INTERNAL REPORT 124

FIRE ECOLOGY PROJECT RESEARCH PLAN FOR 1973

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INTRODUCTION

The following research plan is a result of the March 1972 position paper, "Fire in the Coniferous Biome", edited by Dr. Mark J. Behan, and of the subsequent March 1973 action of the US/IBP Coniferous Forest Biome Directorate, through National Science Foundation Grant No. GB-20963, establishing a Fire Ecology Project at the University of Montana, in Missoula. The Project, under general supervision of Dr. Joan M. Hett, Coordinating Programs Director for the Coniferous Biome, is directed by Mark Behan. Dr. Ronald N. Kickert and Alan R. Taylor are Deputy Project Directors.

The International Biological Program, with its theme of "The Biological Basis of Productivity and Human Welfare", provides a unique opportunity to investigate the effects of fire on coniferous forest ecosystems. Fire cuts across all environmental parameters. It exerts a direct control on succession, setting it back to earlier stages, perpetuating subcycles, or in some cases setting it ahead to later stages. Fire is thus related to forest community structure and composition. It is also related to the rate at which forests grow, their conditon, vigor and resistance to insects and disease, their reproduction cycles and success, and their areal distribution. Energy, moisture, and nutrient systems are also related to fire. The same can be said for microorganisms, soil building factors, wildlife population dynamics, and hydrologic functions.

With so much of the coniferous forest environment related to fire effects, the reasons for seeking a fuller understanding of them are obvious: that man is attempting to exclude fire and replace it with mechanical and chemical alternatives makes the need for such an understanding urgent and compelling.

The purpose of this plan is to firmly establish the specific objectives, scope, and methods of research for the Fire Ecology Project during calendar year 1973.

OBJECTIVES FOR 1973

1. To conduct a Question Survey and subsequent Delphi exercise on Survey-identified research problems, thereby leading to an appraisal of research problem priorities in fire ecology. A publication will be prepared on the basis of this method of inquiry and the results which are obtained.

2. After review of relevant literature, to initiate conceptual, graphic and computer modeling for problems identified as high priority, based largely upon the results of the Delphi exercise in Objective 1. Feedback to other Coniferous Forest Biome modeling activities will be based on these activities.

3. To conduct a problem-development workshop in Fire Ecologic Effects, during October, 1973, in view of the results of Objective 1, above.

4. During the course of literature reviews in specific problem areas of fire ecology, copies of our abstracts will be sent to the Coniferous Forest Biome Central Office for loading into a computerized literature retrieval system.

SCOPE AND METHODS

Question Identification Survey and Priority Ranking

Background

The method of inquiry which will be used initially in examining the various ecologic responses to different kinds of fire events, as well as fire exclusion, will be based on a problem-question identification survey of research scientists and "grass-roots" type land managers. We assume that research progresses most effectively and efficiently when researchers analyze their own scientific activity as (1) identification of possible meaningful questions, (2) selecting some rational means for predicting priorities for each of the questions, or a closely related, set of questions, (3) proposing a set of hypotheses (model) to explain and predict particular responses, with regard to a closely related set of questions, and (4) observing the phenomena in the field environment, so as to evaluate the prediction and thereby the validity of the integrated hypotheses.

Maslow (1970) has presented an extremely thought-provoking discussion of the importance, although rarity, of the question-asking nature of science. Ackerman (1963) emphasized an important ingredient of science being a highly developed sense of problem, although "...most commonly an appreciation of the hierarchy of problems is shared by relatively few in each field." Goodall (1972) stresses the importance of framing the specific question prior to using a computer modeling approach toward integrated research.

Question identification

The questions-survey for this project will occur through two different activities: mailed questionnaires soliciting the identification of important questions and problems, and literature reviews on given problem areas.

The major activity for this purpose will be a questionnaire survey by mail to two separate sets of "experts", one set being the grass-roots-level land managers, and the other set being various research scientists whose experience and specialties impinge upon ecological effects of wildland fire and/or fire exclusion. Potter et al. (1972) have recently compiled an annotated bibliography on the use of questionnaires in research. Heidmann (1972) has used this approach for conducting a survey of a special kind of management problem. Respondents were asked, among other things, "What is your most serious mammal damage problem?"

Eggers and Male (1972) highlight the issue very clearly:

> Since ecosystems are infinitely complex, one must make assumptions and simplifications in constructing analytical models which are within our capabilities. Because of these assumptions and simplifications it is impossible to construct general ecological models - a general model being one which will answer or anticipate all questions. Therefore models must be constructed relevant to specific questions.
>
> A set of meaningful questions should be the foremost component in the strategy which a worker adopts in the construction of a model. These questions allow the modeler to make sets of assumptions and simplifications which make a model both meaningful and workable.

This same argument and method of procedure was employed in computer modeling in the US/IBP Desert Biome, as discussed by Bridges (1971), with very favorable response from desert field biologists. From their activity some 113 questions were solicited from various desert ecologists and compiled in a report of the Desert Biome Modelling Group (1971). We readily recognize that a survey of questions, pointing up needs for understanding, is a temporal snapshot. The question-formulating activity and the circulation of questions between users and research scientists must be a continual re-examining process, as knowledge and needs change continuously.

For soliciting questions regarding the natural role of fire in landscape ecosystems, we view the community of persons concerned with ecologic effects of fire as being an issue-oriented society in Young and Swartzman's (1972) terms. The "general public" in our case is a set of both research scientists and "grass-roots" land managers who have personal field experience with some one, or several, natural physical, biological phenomena in a coniferous forest sere.

Throughout the entire question survey and Delphi assessment, which is described later in this paper, the stratification between the land managers and the research ecologists will be maintained. The research plan description that follows is shown graphically in Figure 1.

Respondents for the land manager group will be a sample from forest rangers of the USDA Forest Service, district managers of the Bureau of Land Management, appropriate personnel of the National Park Service, divisions of the Bureau of Sport Fisheries and Wildlife, state foresters, appropriate personnel from the state fish and game departments and private industrial forests. Prior assurance will be made that the persons contacted have land management

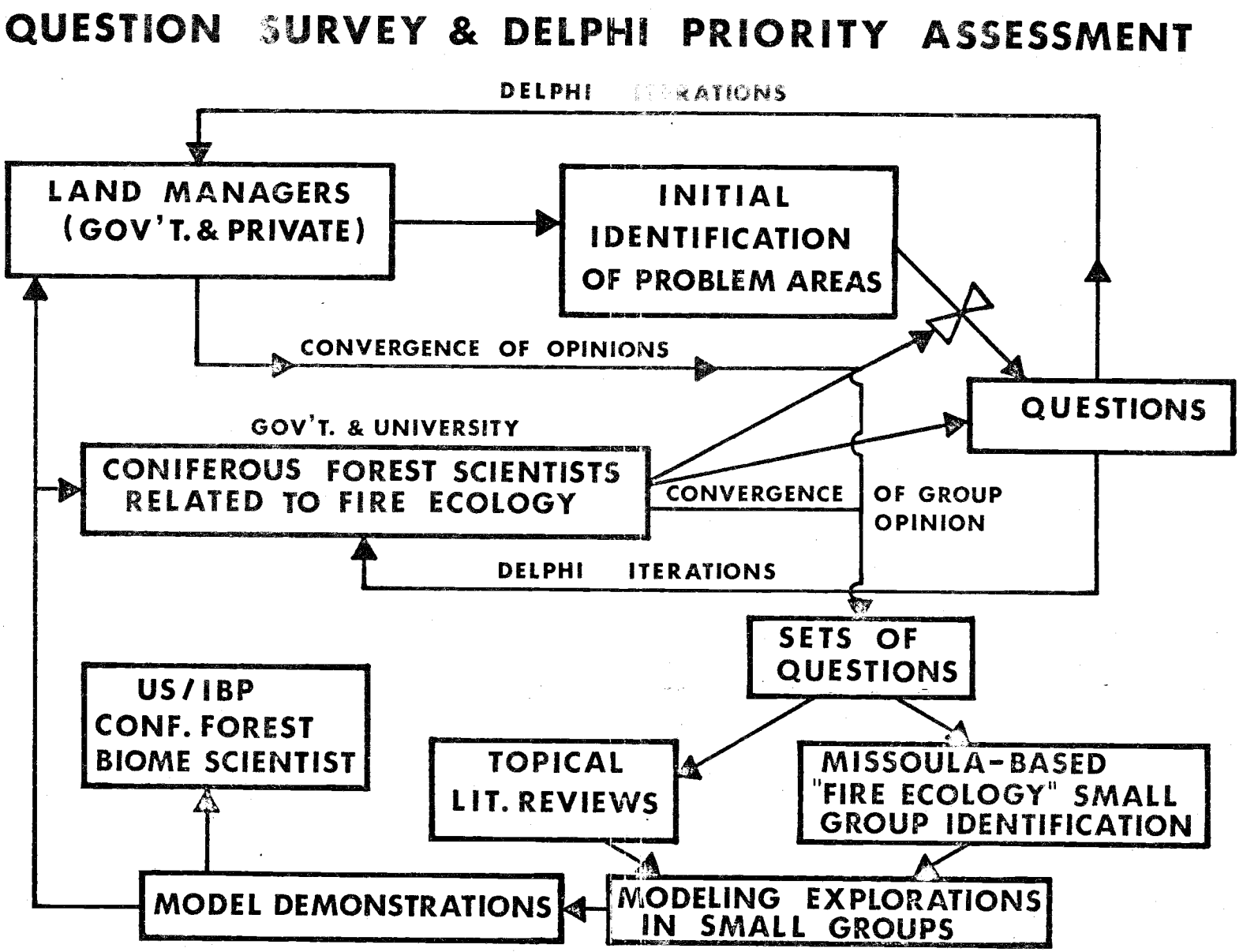

Figure 1.-- Activities involved in the Fire Ecology Project.

responsibility in coniferous forest ecosystems, or seral stages thereof, in any of the states of Alaska, Washington, Oregon, California, Nevada, Idaho, Montana, Utah, Wyoming, Colorado, Arizona, New Mexico, and South Dakota. Investigation is presently underway to obtain permission to include similar persons from the Provincial Forests of British Columbia and Alberta, Canada.

Respondents for the research scientist group will be sampled from universities in the states mentioned, as well as federal government research scientists in some aspect of ecology in the USDA Forest Service, the National Park Service and the Divisions of the Bureau of Sport Fisheries and Wildlife. We expect to include in this group scientists from Canada's Department of the Environment and from universities in Alberta and British Columbia.

With these two groups we shall say, "Assume that we already have 'a' comprehensive, validated computer model for any coniferous forest ecosystem, including seral stages, physical environmental states and processes, mineral cycling, primary production, herbivory, carnivory, decomposition, regeneration, growth and mortality by species for terrestrial and aquatic habitats. - What specific questions would you like to address to this ecosystem model with regard to predicting ecologic consequences of wildland fire or fire exclusion? - It is helpful if you formulate your question as -

"What is likely to be the effect of a change in _____ as observed in _____?"

It may be that the respondent will not be able to zero in on his information needs as specifically as this question format implies. In that case, he may choose to formulate his needs, perhaps, in this format, "How can I predict what might happen to _____ with various degrees of control (suppression) of fire in the landscape?"

There is no one fixed way in which such questions must be framed. As an example, one might ask, "Under what conditions might complete fire exclusion on forested slopes accelerate hydrarch succession in adjacent lowland water bodies such that waterfowl habitats would be eliminated?"

These examples serve only as guides for respondents in their initial question identification attempts. The overall objective of this phase of activity is to get respondents to identify specific interdisciplinary ecological questions which describe their most important predictability needs with regard to fire effects.

Anonymity. The respondent will be asked to mail back his reply to the secretary for the Fire Ecology Project with the respondent having the option to request anonymity for his response. This option

is provided in order not to inhibit a respondent from offering important ecological questions which might in fact be politically sensitive to him in his job position. At such a request, the project secretary is prepared to assign a code number to his question responses prior to passing on his responses to Kickert, Taylor and Behan. In these cases, only the secretary, whose office is located in a building apart from the office of the Fire Ecology Project, has the confidential file of which respondent has which code number. This option in the question survey phase is preparatory to the design criterion of complete anonymity for the subsequent Delphi activity.

The Delphi

As mentioned earlier in this paper, the next activity is selecting some rational means for predicting research priorities for the question sets, or fire ecology research problems, which become identified in the previous activity. The act of ascribing research priorities to potentially interesting ecological questions is an activity which all too often has been performed on the basis of political maneuvering among scientists. It appears that a general method is available, commonly referred to as Delphi, from technological forecasting and futures research (Dalkey and Helmer 1963, Dalkey 1969a, Dalkey 1969b, Turoff 1970, Dickson 1971, Pill 1971, Turoff 1971, Mitroff and Turoff 1973), which can be used as an analytical tool in the process of goal setting and estimation of priorities. The Delphi method has recently been defined by Turoff (1971) as "a method for the systematic solicitation and collation of informed judgments on a particular topic." In our case, the "particular topic" is the overriding problem "What is the role of fire as an ecosystem process in coniferous forests?" The "informed judgments" will be made on specific fire ecology questions which result from the Question Survey and which are collectively subsumed in the overriding problem.

A typical Delphi exercise is generally characterized by three features: anonymity of participants with respect to each other, statistical summarization of group response, and controlled feedback of group judgments and other information to participants through a sequence of iterations or rounds. Often the media for this information system are paper, pencil and postal service, as it will be in this study. There has been considerable effort reported in the literature, however, on using time sharing access to a central computer via remote terminals as the medium for Delphi Conferencing.

In the typical Delphi exercise, the elements in need of judgment are sent to the participants, who in turn write down their individual evaluations and return their replies to the Delphi design team. This team then tabulates a group response which it sends back to each respondent with his original evaluation.

Respondents whose original judgments lie outside of some statistical interval, such as the interquartile range, are asked to re-evaluate their position and if they choose to remain outside of the interval they are asked to justify their decision, and thereby display their reasoning and the information supplies or deficits which they have that the majority of the group might not have. These comments are included anonymously in the next round which is sent back out to the respondents for a re-evaluation of their judgments on the Delphi issues. Anonymity precludes the personality effects which consciously or subliminally prevail in conventional face-to-face committee discussions.

Frequently, although not always, as Turoff (1971) points out, the objective of the design team conducting the Delphi exercise is to gain a consensus of group opinion on the issues at hand. Mitroff and Turoff (1973) have identified the consensus of opinion objective as being based on the inquiry philosophy of Locke. In the context of the Fire Ecology Project, the procedure which we have been describing between page 3 and page 7 begins as a Delphi approach on a different philosophical basis, that of Kant, and evolves into the more conventional Lockean type Delphi as described on page 7. According to Mitroff and Turoff (1973),

> ...a Kantian or 'contributory' Delphi is better suited to setting up a communication structure that allows many 'informed' individuals in different disciplines or specialties to contribute information or judgments to a problem area that is much broader in scope than the knowledge that any one of the individuals possesses.

Surely, this seems an accurate appraisal of our understanding of fire effects in coniferous forests. Systems ecologists might further consider their remark,

> Kantian inquiry may also overwhelm those who are used to 'the single best model' approach to any problem. Of course, this in itself is not necessarily bad if it helps to teach those who hold this belief that there are some kinds of problems for which there is no one best approach.

Might this be true for ecosystem modeling? Oddly enough, despite the extensive use of Delphi methods in business, industry and education, there seems to be, so far, only a few occasions of their use in natural resources research planning (B. F. Anholt 1973, Pacific Northwest Forest and Range Experiment Station, personal communication; J. B. Davis 1973, Pacific Southwest Forest and Range Experiment Station, personal communication).

The results of the Delphi exercise will be used by Kickert,

Taylor and Behan to establish research problem priorities for the subsequent activities in this project. These priorities will then be used to (1) assemble small groups of Missoula-based specialists to explore the effects of fire and fire exclusion in the high priority problem areas, (2) conduct literature reviews in these problem areas. This second activity will constitute a content analysis looking for further research questions, explicit hypotheses resulting from the research article, data tables and curves for functional relationships.

Model Development

It is our intention to employ computer modeling activities as an aid to the explorations of cross-disciplinary problems of primary concern to land managers and research ecologists. It is also our intention to deflate the image that computer modeling is an "end" in itself, for which research investigators are subordinate, which is Kickert's impression of how much of the modeling activities in the various US/IBP Biome programs have evolved. This same implication seems to be present in Gifford's (1972) comment;

> The International Biological Programme was doubtless conceived with human interests in mind, but it has spawned a mass of work, much of it in the fields of energetics or whole systems analysis, which is irrelevant to our pressing problems.

With this in mind, decisions made on question sets, gaining high priority ranking by way of the Delphi technique discussed in the previous section, will help to organize small groups of Missoula specialists (four or five specialists plus Kickert and Taylor) as indicated by the nature of particular question sets.

In view of the policy stated above, a subject area specialist, vis-a-vis the given question set, will be encouraged to be formally in charge of each small study group, and is to be entitled to senior authorship for all publications resulting from the group interaction. Arrangements for meetings, guidance in model formulation, and conversion to a computer program will continue to be done by Kickert.

These groups will meet independently approximately once every two weeks with the objective of identifying the ecosystem components believed to be necessary for formulating conceptual models to deal with given question sets.

Kickert and Taylor will then translate the conceptual models into algorithmic computer models, at times mathematical in nature, at other times based upon extensive conditional logic switching, depending upon the nature of the conceptual paradigm. The nature of modeling approaches for discontinuous disturbances, as discussed

in Part III of Behan's (1972) Position Paper, will receive strong examination in this work. We plan to investigate event-oriented simulation as one such approach. Computer work will be done in ALGOL on the DEC 10 system at the University of Montana, and also, by way of timesharing, in PL/1 at the Washington State University at Pullman, Washington.

Attempts will be made to "tune" the models based upon (1) data and functional curves found to be available in published and unpublished sources as a result of the literature review, and (2) data which the members of the study group might have available as a result of their past field experience. Observations will be noted as to which gaps revealed in the literature review become critical sources of uncertainty for tuning different portions of the computer models.

Tests of sensitivity of model response to changes in parameter values will be made. Explorations will be performed on how the simulated systems react to various frequencies and intensities of disturbance.

The primary objectives of the small study groups will be to obtain conceptual and developmental utility, in Innis' terms (1972), as to how the dynamics of the ecosystem are structured from different fire ecology problem-oriented perspectives. Communication will be maintained with other modeling activities in the Coniferous Forest Biome so that our findings can be integrated with, support, and extend the other model structures. The ultimate objective of numerical prediction, or output utility, will remain a secondary operational objective for this project in the initial modeling activities.

It is expected that each small group will produce an article for publication, describing the question set which initiated the study, the structure of the model identified to deal with the question set, the behavior of the computer model, and the insights believed to be obtained by the group participants as a result of the activity.

October 1973 Workshop on Ecologic Effects of Fire

The objectives of the Fire Ecology Workshop will be to identify and develop conceptual graphic ecosystem models which might be used to examine various aspects of the ecologic effects of fire and fire exclusion, as focused through the question sets, or specific problems, that emerge from activities described in previous sections of this research plan. In order to do this, we plan to organize four groups, of about six persons each, which will meet concurrently at the workshop. Each group will have one problem-oriented systems ecologist to guide the sequence of modeling activities. Each group will also have one professional grass-roots type land manager to

prevent the group from drifting too far astray from the realities found in landscape ecosystems. The remaining group members will be specialists in various aspects of biological ecology and environmental sciences. At times, all four groups might be working in separate quarters on the same problem in order to see, subsequently, how different groups will approach the same problem. At other times, all four groups will be working on different problems. Periodically, the groups will assemble together in order to examine each others work.

A report on the progress of all activity will be written up following the workshop in order to disseminate the groups' suggestions to scientists in the Coniferous Forest Biome.

Literature Review

Review of the literature will center initially upon recent symposia proceedings and major review articles to obtain an overview of past work on ecologic effects of fire and fire exclusion. During and subsequent to the Delphi iterations, the review efforts will focus on published and unpublished topical literature and data surrounding the emerging Delphi question sets. Primary reasons for this approach are to; (1) obtain sure foundations for conceptual and computer simulation modeling of the Delphi question sets, (2) provide a relevant framework for presenting the Delphi results and pertinent literature in a formal problem analysis report.

An informative abstract of each of the original articles reviewed by us will be written on an especially designed 20 x 25 cm. NCR card form to facilitate office storage and manual key-word retrieval (Figure 2). Additionally, a copy of each abstract will be sent to the Coniferous Forest Biome Central Office for loading into a computerized literature retrieval system. Format of the abstract card is also compatible with the generalized bibliographic format for the Environmental Information System of the Eastern Deciduous Forest Biome, Oak Ridge, Tennessee.

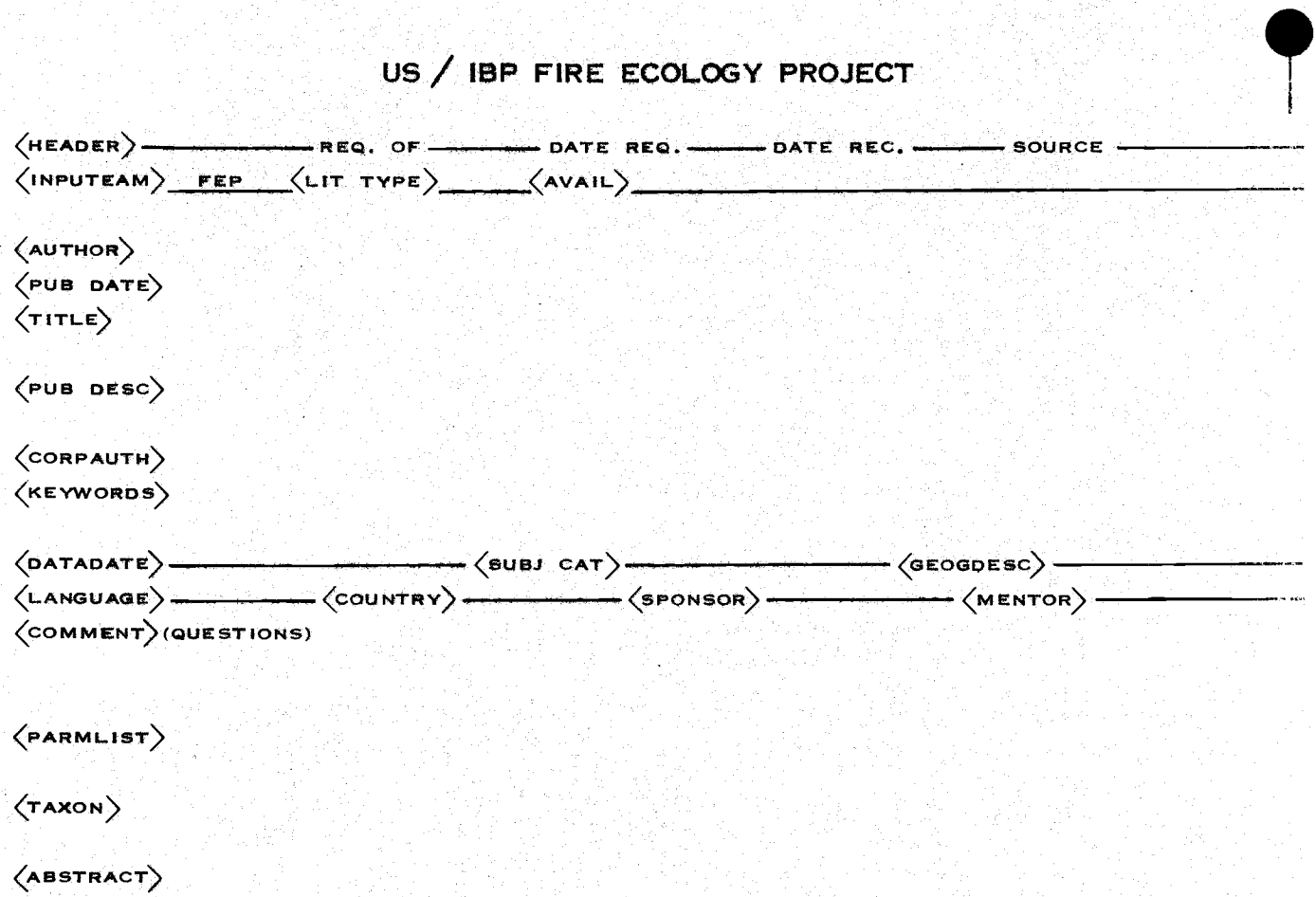

Figure 2.-- Abstract input form.

SCHEDULING

Scheduling of the Delphi exercise, the literature reviews, and the modeling effort is indicated in the Activity level diagram below (Figure 3). As shown, the literature review activity will pulsate intermittently with the Delphi activity. This reflects the iterative nature of the Delphi exercise; the between-round "quiet" periods during which we shall devote almost full time to the literature reviews. The Delphi exercise should be completed at the latest by mid-September 1973, while the literature surrounding emerging question sets will continue to be sought throughout the Project's duration. Preparatory work on modeling will begin in late May 1973, as will the other activities, and will rise to a high level by mid-October and remain so throughout the duration of the project.

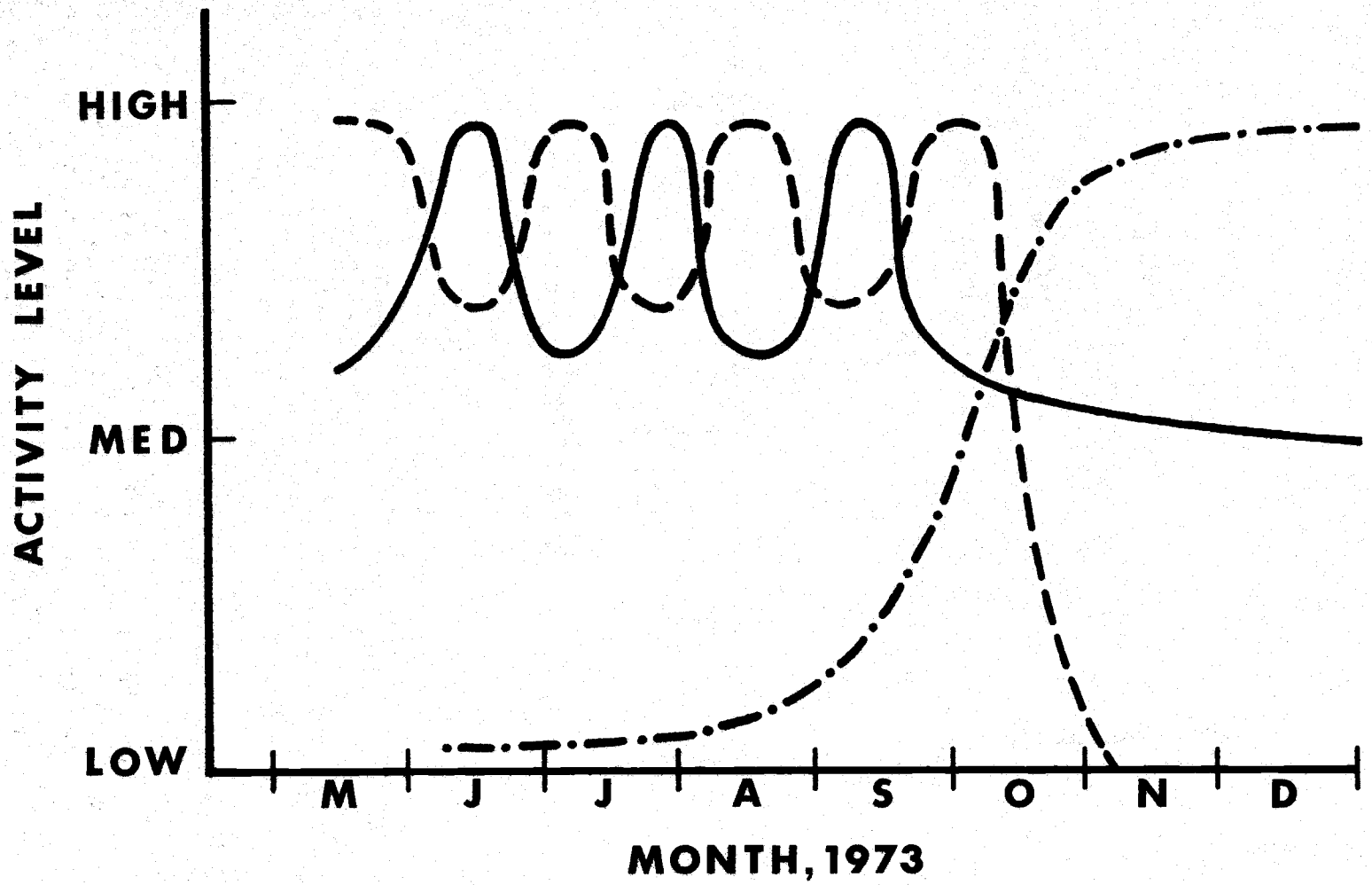

Figure 3.-- Activity level diagram. Key; ____ Literature search; -.-. Modeling; --- Question survey and Delphi activity.

PUBLICATIONS, REPORTS, AND AUTHORSHIP

Authorship and tentative titles and outlets include, but are not restricted to the following:

1. Kickert, R. N., A. R. Taylor, and M. J. Behan, The Delphi approach as an analytical tool in assessing possible priorities for research on ecologic effects of wildland fire. (open literature)

2. One or more publications from the modeling activities: authorship will include Taylor's and Kickert's names, but with main contributing specialist as senior author.

Unpublished reports will include:

1. Taylor, A. R., and R. N. Kickert, Problem Analysis (USFS-INT-2108): Fire effects in western forest ecosystems.

2. Miscellaneous unspecified Coniferous Biome internal reports.

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