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Strategies and Recommendations for Addressing Forest Health Issues in the Blue Mountains of Oregon and Washington

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Abstract

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The Blue Mountains Natural Resources Institute held three types of meetings to obtain public and scientific input into the development of strategies and recommendations for addressing forest health issues in the Blue Mountains of Oregon and Washington. Seven strategies are proposed: (1) plan and implement management activities on a landscape level; (2) enhance training and education on natural resources and forest health; (3) facilitate public involvement in planning, decisionmaking, and implementing solutions to natural resource problems; (4) develop a framework and implement an operational integrated database for landscape-level planning and management; (5) develop a framework and implement an integrated monitoring system for landscape-level planning and management; (6) assess economic and social effects of forest health issues on people, communities, and the area, and assist with adaptation to change; and (7) identify barriers to improving and protecting forest health, analyze the effects of alternatives, and recommend changes to alleviate barriers. The slate of issues and opportunities to implement this strategy will evolve as society's needs change and scientific information becomes available.

Keywords: Forest health, Blue Mountains, landscape-level planning, economic and social adaptation, public involvement.

Contents

Introduction

The Blue Mountains of northeastern Oregon and southeastern Washington are currently experiencing some of the most significant forest health problems in the United States. The situation has manifested itself in millions of dead and dying trees and many related natural resource problems. The Blue Mountains Natural Resources Institute (BMNRI) was formed in 1991, in part to address this problem. The BMNRI is a partnership organization of municipal, county, State, and Federal agencies, private landowners, producer groups, Native Americans, environmental groups, and others interested in the management of natural resources. The BMNRI includes all or part of 10 counties in Oregon and 4 in Washington (fig. 1) and covers over 19 million acres. The BMNRI area is generally defined as those counties containing the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests. One of the first roles the BMNRI had was to bring the divergent parties together to discuss the problems and potential solutions to forest health. This paper will provide the current view of the BMNRI on strategies to deal with the forest health issue on a landscape level in the Blue Mountains.

The Oregon Department of Forestry (1991a) and the USDA Forest Service (Gast and others 1991) have each developed plans to deal with forest health in the Blue Mountains. Each effort focuses on the land ownership type for which that agency has management responsibilities. The USDA Forest Service strategic plan covers the Umatilla, Wallowa-Whitman, Malheur, and Ochoco National Forests and is coordinated with the national strategic plan of the USDA Forest Service (USDA 1988, 1993). The Pacific Northwest Research Station has developed programs to address the research, development, and application aspects of dealing with forest health (USDA 1991). In addition, a scientific assessment of National Forest lands in eastern Oregon and eastern Washington was recently completed by Everett and others (1994). The Oregon Department of Forestry (1991b) also discussed the forest health issue on State and private lands based on its strategic plan and is currently developing a joint strategic approach to fire protection for the east side. The Oregon Department of Fish and Wildlife[1] has developed habitat criteria for forested lands and discussed their views on forest health (Gladson 1991).

The strategies proposed by the BMNRI are based on scientific knowledge and public input through BMNRI-sponsored meetings and a review of strategic plans by the various natural resource management agencies mentioned above. The process of defining strategies must be an evolving activity as more is learned. Thus, what we believe will work to improve forest health may change through time. Land managers will apply new techniques on the ground that will be evaluated. Old paradigms will be rethought and new paradigms developed. The whole concept of forest health necessitates this flexibility.

The USDA Forest Service (USDA 1993, p. 4) defines forest health as a "condition where biotic and abiotic influences on the forest (for example, pests, atmospheric deposition, silvicultural treatments, and harvesting practices) do not threaten management objectives for a given forest unit now or in the future." Because of the role management objectives play in defining forest health, the Forest Service went on to state that these objectives "do not necessarily mean commercial products: objectives reflect the many uses and values of forests, including recreation, wildlife, wilderness, timber, grazing, and water" (USDA 1993, p. 4-5). The Oregon Department of Forestry (1991a, 1991b) uses similar wording in their definition of forest health.

[1] Oregon Department of Fish and Wildlife. Plan review criteria. [No date]. 27 p. On file with: Oregon Department of Fish and Wildlife, 4412 Silverton Road NE, Salem, OR 97305

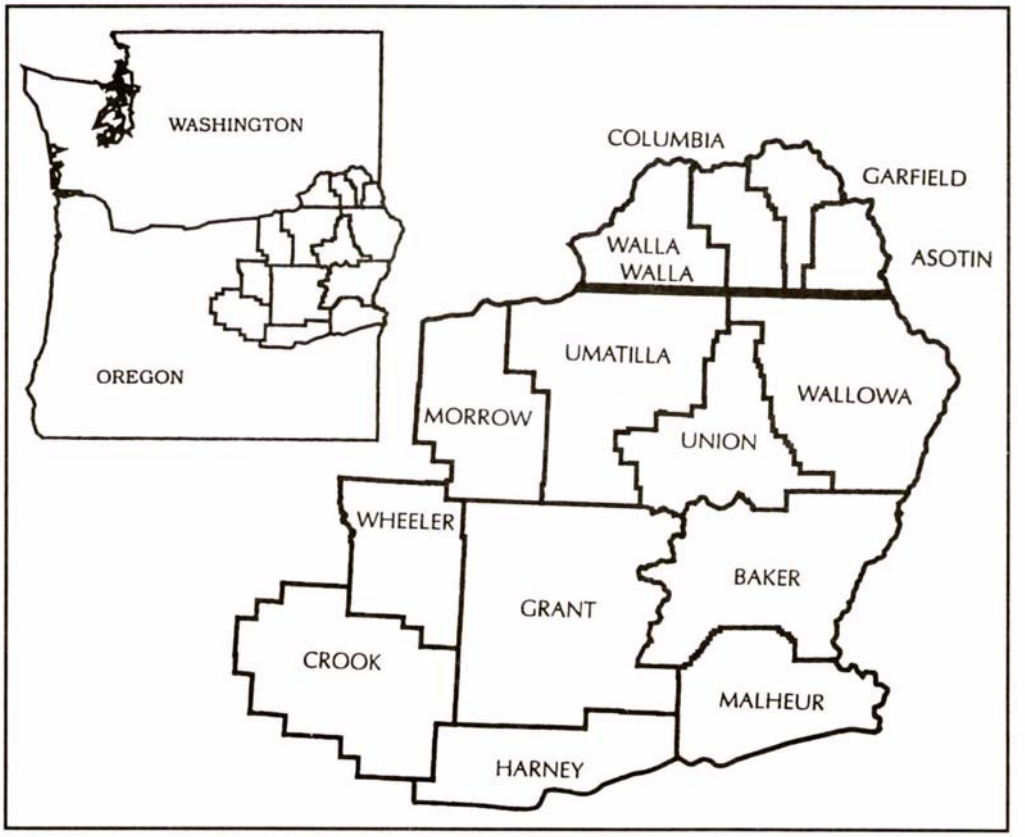

Figure 1—Area comprising the Blue Mountains Natural Resources Institute, by county.

The Forest Health Situation

The current forest health situation is likely the result of societal demands; past management decisions including, but not limited to, natural resource management practices, funding policies for natural resource management, and fire suppression; and natural occurrences of insects, diseases, and drought. The symptoms of the forest health situation are observed through factors such as the acres of dead and dying trees, watershed conditions, numbers of threatened and endangered species, rangeland condition, and acres at high risk of catastrophic fire. The symptoms will fluctuate in a dynamic ecosystem, but their presence highlights the need to address the causal factors. Each of these symptoms will be discussed or illustrated as it relates to the forest health situation. In many cases, area-wide information is not known for all landownership types.

Changes in Ecosystem Conditions

The recently completed scientific assessment of forest lands in eastern Oregon and Washington by Everett and others (1994) found several important changes in ecosystem conditions over the last 40 to 55 years. Their major findings are presented below (Everett and others 1994, p. 1):

> Forest fragmentation and landscape diversity increased in intensively managed watersheds, but declined in wilderness or roadless areas.
>
> The acreage of early-seral, late-seral, and climax stands has decreased, while mid-seral stand acreage has increased. Additionally, the abundance of young and old forest structural stages has declined, and middle-aged structural stages have increased. Such changes have important consequences for species and landscape diversity.

Significant differences in insect and disease hazard severity were not detected at the river basin level because of high within-basin variability; however, some watershed hazards were substantially changed. The largest increases and decreases in specific insect or disease hazards indicate that these disturbance processes have been greatly altered by management.

Tree densities, fuel loads, fuel continuities, and fire hazards have increased in some watersheds, and decreased in others. The assessment analysis was not able to evaluate the contribution of green fuel ladders to fire hazards because appropriate fuel models were unavailable; however, these fuels may be one of the most important fire hazards on the eastside.

Riparian vegetation and associated fish habitats have been adversely affected in many watersheds by grazing, roading, irrigation, and flood control practices.

Fire disturbance regimes have been altered through fire suppression especially on sites adapted to frequent, low- and moderate-severity fires.

Dead and Dying Trees

Historically, the drier sites of the Blue Mountains forests were dominated by ponderosa pine (Pinus ponderosa Dougl. ex Laws.) and western larch (Larix occidentalis Nutt.). The stands were kept fairly open with relatively frequent ground fires that eliminated seedlings and more shade-tolerant and less fire-resistant tree species, such as Douglas-fir *(Pseudutsuga menziesii* (Mirb.) Franco), grand fir *(Abies grandis* (Dougl. ex D. Don) Lindl.), and white fir *(Abies concolur* (Gord. & Glend.) Lindl. ex Hildebr.). With the suppression of low-intensity ground fires, these less-adapted species were allowed to become more abundant over large areas. Stand density also increased. Selective harvesting of ponderosa pine and western larch accelerated the process of fir domination. The result is a forest markedly different today than that of a century ago (Starr and Quigley 1992).

In recent years, an extended drought has occurred in the Blue Mountains (Owenby and Ezell 1992; U.S. Department of Commerce, no date) as has an insect and disease "epidemic." The drought (fig. 2) seems to have stressed the now-dominant firs, rendering them more susceptible to insects and diseases (Wickman 1992). The dead and dying trees are resulting in a massive fuel buildup with an associated increase in the risk of a catastrophic wildfire and many other natural resource impacts. Although precise figures of insect damage are unavailable, between 2 and 4 million acres per year are estimated to be affected to various degrees (figs. 3 and 4). Percentages of timbered areas by land ownership affected by the various insects from the 1991 aerial insect survey are shown in figures 5 and 6. Western spruce budworm *(Choristoneuraoccidentalis* Freeman) appears to be the most damaging insect (figs, 3 and 5). Repeated defoliation for 5 to 7 years may result in heavy tree mortality (Wickman 1992). Figure 5 also shows the total acres of each ownership in the Blue Mountains. Most of the western spruce budworm infestation appears to be occurring on National Forest lands in terms of both absolute and relative area. Figure 6 shows the relative occurrence of the fir engraver *(Scolytus ventralis* LeConte), Douglas-fir bark beetle *(Dendructunspseudotsugae* Hopkins), mountain pine beetle *(Dendroctunusponderusae* Hopkins) on ponderosa pine, and others (Engelmann spruce bark beetle *(Dedroctonus rufipennis* Kirby), western pine beetle *(Dendroctonus brevicomis* LeConte)). Although these insects do not seem to have the widespread distribution of the western spruce budworm, their presence can lead to significant mortality in a single season (fig. 4).

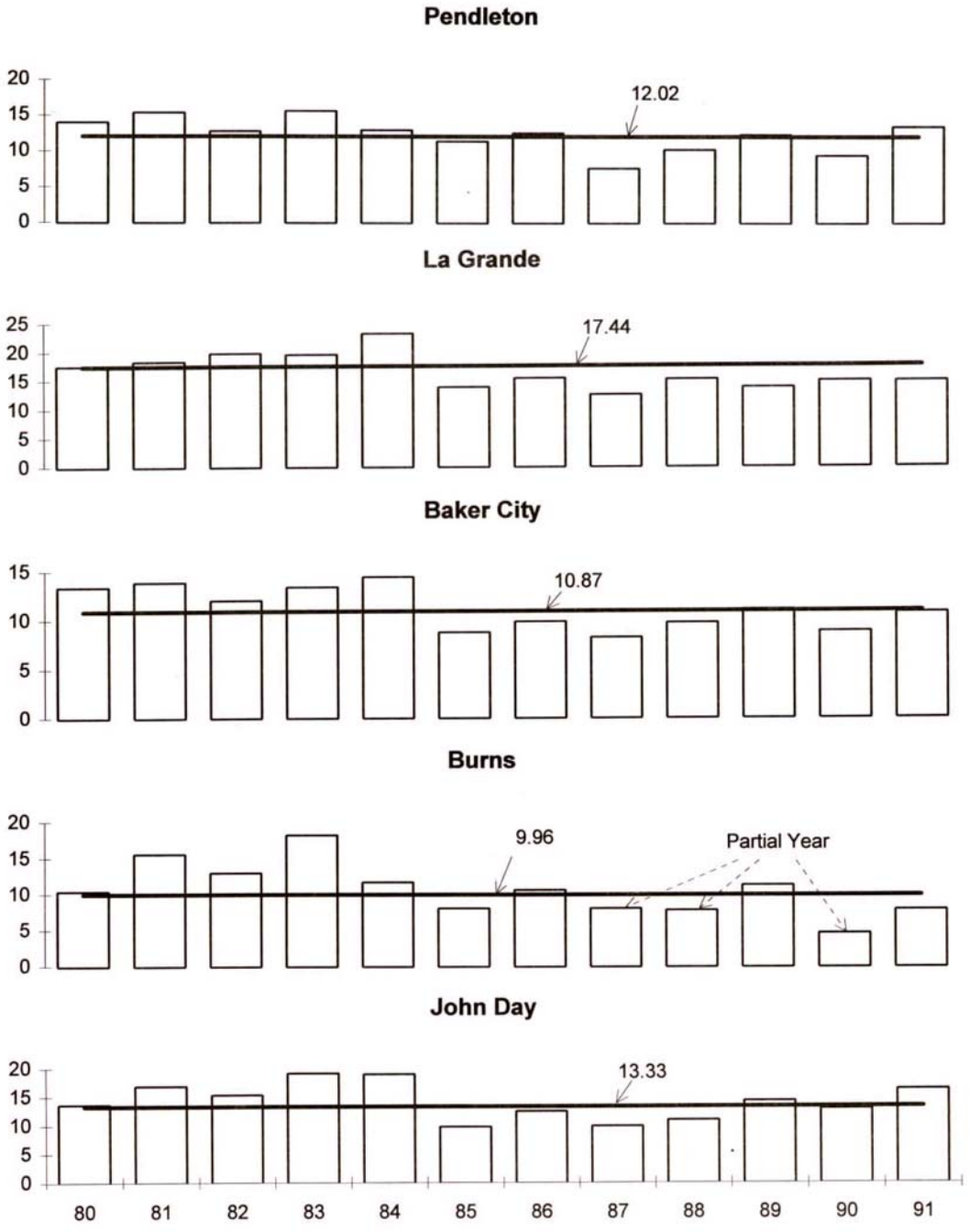

Figure 2-Actual (bars) and average (solid lines) inches of precipitation received at five locations in Oregon from 1980 to 1991. Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration (n.d.).

Federal timber harvests have been important in these areas for the last 40 years (fig. 7). The relative importance of harvests from National Forests has risen from about 40 percent of the total harvest in 1950 to between 60 and 80 percent in the 1980s. The impact of timber losses from National Forest lands to insect damage can be significant to the local economies. The large amount of dead and dying trees also can have significant impacts on other natural resource values. The potential for future problems if the western spruce budworm outbreak continues and infestation levels become more serious can be seen in figure 8. In 1991, most of the land affected by the western spruce budworm was in the lighter infestation levels.

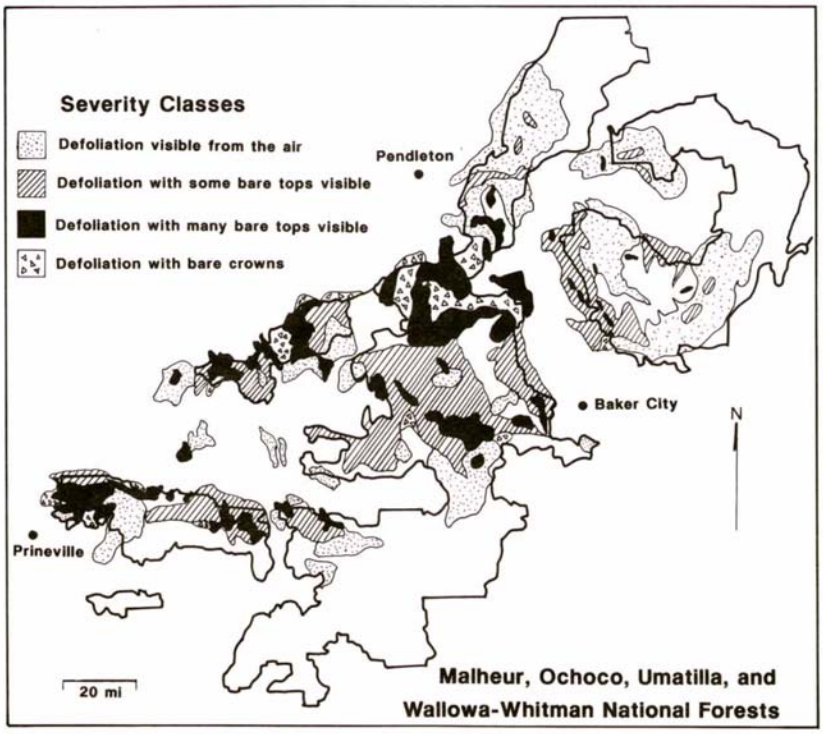

Figure 3—Areas affected by the western spruce budworm in the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests as detected by the 1991 aerial survey.

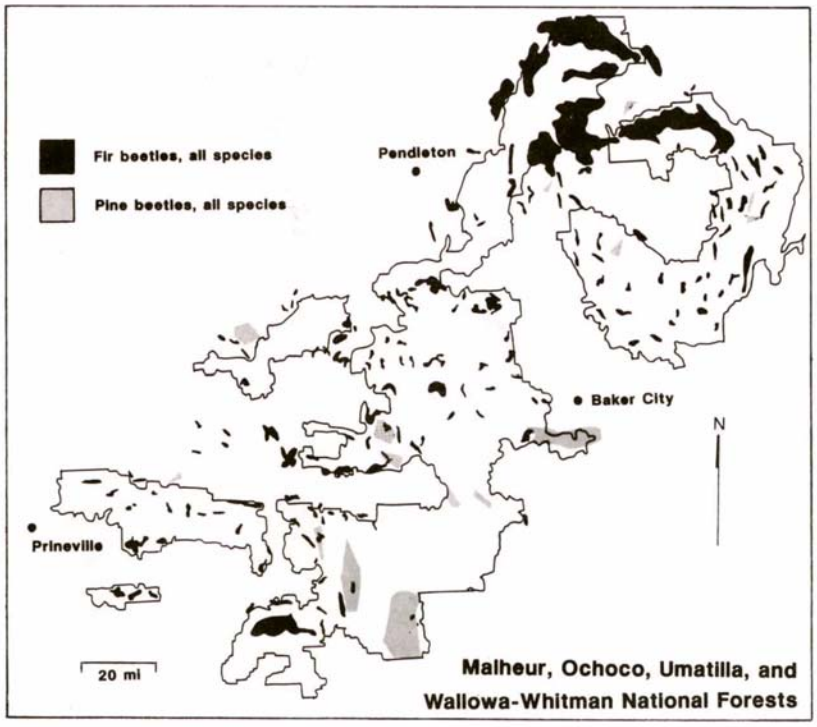

Figure 4—Areas affected by bark beetles in the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests as detected by the 1991 aerial survey.

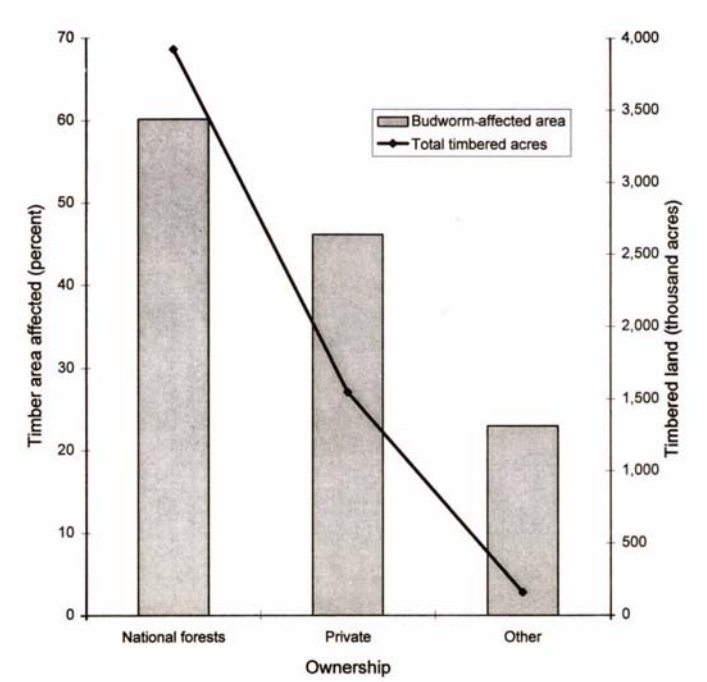

Figure 5—Percentage of timbered area affected in 1991 by the western spruce budworm and total timbered acres, by ownership in the Blue Mountains.

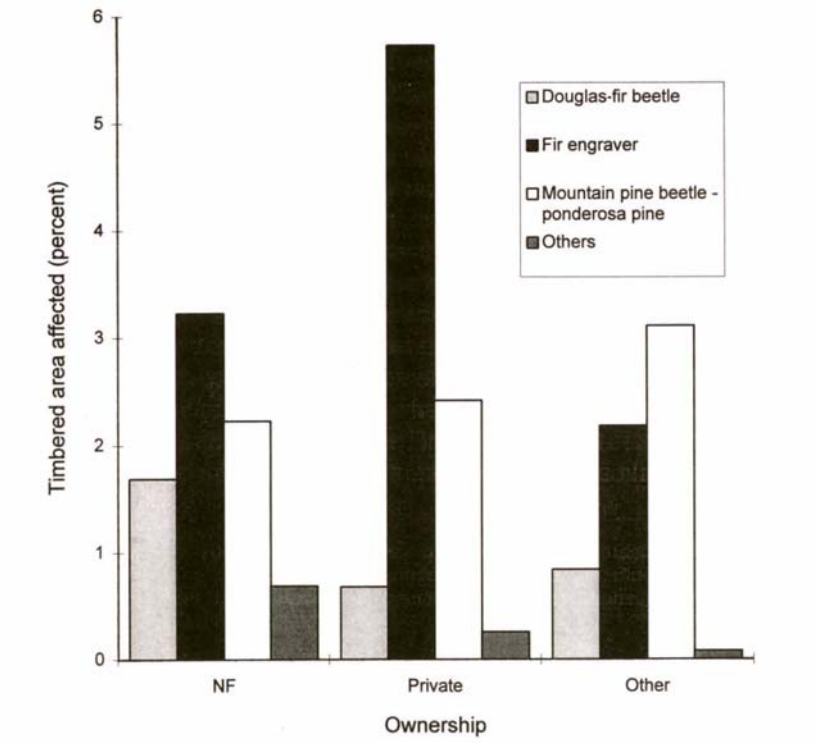

Figure 6—Timbered area affected in 1991 by the Douglas-firbark beetle, fir engraver, mountain pine beetle, and other insects, by land ownership in the Blue Mountains.

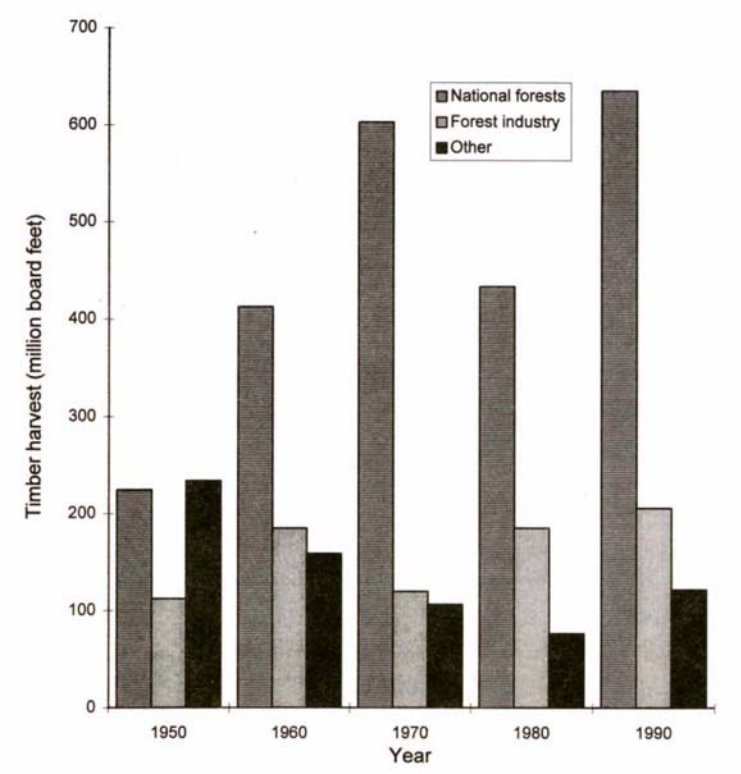

Figure 7—Timber harvest in the Blue Mountains during selected years, by land ownership.

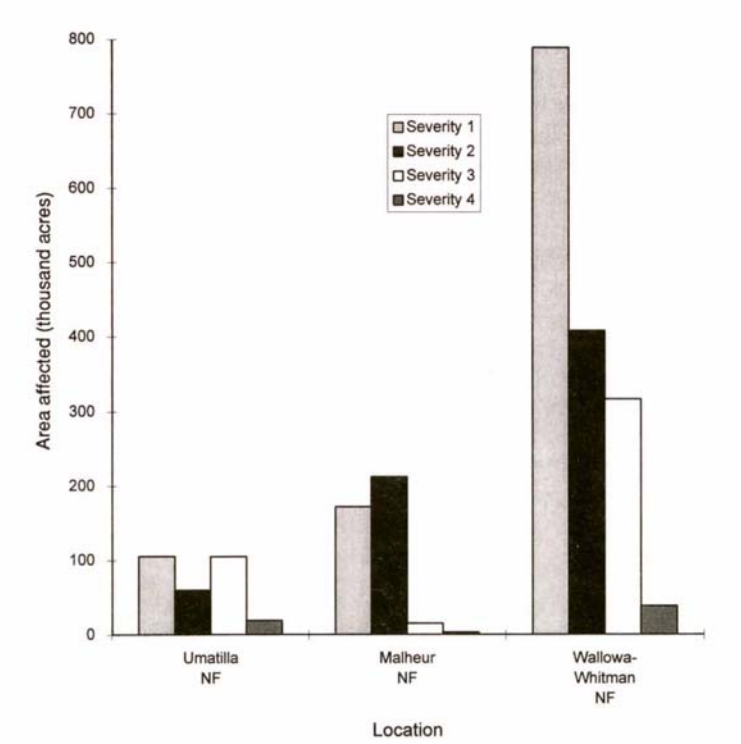

Figure 8—Acres affected by the western spruce budworm in 1991 by severity rating on all land ownerships within and around three National Forests in the Blue Mountains; 1 reflects low severity and 4 severe.

Threatened and Endangered Species

There are many sensitive, threatened, or endangered species of plants and animals present in the Blue Mountains. The most notable species today is the Snake River chinook salmon *(Oncorhynchus tshawytscha)* These anadromous fish have experienced precipitous declines in numbers of returning adults; this decline is probably due to a combination of in-stream dams, water withdrawals, commercial and sport fishing, and spawning habitat degradation (Baron and Thorgaard 1991, Nehlsen and others 1991, Northwest Power Planning Council 1987). Management of riparian areas and uplands to improve habitat quality may require significant changes in many activities. The Upper Grande Ronde River Basin has been the subject of recent focus on the problem of habitat degradation and salmon recovery.[2]

Watershed Conditions

Riparian areas over much of the Blue Mountains have been subjected to many stresses. Today we can see conditions that resulted from management actions deemed proper in the past. Grazing by large ungulates, logging, removal of woody debris, and other activities have led to reduced shade, higher water temperatures, and increased siltation (Gast and others 1991). Only about 28 to 32 percent of the watersheds in the Malheur National Forest, 35 percent of the watersheds in the Umatilla National Forest, and 70 percent of the Wallowa-Whitman National Forest are considered to be at or near their potential (Gast and others 1991). "Potential refers to the inherent capability of a watershed to produce biomass and function hydrologically as determined by its physical, chemical, and biological factors" (Gast and others 1991, p. 111-6).

Rangeland Condition

Rangeland, either grassland or shrubland, in the Blue Mountains is also below its ecological potential in many areas. The U.S. Department of the Interior, Bureau of Land Management (BLM), USDA Forest Service, and the USDA Soil Conservation Service collect information on rangeland condition and trend. In each case, the values derived relate the existing vegetation community to the ecologic potential of the natural community and not to suitability for any particular management activity (for example, commodity production, threatened or endangered species habitat, recreation suitability, or visual quality). Summary data for Oregon were published by the Society for Range Management in 1989 (fig. 9). Of more importance are data suggesting that trend (direction of change) is downward on 5 percent of BLM land, on 17.5 percent of Forest Service land (Pacific Northwest Region), and on 18 percent of all non-Federal rangelands (Society for Range Management 1989). Whether or not these changes are good or bad from the viewpoint of society's demands on rangelands cannot be inferred directly from these numbers. They do indicate land that is moving away from its ecological climax condition.

Risk of Catastrophic Fires

Stand replacement fires have occurred historically in the Blue Mountains. The result of these fires was a variation in stand structure, species, and age classes across the landscape. Controlling these fires has led to widespread, even-aged stands. Trying to re-create and maintain the healthy forest containing various successional stages will require creative approaches. Some combination of silvicultural practices and fire may be necessary along with other changes in management and policies (Mutch and others 1993). There are many unknowns about the reintroduction of fire into the ecosystems including "direct

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[2] USDA Forest Service, Wallowa-Whitman National Forest and Pacific Northwest Research Station, Oregon Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission [and others], 1992. Upper Grande Ronde River anadromous fish habitat protection, restoration, and monitoring plan. Administrative document. On file with: La Grande District, 3502 Highway 30, La Grande, OR 97850.

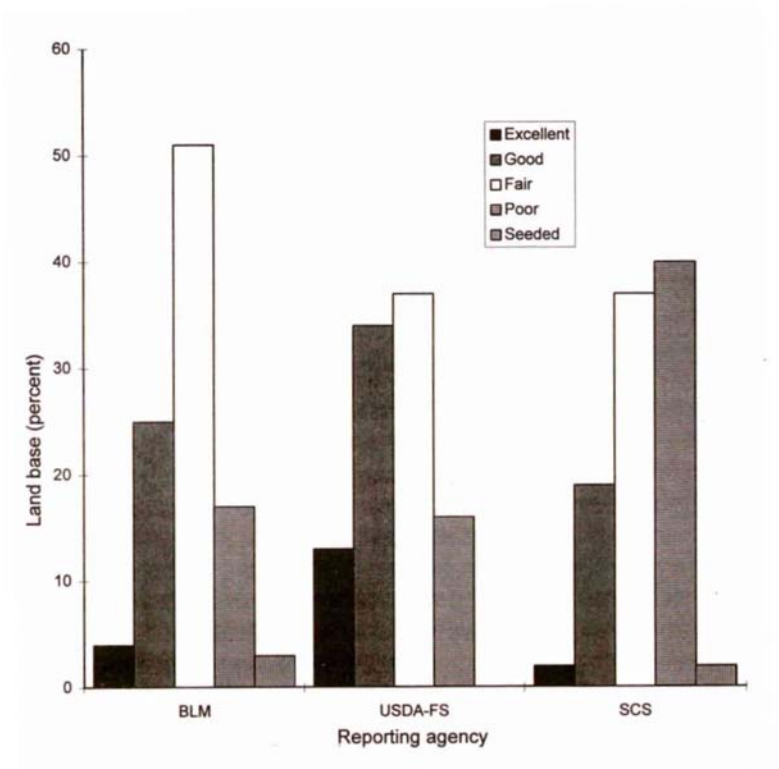

Figure 9—Ecological rangeland condition class in Oregon as reported in 1989 by the Bureau of Land Management, USDA Forest Service, and Soil Conservation Service (Society for Range Management 1989).

and indirect interactions among fire and pests, pathogens, vegetation response, wildlife, water, soil, nutrient distribution and cycling, and air quality" (Mutch and others 1993, p. 9). Present conditions have led to unprecedented fuel buildup with very high risks for catastrophic wildfire. Each National Forest in the Blue Mountains developed a map indicating that Forest's susceptibility to large-scale catastrophic wildfire (for example, fig. 10). Although frequency of fires in the Blue Mountains has stayed relatively constant over the past 20 years, total acres burned has increased markedly (fig. 11).

Cornpeting Interests

As in most natural resource issues in the Western United States, the problem of forest health in the Blue Mountains is compounded by many different private and public landowners and other citizens and groups seeking input to the solutions. The Blue Mountains land is dominated by the Wallowa-Whitman, Umatilla, Malheur, and Ochoco National Forests. The BLM, Native Americans, and private landowners manage the majority of the remaining lands (fig. 5). With the dominance of public lands in the area, there is significant pressure from local, State, and national interest groups concerning management of these lands. The adjacent private landowners are affected by these management decisions as well as by the success of public land management. It has taken us around a century to get to where we are today, and it likely will take many years to "cure the patient" even with cooperation among all parties.

The Blue Mountains Natural Resources Institute Response

As a way to formulate solutions to these problems, the BMNRI sponsored three types of meetings—forums, a workshop, and technical committees—each with a different purpose. Forums were public meetings with presentations given by panelists representing the USDA Forest Service as well as university scientists, forest managers, environmental advocate organizations, Native Americans, fish and wildlife professionals, timber manage-

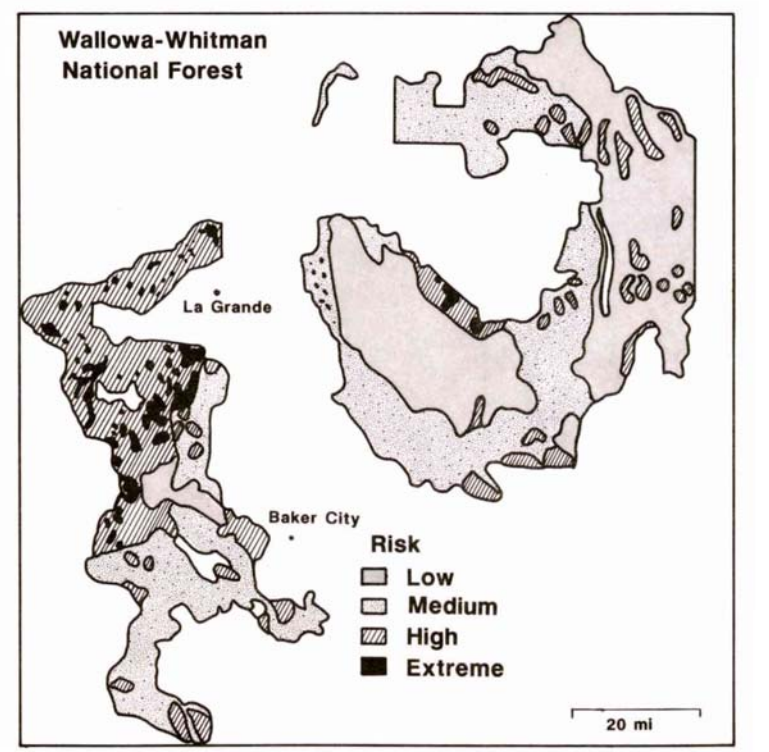

Figure 10—Fire risk rating map for the Wallowa-Whitman National Forest, 1992.

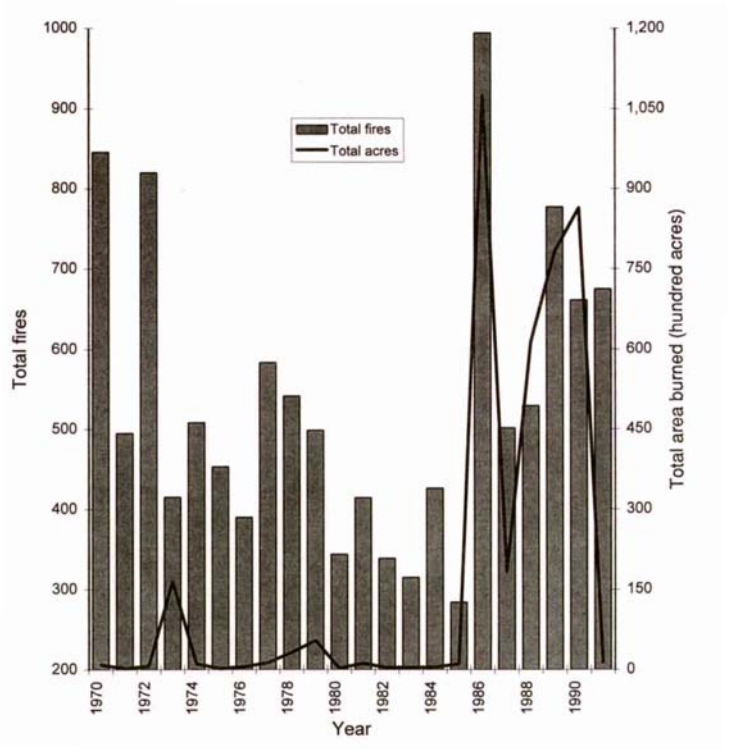

Figure 11-Total number of fires and acres burned in the Blue Mountains, 1970-91.

ment professionals, county governments, and the timber industry. Eight forums were held in Oregon and one in Washington to share information on the state of health of the forests and to gain an understanding of the public's ideas on what to do about the problem. Each scientist and panelist gave a short presentation followed by questions and comments from the audience and responses by various speakers (Starr and Quigley 1992).

The Forest Health Workshop was held November 20, 1991, in Pendleton, Oregon. The purpose of the workshop was to discuss strategies for restoring forest health in the Blue Mountains. It provided an opportunity for participants to meet others interested in forest health, share information on short-term strategies already in place, foster cooperation among participants in dealing with forest health, discuss strategies considered promising by participants, and provide a framework for cooperative problem-solving for the future. Representatives from the BMNRI, Small Woodland Owners, Grant County (Oregon) Stockgrowers, Kinzua Corporation, Oregon Department of Forestry, Oregon Department of Fish and Wildlife, and the USDA Forest Service gave short presentations on the current situation and short-term strategies. The participants then divided themselves into six groups to address specific strategies that appeared promising. The groups addressed restoring healthy ecosystems, preventing catastrophic fires, minimizing loss from insects and disease, economic stability, ensuring production of products, and landowner and public awareness. Each group tried to identify strategies that would lead to success in reaching the goal, be feasible, be generally accepted by the group, and be worth investing time and effort in addressing. Responses to a preworkshop mailing requesting strategies were considered as were other strategies participants suggested. In the time available, work groups did not reach consensus on the strategies; rather, a list of strategies that generally appeared promising was generated.[3]

The final set of meetings were the technical committee meetings, a formal, ongoing part of the BMNRI. BMNRI committees were formed to address (1) biodiversity and noxious weeds; (2) fish, riparian, and water quality; (3) forest productivity and protection; (4) sustainable forest and range management; (5) economic and social issues; (6) wildlif-game and nongame; and (7) technology transfer, education, extension, and public relations. The technology transfer committee was later dropped and a committee on wood utilization and timber products was added, but it was not functioning at the time of strategy development. Each committee is composed of representatives from groups with diverse interests and opinions, *so* that the full range of issues can be addressed. The technical committees provide advice on specific BMNRI programs of research, development, application, demonstration, and education; address priorities; recommend specific studies; review research, development, and demonstration proposals; and provide advice on specific scientific issues. These committees meet as needed and provide input to the board of directors and the BMNRI manager. The entire structure of the BMNRI is documented in the charter of the Blue Mountains Natural Resources Institute.[4]

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[3] Quigley, Thomas M. 1991. Memo dated December 6, 1991, on November 20 forest health workshop. 24 p. On file with: Blue Mountains Natural Resources Institute, 1401 Gekeler Lane, La Grande, OR 97850.

[4] Blue Mountains Natural Resources Institute. 1991. Charter and program. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region; Pacific Northwest Research Station. 10 p. On file with: Blue Mountains Natural Resources Institute, 1401 Gekeler Lane, La Grande, OR 97850.

Based on the information collected from these three types of meetings and from the various agency reports, the BMNRI offers the following strategies to deal with forest health on a landscape level. The term "landscape level" is meant to imply that land ownership boundaries, although important, should not be barriers to addressing the issues. Individual landowners will obviously have different objectives and incentives for management. Addressing all concerns in an integrated fashion is viewed as the overall strategy being emphasized by the BMNRI.

The remainder of this paper will attempt to identify strategies that seem to have merit on a landscape level. Because the BMNRI does not manage land, land management agencies and private landowners are encouraged to adapt these recommendations to their resource planning and management activities.

Strategies and Recommendations

The BMNRI proposes seven major strategies to address forest health issues. Although not irrevocably tied together, the strategies are closely linked. For that reason, they are not presented in an order of priority because all must be done to begin the process of restoring forest health to the Blue Mountains. Specific people, organizations, or agencies have not been identified to take the lead on any of the strategies. We believe there is more than enough work to go around and that carving out pieces of turf will be counterproductive for the natural resources. Each strategy identified is followed by a brief description of the intent and some possible actions required to implement the strategy. The list of actions is not meant to be comprehensive but to represent the current thought, which will evolve as new knowledge becomes available.

1. Plan and Implement Management Activities on a Landscape Level

Planning to address forest health and implementation of the plans must occur at the landscape level; single-ownership plans, forest-stand plans, and project-level analyses will not be sufficient. This strategy includes a multiagency, multiownership, multi-interest group, and multidisciplinary approach to planning. This approach is neither unique nor the common planning practice. The level of investment in forest health must be identified through social and political processes from an array of ecologically sustainable alternatives.

Potential implementation activities:

- Opportunities for integrated landscape-level research should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring the knowledge to landowners, managers, and the general public.

- Recognize differences in landowner objectives, financial resources, and incentives for addressing different aspects of forest health. Allow agency personnel to work on all land ownership types (for example, Oregon Department of Forestry on National Forests and Forest Service managers on private and State lands) in a cooperative, landscape-level planning effort. The process has been used in what is termed "coordinated resource management planning" and similar efforts.

- Adaptive management techniques should be employed to transfer new information to landowners and managers as quickly as possible. Technical assistance to landowners and managers should be provided on the most up-to-date methods, and adaptive management should be encouraged.

- Re-examine forest management plans on State, private, and Federal lands to ensure that the latest information is being applied on the ground. Conversion prescriptions should be based on site potential and management objectives. Insect and weed spray programs should be used only as short-term tactics to enable longer-term strategies to be implemented. Forest conditions should be improved by using stocking level control and establishing pest-resistant species as appropriate and where they are well adapted. Management should focus on the entire ecosystem and not on a specific subset of resources. If salvage of dead and dying timber is required, ensure that the operation looks beyond just the removal and toward restoring forest health. Salvage should not be used to remove the symptom but rather as a tool to begin the healing process. Critical biodiversity components of the landscape should be identified and managed at the genetic, species, and landscape levels. Riparian areas should be managed soundly for all resource uses and users. Timber harvesting systems that reduce onsite impacts to the remaining resources should be developed and applied.

2. Enhance Training and Education on Natural Resources and Forest Health

A concerted effort is needed to educate all sectors of the population on forest health issues and potential solutions. Education must begin at the very youngest ages and continue through the adult level. Land managers, decisionmakers, and interested publics must have information on the most current methods and technologies used to address forest health issues on a landscape level. These efforts should be coordinated among agencies, organizations, educators, and others. The education and training should be a combination of onsite (field) and classroom activities that can be incorporated into existing K-12, college and university, and adult education programs.

Potential implementation activities:

- Opportunities for training and educational activities on integrated landscape-level research should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring the knowledge to the landowners and managers and to the general public.

- Existing education programs should be built upon and new ones developed to meet the needs of students, the general public, landowners, and natural resource managers and consultants. Consistent definitions of terms and prescriptions should be developed and applied by all landowners and managers and by other interested publics.

- A system of demonstration areas should be developed to show effects of land management practices using scientific methods. Objectives for each demonstration area should be established by scientists, managers, landowners, and concerned public, as appropriate. Onsite tours should be conducted, and other materials should be developed for use away from the sites (for example, videos, brochures, photographs, papers).

3. Facilitate Public Involvement in Planning, Decisionmaking, and Implementing Solutions to Natural Resource Problems

The Blue Mountains area is dominated by public ownership and management. Involving the public in planning, decisionmaking, and implementing management activities is seen as a key element in addressing forest health issues. Public awareness programs on the

key issues and potential solutions must be followed by active participation in the planning and decisionmaking processes. Such public involvement from the beginning will give a sense of ownership in the solutions implemented. This same process should be used at the landscape level to include all landowners, agencies, organizations, interested publics, and disciplines.

Potential implementation activities:

- Opportunities for public involvement on integrated landscape-level research should be developed. All interested publics should be involved in the design of research programs to address specific issues. This can be in the form of advisory committees or direct involvement in defining the issues and objectives to be addressed, Specific study designs and methodologies should come from the scientists.

- A coordinated multiagency, interest group, and landowner public awareness program using all available public relations tools should be developed and implemented. There should be a continuous refining and sharing of the knowledge base to develop a comprehensive response to forest health issues.

- Opportunities for public involvement in planning and decisionmaking for the use of natural resources should be developed. Involvement should begin at the earliest time, before alternatives have been developed.

4. Develop a Framework and Implement an Operational Integrated Database for Landscape-Level Planning and Management

Data exist for various purposes in many different forms. To begin planning and managing at a landscape level, the data need to be organized at that level. A framework for the type of data required, scale, collection techniques, source of data, legal requirements, and data ownership needs to be developed across all land ownerships and agencies. Once defined, a method to resolve differences in existing databases needs to be developed and implemented. For example, if a Geographic Information System (GIS) is identified as appropriate and all questions about scale, type of data, and so forth, are resolved, then ways must be found to integrate the many different GIS applications already in use.

Potential implementation activities:

- Opportunities related to research on an operational integrated landscape-level database should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring knowledge to the landowners, managers, and the general public.

- A database format should be developed that will be integrated across all land ownerships. This may be in the form of a GIS. The focus should be on those items most relevant to future management of natural resources at the landscape level. Data availability and reliability, data cost, data updating, and potential use should be considered in design of the database. The database should be made available to natural resource managers.

5. Develop a Framework and Implement an Integrated Monitoring System for Landscape-Level Planning and Management

An overall, integrated framework for monitoring forest health should be developed and implemented at the landscape level. This integrated framework should address project-, stand-, and landscape-level monitoring that reflects the resource being monitored. Monitoring levels should be tied to an integrated landscape-monitoring framework that addresses how the data are to be used in interpreting forest health. All agencies, organizations, and interested public should be involved in the development of this framework.

Potential implementation activities:

- Opportunities related to research on an operational, integrated, landscape-level monitoring system should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring the knowledge to the landowners, managers, and the general public.

- An overall, integrated framework for monitoring forest health on a landscape basis should be developed. The framework should define standards, procedures, and plans to implement the framework cost-effectively. The monitoring data and the operational database must "fit" together for maximum usability by landowners, managers, and others.

6. Assess Economic and Social Aspects of Forest Health Issues on People, Communities, and the Area, and Assist With Adaptation to Change

Forest health issues and solutions will have an impact on people, communities, and the Blue Mountains area. It is essential that any plan include and assess those living in the region. The potential economic and social impacts need to be estimated for each alternative action. If solutions considered to be best for the resources are determined to have a negative economic impact, alternative economic development strategies should be explored. Assistance programs for affected workers and communities should be developed and implemented to deal with the change.

Potential implementation activities:

- Opportunities related to research on economic and social aspects of forest health should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring the knowledge to the landowners and managers and to the general public.

- The social and economic impacts on local communities should be assessed relative to forest health issues and alternative management strategies. Economic diversification strategies should be analyzed including current market and product expansion and improvement.

- Affected workers and communities should receive technical assistance in developing economic strategies that allow them to adapt to change.

- Economic efficiency studies should be conducted for all treatment plans to analyze the benefits and costs to all resources.

7. Identify Barriers to Improving and Protecting Forest Health, Analyze Effects of Alternatives, and Recommend Changes to Alleviate Barriers

There are many barriers to adequately addressing forest health issues. In some cases, the most current knowledge and techniques may not be applied to the landscape because of barriers as simple as a lack of education or as complex as a myriad of rules and regulations. Each barrier, be it law, regulation, lack of information, policy, attitude, or whatever, must be identified and addressed. Once identified, alternative courses of action must be developed and analyzed to ensure that new barriers are not erected. Actions must then be taken to alleviate or eliminate the barrier to change.

Potential implementation activities:

- Opportunities related to research on institutional barriers to improving forest health should be developed. This will include searching the literature, synthesizing existing knowledge, conducting research to address the issues, demonstrating the application of the research, and transferring the knowledge to the landowners and managers and to the general public.

- Funding for forest health activities should be developed on a landscape basis and not on the value of commodities removed. Provide adequate incentives for landowners and managers to implement recommended strategies.

- The issue of reintroducing fire into the ecosystem and the impact on society from smoke should be addressed. Prescribed fire often is discussed as one way to help improve the health of the forest; however, air quality concerns may prevent this from occurring on a large scale.

- Once forest health strategies are demonstrated to work, policy change recommendations should be developed that address barriers to widespread implementation.

Conclusions

The forums, workshops, and technical committees have brought together diverse interests to focus on the management of natural resources in the Blue Mountains area. The strategies and recommendations discussed here are one result of those meetings. The focus of the strategies is at the landscape level and through the use of an integrated approach across land ownerships.

There is much work to be done in dealing with the forest health issue. How that is accomplished on each piece of land will depend on the objectives the landowner or manager has for that land. We believe that our concern should be for the area's natural resources and the long-term productivity and sustainability to meet current and future needs of the people.

The BMNRI will be implementing some of the strategies and recommendations over the next several years in cooperation with many of the partner organizations. These will be accomplished through research, development, demonstration, application, and education. The slate of issues and opportunities likely will evolve as new information becomes available. The mission of the BMNRI requires that it remain flexible and adaptable in the face of economic and societal changes.

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The Blue Mountains Natural Resources Institute held three types of meetings to obtain public and scientific input into the development of strategies and recommendations for addressing forest health issues in the Blue Mountains of Oregon and Washington. Seven strategies are proposed: (1) plan and implement management activities on a landscape level; (2) enhance training and education on natural resources and forest health; (3) facilitate public involvement in planning, decisionmaking, and implementing solutions to natural resource problems; (4) develop a framework and implement an operational integrated database for landscape-level planning and management; (5) develop a framework and implement an integrated monitoring system for landscape-level planning and management: (6) assess economic and social effects of forest health issues on people, communities, and the area, and assist with adaptation to change; and (7) identify barriers to improving and protecting forest health, analyze the effects of alternatives, and recommend changes to alleviate barriers. The slate of issues and opportunities to implement this strategy will evolve as society's needs change and scientific information becomes available.

Keywords: Forest health, Blue Mountains, landscape-level planning, economic and social adaptation. public involvement.

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