heavy thinning--usually leads to increased annual ring width surrounding the pith and to a delay in natural pruning. In contrast, soil improvement measures which increase diameter growth after natural pruning has occurred are frequently very advantageous and counteract the natural decrease in annual ring width in the latter part of the rotation period. In the interest of higher wood quality, forest fertilization is therefore primarily recommended in stands of middle to old age.

MODIFICATION OF THE ROTATION PERIOD

In recent years, German forest research and practice have shown increasing interest in the relationship between wood quality and rotation period. In the past, the rotation periods of our commercial tree species have been strictly the result of maximum yield considerations. But from a wood products and forest economic standpoint, it is often desirable to increase the rotation period beyond the period set by maximum yield. Although with increasing rotation period the number of stems per acre decreases, particularly the proportion of small stems, the remaining stand of large individuals often returns a maximum monetary yield. This monetary yield is due not only to the premium prices often paid for trees of large dimension but also because increasing the rotation period diversifies the number of wood products harvested.

This tendency of increased wood quality through extended rotation period is, however, gradually weakened and finally reversed by greater production risks stemming from increased mortality, decay, and blowdown. Thus the upper limit of rotation age is determined by decline of stand vitality, the increased loss of volume through fungal decay and insect attack, the tendency for diffused-pore deciduous trees to form undesirable heartwood and discoloration, and finally the demands of the wood-using industries for logs and cordwood of small and medium diameters. Attempts to modify the rotation period in order to achieve maximum value have recently led to compromise proposals that the rotation period for valuable "quality tree species" should be somewhat lengthened, while that of the "quantity tree species" should be shortened.

OUTLOOK FOR THE FUTURE

Ideally the foregoing six considerations should lead to the following results in Germany:

a) Concentration of forest production in tree species which, because of their overall properties, are suitable for multiple use.

b) Increase in wood quality in the stand; and

c) Uniformity of wood properties within the individual tree.

If you come to my country today, you will find these ideas which I have just outlined in the initial stage of application in forestry practice. In spite of this, I believe that the broad practical use of these recommendations of forest products research will be increasingly apparent.

The very intensive forestry economy of Germany, as well as that of the other European countries, is presently in a phase of changing tasks and goals. The great technical problems of silviculture and forest protection, which demanded the greatest activity for one and one-half centuries, are now to the greatest extent solved. Now the problems of optimum utilization of our forest products are predominant. Since in Germany wood no longer plays a key role in supplying human needs and since the quantitative and qualitative requirements of the wood market have consequently changed considerably during the past decades, optimum utilization has become a definite production goal.

Therefore our forest economy has no other choice than to influence the quality of forest products as far as possible by producing logs with the highest degree of utilization. We also believe that in our present situation it is no longer only the wood working industry's business to transform low-quality logs into high-quality products.

In facing this problem, the German forest economy no longer relies solely on its own research findings, but increasingly seeks support from the successful and progressive North American forest science. But international progress in forestry necessitates international cooperation through regular exchange of scientific ideas and research findings. It is for this reason, that I am so grateful for the opportunity to attend this distinguished meeting and that I have attempted to make a small contribution to your proceedings. May I thank you once again for your interest and for the invitation to participate.

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CONSERVATION AND RECREATION 1/

by Ernest Swift 2/

I consider it an honor to speak at this conference and to a group of professional foresters, many of whom are also friends. Most of you know that I am not a graduate forester; but with some degree of safety I can say that I have been a general practitioner in resource management. Therefore, I am going to speak from the viewpoint of a general practitioner.

We all reach conclusions as a result of our own individual activities and from where we sit in the grandstand and watch the passing parade. As a result we develop different perspectives, even though we may all be in the general business of conservation.

Today I am attempting to practice what I used to preach. I have a small acreage of hardwood--badly overgrazed when I bought it--and some open field plantings of red pine. I was raised on the land, and coming back to the land has been a great source of satisfaction. I am finding out that even on a 12-acre plot a great deal can be learned about plant and animal succession. I have a marsh hawk which patrols the pine plantation for mice, and a very truculent badger who controls the rabbit population in the hardwoods.

Lessons learned on the land become the foundation of all resource management, and in spite of the imperfections of human endeavors, lessons of and on the land develop the ecological conscience far better than academic theory or oratory. The classroom is a necessary medium for better land management--the land is not simply there, however, for the benefit of bigger and better classrooms.

1/ Address delivered at Conference banquet on September 9.

2/ Conservation Advisor, National Wildlife Federation.

In general terms we can say that the conservation movement started some hundred years ago as a three-pronged but definitely uncoordinated effort:

1. In the 1860's, such men as Olmsted and later Muir and Mathews were attempting to preserve some of the natural wonders of the West. Their untiring efforts led to the establishment of several of our most outstanding National Parks and subsequently to the creation of the National Park Service.

2. Then there was Increase Lapham, and later Fernow, then Pinchot and associates, advocating forest preserves and fire protection. This effort culminated in the establishment of the National Forests and the Forest Service.

3. The third effort was to stop the wanton slaughter of wildlife; buffalo, elk, passenger pigeons; the activities of the plumage hunters; and the commercialization of waterfowl. There were such men as Grinnell, Sheldon, Pierson, Shiras, and Lacey who pioneered in this effort.

A more recent program well within our own lifetime was that of saving the soil. It resulted in the establishment of the Soil Conservation Service.

The history of conservation progressed by fits and starts, and without much balance or consideration of all resources. We are just beginning to understand as a people that the whole natural pattern of ecology must be considered. Of course we have had <u>many</u> individuals who understood this basic premise, but we have not done so collectively as a people. Just how close we are to this complete understanding, this national ecological conscience, is a matter of opinion.

Today we are giving lip service to an all-out effort to manipulate the land and its products so as to satisfy a rapidly increasing number of human desires and a population which some feel will soon reach a saturation point.

Within a half century we have moved from a frontier concept into the space age. As humans increase, so in ratio does the utilization of resources. But the <u>land</u> must produce those resources, and the <u>land</u> does not expand with the growth of population. At what point the <u>limit</u> of the land's ability to produce will be reached is unknown. Near miracles have been performed in increasing farm production in the past 25 years. This has come about at the expense of some other resources and resulted in their lasting damage.

We are occasionally warned of developing lopsided specialists because we cannot afford the arrogance of technological minutiae defeating the main objectives. But we are now encouraging some lopsided public attitudes because we have spawned a landless people whose concepts continue to recede from a basic understanding of the elements that sustain them; people who bottle themselves up in concrete canyons, live a squirrel-cage existence, and take stupidity pills to endure the comforts that have been created for them.

The United States is a rich, an opulent, nation. The good living and luxuries enjoyed are a marvel even to its own citizens and the envy of the less fortunate. With the assumption that nothing will endanger this opulence we are now attempting a massive attack on the proposition of recreational opportunity. We are creating in the minds of these landless people the philosophy that they have been and are being denied their birthright. We are telling them that the entire conservation spectrum revolves around recreation. We are making conservation a spectator sport with no responsibilities to the individual and with no reference to the need of an economic base to support it, no reference to the ecological conscience, or the fact that recreation cannot feed off itself.

I have long and loyally supported the need for outdoor recreational opportunity, but I have never forgotten that it is basically a luxury bonus resulting from sound resource management.

In a fantastically short time, which is breathtaking, we are faced with new concepts of land-use priorities that are causing indigestion in some quarters. For one thing, a new species of public figure recently has come across the horizon. He is called the OUTDOOR PLANNER, and he is part psychiatrist, part welfare worker, and part chamber of commerce promoter; and too often, he has not grown up with any personal experience or responsibility in managing resources. We have a whole parade of professional terminologies, such as "the gospel of work versus the gospel of leisure," "recreation use projection," "intermediate recreation," and "formulas involving the variables used." Being a professional recreationist has now become fashionable and glamorous, and the person who wants to go on a picnic or take a long walk has become a specimen for microscopic study.

Professor C. R. Gregory of the University of Michigan has made the following statement which takes considerable digestive ability to assimilate on my part: "By 1984, recreation will be the number-one use of all state and federal land, and I suspect that the forest products industries will have to fit their activities to the recreation seekers, not the other way around, as now."

That is a pretty big biteto swallow, gentlemen, and leads one to speculate as to whether your efforts as professional foresters, which involves research, are going to be thrown out the window. We all know that within the philosophy of multiple-use, equal use cannot prevail on each acre, but this statement does not seem to contemplate multiple-use in the present accepted sense.

A bureau has been created by this session of Congress within the Department of Interior to coordinate all recreational efforts, federal and state. This bureau has ambitions of ultimately having a half billion dollar budget to use for loans to the states and for use by other federal bureaus. The ratio would be 60 percent for the state loans and 40 percent for the various federal bureaus. Money is a powerful force--either as an ear of corn tied to a stick to lead a donkey or to rawhide agencies into regimented action. This bureau is now expanding in manpower and establishing regional offices.

In part at least, its philosophies and objectives are contained in a statement by its Director, Edward C. Crafts: "Two basic philosophies reflect the orientation of the Bureau of Outdoor Recreation. The first is that the most important single force in outdoor recreation is private endeavor. The second is that the states occupy the key or pivotal role in government. These were the conclusions of the Outdoor Recreation Resources Review Commission and we subscribe to them fully. But let me say, too, that to the extent states and private enterprise fail to respond to their opportunities and public responsibilities to supply recreational demands, the federal government will tend to move in. This is the natural process in this country that follows private and state abdication. The pressure of recreational demand is such that it will not go unfulfilled and, if necessary, the federal government will fill the vacuum."

That word "abdication" is unfortunate. Within their ability, state agencies have assumed their responsibilities, well realizing the pressures on them for increased effort at this time. And what responsibilities to recreation have private land owners abdicated? Does that mean forest industry or farmers?

If forest industry attempts a multiple-use policy of equal production and equal recreation, can they supply their mills and keep up with market demands--which is public demand. Will recreation profits offset a reduction of raw materials? With this reduction, who will have jobs or money to recreate with?

With all these new philosophies confronting them I would say that forest industry has some very fundamental survival factors facing them. Survival includes taking risks in a highly competitive free economy, at the same time remaining solvent--and the latter means making a profit. That word "profit" is a nasty word to some people, in spite of the fact that it pays taxes and wages so that people can afford to recreate.

To be economically sound, forest industries require extensive acreages whose primary purpose is timber production; and industrial forests require much more than intelligent land management. There must be a guarantee of an equitable and stable tax base, because the harvest is not annual but must be figured in decades. High annual taxes can kill off the best managed industrial forest in existence.

With the rising tide of recreation, back-country land values are climbing. This has inspired some local tax assessors to look with a hopeful eye on taxing industrial forest holdings for their recreational potential as well as their timber crop. This in turn would increase the cost of the timber and its conversion if this idea prevailed, and too few budding conservation authorities of today realize that excessively high taxes prompted much of the cut-out-get-out policies of a few decades ago; that and the consequent fire risk.

Another problem is the utter disregard for private property rights on the part of recreationists, even though a minority is involved. Public agencies supplying recreation are in a constant battle against vandalism and have frequently documented the destruction, but in this instance the taxpayers foot the bill.

Fire is another constant hazard with people in the woods, especially during the dry seasons. And over and above the actual loss of timber, the pre-suppression costs of manpower and equipment will increase. Not only do the above-mentioned factors increase management costs, but the liability laws of many states are at present wholly inadequate to meet the situation.

This is no smoke screen that industry uses to hide behind, as over 90 percent of forest industry lands are open to the public for some form of recreation. Industry up to the present time has been reluctant to get into the user-fee business, but industry may be forced to climb on that bandwagon if they wish to survive the competition with public agencies and farmers.

I have been accused at times of using ludicrous comparisons, but if the Vikings' football team and the Twins' baseball team decided to move out of Minnesota would that constitute an abdication of sufficient importance for the federal government to go into the baseball and football business; and if I fail to supply picnic tables on my 12 acres am I some kind of a delinquent citizen?

For years there has been a cry that "multiple-use" is only a convenient slogan, and only accepted if the priority interest of groups and individuals come first. But Professor Gregory seems to give a priority to recreation regardless of other needs, such as community development, etc. And with the states and private industry being warned of abdication of responsibilities, multiple-use has received another cross-pollination of sanctimonious aphorism.

I am well aware that any speaker can use the term multiple-use as a stage setting, which by inference is supposed to establish his depth of understanding and void any potential challenge of the conservation gospel he might wish to preach. What does this term mean?

To some manufacturers, wise-use means dumping their filth into a nearby stream so as to reduce production costs; the spraying of herbicides or insecticides is construed as wise-use by farmers to increase crop production, and by highway departments to minimize labor costs.

Congressional sanction for the draining of wetlands becomes wise-use or a part of multiple-use so that new crops can come under price supports paid by the taxpayer for the benefits of a minority. Associated values in preserving water tables and wildlife are too unrealistic to be counted as wise-use. High dams on the Columbia River and its tributaries are authorized by the Federal Power Commission and considered multiple-use even though they destroy the Pacific salmon run and flood out much merchantable timber. Superhighways are sacrosanct even though they destroy much fertile land, and many marshes and clean-running streams.

Outdoor recreation today is attempting to pull itself up by its own bootstraps to a pedestal above the calculated grossness of merchandising as the epitome of multiple-use, but the present synthetic trends and commercialism do not rate this esthetic camouflage. So long as the urban dweller must bring his city images with him to the woods and is unhappy and lost without them, the primitive simplicity of the hinterlands will soon disappear.

It should be pointed out that all these enumerated activities can be included in multiple-use, but not to the exclusion or total disregard for other associated resources. Nor should the integrity of disagreement be impugned, but knowingly or unknowingly this juggling of words becomes a play on semantics to justify any situation wherein mankind desires to plunder this planet.

Most lamentable is the fact that many sincere conservationists have not come to realize the degree of distortions. Decisions must come before the "doing," and wise decisions take thought. There's the rub--too few think resource management through with all its complex ramifications.

The only definition to date that captures the entire spectrum of resource management was long ago expressed by Aldo Leopold: "Conservation is a state of harmony between men and land." That statement should be sufficient, but he goes on to enlarge in case some do not grasp the significance of "harmony."

"By land is meant all of the things, over, or in the earth. Harmony with the land is like harmony with a friend; you cannot cherish his right hand and chop off his left. This is to say, you cannot love game and hate predators; and you cannot build a forest and mine a farm. The land is one organism. Its parts, like our parts, compete with each other and cooperate with each other. The competitions are as much a part of the inner workings as the cooperations. You can regulate them--cautiously--but you cannot abolish them."

I like the word caution. I think today we are hell-bent on a big recreational HURRAH without much caution, as we have done some other things in the past.

I well realize that in a democracy all things advance through compromise. Conservation is no exception. Nor will conservation prosper by having each of us join a mutual admiration society or by having us stuff our ears with cotton to drown out the opposition. To counteract this tendency of self-righteousness and to be apprised of the fact that conservation is composed of many facets of interest, we should listen to the views and problems of others with an open mind.

However, all tax supported programs should be able to stand the test of public scrutiny and debate. And there are times when an impatient administration condemns the friction of analysis as unwarranted criticism of its program. I am convinced that that is true today.

As a nation we pride ourselves on promoting a diversified economy as a safeguard to the general well-being of the nation, and at the same time boast of the simplification achieved in modifying the biological community. Successful farming, for example, has been aimed at pure stands of crops to a single species, as have forest plantings in many instances. We further eliminate any counteractives by various means including poisoning unwanted plants and insects--even animals.

We hold in contempt an affinity for working with nature; our unspoken goal is to subdue nature. Even the recreationists of today, the cottage owner and the transients, relish the idea of subjugation. Multiple-use has become a term of pious justification, whereas we should be learning to harmonize our efforts with nature, which is real multiple-use. Subjugation has become the entire concept of resource management, and we fail to recognize that as we continue to project this artificial creation, the entire structure of our civilization becomes more precarious. People who eulogize Muir and Thoreau do not want any part of the way they lived.

Part of our scientific efforts attempts to substantiate this philosophy under the terms multiple-use, while other parts would repudiate it. If our entire scientific effort does not accept the natural community and regulate it with extreme caution, there will always be needless destruction of resources. Man is a part of nature, and endless rows of test tubes cannot change this.

It might be well to re-examine what the test tubes have produced to see if the results are in harmony with each other, with nature, and with man's best interests. Possibly the first need is to redefine those interests in relation to man's well-being into the coming centuries.

Today's objectives are to create an artificial environment walling mankind away from the natural environment surrounding him. A state of harmony between men and land will become increasingly difficult to achieve, but as an indestructible principle it will survive mankind.

I am confident that the specialties which you gentlemen have developed will survive in spite of all the temporary interests which seem to have captured the public imagination and forced public agencies in charge of basic resources to divert their efforts. We will learn that recreation cannot feed off itself even though we have to learn the hard way.

It is a sign of maturity for every man to analyze the trend of the times, and if need be to walk alone. Maybe you will have to walk alone for the time being, but I predict, not for too long.

REPORT OF THE SEED CERTIFICATION SUBCOMMITTEE OF THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE

by W. H. Brener[1/]

BACKGROUND

The Forest Genetics Conference held at Eagle River, Wis., on March 30 - April 1, 1953, unanimously adopted a resolution approving the formation of a "Lake States Forest Tree Improvement Committee." Part 3 of that same resolution read: "That the tree improvement committee, as one of its first activities, take steps to foster forest tree seed certification in the three Lake States."

Consequently one of the first subcommittees formed within the Lake States Forest Tree Improvement Committee was that on Seed Certification. Its first activity was to develop for the region a set of seed collection zones based on the cumulation of temperatures above 50° F. and on January temperatures. A report embodying these recommendations was published by the Forestry Division, Michigan Conservation Department in 1957.[2/]

1/ Chairman of the Seed Certification Subcommittee and Superintendent of Nurseries, Wisconsin Conservation Department. The other Subcommittee members are D. W. French, F. J. Hodge, E. Kukachka, E. N. Lee, G. Meyer, D. W. Renlund, and Paul O. Rudolf.

2/ Forest Tree Seed Collection Zones for the Lake States. 1957. Mich. Dept. Conserv., Forestry Div. (no series), 13 pp., illus.

Further direction to the Subcommittee came in the form of another unanimous resolution adopted by the Lake States Forest Tree Improvement Committee at Douglas Lake, Mich., in the summer of 1956. It read as follows:

> "The Lake States Forest Tree Improvement Committee believes that a well-organized and adequately controlled system of seed (and seedling) certification could be an immediately effective method of significantly improving the genetic quality of planting stock. It is our judgment that the answers to several of the problems involved in developing a system which eventually could be widely applied can best be found by directly undertaking to produce certified stock on a pilot basis under public auspices. Problems requiring particular attention are: (1) selection of superior tree populations as seed sources, (2) preservation and management of selective stands for seed production, (3) maintenance of identity of seed lots during collection and processing of cones and during the production and distribution of seedlings, (4) statutory provisions for regulating the trade in certified seed and seedling stocks."

The Subcommittee next made a brief survey of tree seed certification throughout the United States and issued a report in October 1959 that included this recommendation:

> "The Lake States Forest Tree Improvement Committee should accept the responsibility of preventing any hasty, ill-advised, or inadequate legislation in the Lake States that may bring forest tree seed certification into disrepute. To this end, it is recommended that the Subcommittee on Forest Tree Seed Certification prepare a set of certification standards which are suitable for Lake States conditions. These standards plus advice on procedures should be available to any group wishing to promote forest tree seed certification in any one of the three Lake States."

Other Certification Activities

The same fall (1959) the International Crop Improvement Association (ICIA) adopted a set of minimum standards for certifying forest tree seeds. These standards had originally been prepared by the Georgia Chapter of the SAF, and they were applicable primarily to southern pines.

Stimulated by this action, the Society of American Forester's Committee on Tree Improvement appointed a Seed Certification Subcommittee with which the Lake States group cooperated. The SAF Subcommittee made a survey of opinion throughout the nation on tree seed certification and proposed a new set of minimum standards for tree seed certification of wider applicability.

In view of these developments our Subcommittee decided to await issuance of the SAF Subcommittee recommendation and to evaluate their applicability in this region.

Developments in Legislation

From the standpoint of legislation the current situation in the Lake States is this: Michigan has a law that provides (as of 1957) for the labeling of tree seeds offered for sale there. Apparently it also could provide for certifying tree seeds if the necessary machinery were set up. Minnesota's seed law defines "agricultural seed" as including seeds of "fiber plants." In some states this has been interpreted to include tree seeds, although others believe an amendment would be required to cover woody-plant seeds. The Wisconsin seed law spells out the definition of "agricultural seed" in more specific terms and would not permit inclusion of tree seeds without an amendment.

The Association of American Seed Control Officials (AASCO) has developed a Recommended Uniform Seed Law, actually a model state seed law, to foster uniformity in seed legislation. AASCO had a Flower, Tree and Shrub Seed Committee that proposed, in 1961, amendments to this model law to cover woody-plant seeds. It also recommended the extension of the Federal Seed Act to cover woody-plant seeds. Largely at the request of foresters to study these proposals further, the AASCO has not yet acted on its committee's recommendations.3/

RECENT ACTIVITIES OF THE SUBCOMMITTEE

The Subcommittee has studied the 1962 ICIA minimum certification standards for tree seeds (based on the SAF Seed Certification Subcommittee recommendations). It considers them suitable for adoption in the Lake States except that designation of "elevation to the nearest 500 feet of the original geographic source" need not be an essential requirement.

The Subcommittee also has studied the Recommended Uniform Seed Law and the amendment to it recommended by the former Flower, Tree and Shrub Seed Committee of the AASCO. It believes that the amended model law, or something comparable to it, would be a desirable guide for the development of state tree seed laws in this region when and if such legislation is needed.

3/ Ed. Note. AASCO did, however, take affirmative action in October 1963 on these recommendations.

In addition the Subcommittee has reviewed the following resolution adopted by the Northeastern Forest Tree Improvement Conference in 1962:

"Be it resolved that this Conference go on record as favoring steps to inform the public authorities and administrators on the need for tree seed improvement and that such improvement be accomplished by enacting the following two amendments into the Federal Seed Act as soon as possible: (A) Prohibit the interstate shipment of tree and shrub seeds unless the seeds so shipped conform to the requirements of the seed laws and the rules and regulations pertaining to such seeds in the state into which the seeds are shipped, (B) prohibit importation into the United States of any tree and shrub seeds which fail to meet minimum standards of purity and germination to be established by the Secretary of Agriculture."

The consensus of the Subcommittee was that this resolution made good sense. The provisions of the resolution if enacted would protect U.S. purchasers against imported tree seed of low physical quality and would protect users in states with tree seed laws against inferior seed from out of state while imposing no restrictions within states that for one reason or another did not want or need their own tree seed laws.

Finally the Subcommittee is aware of the substantial progress in establishing seed production areas throughout the region during the past 5 years.

SUBCOMMITTEE RECOMMENDATIONS

The following are apparent to the Subcommittee:

(1) The great majority of foresters contacted support tree seed certification in principle.

(2) Mandates from the original Lake States Forest Genetics Conference and from the Lake States Forest Tree Improvement Committee since then have directed the Subcommittee to provide guidelines for tree seed certification in this region.

(3) Currently nurseries in the Lake States use about 6 tons of tree seed annually, about 60 percent in public nurseries and about 40 percent in private nurseries. Although much of this seed is collected or procured locally by the user, commercial trade in tree seed gives signs of increasing in the region and seed imports may increase.

(4) Within the next few years an increasing amount of seed from seed production areas will be used by public nurseries, and within 20 years there may be a significant amount of seed produced from seed orchards in the Lake States. Some of this may enter the seed trade.

In view of these facts and the background information previously related, and in the belief that tree seed certification will protect seed buyers, will encourage the production of seed of improved forest trees and will lead to more intensive forestry the Subcommittee recommends that:

1. The ICIA minimum standards for tree seed certification be considered as a basis for local tree seed certification standards in the Lake States. We suggest that the Upper Mississippi Valley Section and the Wisconsin-Michigan Section of the SAF refer the standards to appropriate committees for study, the development of local standards, and their referral to appropriate authorities or associations when standards are needed.

2. A model law, similar to the Recommended Uniform Tree Seed Law as amended by the former Flower, Tree and Shrub Seed Committee of AASCO, be provided to guide the development of state legislation, particularly in Minnesota and Wisconsin, when needed. This might well be done by the respective SAF Sections as suggested under item 1. State agencies should be encouraged to develop tree seed legislation only after it is apparent that there is a real need for it and only if they are assured of the necessary manpower and funds to administer and enforce such legislation.

3. We support amendments to the Federal Seed Act that will (a) prohibit interstate shipment of woody-plant seeds unless the seeds so shipped conform to the requirements of the seed laws and the rules and regulations pertaining to such seeds in the states into which they are shipped, and (b) prohibit importation into the United States of woody-plant seeds that fail to meet minimum standards of purity and germination to be established by the Secretary of Agriculture. Appropriate organizations, agencies, and officials should be advised of our stand.

4. Users who collect their own tree seed look to the recommended seed certification standards as a guide to classification of and record-keeping on the seed they use.

In concluding this report we wish to stress that tree seed certification should be primarily for the benefit of the seed user. He should realize that he will have to bear the added costs of certifying seed, and he should therefore understand the probable value of the different seed categories and that the stock developed from such seed must be grown under certain conditions to attain its potential value.

REPORT OF THE SUBCOMMITTEE ON RESEARCH EVALUATION, COORDINATION, AND PLANNING: USEFUL ADAPTATIONS OF GENETIC RECORD SYSTEMS FOR COMPUTER ANALYSIS

by Jonathan W. Wright[1/]

Computers are becoming so generally available that they can be expected soon to be used for most computational work connected with forest genetic studies. Efficient computer use requires that both measurement and record-system techniques be designed with computer computation in mind. This can save up to 90 percent in data-preparation time. Following are some helpful generalizations which have come out of the past few years' experience.

1. Data are presented to a computer as numbers in rows and columns. They can be recorded in the same manner--there is no need for decimal points, slant lines, letter symbols, etc. Records in which it is necessary to look from one page to the next to make a comparison are especially troublesome.

2. Use of a computer does not lessen the need for assessing the usefulness of data prior to collection. Willy-nilly processing of data without thought leads to large increases in interpretation time.

3. Port-a-punch cards are probably not useful in genetic studies. A moderately good typist can type tape or cards from written sheets at the rate of 10,000 characters per hour. Thus, the port-a-punch cards can possibly save no more than 1 hour for every 10,000 numbers recorded. Actually, their use involves additional rather than less time. The same principle applies to mark-sense cards. Ruled sheets of paper are apparently the most efficient recording media.

4. Currently there are several large geographic origin tests which are represented in each of several different localities. The measurements and analyses of the individual plantings probably will be made by the individuals who established them, but it is desirable to make overall summaries also. If the analyses of the individual plantings are complete and properly done, the overall statistical analyses often can be accomplished in one or two days. However, to do that, the method of analyzing and reporting the individual plantings must be thought out carefully.

1/ Member of the RECAP Subcommittee and Associate Professor, Forestry Department, Michigan State University. The Chairman of the RECAP Subcommittee is Paul O. Rudolf, and the other members are Dean Einspahr, H. L. Mitchell, and Stephen H. Spurr. Since there are no other reportable activities, the above paper constitutes the Subcommittee report.

a) Each person should report in columns if the others report in columns. It is desirable but not necessary that the same measurement-set be recorded in the same column by all. It is not necessary for all investigators to use cards or tapes as input for the computers for their results to be combined easily.

b) The variety-sequence in which data are reported should be the same for all. Suppose one investigator included 108 varieties in his planting and the second only 72 of those 108 varieties. The second investigator should report for all 108 even though he inserts dashes for the 36 which are missing from his field test.

c) Investigators need not measure the same traits at the same time to make useful comparisons. However, if they do measure the same traits, they should use the same units and approximately the same accuracy of measurements. Comparisons are very weak if one man recognizes 2 color grades and another person recognizes 10. There is considerable confusion and increase in time if it is necessary to do much conversion from one set of units to another.

d) Except in special circumstances it is necessary when making overall summaries to have access to <u>all</u> the data gathered by each cooperator. This includes the plot means (recorded by variety and trait) and varietal totals (totals certainly, varietal means possibly) for each measurement set (including the degrees of freedom, sums of squares, mean squares, F values), and the complete analyses (b's, r's, variances, covariances) when correlating one trait with another. With all computers there are facilities for easy duplication so that there is no reason why an individual investigator cannot supply <u>all</u> data to the central agency doing the summarizing.

Space is too limited here to give all the reasons for requiring that all these data be supplied to a summarizer. However, it can be pointed out that an investigator supplied with all the data and analyses need not go through any unnecessary duplication of effort when he decides to combine data if he has everything in front of him. For example, varietal totals are needed if one wishes to compute genotype-environment interaction. If they have already been calculated, why go through the work again?

e) In certain perfectly regular experiments a summarizer can get by with less information. Suppose the same 20 varieties are replicated 10 times in each of 5 field tests. An investigator armed with varietal and replicate totals for each planting; plantation totals; and sums of squares for error, variety, and replicate in each planting can turn out a complete overall analysis of variance in a half-hour or so.

5. A person who plans to use a computer for his analysis work should spend at least one week acquainting himself with the computer and its operation before going to the field to make his measurements. When this is not done, about 90 percent of the measurement-sets later prove unsuitable for analysis or in need of extensive editing before submission to the computer. On the other hand, it is usually possible to take measurements in such a manner that a week's data can be analyzed in 2 hours at the end of the same week.

LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE AFFAIRS

by Paul O. Rudolf[1/]

Members of the Lake States Forest Tree Improvement Committee serve 4-year overlapping terms. At each biennial conference the terms of half the members are completed, and an equal number of new appointments or reappointments are made. At this time a new Chairman and Vice Chairman also are elected. The Executive Secretary serves a continuing term.

At the close of the Grand Rapids conference, committee officers, membership, and subcommittee assignments were as follows:

1/ Executive Secretary, Lake States Forest Tree Improvement Committee.

Name	Address	Appointed through	Subcommittee assignments
Scott S. Pauley (Chairman)	School of Forestry University of Minnesota St. Paul, Minn. 55101	1957	RECAP
Jonathan W. Wright (Vice Chairman)	Department of Forestry Michigan State University East Lansing, Mich. 48824	1965	RECAP
Paul O. Rudolf (Exec. Sec'y)	Lake States Forest Expt. Station St. Paul Campus University of Minnesota St. Paul, Minn. 55101	1965	RECAP (Chairman) Seed Certification
W. H. Brener	Griffith State Nursery Wisconsin Rapids, Wis. 54494	1965	Seed Certification (Chairman)
Dean Einspahr	Institute of Paper Chemistry Appleton, Wis. 54910	1967	RECAP
Gene Hesterberg	Department of Forestry Michigan Technological University Houghton, Mich. 49931	1967	Seed Certification
F. J. Hodge	Forestry Division Michigan Conserv. Dept. Lansing, Mich. 48926	1967	Seed Certification
Fred Knight	School of Natural Resources University of Michigan Ann Arbor, Mich. 48105	1967	RECAP
Emil G. Kukachka	Division of Forestry Minn. Conserv. Dept. St. Paul, Minn. 55101	1965	Seed Certification
E. N. Lee	U. S. Forest Service 710 North Sixth Street Milwaukee, Wis. 53203	1967	Seed Certification
Gene Meyer	Marathon, A Division of American Can Co. Box 121, Mercer, Wis. 54547	1965	Seed Certification
H. L. Mitchell	Forest Products Laboratory Madison, Wis. 53705	1967	RECAP

Name	Address	Appointed through	Subcommittee assignments
R. F. Patton	Dept. of Plant Pathology University of Wisconsin Madison, Wis. 53706	1965	RECAP
Stephen H. Spurr	School of Natural Resources University of Michigan Ann Arbor, Mich. 48105	1965	RECAP

Plans for next regional conference.--The next biennial conference will be held in 1965. In normal sequence it will be held in Michigan, and it is so planned. Jonathan W. Wright, as Vice Chairman of the Lake States Forest Tree Improvement Committee, automatically serves as program chairman, and he will be responsible for planning and arranging the Seventh Lake States Forest Tree Improvement Conference. He will be assisted by other members of the Committee, especially those from Michigan who will serve with him as the Program Committee.

Newsletter.--The Lake States Forest Tree Improvement Committee issues a newsletter, "Trebredinews," at irregular intervals, but about once a year between the regional conferences. The newsletter includes brief reports of the status of tree improvement work among agencies in the Lake States, information on recent or forthcoming regional conferences, and news of tree improvement interest from other regions and countries. Each issue is prepared and distributed by one of the member agencies of the Lake States Forest Tree Improvement Committee. The most recent issues were distributed in February 1962 (by the Michigan Conservation Department) and April 1963 (by the U. S. Forest Service, Region 9).

Action on tree seed certification.--The report of our Seed Certification Subcommittee was presented informally to the Upper Mississippi Valley Section of the Society of American Foresters on September 9. Since then the report has been transmitted formally by Chairman Pauley to the respective chairmen of the Upper Mississippi Valley Section and the Wisconsin-Michigan Section, SAF. We understand that both Sections have referred the report to Section committees for action.

RESOLUTION PRESENTED TO SIXTH LAKE STATES FOREST TREE IMPROVEMENT CONFERENCE

Meeting Jointly with the UPPER MISSISSIPPI VALLEY SECTION SOCIETY OF AMERICAN FORESTERS

It is resolved that the members of the Sixth Lake States Forest Tree Improvement Conference and the Upper Mississippi Valley Section, Society of American Foresters, unanimously express their appreciation and thanks to the following for their part in arranging the meeting:

Scott S. Pauley of the University of Minnesota who bore the overall responsibility for organizing this meeting;

William Cromell of the University of Minnesota North Central School and M. J. Latimer of the Blandin Paper Company who were co-chairmen in charge of local arrangements;

William Matalamaki, Superintendent, and other staff members of the University of Minnesota North Central School and Agriculture Experiment Station for providing meeting and eating facilities.

Other members, too numerous to mention individually, of the Northwest Chapter, Upper Mississippi Valley Section who carried out all those essential details that contribute to the smooth operation of a meeting;

The Blandin Paper Company, the University of Minnesota, the Chippewa National Forest, and the Lake States Forest Experiment Station for making their facilities available for the field trips;

The elected officers of the Lake States Forest Tree Improvement Committee, F. J. Hodge and S. S. Pauley, and the Upper Mississippi Valley Section of the Society of American Foresters, James Morgan, Carl Stoltenberg, and Bruce Brown, who have served their respective organizations during the past year;

and especially to Paul O. Rudolf, Executive Secretary of the Lake States Forest Tree Improvement Committee, who, with unflagging interest and enthusiasm, has guided this organization during the 10 years of its existence.

W. H. Brener /s/ W. H. Brener

G. W. Hammer /s/ George W. Hammer

A. L. Lundgren /s/ Allen L. Lundgren
Chairman
Resolutions Committee

Grand Rapids, Minn.
September 9, 1963

NC-51 COMMITTEE MEETING

On September 8 and 9 the Forest Tree Improvement Committee of the North Central Region land grant colleges (NC-51) met at Grand Rapids. They discussed the current status of cooperative regional tree improvement studies, new methods of alloting funds for such projects, requirements for project reports, and plans for new studies and the continuation of those already established.

Members of the Committee present were as follows: Clair Merritt (Indiana), J. J. Jokela (Illinois), G. E. Gatherum (Iowa), Paul Roth (Kansas), Maurice Day (for Jonathan Wright - Michigan), Scott S. Pauley (Minnesota), R. Brooks Polk (Missouri), Walter J. Bagley (for Ralph Read - Nebraska), Donald T. Lester (Wisconsin), Robert W. Hougas, Adviser (Wisconsin), Philip N. Joranson (Cooperative State Experiment Stations Service), and Paul O. Rudolf (Lake States Forest Experiment Station).

CONFERENCE BANQUET

On the evening of September 9, the conference banquet was held at the Rainbow Club in Grand Rapids. The skillful and effective master of ceremonies was Roger Bay of the Lake States Forest Experiment Station, Grand Rapids. The feature of the evening was a well-delivered, thought-provoking address by Ernest F. Swift now functioning as Conservation Advisor to the National Wildlife Federation which he formerly served as Executive Secretary. Mr. Swift previously headed the Wisconsin Conservation Department and held high positions in the U. S. Fish and Wildlife Service.

FIELD STOPS ON THE PROGRAM OF THE SIXTH LAKE STATES FOREST TREE IMPROVEMENT CONFERENCE

The Sixth Lake States Forest Tree Improvement Conference followed the pattern of the Fifth Conference: half a day was spent in indoor sessions and 1½ days in the field.

Most of the field stops represented tree improvement or site preparation activities of some of the member agencies of the Lake States Forest Tree Improvement Committee. One or more representatives of the respective agencies acted as tour guides at each stop. In the following pages we give pertinent facts presented by the tour guides.

University of Minnesota, North Central School and Experiment Station

Tour Guide: William Cromell[1/]

Chapman Plantation

One of the oldest successful plantations in Minnesota was established in 1900 by H. H. Chapman, then Superintendent of the North Central Experiment

1/ Instructor, North Central School and Experiment Station, University of Minnesota.

Station. He obtained wild Norway (red) pine seedlings from Carlton County. This stock was set out in rows on previously cultivated land here on the station, and the seedlings were cultivated for three growing seasons prior to the April 1900 planting date. The portions of the plantings observed on this tour are located on sandy soil that had been cut over and had little value for agricultural crops. The pine was planted here at a 6 x 6-foot spacing; survival was satisfactory at the end of the 1901 growing season.

In 1905, a spring fire killed many of the young pines, but enough trees remained to justify keeping records on them. In 1915 Professor J. H. Allison from the School of Forestry recorded the first data. Each tree was numbered and has been accurately measured every 5 years. Professor Allison has been part of the 2-man team making the measurements since he initiated the project. The 1961 data are as follows:

	Plot A	Plot B	Plot C
Original no. of trees	1,200	1,200	1,200
Present no. of trees	387	210	173
Present basal area - square feet	240.4	180.6	185.1
Present total merch. vol.--cords	93.4	73.0	74.5
Present vol. Scrib. Dec. C--bd. ft.	36,024	28,464	29,664
Mean annual growth--cords	1.60	1.17*	1.19*
Mean annual growth--bd. ft.	554	438	456
Total height--feet	69-78	70-74	70-74
D.B.H. spread--inches	7-18	7-17	10-18
Ave. D.B.H.--inches	10.7	12.6	14.0

*These rates of growth would be higher if all thinning material had been included.

Norway Pine Christmas Tree Plantings

During the winter of 1958 the low-grade hardwoods and brush were cut on this area. The only product salvaged from the site was fuel wood. The tops and brush were piled and burned. The next summer (1959) the area was very heavily invaded with root and stump sprouts. During July 1959 the area was sprayed with a combination of 2,4-D and 2;4,5-T in the ester form, each 21.3 percent by weight or 2 pounds per gallon, using a water carrier.

This combination was mixed at the rate of 5 quarts for each 150 gallons of water and was applied at the rate of 60 gallons per acre with a farm tractor and tank. The total cost per acre for spraying, including chemicals, labor, and tractor costs, was $10.74. Our average per acre for all spraying on such sites at the station is $11.20. This treatment gave a 70 percent kill of the new sprouts in the following spring. Some spot spraying may still be necessary.

In April of 1960 a block of 3,500 2-2 Norway pine and a similar block of 3-0 Norway pine were hand planted at a spacing of 5 x 5 feet or about 1,700 trees per acre. The spring of 1960 was very dry. Survivals were 88 percent for the transplants and 55 percent for the seedling stock. Replacements were made in 1961 in the seedling block. The trees in the transplant block averaged 28 inches this July (1963). About one-half, or 700 per acre, of the remaining trees in the 2-2 transplant block were sheared. The 3-0 seedlings were just reaching grass and weed height, so no shearing was done.

This project will be carried through until the trees are harvested as Christmas trees.

University of Minnesota, School of Forestry and the Blandin Paper Company

Tour Guides: Scott S. Pauley, Jerome Klein, Carl Mohn, and Lawson Winton[2/]

Several experimental plantations have been established by the University of Minnesota in cooperation with the Blandin Paper Co. at the D. M. Gunn Memorial Park near Grand Rapids. They include white spruce, black spruce, red spruce, Norway spruce, Rosendahl spruce, Japanese larch, some miscellaneous conifers, and an arboretum representing primarily species of *Populus* and *Betula*. Special attention was devoted to four of these plantings.

Plantation A

In the spring of 1958 twenty-five lots of stock were hand planted 5 feet apart in lattice square arrangement, using 25-tree square plots and three replications of each lot. Fail spots were replanted in May 1961. The stock included 19 Ontario and Quebec sources of white spruce (grown in 1954 and 1955 at the Petawawa Forest Experiment Station Nursery, Chalk River, Ontario and in 1956 and 1957 at the Hugo Sauer Nursery, Rhinelander, Wis.), three

2/ Respectively Professor, and Research Assistants, School of Forestry, University of Minnesota.

additional white spruce sources and one each of black spruce, Norway spruce, and balsam fir (grown at the General Andrews State Nursery and Kimberly-Clark Inc.'s Knife River Nursery, both in Minnesota). White spruce border rows were planted so there are two around each block and one around each plot.

Some distinct differences between sources are becoming apparent.

Plantation B

In the spring of 1962 there were planted 26 lots of 2-2 stock in randomized complete blocks, using 10 replications of 4-tree (row) plots. The trees were hand-planted at an 8 x 8-foot spacing, using two local white spruce border rows around the plantation.

The stock consisted of 25 sources of white spruce from over the species' range (supplied by LSFES as 2-0 stock from the Hugo Sauer Nursery, Rhinelander, Wis. in the spring of 1960 and grown in the NCSES nursery until the spring of 1962), one Itasca County source of white spruce, and one Itasca County source of black spruce, both supplied by the Blandin Paper Co. nursery. Most of these sources were also outplanted near Burgeson's Landing, Cloquet, North Branch, and St. Paul, Minn.

Some source-related differences already seem evident.

Plantation C

Five sources of 2-2 Norway spruce were hand-planted at 8 x 8-foot spacing in the spring of 1962. This stock was supplied by the LSFES as 2-0 stock obtained from the Petawawa Forest Experiment Station in the spring of 1960 and was grown for 2 additional years in the NCSES nursery. The study is laid out in randomized complete blocks using 5 replications of 4-tree (rows) plots per source. There is a single border row around most of the plantings; three different lots of stock (some hybrid white x black spruce, some white spruce, and some black spruce) were used in it.

These Norway spruce sources were also outplanted at the North Central School and Experiment Station and at North Branch.

Plantation E

In May 1962 the following stock was hand-planted at 8 x 8-foot spacing in 12-tree row plots: (1) open-pollinated Cromwell white x black (Rosendahl) spruce hybrid, and (2) Itasca County black spruce. Itasca County white spruce stock was planted as border rows on the north and south sides without replication.

Blandin Paper Company

Tour Guide: M. J. Latimer[3/]

In addition to the cooperative studies at the Gunn Memorial Park, the following Blandin Company activities were observed: (1) The Blandin Nursery, (2) site preparation in progress with the K/G shearing blade, and (3) spruce plantations.

The Blandin Nursery

A quick tour of this modern nursery provided an opportunity to see seed extraction, seeding, and cultivation equipment; spruce seedling and transplants beds; and some fertilizer trials. The stock looked very good.

Site Preparation

The details as to methods and costs of the site preparation methods used by the Blandin Paper Company are given in Latimer's paper earlier in the Proceedings. The group did, however, have an opportunity to see equipment in action using the K/G blade and to see what these aspen areas looked like before and after treatment.

Spruce Plantations

Machine-planting was demonstrated on a recently sheared area. Some recently established plantings also were examined in the field. In addition a 1957 white spruce plantation in the Gunn Memorial Park was observed. It demonstrated white spruce's ability to grow through competing vegetation and indicated that postplanting releases probably would not be required.

Portage Lake Seed Production Area, Chippewa National Forest

Tour Guide: Roger Hatch[4/]

This red pine seed production area, recently completed, occupies 32 acres and is surrounded by a 400-foot-wide buffer zone which occupies an additional 32 acres. The good-quality stand is about 60 years old and has a site index of 60. It is anticipated that the seed production area will provide enough seed to produce 1,000,000 plantable seedlings per year.

3/ Forester, Blandin Paper Company.

4/ District Ranger, Bena District, Chippewa National Forest.

The trees selected for seed production have the following characteristics: Straight, well-formed single stems--no crooks or forks and a minimum of sweep; high form class; natural pruning as high as or higher than comparable neighboring trees; small limbs arising from the main stem at an angle of about 90°; dominant or codominant crown class; healthy, narrow, full, and even crowns; a rate of growth at least average for the stand; freedom from serious insect or disease damage; and evidence of good ability to bear cones. Trees were removed if they showed any spiral or twist in the bole; repeated crooks not directly attributable to mechanical injury; heavy, persistent branching; ramicorn branches; and diseased or insect-infested trunks or crowns.

During the tour National Forest personnel demonstrated climbing equipment and techniques and cone collection methods.

Site Preparation on the Chippewa National Forest

Tour Guides: Robert Lease and James Seward[5/]

The reforestation program on the Chippewa National Forest has reached the stage where the open areas and easy chances are largely planted and the primary job remaining is the conversion of low-grade hardwoods and poor-site aspen. The Forest has been trying out different methods of site preparation to determine the cheapest and most satisfactory method for various conditions. Furrowing, discing, brush chopping, shearing, and burning have been tried under various conditions. The tour passed along the edge of an area of more than 300 acres that has been cleared by mechanical means but did not make a stop there. The tour did stop at a second area on which more than 100 acres have been cleared by prescribed burning.

Furrowing has been the cheapest and has been satisfactory in brush and small sapling stands. Heavy slash or stump concentrations prevent a good job of furrowing. Furrowing costs have run from $5.25 to $22.00 per acre, averaging $5.50 to $7.00 per acre.

Discing had been used extensively up to about 1959 when other types of clearing equipment became available. Discing is cheaper than brush chopping or shearing but generally results in heavy sprouting. Heavy stump concentrations prevent a good job. Plantings in disced areas appear to have suffered heavier losses from drought conditions than those in brush-chopped areas. No comparisons are yet available with sheared areas. Discing costs have varied from $8.45 to $16.00 per acre.

5/ Respectively Timber Management staff officer, Chippewa National Forest, and District Ranger, Cass Lake District, Chippewa National Forest.

Brush chopping has been used rather extensively and has given good results where the stand was not too heavy and stumps were not a problem. It has been used primarily on areas covered with brush, saplings, or small poles. It has been most effective in aspen stands on sandy soils. Again heavy stump concentrations prevent a good job. Stands too dense for discing can be brush chopped. Optimum stands for brush chopping are those containing very few trees over 8 inches d.b.h. Brush-chopped areas cannot be machine planted, and they usually require release earlier than sheared or burned areas. Costs have varied from $22 to $33 per acre, averaging $31.

Shearing with a Rome K/G blade was started in 1962. Heavier stocked stands can be cleared and larger trees handled than by any other method tried. Trees up to 13 inches present no problem. Red and white oak 18 inches d.b.h. have been sheared in winter, but we feel it is not economical to shear trees over 13 inches d.b.h. Shearing when the ground is frozen is easier and cheaper but results in heavier sprouting. Shearing in light soils in unfrozen ground results in more uprooting than shearing.

Windrows after winter shearing are reasonably compact, contain very little soil, and can be burned easily the following summer. Summer windrowing generally contains too much soil to burn easily. In windrowing, the greater the distance the trees are pushed the more soil there is in the windrows. We feel the optimum distance apart for the windrows is 125 to 150 feet. At this distance the windrows generally occupy from 10 to 15 percent of the area. Windrow area in winter shearing has been as low as 8 percent.

Sheared area can be machine planted, although a small hand crew is generally necessary to fill in beside the windrows.

Shearing costs have varied from $27.40 to $38.00 per acre. The increased cost is partially compensated by the lower costs of machine planting.

Prescribed burning has been tried at several seasons. In general, summer fires have proved to be safer and more effective than spring fires. Prescribed burning is used predominantly on cutover areas. In some instances brush on an area has been deadened by chemical sprays before the area has been burned. Burned areas usually can be planted by machine, and release is not required as soon as on brush-chopped areas.

Prescribed burning costs have ranged from $10 to $20 per acre with the mode about $13 to $15.

Field stops were not made on the Chippewa National Forest to examine areas where mechanical ground preparation methods had been used because similar conditions had been viewed the previous day. The tour did, however, pass by a sizable area on the Cass Lake District on part of which brush chopping had been done during the summer of 1961 and on another part of which shearing had been done in the fall of 1962. These areas were pointed out in passing. Most of them had been planted between the fall of 1961 and the spring of 1963.

A field stop was made at two burns on the Cass Lake District. One, of 63 acres, had been burned in May 1960 at a cost of $11.23 per acre and planted with red pine transplants shortly thereafter. The area was replanted in the spring of 1961 and again in the fall of 1961 and was released in the summer of 1961 by an aerial spray of $1\frac{1}{2}$ pounds per acre of 50-50 mixture of 2,4-D and 2,4,5-T. On an adjoining area of 99 acres, 30 acres had been burned in August 1962 at a cost of $16 per acre. It was planted in the fall of 1962 with 2-1 red pine.

Regional Jack Pine Seed Source Study

Tour Guide: Thomas D. Rudolph[6/]

In 1951 the Lake States Forest Experiment Station and the University of Minnesota jointly drew up plans for a regional jack pine seed source study to complement two such tests already underway, one in Minnesota and one in Michigan, to study racial differences in jack pine within the Lake States.

Federal, State, and private forestry agencies collected cones from 29 jack pine stands in the three Lake States during 1951 and 1952. Stock was grown in state nurseries in Minnesota and Wisconsin.

The 2-0 stock was set out in 17 plantations in the Lake States, one of which is the plantation on the Chippewa National Forest. This plantation was established in May 1954 and contains all of the 29 sources plus a "local" source. A 2-row isolation strip surrounds the plantation.

A randomized block design with four replications was used in all the plantations. Each seed origin was represented in each block by a 64-tree plot arranged in 8 rows of 8 trees at a 5 x 5-foot spacing.

Survival counts made at the end of the first, second, and fifth growing seasons showed considerable variation between seed sources, but no definite patterns of differences were apparent.

At the end of the fifth year in the Chippewa National Forest Plantation Source 1595 from St. Croix State Park in Minnesota was the tallest, and Source 1605 from the Chequamegon National Forest in Wisconsin was the shortest. Average height development in this plantation was the poorest of the six Minnesota plantations and was only slightly over 50 percent of that in the best Minnesota plantation.

Repeated attacks of various insect pests probably account for much of the poor development of this planting. Striking apparent differences between seed sources in susceptibility to the jack-pine shoot moth and white-pine weevil were revealed by the fifth year observations.

6/ Plant Geneticist, Lake States Forest Experiment Station, Institute of Forest Genetics, Rhinelander, Wis.

Lammas growth and prolepsis occurrence in 1958 in this plantation differed significantly between seed sources. These late shoots occurred most frequently in the more southerly sources and least often in the northern sources (see table 1).

Further information on the early results of this jack pine seed source study is available in the following publications:

Arend, John L., Smith, Norman F., Spurr, Stephen H., and Wright, Jonathan W. 1961. Jack pine geographic variation--five-year results from Lower Michigan. Mich. Acad. Science, Arts, and Letters Papers 46: 219-238.

Batzer, H. O. 1961. Jack pine from Lake States seed sources differ in susceptibility to attack by white-pine weevil. U.S. Forest Serv., Lake States Forest Expt. Sta. Tech. Note 595, 2 pp. (Processed.)

Jensen, Raymond A., Schantz-Hansen, T., and Rudolf, Paul O. 1960. A study of jack pine seed source in the Lake States. Minn. Forestry Notes No. 88, 2 pp. (Processed.)

King, James P.,and Nienstaedt, Hans. 1963. Variation in needle cast susceptibility among 29 jack pine seed sources. (Ms. in preparation for publication.)

Rudolph, T. D. 1963. Lammas growth and prolepsis in jack pine in the Lake States. (Forest Science Monograph in press.)

Stoeckeler, J. H., and Rudolf, Paul O. 1956. Winter coloration and growth of jack pine in the nursery as affected by seed source. Zeitschr. Forstgen. Forstpflanzenzüchtung 5: 161-165.

Table 1.--Characteristics of the jack pine seed source plantation on the Chippewa National Forest in 1958 after 5 years in the field

Source no.	Origin	Survival	Ave. height	Trees injured by J.P. shoot moth	Trees injured by white-pine weevil	Trees with lammas growth	Trees with prolepsis
		Percent	Feet	Percent	Percent	Percent	Percent
Local	Chippewa N.F.	89	2.8	13.2	2.6	---	---
1589	Chippewa N.F.	86	2.8	7.7	4.1	11.5	19.7
1590	Chippewa N.F.	91	3.0	10.3	3.0	--	--
1591	Cutfoot Expt. For.	86	2.9	11.9	2.7	--	--
1592	Superior N.F.	93	2.8	13.4	2.9	--	--
1593	Superior N.F.	95	2.9	19.0	3.3	1.9	2.8
1594	Superior N.F.	91	3.0	15.9	3.4	--	--
1595	St. Croix State Park	89	3.3	9.2	12.3	--	--
1596	Gen. Andrews Expt. For.	92	3.1	7.7	12.3	4.5	16.1
1597	White Earth S.F.	89	3.0	9.1	4.4	--	--
1600	Crow Wing S.F.	89	2.9	15.0	3.5	--	--
1601	Miss. Headwaters S.F.	89	2.7	8.3	3.1	2.9	5.7
1602	Geo. Wash. S.F.	91	2.9	9.9	5.2	--	--
1604	Mosinee Ind. For.	86	3.2	8.6	8.6	--	--
1605	Chequamegon N.F.	84	2.6	6.5	1.8	--	--
1606	Nicolet N.F.	86	2.8	10.4	5.9	--	--
1607	Nicolet N.F.	83	3.1	8.9	6.6	--	--
1608	Burnett Co. For.	89	3.2	11.9	7.5	--	--
1609	Marinette Co. For.	87	3.1	7.2	9.9	13.8	16.0
1610	Nepco Ind. For.	84	3.0	11.1	8.8	14.6	16.7
1611	Nepco Lake Area	90	3.1	11.7	11.3	19.3	34.1
1612	Ottawa N.F.	91	2.9	9.5	12.1	--	--
1613	Ottawa N.F.	85	3.1	12.0	3.2	--	--
1614	Hiawatha N.F.	87	3.0	12.6	4.5	--	--
1615	Marquette N.F.	85	2.7	12.4	6.9	--	--
1616	Manistee N.F.	87	3.1	9.0	4.5	20.4	35.5
1617	Ogemaw S.F.	85	3.0	11.5	5.5	--	--
1618	Alpena S.F.	80	3.2	12.7	8.3	9.8	17.4
1620	Huron N.F.	76	3.2	3.6	4.1	--	--
1621	Lake Superior S.F.	82	2.6	17.7	4.3	5.7	12.6

International Union Seed Source Studies

of Scotch Pine and Norway Spruce

Tour Guide: Hans Nienstaedt[7/]

For many years racial variation of forest trees has been a challenge to foresters in Europe where trees have been planted extensively for a couple of centuries. Studies dating back more than 100 years have enabled European foresters to improve management practices in several respects:

1. Decreased yields resulting from the planting of races poorly adapted to particular environmental conditions are now avoided.

2. Yields can in some instances be increased through the planting of races better adapted than local races.

3. By selecting and crossbreeding the right races, it has been possible to increase yields over and above what any naturally occurring races could produce.

4. Studies have furnished information essential for the production of high-yielding species hybrids.

This is the type of data that well-designed seed source studies will supply.

These plots on the Pike Bay Experimental Forest are one of the two plantings in the Lake States of seed source studies sponsored by the International Union of Forest Research Organizations and initiated just before World War II. The same material has been planted in New England and throughout Europe. The trees are now 25 years from seed, the original spacing was 2 x 2 feet, the first thinning was completed 1951, and thinning has been repeated since then.

Formal measurements have not been made in the Pike Bay plots. However, local observations on winter injury of Scotch pine indicate seed source differences--Northern European and Russian collections are not damaged, while Southwestern and low-elevation Central European seed sources are. Height measurements--15-year results--on the same seed sources grown at Wellston, Mich., indicate that both spruce and pine seed collected in certain locations in Poland may give the best results in this region.

7/ Plant Geneticist, Lake States Forest Experiment Station, Institute of Forest Genetics, Rhinelander, Wis.

One of the current important uses of Scotch pine is for Christmas trees--large areas are being planted in the Lake States annually. For this purpose winter discoloration is of major concern. It is a factor greatly affected by seed source. Southwestern and low-elevation Central European seed sources usually retain the best green color during the winter months.

Hybrids of western white pine and the native species are also being tested at Pike Bay. The hybrids were made in an attempt to develop a new blister rust-resistant strain. It has been a failure because the seed source of the western pine was poorly adapted to the test environment.

Photoperiodism in Several Lake States Forest Tree Species

Tour Guide: Richard Watt[8/]

Stock of red pine, white pine, black spruce, and white spruce was grown in a nursery in northern Florida and a nursery in northeastern Wisconsin. Artificial light was used to supplement the naturally short photoperiod that accompanies the long growing season in Florida. As a check, artificial illumination was also used on part of the material in the Wisconsin nursery.

With the added light, stock of all four species grew about twice as fast in the southern nursery as in the Lake States nursery. The added daylight also increased somewhat the growth of the spruces, but not the pines, in the Lake States nursery.

Southern-grown 2-0 stock was planted along with northern-grown stock of similar size (but 2-2 in age) on the Pike Bay Experimental Forest. After 2 years in the field the southern-grown stock has done just about as well as the older and more expensive stock from the northern nursery.

Results of this study may ultimately open the way to cheaper and more rapid production of high-quality outplanting stock for reforestation in the Lake States. The extension of the photoperiod in nurseries in the Lake States may also prove advantageous for growing spruce stock.

8/ Research Forester, Lake States Forest Experiment Station, St. Paul Minn.

Red Pine Seed Source Study Plot

Tour Guide: Robert Buckman[9/]

In 1937, 2-1 stock of 48 sources of red pine was field planted on a completely prepared site on the Pike Bay Experimental Forest. Hand cultivation during the first few years kept down competition.

Growth has been excellent, and two silvicultural thinnings have been made. This treatment, along with the natural lack of strong variation within the species, has resulted in little evident difference between sources. At age 27, for example, there was little or no significant difference in height between sources. Measurements of diameter, volume per acre, kinds of injury, or other features were not analyzed at that time. Some of those might have varied more than height. At any rate a companion plantation made in the Northeast at the same time with most of the same sources has shown some definite source-related differences.

9/ Research Forester, Lake States Forest Experiment Station, Grand Rapids, Minn.

COMMON AND SCIENTIFIC NAMES OF WOODY PLANT GENERA AND SPECIES MENTIONED IN THE TEXT[1/]

Common Name	Scientific Name
Alder	*Alnus*
Ash, green	*Fraxinus pennsylvanica*
Ash, European	*F. excelsior*
Ash, white	*F. americana*
Apple	*Malus communis*
Aspen, bigtooth	*Populus grandidentata*
Aspen, quaking	*P. tremuloides*
Barberry	*Berberis*
Basswood	*Tilia glabra*
Beech, European	*Fagus sylvatica*
Birch, paper	*Betula papyrifera*
Birch, bog	*B. glandulosa*
Cherry	*Prunus*
Cottonwood	*Populus deltoides*
Douglas-fir	*Pseudotsuga menziesii*
Elm, American	*Ulmus americana*
Fir, balsam	*Abies balsamea*
Fir, grand	*A. grandis*
Fir, white	*A. concolor*
Hackberry	*Celtis occidentalis*
Hemlock, eastern	*Tsuga canadensis*
Hazel	*Corylus*
Larch, European	*Larix decidua*
Larch, Japanese	*L.leptolepis*
Larch, Siberian	*L. sibirica*

1/ Authorities for nomenclature are: Check List of Native and Naturalized Trees of the United States, by Elbert Little, U.S.D.A. Agr. Handb. 41, 1953; and Standardized Plant Names, by Harlan P. Kelsey and William A. Dayton, 1942; Harrisburg, Pa.

Common Name	Scientific Name
Maple	Acer
Maple, sugar	Acer saccharum
Maple, bird's-eye	A. saccharum
Oak, English	Quercus robur
Oak, red	Q. rubra
Oak, white	Q. alba
Pear	Pyrus communis
Pine, Austrian	Pinus nigra
Pine, Balkan	P. peuce
Pine, cembran (see Swiss Stone)	
Pine, eastern white	P. strobus
Pine, European black (see Austrian)	
Pine, jack	P. banksiana
Pine, Korean white	P. koraiensis
Pine, limber	P. flexilis
Pine, lodgepole	P. contorta
Pine, mugho	P. mugo
Pine, Norway (see red)	
Pine, ponderosa	P. ponderosa
Pine, red	P. resinosa
Pine, Scotch or Scots	P. sylvestris
Pine, Swiss Stone	P. cembra
Pine, Virginia	P. virginiana
Pine, western white	P. monticola
Poplar	Populus
Poison-ivy	Toxicodendron radicans
Redcedar, eastern	Juniperus virginiana
Spruce, black	Picea mariana
Spruce, blue	P. pungens
Spruce, Norway	P. abies
Spruce, red	P. rubens
Spruce, Rosendahl	P. glauca x mariana
Spruce, Siberian	P. obovata
Spruce, Sitka	P. sitchensis
Tamarack	Larix laricina
Walnut	Juglans
Willow	Salix
Willow, prairie	S. humilis

APPENDIX I

MEMBERSHIP AND OFFICERS OF THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE, 1953-1963

MEMBERSHIP

Name	Agency	Years served
Earl J. Adams	Minnesota Conservation Department	1953-61
Bruno L. Berklund	Lake States Council of Industrial Foresters (Nekoosa-Edwards Paper Co.)	1953-57
Wm. H. Brener	Wisconsin Conservation Department	1953-date
R. A. Brink	University of Wisconsin	1953-61
Dean Einspahr	Institute of Paper Chemistry	1961-date
D. W. French	Forest Pathology (Univ. of Minn.)	1959-63
F. J. Hodge	Michigan Conservation Department	1953-date
A. C. Hodson	Forest Entomology (Univ. of Minn.)	1955-59
Philip N. Joranson	Institute of Paper Chemistry	1955-61
Emil G. Kukachka	Minnesota Conservation Department	1961-date
E. N. Lee	North Central Region, U.S. Forest Serv.	1959-date
John W. Macon	Lake States Council of Industrial Foresters (Consolidated Water Power and Paper Co.)	1957-61
Gene Meyer	Lake States Council of Industrial Foresters (Marathon, Div. of American Can Co.)	1962-date
Harold L. Mitchell	Forest Products Laboratory	1955-date
H. E. Ochsner	North Central Region, U.S. Forest Serv.	1955-59
R. F. Patton	University of Wisconsin	1961-date
Scott S. Pauley	University of Minnesota	1955-date
Don O. Prielipp	Lake States Council of Industrial Foresters (Kimberly-Clark Corp.)	1961-62
Donald W. Renlund	Forest Entomology (Wis. Conservation Dept.)	1959-63
A. J. Riker	Forest Pathology, Univ. of Wis.	1955-59
P. W. Robbins	Michigan State University	1953-57
Paul O. Rudolf	Lake States Forest Expt. Station	1953-date
T. Schantz-Hansen	University of Minnesota	1953-55
Stephen H. Spurr	University of Michigan	1953-63
Jonathan W.Wright	Michigan State University	1957-date

APPENDIX I (Continued)

OFFICERS

Officers	Period served
Chairmen:	
Paul O. Rudolf	1953-1955
Earl Adams	1955-1957
W. H. Brener	1957-1959
Stephen H. Spurr	1959-1961
F. J. Hodge	1961-1963
Vice Chairmen:	
W. H. Brener	1955-1957
Stephen H. Spurr	1957-1959
John W. Macon	1959-1961
Scott S. Pauley	1961-1963
Executive Secretary:	
Paul O. Rudolf	1955-date

APPENDIX II

PUBLICATIONS ISSUED FOR THE LAKE STATES FOREST TREE IMPROVEMENT COMMITTEE

Proceedings and Reports

Proceedings, Lake States Forest Genetics Conference, March 30 - April 1, 1953. Lake States Forest Expt. Sta. Misc. Rpt. 22, 83 pp. 1953.

Proceedings, Lake States Forest Tree Improvement Conference, August 30-31, 1955. Lake States Forest Expt. Sta. Misc. Rpt. 40, 108 pp., illus. 1955.

Forest Genetics in the Lake States, an Annotated Bibliography, by William J. Libby, Burton V. Barnes, and Stephen H. Spurr. Univ. Mich. School of Natural Resources (no series), 74 pp. 1956.

Guide for Selecting Superior Trees and Stands in the Lake States, by Paul O. Rudolf. Lake States Forest Expt. Sta., Sta. Paper 40, 32 pp., illus. 1956.

Forest Tree Seed Collection Zones for the Lake States. Mich. Dept. Conserv., Forestry Div. (no series), 13 pp., illus. 1957.

Proceedings, Third Lake States Forest Tree Improvement Conference, Sept. 17-18, 1957. Lake States Forest Expt. Sta., Sta. Paper 58, 87 pp., illus. 1958.

Forest Tree Improvement Research in the Lake States; A Survey by the Lake States Forest Tree Improvement Committee. Lake States Forest Expt. Sta., Sta. Paper 74, 56 pp. 1959.

Registering and Marking Selections in the Lake States; A Report of a Subcommittee of the Lake States Forest Tree Improvement Committee, by Paul O. Rudolf and H. E. Ochsner. U.S. Forest Serv., North Central Region (no series), 9 pp. 1959.

Forest Tree Seed Certification in the United States; A Report of a Subcommittee of the Lake States Forest Tree Improvement Committee, by J. W. Macon. Consolidated Water Power and Paper Co. (no series), 3 pp. 1959.

Proceedings of the Fourth Lake States Forest Tree Improvement Conference, Oct. 6-7, 1959. Lake States Forest Expt. Sta., Sta. Paper 81, 60 pp., illus. 1960.

APPENDIX II (Continued)

Proceedings of the Fifth Lake States Forest Tree Improvement Conference, Sept. 19 & 20, 1961. Lake States Forest Expt. Sta., Sta. Paper 98, 42 pp. 1962.

Report of the Seed Certification Subcommittee of the Lake States Forest Tree Improvement Committee, by W. H. Brener. Wisconsin Conserv. Dept. (no series), 4 pp. 1963.

Newsletters

"Lake States Trebredinews"

Number	Date	Pages	Issued by
1	October 1954	15	Minnesota Conservation Dept. Division of Forestry
2	July 1955	7	Lake States Forest Expt. Sta.
3	July 1956	9	Univ. of Minn., Div. of Forestry
4	April 1957	11	Lake States Forest Expt. Sta.
5	June 1958	12	Institute of Paper Chemistry
6	May 1959	10	Forest Products Laboratory
7	February 1960	7	Wis. Conserv. Dept., Forest and Parks Div.
8	February 1961	11	Univ. of Wis., Dept. of Genetics
9	February 1962	10	Mich. Conserv. Dept., Forestry Division
10	April 1963	15	U.S. Forest Serv., Region 9, Div. of Timber Management

APPENDIX III

MEMBERSHIP AND OFFICERS ON THE NC-51 COMMITTEE, 1963

Name	Agency represented
Jonathan W. Wright Chairman	Dept. of Forestry, Michigan State University, East Lansing, Michigan
J. J. Jokela Vice Chairman	Dept. of Forestry, University of Illinois, Urbana, Illinois
Paul L. Roth Secretary	Dept. of Horticulture, Kansas State University, Manhattan, Kansas
Robert W. Hougas Adviser	Wisconsin Agricultural Experiment Station, University of Wisconsin, Madison, Wis.
Clair Merritt	Dept. of Forestry and Conservation, Purdue University, West Lafayette, Indiana
Gordon E. Gatherum	Dept. of Forestry, Iowa State University, Ames, Iowa
Donald T. Lester	Dept. of Forestry, University of Wisconsin, Madison, Wis.
Ralph A. Read	Dept. of Horticulture, University of Nebraska, Lincoln, Nebraska
Scott S. Pauley	School of Forestry, University of Minnesota, St. Paul, Minn.
R. Brooks Polk	School of Forestry, University of Missouri, Columbia, Missouri
H. B. Kriebel	Dept. of Forestry, Ohio Agricultural Expt. Station, Wooster, Ohio
Paul E. Collins	Dept. of Horticulture, South Dakota State College, Brookings, So, Dak.
Philip N. Joranson	U.S. Dept. Agr. Cooperative State Experiment Station Service, Washington, D.C.
Paul O. Rudolf	U.S. Dept. Agr. Forest Service, Lake States Forest Expt. Sta., St. Paul, Minn.

APPENDIX IV

SEED PRODUCTION AREAS AND SEED ORCHARDS IN THE LAKE STATES - 1963

Owner or manager[1/] and location	Expected annual cone production	Stand age	Area occupied: Total	Area occupied: Minus isolation zone	Dates: Established	Dates: First seed production
			SEED PRODUCTION AREAS			
	Bushels	Years	Acres	Acres	Year	Year
			Red Pine			
Wisconsin Conservation Dept.						
Vilas Co., Wis.	50	75	23	23	1957	1957
USFS, Chequamegon N.F.						
Bayfield Co., Wis.	100	70	43	10	1961	1963
USFS, Chippewa N.F.						
Itasca Co., Minn.	450	50	65	32	1959	--
Cass Co., Minn.	400	65	64	24	1961	--
USFS, Hiawatha N.F.						
Schoolcraft Co., Mich.	350	60	60	20	1961	--
Chippewa Co., Mich.	300	70	60	20	1961	--
USFS, Manistee N.F.						
Lake Co., Mich.	65	60	5	5	1959	1960
USFS, Huron N.F.						
Crawford Co., Mich.	100	50	50	15	1960	1963
Crawford Co., Mich.	300	45	60	20	1960	1963
Oscoda Co., Mich.	20	60	4	4	1959	1963
Oscoda Co., Mich.	15	100	20	5	1958	1960

1/ In addition to those listed in this table there are several more partially completed seed production areas on National Forests, and we have information to indicate that the following companies have begun to develop seed production areas or seed orchards, but we have no details as to species, areas involved, etc: Kimberly-Clark and Nekoosa-Edwards Paper Co. Furthermore, Consolidated Water Power and Paper Company and Marathon Division of American Can Company are obtaining seed from phenotypically superior spruce trees, and Packaging Corporation of America is getting seed from phenotypically superior aspen clones.

APPENDIX IV (Continued)

Owner or manager and location	Expected annual cone production	Stand age	Area occupied: Total	Area occupied: Minus isolation zone	Dates: Established	Dates: First seed production
	SEED PRODUCTION AREAS					
	Bushels	Years	Acres	Acres	Year	Year
		Red Pine				
USFS, Nicolet N.F.						
Forest Co., Wis.	250	65	28	24	1962	-- [c]
Forest Co., Wis.	400	40	109	24	1961	--
Rhinelander Paper Division						
Ashland Co., Wis.	50?	40-60	30	20	1962	1963+
		White Pine				
USFS, Manistee N.F.						
Lake Co., Mich.	92	70	5	5	1960	1963
Newaygo Co., Mich.	750	60-100	20	20	1961	1963
		White Spruce				
USFS, Chequamegon N.F.						
Ashland Co., Wis.	50	65	85	28	1959	1960
USFS, Chippewa N.F.						
Beltrami Co., Minn.	25	35	40	10	1959	--
USFS, Hiawatha N.F.						
Schoolcraft Co., Mich.	15	70	30	5	1962	--
USFS, Huron N.F.						
Oscoda Co., Mich.	4	70	2	2	1959	--
Alcona Co., Mich.	8	80	5	1	1959	--
USFS, Nicolet N.F.						
Oconto Co., Wis.	50	60	26	4	1960	1962
USFS, Superior N.F.	50	59	46	13	1961	1962

APPENDIX IV (Continued)

Owner or manager and location 2/	Kind of stock		Area occupied		Dates	
	Grafted	Seedling	Total	Minus isolation zone	Established	First seed production
SEED ORCHARDS						
	Year	Year	Acres	Acres	Year	Year
White Spruce						
Rhinelander Paper Division, St. Regis Paper Co., Oneida Co., Wis.	1961	--	1	1	1961	Unknown
Red Pine						
Wisconsin Conservation Dept.						
Juneau Co., Wis.	1960	--	40	40	1960	?
Waukesha Co., Wis.	1959	--	10	10	1959	?
Waukesha Co., Wis.	1961	--	8	8	1962	?
Several Species 3/						
Wilderness Research Foundation	1952	--	10	10	1952	1955

2/ In addition to the orchards listed the Ottawa National Forest set out root stock plants for a white spruce seed orchard in 1963, and plans have been firmed for six more seed orchards to be established during the next four years on Lake States National Forests.

3/ White pine, cembra pine, Balkan pine, and Korean white pine scions on white pine and red pine root stocks; white pine and cembra pine on Scotch pine, mugho pine and balsam fir root stocks; white spruce on black spruce root stocks; and black spruce on Norway pine root stock.

SOME RECENT RESEARCH PAPERS
IN THE LAKE STATES STATION SERIES

Seed Stored in Cones of Some Jack Pine Stands, Northern Minnesota, by Eugene I. Roe. U.S. Forest Serv. Res. Paper LS-1, 14 pp., illus. 1963.

Forest Soil Freezing and the Influence of Management Practices, Northern Minnesota, by Sidney Weitzman and Roger R. Bay. U.S. Forest Serv. Res. Paper LS-2, 8 pp., illus. 1963.

Direct Seeding of Conifers in the Lake States: A Review of Past Trials, by Eugene I. Roe. U.S. Forest Serv. Res. Paper LS-3, 16 pp., illus. 1963.

Cutting Methods in Mixed Conifer Swamps, Upper Michigan, by John W. Benzie. U.S. Forest Serv. Res. Paper LS-4, 24 pp., illus. 1963.

Pulpwood Production in Lake States Counties, 1962, by Arthur G. Horn. U.S. Forest Serv. Res. Paper LS-5, 16 pp., illus. 1963.

Water Yield and Soil Loss from Soil-Block Lysimeters Planted to Small Trees and Other Crops, Southwestern Wisconsin, by Richard S. Sartz. U.S. Forest Serv. Res. Paper LS-6, 23 pp., illus. 1963.

Seeding and Planting Tests of Northern Red Oak in Wisconsin, by Harold F. Scholz. U.S. Forest Serv. Res. Paper LS-7, 7 pp., illus. 1964.

Recreational Use of the Quetico-Superior Area, by Robert C. Lucas. U.S. Forest Serv. Res. Paper LS-8, 50 pp., illus. 1964.

Forest Owners and Timber Management in Michigan, by Con H Schallau. U.S. Forest Serv. Res. Paper LS-9, 39 pp., illus. 1964.

The Causes of Maple Blight in the Lake States, by Lake States Forest Experiment Station. U.S. Forest Serv. Res. Paper LS-10, 15 pp., illus. 1964.

Identification of Hardwood Insects by Type of Tree Injury, North Central Region, by H. J. MacAloney and H. G. Ewan. U.S. Forest Serv. Res. Paper LS-11,70 pp., illus. 1964.

The Identification of Primary Red Pine Cone Insects, by John S. Hard. U.S. Forest Serv. Res. Paper LS-12, 10 pp., illus. 1964.