Disease Losses in North Carolina Forests: III. Rationale and Recommendations for Future Cooperative Survey Efforts

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ABSTRACT

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A cooperative effort by university, state, federal, and Renewable Resources Evaluation (RRE) personnel provided the first objective estimates of damage to North Carolina forests since 1952. The advantages and limitations of using RRE data for estimates of disease losses are described, and recommendations are made for a regionwide cooperative program to improve disease loss assessments in the southeastern United States.

In this era of increasing public accountability, the programs and budgets of federal, state, university, and industrial research and extension agencies are being examined as never before for evidence of cost-benefit effectiveness. In recent years, plant pathologists in general and forest pathologists in particular (4) have made only limited efforts to develop current and accurate disease-loss and research-benefit estimations. A notable exception is provided by Hepting and Jemison's classic paper, "Forest Protection," in the so-called Timber Resources Review (TRR) (7). This analysis led to the first general recognition that the amount of timber destroyed by fungi, insects, animals, and other agents in the United States was actually about 45% of the amount harvested. With the exception of a few special disease surveys, TRR estimates of losses from forest diseases and insects were based on 1952 data obtained originally by personnel of the Forest Survey, a division of the U.S. Forest Service recently renamed Renewable Resources Evaluation (RRE).

One of the most important consequences of Hepting and Jemison's analysis was markedly increased investments in research and extension activities in forest pathology and entomology by federal, state, university, and industrial agencies all over the United States (5). At North Carolina State University, for example, TRR data were used in reallocating research funds that permitted development of a major program of research and graduate education in forest pathology. During the next 10 yr, three more research and extension positions were added at NCSU in the fields of forest pathology, entomology, and wood-products pathology.

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In September 1972, 14 yr after TRR data were prepared and 20 yr after the base year on which they were calculated, these data still were the only reliable estimates of forest disease losses in North Carolina! Accordingly, a new cooperative effort was initiated by forest pathologists and RRE personnel in the state. The major results of this survey are presented in the first two papers in this series (8,9).

The major purposes of this paper are: 1) to stimulate greater cooperation between forest pathologists, entomologists, and RRE personnel, 2) to identify the advantages and limitations of using RRE data for disease-loss assessment, and 3) to stimulate interest in a pilot assessment program for the southeastern United States.

Background information. At an insect and disease workshop sponsored by the U.S. Forest Service in 1972, leading entomologists and pathologists concluded that the United States "does not have an adequate system for measuring, evaluating, and predicting insect and disease caused impacts on the forest resources of the nation" and "needs an adequate impact data and information base for research, inventory, and action programs *now*" (4). At present, 8 yr later, we still have no national system for disease and insect assessment, but the recently completed survey of North Carolina forests has provided a useful model for building a more adequate loss-assessment system.

The term "growth impact" includes both mortality and growth loss and is therefore an ideal unit of measurement. Mortality represents the volume of timber actually killed by diseases, insects, weather, and other natural causes. Growth loss is the sum of growth deficiencies resulting from poor stocking, reduced vigor, increase in cull, etc., plus the loss of potential growth (growth foregone) on trees killed by natural causes. Most estimates of loss fall short of the ideal because they give either mortality or growth loss but rarely both.

Reliable growth-impact information is needed for many useful purposes. The primary benefit would be the ability to base management decisions for research and extension activities on knowledge of actual forest conditions. Personal estimates, incomplete local surveys, and conventional wisdom are not firm bases for rational management decisions. The same impact information collected periodically over time would provide a basis for continuous monitoring of the effectiveness of advisory and extension services. Pest-management practices then could be evaluated in the light of the incidence of certain damages. For example, earlier RRE data showed the effect of shorter rotations on the prevalence of heart rot in conifers throughout the southern states (7).

Productivity and growth information could also improve decisions about the acquisition of public and industrial forest land. Detailed hazard zones for such conditions as annosus root rot, fusiform rust, and littleleaf disease would be especially useful for industrial landowners.

Present and potential benefits. The RRE obtained information on: 1) general health of the major softwood and hardwood species, 2) incidence of specific diseases (eg, fusiform rust, heart rot, and cankers), 3) amount of cull, and 4) geographic distribution of damage (8,9). These estimates were made by RRE crews already collecting other data at nearly 5,000 sampling sites throughout the state and without expensive duplication of travel, personnel, and other costs. Most members of the RRE field crews are graduate foresters, well trained and dedicated to the goals of the RRE. In addition, measurements made by individual crew members are systematically checked to insure the quality of data.

The RRE data on damage by diseases, insects, and other factors were collected systematically with the same sampling intensity throughout North Carolina and in adjacent states, allowing direct comparisons among areas ranging from individual counties to several states. Thus, geographic and physiographic trends of damage within states and in multistate regions can be determined. Also, a particular type of damage can be correlated with a wide range of other parameters compiled by the RRE, including land ownership, type of forest (natural vs. plantation), site class, species composition, stand age or size, land use, past treatment of land, and physiographic regions (3). For example, RRE data provided information on the abundance of oaks in the Southeast so correlations could be made with the incidence of fusiform rust (15). As a result, the abundance of water oak was found to be strongly correlated with rust incidence in slash pine.

Because sample plots are permanent and surveys are repeated every 8–10 yr, important information can be obtained about trends in the incidence and geographic distribution of disease.

One important benefit of cooperative work with the RRE is the availability of computer support services. The Forest Information Retrieval (FIR) system in the Southeast is a progressive information storing and processing system (12) that can give a wide range of data manipulations. For example, the system has been used to assess the biological potential for the loblolly pine ecosystem east of the Mississippi River (2), to evaluate performance of certain stands on selected sites (10), and to describe the size of timber stands in the Piedmont of South Carolina (11). The data collected in the fourth survey of North Carolina have provided the basis for estimating wood volume and financial losses incurred from mortality and damage since the last survey (13). This assessment of financial and volume losses is a major step in the right direction, but the data only partially address growth impact.

Limitations and problems of the RRE data base. Certain limitations are inherent in the RRE data base. For example, the RRE system can be used to assess only types of damage lending themselves to permanent-plot sampling in all seasons of the year, ie, the damaging agent must produce durable symptoms. Fusiform rust galls, poor form, and cankers are excellent types of damage for year-round sampling on permanent plots, whereas foliage blights, root rots, wilts, and insect defoliations are not. Disease epidemics or insects that develop or subside rapidly may be missed entirely during the 8–10 yr between surveys.

The intensity of sampling by the RRE must be adequate to obtain reliable data. At least 100 trees (more commonly 300–3,000 trees) of each species and size class are measured by each survey unit. This sampling intensity is too limited for diseases of very low incidence, such as white pine blister rust, but is entirely adequate for many other types of damage.

Obviously, training of RRE crews must be excellent to insure the quality of their data. Some types of damage are so ephemeral or so similar to others that accurate diagnosis is not possible. For example, annosus root rot and littleleaf disease are much more difficult for survey crews to detect than fusiform rust or hardwood cankers (8,9). Thus, the relative cost-effectiveness of training for field crews is inversely proportional to the difficulty of accurate diagnosis. Follow-up training and troubleshooting must also be well done, expecially to offset turnover among field crews. Periodic training sessions would provide new crew members with training and reemphasize the importance of the data being collected for established crew members.

Most insect problems are not easily evaluated by RRE methods, and impact assessment is difficult to incorporate into RRE survey procedures. Insects rarely induce durable characterisitic symptoms, and damaging populations rise and fall at irregular intervals. Evaluation of insect damage is complex and should include assessment of intensity and trends of pest populations, natural control factors, extent of infestations, and economic losses (1).

Difficulty in assigning a specific cause of mortality is an additional limitation of the present 10-yr cycle of RRE measurements. After 2–3 yr, dead trees often are too decayed for reliable assessment of the cause of death.

Some problems, seen as drawbacks in the fourth survey of North Carolina and in other survey regions throughout the country, are limitations in practice that can be corrected or modified. For example, distinctions on field tally records among logging injuries, fires, and other basal injuries as causes of heart rot apparently were not clear enough for adequate diagnosis in the field. Thus, when field crews could not be sure if logging or fires were involved, "other basal injuries" was used as a catchall category. Better definitions and training could have avoided this problem.

Another problem in the fourth survey was that only one type of damage could be assessed on a given tree, even though some trees showed two or more types of damage. The survey crew member decided which damage was of greatest importance, and this practice probably resulted in underestimation of some types of damage. The present data-recording system could be modified to allow assessment of at least two types of damage per tree.

Damage codes should be as precise and unambiguous as possible for the entire survey region. This is an important point to consider in formulating damage codes and in designing follow-up training programs. Continuing contact between a qualified pathologist and field personnel, achieved through a formalized cooperative effort, could minimize problems with damage codes that otherwise might grow into major drawbacks in the analysis and interpretation of field data.

The present system of using RRE data for growth-impact assessment is not well coordinated. Pest management personnel in Virginia, South Carolina, and Florida have taken some initiatives, but no single agency has assumed responsibility for loss assessment throughout the region. As a result, only rarely has information available from federal research personnel, the Division of State and Private Forestry, national forest administrators, state forest services, industry, and universities been combined. In many cases, available data were not collected by the same methods. This is a major drawback in attempts to make regional or national recommendations to pest control supervisors, resource managers, and research directors.

The Division of State and Private Forestry (S&PF) appears to be the logical agency to assume a coordinating role. In the Cooperative Forestry Assistance Act of 1978 (14), S&PF was directed by Congress to "conduct surveys to detect and appraise insect infestations and disease conditions affecting trees." In the Southeast, S&PF personnel in the Forest Insect and Disease Management (FIDM) group have been working with the RRE to improve the collection damage data. Additional training sessions for field crews have been provided, and plans are now being drawn up for achieving better loss assessment data in additional states. Also, the Forest Service has recently established in Davis, CA, a special Methods Application Group within the FIDM staff of S&PF. One of its primary functions is to coordinate S&PF survey activities across both state and regional boundaries.

Cooperative efforts with the RRE become less productive when the interest and support of the cooperator do not continue throughout the survey or when the data collected are not analyzed or are analyzed only after long delays because of other obligations. The present report is an example of the latter. Personnel in other areas of the nation apparently have similar problems. Data on the incidence of white pine blister rust, *Fomes annosus* root rot, Dutch elm disease, beech nectria, hypoxylon cankers, and other disease and insect problems were collected in the 1972 RRE assessment of Vermont and New Hampshire. To date, however, little use has been made of this information (J. Peters, *personal communication*).

The choice of publication outlet is just as important as the collection of data. Publications must be readily available if they are to be used. This has not always been the case, as illustrated by the impact report on timber damage and mortality in North Carolina (13).

Recommendations for improvements. Cooperation among responsible agencies must increase if assessment programs are to be improved. Greater coordination between special surveys and RRE surveys would give a more holistic view of growth impact. This should include both S&PF surveys and surveys of industrial holdings. The effectiveness and continuity of education and training programs of RRE field crews by federal, state, and university groups must also be augmented. A backup troubleshooting service should be available for RRE crews encountering problems. Finally, increased funding or reallocation of funds would allow the addition of a growth-impact assessment-survey coordinator for the southeastern United States. Additional funds will be needed to permit implementation of intensive surveys by cooperating agencies and the RRE. The need for growth-impact assessment is not fully appreciated, and a process for obtaining this information will have to be organized.

Improvements in assessment of impact by cooperative operations. The RRE has many resources that can facilitate assessment of disease and insect impact. These include technical expertise in sampling, data collection, computer usage, data analysis, and aerial photograph interpretation. The RRE also has thousands of permanent and associated plots in each state, with critically useful information recorded on each plot, that are sampled every 10 yr or less. The S&PF branch of the Forest Service can work with the research branch in developing reliable sampling systems for specific types of damage. S&PF also has the expertise to help train and direct survey efforts, including those by the RRE. State forestry agencies have many qualified personnel familiar with field situations, training programs, and the occurrence of damage. Universities and industries have materials and personnel to help with surveys, data analysis, and training. Personnel in these groups, however, tend to be connected mainly with the routine duties and problems associated with their own organization. Budgets are tight, and expansion to include assessment of disease and insect impact is not appealing. For this reason, we are proposing a new approach to the problem.

A regional program for assessment of forest diseases and insects. An obvious ingredient lacking in past attempts to produce impact information has been continuous interest and support on the part of cooperating groups. This is especially true in the case of cooperation with the RRE. Past surveys have been mainly of short range and have not been carried to the point where the total impact is known.

To remedy some of these problems, we propose a pilot program in disease impact assessment for the Southeast. The program would be based on cooperative efforts brought together by a regional coordinator assigned to the S&PF group at Asheville, NC. This location would facilitate work with the Forest Survey, S&PF, and Forest Research groups headquartered there. To insure success of this program, the coordinator should have good field diagnostic skills, quantification-biomathematics skills, ability to work with people, and a dedicated interest in disease and insect impact.

The regional coordinator would become the driving force behind cooperative efforts in damage assessment, and his timely, enthusiastic, and sustained support would smooth cooperative operations. Specifically, the problems mentioned earlier about past use of RRE data could be eliminated by the coordinator through early planning with interested groups in each state, coordination of initial training of survey crews, continuous monitoring of survey results, and provision of an information source for problems arising in the field. The coordinator could set up standards of training and formulation of damage codes to facilitate analysis of data and assessment of impact on a region as well as on a smaller land area.

The coordinator would be responsible for total impact assessment in the Southeast, not just the portion that can be obtained from the RRE. Thus, the coordinator would arrange with other federal and state agencies and forest industries for the implementation of intensive supplementary surveys of disease and insect problems that do not lend themselves to assessment by the RRE. Also, funds could be solicited to expand the RRE's operation to handle specific assessment needs. Placement of trained pathologists and entomologists with the survey crews may be another possibility in an overall loss assessment program, an idea suggested 30 yr ago by Hepting and Cruickshank (6). The results of complementary intensive surveys could be used to assess the correlation with the less intensive RRE results. If the correlations are good, limitations of the RRE may be lessened.

The coordinator would see that survey data were published in a timely fashion, in appropriate outlets, and then *used* by responsible agencies, industries, state and federal pest-management groups, and university administrators.

Providing information on the impact of disease and insect losses will be a dynamic process requiring considerable manpower and revisions over time. The Southeast is a major timber-producing area, with plantation forestry becoming the norm and available forest land being converted to other uses. This region also has considerable public land with water management and recreational functions. Thus, growth-impact assessment can be extremely beneficial to both the public and the industrial groups in this area.

The capabilities of the RRE and other federal and state agencies and the interest in assessment by large landholding forest industries provide another justification for a regional pilot program. All indications are that an insect and disease growth-impact assessment program will work in the Southeast and will set the stage for a nationwide program.

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