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Contents

Strategic Planning in Public Forestry Research Organizations[1]

David N. Bengston, Principal Economist
U.S. Department of Agriculture
Forest Service, North Central Forest Experiment Station
1992 Folwell Avenue, St. Paul, MN 55108 USA

Introduction

What Is Strategic Research Planning?

Strategic research planning is concerned with shaping the nature and direction of a research organization (What is our mission? Where are we going?) and developing broad strategies for accomplishing the mission (How do we get there?). Successful strategic planning involves confronting difficult choices, setting broad priorities, envisioning the organization's future, and developing procedures to achieve that future (Pfeiffer et al. 1989). The time frame is long-term, 10 years or longer in some cases. Strategic planning is the responsibility of senior research management.

A distinction should be made between strategic planning and traditional long-range planning. Strategic planning:

- focuses on identifying, managing, and resolving issues;
- emphasizes assessment of the environment outside and inside the organization; and
- is concerned with the "vision of success" of a research organization and how to achieve it.

Long-range planning:

- focuses on achieving specified objectives of the organization;
- emphasizes management of the internal environment — the human, financial, and physical resources expected to be available to the organization; and
- tends to be based on historical projections and does not work well under changing external conditions.

Long-range planning has the flaw of focusing managers' attention on predicting rather than creating the future (Hanna 1985).

Why Is Strategic Planning Needed?

Uncertainty, complexity, and change characterize the external environment in which research organizations operate. Research managers need to respond quickly and effectively to changing circumstances. Strategic planning helps to define an overall sense of direction and purpose for a research organization, and thereby helps managers respond to change. Vihavainen (1987) notes

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1. An earlier version of this paper appeared as a chapter in Gregersen et al. (1990). The author thanks Hans Gregersen, Allen Lundgren, and Barbara Weber for helpful comments on this paper.

that the dynamic and uncertain environment of research suggests that dynamic management systems — including strategic planning — are well suited for the management of research.

Several potential contributions of strategic planning may be identified, including:

Short-term benefits:

- raising awareness about the external environment
- improving the dialogue among managers on strategy
- improving the dialogue between managers and professional staff
- improving the dialogue between the research organization and its stakeholders
- building teamwork and planning expertise

Longer term benefits:

- providing direction, coherence, and unity to organizational efforts
- improving organizational performance
- stimulating forward thinking in the organization, especially among top managers

The last point is perhaps the most important contribution. Strategic planning is not an end in itself, but should help research managers *think* and *act* strategically. Successful research organizations have always been guided by strategic thought and action, and a strategic planning process can aid in developing this perspective.

A Strategic Planning Process

The approach used for strategic planning should be adapted to suit the nature and circumstances of the particular organization (Milne 1989). Strategic planning in a large corporation will differ in certain ways from strategic planning in a small, public research organization, e.g., in the size of the planning team, resources devoted to the planning effort, the amount of involvement from outside the organization. But the essence of strategic planning is a process of thinking that is largely independent of scale and is useful in all types of organizations (Goldsworthy 1987). As Espy (1986) notes, if an organization is large enough to work, it is large enough to plan.

This section provides a systematic approach to strategic research planning that can be adapted to the needs of a particular research organization, and implemented by existing personnel at reasonable cost and in a timely fashion. The following strategic planning process is adapted from Bryson (1988), Pfeiffer et al. (1989), and Barry (1986), and is depicted in Figure 1. It is similar to the process used in recent nationwide and regional strategic planning efforts of USDA Forest Service research (Sesco and Bey 1989, Alig 1989).[2] The planning process involves eight major steps:

1. Initiating and agreeing on a strategic planning process
2. Identifying and clarifying organizational mandates
3. Conducting a stakeholder analysis
4. Developing a mission statement

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2. See Goldsworthy (1987), Rocheteau (1987), Milne (1989) and Collion (1989) for other descriptions of strategic planning processes for public research organizations and research systems.

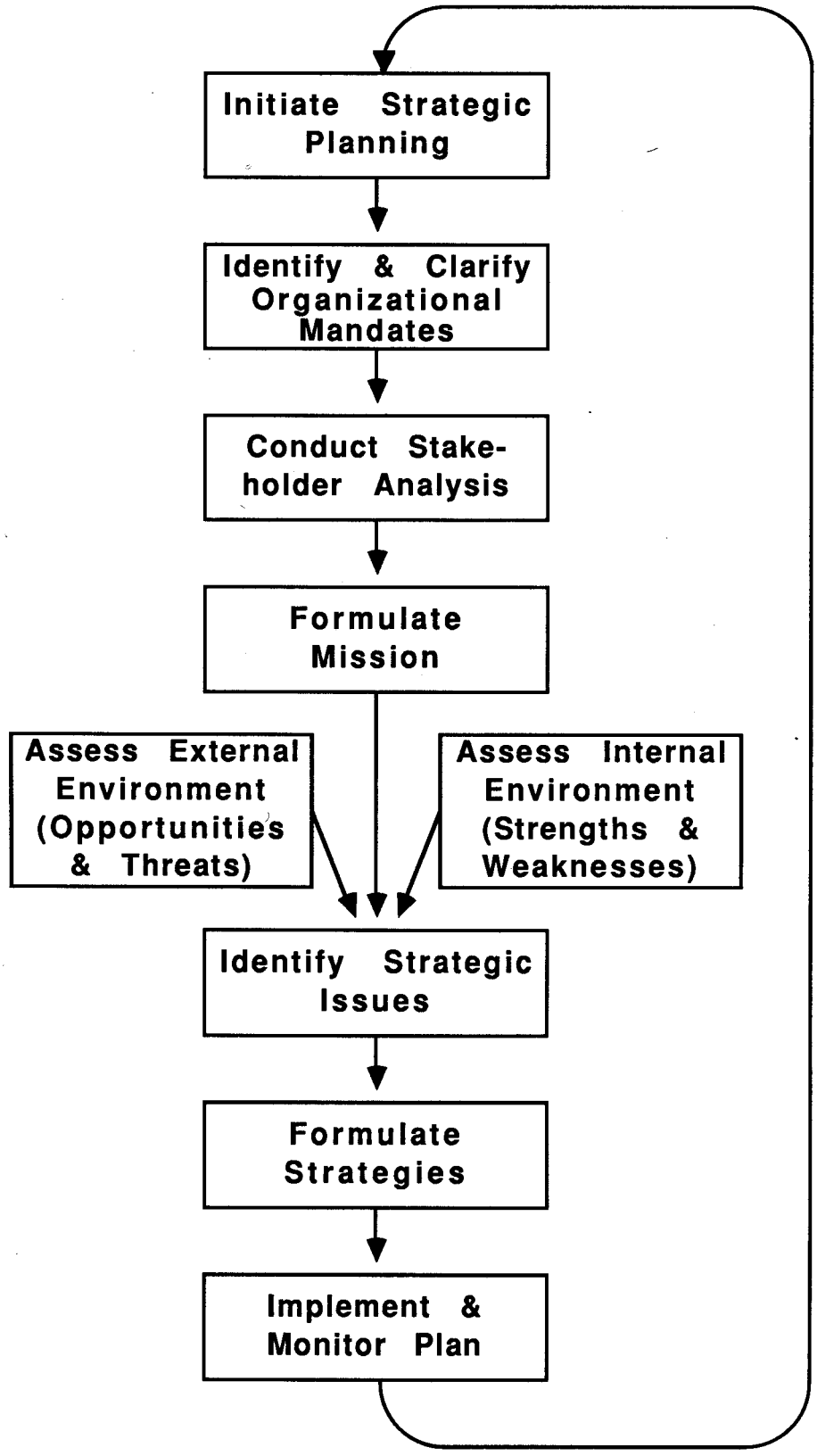

Figure 1. A strategic planning process.

Source: Adapted from Bryson (1988), Pfeiffer et al. (1989), and Barry (1986).

5. Assessing the external and internal environments
6. Identifying strategic issues
7. Formulating strategies to manage strategic issues
8. Implementing and monitoring the strategic plan

The following sections describe these steps.

1. Initiating and Agreeing on a Strategic Planning Process

The first step in strategic planning is to reach initial agreement about the nature, purpose, and process of strategic planning. A strategic planning team should be formed to address the following important preliminary questions: Who should be involved in the effort (individuals and organizations)? Who will be on the strategic planning team? Who will oversee the effort? What are the potential benefits to the organization of strategic planning? What resources are needed to proceed with the effort? What are the desired outcomes? What specific steps should be followed? What should be the form and timing of reports?

Key research decision makers should be included on the planning team, and perhaps some representatives of important external "stakeholder" groups (e.g., representatives from forest-based industries, conservation groups, government agencies that use research results). On the other hand, research managers may decide not to involve external stakeholders initially — outside involvement will complicate the process. Representative team leaders and scientists should also be involved from the begining. The planning team should include one or more highly intuitive individuals, who tend to be the most innovative and insightful in strategic thinking and decision making (Agor 1989).

The appropriate number of people directly involved in strategic planning will depend on the size of the research organization. In small research organizations, the planning team may be very small, consisting of a few key individuals. In medium-size organizations, two groups may be required to help ensure an effective planning effort: a relatively large group to provide broad representation and legitimization of the planning process, and a smaller executive committee that does most of the actual work and makes recommendations to the larger group. Large organizations may want to structure the planning process by establishing several specialized committees. Alig (1989) describes four planning teams set up at the USDA Forest Service, Southeastern Forest Experiment Station:

- Policy team. Consisting of the Station Director and other research managers, the policy team makes decisions and provides input to the planning process.
- Core team. Representatives from management, scientists, information services, and the National Forest System (a major user of research results) make up the core planning team. Their task is to facilitate the planning process by gathering information and making recommendations to the policy team.
- Expert teams. Several teams of senior scientists provide technical expertise, e.g., to ensure that that research goals are in fact attainable.
- Review team. Draft planning documents are reviewed by a team of stakeholders from inside and outside of the Forest Service.

2. Identifying and Clarifying Organizational Mandates

What is the research organization required to do and not do? Consideration should be given to formal mandates such as legal requirements and government policy and appropriations, as well

as to informal mandates such as interest group reports, agreements and understandings with other organizations, and social norms, that are no less binding. The purpose of this step is to identify externally imposed mandates and clarify how they affect the research organization. By clarifying what is not ruled out by the mandates, the rough boundaries in which the organization may operate become clearer.

The process for identifying organizational mandates is straightforward. The strategic planning team (or several individual members) compiles a list of formal and informal mandates affecting the organization. This list is reviewed and modified by the entire planning team to clarify what the various mandates imply for the organization, i.e., What is required? What is allowed? Organizational mandates are one of the important inputs used in developing a mission statement in step 4 below.

3. Conducting a Stakeholder Analysis

Stakeholders are defined as people, groups, or organizations that have a claim on the research organization's attention, resources, or output, or are affected by that output. Examples of stakeholders for a research organization include public officials, governing bodies, a wide variety of interest groups (such as industry groups, conservation groups), extension agents and organizations, future generations, farmers, taxpayers, other public and private research organizations within the country, research organizations in other countries, educational institutions, international donor and technical assistance agencies, and employees. Important employee groups should be explicitly identified as stakeholders. Scientists are perhaps the most important employee group because their own satisfaction is important to the success of a research organization. Moreover, scientists tend to judge organizational performance based on standards of scientific research, and they hold the organization more to exacting scientific and professional standards than other stakeholder groups do.

A key to the success of a research organization and its ability to generate financial and political support is the satisfaction of key stakeholders. An organization that does not have a clear idea of who its stakeholders are, what they want from the organization, and how they judge the organization will have little chance of satisfying them. The stakeholder analysis can be structured around the following questions:

- Who are the organization's stakeholders?
- What do they want from the research organization?
- What criteria do the stakeholders use to evaluate the research organization?
- How is the organization performing against those criteria?

The first question can likely be answered through a brainstorming session of the strategic planning team. The second and third questions can be approached in two ways. One is for the planning team to make informed judgments about the wants and evaluation criteria of stakeholders. The second approach is to ask the stakeholders, through interviews or surveys, what their wants and criteria are. The first approach is obviously much faster and avoids any problems with stakeholders not being completely honest. For example, an elected official may be concerned primarily with whether the performance of the research organization enhances his or her prospects for reelection, but would be unlikely to publicly state this criterion.

The fourth question to be answered in the stakeholder analysis concerns how well the organization performs against the stakeholders' criteria. To prompt useful discussion on this question, it may be sufficient to indicate whether the organization's performance is poor, sufficient, or excellent relative to the various criteria. Once the stakeholder analysis has been

completed, it should serve as a basis for discussion of exactly how the various stakeholders influence the organization and which are the most important stakeholders. It may be useful to rank the stakeholders according to their importance to the organization.

4. Developing a Mission Statement

A well-conceived mission statement can be a valuable managment tool, providing future direction and a basis for decision making. A mission statement should ideally serve as a guide to what management wants the organization to be (Pfeiffer et al. 1989). It should remind and motivate researchers and other employees to identify with the goals and philosophy of the organization, and orient employees toward the national needs that the organization exists to fill. Mission statements should also fulfill an important public relations role by concisely communicating to stakeholders what an organization is all about. Unfortunately, many forestry research organizations do not have mission statements — they are noticeably absent from annual reports and other key documents.

The stakeholder analysis provides information that is useful in developing a mission statement, but much more is needed. The mission statement should grow out of responses to the following questions:

- Who are we as an organization?
- What social needs do we exist to fill?
- What should our organization do to recognize or anticipate and respond to these needs?
- How should we respond to our key stakeholders?
- What is our philosophy and what are our core values?
- What makes our organization distinctive or unique?

Thoughtfully addressing these questions and developing a mission statement is a demanding process. Each member of the strategic planning team should answer the questions individually first, and then come together as a group for discussion. After the group discussion, the task of developing a draft mission statement for further discussion should be assigned to an individual. The draft mission statement should be discussed and modified as needed throughout the remainder of the strategic planning process. Figure 2 is an example of a forestry research mission statement for the Newfoundland Forestry Centre of Forestry Canada. It concisely describes what this organization does, who its stakeholders or clients are, and the desired impact of its program.

The Newfoundland Forestry Centre of Forestry Canada is the lead federal agency in Newfoundland and Labrador responsible for:

- conducting forestry research to produce scientific and technical knowledge,
- managing forestry development agreements and related programs,
- disseminating scientific and technical information, and
- providing forest policy advisory services,

to enhance the economic, environmental and social benefits from the forest resources in the region. The principal clients are the provincial, federal, and private forestry related agencies, the scientific community, educational institutions, and the general public. The programs of the NeFC are designed to have a significant impact on the forest sector, primarily in the region, and contribute to national and international knowledge in forestry.

Figure 2. Mission statement for the Newfoundland Forestry Centre, Forestry Canada. Source: Milne (1989).

5. Assessing the External and Internal Environments

A major purpose of strategic planning is to identify external threats and opportunities that may demand a response in the foreseeable future. The idea is to prepare an organization to respond effectively before a crisis develops or an opportunity is lost. Assessing trends in the external environment for research is therefore an important part of strategic research planning. What are the recent issues and emerging trends affecting the research organization? These could include political, economic, social, technological, and environmental trends and issues that may be local, national, or worldwide in scope.

Some large public organizations use formal, institutionalized "external scanning" procedures (Pflaum and Delmont 1987). But elaborate and demanding procedures are generally less desirable than simple and practical approaches. Most research organizations rely on the knowledge of members of the strategic planning team and use group discussions to identify external threats and opportunities and assess their significance to the organization. Other approaches include organizing workshops involving stakeholder representatives to identify major issues, or using various survey techniques (e.g., Milne 1988, Gregersen et al. 1989, Jakes et al. 1990).

The internal environment should also be assessed to identify strengths and weaknesses that help or hinder the organization in carrying out its mission. Broad categories of internal strengths and weaknesses include:

- resources available to the organization (such as scientific and technical personnel, support personnel, scientific equipment, facilities, supplies, library and information resources, computer resources, and funding);
- organizational structure (the institutional forms and mechanisms that govern a research organization and by which research priorities are set and resources are mobilized for the implementation of the research program); and
- organizational performance (outputs and the impacts of outputs on clients).

Using these categories, the planning team should develop a list of the major internal strengths and weaknesses of the organization. This list, along with the list of external opportunities and threats, should then be discussed and analyzed. Pfeiffer et al. (1989) note that scanning and assessing the external and internal environments should be a continual activity in an organization so that relevant information is always available to key decision makers.

6. Identifying Strategic Issues

The preceding steps of the strategic planning process lead to the identification of strategic issues. Bryson (1988) defines a strategic issue as a fundamental policy choice facing an organization. For research organizations, strategic issues affect or call for a reexamination of the organization's mandates, missions and values, and the kinds, level, and mix of research services provided. Strategic issues usually arise when:

- external events beyond the control of the organization make or will make it difficult to accomplish objectives given the resources available;
- choices for achieving organizational objectives change, or are expected to change (e.g., changes in technology, financing, staffing, managment); or
- new opportunities arise (Bryson et al. 1985).

In identifying strategic issues, particular attention is given to potential discontinuities that

might have a major impact on the organization (Hanna 1985). Examples of strategic issues that a research organization might face include an increasing rate of deforestation, increasing conflicts among groups that utilize forests (Jakes et al. 1990), long-term decline in real research budgets or civil service salaries (Bengston 1989), increasing demand for non-timber forest outputs in the future (Sesco and Bey 1989), a high proportion of scientists approaching retirement age (Sesco and Bey 1989), and privatization of research or other significant organizational changes (Theron 1989). Note that some of these strategic issues relate to changing research needs and priorities, and others relate to research policy, organization, and management.

The process of identifying strategic issues involves first reviewing the mandates, mission, external threats and opportunities, and internal strengths and weaknesses. Each member of the planning team is then asked to individually identify strategic issues by answering three questions for each issue:

- What is the issue? The issue should be described succinctly in a single paragraph and should be framed as a question that the organization can address.
- What factors make the issue a fundamental policy question? How does the issue affect mandates, mission, internal strengths and weaknesses, etc.?
- What are the consequences of not addressing the issue? If there are no consequences, it is not a strategic issue; if the organization will be significantly affected by failure to address an issue or will miss an important opportunity, the issue is highly strategic and should receive high priority.

Planning team members will need time to reflect on these questions, and at least a week should be devoted to individual identification of strategic issues. The entire planning team then convenes and tentatively agrees on what the issues are. Each issue should be summarized on a single page, addressing each of the three questions posed above. Strategic issues are then prioritized to aid in developing strategies to deal with the issues.

7. Formulating Strategies to Manage Strategic Issues

Bryson (1988) recommends a five-part process for developing strategies to manage strategic issues. For each issue that has been identified, the following questions should be addressed:

- What are the practical alternatives the organization might pursue to address a particular strategic issue?
- What are the barriers to realization of these alternatives?
- What major proposals might be pursued to achieve the alternatives directly or to overcome the barriers?
- What actions must be taken within the next year to implement the proposals?
- What specific steps must be taken within the next six months to implement the major proposals, and who is responsible?

. The purpose of these questions is to clarify what has to be done and who has to do what to deal with each strategic issue. For example, suppose a strategic issue facing a research organization (posed as a question that the organization can address) is: *How can we best recruit and retain a highly talented and qualified research staff?* Practical alternatives to address this particular issue might include:

- Better anticipate shortages of trained research personnel.
- Simplify hiring practices.
- Develop and maintain close ties with universities to identify potential researchers for

recruitment.
- Improve the system of rewards and incentives for researchers to increase retainment.

Using the last alternative as an example, potential barriers to realizing this alternative might include:

- Lack of funding to increase researcher salaries.
- Rigidity of the mandated civil service system limiting possibilities for career advancement in research.
- Lack of funding to establish a program of financial awards for outstanding researchers.

Proposals to achieve the alternative directly (improve the system of rewards and incentives for researchers) or to overcome the barriers might include:

- Establish a program of nonfinancial awards and recognition to reward outstanding research productivity and quality, contributions to technology transfer, etc.
- Provide opportunities for international travel (to attend scientific conferences or training courses) as a reward for productive researchers.
- Provide other nonsalary benefits to productive researchers.

The last two questions of the five-part process involve identifying the specific actions that need to be undertaken and assigning responsibility for carrying out the strategy to an individual or ad hoc committee. Alternatively, the planning team may address only the first question — identifying practical alternatives to deal with a strategic issue — and a key staff member would then be assigned to follow up on one or more of the alternatives as part of the implementation of the strategic plan.

8. Implementing and Monitoring the Strategic Plan

The true test for any strategic planning process is the extent to which it affects the activities of the organization and the behavior of employees. The purpose of strategic planning is to develop a better road map to guide the organization. Unless this road map actually guides decisions and actions, the planning process is nothing more than an academic exercise (Pfeiffer et al. 1989). But implementation of the strategies developed does not follow automatically. Change will be threatening to some and almost inevitably faces resistance. Resistance to the implementation of strategies may take the form of procrastination, "paralysis by analysis," lack of implementation followup, or even outright opposition.

The role of the director of the research organization in implementing the strategic plan cannot be overemphasized. The director should be closely involved in the process from the outset and must be totally committed to the strategic plan and lead the support. All managers need to be committed to the plan and use it to guide decision making, particularly in developing annual objectives and budgets. Management must communicate the plan and its rationale to all employees, especially those that may be affected by it.

Periodic review and updating of the strategic plan and monitoring of its implementation are vital. Every six months the specific steps to implement the plan should be reviewed. Every year or two the strategies to deal with strategic issues should be reviewed and progress evaluated. And every three to five years the entire strategic plan should be reviewed by the strategic planning team and modified as needed. Barry (1986) notes that many organizations review and update their strategic plans yearly, before planning and budgeting for the coming year.

The Written Strategic Plan

The final written strategic plan should be a summary of the planning team's efforts, usually limited to 10 to 15 pages. The simplest form for a written strategic plan consists of the final versions of some of the components completed by the planning team, such as:

- Mission statement
- Organizational mandates (formal and informal)
- External opportunities and threats (factors that might affect the direction of future programs)
- Internal strengths and weaknesses
- Strategic issues facing the organization
- Strategies to manage the issues
- Plans for implementation

A key staff person should be assigned the task of preparing the first draft of the written strategic plan. The draft is then reviewed and modified by other members of the planning team, by key decision makers, and possibly by external stakeholders. After a final review by internal and external reviewers, the plan will be ready for formal adoption and implementation.

Limitations of Strategic Research Planning

Strategic planning can be a powerful and practical tool for managing research, but its limitations and potential pitfalls should be clearly recognized. Barry (1986) and Rocheteau (1989) discuss the following limitations:

Costs can outweigh benefits. Depending on the scope of the planning effort, strategic planning may be costly in terms of money and human resources, especially the scarce time and efforts of high level research managers. The potential benefits of strategic planning should be weighed against these costs. If the planning effort is likely to fail or to fall significantly short of expectations, resources devoted to planning would be used more productively for other purposes. The question "Will the benefits of strategic planning outweigh the costs?" must be asked at the outset.

Formal strategic planning may be unnecessary. Some research organizations operate effectively by responding quickly to new opportunities and threats as they emerge, or "muddle along" without formal planning. A formal strategic plan may be unnecessary for small research organizations that operate effectively in this manner. In addition, some organizations have gifted leaders that instinctively think and manage strategically. Although such leadership is rare, organizations with unusually insightful and gifted leaders may not need to develop a formal strategic plan.

Planning may become a bureaucratic exercise. One of the main goals of strategic planning is to stimulate forward thinking and creativity. But formal planning efforts sometimes become bureaucratic exercises that actually dampen initiative, creativity, and risk-taking. Some planners may focus excessively on the planning process and neglect strategic thinking.

Planning may be overemphasized. The planning function is only one of the responsibilities of managers. Too much emphasis on planning may result in the neglect of other vital areas of research management. Development of a strategic plan should obviously be put aside when an organizational crisis develops, such as a severe cash shortage.

Concluding Comment

Strategic planning is clearly not a panacea for public research organizations, but it can provide an improved road map to help managers guide their organizations through the uncertain, complex, and changing environment that all organizations must traverse. Although successful research managers have always thought and acted strategically, not all have been particularly successful. Formal strategic planning offers some hope of increasing research managers' chance of success and improving the performance of public forestry research organizations.

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THE USE OF DIFFUSION-ADOPTION THEORY IN EVALUATING FORESTRY RESEARCH

by

Donald G. Hodges[1], Victoria N. Parmele[2], A.E. Luloff[3], and C.T. Smith[1]

Introduction

Evaluating the benefits and costs of forestry research has recently become an increasingly important topic for forest social scientists and policy makers. Despite the extensive evaluation literature on agricultural research (c.f., Bengston 1985, Ruttan 1982, Norton and Davis 1981), interest in the impacts of forestry research is much more recent.

Evaluating public forestry research was initially encouraged by the Forest and Rangeland Renewable Resources Planning Act of 1974. This legislation requires the U.S.D.A. Forest Service to periodically evaluate the status of renewable natural resources and to propose programs, including research, that satisfy the requirements for properly managing these resources. In 1979, agency research administrators developed criteria for evaluating current and proposed Forest Service research programs. The agency formally recognized the value of research evaluation by establishing the research evaluation work unit at the North Central Forest Experiment Station in St. Paul, Minnesota.

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1 Department of Forest Resources, University of New Hampshire, Durham, NH.

2 New Hampshire Office of State Planning, Concord, NH.

3 Department of Rural Sociology and Agricultural Economics, Pennsylvania State University, State College, PA.

Numerous evaluations have been conducted since the work unit was established (c.f. Seldon and Newman 1987, Haygreen et al. 1986, Bengston 1984). Bengston (1985) states that most studies have used simple assumptions concerning the diffusion of innovations and that the results may be highly sensitive to these assumptions. The use of untested diffusion assumptions is due to the lack of research findings relevant to forestry's unique characteristics.

Before models which forecast the rate of adoption can be developed, however, initial research on those factors affecting the adoption of forestry innovations must be conducted. Several disciplines have established traditions for conducting diffusion research including economics, geography, psychology, and rural sociology. The analyses conducted on forest landowners largely have followed the rural sociology tradition - focusing on the characteristics of potential adopters as explanatory variables. Sociologists have defined the adoption process as "(1) acceptance, (2) over time, (3) of some specific item -- an idea or practice, (4) by individuals, groups, or other adopting units, linked (5) to specific channels of communication, (6) to a social structure, and (7) to a given system of values, or culture," (Katz et al. 1963). While very general, this definition provides the key elements of adoption typically examined in natural resource-related research. Specifically, these are the characteristics of the adopting unit, channels of communication, and the social structure.

Several researchers have identified personal characteristics influencing landowners and foresters to adopt forestry innovations. As with the agricultural literature, the forest landowners studies have revealed that higher education and income levels, contact with professional resource managers, the use of a number of information sources, and an interest in timber management are positively related to the likelihood of adopting forest management practices (Palmer et al. 1985, Sollie 1965). Unfortunately, these findings are of limited value in research evaluations and diffusion studies because they do not involve factors which are policy malleable (Miller 1986, Bengston 1985).

Innovation Decision Process

Rogers (1983) provides a detailed discussion of the adoption decision. He contends that potential adopters progress through a five-step thought process which he terms the innovation decision process. These five steps are termed the Knowledge, Persuasion, Decision, Implementation, and Confirmation.

The initial step, the Knowledge State, begins when the individual is exposed to the new technology's existence and gains some knowledge of the innovation's function. An innovation normally contains three types of information: software knowledge reduces the uncertainty about the "cause-effect relationships" required for successful implementation, how-to knowledge is the information of "how-to" use the innovation properly, and principles knowledge concerns the theory behind the innovation. For example, an understanding of tree physiology and chemistry represent the principles knowledge necessary to comprehend the function of chemical site preparation. Obviously few foresters have the resources to sufficiently educate landowners in principles knowledge. As Rogers notes, the majority of change agents concentrate on creating awareness of the innovation, though their most important role may be in providing how-to knowledge. During this stage, mass media may be the most effective means of creating awareness but are not as useful for providing detailed how-to information. Assistance foresters typically combine the two. While extension foresters concentrate on awareness, the assistance foresters increase landowners' awareness of their management problems and most often offer solutions. Rather than directly transferring the how-to knowledge to the landowner, most private foresters assume the responsibility for applying their recommendations--if the landowner allows. In contrast, most state service foresters attempt to inform their clients to the extent that they can carry out many of the management practices. Little effort is expended to provide principles knowledge as most often a forester's resources are too limited. In their role as adopters of new innovations, foresters are in

a much more advantageous position to evaluate new technology. Their college education has provided them with the principles knowledge concerning forest management. The remaining tasks in this state, therefore, involve becoming aware of the innovations and how they operate.

During the persuasion stage, the decision-maker develops an attitude towards the innovation. At this point, the decision-maker seeks additional information which is then used to form a favorable or unfavorable attitude. Important determinants of subsequent adoption during this stage include where the decision-maker seeks information, what information is received, and how this information is perceived. The importance of selective perception is critical. Rogers suggests that the attributes most often considered at this stage are the relative advantage, compatibility, and complexity of the innovation. For most landowners, and not surprisingly for the U.S. Forest Service and Cooperative Extension Service, comparative advantage often is interpreted as economic advantage as the costs and benefits of changing current management regimes are weighed.

In addition to supplying information on costs and returns, foresters can also provide landowners with ideas on the compatibility of the innovation with current management practices and some estimate of the complexity of applying the innovation. However, the forester's effectiveness at influencing the probability of a favorable attitude is somewhat limited during this stage. As established elsewhere (Rogers 1983), the decision-makers (landowners) primarily rely on peers for the above information, reflecting the general preference for personal experience over scientific or professional information.

During the third stage of Rogers' innovation-decision process, the decision-maker determines whether to adopt or reject the innovation. Indeed individuals often try the innovation on a limited basis before deciding whether to adopt the innovation completely. Unfortunately, given the time frame and characteristics of most forest management practices, such trials may not be feasible. Landowners, therefore, rely on past clients of the assistance foresters or forestry demonstrations.

Crossett Experimental and Demonstration forest in southeast Arkansas is perhaps the most popular example of a forest managed to demonstrate the benefits of forest management practices and innovations to landowners. As with the persuasion stage, personal contacts remain the major source of information, although foresters, through demonstrations of the innovation's successful adoption can have considerable impact.

The implementation stage involves the actual use of the innovation. The adopted, continues to seek information, both on its successful use and for remedies for problems which might arise. The forester's role as change agent is crucial, especially since, the forester carries out the actual implementation. Despite this, the adopter continues to rely on landowners with past experience in an effort to reduce the remaining uncertainty.

The final stage of the innovation-decision process is confirmation or reinforcement of the innovation decision. Rogers notes the decision-maker attempts to either avoid or reduce dissonance, that is, the individual attempts to maintain agreement between attitudes and activities. Foresters assist in this stage by supplying additional information concerning the innovation's benefits derived by previous adopters or quickly resolving any difficulties that arise. In terms of the forester's decision to adopt, dissonance may be avoided or reduced by conferring with colleagues and specialists or altering the innovation to more closely fit the needs of the forester. For both landowners and foresters, if the dissonance is too great, the innovation may be discontinued.

Recent Empirical Studies

While most of the early adoption-diffusion research in forestry focused on the adoption decisions of private forest landowners, recent studies have been concentrated on the behavior of foresters. This research is crucial if we are to successfully evaluate the likelihood of both organizations and private landowners ultimately adopting new and emerging forest management

technology. To date, the results of three forester adoption studies have been published, and have examined the behavior of foresters in the southern U.S., the Lake States, and New Hampshire.

Such research is important to adoption-diffusion research and research evaluation for two reasons. First, foresters represent the primary adopting unit for most public land management agencies and forest products firms. As a result, their behavior directly affects the timing of adoption. Secondly, state service foresters and private consultants, who assist private landowners must face the adoption decision process before encouraging landowner to adopt the technology. Assistance foresters, therefore, act as both adopters in evaluating new technology and as change agents in encouraging landowners to adopt forest management innovations.

Adopting Computer Programs

Miner (1986) examined the adoption decisions of foresters in the Lake States (Michigan, Minnesota, and Wisconsin) regarding computer growth and yield programs. She concentrated on how the adoption decision was affected by computer availability, organizational innovativeness, communication channels, and knowledge obsolescence, or the extent that the availability of the computer software will make the foresters' knowledge obsolete. Foresters who perceive that the software will result in obsolescence were hypothesized to be less likely to adopt the computer programs than those with more positive perceptions.

More than 400 foresters were surveyed via mail questionnaires, with 323 responses, or 74 percent, being used for the analyses. The results indicated that 26 (8 percent) of the respondents had used at least 1 of the 2 programs studied (STEMS and TWIGS). Public foresters, both federal and state, constituted the bulk of adopters. Adoption of the programs and computer availability were highly correlated, as would be expected. Forty-eight percent of non-adopters indicated that computers were available, compared to 85 percent of the adopters. Similarly, 89 percent of the

adopters perceived their employer or organization as innovative. Sixty-two percent of the non-adopters viewed their organizations as innovative, a difference which was significant at the 0.05 level between the two groups.

The influence of communication channels was evaluated with two variables: (1) read about STEMS/TWIGS in journals or other publications, and (2) attended STEMS/TWIGS workshops. Differences between adopters and non-adopters were obtained at the 0.05 level. Almost all adopters (96 percent), and 72 percent of the non-adopters, had read about STEMS/TWIGS in journals, Forest Service publications, or other forms of printed material. Attendance at STEMS/TWIGS workshops, produced similar results, with 54 percent of the adopters and 27 percent of the non-adopters attending the workshops. Miner reported no differences for the knowledge obsolescence variable. Ninety-two percent of both groups reported no concern about the software rendering the forester's knowledge obsolete.

Miner concluded that computer availability, organizational innovativeness, and communication channels affect the adoption decisions regarding STEMS and TWIGS. All of these variables are largely determined by the organizational environment. At the time of the study, computers, publications, and workshops were most accessible to federal foresters. State foresters, though characterized by more limited computer availability, were also like to adopt the programs. Miner attributes this to the formal and informal relations between the federal and state foresters. Finally, private foresters were the least likely to adopt the software, perhaps reflecting the limited availability of computers for industry and consulting foresters.

Adoption Behavior of Southern Foresters

The second study examined the decisions of foresters in 12 southern states with respect to their forest management practices (Hodges and Cubbage 1990). Logit analysis was employed to

determine how a forester's employer, activity level, channels of communication, and perception of his/her management situation affect the adoption decisions. Logit analysis represents one of the more commonly utilized multivariate regression techniques for analyzing a dichotomous dependent variable. Here the dependent variable was whether the forester had or had not changed his/her management practices during the past five years.

Preliminary Results. -- Approximately 300 questionnaires were mailed to state service foresters, consulting foresters, and industry foresters with responsibilities for assisting nonindustrial, private forest landowners. Eighty-two percent of the sample population (240) returned completed surveys. The surveys included questions concerning the forester's employer, the extent and type of assistance provided to private landowners, communication channels used for obtaining information, and perceptions of the specific management situation faced. Of the 240 respondents, 214 completed the section of the survey pertaining to changes in management practices. The remaining 26 had not been practicing forestry for 5 years.

The results revealed several significant differences among the adopters and non-adopters. Of the 214 respondents, 163 foresters indicated that they had changed their forest management practices in the preceding 5 years. The most commonly selected factors for the change in management practices included to reduce costs, increase timber yields, and respond to new information. Interestingly, no significant difference was found between the number of information sources used by the two groups. Foresters who had changed their management practices utilized 4.5 sources of information, while non-adopters averaged 3.7 sources (Hodges 1988).

Non-adopters relied primarily on journals and regional meetings for information. Journals serve as the profession's mass media by providing general information on current problems and new techniques. Regional meetings also serve to present new ideas that are applicable to the specific

problems of the region. While such meetings provide excellent opportunities to converse with colleagues on the relative merits of new developments in forest management, less than one-half of the non-adopters who listed these meetings as a source of new information noted the importance of fellow professionals. In contrast, adopters utilized the mass media, as well as colleagues and training sessions for information.

One characteristic of early adopters is the use of information sources close to the originator of the innovation (Bertrand and South 1963). University faculty and publications were listed as information sources by 32 percent of the adopters and only 18 percent of the non-adopters. The use of U.S. Forest Service publications was approximately equal for both groups.

Logit analysis. -- Based on the results of the preliminary analysis, several variables were selected for evaluation within the logit framework. These included a variable representing the respondent's employer, measures of landowner assistance activity, dummy variables for the use of communication networks, and variables for the respondent's perception of the management situation that they typically encounter (Table 1).

The forester's perceived management situation consisted of responses to a battery of 20 statements each of which indicated how closely the statement represented their particular situation (1 = not representative, 5 = very representative). These responses were then factor analyzed in order to consolidate them. Factor analysis is a multivariate statistical method designed to describe the covariance structure among a large set of variables in terms of a reduced number of underlying dimensions. This data reduction technique produced 5 factors which represented the applicability of even-aged management, multiple use objectives, economic concerns, landowner knowledge, and natural stand management. This information, in factor score form, was included in the logit analysis.

The results of the logit analysis are presented in Tables 2. Eight variables were included in the final model, with all variable types being represented by at least one variable. Partial derivatives were calculated for each variable and represent the probability of change corresponding to a one-unit change in an independent variable evaluated at the means.

The respondent's employer (EMPLOY) was positively and significantly related to the probability of a change in forest management practices. State service foresters was the employee type most likely to change management practices, followed by industry foresters, while consultants were the least likely to change management practices. OWNERS, or the number of landowners assisted, was positively related to the propensity to change management practices as well. Here, a one-unit increase in the number of landowners assisted would correspond to a 0.1 percent increase in the probability of changing practices.

Several communication network variables were significantly related to the change decision. Using foresters outside the organization (FOUT) and university sources (UNPUB) increased the likelihood of change by 9.3 and 8.8 percent, respectively. Conversely, membership in the Society of American Foresters (SAF) decreased the probability of change by 11 percent. This perhaps reflects that SAF members rely almost exclusively on the Society's publications as sources of information, while adopting foresters rely on a more extensive information network. The finding may also suggest that SAF needs to enhance its technology transfer efforts.

Finally, the factors concerning the applicability of even-aged management and the riskiness of natural stand management were significantly related to the change of management practices. Foresters facing situations where managing for even-aged stands was typical or where natural stand management was risky would be more likely to change their management practices. The results indicate, therefore, that foresters who rely primarily on even-aged management techniques are more likely to adopt innovations than those who practice less intensive forms of management. It is not

evident, however, whether this result is caused by forester characteristics or the past forest management research emphasis. Few foresters would argue that the greatest research emphasis during the past 30 years has been placed on intensive, even-aged management. A determining factor in the increased probability of change for foresters practicing even-aged management then may be that most innovations in forestry in recent years have been in this management type.

Use of Soils Information in New Hampshire

The last adoption study examined the use of forest soils information by foresters in New Hampshire (Parmele 1989). Three types of soils information were evaluated: County Soil Survey information regarding woodland productivity potential and forest management limitations, Important Forest Soils Groups (Spielman et al. 1984) which was developed to provide easily applied information on soil-silvicultural relationships, and the Habitat Classification System developed by Leak (1982) which represents a bio-physical classification system.

Questionnaires were mailed to 437 New Hampshire foresters, including federal and state foresters, industry foresters, and private consultants. Thirty-seven names were eliminated from the list for various reasons, leaving a final sample population of 400. Of the 400, 238 foresters returned completed questionnaires for a response rate of approximately 60 percent.

Preliminary results. -- The use of the forest soils information varied considerably over the three sources. More than 70 percent of the foresters indicated that they had used the County Soil Surveys for forest management activities, with 41 percent noting that they had used the information at least 4 times during the past year. Less than one-half as many foresters (30 percent) had utilized the Important Forest Soils Groups information, with 9 percent using it 4 or more times during the year.

Leak's Habitat Classification System was utilized by only 13 percent of the respondents, with 7 percent employing the system 4 or more times during the year.

Much of the variation in use of these sources can be traced to the length of time that each has been accessible. Both the Important Forest Soils Groups and Habitat Classification System were published after 1980, while County Soil Survey information has been available for several decades. As a result, foresters have had more time to learn about the Soil Surveys. The foresters' sources of information provide additional insight into this differentiation. Since the mean year of college graduation for the respondents was 1970, only a small portion of the respondents would have been exposed to the two new forest soils classification systems in the classroom.

Discriminant analysis. -- In order to determine the significant factors in the adoption decision of foresters, the discriminant analytical technique was employed. This procedure determines the differences between two or more groups, with respect to a set of independent variables. A linear combination of the independent variables called the discriminant function is formed, allowing for assignment of individuals into maximally separated groups. The coefficients are determined so that each group's value on the discriminant function, called the group centroid, differs as much as possible from the discriminant function values of the other groups.

In each of the three analyses, the dependent variable was dichotomized on the decision to utilize each particular forest soils information. The independent variables included age, employer, attitudes towards the importance of soils information to forest management, and sources of information. Employer and information sources were the most important variables in the three discriminant analyses (Table 3). The three employer variables revealed that industry and self-employed foresters would be more likely to adopt the Soil Survey information, while foresters employed by the U.S. Forest Service would be very unlikely to do so. Non-college sources of

information had the highest standardized coefficient in the Soil Survey analysis, followed by the age and employer variables. The model explained 28 percent of the variance.

The Important Forest Soils Groups discriminant analysis provided similar results. The model was dominated by two sources of information variables, College and Non-college. Other important variables included "Prior use of county soil information" and "Importance of forest soils information". The model correctly classified 86 percent of the foresters, with a significant improvement over the Soil Survey model in classifying non-adopters. This model explained 43 percent of the variance in adoption.

The discriminant analysis for Leak's Habitat Classification System provided the best classification model, correctly identifying 92 percent of both adopters and non-adopters. As in the previous models, Non-college sources of information was the dominant variable. The model accounted for 53 percent of the variation in adoption.

Discussion

Each of the three studies reviewed the applicability of adoption-diffusion research for evaluating the adoption of forestry technology. All of these analyses reveal the importance of employer and information services on the innovation decision process.

Interestingly, there is little evidence that sociodemographic characteristics affect the adoption decisions of foresters. This is perhaps the result of little variation among foresters in terms of income, education, and background. The bulk of practicing foresters in the United States have earned Bachelor of Science degrees in forestry. Because these schools must meet the curriculum requirements of the Society of American Foresters for accreditation, the undergraduate curricula are very similar. As a result, most foresters share a common educational background. Hodges

(1988) and Parmele (1989) both note that graduate education has no effect on the adoption behavior of their sample populations. Finally, foresters share a set of common beliefs, as do most professions. Kaufman (1960) notes that the indoctrination into the U.S. Forest Service system begins in forestry school. Although a much smaller percentage of the total forester population is employed by the Forest Service today than during Kaufman's study, forestry students and foresters share a common core of beliefs. As a result, there are few sociodemographic or attitudinal variables that should be expected to exhibit wide variation among this segment of the population.

Information sources were the most significant influences in all three studies. Sociologists have recognized the importance of information in the adoption process for some time. In recent years, differential access to information sources has been considered the overriding factor in adoption analysis. Rogers (1983), in a survey of adoption research, notes that adopters are characterized as having more social participation, greater access to communication channels, and are more highly interconnected to the social system. The findings of Hodges and Cubbage (1990) and Parmele (1989) support these conclusions. Significant sources of information for the southern foresters consisted of foresters outside the respondent's organization and university sources. Non-adopters were characterized as relying on forms of mass media for new information. Parmele reported that external sources of information were most important in the discriminant analyses. Adopters clearly can be characterized as relying on a much more extensive communication network than the non-adopters.

Type of employer was also a significant factor in all three studies. For the most part, public foresters (federal and state) were more innovative than privately or self-employed foresters. Two explanations were offered for this difference in behavior. Hodges and Cubbage (1990) attribute it to differences in risk aversion and organizational objectives. State service foresters assume responsibility for increasing landowner awareness. As a result, state foresters experiment with a

wide range of management alternatives to satisfy the objectives of a diverse set of landowners. Self-employed foresters, on the other hand, rely on income generated from their management activities, and are much less likely to deviate from successful management techniques. Industry foresters can assume a more moderate stance, as their organizational success is linked to their management expertise, though not as closely as the self-employed foresters. Parmele (1989) attributes the employer effect to information access. This is particularly relevant to the adoption of forest soils information, where one of the sources (Leak's Habitat Classification System) was developed specifically for the White Mountain National Forest.

Implications for Future Research

These studies provide a sound base for applying a sociological approach to forestry adoption analysis. Indeed, we now have results from three separate analyses, in terms of geographic distribution, analysis techniques, and subject matter. All three reach similar conclusions regarding the influence of employer and information sources on foresters' adoption decisions.

More work is needed, however, before the information gained from these studies can be applied to forestry research evaluations and technology transfer efforts. Most notably, we must examine how the variables identified by the previous work affect the timing of adoption. Rogers (1983) notes that the importance of specific information sources varies throughout the innovation decision process. More information is needed, therefore, on when foresters utilize the various information sources. Additionally, political and economic factors must be incorporated into future adoption studies. As many foresters noted in the southern study, a technology's comparative advantage is an important consideration. The timing of adoption obviously could be estimated more precisely if such factors were considered.

In addition, both Hodges (1988) and Parmele (1989) note the need to improve the definition of the dependent variables used in such analyses. Both studies did not rely on the adoption of "innovations", but rather the use of existing or modified technology. Modeling the diffusion of a forest management innovation from its development through its successful adoption is crucial. Such an analysis would provide valuable insights into the influence of adopter characteristics, economic and political factors, and the nature of the innovation on the diffusion of the technology. Research evaluations can then be developed with reliable information on the timing of adoption.

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Table 1. Independent Variables Tested in Logit Regression Model of Change in Management Practices

Variable Group	Variable	Description	Measurement
Objectives	EMPLOY	Forester's employer	1,2-consultant 3- industry 4-state
Activity	OWNERS	Number assisted	reported number
	TRTAC	Acres treated	acres regenerated + T.S.I. acres
	HARAC	Acres harvested	acres reported for all harvesting methods
Communication	FWOR	Foresters within own organization	1-used as source 0-otherwise
	FOUT	Foresters outside own organization	1-used as source 0-otherwise
	UNPUB	University faculty and publications	1-used as source 0-otherwise
	SAF	Society of American Foresters	1-member 0-otherwise
Management	FACTOR 1	Factor relating to applicability of even-aged pine management	factor score
	FACTOR 2	Factor relating to popularity of non-timber objectives by landowners	factor score
	FACTOR 3	Factor relating to economic factors	factor score
	FACTOR 4	Factor relating to landowner knowledge of forest management practices and product markets	factor score
	FACTOR 5	Factor relating to difficulty of using natural stand management practices	factor score

Table 2. Final Logistical Regression Model for the Likelihood of Change in Management Practices.

Variable	Mean	Beta (t-ratio)	Derivative (prob @ mean)
Intercept	--	0.0966 (0.10)	
EMPLOY	2.852	0.3915** (1.94)	0.36
OWNERS	140.586	0.0074*** (2.06)	.001
SAF	0.657	-1.1831*** (2.140)	-.110
FOUT	0.420	1.0119*** (2.05)	.094
UNPUB	0.284	0.9522** (1.75)	.088
FACTOR 1	0.004	0.6202*** (2.11	.057
FACTOR 2	0.025	-0.6867**** (2.71)	-.064
FACTOR 3	0.030	-0.42818 (1.31)	-.040

P(Y-1) @ means .897

**** significant at α - .01
*** significant at α - .05
** significant at α - .10

X^2_8 - 48.36 α < .001

Table 3. Discriminant Analysis Results - Summary/Comparison

Variable	County Soil Survey Information	Important Forest Soils Group	Leak's Habitat Classification System
Age	-0.50		---
Year finished school			+0.02
Length of time in community			-0.13
Importance of forest soils information to foresters	+0.33	+0.19	+0.01
Effect of soil factors on growth			+0.09
Number of conferences attended	+0.16	0.14	+0.05
Percent of time practicing multiple use management		+0.10	+0.11
Non-college sources of information	+0.73	+0.83	+0.93
College sources of information		+0.60	
Forestry employment			
X_1	0.36		-0.11
X_2	0.22		-0.02
X_3	-0.51		+0.05
Prior use of County Soil Survey Information		+0.33	

APPENDIX

PROGRAM FOR THE AUGUST 7-9, 1990, MEETING OF IUFRO SUBJECT GROUP S6.06/S6.08 AT XIX CONGRESS OF THE INTERNATIONAL UNION OF FORESTRY RESEARCH ORGANIZATIONS, MONTREAL, CANADA.

SPEAKERS ATTENDING THE AUGUST 7-9, 1990, MEETING OF IUFRO SUBJECT GROUP S6.06/S6.08 XIX CONGRESS OF THE INTERNATIONAL UNION OF FORESTRY RESEARCH ORGANIZATIONS, MONTREAL, CANADA.

AGENDA

S6.06 - RESEARCH MANAGEMENT FOR THE FUTURE

August 7, 1990

DENVER P. BURNS, LEADER S6.06

SESSION 1 - MODERATOR: DR. STAN BARRAS

TITLE: RESEARCH MANAGEMENT

TIME	SUBJECT	SPEAKER
4:30 - 4:50 p.m.	A New Approach to Managing Multi-Client Forest Research Program	Dr. Colin O'Loughlin Ministry of Forestry Forest Research Institute Wellington, New Zealand
4:50 - 5:05 p.m.	Research and Education Systems for Private Forestland Management and Woodland Utilization	John A. Vance, Deputy Administrator USDA Extension Service Washington, DC
5:05 - 5:20 p.m.	Sugar Maple Decline Project Implementation	Dr. Max McFadden, Program Manager Eastern Hardwoods Research Cooperative USDA, Forest Service Radnor, PA
5:20 - 5:40 p.m.	North American Sugar Maple Decline Project -- Data Acquisition and Preliminary Results	Dr. Doug Allen Professor of Forest Entomology State University of New York Syracuse, NY
5:40 - 6:00 p.m.	Quality Assurance/Quality Control Implementation and Evaluation in the North American Sugar Maple Decline Project	Bill Burkman*, I. Millers, D. Lachance N.S.I. Technical Services Corp. % USDA Forest Service Radnor, PA
6:00 - 6:15 p.m.	Forestry Research - An Interdisciplinary Approach	Dr. Abdul Manap Ahmad, Dean University of Malaysia, Faculty of Forestry Sedang, Selango, Malaysia
6:15 - 6:30 p.m	Research's Hidden Assets -- Tapping into Employee Knowledge and Experience	Dr. Denver P. Burns, Director Northeastern Forest Experiment Station Radnor, PA

*Will present paper

AGENDA

S6.06/S6.08 - RESEARCH MANAGEMENT FOR THE FUTURE

August 9, 1990

DENVER P. BURNS, LEADER S6.06

SESSION 2 - MODERATOR: DENVER P. BURNS

TITLE: RESEARCH PLANNING AND EVALUATION

TIME	SUBJECT	SPEAKER
2:00 - 2:20 p.m.	Development Agenda for the 90s	Dr. Jerry Sesco, Deputy Chief Research and Cal Bey, Special Assistant to Deputy Chief Washington, DC
2:20 - 2:40 p.m	International Forestry Products Program at FPL	John Erickson, Director Forest Products Laboratory Madison, Wisc.
2:40 - 3:00 p.m.	The Productivity of Forest Research: Recent Experience from five U.S. Industries and Their Implications for the Rest of the World	William Hyde, Chief, Dave Newman, and Barry Seldon Economic Research Service; Soil & Water Branch Washington, DC 20005 -- 4788
3:00 - 3:30 p.m.	(1) Strategic Research Planning (2) The Impacts of Technical Change on Outdoor Recreation: A Technical Assessment Framework	Dr. David Bengston, Author Given by Dennis Bradley Research Forester USDA Forest Service North Central Forest Exp. Station St. Paul, Minn.
3:30 - 4:00 p.m.	The Use of Diffusion-Adoption Theory in Evaluating Forestry Research	Donald G. Hodges, Assistant Professor, University of Natural Resource Management University of New Hampshire Durham, N.H.

PRESENTERS AT THE AUGUST 7-9, 1990, MEETING OF IUFRO SUBJECT GROUP S6.06/S6.08 AT MONTREAL, CANADA

Dr. Colin O'Loughlin, Ministry of Forestry, Forest Research Institute, Wellington, New Zealand

Mr. John A. Vance, Deputy Administrator, USDA Extension Service, Washington, D.C.

Dr. Max McFadden, Program Manager, USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA.

Dr. Doug Allen, Professor of Forest Entomology, State University of New York, Syracuse, NY.

Dr. William Burkman, Forest Health Monitoring Coordinator, USDA, Forest Service, Northeastern Area - State & Private Forestry, Radnor, PA.

Dr. Abdul Manap Ahmad, Dean, University of Malaysia, Faculty of Forestry, Sedang, Selango, Malaysia.

Dr. Denver P. Burns, Director, USDA, Northeastern Forest Experiment Station, Radnor, PA.

Dr. Jerry Sesco, Deputy Chief for Research, USDA, Forest Service, Washington, D.C.

Dr. Cal Bey, Special Assistant to Deputy Chief for Research, USDA, Forest Service, Washington, D.C.

Dr. John Erickson, Director, USDA, Forest Service, Forest Products Laboratory, Madison, Wisconsin.

Dr. William Hyde, Chief, USDA, Economic Research Service, Soil & Water Branch, Washington, D.C.

Dr. Dave Newman, USDA, Economic Research Service, Soil & Water Branch, Washington, D.C.

Dr. Barry Seldon, USDA, Economic Research Service, Soil & Water Branch, Washington, D.C.

Dr. Dennis Bradley, USDA, Forest Service, North Central Forest Experimenmt Station, St. Paul, Minn.

Dr. Donald G. Hodges, Assistant Professor, University of Natural Resource Management, University of New Hampshire, Durham, N.H.

Burns, Denver P., tech. coord. 1991. **Research management for the future**; 1990 August 5-11; Montreal, PQ. Gen. Tech. Rep. NE-157. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 143 p.

Presents technical papers delivered at the 19th World Congress of the International Union of Forestry Research Organizations held in Montreal, Quebec, Canada, on August 5-11, 1990.

Keywords: Sugar maple, research planning, research evaluation, forest products

Headquarters of the Northeastern Forest Experiment Station is in Radnor, Pennsylvania. Field laboratories are maintained at:

Amherst, Massachusetts, in cooperation with the University of Massachusetts

Burlington, Vermont, in cooperation with the University of Vermont

Delaware, Ohio

Durham, New Hampshire, in cooperation with the University of New Hampshire

Hamden, Connecticut, in cooperation with Yale University

Morgantown, West Virginia, in cooperation with West Virginia University

Orono, Maine, in cooperation with the University of Maine

Parsons, West Virginia

Princeton, West Virginia

Syracuse, New York, in cooperation with the State University of New York, College of Environmental Sciences and Forestry at Syracuse University

University Park, Pennsylvania, in cooperation with The Pennsylvania State University

Warren, Pennsylvania

"Caring for the Land and Serving People Through Research"