



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
THE ADMINISTRATOR

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Honorable William K. Reilly
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Subject: Science Advisory Board's review of the Office of Research and Development draft research plan Effects of Tropospheric Ozone on Forest Trees.

Dear Mr. Reilly:

At the request of the Office of Research and Development, the Forest Research Subcommittee of the Clean Air Scientific Advisory Committee (CASAC) reviewed a draft research plan designed to assess the role of ozone as an anthropogenic stressor influencing forest resources in the United States. The Subcommittee met on December 14, 1988, in Research Triangle Park, North Carolina. Due to an oversight, completion of the Subcommittee's report was delayed, but, after consulting with the appropriate research program staff, we believe that the report still has utility to the Agency. We do regret the delay.

The draft plan comprises eight research tasks tailored to meet the information input needs of the standard setting process, including region-specific tree response studies, investigations of the exposure dynamics for ozone, development of exposure response functions for several species, and risk assessment. Within these tasks, there is an explicit focus on mechanisms of action, beginning with the whole-plant physiology of seedlings and saplings, and extending to mature trees and forest stands. This approach is essential to provide the scientific underpinnings necessary to extend site-specific data along spatial and temporal scales. Failure to use such an approach to scaling and data translation has been a shortcoming of some predecessor programs.

The plan specifically addresses a highly relevant and challenging issue-- welfare effects--and its formulation recognizes that welfare effects will play a greater role in developing ambient air quality for ozone than has heretofore been the case. The

Clean Air Act Amendments enacted in 1990 call for a study of the criteria for setting/revising secondary National Ambient Air Quality Standards (NAAQS), making this aspect of the research plan assume even more significance than at the time of its formulation.

The Subcommittee identified several concerns regarding some specific sections of the plan, and provided several recommendations for its improvement (both described within the body of the attached report); in the broad view however, we endorse the proposed research plan as being a scientifically sound and defensible program to address the influence of ozone on the nation's forest resources, as well as one that is responsive to the needs of the Agency. We look forward to seeing the program's activities contribute to the standard setting process.

The Committee is pleased to have had the opportunity to review the draft document and to offer its advice. We would appreciate your response to the major points we have raised in the report.



Dr. Roger McClellan
Chairman
Clean Air Scientific Advisory
Committee



Dr. George E. Taylor, Jr.
Chairman
Forest Research Subcommittee

ATTACHMENT



THE EFFECTS OF TROPOSPHERIC OZONE ON FOREST TREES

**REVIEW OF THE OFFICE OF
RESEARCH AND DEVELOPMENT'S
DRAFT RESEARCH PLAN BY THE
FOREST EFFECTS
SUBCOMMITTEE OF THE CLEAN
AIR SCIENTIFIC ADVISORY
COMMITTEE**

ABSTRACT

The Forest Research Subcommittee of the Clean Air Scientific Advisory Committee reviewed in public session the U.S. Environmental Protection Agency's research plan: "Effects of Tropospheric Ozone on Forest Trees." The Subcommittee unanimously endorses the plan as a scientifically sound program and one that is responsive to the needs of the Agency. The plan addresses the role of welfare effects in standard setting, and provides for parallel modeling and experimental tasks to scale site-specific and time-specific data to regional and national concerns. The Subcommittee offers recommendations on selected aspects of the plan, and looks forward to the plan's products providing a unique data base which will help in developing the secondary National Ambient Air Quality Standards for ozone.

Keywords: Ozone; forest; ambient air standards; productivity; welfare

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1.0 EXECUTIVE SUMMARY

This report presents the formal conclusions and recommendations of the Clean Air Scientific Advisory Committee (CASAC) review of the U.S. Environmental Protection Agency (EPA) Research Plan: "Effects of Tropospheric Ozone on Forest Trees." The basis for these conclusions and recommendations was the public meeting of the Forest Research Subcommittee of CASAC, conducted on December 14, 1988, in Research Triangle Park, North Carolina.

The Plan is a unique research program addressing the role of ozone as an anthropogenic stress influencing forest resources in the United States. It comprises eight research tasks (See Table 1) tailored to meet the information input needs of the standard setting process. Notable examples are the region-specific tree response studies (Task 2), investigations of the exposure dynamics for ozone (Task 6), development of exposure response functions for several species (Task 7), and risk assessment (Tasks 3 and 8). The results of this research should make a major contribution to meeting the information needs of the Office of Air Quality Planning and Standards (OAQPS) and to the process of developing National Ambient Air Quality Standards (NAAQS).

1. DEFINING THE SCOPE OF THE PROBLEM: OZONE EFFECTS ON FOREST SPECIES
2. EXPOSURE STUDIES: SCREENING OF SPECIES
3. INTERIM OZONE HAZARD ASSESSMENT
4. DEVELOPMENT, APPLICATION, AND VALIDATION OF TREE MODELS FOR SIMULATING BIOLOGICAL RESPONSE TO OZONE
5. MECHANISTIC STUDIES OF OZONE RESPONSE
6. EXPOSURE DYNAMICS STUDIES
7. EXPOSURE STUDIES: DEVELOPMENT OF EXPOSURE-RESPONSE FUNCTIONS FOR FOREST TREE SPECIES AND ROLE OF AGE AND SIZE IN THE RESPONSE TO OZONE
8. ASSESSMENT OF OZONE RISK TO FOREST SPECIES

Table 1 Ozone Forest Research Plan Tasks

The Plan's second major attribute is its explicit focus on mechanisms of action, beginning with the whole-plant physiology of seedlings and saplings (Task 5) and extending to mature trees and forest stands (Tasks 4 and 7). This approach is essential to provide the scientific underpinnings necessary to extend site-specific data along spatial and temporal scales. Failure to use such an approach to scaling and data translation has been a shortcoming of some predecessor programs.

The combination of these two major features into a single interactive research plan (i.e., addressing the needs of the standard setting process while developing an understanding of the mechanisms underlying a tree's response to ozone) is exemplary. In the larger context, the Subcommittee unanimously endorses the Research Plan as being a scientifically sound

and defensible program to address the influence of ozone on the nation's forest resources as well as one that is responsive to the needs of the Agency. We look forward to seeing the program's activities contribute to the standard setting process.

The Subcommittee's concerns regarding several specific features in the Plan are described in the body of this report.

2.0 INTRODUCTION

At the request of the Office of Air Quality Planning and Standards (OAQPS), the Forest Research Subcommittee of the Clean Air Science Advisory Committee (CASAC) reviewed the Research Plan entitled "Effects of Tropospheric Ozone on Forest Trees," developed by the EPA's Environmental Research Laboratory in Corvallis, Oregon. The CASAC was invited to review and provide comment on the program because a primary goal of the proposed research is to contribute to the standard setting process. The review was conducted on December 14, 1988 in Research Triangle Park, North Carolina.

3.0 RISK ASSESSMENT

The inclusion of risk characterization as both interim and final tasks is commendable. The Subcommittee recommends that characterization of risk be considered as an initial effort as well. The objective would be to define the research needs emerging from the forest assessment in the November 1988 draft Staff Paper ("Review of the National Ambient Air Quality Standards for Ozone: Assessment of Scientific and Technical Information" - Chapters IX, X, and XI) and the integrated assessment efforts currently ongoing by EPA and other agencies on both national (National Acid Precipitation Assessment Program - NAPAP) and regional (e.g., San Bernadino National Forest, Appalachian Crest, southeastern pine plantations) scales. Assuming that this recommendation is enacted, the interim assessment (Task 3) would be designed to re-evaluate the program's research needs based on the progress achieved as outputs from Tasks 1 and 2. This evaluation could easily be incorporated into the existing Task 1. Moreover, its inclusion would provide a more formal methodology for scoping other efforts.

The interim assessment (Task 3) should be done quickly to determine and document the risk assessment methodology (p. 33, point 8 of the Research Plan) and provide a preliminary integrated analysis of selected regional areas, utilizing output from research Task's 1, 2, and 7 (as noted on page 34 of the research plan). This assessment should clearly indicate the data needs, monitoring inputs, models, and methodological developments necessary to complete a balanced and comprehensive assessment at the end of the five year program. Both assessments for Tasks 3 and 8 should address regional differences and policy issues central to the role of OAQPS in the standard setting process for ozone and photochemical oxidants.

4.0 LINKAGES WITH OTHER RESEARCH PROGRAMS

The proposed program provides linkages (page 69) with selected other forest response activities, including the national Forest Response Program (FRP) and the Electric Power Research Institutes's (EPRI) "Response of Plants to Interacting Stresses." There are also other programs in various stages of development (from proposed to completed) with which more explicit linkages could be established to assure (1) that the planned research is complementary; (2) that maximum exchange of pertinent information takes place; and (3) mutual assistance is provided for recurrent program planning exercises. Of particular importance to assessing the forest effects of ozone is air quality/aerometric research designed specifically to characterize ozone climatology in forested landscapes; global climate programs in the U.S. EPA and elsewhere (e.g., biodiversity, carbon dioxide, UV-B radiation); forest health and productivity programs being developed on a national and regional scale by the U.S. Forest Service; and econometric analyses in existing or anticipated extensions of the NAPAP program in risk assessment of biotic resources. Lastly, steps should be taken to assure that the research effort benefits from the lessons learned from the EPA's Office of Research and Development evaluation of the NAPAP's findings on the impacts of acidic precipitation on forest resources.

5.0 MITIGATION AND ADVERSITY

In Task 7 of the plan, exposure/response functions will be developed for multiple tree species representing most of the regional forest types in the United States. That information is critical to develop a plan that is national in scope, and the Subcommittee endorses that feature. At the same time, the Subcommittee expresses some concern that the results of such functional analyses may misstate both the direction of adverse effects or the rate of change, since natural processes and human management strategies may partially or totally mitigate some chronic stresses. For example, due to interspecies competition, ozone sensitive species may decline in dominance and be replaced in the canopy by more resistant species. Species that are unaffected by ozone in exposure response studies may be more or less sensitive under natural conditions of competition for limited resources in forest stands. Accordingly, some anticipated long-term changes (either "positive" or "negative") in forest resources, associated with changes in ozone levels, may not be realized. The assessment of exposure/response functions should thus include some verification of species in natural forest stands. Such verification would also help in defining "adverse impacts" in terms of recreation, ecosystem stability, and commercial productivity of forest resources. Models of mitigation strategies need to be validated by well-planned follow-up studies in such forests.

It is not clear to the Subcommittee if this aspect of longer term changes due to natural or human intervention will be addressed. It clearly falls within the realms of modeling (Task 4) and risk assessment (Task 8). Because the risk assessment approach would require accessing the more rigorous ecological modeling skills developed in the last decade to address forest community dynamics (Task 4), it is recommended that these two tasks be developed jointly.

6.0 TIME FRAME OF RESEARCH PROGRAM

This plan presents a comprehensive and unique series of tasks focusing on the standard setting process for ozone. Among these tasks are a review of current literature, complex mapping analyses, elaborate field and laboratory studies (i.e., exposure response, exposure dynamics, mechanisms of action), development and validation of process-level models of whole-tree growth and development, and interim and final risk assessments. The Subcommittee is concerned that the program is too comprehensive and optimistic in scope.

The Subcommittee suggests that the 5-year time plan be revisited, taking into account those tasks and objectives that are most likely to (1) impact the standard setting process, (2) develop interest within the Agency for a longer-term commitment, and (3) benefit from the lessons learned from the 10 year NAPAP experience and the 1990 Clean Air Act amendment process. This reassessment will focus attention on the prioritization of tasks and help clarify the level of effort to be invested in specific program components.

7.0 POLICY AND TASKS

Four basic "policy questions" presented at the beginning of the plan set the direction and goals for research. These questions should be revised to relate them directly to specific strategies for addressing ozone, forest resources, and the air quality standard setting process. If the framing of the policy questions is consistent with the work plan, it will focus the research and increase its relevance. The questions might be restated as follows:

1. Are current levels of ozone in forested areas high enough to reduce rates of growth and/or increase rates of mortality of tree species?
2. Is the current NAAQS for ozone appropriate to prevent adverse changes in rates of growth and/or rates of mortality of trees in forested regions of the United States?
3. What incremental changes in rates of growth and/or rates of mortality of tree species indigenous to different regions of the country would be produced by 10, 25, 50% changes in ambient ozone from current levels?

8.0 REGIONAL ASSESSMENT OF RESPONSES

The Subcommittee endorses the plan's focus on regional forest types as a means of screening forest tree species for their sensitivity to ozone (Task 2). This endorsement is based on a variety of biologic, climatic, and edaphic factors that are region-specific and influence a plant's responsiveness to ozone. Of notable concern are a region's unique combination of temporal patterns in ozone concentrations (i.e., diurnal, seasonal), tree species composition, intra-species variability, climate, and availability of soil nutrients and

water. Subsequently, region-specific outputs can be aggregated to address national policies on ozone and forests. The plan is less specific with respect to how it will address such issues as commercial forests, national and state forests, and woody plants in urban and horticultural environments, although such analyses are traditionally a component of the risk assessment. The issue of urban vegetation was discussed specifically with respect to the plan. However, it is recognized that the majority of species in urban forests are indigenous and will be factored into the research program through Tasks 1 and 2.

9.0 INTERIM REPORT ON PROTECTION PROVIDED BY EXISTING STANDARDS

Much of the current plan is directed to a long-term assessment of forest response to current and alternative ozone levels. In the interim, the secondary NAAQS will be based principally on the responsiveness of agricultural resources as studied over the preceding 5 to 10 years. It would be beneficial for the interim assessment of the program to provide information, qualitatively or quantitatively, to compare the relative responsiveness of trees and agricultural species. Currently, this comparison is highly imprecise because of limited data sets, differences in physiological and ecological properties of the life forms, and often times disparate ozone exposures between forests and agricultural landscapes. Addressing this issue will provide guidance to analyses of the existing crop-based NAAQS with respect to its ability to afford protection to forest resources. Specifically, this guidance would be offered as probability analyses focusing on whether net impacts might occur that would have substantive adverse effects on commercial, recreational or ecosystem values.

10. SUMMARY AND CONCLUSIONS

The objective of this review and the resultant report is to assure that the draft research plan, "Effects of Tropospheric Ozone on Forest Trees," meets the needs of the EPA standard setting process.

The plan addresses a highly relevant and challenging issue--welfare effects--and its formulation recognizes that welfare effects will play a greater role in developing ambient air quality standards for ozone than has heretofore been the case.¹ The scope of the research proposed is consistent with the need to address this issue.

The Subcommittee specifically endorses several attributes of the research plan. Foremost of these attributes is the manner in which the plan deals with the needs of the standard setting process, interactively with a mechanistic understanding of tree responses to ozone. The planned objective to develop parallel modeling and experimental tasks to

¹ The Clean Air Act Amendments enacted in 1990 call for a study of the criteria for setting/revising secondary NAAQS, making this aspect of the research plan assume even more significance.

scale site-specific and time-specific data to more regional- and national-level concerns of ozone effects on forest resources is of equal importance.

The Subcommittee recommends that several aspects of the plan be revisited, and these are detailed in the body of the report. Most notably, we recommend that the plan include an expanded role for risk assessment, greater specificity in addressing regionalization of the results, and a more realistic time frame for meeting the specific objectives.

In summary, and notwithstanding the suggestions above, the Subcommittee endorses the draft plan as one which will provide scientifically sound data to support the standard setting process.