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Expanding Horizons of Forest Ecosystem Management:

Proceedings of the Third Habitat Futures Workshop

Cover Photo

1988 infrared satellite imagery of central Oregon Cascades region; courtesy NASA and William Ripple, Oregon State University.

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Applications of Ecosystem Management

Mark H. Huff, Stephen E. McDonald, and Hermann Gucinski
Technical Coordinators

Expanding Horizons of Forest Ecosystem Management:

Proceedings of Third Habitat Futures Workshop

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Abstract

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New approaches and technologies to evaluate wildlife-habitat relations, implement integrated forest management, and improve public participation in the process are needed to implement ecosystem management. Presented here are five papers that examine ecosystem management concepts at international, national, regional, and local scales. Two general management problems were addressed: how to incorporate different components of ecosystem management into specific forestry and wildlife management practices, and how to resolve conflicts and involve citizens more effectively in the management process. These papers are examples of new concepts and procedures being tested for use in managing resources by using an integrated ecosystem basis.

Keywords: Biodiversity, conservation planning, forest plantations, forest structure, land management planning, landscape, Pacific Northwest, British Columbia, protected areas, public participation, regional planning, resource conflicts, silvicultural treatments, sustainable forest development.

Foreword

Incisive legislation of the late 1960s and 1970s, including the National Forest Management Act, National Environmental Protection Act, and Endangered Species Act, signaled a growing awareness that humans need to be more responsible for their effect on the environment. Prolonged conflicts over complying with these and similar laws, while meeting the economic and social demands for natural resources, forewarned of a need to develop and test new management approaches to resolve such conflicts. The most promising conceptual framework for innovative methods is one based on ecosystem science.

The purpose of this publication series, "Applications of Ecosystem Management," is to provide a focal point for the dissemination of new findings, concepts, and other information that advance ecosystem science and management. It is also a crossroads where scientists, developers, resource specialists, and managers can come together to provide a clearer understanding of ways to manage ecosystems.

Management based on the principles of ecosystem science must be interdisciplinary and address the maintenance and restoration of biological diversity, maintenance of long-term site productivity, and sustainability of renewable natural resources. Although ecosystem science and management could be considered all-encompassing, our focus in this series is to expand knowledge of geographic and temporal scales meaningful to different ecosystem components and processes; ecosystem structure and composition as it relates to functions, adaptability, and natural and human-caused disturbances; landscape interconnections, flows, patterns, and linkages; and viability of species relative to multiple scales and multispecies interactions. Further, advancing knowledge of the human interactions in ecosystem maintenance and restoration will be crucial to successfully implementing ecosystem management.

The challenges ahead to develop and implement ecosystem management approaches are complex. Clearly, ecosystem management strategies will be revised and improved continually as new knowledge becomes available. To integrate ecosystem science into management practices requires a medium in which information can be transferred quickly and understandably. We envision this publication series as providing that medium, creating new opportunities and cultivating new insights.

Mark H. Huff
Stephen E. McDonald
Hermann Gucinski

Technical Coordinators

Preface

Public interest in the management of forest and wildlife resources continues to increase in Canada and the United States. As managers attempt to meet the demands for resource allocations, uses, and conservation, they face ever more complicated decisions about forestry practices and wildlife management. To aid in the decisionmaking, researchers are managers throughout North America are developing new approaches and technologies to evaluate wildlife-habitat relations, implement integrated forest management, and improve public participation in the process.

In 1992, the third Habitat Futures workshop was convened to examine new approaches to forest ecosystem management. Habitat Futures workshops have proven to be stimulating forums for exchanging ideas and evaluating tools and techniques for integrating timber and wildlife management. The papers in this publication are the product of a workshop held in October 1992 at Vernon, British Columbia. Although this Habitat Futures workshop focused on the Pacific Northwest region, including British Columbia, Washington, Oregon, Idaho, and Montana, the concepts and information exchanged have broad application.

The 1992 workshop examined the concept of ecosystem management from a variety of scales (national, international, regional, and local) and explored two management problems: how to incorporate different components of ecosystem management into specific forestry and wildlife management practices, and how to resolve conflicts and involve citizens more effectively in the management process. The papers included here represent examples of new concepts and procedures being tested for use in managing resources by using an integrated ecosystem basis.

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Forest at UNCED:
An Emerging Global Consensus Toward Sustainability

Gary L. Larsen

Abstract

Larsen, Gary L. 1994. Forests at UNCED: an emerging global consensus toward sustainability. In: Huff, Mark H.; Norris, Lisa K.; Nyberg, J. Brian; Wilkin, Nancy L., coords. Expanding horizons of forest ecosystem management: proceedings of third habitat futures workshop; 1992 October; Vernon, BC. Gen.Tech. Rep. PNW-GTR-336. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 1-15. (Huff, Mark H.; McDonald, Stephen E.; Gucinski, Hermann, tech. coords.; Applications of ecosystem management).

The United Nations Conference on Environment and Development (UNCED) gave rise to the first global consensus on forests. The consensus has three basic elements: (1) acceptance by countries of an assessment acknowledging the threats to and conditions of the forests of the world; (2) adoption of a statement of forest principles expressing a consensus among all countries on a wide range of social, economic and environmental dimensions of sustainability; and (3) adoption of "Agenda 21 ," chapter 11, "Combating Deforestation"—an action plan providing a common approach for countries to integrate national actions and international cooperation for the conservation and sustainable development of forests.

Keywords: UNCED, sustainability, global agreements, forest conservation, sustainable development, forest principles, international forestry, Earth Summit, Agenda 21.

Introduction

The June 1992 Earth Summit in Rio de Janeiro, more properly known as the United Nations Conference on Environment and Development (UNCED), Was described by its secretary-general, Maurice Strong, as "the most important conference in the history of humanity." lt was the largest diplomatic effort ever mounted and marked a significant turning point in the affairs of the world. Most world leaders attended. They proclaimed the inextricable link between environment and development.

UNCED had it genesis in two earlier events. The first was the 1972 Stockholm Conference on the Human Environment, which led to the creation of the United Nations Environment Program (UNEP); the Global Environment Monitoring System, Earthwatch, the Convention on the International Trade of Endangered Species of Wild Flora and Fauna (CITES); the World Heritage COnVention; and the Regional Seas Program Valentine 1991). The

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second event was the publication in 1987 of “Our Common Future,” the report of the World Commission on Environment and Development,[1] which developed the most comprehensive link to date between the environment and development and called for a global conference, which became UNCED (World Commission on Environment and Development 1987).

The Earth Summit marked the conclusion of 2 years of extensive diplomatic negotiations in preparation for UNCED. Three major agreements were adopted by the consensus of nearly 180 countries: “Agenda 21”—an action plan of 40 chapters; “Rio Declaration on Environment and Development”; and a statement of principles for forests. In addition, two major conventions on climate change and biodiversity, negotiated outside of UNCED, were opened for signature by heads of state at Rio de Janeiro.

UNCED was both a catalyst and an expression of deep-rooted changes taking place in the world. It marked a turning point from an old world order dominated by national security issues defined along an east-west axis to a new world order whereby the notion of national security embraces issues of economic and environmental security, defined along a north-south axis with developed countries at one pole and developing countries at the other. This new order is focused on economic and social development. UNCED linked these to the stewardship of natural resources.

The intertwining themes of the economic, social, and environmental dimensions of sustainability were woven throughout the UNCED negotiations and agreements. While the Earth Summit in Rio de Janeiro marked the end of 2 years of extensive diplomatic negotiations, it also marked the emergence of a new era. The actual outputs are all starting points:

- Initiation of action among signatories to deal with biodiversity and climate change through signing and subsequent ratification of two legally binding conventions.

- A consensus among all countries declared in two sets of principles—one on environment and development, the “Rio Declaration on Environment and Development,” and the other on forests (forest principles) (United Nations 1992b, 1992c).

- An extensive global action plan, “Agenda 21,” adopted to put the world on the course of sustainable development for the 21st century (United Nations 1992a).

- Agreement to establish within the United Nations a Commission on Sustainable Development that will provide an intergovernmental forum for pursuing the agreements made at UNCED.

The “Rio Declaration on Environment and Development” is a proclamation of 27 principles aimed at meeting the needs of present and future generations by integrating environment and development (United Nations 1993c). The principles can be organized by subject matter into four broad categories: (1) meeting the needs of present and future generations, (2) international cooperation, (3) actions of national governments, and (4) transboundary issues. Figure 1 shows the main topics of the principles and displays the wide range of issues dealt with in this declaration.

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[1] Also known as the Brundtland Commission Report, named after its Chair, Gro Harlem Brundtland of Norway.

Meeting Needs of Present and Future Generations	International Cooperation	National Government Actions	Transboundary Issues
• Human Entitlements (1) • Intergenerational Equity (3) • Eradication of Poverty (5) • Citizen Participation (10) • Role of Women (20) • Mobilization of Youth (21) • Indigeneous People and Local Communities (22) • People Under Oppression (23) • Peace, Development, and Environment (25)	• Least-Developed Countries (6) • Common Responsibilites (7) • Technology Cooperation (9) • Supportive Economic System (12) • Good Faith Cooperation (27)	• Environmental Protection (4) • Unsustainable Patterns of Production and Consumption (8) • Environmental Legislation (11) • Liability and Compensation (13) • Precautionary Approach (15) • Internalization of Environmental Costs (16) • Environmental Impact Assessment (17)	• Sovereign Rights and Responsibilities (2) • Toxic Export (14) • Disaster and Emergency Notification (18) • Consultation on Adverse Effects (19) • Environmental Protection in War (24) • Peaceful Dispute Resolution (26)
Numbers in parenthesis refer to principles as numbered in the Rio Declarationon Environment and Development			

Figure 1—"Rio Declaration on Environment and Development," overview of principles, arrayed by subject matter.

The forest principles express a consensus among all countries on a wide range of issues pertaining to forests, including functions of forests, integration of environment and development, nationally based actions, involvement of people, research and education, trade, and international cooperation (United Nations 1993b).

"Agenda 21" is a large document of 40 chapters that also expresses a consensus among all countries on global partnership for sustainable development. It provides a blueprint for moving the world to sustainable development by the 21st century (United Nations 1993a).

Significance of Forests in Canada and the United States

To fully appreciate what the Earth Summit and its accords mean for forests and forestry in countries like the United States and Canada, it is useful to set the stage by describing U.S. and Canadian forests, their role in the economy, and some international aspects of forests.

One-third of the United States, over 730 million acres (296 million ha), is covered by forests. Nearly one-half of Canada, 1.1 billion acres (453.3 million ha), is covered by forests. Forests and forest management can be considered as an aggregate of six different forest estates or holdings:

- Industrial forests
- Nonindustrial woodlands
- Federal forests
- Triballand forests
- State and other public forested lands
- Urban forests

Nearly two-thirds of U.S. forests, 483 million acres (196 million ha), are productive timberland. More than half, 57 percent, of the productive timberland is owned by farmers and other individuals in the United States. Forest industries own 15 percent of the U.S. timberland, and the balance of 28 percent is in public ownership, most of it contained in National Forests administered by the USDA Forest Service (Haynes 1990).

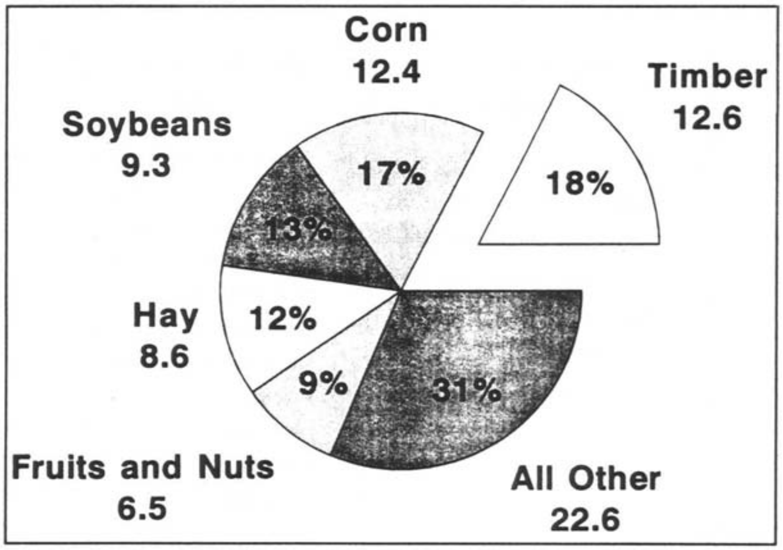

Figure 2—U.S. timber and agricultural crops, 1986 value in billions of U.S. dollars. Data from Haynes (1990).

Of the 1.1 billion acres (453.3 million ha) of forests in Canada, slightly more than half, 54 percent, of the inventoried forests (602 million acres [244 million ha]) is productive timberland. The majority of nonreserved productive timberland, 88.9 percent, is publicly owned—80.6 percent by the Provinces and the remaining 8.3 percent by the Yukon and Northwest Territories. Private timberlands account for 9.9 percent of the timberlands with nonindustrial forest lands accounting for the largest proportion, 6.3 percent (Canadian Council of Forest Ministers 1992a).

Most people know that forests provide a wide diversity of goods, services, and amenity values. It is not well known however, that, depending on the year, the value of timber produced from U.S. forests has often exceeded the value of corn, the largest agricultural crop in the country. In 1986, for example, the value of timber crops was $12.6 billion, compared to corn which was $12.4 billion (fig. 2). Lumber and other solid wood products rank in the top three manufacturing industries in most regions of the United States. Figure 3 shows that the timber industry in the United States was responsible for more than 1.5 million jobs in 1986, and salaries paid out exceeded $32 billion (Haynes 1990).

Forests also contribute significantly to the economic and social well being of Canadians. The significance of Canadian forests is reflected in the Canadian Forestry Act (Government of Canada 1989), which explicitly requires the Federal Minister of Forests to promote sustainable development of forests (Maini 1991). Forestry in Canada generates more than 800,000 jobs, and about 350 communities are dependent on forestry. In 1989, shipments from Canada of manufactured forest products amounted to Can$50 billion. In addition, Canadian forests support a multibillion dollar tourism and recreation industry (Canadian Council of Forest Ministers 1992b).

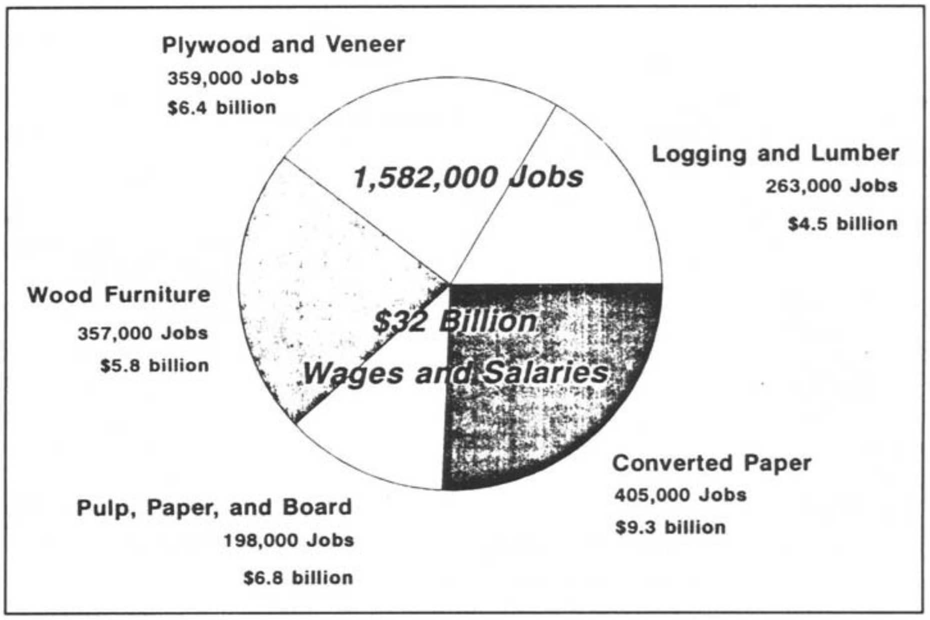

Figure 3—United States timber industry employment, jobs, and wages and salaries, 1986. Data from Haynes (1990).

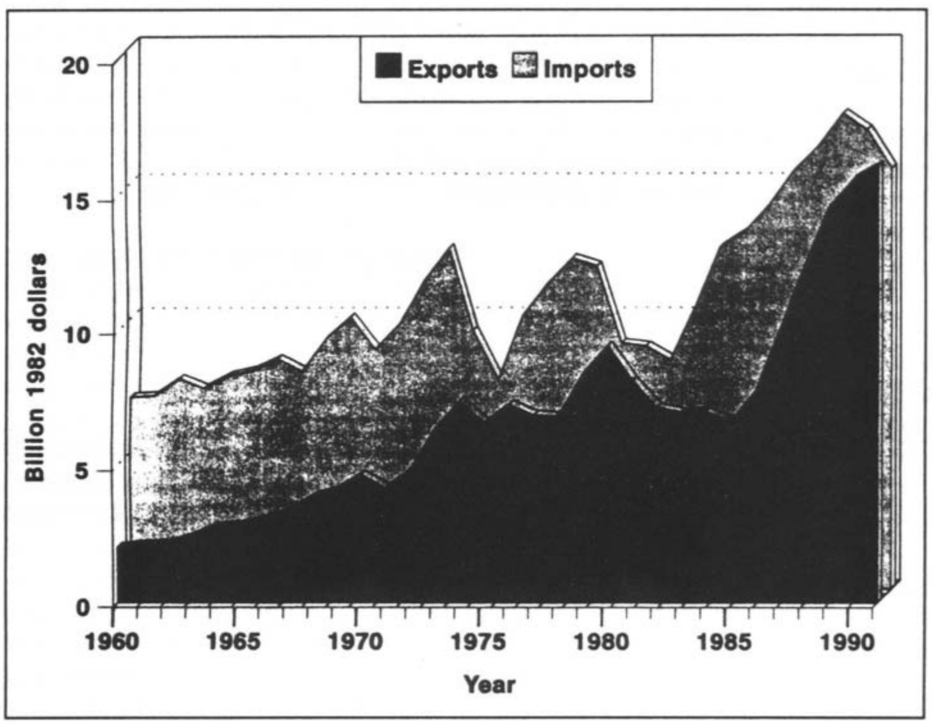

Figure 4—U.S. forest products imports and exports, billion 1982 dollars. Data from Haynes (1990).

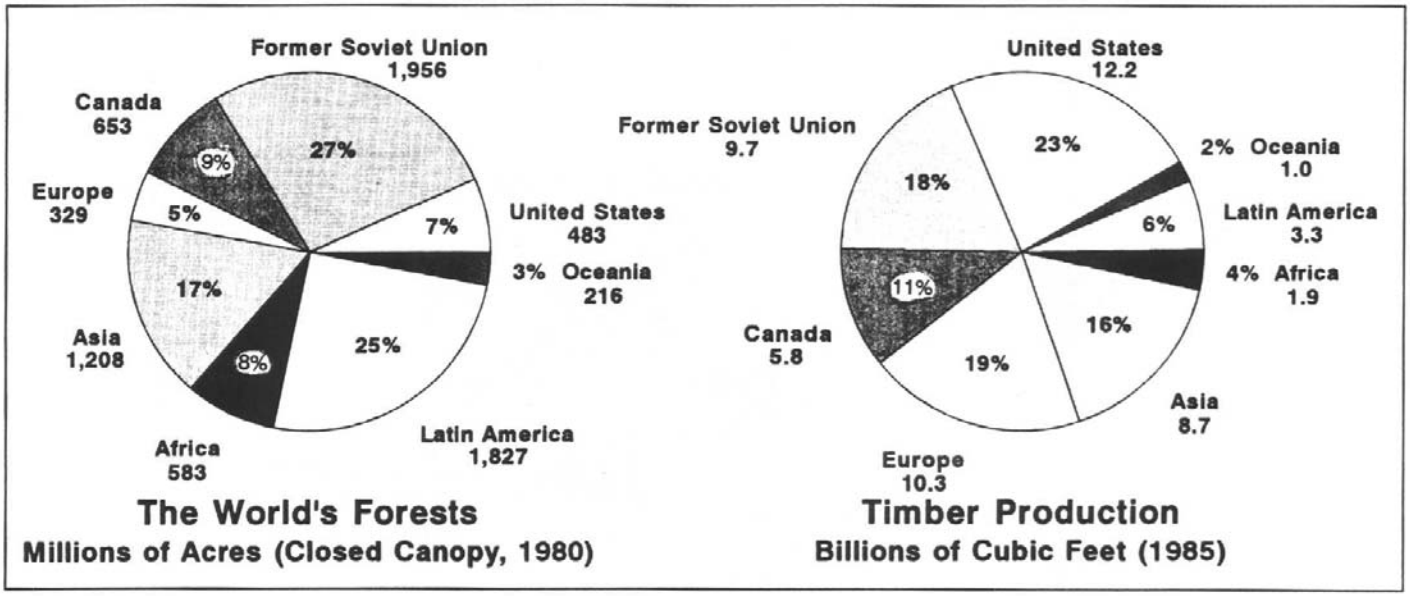

Figure 5—Timber production and the world's forests. Data from Haynes (1990).

Forest Products in International Trade

Canadian exports in 1990 contributed Can$18.8 billion to the net balance of trade (Canadian Council of Forest Ministers 1992b). Forest products also figure significantly in U.S. international trade (fig. 4).They account for about 4 percent of U.S. imports and exports. The United States is the world's leading importer of forest products and second only to Canada in forest exports. Even though the United States has only 7 percent of the forests of the world (fig. 5), it is the world's largest single producer of forest products. Taken together, the United States and Canada account for 16 percent of the world's forests and 34 percent of world timber production (Haynes 1990).

The United States consumes more of the world's forest products than any other country or region (fig. 6). The United States has about 5 percent of the world population (World Resources Institute 1992) and consumes 28 percent of the world's industrial forest products (Ulrich 1990). The importance of the links of our economy to the economies of other countries through the international marketplace is obvious.

Globalizing Forestry Issues

It became apparent during UNCED negotiations that relations between countries that were established during the cold war era have given way to new terms of engagement between the rich countries of the north and poor countries of the south. As historic military strategic concerns have waned since the cold war, the imperatives of food and environmental security are coming increasingly to the forefront.

Developed countries call on developing countries to protect their environments, thereby protecting and securing broad self-interests recognized by developed countries, but not necessarily recognized by developing countries in the same way.

Developing countries, in response, are demanding recognition of sovereign rights to manage their natural resources according to their own view of their self-interest, and insist that their sovereign right to development is not negotiable. Developing countries contend that the unsustainable patterns of consumption and production by developed countries has led to most of the pollution in the world. They point out the inequities caused by a very small proportion of the world's population consuming most of the world's resources. Developing

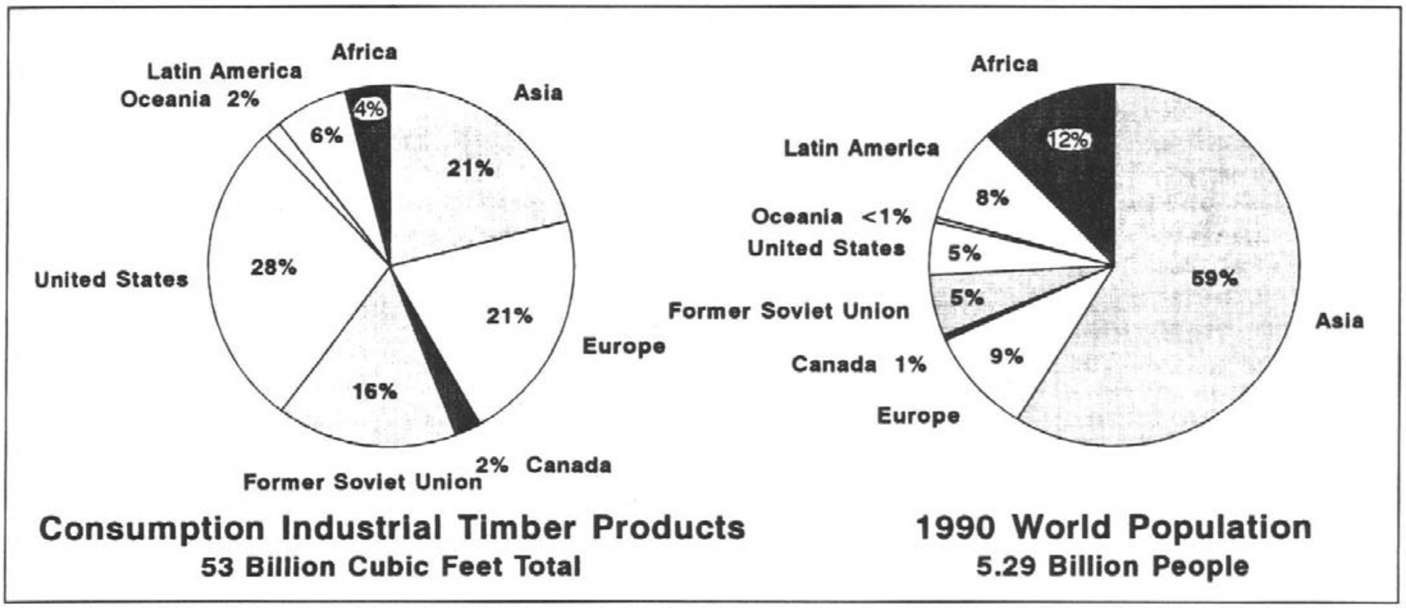

Figure 6—Timber consumption and population. Data tom Haynes (1990) and World Resources Institute (1992).

countries further call for transfer of financial resources to redress the inequities by stimulating development.

The high profile of forests at UNCED Signaled the globalizing of forest issues. Countries declared by consensus that the conservation, management, and sustainable development of forests is firmly connected to social, economic, and environmental issues outside the forests. The first preambular paragraph of the UNCED forest principles proclaims that "the subject of forests is related to the entire range of environmental and developmental issues and opportunities, including the right to socio-economic development on a sustainable basis" (United Nations 1992b). Figure 7 shows the extremely broad range of issues dealt with in the forest principles.

The environmental community was successful in placing forests on the international policy and political agenda. Forests were moved to the forefront of the international political agenda because then-U.S. President George Bush, joined by leaders of other industrialized nations at the Houston Economic Summit of July 1990, called for a convention on forests to be signed at the Earth Summit in Rio de Janeiro. Forests therefore became a central consideration at UNCED.

Consensus on Forests at UNCED

Forests were the subject of negotiations that led to the formulation of forest principles and one chapter of "Agenda 21," as well as being important parts of the two conventions on biodiversity and climate change. Although the goal of a convention for forests was not realized at UNCED, the political will to deal with forests generated by the call for a convention served to energize negotiations on forests and gave rise to the first global consensus on forests. This consensus has established a foundation for the management, conservation, and sustainable development of all types of forests worldwide.

Canada and the United States both played vital roles in helping to catalyze the first global consensus and building a new foundation for international forestry. This foundation will have far-reaching and long-lasting effects on the way countries deal with forest issues and opportunities domestically and internationally. UNCED recognized and brought clearly

PREAMBLE:

- Range of Related Issues (0a)
- Guiding Objectives (0b)
- Multiple Benefits (0c)
- Committment to Implement (0d)
- Applicable to All Forests (0e)
- Ecological Basis (0f)
- Forests are Essential (0g)
- Government Levels (0h)

RIGHTS

- Primacy of Sovereign Rights and Responsibilities (1a)
- Rights to Forests (2a)
- Indigenous People and Communities (5a)
- Biotechnology (8g)

FUNCTIONS OF FORESTS

- Inter-generational Needs (2b)
- Ecological Processes (4)
- Meeting Energy Needs (6a)
- Planted Forests (6d)
- Natural Forests (6e)

INTEGRATION OF ENVIRONMENT AND DEVELOPMENT

- Integration Environment and Development (3c)
- Adjacent Areas (8e)
- Environment and Market Forces (8e)
- Policy Integration (13d)
- Incentives and Avoiding Forest Degradation (13e)
- Assessment-based
- External Pressures (9c)
- Control of Pollutants (15)

NATIONAL CONTEXT

- National Framework (3a)
- Environmental Impact Assessments (8h)
- Comprehensive Policy Development (6b)
- Management Guidelines (8d)
- Maintain and Increase Forest Cover (8b)
- Protected Areas (8f)

INVOLVEMENT OF PEOPLE

- Provision of Information (2c)
- Public Participation (2d)
- Participation of Women (5b)
- Local Knowledge (12d)

RESEARCH AND EDUCATION

- Research and Inventory (12a)
- Education and Training (12b)
- Exchange of Information (12c)

TRADE

- International Trade (13a)
- Tariffs and Markets (13b)
- Trade Restrictions (14)

INTERNATIONAL COOPERATION

- International Institutions (3b)
- International Support (9a)
- Rural and Urban Poverty (9b)
- Sharing of Costs (1b)
- Financing Convservation and Reserved Areas (7b)
- Greening the World (8a)
- Financial Resources (10)
- International Economic Climate (7a)
- Support of Implementation (8c)
- Technology Transfer (11)

Numbers in parenthesis refer to principles as numbered in final negotiated text

Figure 7—Overview of UNCED forest principle topics, arrayed by subject matter.

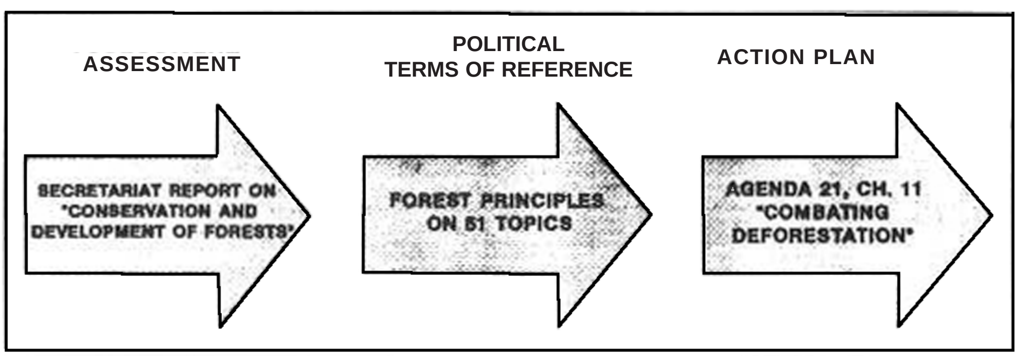

Figure 8—UNCED: Elements of the first global consensus on forests.

into focus the economic development opportunities provided by forests, particularly to many developing countries. The foundation contains the basic elements shown below and in figure 8:

- Acceptance by countries of a report prepared by the secretary-general of UNCED, "Conservation and Development of Forests," which is an assessment and acknowledgment of the threats to and conditions of the world's forests. This report is of suitable depth to be a cornerstone of international forestry assessments.[2]

- Adoption of forest principles establishing political terms of reference by expressing the current consensus among all countries on a wide range of issues, including functions of forests, integration of environment and development, nationally based actions, involvement of people, research and education, trade, and international cooperation (United Nations 1992b).

- Adoption of "Agenda 21," chapter 11, "Combating Deforestation," an action plan developed by consensus among all countries that provides a common approach for countries to integrate national actions and international cooperation for the conservation and sustainable development of forests (United Nations 1992a).

The consensus is further broadened by those aspects of the conventions on climate change and biodiversity that pertain to forests-particularly with regard to the role of forests as carbon sinks and reservoirs and as rich storehouses of biodiversity.

Social, Economic, and Environmental Dimensions

UNCED proclaimed the primacy of sustainability, particularly in forests, and also proclaimed that sustainability needs to be considered from all its social, economic, and environmental dimensions. It became obvious during negotiations, however, that sustainability could not be defined simply. The search for the meaning of sustainability that took place during UNCED Was conducted through arduous and often contentious negotiations, where the many different views of what constitutes sustainability were considered in turn.

Many environmental conflicts in Canada and the United States likewise derive from differing views of what constitutes sustainability. Both the negotiations at UNCED and domestic public debate over environmental issues can be characterized as dialogues taking place in three distinct dimensions—social, economic, and environmental. Figure 9 shows a visual representation of these differing views. The ultimate definition of sustainability, while not presently agreed to by those holding differing views, lies in the area of intersection of all three dimensions, labeled as area IV in figure 9.

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[2] United Nations Conference on Environment and Development. 1991. Conservation and development of forests: report prepared by the secretary-general of the conference for preparatory committee for the United Nations Conference on Environment and Development, third session, working group I. Conches, Switzerland: United Nations Secretariat for United Nations Conference on Environment and Development. Background document prepared by UNCED secretariat. On file with: U.S. Department of Agriculture Forest Service, International Forestry, 14th and Independence, S.W., P.O. Box 96090, Washington, DC 2009-6090.

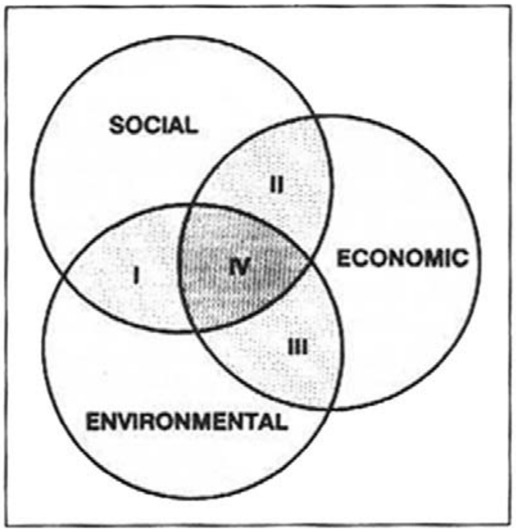

Figure 9—Dimensions of sustainability: area I = not economically sustainable, area II = not environmentally sustainable, area III = not socially sustainable, area IV = sustainable in all dimensions.

The approach shown in figure 9 can be useful for gaining understanding about the domestic public debates on environmental issues taking place in both the United States and Canada. In this context, society can be seen as struggling to define what constitutes sustainability in its three basic dimensions, as the various social, economic, and environmental aspects of the issue are weighed. In both Canada and the United States, the struggle takes place simultaneously on many fronts through legislation, the courts, and the popular press, and in academia, in the professional disciplines, and in the actual management and administration of forests and their associated natural resources. As we collectively learn more about sustainability and move our perceptions to a new vision of sustainability, the area of agreement labeled as area IV will grow, thereby moving toward the goal of complete congruence of the three dimensions.

Learning About and Moving Toward Sustainability

People, governments, and institutions are beginning to grapple with the problems facing us in newly robust and purposeful ways. Public debate often is the catalyst. As a society, we are beginning to recognize the inextricable links among the social, economic, and environmental dimensions of sustainability. Collectively and individually, we are learning about what sustainability means in an increasingly complex world. The negotiations that took place during UNCED are a highly visible example of the international community learning about sustainability and forging a global response.

Moving toward sustainability will require continued purposeful self-directed learning on the part of institutions, organizations, and governments. The lessons are difficult because the most fundamental aspects of sustainability revolve around the integration of the sociopolitical, economic, and environmental dimensions. These dimensions do not easily mesh because sectors of government, academic training for experts, and institutional activity often take place wholly within only one of the dimensions. It may prove useful in this endeavor to reflect on the basic elements of learning to help facilitate the move toward sustainability.

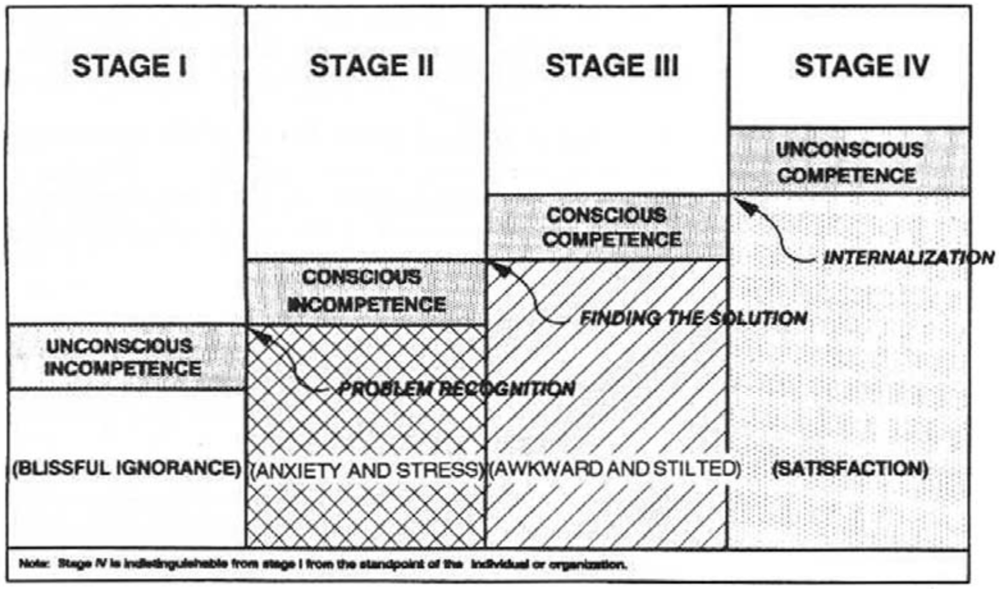

Figure 10—How people learn.

Learning on the part of individuals, and also on the part of institutions, organizations, and governments, seems to take place by fits and starts through successive stages of learning as shown in figure 10.[3] The first stage, stage I in figure 10, is where an individual (or institution, organization, or government) is blissfully ignorant and unconscious of incompetence. The transition from this first stage usually is accomplished through sudden awareness of incompetence, such as by a court-ordered injunction, leading directly to the second stage, trying to resolve the problem. Finding a solution to the problem marks the transition to stage III where newly chosen or learned behaviors are applied to a new situation. The transition to stage IV is gradual and represents the progressive internalization of newly chosen or learned behaviors to a state of unconscious competence.

It is interesting to note that stage IV, "unconscious competence," is indistinguishable from stage I, "unconscious incompetence," from the standpoint of the individual (or institution, organization, or government). This dynamic is caused by the fact that changes in the outside world are unknown to the individual until the revelation that marks the transition from unconscious to conscious incompetence. The phenomenon of not being aware of unconscious incompetence has particular applicability to learning about what constitutes sustainable and unsustainable policies and activities, because typically institutions, organizations, and governments rarely take time to reflect on the sustainability of either particular or cumulative policies and activities.

The Challenges of UNCED for Forestry

Learning took place at UNCED in many different topic areas and at many different levels. Many of these areas of learning have significant implications for domestic forest and related natural resource conflicts and represent or are precursors to the domestic challenges facing natural resource institutions and organizations. The forest community was largely

[3] Adapted from a model presented at a workshop "Solving people problems." 1979. Conducted by: Gerry Brummitt, Cybernetics Leadership Center, 818 Encino Lane, Coronado, CA 92118.

absent in preliminary stages of UNCED deliberations; forests were put on the international agenda by the environmental community and by politicians—not by foresters. Outlined below are some of the most significant challenges for forestry that arose from UNCED.

The notion of a global commons or global interest in forests was hotly debated at UNCED, but no consensus was reached. Developed countries asserted that indeed there was a global interest in environmental issues. Developing countries were acutely aware that if a global interest existed, rights and obligations possibly infringing on national sovereignty would be sure to follow.

Forest conditions in a particular country, however, were a legitimate subject for debate. The interest by developed countries in stemming the tide of tropical deforestation was countered by charges from developing countries that the United States was destroying old-growth forests in the Pacific Northwest and Europe was destroying its forests through acid rain.

Because of the strong positions the United States and other developed countries took at UNCED, domestic management of public and private forests has become a matter of international debate. The United States can expect domestic public and private forestry to come under increased scrutiny. Developed countries are being held to the same high standards and values as they proffered.

Environmental groups, industry associations, and professional societies participated in UNCED negotiations to an unprecedented extent. Many see themselves as key players in the conservation and sustainable development of forests. They also are acutely interested in domestic forest issues. Many groups will be taking steps to ensure the practice of what was preached. Some will increasingly assert that national or global interests override private interests when significant adverse environmental effects may occur.

It can be expected that privately held forest lands also will be held to high standards by some segments of the public—perhaps even to the point that some basic tenets of property rights will be challenged in the name of environmental protection for the common good. This point has not been lost on the domestic timber industry.

Members of the American Paper Institute, the majority of industrial forest land owners in the United States already have responded to this issue by developing a code of conduct for forestry practices.[4] Chief executive officers have to certify annually that their company is meeting the code as a condition of continued membership in the association. This code of conduct goes well beyond traditional industry practices by incorporating environmental values in forest management.

[4] American Paper Institute. 1992. Principles for forest industry resource management in the 1990's, and associated implementation guidelines. Approved by American Paper Institute Board of Directors March 9, 1992. Leaflet. Available from: The Paper Information Center, Suite 360, 1250 Connecticut Avenue, NW, Washington, DC 20036

For public lands in the United States, the Chief of the Forest Service and Director of the Bureau of Land Management made announcements, as part of a Presidential initiative put forward at the Earth Summit in Rio de Janeiro, to end the use of clearcutting as a standard commercial timber harvest practice on Federal forest lands as part of an ecosystem approach to the sustainable management of forests.[5]

In March 1992, Canada completed its "National Forestry Strategy" (Canadian Council of Forest Ministers 1992b) after 2 years of extensive consultations across Canada that engaged all stakeholders in forest issues and opportunities. This strategy sets the strategic agenda for practicing sustainable forestry in Canada. The Federal and Provincial governments, as well as other stakeholders, fully endorse this strategy as signatories of the "National Forest Accord.

States, because of their authority to regulate forest practices on private lands, and Provinces likely will come under increased scrutiny. Differences in environmental standards between Federal and the State and Provincial governments will be brought more sharply in focus through public concern and debate. Economic, social, and environmental sustainability across jurisdictional and property boundaries will be a recurrent theme.

International trade also was a subject of contentious debate at UNCED. Many developing countries, particularly those whose harvest of timber is often regarded as unsustainable, demanded an end to boycotts of timber by consumers, municipalities, and states. They asserted that under existing international trade agreements, developed countries, even where constitutions distribute rights among states and local governments, have an affirmative obligation to ensure free trade in all tropical timber, whether it is sustainably produced or not.

Although the United States did not initially sign the convention on biodiversity in Rio de Janeiro, it actively supports the basic principles and ultimately signed the convention. Protection of biodiversity will continue to be of growing concern on both private and public lands. The local, regional, and global dimensions of biodiversity will be subjects of intense continued debate-domestically and internationally.

A lack of understanding or agreement still exists among scientists, natural resource management professionals, the environmental community, and industry about what constitutes conservation and sustainable management of natural resources. For environmental groups in particular, protection of areas by the complete exclusion of multiple use management, such as wilderness and research areas, will continue to be a common denominator and the policy instrument of choice for many who want to protect the environment-domestically and internationally.

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[5] Robertson, F. Dale, Chief, U.S. Department of Agriculture, Forest Service. 1992. Letter dated December 22, 1992, to Regional Foresters and others. File designation 1550. On file with: U.S. Department of Agriculture Forest Service, 14th and Independence, S.W, P.O. Box 96090, Washington, DC 2009-6090.

Key Implications for Natural Resource Managers

Canadian and U.S. forests are an aggregate of six different types of forest estates or holdings: Federal, industrial, nonindustrial woodlands, tribal, State or Provincial and other public, and urban. Forests in other countries likewise are comprised of a mix of ownerships and purposes. Managing for sustainability therefore will increasingly compel forest managers to deal with and take leadership in forest issues pertaining to forests of various ownerships and purposes.

We cannot draw an administrative line on the map and proclaim that we, as natural resource managers, are dealing only with what is inside the line in the name of ecosystem management. The social, economic, and environmental dimensions of sustainability are inextricably woven together; ecosystems, and the social and economic dimensions in particular, transcend mere legal or administrative boundaries.

Because ecosystems often are a mosaic of public and private ownership, and because social, economic, and environmental dimensions are tightly intertwined, no resource manager can manage in isolation. Sustainable ecosystem management requires working together with other owners, managers, cooperators and the public—first, to reach agreement on what constitutes sustainability, and second, to work toward it.

Examples of Government Responses

The Chief of the USDA Forest Service, in responding to the spirit and substance of UNCED, made a commitment to broadening the global consensus on forests and fostering the conservation and sustainable development of forests worldwide. In addition, the Chief directed that the Forest Service (see footnote 5):

- Implement ecosystem management on National Forests.
- Incorporate both the spirit and substance of UNCED in long-term Agency planning and decisionmaking through the 1995 Resources Planning Act assessment and development of the Agency's program.
- Promote forest principles and "Agenda 21" to international organizations, such as the World Bank and others instrumental in international forest activities.
- Promote UNCED results and find common areas of interest with the national and international groups and organizations interested in forestry, including State Foresters, academia, and those in the Washington, DC, area.
- Make forest-related UNCED documents widely available.

Canada, also responding to the issues related to UNCED, developed a national commitment to achieve the primary goal of sustainable forests nationwide. The Canadian Council of Forest Ministers launched development of a new national forest strategy in 1991. A vision emerged from people's concerns, hopes, and ideas that was expressed in a series of public forums across the Nation.The vision expressed commitment to nine strategic directions, each with a set of principles and a framework for action. Commitment was made to an overarching goal of sustainability that states, "Our goal is to maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations" (Canadian Council of Forest Ministers 1992b).

Where Do We Go From Here?

The United States and Canada both have a rich fabric of laws, policies, and institutions at the Federal, State or Provincial, and local levels that guide the management of forests and related natural resources. Much, however, remains to be done, both domestically and internationally, to move toward the goal of sustainability. Contentious views remain about what exactly constitutes sustainability, particularly in reconciling the often conflicting social, economic, and environmental perspectives. The immediate challenge for natural resource managers is therefore to find ways to further dialogue and stimulate dialogues that can lead to self-education by individuals and institutions to learn more about the overlapping social, economic, and environmental aspects of sustainability. It is only by consensus and common understanding that our societies will be willing to undertake the significant changes that may be required to move forward on the path of sustainability.

If there is but one lesson that comes from UNCED and the emerging global consensus on forests it is this: Forests cannot be managed sustainably in isolation either geographically or with respect to the various sectors of society, and this lesson is applicable regardless of scale—local, regional, national, or international. In particular, federal natural resource managers cannot manage federal resources in isolation. And other nonfederal resource managers need cooperation, support, and predictability from federal managers to manage their resources.

As noted earlier, the actual outputs of UNCED at Rio de Janeiro are all starting points. It is incumbent on natural resource managers all over the world to (1) acknowledge the interconnectedness of social, economic, and environmental dimensions of sustainable natural resource management; (2) take actions that foster public and political dialogue and learning across many sectors; and (3) manage natural resources to demonstrate recognition that forests are part of a broader social, political, and economic context and as such cannot be managed in isolation or without conflict—after all, it is through public debate that democracies deal with the crucial issues before them. Sustainability is a most important critical issue; natural resource managers can either choose to be leaders or they will be led.

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Protected Areas Planning in British Columbia

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Abstract

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British Columbia's Protected Areas Strategy will increase the protected areas of the Province from the current 6.5 percent to 12 percent by 2000. A lack of coordination and cooperation within and among agencies and an often opportunistic approach have resulted in a system of protected areas that represents some ecosystems better than others. This paper reviews the existing protected area designations in British Columbia and evaluates the resulting system. General principles, methods, and criteria are proposed to improve protected areas planning, based on the concept of representative ecosystems—that ecosystems will be represented in protected areas in proportion to their occurrence on the landscape. To help ensure that protected areas better contribute to the conservation of biodiversity, additional criteria are proposed to address concerns for ecosystem viability, rare and endangered species, and species requiring special habitats.

Keywords: Protected areas, conservation planning, gap analysis, British Columbia.

Summary

British Columbia's Protected Areas Strategy was initiated to coordinate protected areas planning in the Province and to increase protected areas from the current 6.5 percent to 12 percent of the Provincial landbase. Existing protected areas currently provide a poor sample, or no sample whatsoever, of many of British Columbia's ecosystems. The methodology proposed here is based on four broad criteria: representativeness, naturalness, viability, and rarity-scarcity. A "coarse filter" analysis based on ecosystem representation is combined with a "fine filter" analysis, intended to identify the rare, scarce, and otherwise special elements that need protection but that may not be captured within the coarse filter, representative ecosystems.

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This proposed methodology is intended to address concerns about protected areas planning for conservation purposes. It must be supplemented with protected areas planning for other purposes (for example, recreation, cultural heritage), and the entire package evaluated for its social acceptability and economic feasibility.

Introduction

Most of the papers presented at Habitat Futures have to do with land management issues; the theme for this meeting of Habitat Futures is "Expanding Horizons for Forest Ecosystem Management." Indeed, in this context, the way protected areas are managed will determine, in large part, whether they "work" as intended. In terms of a protected areas strategy, this paPer will focus on issues of land allocation rather than land management.

Obviously such a dichotomy (allocation vs. management) is highly artificial. If plans for "managed lands" incorporate some principles of planning for maintenance of biodiversity, then fewer and smaller protected areas may be required. Even with modified management practices on our "managed lands," protected areas still will be required to maintain some elements of biodiversity, particularly for those species sensitive to human disturbance, habitat loss, and habitat fragmentation. Protected-areas planning must be able to assume that management practices for the rest of the landscape will be designed with conservation of biodiversity in mind. Integration of land management planning that places protected areas in the context of the overall landscape (for example, Noss and Harris 1986, Saunders and others 1991) must take place.

Ideally, ecosystem management should dictate a continuum of protectedness, from intensively managed lands to unmanaged lands, rather than a simple division into protected vs. unprotected. In British Columbia, the degree of "protection" provided by existing protected areas differs greatly depending on the management objectives (designated spotted owl habitat (*Strix occidentalis*) being used less by humans than are recreation areas, for example). A variety of protected-area designations exist in this Province to accommodate these different uses (reviewed in the next section).

Existing protected-area networks in British Columbia and the United States suffer from a distressingly similar set of shortfalls. Multiple government agencies at Federal, Provincial, State, and municipal levels propose and create protected areas with different and often conflicting objectives (conservation vs. recreation vs. preservation); different system plans A and classification systems (leading to duplication and "holes" in representation); different degrees of protection; different management philosophies (for example, different degrees of human use allowed); and little or no coordination within and among agencies and administrative planning units.

The predictable result is a protected-areas system representing some areas, and some interests, better than others. Uneven representation of British Columbia's ecosystems in existing protected areas is documented later in the paper. Uneven representation has led the Government to initiate the development of a protected-areas strategy for the Province. Many of the topics and issues discussed here may be addressed by this new strategy.

As with any component of ecosystem management, protected areas will work only if they are ecologically reasonable, economically feasible, and socially acceptable.[1] The

[1] Salwasser, H.; MacCleery, D.W.; Snellgrove, T.A. 1992. New perspectives for managing the U.S. National Forest System. Report to the North American Forestry Commission Sixteenth Session, Cancun, Mexico.

government of British Columbia has taken the unusual first step of defining what is socially acceptable—12 percent of the Provincial landbase in protected areas—in accordance with the World Commission on Environment and Development (Brundtland 1989). This figure clearly is not socially acceptable to all British Columbians, but for pragmatic purposes it is the figure we plan for at present.) There has been much discussion about the concept of working within such an arbitrarily fixed target. Some of the benefits are inclusion of the concept of social and economic acceptability into the process of protected area planning (albeit in a somewhat arbitrary, nonconsultative fashion); provision of a relatively straightforward target; and avoidance, initially, of much of the conflict seen in other jurisdictions about how much should be "set aside." On the other hand, there are numerous weaknesses and dangers associated with this course: in theory, it would be better to start with clearly stated conservation objectives, and let these decide how much land to allocate as protected area; on its own, ale-percent rule may not provide adequate representation (for example, protected areas may be distributed unevenly across and within the broad ecological regions of the Province).

This paper focuses on how a socially acceptable 12 percent is allocated such that it is ecologically reasonable. The other step required, and one beyond the scope of this paper, is how to determine which ecologically reasonable option is most economically feasible.

The area currently protected represents about 6.5 percent of the Province (6 357 230 hectares [15,708,720 acres]). Adding an additional 5.5 percent in protected areas (about 5 379 200 hectares [13,292,000 acres]) will be difficult and expensive, considering that timber cutting and mineral or petroleum exploration rights have been allocated over nearly all of British Columbia's resource land base. Our role as scientists and resource managers in this regard is twofold; we must ensure that policymakers understand (1) that difficult decisions will be required, and these decisions should be made based on a systematic and ecologically based analysis of existing protected areas and opportunities for protecting and managing biodiversity; and (2) that they represent the last generation of policymakers with options for achieving biodiversity conservation objectives.

Within British Columbia, most analyses of existing or proposed protected areas, or of biological resources in general, have been conducted by different agencies based on incongruent analytical units. For example, existing protected areas may have been evaluated for the Northern Region of the B.C. Ministry of Parks, fish and wildlife resources for the Northern Region of the B.C. Ministry of Environment, and fish and wildlife habitat resources for the Prince George Region of the B.C. Ministry of Forests. There are several problems with this approach: the areas of analysis are inconsistent; resource evaluation and management is the responsibility of different agencies, often using incompatible techniques and scales; and most jurisdictional responsibility ends at Provincial, national or State boundaries. This results in inefficient use of limited resources, duplication of or gaps in management, and inevitably, a more expensive process and less useful product. A coordinated resource inventory, mapping, and management approach should be more efficient.

Unless a more systematic and ecological approach is brought to bear on identifying new areas to fill gaps in our existing system of protected areas, weaknesses in the system will remain (for example, subalpine and alpine areas are presently overrepresented in protected areas). A recent government protected-areas planning initiative identified 184 candidate areas for study as protected areas (B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests 1992). Unfortunately the process used to select these study areas was not systematic or ecologically based. The results are predictable; if all the study areas were incorporated into the existing protected areas network, the existing bias toward representation of alpine and subalpine areas actually would increase significantly (table 1).[2]

In consideration of the above, we propose using common ecological (ecosection-biogeoclimatic units) rather than administrative or other analytical units for planning and analysis of existing and proposed protected areas. The benefits were suggested above. A few problems to overcome include:

- Disruption to the status quo
- Reallocation of planning responsibilities
- Reallocation of funding among and within agencies
- More effort involved in working with other agencies
- Development of new, imaginative protected-area concepts and approaches in intensively developed areas

A Review of Existing Protected-Areas Programs in British Columbia

There is a broad spectrum of land designations and regulatory mechanisms available in British Columbia to protect natural resource values, ranging from ecological reserves providing for strict preservation to integrated resource management lands where all forms of resource extraction may be permitted. Each designation or mechanism differs in the degree and permanency of protection it offers, the type and level of resource uses permitted, the management objective(s), and the type and level of access and recreational use. Appendix 1 highlights the most distinguishing characteristics (primarily the type and level of human use permitted) and provides a comparison with the International Union for Conservation of Nature (IUCN) classification of worldwide protected areas to provide an international context.

The major protected-area designations and programs in British Columbia are described below. Others, such as migratory bird sanctuaries, national wildlife areas, regional parks, and lands owned and protected by nongovernment organizations or private citizens make up about 3 percent of the Province’s total protected area and therefore are not discussed here. Table 2 provides a summary of each of the major protected area program’s stated objectives and analytical frameworks as they relate to the conservation of biological diversity and wilderness values. Appendix 2 details their objectives, frameworks, and selection and design criteria. The programs have considerable overlap in objectives and differences in planning frameworks and criteria.

Most of British Columbia’s 6 357 230 hectares (15,708,720 acres) under protected-area status are in the Provincial park system (82 percent; fig. 1).

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[2] For park system planning purposes, BC Parks uses their own analytical units known as landscapes. Of the 59 regional landscapes identified for British Columbia, BC Parks regards only 13 as having satisfactory representation, 4 near satisfactory, 15 partially represented, and 27 with no representation at all. For 12 of the 13 with satisfactory representation, missing landscape elements were still identified (lack of low-elevation forest land represented in the East Vancouver Island Mountains Landscape) (B.C. Ministry of Parks 1991).

Table 1—Designated parks and wilderness in British Columbia, and parks and wilderness study areas, by biogeoclimatic zone

Biogeoclimatic (BGC) zones	Total area		Designated large parks and wilderness			Park and wilderness study areas			Designated parks, wilderness, and study areas		
	Million hectares	Percent of B.C.	Thousand hectares	Percent of parks and wilderness	Percent of BGC zone	Thousand hectares	Percent of study areas	Percent of BGC zone	Thousand hectares	Percent of designated and study areas	Percent of BGC zone
Alpine tundra/glacier	18.2	20	2037	34	11	4635	40	25	6673	38	36
Spruce-willow-birch	8.4	9	688	12	8	2190	19	26	2878	17	34
Boreal white and black spruce	14.8	16	263	4	2	1105	10	8	1368	8	9
Sub-boreal pine-spruce	2.4	2.5	55	1	2	6	0	0.3	61	0.4	2
Sub-boreal spruce	9.3	10	287	5	3	139	1	2	426	2	5
Mountain hemlock	4.2	4.5	309	5	7	731	6	17	1040	6	25
Englemann spruce-subalpine fir	13.2	14	1228	21	9	1232	11	9	2460	14	19
Montane spruce	2.6	2.5	72	1	3	88	1	3	160	1	6
Bunchgrass	0.3	0.3	0	0	0	0	0	0	0	0	0
Ponderosa pine	0.3	0.3	2	0	1	0	0	0	2	0	1
Interior Douglas-fir	4.4	4.5	41	1	1	39	0.3	1	80	0.5	2
Coastal Douglas-fir	0.2	0.2	0	0	0	2	0	1	2	0	1
Interior cedar-hemlock	5.0	5.2	238	4	5	227	2	5	464	3	9
Coastal western hemlock	10.6	11	702	12	7	1108	10	10	1810	10	17
Total	93.9	100	5922	100	6	11 502	100	12	17 424	100	18

Source: British Columbia Ministry of Forests 1992.

Table 2—Objectives and analytical frameworks of existing protected-areas programs related to the conservation of biological diversity and wilderness values

Protected area programs	Representation of ecosystems	Protection of wildlife (species and habitats)	Protection of special or unique natural features	Protection of wilderness values
Ecological reserves	Protect representative examples of the major ecosystems of the Province (forested; alpine and subalpine; wetland; grassland and marine). Framework: Ecosystems (76 units) and biogeoclimatic subzones and variants within each.	Protect rare, threatened and endangered plants and animals in their habitat.	Protect unique or outstanding zoological, botanical, or geological phenomena.	
Provincial parks and recreation areas	Protect representative examples of the Province's different landscapes. Framework: Landscapes (59 units) and key landscape elements within each.	Representative objective includes protection of wildlife habitats and species as elements characteristic of the landscape unit.	Protect British Columbia's most outstanding physical, biological, and cultural features.	Provide outstanding backcountry adventure recreation experiences across the Province.
National parks	Protect representative natural areas of Canadian significance. Framework: Canadian natural regions (9 or 39) occur in British Columbia) and biophysical themes within each (wildlife, vegetation, geology, and landforms).	Representation objective includes protection of wildlife characteristic of the region.	Representation objective includes protection of the geology and landforms characteristic of the region.	
Wildlife management		Protect endangered or threatened species. Provide habitat for "valuable" species. Facilitate management of areas of special importance to more abundant fish and wildlife species.		
Wilderness areas	Preserve representative examples of the Province's diverse natural landscapes. Framework: Ecosections and biogeoclimatic subzones and variants within each.	Maintain biological diversity.	Protect special or unique features.	Provide opportunities for a wilderness experience. Framework: Unroaded lands (based on recreation opportunity spectrum classification).

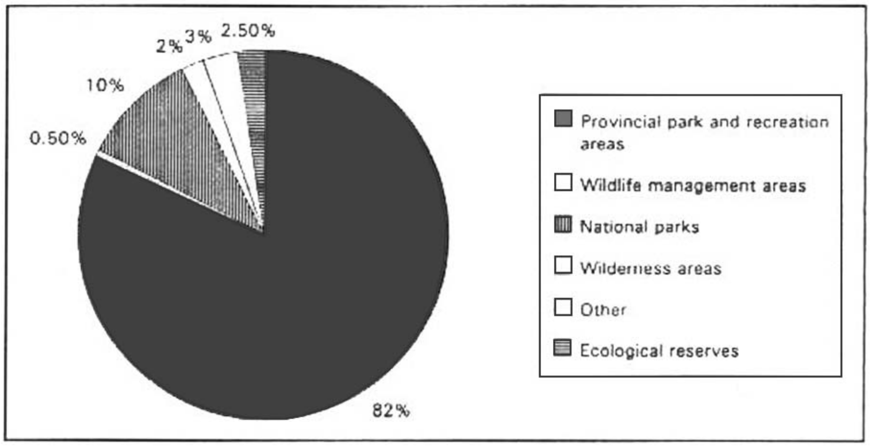

Figure 1—Major British Columbia protected area designations: percentage of Provincial land base in protected areas.

Ecological Reserves

The ecological reserve system is the only legislative mechanism in British Columbia dedicated exclusively to the preservation of representative rare, threatened, or endangered ecological values. Managed by B.C. Parks under the authority of the Ecological Reserves Act of British Columbia (1979), ecological reserves are established to:

1. Serve as benchmarks for long-term scientific research and education use.
2. Preserve representative examples of plant and animal communities.
3. Serve as examples of habitats recovering from modification caused by human activity.
4. Protect rare and endangered plants and animals in their natural habitat.
5. Preserve unique or rare zoological, botanical, or geological phenomena.

The Ecological Reserves Regulations (1975) prohibit all consumptive resource uses in reserves (for example, logging, mining, hydro development, hunting, trapping, use of motorized vehicles, grazing, camping, lighting fire, and removal of materials, plants, and animals). The main function of ecological reserves are research and conservation; they are not created for outdoor recreation. Many are open to the public for nondestructive, observational use (hiking, photography, bird-watching), but in other reserves having resources easily impacted by human presence (for example, seabird colonies), access is allowed only for research purposes under ministerial permit.

Ecological reserves have the potential to make a key contribution to conservation in British Columbia. In many cases they can provide greater protection than Provincial parks, particularly for resources requiring minimal disturbance from humans (for example, rare and endangered species). Because of legislated limitations on the degree of human activity permitted within ecological reserves, however, they are less suited to conserving features and phenomena that require active management or intervention to sustain them.

At present, there are 131 ecological reserves, encompassing an area of 158 750 hectares (392,280 acres) (at least 50 000 hectares [123,550 acres] consist of marine waters). This represents only 0.11 percent of the British Columbia land base. The majority of ecological reserves are small, only three are greater than 10 000 hectares (24,710 acres), and two of those are marine. The 14 next largest reserves average 2890 hectares (7,150 acres), and the remaining 114 ecological reserves average 200 hectares (500 acres). Small size limits their individual and collective long-term conservation value.

Provincial Parks and Recreation Areas

The Provincial parks system in British Columbia is managed under the authority of the Park Act (1979), which explicitly prohibits commercial resource extraction in class A parks and enables the establishment of parks of varying size for both conservation and recreation purposes. Provincial parks currently account for 5.5 percent of the land base in British Columbia (about 5 379 200 hectares [13,292,000 acres]) and have a full management infrastructure in place to protect the resources within. There are four classes of Provincial parks:

1. Class A parks. These account for 327 out of a Provincial total of 389 and encompass 4 271 623 hectares (10,555,180 acres); 82 percent of total protected area. These parks are afforded the highest level of protection, because they are entirely free of commercial resource development (logging, mining, hydro development). Additional protection may be provided through the establishment of nature conservancy areas or other special zoning within individual parks, both of which can limit access, facility development, and recreation activities.
2. Class B parks. In class B parks, resource use can be permitted, if, in the opinion of the minister, it is not detrimental to the recreational values of the park. Although this class of park is no longer being used, two class B parks remain: Strathcona-Westmin and Sooke Mountain. Mining continues in Strathcona-Westmin.
3. Recreation areas. Recreation areas offer similar protection to class A parks, with the exception that they are lands temporarily held in park reserve until the cabinet decides whether or not they should be established as class A parks. This decision is based on evaluations of mineral potential or resolution of existing resource tenures. Before any consideration for designation as class A parks, lands must be open for a minimum, interim period of 10 years to permit mineral resource evaluation. During this time, no other forms of commercial resource extraction are allowed, and conservation and recreation values are given very high status in the review and approval of exploration work. There are presently 35 recreation areas.
4. Class C parks. Class C or community parks make up a small percentage of the current system with 28 areas totalling 816 hectares (2,020 acres). Because of their generally small size and proximity to urban areas, administration is gradually being turned over to municipal and regional governments.

Two goals of the B.C. parks system are for conservation purposes; the other four are recreation goals (see appendix 2).The conservation goals are to conserve British Columbia's natural diversity by protecting viable, representative examples of our different landscapes and to protect British Columbia's most outstanding physical, biological, and cultural features. Although these goals represent a fundamental philosophical shift toward conservation values, they remain largely unachieved as a result of the traditional concentration of park agencies toward recreational and scenic values, and because establishment of parks has been (and remains) much easier in places where land-use conflicts are few. Recent analyses show clearly that the current system of Provincial parks well represents the high-elevation, alpine, and subalpine ecosystems of the Province (for example, see table 1).

National Parks

The Canadian Parks Service, the Federal agency responsible for national parks and national historic sites, has a mandate "to protect for all time those places which are significant examples of Canada's natural and cultural heritage and also to encourage public understanding, appreciation and enjoyment of this heritage in ways which leave it unimpaired for future generations (Environment Canada Parks Service 1990)." Under the authority of the National Parks Act (1985), national parks provide for environmental protection at a level equivalent to class A Provincial parks. There are presently four national parks and two national park reserves in British Columbia, totaling 630 200 hectares (1,557,220 acres). or 0.66 percent of the Province.

The Canadian Parks Service is concerned with places of national heritage significance with an emphasis on extensive natural areas, and Provincial parks include areas of local to national significance, ranging in size from a few to several hundred thousand hectares. Like Provincial parks, national parks provide for both conservation and outdoor recreation opportunities. The similarity in purpose and services of the national and Provincial park systems necessitates close coordination. The national park system suffers representation deficiencies similar to those described for the Provincial park system above.

Under the authority of the Wildlife Act (1982), B.C. Ministry of Environment can establish areas for the protection and management of important fish and wildlife habitats. Wildlife management areas have tended to be small and intensively managed for specific fish and wildlife objectives not achievable through normal referral or planning processes. Depending on the management objective, other activities, including resource development, may be permitted (for example, livestock grazing, logging).

Wildlife Management Areas

Wildlife management areas can contribute significantly to the conservation of British Columbia's wildlife diversity, particularly of wildlife requiring intensive or specialized management and manipulation to sustain them (for example, the white pelican). Three types of wildlife management areas can be established:

1. Wildlife management areas, on which fish and wildlife species and habitat may be intensively managed.
2. Wildlife sanctuaries, on which hunting, angling, or trapping may be prohibited.
3. Critical wildlife areas, which are intended for the protection of threatened and endangered wildlife species.

The wildlife management area designation has been relatively ineffective to date. There are presently 11 wildlife management areas designated in British Columbia, representing only 0.02 percent of the B.C. land base (19 300 hectares [47,690 acres]). No sanctuaries and only one critical wildlife area have been designated to date.

Wilderness Areas

Recently added to the B.C. Ministry of Forests' legislated mandate is the responsibility to manage wilderness in Provincial forests. The purpose of the Forest Service's new wilderness program is to maintain a wilderness resource and provide opportunities to enjoy a wilderness experience, while also permitting compatible, limited resource use. Under the authority of the Forest Act (1979), wilderness areas can be established by order in council. Logging is not permitted, but mining and other commercial activities are not precluded. According to Forest Service policy, subsurface resource use is carefully regulated but not prohibited; hunting and existing trapping and grazing will, in most cases, be permitted; and normal agency jurisdictions will prevail (for example, commercial recreation use administered by the Ministry of Crown Lands subject to wilderness management plans).

The B.C. Ministry of Forests recently began a detailed analysis of wilderness in British Columbia and has identified many wilderness study areas for possible addition to the wilderness areas system (see B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests 1992). Because both B.C. Parks and the B.C. Ministry of Forests have a mandate to protect wilderness, the two agencies have begun to work together to integrate their analyses of system gaps and study areas.

The wilderness area program is still young in its evolution; there presently are only four designated wilderness areas (Height-of-the-Rockies, Lower Stein, Upper Stein, and Swan Lake) covering 130 000 hectares (321,230 acres) of land (0.14 percent of B.C. land base).

An Evaluation of Protected-Area Planning in British Columbia

A great deal of overlap currently is present in protected-areas program objectives and the general approach to selecting and designing protected areas: there is little or no coordination or integration among (or sometimes within) agencies. This has resulted in unnecessary duplication of effort where objectives overlap (that is, four of the five protected-area programs in British Columbia have explicit objectives to represent the Province's ecosystems; see table 2). Even more importantly, gaping holes are apparent in representation and protection of certain ecosystems and species where objectives conflict or where objectives have been collectively overlooked or made a low priority. In addition, despite the fact that system plans have been in place for years and that explicit objectives exist addressing conservation of biological diversity, in most cases, planning has not been carried out systematically. This has only exacerbated problems in achieving stated objectives.

How well have we done in representing B.C. ecosystems in protected areas? Only recently have systematic gap analyses been initiated to determine how well we are doing; albeit even these are presently limited to a "coarse-filter" level. The Province's protected areas are evaluated here within a framework based on a combination of two complementary systems of classification: ecoregion and biogeoclimatic. This framework is emerging as a common approach to assessing representative ecosystems in most B.C. protected-area programs. The ecoregion classification system (Demarchi and others 1990), based primarily on landform and climate, is used to stratify the Province into broad geographic units nested in a hierarchy of 10 ecoprovinces, 43 ecoregions, and 110 ecosections (fig. 2) These broad biogeographical units help to distinguish between distinct animal communities by recognizing those factors, such as landforms, barriers to dispersal, and macroclimate, that may be important in determining animal distributions. Ecoregions and ecosections are, however, too broad to recognize the ecological variation associated with elevational gradients. To overcome this limitation, the biogeoclimatic classification (Meidinger and Pojar 1991) based on climate, soils, and vegetation can be used to delineate distinct ecological zones within the ecosections. Biogeoclimatic subzones are the basic units of zonal classification and consist of "unique sequences of geographically related ecosystems, in which climatic climax ecosystems are members of the same zonal plant association" (Meidinger and Pojar 1991). Biogeoclimatic variants "reflect further differences in regional climate and are generally recognized for areas that are slightly drier, wetter, snowier, warmer, or colder than other areas in the subzone" (Meidinger and Pojar 1991). This basic protected area planning framework requires that all significant occurrences of a biogeoclimatic subzone or variant within each ecosection be represented.

Recent Provincial analyses show that the percentage of protected area ranges from zero percent in many ecosections and ecoregions to 42.1 percent in the Southern Boreal Plateau ecosection. Even within comparatively well-protected ecosections, protected areas tend to "overrepresent" (relative to the 12-percent target) alpine and subalpine ecosystems and "underrepresent" mid- and low-elevation ecosystems. In table 3, each of the three ecosections within the Western Vancouver Island Ecoregion is analyzed by biogeoclimatic units. For each of the ecosections, representation of biogeoclimatic units is very uneven. Higher elevation areas with less productive forests are well represented and often exceed the 12-percent target (for example, 10 percent of the subalpine, moist maritime Mountain Hemlock [MHmm1] is protected in the Northern Island Mountains Ecosection [NIM]; 26.3 percent is protected in the Windward Island Mountains Ecosection [WIM];

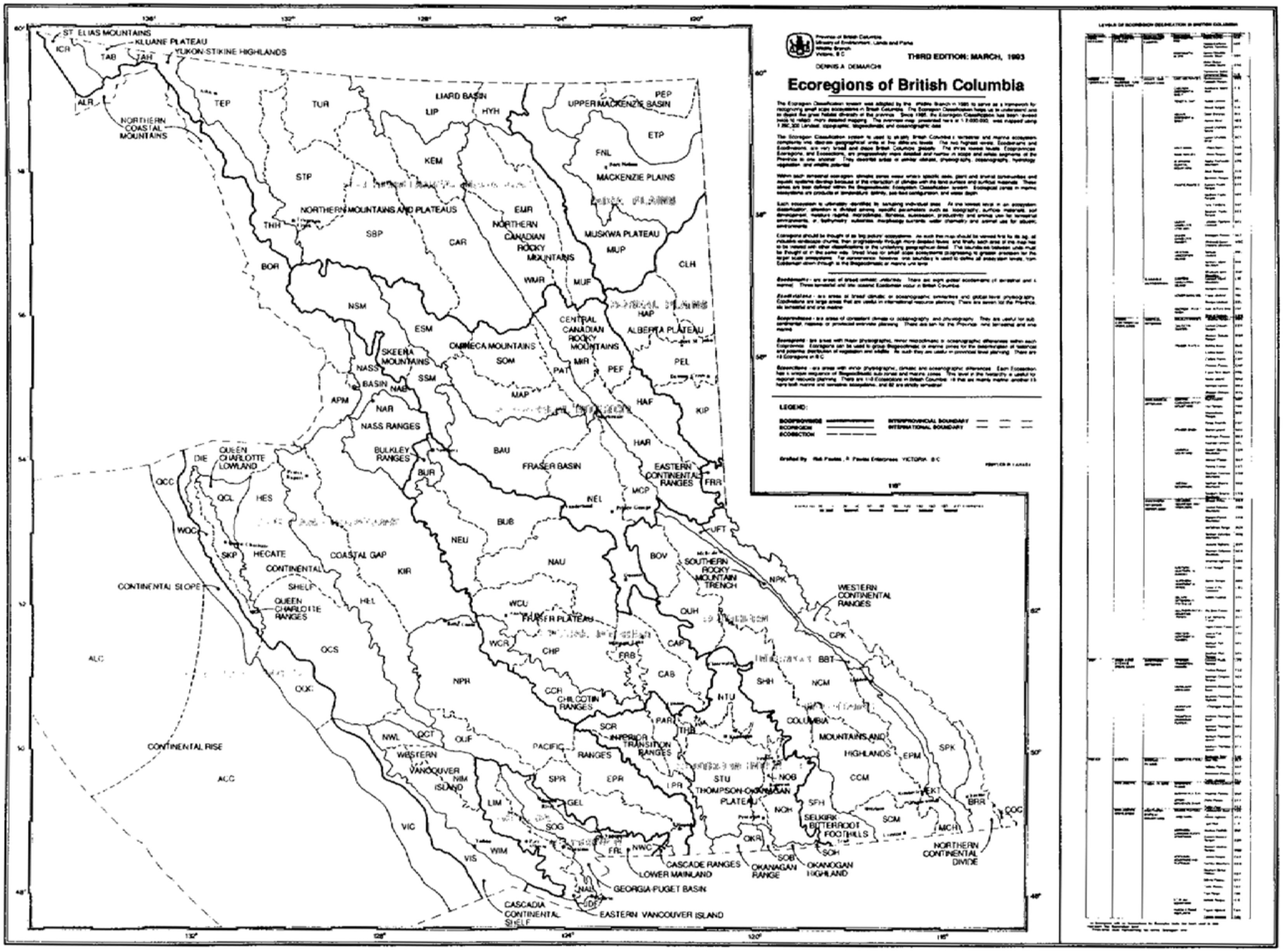

Figure 2—Ecosection, ecoregions, and ecoprovinces of British Columbia (Demarchi 1993).

Table 3—Biogeoclimatic unit representation within ecosections of the western Vancouver Island ecoregion

Biogeoclimatic unit	Area in ecosection	Existing protected areas	BGC unit in protected areas	Area needed to achieve 12 percent representation
	- - - - - - - -Hectares- - - - - - - -		*Percent*	*Hectares*
Nahwitti Lowland Ecosection (4.85 Percent protected areas):				
CWHvh1[a]	110 190	11 320	10.3	1900
CWHvm1	132 730	710	0.5	15 220
CWHvm2	5010	0	0	600
Lake, MHmm1	(minor components)			
Northern Island Mountains Ecosection (6.4 percent protected areas):				
CWHvm1	198 090	7830	4.0	15 940
CWHvm2	157 310	8530	5.4	10 350
CWHxm2	58 260	40	0.1	6950
MHmm1[b]	128 180	13 190	10.3	2190
MHmmp1	23 300	4410	18.9	(-1410)
Lake	11 650	880	7.6	520
CWHmm2, AT[c]	(minor components)			
Windward Island Mountains Ecosection (8.5 percent protected areas):				
CWHmm1	23 390	0	0	2810
CWHvh1	210 470	35 500	16.9	(-10 240)
CWHvm1	619 720	24 750	4.0	49 620
CWHvm2	210 470	13 140	6.2	12 120
Lake	23 390	1500	6.4	1310
MHmm1	81 850	21 540	26.3	(-11 720)
AT, CWHmm2, CWHxm2, MHmmp1	(minor components)			

[a] CWH - Coastal Western Hemlock biogeoclimatic zone, equivalent to British Columbia's coastal temperate rainforest. Lower-case letters = subzone designations, subdivisions of the zones based on climate (v=very wet, m=moist, x=xeric) and influence of the ocean (m=maritime, h=hypermaritime). Numbers - variant designations, subdivisions of the subzones based on local climate (for example, 1, 2).

[b] MH - Mountain Hemlock biogeoclimatic zone, the subalpine above the CWH.

[c] AT - Alpine Tundra biogeoclimatic zone, treeless areas above the MH.

Source: Eng (see footnote 3).

and 18.9 percent of the subalpine, moist maritime parkland Mountain Hemlock [MHmmp1] is protected in the NIM). Very wet, less productive lower elevation rainforest also is well represented (for example, 10.3 percent of the very wet hypermaritime Coastal Western Hemlock [CWHvh1] is protected in the Nahwitti Lowland Ecosection [NWL]; 16.9 percent is protected in the WIM). Highly productive rainforest is poorly represented (for example, 0.5 percent and 0 percent, respectively, of the very wet maritime Coastal Western Hemlock [CWHvm1 and vm2] are protected in the NWL; 4.0 percent and 5.4 percent protected in the NlM; and 4.0 percent and 6.2 percent protected in the WIM). The additional area required to achieve a balanced representation for each ecosystem type (using 12 percent as a target) is significant and shows a consistent requirement for more of the most productive low-elevation ecosystems. Additional information for biogeoclimatic unit representation within ecosections is available in Eng,[3] Vold (1992), and Lewis and MacKinnon.[4]

Protected-area planning to date also has failed to recognize many important habitat features of old-growth forest and nonforest ecosystems, such as riparian ecosystems, grassland communities, wetlands, estuaries, flood plains, and so forth. For example, Roemer and others (1988) determined that there were only 185 000 hectares (457,140 acres) of old-growth forest protected in coastal British Columbia. The extent of coastal old growth before forest exploitation is not known, but as of 1988, 2 570 850 hectares (6,352,570 acres) of operable old-growth forest and 7 260 000 hectares (17,939,460 acres) of the coastal productive forest land remained in the working forest. This means that in 1988 the amount of protected coastal old growth ranged between 2.6 and 7.2 percent. Furthermore, in keeping with the Provincial pattern of inconsistent ecosystem representation, Roemer and others found “reasonable coverage” of the higher elevation old growth for *Amabilis* fir-mountain hemlock (*Abies amabilis-Tsuga mertensiana*), Alaska-cedar-western redcedar (*Chamaecyparis nootkatensis-Thuja plicata*), mountain hemlock-Alaska-cedar (*Tsuga mertensiana-Chamaecyparis nootkatensis*), and mountain hemlock (*Tsuga mertensiana*) forest types. Others forest types, such as Douglas-fir (*Pseudotsuga menziesii*), productive fluvial Sitka spruce stands (*Picea sitchensis*), and productive stands dominated by western redcedar or Alaska-cedar, were found to be “disturbingly underrepresented.

In some regions of the Province, existing protected areas meet, and indeed may exceed, some anthropocentric needs (that is, recreation). But if the current system of protected areas overrepresents some ecosystems and interests and poorly represents others, it will not meet biodiversity goals. Failure to adequately protect representative and special wildlife habitats and features have likely contributed to the declines in many of the wildlife populations in British Columbia. The current lists of rare, threatened, and endangered species (red and blue listed) are long. In the Western Vancouver lsland Ecoregion alone are five red-listed mammals, six red-listed birds, six blue-listed birds, and one red-listed herpetile.[5] Additional representative habitats and ecosystems therefore will need to be

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[3] Eng, M. 1992. Vancouver lsland gap analysis. Victoria, BC: British Columbia Ministry of Forests. Unpublished report. On file with: Research Branch, British Columbia Ministry of Forests, 31 Bastion Square, Victoria, BC V8W 3E7.

[4] Lewis, K.; MacKinnon, A., comps. 1992. Gap analysis of British Columbia’s protected areas by biogeoclimatic and ecoregion units. Victoria, BC: British Columbia Ministry of Environment, Lands and Parks and British Columbia Ministry of Forests. Unpublished report. On file with: Research Branch, British Columbia Ministry of Forests, 31 Bastion Square, Victoria, BC V8W 3E7.

[5] Page, R. 1992. Unpublished data. On file with: Research Branch, British Columbia Ministry of Forests, 31 Bastion Square, Victoria, BC V8W 3E7.

protected, and these areas must be large enough and ecologically connected enough to maintain viable populations of all organisms distributed throughout the landscape. Unfortunately, opportunities are rapidly decreasing as development proceeds apace. Each year about 200 000 hectares (500,000 acres) of British Columbia's forests are logged (B.C. Ministry of Forests 1985-90). In addition, mining, hydroelectric development, and increasing urbanization continue to modify and fragment remaining natural areas.

Undeveloped watersheds and roadless areas are two measures of our remaining options to protect large portions of unfragmented landscapes. Along coastal British Columbia, only 20 percent of the 354 primary watersheds larger than 5000 hectares (12,360 acres) are pristine, 15 percent are modified (relatively minor signs of industrial activity), and 67 percent are developed (Moore 1991). Only 9 of 354 undeveloped watersheds are protected; 6 of the 9 are pristine; 106 are scheduled for timber harvest. There also is considerable geographic variation: for example, on the north coast 36 percent are pristine and 26 percent are modified; on the south coast (Fraser-Lower Mainland), 100 percent are developed. Provincially, similar variation exists: the Coastal Gap and Columbia Mountains Ecoregions have 87 and 86 undeveloped watersheds, respectively; and the Fort Nelson Lowlands, Lower Mainland, Straight of Georgia, and Southern Rocky Mountain Trench ecoregions have none (B.C. Ministry of Forests 1992).

Roadless areas represent areas generally free of human disturbance. As such, like undeveloped watersheds, they provide a measure of conservation opportunity. Roadless areas are defined as areas farther than 1 kilometer (0.62 mile) from a road and more than 1000 hectares (2,470 acres) in size. As with undeveloped watersheds, this roadless area measure ranges from zero percent in a number of ecosections (East Kootenay Trench, Fraser Lowland, Nanaimo Lowland, Southern Okanagan Basin, Southern Okanagan Highlands) to oVer 95 percent in other, usually mountainous ecosections (Alsek Ranges, Kechika Mountains, Muskwa Foothills, Tuya Range) (Vold 1992).

Suggested Alternatives: General Principles, Criteria, and Methods

To improve protected-area planning in British Columbia, several problems need resolution. Clearly, the first step is agreement (among agencies and internationally) on a common set of goals and objectives and clarification of the roles and responsibilities of the various agencies, levels of government, and private landowners.The next step is a mutually agreed upon method of achieving these goals and objectives; that is, a common ecological framework and set of criteria (derived from the science of conservation biology) to apply systematically to selection and design of newly protected areas. Finally, baseline information and mapping (at appropriate scales) must be developed for gap analyses, for the selection and design of potential protected areas, and for the identification and evaluation of the social and economic implications of designating them as protected areas.

Many of the following proposed principles, criteria, and methods are being applied in British Columbia within the socially acceptable, 12-percent goal established by the Provincial government. Regardless of its strengths and weaknesses (discussed above), the B.C. government's 12-percent goal currently is being pursued. The principles below attempt to address some of the weaknesses of using such an arbitrary target. To further address them, monitoring of species populations and ecological processes within and around protected areas must become an ongoing component of all protected areas programs to ensure that the 12 percent is achieving the goals for which our protected areas network has been established. Noss (1990) suggests a set of indicators and guidelines to monitor biodiversity over time.

General Principles to Guide Protected-Areas Planning in British Columbla

To improve protected-areas planning in British Columbia, the following set of principles are suggested:

1. Base the protected-area planning framework on the concept of representative ecosystems. Use the biogeoclimatic classification system (Meidinger and Pojar 1991) in combination with the ecosection classification system (Demarchi and others 1990) as the framework to select and assess protected areas. Protected areas should collectively represent the full range of ecosystems within biogeoclimatic subzones and variants within each ecosection. Similar ecological classification systems need to be developed to assist in defining representative aquatic and marine ecosystems: these have yet to be developed and are urgently required.
2. Protect representative examples of the full range of ecosystems, both as elements of the biological diversity of a region and as a coarse filter to protect viable populations of wildlife, fish, and vegetation species, or species groups, within their ecological context.
3. Focus additional efforts on protecting the rare, endangered, vulnerable, or critical habitats and elements of the Province's natural environment not captured within the representative ecosystems (that is, fine filter approach).
4. Do not treat all ecosystems or species as equal, but rather give priority to those ecosystems and species most sensitive to human disturbance. Give priority to the study and protection of:
   - ecosystems or species naturally rare or scarce.
   - habitat types most at risk and most difficult to replace or restore (that is, old-growth forests, riparian deciduous forests, native grassland communities).
   - areas providing preferred habitat for rare or endangered species.
5. Replicate, where feasible, rare and vulnerable ecosystems or elements within the system of protected areas to help ensure against the loss of diversity due to natural disturbance, human-induced environmental change, or catastrophic events.
6. Establish protected areas to undertake restoration management (that is, access restriction and reclamation, intensive species and habitat management, appropriate silvicultural manipulations, controlled burning) in areas where major losses of biological diversity have occurred or representative examples of natural ecosystems are no longer available.
7. Conduct gap analyses on an ongoing, iterative basis to determine which ecosystems, habitats, species, and features are not adequately represented in the protected areas network, to identify and refine conservation priorities as land uses change, and to identify and evaluate potential protected areas to fill the gaps.
8. Establish protected areas in a wide range of sizes. Some very large and well-distributed landscape-scale areas for basic ecosystem representation (100 000-1 000 000 hectares [about 250,000-2,500,000 acres], such as Tweedsmuir Provincial Park and Yoho and Kootenay National Parks); more numerous medium-sized areas, closer together to provide sufficient sampling and refine representation based on other criteria (10 000-100 000 hectares [about 25,000-250,000 acres], such as Manning Provincial Park and Height of the Rockies Wilderness Area); and many small areas, close together to improve connectivity in the overall network, to provide replicates where needed, and to protect those rare or "fine filter" elements with small area requirements (100-10 000 hectares [about 250-25,000 acres], such as Robson Bight Ecological Reserve and Junction Wildlife Management Area). Ultimately, the degree to which sound, integrated resource management practices are carried out on the land base outside reserves

will have a major bearing on the required number, size, contents, and distribution of formally designated protected areas.

9. Select, locate, and design protected areas to establish an integrated network of protected areas including insulating support zones to buffer protected areas from detrimental effects of intensive land use practices on adjacent lands (for example, for old growth this might involve long rotation management, partial cutting harvest methods, and limiting access). Protected areas and buffers also should be linked by a range of land use practices promoting species movement and dispersal. Both will help to ensure that protected areas' individual and collective ecological integrity is sustained over the long term.

10. Apply the 12-percent target with some flexibility. Opportunities still exist in some parts of the Province to protect large wilderness areas or intact predator-prey systems with large ungulates and carnivores; protection of these areas may require more than 12 percent of any one ecosection. In some areas, 12 percent may be an unachievable goal, owing to land use modification and alienation. Even though the total protected areas in the Province will total about 12 percent, local areas will contain more or less than this Provincial target.

11. Manage protected areas to ensure their ecological viability and integrity. Any activities permitted within a protected area should be compatible with the long-term conservation of the natural and biological values in that area.

12. Investigate and monitor the viability of species populations and integrity of ecological processes within protected areas on a~ ongoing basis to assess and document human-influenced change and the effectiveness of the design and management of each area.

Criteria and Methods for Evaluating, Selecting, and Designing Protected Areas

Gap analysis—To achieve a representative and comprehensive system of protected areas, the existing protected area system must be evaluated to determine what resources and values are currently protected and where there are gaps. The conventional approach to this evaluation is commonly referred to as gap analysis and has been widely endorsed (Burley 1988). Gap analysis methods have been used in a number of areas (see for example, Bedward and others 1992; Pressey and Nicholls 1991; Pressey and others, in press, for Australia; Scott and others 1993 for a U.S. review). All use various classifications to determine which ecosystems, vegetation types, species, and so forth, are currently represented and which are priority additions to protected-area systems.

For protected-areas planning in British Columbia, we propose using two broad levels of analysis: coarse filter and fine filter (after Jenkins 1976). The coarse filter analysis will determine to what extent the current system of protected areas represents the Province's major ecosystems. A fine filter analysis is required to identify the rare, scarce, or otherwise special elements needing protection but that may not be captured within the coarse filter, representative ecosystems and will require individual attention.

The scale of analysis must include consideration of areas and values of Provincial, national and international significance. Flexibility is the key: we must be able to move from regional analytical scales (1:500,00-1:250,000) to more detailed, larger scale analytical units (1:20,000 or larger) in the planning process. In general, the preferred scale of analysis will be 1:250,000. This is large enough to clearly indicate watershed boundaries, species ranges, and ecological units such as ecosections and biogeoclimatic variants, yet small enough to show spatial relations among watersheds, including movement corridors for highly mobile species. Baseline information and mapping products must be developed (at appropriate scales) for purposes of facilitating both coarse and fine filter gap analyses, selecting suitable study areas, and ultimately, making designation decisions.

Separate protected-area plans should be developed for each ecosection to ensure that each unit is adequately represented. Where ecosections cross administrative boundaries (for example, district, region, Provincial, international), plans for that ecosection should be developed co-operatively by the agencies involved. Some conservation objectives (for example, grizzly bear habitat needs, predator-prey systems) will dictate inter-ecosection plans. In these cases, plans for individual ecosections must be coordinated at a higher level (for example, ecoregions or ecoprovinces).

Specific criteria are required to guide the actual selection and design of newly protected areas. Protected-area selection and design should consider four broad categories of criteria: representativeness, naturalness, viability, and scarcity and rarity. These criteria are common to those used or recommended for use in carrying out conservation evaluations over the past few decades (for example, Margules and Usher 1981, Smith and Theberge 1986; also see footnote 6). All lend themselves to quantification, which is essential for true comparisons to be made among candidate areas (Margules and Usher 1981). For each criteria, we indicate information and mapping products available to address them in British Columbia. The products often are specific to the B.C. situation, but similar products would be needed in other geographic areas.

Representativeness—Representativeness does not refer to some notion of typicalness but rather that a reserve or system of reserves should contain the range of biological variation found within some land class or region (Austin and Margules 1986). For purposes of protected-areas planning in British Columbia, protected areas should be selected to collectively contain representative examples of the full range of ecosystems within each biogeoclimatic subzone and variant within each ecosection of the Province.

Ecosections contain unique sequences of biogeoclimatic units (subzones and variants) and can be stratified by these units to better delineate the range of climates and vegetation found within them. In general, the amount of each biogeoclimatic unit protected should be proportional to its occurrence in that ecosection (using 12 percent of each unit as a guideline). This framework provides sufficiently intense sampling of similar biogeoclimatic units across their full geographic distribution (that is, biogeoclimatic units are often distributed over several ecosections) to capture genetic variation within species and to help maintain viable populations of species by representing multiple subpopulations of metapopulations (Gilpin 1987). The biogeoclimatic-ecosection framework also lends itself extremely well to coarse filter gap analysis. By overlaying map layers of the ecosection, biogeoclimatic units, and existing protected areas, one can easily calculate the percentage of the different biogeoclimatic units within each ecosection presently protected; any representation below the 12-percent level becomes a gap.

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[6] Hopwood, D. 1992. Ecological framework and criteria for protected areas to conserve the biological diversity of old growth forests in British Columbia. Unpublished report to the Old Growth Strategy Project, British Columbia Ministry of Forests. On file with: Research Branch, British Columbia Ministry of Forests, 31 Bastion Square, Victoria, BC V8W 3E7.

Biogeoclimatic and ecosection maps at 1:250,000 are available digitally for the Province from the B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks, respectively. With several exceptions, the ecosection maps extend only to the B.C. borders, but mapping is now being extended into adjacent Provinces and States. Where ecosections extend beyond Provincial boundaries, the biogeoclimatic mapping is generally unavailable.

If biogeoclimatic units are proportionally represented within ecosections, and protected areas are large enough and numerous enough, it can be assumed that most ecosystem variation within the ecosection will have been represented within protected areas. There are limitations to this coarse filter approach, however, such as the failure of classification systems to distinguish among most seral stages, to indicate gradual ecotones, or to indicate small but important habitat patches (Scott and others 1993). A higher resolution assessment or "enhanced" coarse filter is required to ensure that this important variation and diversity are captured. For purposes of protected-areas planning in British Columbia, protected areas should be checked to ensure that they contain the full range ecosystems characteristic of each biogeoclimatic unit. Within biogeoclimatic units, variation in soil moisture, nutrients, and in disturbance history, result in a mosaic of different, but geographically related, ecosystems and successional stages of ecosystem development across the landscape. These are sometimes mapped as biophysical habitat classes or as site series. Examples of ecosystems of high importance, from a biodiversity perspective and that should nat be missed, include wetlands, estuaries, riparian zones, and alluvial habitats. Special attention also should be paid at this stage to capturing those successional stages of ecosystem development most at risk and most difficult to replace. For forests, this usually will mean old growth, but other types, such as riparian habitats and naturally occurring seral stages, should not be excluded. For most of the Province, biophysical habitat class maps or site series maps are not yet available. An alternative is to rely on topographical maps to ensure that protected areas contain a variety of slope classes, positions, and aspects within each subzone or variant.

Wherever possible, areas should be selected to capture an ecosection's characteristic sequence(s) of biogeoclimatic units (and thereby a diverse range of ecosystems and elevational gradients) within one or a few landscape-scale protected areas (size range 100 000-1 000 000 hectares [about 250,00-2,500,000 acres]). This will help to ensure long-term protection of functional ecosystems and representation of each ecosection's typical landscape or landform and hydrology patterns. It also will help to avoid the pitfalls of selecting large numbers of small, potentially isolated reserves (see for example, Noss and Harris 1986, Saunders and others 1991).

Ecosystems can be defined at various scales. At the landscape scale, ecosystems must contain fairly extensive landscape units, generally defined by physiographic features and encompassing a full range of ecosystems within them (due to inherent topographic and environmental variation).The watershed is a good example of a complete landscape unit useful in conservation planning.[7] Watersheds come in a range of sizes, but generally constitute single, large, functional ecosystems at the landscape level. Particularly advantageous is the fact that watersheds contain riparian zones with high wildlife habitat value, which act as natural movement corridors for wildlife among different habitat types within a given watershed.

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[7] Lertzman, K.; Kremsater, L.; Bunnell, F. [and others]. Why watersheds? Are intact watersheds the best units for preserving old-growth forest ecosystems? Manuscript in preparation.

The B.C. Ministry of Forests (1992) has a Provincial map of undeveloped watersheds greater than 5000 hectares (12,360 acres) at a scale of 1:2,000,000 and a more detailed map of undeveloped watersheds greater than 1000 hectares (2,470 acres) on Vancouver Island. Moore (1991) and the B.C. Ministry of Forests (1992) have inventories of remaining undeveloped watersheds by ecosection and an assessment of their biogeoclimatic unit makeup.

Because protected areas often will be limited to a relatively small proportion of the land base in most regions (12 percent in British Columbia), protected areas should be selected to complement rather than duplicate each other. Iterative selection procedures have been developed in Australia to assist in the selection of the best combination of areas (Bedward and others 1992; Margules and others 1988; Pressey and others, in press). These procedures work through a list of candidate areas to choose the best candidate at each step according to explicit rules (for example, select site that contributes the largest number of as yet inadequately represented ecosystems) until a set of areas is identified that together represent the biodiversity of a given region in the most efficient way possible. Recent improvements to these selection algorithms help to minimize the possibility of selecting many small, widely dispersed sites (Nicholls and Margules 1993). The resulting best set of areas can serve as a core for designing a network of areas that considers additional criteria, such as population viability and ecological integrity (Nicholls and Margules 1993). Those areas within the core set that are most threatened should be targeted as priorities for action.

To use the algorithms, levels of representation must be specified, either as a percentage of the total area of a given unit or simply as the presence of an attribute one or more times. These procedures easily could be adopted to B.C. protected-areas planning, because our proposed framework (biogeoclimatic-ecosection) clearly provides required levels of representation of the biogeoclimatic units within ecosections at the 12-percent level. Levels of representation of the range of ecosystems within biogeoclimatic units could be assessed for their presence a fixed number of times.

Naturalness—Protected areas should be located in areas that have experienced the least degree of human development and disturbance (for example, roads, logging, mining, grazing, recreational and residential development). Roads are of particular concern because they not only fragment the landscape and act as barriers for some wildlife species but also provide for human access for activities such as poaching and firewood collection. Where disturbance has occurred, the area should have the ability or potential to recover to a natural state on its own or with management intervention.

Various land cover maps can be used to distinguish between disturbed and undisturbed areas (that is, urban, agricultural, and other settled land; immature vs mature forest; nonforested habitats; roads). Three have been used to date in British Columbia and all have their strengths and weaknesses:

1. Forest cover maps. Strengths: available for much of the Province; provide detailed timber information at large scales (1:20,000 or 1:50,000); most available digitally. Weaknesses: not available for some areas Tree Farm Licenses [TFC's]), larger older parks, private land); sometimes not very current; relatively limited information base; large scales may be incompatible with small-scale (1:250,000) ecological overlays (B.C. Ministry of Forests is presently developing the methodology to aggregate forest cover inventory data to 1:250,000).

2. lnterpreted satellite imagery. Strengths: Potentially available for all areas in the short term (that is, continuous coverage); small scales compatible with small-scale ecological overlays; up-to-date. Weaknesses: information less detailed than forest cover maps; relatively limited information base; only available for the coast so far; much more complex to interpret in the interior.

3. lnterpreted air photos. Strengths: available for all areas in the short term; up-to-date information; provides detailed information at large scales (for example 1:70,000). Weaknesses: large scales may be incompatible with small-scale (1:250,000) ecological overlays; interpretation is labour intensive and requires special skill set.

To further assist in the work of delineating large, unfragmented natural areas, the B.C. Ministry of Forests has digital maps (at scales of 1:50,000, 1:250,000, and 1:600,000) of roadless areas based on their Recreation Opportunity Spectrum classification system.

Viability—Viability is the ability of protected areas and the values protected within them to be maintained in perpetuity. Protected areas should be selected, located, and designed to establish a network in which the individual and collective viability of the areas and their component ecosystems and species can be sustained over the long term. Considerations should include size, distribution, compatibility of adjacent land uses, shape, watershed completeness, and replication requirements (discussed below).

Ecosystem representation alone is unlikely to secure maintenance of viable populations of all species. Although some information exists on species abundance, distribution, and habitat requirements, very little is really known about most species (invertebrates, nonvascular plants, microbes, fungi, and lichens). It is thus impossible to plan explicitly for their long-term viability. Furthermore, although the needs of many small animals may be met in reserves of 10 000 to 100 000 hectares (about 25,000-250,000 acres), large carnivores and the predator-prey systems in which they participate may require 1- to 10-million-hectare (about 2.5- to 25-million-acre) reserves (Newmark 1985, 1987; Noss, in press).

We suggest that a first step toward developing a protected areas strategy that considers the long-term viability of Populations and species is to compile an ecosection checklist far known species (or species groups) and document, when known, species' abundance, distribution, habitat requirements, and population trends and threats to their habitat.

Once the initial checklist has been completed, the second step is to consider and group populations and species into one of the following four groups (modified from Hopwood; see footnote 6). For vertebrates and vascular plants, there are three groups: featured species; species whose populations are not in danger; and, rare, threatened, or endangered plants and animals. The majority of invertebrates, nonvascular plants, microbes, fungi, and lichen species, for which very little is known, form a fourth group. Suggested approaches to planning for species viability differ by group.

1. **Featured vertebrate species (very large, wide-ranging, keystone, or umbrella species).** These species should be planned for individually. Given that many such species have large area requirements, it is unlikely that single protected areas will be large enough to maintain viable populations (Newmark 1985, 1987). Protected areas therefore should be selected to encompass preferred, core habitat with appropriate special management on the surrounding land to buffer the core area and provide linkage to other protected areas (Noss and Harris 1986).

Biophysical habitat mapping is available for much of the province through the B.C. Ministry of Environment, Lands and Parks (Wildlife Branch), and may be useful in identifying preferred habitat for feature species. This mapping includes information on soils, vegetation, and wildlife biology and is available at various scales (1:250,000, 1:50,000, and 1:20,000). A recognized weakness of this mapping is that the methodology is not consistent with other Provincial ministries (for example, Forests) and with adjacent jurisdictions (Provincial, State, national).

2. **Vertebrate and vascular plant species with moderate area needs and whose populations are not in danger (majority group).** We can assume that most of these species will be protected if the full range of coarse filter representative ecosystems are captured (Jenkins 1976). For species known to have specialized habitat requirements (for example, old-growth-dependent species), we must explicitly plan for the representation of their preferred habitats; these habitats should be included as part of the enhanced coarse filter.

3. **Rare, threatened, or endangered vascular plants and vertebrates.** Protection of these species cannot rely on the coarse filter approach, because these species often are localized in their distribution, have poor dispersal abilities, or have highly specialized habitat requirements. A fine filter approach, which directs site-specific conservation efforts to individual species and populations, is required.

Two key sources of information on rare and endangered species are available in British Columbia. Although still in its infancy, the new B.C. Conservation Data Centre (one of The Nature Conservancy's Natural Heritage Data Centres; see Jenkins 1976, 1988) will increasingly become the primary source of data on species occurrence, site-specific protection, and special management considerations. Data are being compiled on plants, animals (from insects to carnivores), and habitats.The Provincial, national, and global rarity rankings will be particularly useful in establishing conservation priorities. At present only limited data are available for most species, and the compilation of additional required information is slow owing to funding and time constraints.

The B.C. Ministry of Environment, Lands and Parks, Provincial rare and endangered species lists provide a second source of data. These lists identify endangered or threatened (red-listed) and sensitive or vulnerable (blue-listed) indigenous species for the Province, provide status reports for those species, rank management requirements and activities for specific species, and identify population estimates where available. Unfortunately, these lists are available only at the ecoprovince level and do not recognize the important contribution the Province makes in a global wildlife context (for example, British Columbia has a large percentage of the world populations of blue grouse, Stone's sheep, mountain goats, and wintering trumpeter swans). In addition, little is known about the life history and biology of most of the listed species, and species recovery plans exist for only a select few species.

4. **Invertebrates, nonvascular plants, microbes, fungi, and lichens.** Planning and managing for the requirements of individual species or species guilds in this group is impractical when species ecology (and often taxonomy) is unknown. Again, the maintenance of "representative ecosystems" is the best strategy for maintaining populations of these species. As suggested by Hopwood (see footnote 6), we must "...remind ourselves that we do not have adequate knowledge, or programs in place, to protect the myriad of small or invisible life forms affected by our actions."

Once a set of areas has been selected in which all ecosystems and species will be represented, current concepts of conservation biology need to be applied to their design to meet the needs for population viability and ecosystem integrity. The following provides a summary list of considerations for reserve design:

- The land and water base required to maintain viable populations of species and complete, functional ecosystems.
- The compatibility of adjacent land uses (the availability and proximity of support zones and corridors; distance to next protected area) to minimize the degree of isolation and fragmentation of ecosystems.
- Shape considerations: boundaries should mimic natural shapes, follow geomorphic or ecological features of the landscape (for example, watershed boundaries, mountain ranges, and large bodies of water) to minimize edge effects and to maintain ecological processes (Newmark 1985, Theberge 1989).
- Watershed completeness (to maintain complete and functional ecosystems and protect water quality [see footnote 7]).
- The frequency, size and intensity of natural disturbance regimes: the area should be several times as large as the size of the largest average disturbance; if not, seek replication. In most regions of British Columbia, wildfire is assumed to be the most prevalent form of disturbance. Other forms of disturbance, such as insect infestations, disease, and windstorms, may cause major disturbances in some regions of the Province, and where prevalent, should be considered.

A more detailed treatment of reserve design is beyond the scope of this report (see Grumbine 1990; Harris 1984; Margules and others 1982; Noss, in press; Noss and Harris 1986; Pickett and Thompson 1978).

Rarity and scarcity—Although many naturally rare or scarce species, features, or ecosystems may be incidentally captured within representative protected areas, a more focused and systematic approach (fine filter) is required to identify those not captured and ensure that their special protection needs are met (Jenkins 1976, Noss 1987). Many of these elements are not recognized by general ecological and habitat classification. Examples include:

- Rare species, subspecies, and populations
- Biologically exceptional sites (important seasonal or migratory breeding, feeding, resting, or wintering concentrations of animals; sites of high species richness and endemism; sites of species at the extremes of their ranges; highly productive habitats; microclimate anomalies and; the biggest, best, or smallest)
- Physically exceptional sites (unique landforms, physical features, hydrologic features, soils, or geology)
- Paleontological resources (fossils)
- Remnants (representative sites too small or fragmented to be captured within the larger representative protected areas)

Steps in any fine filter analysis should include defining the fine filter elements, assessing the elements to determine if they require formal protection, identifying and protecting known occurrences of those elements requiring protection, and giving priority to identifying occurrences of globally versus nationally versus provincially versus regionally rare elements. Rarity rankings are available through the B.C. Conservation Data Centre for some better known biological elements (for example, vascular plants, vertebrate animals, and plant communities), but most biological and other nonbiological elements have not been ranked. This will need to occur by using a methodology similar to that of the Natural Heritage Data Centres (Jenkins 1976). The Conservation Data Centre will become a key source for gathering and disseminating data and rankings for most biological elements, and local knowledge and expertise are and will continue to be critical sources of information for conservation planning for both the biological and nonbiological elements (for example, Federation of British Columbia Naturalists t 992). Cooperative initiatives should be developed on a local level between government agencies and amateur naturalists and their conservation organizations.

Conclusion

The principles, criteria, and methods proposed here are intended to address concerns about protected areas planning for conservation purposes. They must be supplemented with protected areas planning for other purposes (recreation, cultural heritage) and the entire package evaluated in light of its social acceptability and economic feasibility.

The coarse filter analysis of the level of protection afforded biogeoclimatic subzones and variants within ecosections is a valuable, first approximation of how effectively existing protected areas represent the ecosystems of British Columbia. An enhanced coarse filter is required, however, to ensure that the full range of ecosystems within the biogeoclimatic units are captured, especially those ecosystems of high importance from a biodiversity perspective, most at risk, and difficult to replace or restore. Because ecosystem representation alone is unlikely to secure viable populations of all species, effort must be enhanced for featured species and species with known specialized habitat requirements. The rare, a threatened, or endangered elements of the natural environment, from rare plant species to unique geological features, must be given even greater individual, site-specific attention.

This methodology encourages a more systematic and ecologically based approach to protected areas planning than has previously existed in British Columbia. Of particular importance, the basic planning framework (ecosection-biogeoclimatic) helps to address the weaknesses inherent in using a goal of 12 percent, by attempting to allocate it in an ecologically meaningful way. It also lends itself well to iterative selection procedures, which can assist planners in selecting protected areas to most efficiently represent the biodiversity of a given region.

But, regardless of how well British Columbia selects its next 5.5 percent, the long-term viability of species and integrity of ecological processes will not be achieved without an integrated approach to ecosystem management that places protected areas in the context of the overall landscape. Management practices on our managed lands must be designed with the conservation of biodiversity in mind and direct concern to both the internal dynamics of and external influences on protected areas.

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Appendix 1
Protected Area-Land Use Spectrum

Core Protected Areas ⟷ ***Integrated Resource Management***

ICUN Protected Areas Categories (*defined below)

I - Scientific Reserves and Wilderness Areas	II - National Parks and Equivalent Reserves		IV - Habitat and Wildlife Management Areas	V - Protected Landscapes	
BC Protected Area-Land Use Designations					
Ecological Reserves	Provincial Parks (class A) National Parks	Recreation Areas	Wildlife Management Areas	Wilderness Areas	Provincial Forest
• prohibit all commercial resource use and other consumptive resource uses • public access can be regulated by permit for individual reserves • where public access, recreation limited to observational use only	• prohibit all commercial resource extraction (no logging, mining, or hydro development) • wide range of recreation use permitted • special zoning used to provide additional protection where needed (for example, to limit access or facility development)	• prohibit all commercial resource extraction, except mineral evaluation • lands are open for minimum 10-year period of mineral resource evaluation; these lands may become class A park upon completion of evaluation • wide range of recreation use permitted	• depending on management objective, commercial resource extraction and other consumptive uses may be permitted • intensive wildlife-habitat management-manipulation may be required to maintain or enhance wildlife values	• no commercial logging • mining not prohibited, but carefully regulated • existing trapping and grazing may be allowed	• commercial resource extraction permitted as per local land use plans and resource development plans • environmentally sensitive areas protected

*ICUN = International Union for Conservation of Nature

Description of the IUCN Protected Areas Categories

Category I - Scientific Reserves and Wilderness Areas

Scientific reserves are areas possessing outstanding or representative ecosystems, features, or species of flora and fauna of scientific importance available primarily for scientific research or environmental monitoring. These areas are significantly free of human intervention.

Wilderness areas are large areas retaining their natural character and influence without permanent improvements, which are protected and managed to preserve their natural conditions. Human disturbance should be substantially unnoticed and the area should offer outstanding opportunities for solitude of primitive and nonmotorized types of recreation.

Category II - National Parks and Equivalent Reserves

National parks are relatively large, outstanding natural areas managed by national authorities. They are established to protect the ecoiogical integrity of one or more ecosystems, and exploitation or intensive occupation is prohibited.

Equivalent reserves are outstanding natural areas managed by Provincial governments, tribal councils, foundations, or other legal bodies that have dedicated the areas to long-term conservation. The objective of national parks and equivalent reserves is to protect natural and scenic areas of national and international significance for spiritual, scientific, educational, recreational, and tourism purposes.

This category should perpetuate, in a natural state, representative samples of physiographic regions, biotic communities, genetic resources, and species to provide ecological stability and diversity.

Category III - Natural Monuments

The objective of this category is to protect and preserve outstanding natural features for their special interest, or unique or representative characteristics, and to the extent consistent with this objective, to provide opportunities for interpretation, education, research, and public appreciation. These features are not large enough, nor do they contain a sufficient diversity of features required to justify a category II designation.

Category IV - Habitat and Wildlife Management Areas

These areas are subject to human intervention for conducting research on the nesting, feeding, and survival requirements of specific species. Maintaining sustainable wildlife populations, as well as protecting rare and threatened species, is an integral function of these areas. Although a variety of areas may fall within this category, each would have the protection of nature and the survival of species as its primary purpose. The production or use of harvestable, renewal resources may play a role in management.

Category V - Protected Landscapes

The objective of this category is to maintain significant areas that characterize the harmonious interaction between nature and culture. They provide opportunities for public enjoyment through recreation and tourism, while supporting normal lifestyles and economic activities. These areas also serve scientific and educational purposes as well as maintaining biological and cultural diversity.

Appendix 2
Objectives, Frameworks, and Criteria of B.C. Protected-Area Programs

Ecological reserves—
Objectives, frameworks, and criteria[1]—

1. To protect viable, representative examples of the major, natural ecosystems within the Province, to help ensure that the ecological diversity of British Columbia is maintained.
   Framework: Ecosections and biogeoclimatic subzones and variants.
   Criteria:
   Representativeness: capture characteristic range of biotic and abiotic diversity of each ecosystem unit.
   Diversity: include areas of high diversity
   Naturalness: minimal degree of human-induced disturbance; maximize inclusion of mature-climax vegetation versus successional-second-growth vegetation.
   Viability: sufficient size to ensure long-term integrity; ecologically functional bound aries; locate to minimize degree of isolation and fragmentation effects; security of buffer areas and corridors.
   Vulnerability: include ecosystems, communities and features highly vulnerable to human land use, activities, or presence; give priority to areas formerly representative, but now rare due to the rate and intensity of development threats.
   Scientific research and education suitability and significance.
2. To protect rare, threatened and endangered native plants and animals in their natural habitat to provide for their continued existence.
   Framework: Lists of rare, threatened and endangered plants and animals generated by scientifically credible individuals and agencies: plants—Conservation Data Centre; wildlife—red and blue lists, Wildlife Branch, BC Environment.
   Criteria: Not yet articulated.
3. To protect unique or outstanding zoological, botanical or geological phenomena highly sensitive or vulnerable to human impacts and disturbance.
   Framework and criteria: Not yet developed.
4. To protect selected examples of human-modified ecosystems to facilitate long-term research and study of their recovery from human alteration.
   Framework and criteria: Not yet developed.

Provincial parks and recreation areas—
Objectives, frameworks, and criteria[2]—

Conservation

1. To conserve British Columbia's natural diversity by protecting viable, representative examples of the different landscapes.
   Framework: Fifty-nine B.C. landscapes and key landscape elements identified within each landscape (landscape descriptions are available and identity characteristic physiography, hydrology, vegetation, wildlife habitats and species, and unique and rare features).

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[1] Source: Lewis, K. System plan for ecological reserves: part 1. Victoria, BC: British Columbia Ministry of Environment, Lands and Parks. Draft document. On file with: British Columbia Ministry of Environment, Lands and Parks, 2d Floor, 800 Johnson St., Victoria, BC V8V 1X4.

[2] Source: British Columbia Ministry of Parks. Technical background: draft system plan for BC Parks. Victoria, BC. On file with: British Columbia Ministry of Environment, Lands and Parks, 2d Floor, 800 Johnson St., Victoria, BC V8V 1X4.

Criteria (evaluation and selection):
Representativeness: inclusion of key landscape elements; at least one large, contiguous area protected.
Naturalness: minimum human modification; potential for restoration.
Diversity: maximize number and type of key landscape elements.
Viability and manageability: single large vs several small; minimum critical size; ecological vs administrative boundaries; buffering and connectivity.

2. To protect British Columbia's most outstanding physical, biological, and cultural features.
   Framework: Preliminary list of categories of physical, biological, and cultural features of potential park interest.
   Physical features: topographic, bedrock, surficial, aquatic, littoral and miscellaneous shoreline, wetland, climatic, and miscellaneous.
   Biologic features: flora, fish and wildlife, special ecosystems and species.
   Cultural features: native Indian, historic, modern cultural, scenic viewpoints and landscapes, recreation activities.
   Criteria:
   Representativeness: include elements and conditions characteristic of feature category
   Naturalness: minimum human modification.
   Diversity: maximize number of special features and feature categories.
   Viability and manageability: compatible with public use and appreciation (if not, consider more protective designation such as ecological reserve); minimum critical size; buffering.

Recreation

1. To provide park attractions and services that enhance the Province's major tourism travel routes.
   Framework: 21 major tourism travel routes of the Province (19 land based; 2 water based); major theme categories of key recreational resources and attributes—shoreline activities; boating; cultural heritage; vegetation and wildlife viewing; winter use; camping.
   Criteria:
   Lands that capture key recreational attributes and character of each of the major travel routes.
   Wherever possible, select special features (as defined in conservation goal 2) to serve as attractions to travel routes.
   Strategically located lands to serve as stopovers and to complement roadside rest areas.
   Stopovers to feature camping convenient to highway routes and safe anchorages and camping spots on the coast and inland lakes.
   Key lands and features along the protected waterways of the west coast inside passage.
   Resources protected should feature high-quality opportunities for picnicking; camping; swimming and water sports; boating—power, sail, paddling; strolling and hiking; nature appreciation; fishing; horseback riding; diving; other specialized activities-climbing, spelunking, river rafting, and so forth, as appropriate to the travel route.
2. To provide park attractions that serve as or enhance outdoor recreation holiday destinations in key areas across the Province.
   Framework: Twenty-two potential and existing outdoor recreation destination areas; major theme categories of key recreational resources and attributes-shoreline

activities; boating; cultural heritage; vegetation and wildlife viewing; winter use; camping.

Criteria:

Areas of Provincial significance with the potential of attracting people for extended vacations.

Wherever possible, select special features (as defined in conservation goal 2) to serve as attractions to travel routes.

Resources protected should feature the widest possible variety of recreation opportunities, including traditional park activities and emerging interests of society.

3. To provide outstanding backcountry adventure recreation experiences across the Province.

   Framework: None identified.

   Criteria:

   Large, expansive natural areas.

   Wherever possible, lands should be chosen for landscape representation as well as for backcountry recreation value.

   Lands protected should feature high-quality opportunities for compatible, backcountry recreation activities throughout the year.

   Small park areas may be designated as key access points or camping areas for large crown land areas presently used for backcountry recreation.

   In remote, coastal areas a group of small park areas may be designated to provide for backcountry boating experiences.

4. To ensure access to local outdoor recreation opportunities for all residents of the Province.

   Framework and criteria: None identified

National Parks—
Objectives, framework, and criteria[3]—

Goal: To protect for all time representative natural areas of Canadian significance in a system of national parks, and to encourage public understanding, appreciation, and enjoyment of this natural heritage so as to leave it unimpaired for future generations.

Framework: National park natural regions. Canada has been divided into 39 terrestrial natural regions, based on physiography and vegetation; 9 natural regions occur in British Columbia.

Identification criteria:

Area must portray the diverse geological, physiographical, and biological themes of a natural region.

Any modification by human activity must be minimal, or if significant modification has occurred, the area must have potential for returning to a natural state.

Selection criteria:

Actual and potential threats to the natural or cultural environment of the area.

Competing land uses.

Geographic balance of national parks throughout Canada.

Location and objectives of other protected natural areas.

Opportunities for public understanding and enjoyment.

International criteria for national parks.

Potential for establishing an adjacent national marine park.

Implications of comprehensive land claims and treaties with aboriginal peoples.

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[3] Sources: Environment Canada Parks Service 1990, 1991; Parks Canada 1979.

Design criteria:
Boundaries of potential national parks will be proposed so that their size and configuration:
- include one or more definable ecological units whose long-term protection is feasible.
- offer opportunities for public understanding and enjoyment.
- benefit the social and economic conditions in the surrounding region.
- exclude communities.

Wildlife management areas—
***Objectives, frameworks, and criteria*[4]—**
Goal: To secure for fish and wildlife species those habitats required for the achievement of those management objectives that cannot be achieved through normal referral or planning processes. Wildlife management areas are further intended to:
- protect endangered or threatened species.
- facilitate management of areas of special importance to more abundant fish and wildlife species (that is, spawning, rearing, calving, denning or nesting sites; winter range; portions of migration routes).
- provide habitat for "valuable" species.

Framework: Not articulated.
Criteria:
Biological factors:
- species richness
- status of the species (rare or endangered; management priority)
- uniqueness of habitat
- importance of habitat to species management
- present carrying capacity and successional stage
- habitat capability
- habitat management potential
- wilderness values
- size of area (viability as ecological unit)

Economic factors:
- benefits
- cost of purchase or lease, payments required
- opportunity cost of alternate uses
- annual costs: tax commitments, estimated operation and maintenance costs, management costs
- capital improvement costs
- financial assistance from other agencies in funding acquisition, capital costs, maintenance, and management efforts.

Land use factors:
- recreational potential
- accessibility
- options for accommodating other forms of land use
- vulnerability to other forms of land use
- imminence of alternate developments
- potential and existing land use conflicts and resource allocation conflicts
- possibility of administration transfer from other agencies

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[4] Source: British Coumbia Ministry of Environment 1989.

- constraints to management imposed by use or ownership of adjacent lands
- time period over which administrative control is transferred to agency
- acceptability of management plan by other agencies

Wilderness areas—
Objectives, frameworks, and criteria[5]—

Objectives:
1. Preserve representative examples of the Province's diverse natural landscapes.
2. Maintain biological diversity.
3. Protect special or unique features.
4. Provide opportunities for a wilderness experience (this includes meeting the greater demands that may be placed on wilderness resources close to population centres).
   Frameworks and criteria: Not clearly articulated by goal.
   Evaluation of the B.C. wilderness resource and selection of wilderness area study areas has been based primarily on the application of the following existing resource inventories:
   (i) Unroaded lands (using the Recreation Opportunity Spectrum classification system—specifically the primitive and semiprimitive nonmotorized or semiprimitive motorized classes)
      Primitive: 5000+ ha; 8+km from four-wheel-drive road
      Semiprimitive nonmotorized: 1000+ ha; 1+km from four-wheel-drive road
      Semiprimitive motorized: 1000+ ha; 1+km from two-wheel-drive road
   (ii) Ecoregion units and biogeoclimatic units to assess the distribution of wilderness resources in terms of representation of natural environments (landscapes)
   (iii) Proximity to major population centres (220-km radius)
   (iv) Forest Service recreation features inventory
   (v) Commercial timber lands (to determine unroaded lands that are part of the net land base and contribute to the allowable annual cuts; unroaded character will be affected by conventional harvesting)
   (vi) Mineral potential; identifies at 1:2,000,000 areas of high, moderate, low, and unknown mineral potential

Goal 1 uses(i) and (ii).
Goal 2 uses (i) and criteria that need to be developed under the protected areas strategy.
Goal 3 uses (iv).
Goal 4 uses (i) and (iii).
Inventories (v) and (vi) gives a preliminary measurement of resource impact.

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[5] Sources: British Columbia Ministry of Forests 1989, 1990.

Appendix 3

Summary of Available Protected-Area Information and Gap Analysis Work for the Western Vancouver Island Ecoregion[1]

The Western Vancouver Island Ecoregion includes the western lowlands, islands, and mountains of Vancouver Island. According to the British Columbia Ministry of Forests (1992) this ecoregion contains 14 undeveloped watersheds > 5000 hectares (12,350 acres) in size, with 4 fully protected and 1 partially protected: Bancroft Creek (5000 hectares [12,350 acres]), upper Burman River (10 000 hectares [24,700 acres]), upper Elk River (5000 hectares [12,350 acres]), and Moyeha River (18 000 hectares [44,480 acres]) are fully protected in Strathcona Provincial Park; Megin River (24 000 hectares [59,300 acres]) is partially protected in Strathocona Provincial Park.

The Western Vancouver Island Ecoregion contains three ecosections: the Nahwitti Lowland, the Northern Island Mountains, and the Windward Island Mountains.

Nahwitti Lowland—The Nahwitti Lowland Ecosection is an area of low to rolling topography, with high precipitation, located at the north end of Vancouver Island. This ecosection is 336 300 hectares (831,000 acres), including a marine component; the terrestrial component is 266 000 hectares (657,300 acres) (Vold 1992). Eng (see footnote 3 in text) lists the Vancouver Island terrestrial component at 250 426 hectares (618,800 acres). This ecosection contains the following biogeoclimatic subzone and variant sequences:[2]

- 45 percent - CWHvh1
- 45 percent - CWHvm1
- 10 percent - CWHvh1; CWHvm1

The biogeoclimatic makeup of this ecosection on Vancouver Island is (see footnote 3 in text):

- CWHvh1, 44 percent
- CWHvm1, 53 percent
- CWHvm2, 2 percent
- lake, 0.8 percent
- MHmm1, 0.1 percent

The following protected areas occur in this ecosection:

Cape Scott Provincial Park (major portion); 14 200 of 15 070 hectares (35,000 of 37,200 acres); portion of 6,400 hectares (15,800 acres) old growth.
  Subzones and variants: CWHvh1 - 10 412 hectares (25,700 acres)
  lakes - 4658 hectares (t 1,500 acres)

Raft Cove Provincial Park; 670 hectares (1,650 acres) amount of old growth unknown.
  Subzones and variants: CWHvh1 - 405 hectares (1,000 acres)
  lakes - 265 hectares (655 acres)

Sartine Island Ecological Reserve; 13 hectares (32 acres) no old growth.

Beresford Island Ecological Reserve; 7.7 hectares (19 acres); no old growth.

Anne Vallee (triangle Island) Ecological Reserve; 85 hectares (210 acres); no old growth,

Duke of Edinburgh Ecological Reserve; 660 hectares (1,630 acres); no old growth.

The total area protected is 15 636 hectares (38,600 acres) or 6.2 percent of the terrestrial component of the ecosection,

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[1] Source: Lewis, K.; MacKinnon, A., comps. 1992. Gap analysis of B.C.'s protected areas by biogeoclimatic and ecoregion units. Victoria, BC: British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests. On file with: British Columbia Ministry of Environment, Lands and Parks, Parks Division, 2d Floor, 800 Johnson St., Victoria, BC V8V 1X4.

[2] von Sacken, B.; Meidinger, D. comps. 1992. Unpublished data. On file with: Research Branch, British Columbia Ministry of Forests, 31 Bastion Square, Victoria, BC V8W 3E7.

Vold (1992) also records 6.2 percent in designated park and wilderness: 100 percent CWH. Eng (see footnote 3 in text) lists 4.82 percent of this ecosection as park: 93.79 percent CWHvh1, 5.88 percent CWHvm1, and 0.32 percent lake. This means 10 percent of the CWHvh1 and 0. 5 percent of the CWHvm1 is protected and that the CWHvm2 and MHmm1 have no representation. According to Vold (1992), this ecosection is 35 percent unroaded. Moore (1991) lists this ecosection as containing 15 primary watersheds > 5000 hectares (12,350 acres); 14 developed; 1 modified; 3 pristine (all in the 1-2500 hectare [2.5-6,000 acres] size range)—the Irony, Skinner, and one unnamed. No entire primary watershed of any size is protected. Cape Scott Provincial Park protects 13 percent (1125 hectares [2,780 acres]: 1125 CWH hectares [2,780 acres]) of the lower Fisherman watershed (450 hectares [1,100 acres] of the upper watershed is logged).

Northern Island Mountains—The Northern Island Mountains Ecosection is a partial rainshadow area of wide valley and mountains located in the northern portion of Vancouver Island.This ecosection is 582 000 hectares [1,466,500 acres] O/old 1992).This ecosection contains the following biogeoclimatic subzone and variant sequences (see footnote 2, this appendix):

60 percent - CWHxm1; CWHvm1; CWHvm2; MHmm1; MHmmp1; AT
30 percent - CWHvm1; CWHvm2; MHmm1; MHmmp1; AT
10 percent- CWHxm1; CWHvm1; CWHvm2; MHmm1

The biogeoclimatic makeup of this ecosection on Vancouver Island is (see footnote 3 in text):

AT, 0.39 percent
CWHmm2, 0.08 percent
CWHvm1, 34.12 percent
CWHvm2, 27.09 percent
CWHxm2, 10.14 percent
lake, 2.29 percent
MHmm1, 22.24 percent
MHmmp1, 3.65 percent

The following protected areas occur in this ecosection:

Schoen Lake Provincial Park; 8170 hectares (20,200 acres); 3500 hectares (8,650 acres) old growth.

Subzones and variants:	CWHvm1 - 2696 hectares (6,660 acres)
	CWHvm2 - 2206 hectares (5,450 acres)
	MHmm1 - 2206 hectares (5,450 acres)
	MHmmp1 - 735 hectares (1,820 acres)
	lakes/foreshore - 327 hectares (808 acres)

Strathcona Provincial Park and Strathcona-Westmin Provincial Park (portion); 34 800 of 222 632 hectares (86,000 of 550,100 acres); portion of 47 600 hectares (117,600 acres) old growth.

Robson Bight Ecological Reserve; 1753 hectares (4,330 acres); 400 hectares (990 acres) old growth.

Subzones and variants:	CWHvm1 - 505 hectares (1,250 acres)
	foreshore - 748 hectares (1,850 acres)

Nimpkish River Ecological Reserve; 18 hectares (45 acres); 16 hectare (40 acres) old growth.

Tsitika Mountain Ecological Reserve; 554 hectares (1,370 acres); 180 hectares (445 acres) old growth.

Subzones and variants:	CWHvm2 - 346 hectares (855 acres)
	MHmm1 - 92 hectares (230 acres)
	MHmmp1 - 116 hectares (287 acres)

Mount Derby Ecological Reserve; 557 hectares (1,380 acres); 350 hectares (865 acres old growth.

Subzones and variants: CWHvm1 - 33hectares (82 acres)
CWHvm2 - 184 hectares (455 acres)
MHmm1 - 184 hectares (455 acres)
MHmmp1 - 156 hectares (385 acres)

Tsitika River Ecological Reserve; 110 hectares (270 acres); 60 hectares (148 acres) old growth.

Subzones and variants: CWHvm1 - 110 hectares (270 acres)

Mount Elliot Ecological Reserve; 324 hectares (800 acres); 160 hectares (395 acres) old growth.

Subzones and variants: CWHvm2 - 32 hectares (79 acres)
MHmm1 - 130 hectares (320 acres)
MHmmp1 - 130 hectares (320 acres)
lakes - 32 hectares (79 acres)

Claud Elliot Creek Ecological Reserve; 231 hectares (570 acres); 231 hectares (570 acres) old growth.

Subzones and variants: CWHvm1 - 231 hectares (570 acres)

The total area protected is 46 517 hectares (114,940 acres) or 8 percent of the ecosection. Vold (1992) records 27 600 hectares (68,200 acres) or 4.7 percent as designated park and wilderness in this ecosection, with the 4.7 percent in the CWH (2.2 percent), the MH (2.4 percent), and the AT (0.1 percent).

Eng (see footnote 3 in text) lists 37 230 hectares (92,000 acres) or 6.4 percent of this ecosection as park: 35.38 percent MHmm1, 22.87 percent CWHvm2, 21.01 percent CWHvm1, 11.82 percent MHmmp1, 5.21 percent AT, 2.36 percent lake, 1.26 percent CWHmm2, 0.09 percent CWHxm2, This means 4 percent of the CWHvm1, 5 percent of the CWHvm2, 0.05 percent of the CWHxm2, 10 percent of the MHmm1, and 21 percent of the MHmm1p are protected. According to Void (1992), this ecosection is 35 percent unroaded, with most of that in the CWH (20 percent) and MH (15 percent). Moore (1991) lists this ecosection as containing seven primary watersheds; all are developed. No entire primary watershed is protected. Strathcona Provincial Park protects 20 percent (20 700 hectares [51,150 acres]; 3500 CWH hectares [8,650 acres]) of the Gold watershed (parts of the Upper Gold watershed and the Ucona and Heber tributaries).

Windward Island Mountains—The Windward Island Mountains ecosection is the area of lowlands, islands, and mountains on the western margin of Vancouver Island. This ecosection is 1 371 900 hectares (3,389,960 acres), including a marine component; the terrestrial component is 1 114 000 hectares (2,752,690 acres) (Vold 1992).Eng (see footnote 3 in text) lists the Vancouver Island terrestrial component at 1 169 286 hectares (2, 889, 300 acres).

This ecosection contains the following biogeoclimatic subzone and variant sequences (see footnote 2, this appendix):

30 percent - CWHvh1; CWHvm1; CWHvm2
30 percent - CWHvm1; CWHvm2
20 percent - CWHvm1; CWHvm2; MHmm1
10 percent - CWHvh1; CWHvm1; CWHvm2; MHmm1
10 percent - CWHvm1; CWHvm2; MHmm1; MHmmp1; AT

The biogeoclimatic makeup of this ecosection on Vancouver Island is (see footnote 3 in text):

- AT, 0.08 percent
- CWHmm1,2.22 percent
- CWHmm2, 0.29 percent
- CWHvh1, 17.54 percent
- CWHvm1, 53.34 percent
- CWHvm2, 17.90 percent
- CWHxm2, 0.05 percent
- lake, 1.59 percent
- MHmm1, 6.58 percent
- MHmmp1, 0.43 percent

The following protected areas occur in this ecosection:

Botanical Beach Provincial Park; 353 hectares (870 acres); amount of old growth unknown.

Subzones and variants: CWHvh1 - 231 hectares (570 acres)
foreshore - 120 hectares (296 acres)

Brooks Peninsula Recreation Area; 28 780 hectares (71,100 acres); amount of old growth unknown.

Subzones and variants: CWHvh1 - 22 948 hectares (56,700 acres)
foreshore - 5832 hectares (14,410 acres)

Carmanah Pacific Provincial Park; 3592 hectares (8,870 acres) amount of old growth unknown.

Subzones and variants: CWHvh1 - 70 hectares (173 acres)
CWHvm1 - 3162 hectares (7,810 acres)
CWHvm2 - 360 hectares (890 acres)

Rugged Point Marine Provincial Park; 518 hectares (1,280 acres); amount of old growth unknown.

Subzones and variants: CWHvh1 - 259 hectares (640 acres)
foreshore - 259 hectares (640 acres)

Strathcona Provincial Park and Strathcona-Westmin Provincial Park (portion); 43 100 of 222 632 hectares (106,500 of 550,100 acres); portion of 47 600 hectares (117,600 acres) old growth.

Pacific Rim National Park Reserve; 27 270 hectares (67,380 acres); 16 200 hectares (40,000 acres) old growth.

Cleland Island Ecological Reserve; 7.7 hectares (19 acres) no old growth.

Solander Island Ecological Reserve; 7.7 hectares (19 acres); no old growth.

Baeria Rocks Ecological Reserve; 53 hectares (130 acres); no old growth.

Nitnat Lake Ecological Reserve; 79 hectares (195 acres); 67 hectares (165 acres) old growth.

Subzones and variants: CWHvm1 - 79 hectares (195 acres)

Clanninick Creek Ecological Reserve; 37 hectares (91 acres); 28 hectares (69 acres) old growth.

San Juan Ridge Ecological Reserve; 98 hectares (242 acres) 32 hectares (79 acres) old growth.

Subzones and variants: CHWvm2 - 49 hectares (121 acres)
MHmm1 - 49 hectares (121 acres)

Sutton Pass Ecological Reserve; 3.4 hectares (8.4 acres); no old growth.

Megin River Ecological Reserve; 50 hectares (123 acres); 31 hectares (77 acres) old growth.

Subzones and variants: CWHvm1 - 50 hectares (123 acres)

Checleset Bay Ecological Reserve; 34 650 hectares (85,600 acres); majority marine waters; 350 hectares (865 acres) old growth.
Tahsish River Ecological Reserve; 70 hectares (173 acres) 12 hectares (30 acres) old growth.
Klaskish River Ecological Reserve; 132 hectares (326 acres); amount of old growth unknown.

Subzones and variants: CWHvh1 - 110 hectares (272 acres)
lakes/foreshore - 22 hectares (54 acres)

The total area protected is 97 448 hectares (240,800 acres) or 8.3 percent of the ecosection.

Vold (1992) records 103 775 hectares (256,400 acres) or 9.3 percent as in designated park and wilderness, with the 9.3 percent in the CWH (7.2 percent), MH (1.5 percent), and unassigned or water (0.6 percent).

Eng (see footnote 3 in text) lists 8.51 percent of this ecosection as park: 35.68 percent CWHvh1, 24.87 percent CWHvm1, 21.65 percent MHmm1, 13.21 percent CWHvm2, 2.16 percent MHmmp1, 1 .51 percent lake, 0.76 percent AT, 0.16 percent CWH mm2. This means 17 percent of the CWHvh1, 4 percent of the CWHvm1, 6 percent of the CWHvm2, and 28 percent of the MHmm1 are protected.

According to Vold (1992), this ecosection is 39 percent unroaded, most in the CWH (34 percent) and MH (5 percent).

Moore (1991) lists this ecosection as containing 44 primary watersheds > 5000 hectares (12,350 acres); 35 in 5-20 000-hectare (12-49,000-acre) size range; 9 in 20-100 000-hectare (49-247,000-acre) size range; 37 (84 percent) are developed; 2 are modified (the Klaskish and Power); 5 are pristine (includes the Megin which is > 20 000 hectares [49,000 acres]; the other 4 are in the 5-20 000-hectare [12-49,000-acre] range). Strathcona Provincial Park protects one entire, pristine primary watershed > 5000 hectares (12,350 acres), the Moyeha (18 220 hectares I45,000 acres]). Pacific Rim National Park Reserve protects one smaller pristine, primary watershed, the Tsusiat (3300 hectares [8,150 acres]). Brooks Recreation Area protects four smaller pristine, primary watersheds: two unnamed (at 1000 hectares [2,470 acres] and 1300 hectares [3,200 acres]), the Amos (2400 hectares [5,930 acres]), and the Marks (2800 hectares [6,920 acres]). Strathcona Provincial Park and the Megin River Ecological Reserve together protect 12 percent (3000 hectares [7,400 acres]; 1000 CWH hectares [2,470 acres]) of the Megin watershed (upper Mitla and upper reaches of two other tributaries in Strathcona; 50 hectares [123 acres] of lower watershed is in the ER). Strathcona Provincial Park also protects 51 percent (10 700 hectares [26,440 acres]; 5500 CWH hectares [13,600 acres]) of the Bedwell watershed (upper Bedwell), but most of the lower slopes on both sides of the watershed within the park have been logged; 80 percent (19 375 hectares [47,900 acres]; 6500 CWH hectares [16,000 acres]) of the Burman watershed, but logging extends up to the park boundary. Carmanah Provincial Park protects 53 percent (3500 hectares [8,650 acres]: 3500 CWH hectares [8,650 acres]) of the Carmanah watershed.

Continue

Biodiversity Planning and Forest Management at the Landscape Scale

Jim Pojar, Nancy Diaz, Doug Steventon, Dean Apostol, and Kim Mellen

Abstract

Pojar, Jim; Diaz, Nancy; Steventon, Doug; Apostol, Dean; Mellen, Kim. 1994. Biodiversity planning and forest management at the landscape scale. In: Huff, Mark H.; Norris, Lisa K.; Nyberg, J. Brian; Wilkin, Nancy L., coords. Expanding horizons of forest ecosystem management: proceedings of third habitat futures workshop; 1992 October; Vernon, BC. Gen. Tech. Rep. PNW-GTR-336. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 55-70.

In northwestern North America, landscape-level management in National and Provincial Forests has taken the form of timber management. Conservation of biological diversity has become an important goal of forest land stewardship, and forest managers require information and guidance on how to incorporate landscape considerations for biodiversity into forest management. Landscape ecology examines ecosystem structure and function at the landscape scale. In British Columbia, there are several concurrent initiatives for a biodiversity strategy at the landscape level. A management strategy for biodiversity in the Prince Rupert Forest Region is described; it encompasses six recommendations for incorporating biodiversity at the landscape scale. In the United States, the landscape analysis and design process was developed to provide a means for understanding forest landscapes as ecological systems and to synthesize this knowledge with objectives and policies from Forest plans. The eight steps of the process are described.

Keywords: Landscape ecology, biodiversity, ecosystems, British Columbia, Pacific Northwest, forest management.

Introduction

The conservation of biological diversity (biodiversity) has become an important goal of forest land stewardship (Commission on Resources and Environment 1992, National Forest Management Act of 1976). The logical way to maintain forest biodiversity while continuing to produce commodities is to practice forest ecosystem management. Such management must be applied over many scales, from regional ecosystems to individual trees. To keep this paper relatively concise, we address primarily landscape-level considerations. Biodiversity at the regional level is being addressed, in part, through protected area planning (Lewis and others, this volume), and stand-level management is discussed by McComb and others (this volume).

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For the most part, landscape-level management in National and Provincial Forests has taken the form of timber management—timber supply planning and allocation, harvest scheduling, cutblock design and location. Rarely has there been an analysis of the ecological significance of existing landscape patterns, or of how the landscape pattern emerging from timber management affects biological resources and ecosystem processes. In northwestern North America (the area from the Rocky Mountains west, but north of California and the Great Basin and south of the Yukon Territory), forest management is altering landscape patterns over large areas with little regard for the natural landscape mosaic, the processes that created it, and the life in it (Swanson and others 1990). Forest managers require information and guidance on how to incorporate landscape considerations for biodiversity into forest management.

Many questions are unanswered about how landscapes operate as ecological systems. For example, little is known about the landscape-level habitat needs of individual wildlife species and how they respond to landscape patterns.There also is incomplete understanding of the role of connectivity in landscapes and how corridors do or do not function (Hobbs 1992, Simberloff and others 1992). Some of the key concepts and many of the details of ecosystem management are not compellingly supported by available research and require rigorous testing or further refinement. There are data, inferences, and interpretations (for example, Hansen and others 1991), nevertheless, that should be used as landscape patterns continue to be modified and to change in our forests. An adaptive management approach should be encouraged, whereby we judiciously apply new ideas operationally, while monitoring and learning from the results of management.

What Is a Landscape?

Landscape ecology in a general sense has a long tradition, but only recently have landscape studies changed in emphasis from describing observable patterns and the processes that cause the patterns, to characterizing landscape patterns and their effects on ecological processes Turner 1989). In common usage, a landscape is the aggregate of landforms in a region, or the land surface and its associated habitats at scales of hundreds to many thousands of hectares Turner 1989). 1 n technical terms, a landscape is “a spatially heterogeneous area” Turner 1989); “a mosaic of heterogeneous land forms, vegetation types, and land uses” (Urban and others 1987); and “vegetation patches established in response to spatial patterns of resource availability and disturbances” (Swanson and others 1992). All true of course, but these definitions have limited practical value, other than to remind us of such recurring themes as patches, pattern, heterogeneity, and disturbance.

Urban and others (1987) suggest that a forest landscape be viewed as a hierarchy of gaps, stands, and watersheds, and that a landscape is an order 5-6 watershed (or group of similar interacting watersheds), at a scale of 10 000s of hectares (25,000s of acres). In British Columbia, for example, a landscape is a watershed or a portion of a plateau with major topographic boundaries, usually between 5000 and 90 000 hectares (12,400 to 222,400 acres).

Scale and perspective are fundamental to the concept of landscape. Spatial and temporal scales must be considered because the structure, function, and dynamics of landscapes are scale-dependent (Levin 1992, Turner 1989). Life history variation, territoriality, and trophic roles are examples of such scale-dependent phenomena. A grizzly bear (*Ursus arctos* L.) experiences and functions in a landscape in a much different way than does a Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) than does a chytrid (*Chytridiomycota* spp.). Furthermore, landscape as a management concept is landscape as perceived by humans. The scale at which we perceive boundaries and patches and structure in the landscape may have little relevance to the energetics of the system or the population dynamics of most of its organisms.

Some Landscape-Level Concepts

Pattern, Process (Function), Fragmentation

Landscape patterns result from the interplay of abiotic factors, disturbances, and biotic processes (Urban and others 1987). Basic abiotic factors include climate, terrain geology, and soil type. These physical underpinnings change relatively little in response to most disturbances, natural or due to forest management. Natural disturbances range from loss of individual organisms to catastrophic fire. Disturbances shape the distribution of structural types and successional stages, which in forests we can broadly distinguish as early seral, midseral, and late seral (including old growth) stages. Disturbance and succession are really two facets of one large phenomenon: change. Disturbances change landscape structure by modifying vegetation and can be characterized by their type, intensity, frequency, duration, and effect. Wildfire, insect epidemics, pathogens, windthrow, landslides, floods, and drought are the major agents of disturbance in the unmanaged landscape. The biota evolve and adapt in response to these abiotic factors, disturbances, and biological interactions operating at different scales in space and time.

Landscapes can be interpreted as the aggregate of three basic features: background matrix, patches, and corridors (Forman and Godron 1986), all usually described in terms of vegetation. The matrix is the most connected portions of the landscape; that is, the vegetation type that is most contiguous. In northwestern North America (specifically, the Pacific Coast and Rocky Mountain forest formations), the matrix often is (was) mature coniferous forest (Barbour and Billings 1988) and often is the most extensive landscape element, as well. In heavily logged landscapes, the matrix may have shifted from mature forest to early successional forest.The matrix is thought to control landscape flows (movement of materials, energy, and organisms) because of its habitat connectivity (Forman and Godron 1986).

Patches are smaller areas of similar vegetation or other features (for example, rock outcrops) dispersed within a matrix or among other patches. Corridors are landscape elements connecting similar patches. Patches and corridors can be created by disturbances such as wildfire or logging, or can represent remnants after disturbances that alter most of the matrix.

Fragmentation is the process of transforming a matrix into one or more smaller patches surrounded by disturbed areas; for this discussion, patches of mature forest surrounded by early seral vegetation. Besides natural disturbances, agriculture, and urbanization, forest harvesting is a major cause of fragmentation. Rate of cut, size and type of opening, and cutblock distribution all influence fragmentation. Assuming an initial landscape with a matrix of relatively homogeneous, mature forest, some conversion to early seral stages (and creation of new patches) will increase biodiversity. However, as fragmentation from forest harvesting increases, species requiring mature forest will begin to be lost.

The threshold level of cut and the extent of negative effects on diversity are largely unknown for forests of western North America (Franklin and Forman 1987, Hansen and others 1 991, Ruggiero and others 1991). But obviously the higher the rate of cut the greater the risk to species, especially vertebrates, requiring mature forest (Hunter 1990).

Note that fragmentation is not necessarily bad for biodiversity. The effects of fragmentation have often been assessed in agriculture-forest mosaics, where forest remnants are isolated by nonforested areas that are or seem to be somehow alien or hostile to the forest organisms (Saunders and others 1991). The concept of habitat variegation, whereby the intervening areas are modified versions of the original ecosystems (Mclntyre and Barrett 1992), is more appropriate to managed forest landscapes-especially in partial cutting regimes.

Patches and Edges

As wild forests are converted to managed stands, remnant patches of forest become smaller. As patch size decreases, the proportion of edge (the interface between different landscape elements) increases. Edges have environmental conditions that differ from those of either element. In the Pacific Northwest, this “edge effect” is commonly assumed to occur 150 metres (500 ft) into forest patches from a forest-opening interface (Diaz and Apostol 1992). That part of the patch not influenced by edge is considered interior habitat. As patch size decreases, the amount of interior habitat decreases. Some species benefit from the increased edge, others suffer (Reese and Ratti 1988, Yahner 1988, Yahner and Scott 1988). Increased amounts of edge may increase species richness, but perhaps at a cost to rarer species associated with interior habitats (Hansen and Urban 1992, Reese and Ratti 1988, Rosenberg and Raphael 1986).

Reserves

Forest reserves are remnants of what once were much more extensive wild forests. They may be totally protected from logging or may be areas requiring “special management,” such as harvesting with constraints, prescribed burning, pest management, or control of exotic species. We think managed landscapes require reserves to maintain natural ecological conditions for those species dependent on them. Reserves can be established to conserve tracts of old forest sufficiently large to maintain forest interior conditions or to protect special areas, such as wetlands, unusual bedrock exposures, or riparian ecosystems.

Biodiversity is not distributed evenly or randomly across the landscape. Some areas are especially rich in number of species or unusual habitats, or have high biological productivity. Such areas may play key roles in the maintenance of biodiversity at the landscape level and merit special attention in a system of reserves. Tidal marshes and riparian ecosystems are important examples of areas not only influencing aquatic ecosystems but also functioning as the interface between terrestrial and aquatic systems.

Connectivity and Linkages

Connectivity is the spatial contiguity within a landscape. Connectivity links landscape elements and allows organisms to move through the landscape. Connectivity may be provided through the matrix or corridors linking patches. Lack of connectivity within a landscape, and among landscapes, may cause problems for some organisms. Small populations of poor dispersers restricted to forest fragments and isolated by roads, clearings, and other barriers may not be viable in the long term. Some species, especially large mammals, range widely across a landscape or several landscapes, relying on links to move among habitat patches (Noss and Harris 1986, Simberloff and Cox 1987). Therefore, connectivity should be provided in managed landscapes, through habitat corridors or a matrix composed of dispersal habitat, to link reserved areas and other important habitats. Such links may provide important seasonal and annual movement corridors for some species and provide critical habitat for the dispersal of other species among isolated habitat fragments (cf. Harris and Scheck 1991, Simberloff and others 1992).

British Columbia Case Study

To our knowledge, there is no operational case study of a biodiversity strategy fully implemented at the landscape level in British Columbia. There are several concurrent initiatives underway, however, including development of coastal biodiversity guidelines and a management strategy for biodiversity in the Prince Rupert Forest Region (the northwestern quarter of the Province), but these processes are just beginning to be applied. Material below is drawn from Steventon[1] and the draft coastal guidelines.

Management Strategy

Goal and objectives—Our goal is to sustain biological diversity in the forests of British Columbia. The proposed strategy has two objectives: (1) To ensure that the ecological processes of natural forests continue, and (2) to maintain populations of native species well distributed across their ranges by:

- Establishing a network of old forest and special habitats within each landscape unit (watershed or equivalent chunk of terrain, 5000 to 90 000 hectares [12,400 to 222,400 acres]).
- Planning harvesting activities to distribute a variety of seral stages across the landscape unit.
- Using stand-level practices to provide structural and species diversity in the managed forests within the landscape unit.

Assumptions—The strategy relies on three key assumptions that acknowledge the major limitations in knowledge of biodiversity and in ability to manage at different scales, and that underlie a “coarse-filter” approach to managing for biodiversity.

1. By maintaining broad geographical distribution of species and ecosystems, genetic and functional diversity will be maintained.
2. The maintenance of a variety of seral stages, stand structures and patch sizes, across a variety of ecosystems and landscapes will meet the habitat needs of most forest organisms.
3. A reserve-corridor approach, in conjunction with appropriate management practices, is a feasible way to maintain biodiversity at the landscape scale.

Principles—The strategy attempts to embody four important principles:

l. Management for biodiversity must be flexible and adaptive.
2. We must manage at various scales: regional, landscape, stand, and even individual tree.
3. It is not feasible to maintain all elements of biodiversity on every hectare, but stand management for biodiversity should be applied to every cutblock or treatment unit.
4. We cannot manage for all species individually, but some species, ecosystems, or habitats will require special management attention.

Landscape-level recommendations—The British Columbia strategy recommends the following seven tactics.

1. Delineate landscapes of 5000 to 90 000 hectares (12,400 to 222,400 acres), based on watersheds or similar physiographic units, as the primary planning units for biodiversity.

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[1] Steventon, J. Douglas. 1993. Managing for biodiversity in the Prince Rupert Forest region: a discussion paper. 33 p. Unpublished manuscript. On file with: Ministry of Forests, Prince Rupert Forest Region, Smithers, BC.

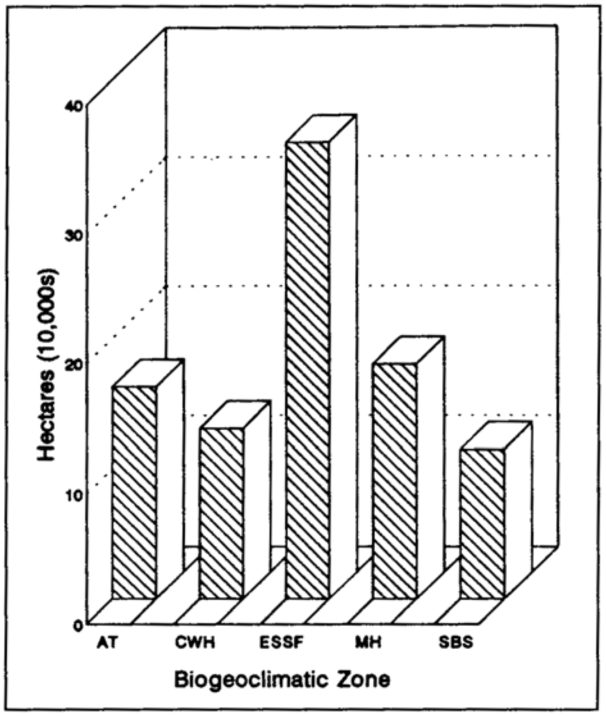

Figure 1—Biogeoclimatic units of the 80 000-hectare (200,000-acre) Copper River landscape, Bulkley Timber Supply Area, west-central British Columbia. AT=Alpine Tundra; CWH=Coastal Western Hemlock; ESSF=Engelmann Spruce-Subalpine Fir; MH=Mountain Hemlock; SBS=Sub-Boreal Spruce (Meidinger and Pojar 1991).

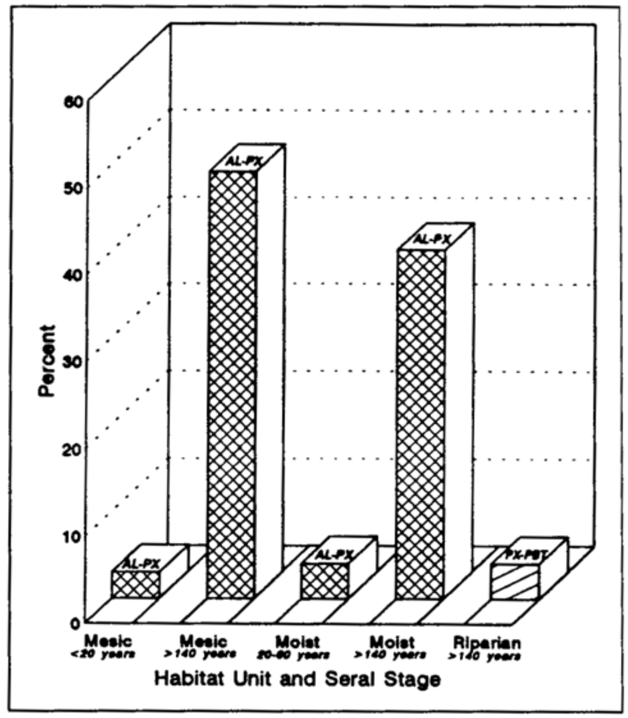

Figure 2—Generalized habitat units and seral stages in the Sub-Boreal Spruce Zone, Copper River landscape. AL=*Abies lasiocarpa*; PX=*Picea glauca x engelmannli*; *PBT=Populus balsamifera ssp. trichocarpa*.

Ideally, regional-level forest plans would be based on ecological units like regional ecosystems or ecosections. Realistically, the Timber Supply Area or Tree Farm License will continue to be the management unit at this level of planning. These management units are usually 500 000 to 2 000 000 hectares (1,240,000 to 4,900,000 acres), and they should be mapped into smaller, 5000- to 90 000-hectare (12,400- to 222,400-acre) landscape units based on watersheds or other geographic features. Watersheds also are useful units for dealing with other management concerns such as fisheries, hydrology, recreation, and access management.

2. Stratify each landscape ecologically; that is, by biogeoclimatic subzone and by generalized habitat unit.

The landscape should first be stratified by biogeoclimatic zone and subzone (Meidinger and Pojar 1991) and then mapped into generalized ecosystem or habitat units. Depending on the complexity of terrain and ecosystems, this mapping could be done at scales from 1:50,000 to 1:250,000. Detailed habitat mapping usually is not available, so the broad habitat units will have to be derived from B.C. Ministry of Environment biophysical habitat mapping (1:250,000) or from interpretation of terrain and forest cover information from inventory maps, air photos, and satellite imagery. Riparian units should be highlighted, as well as wetlands, azonal or rare and sensitive ecosystems, and special wildlife habitats.

3. Develop a landscape summary.

Derive summaries based on the ecological stratification and mapping, for each landscape:
- tabulation of the area of each biogeoclimatic subzone and of each habitat until by seral stage (figs. 1 and 2).

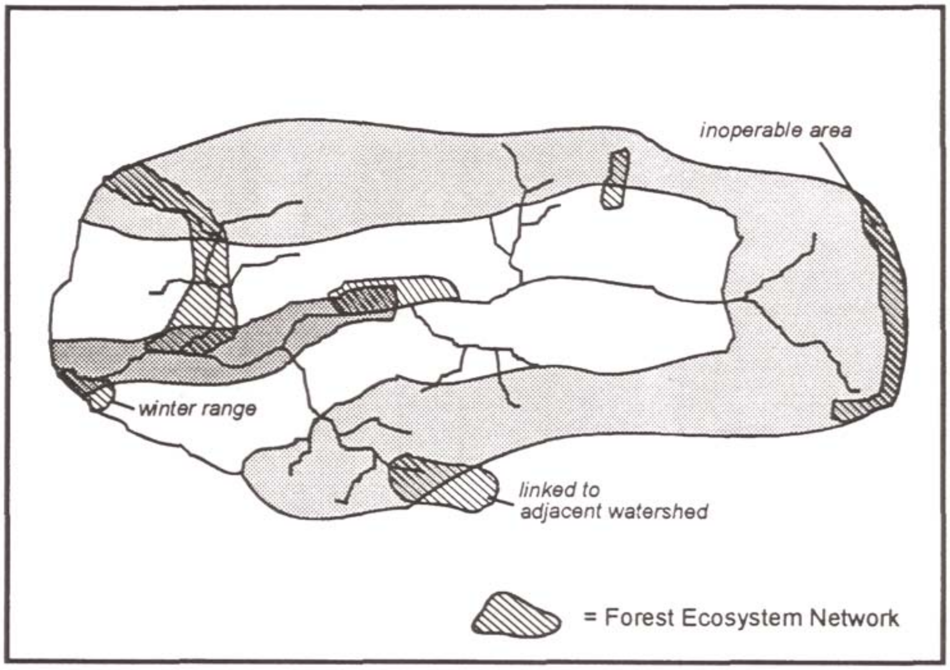

Figure 3—Distribution of a Forest Ecosystem Network within a hypothetical landscape with three biogeoclimatic zones.

- presence (known or expected) of rare or sensitive ecosystems and species (especially red- or blue-listed species; see British Columbia Wildlife Branch 1991).
- degree of existing development (kilometres of road, hectares logged).

This information can be used to compare landscapes and identify opportunities and limitations for maintaining diversity identified.

4. Establish and maintain a network of unmanaged areas representative of the range of ecosystems across the landscape.

This recommendation is aimed at maintaining a network (often referred to as a Forest Ecosystem Network[2] of unmanaged habitats, with emphasis on old forest and ecosystems that are rare, sensitive, especially productive, or habitat for threatened and endangered species. The Forest Ecosystem Network consists of permanent" reserve areas and the links that connect them. Links can be temporary and "move" across the landscape, thus being replaced over time with other suitable areas. For example, a link having old-growth characteristics could be replaced with an adjacent, previously logged stand managed for old-growth attributes. The size, configuration, and location of this network must be a landscape-specific decision. Inoperable (unharvestable) areas and reserves established far other purposes should be part of the network (figs. 3 and 4), provided ecosystem representation is assured.

5. Manage for a well-distributed variety of seral stages, stand structures patch sizes, and habitat types across the landscape, through time, heading the natural pattern.

The intent of this recommendation is to maintain a full range of seral stages and habitat types, appropriate to the landscape unit and its biogeoclimatic zones (table 1).

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[2] Personal communication. 1992. 1. McDougall, Habitat Protection Biologist, B.C. Ministry of Environment, Lands and Parks, Wildlife Branch, Vancouver Island Region, Nanaimo, BC.

Errata
The artwork for figures 4 and 5 on pages 62 and 65, respectively, was inadvertently reversed. The artwork on p. 65 should be on p. 62 as figure 4. The artwork on p. 62 goes with the caption on p. 65. We are sorry for any inconvenience this may cause.

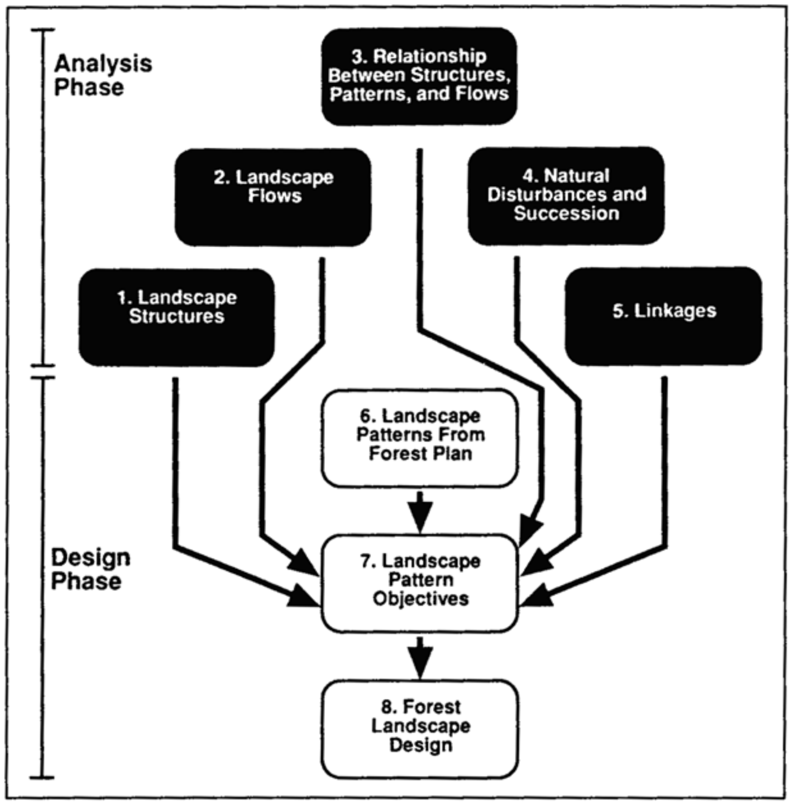

Figure 4—Hypothetical example of development plan incorporating landscape considerations for biodiversity.

Table 1—General seral stage objectives (percent of habitat unit) by biogeoclimatic zone for the 80 000-ha (200,000-acre) Copper River landscape

	Biogeoclimatic zone[a]		
Stand parameter	ESSF/MH	SBS	CWH
Early seral (0–20 years)[b]	<30%	5–50%	<30%
Mature (80+ years)	>50%	>30%	>40%
Harvest unit size[c]	0–100 ha (0–247 acres)	0–200 ha (0–494 acres)	0–100 ha (0–247 acres)

[a] ESSF=Engelmann Spruce-Subalpine Fir Zone; MH-Mountain Hemlock Zone, SBS=Sub-Boreal Spruce Zone; CWH=Coastal Western Hemlock Zone (Meidinger and Pojar 1991).
[b] Stand ages are approximate. Includes protected areas in the “Forest Ecosystem Network” and managed uneven-aged stands that structurally resemble mature stands.
[c] There should be more smaller than larger units, averaging perhaps 40 hectares (100 acres). Larger units may consist of a cluster of small blocks.

We think early seral stands, including cut-overs and naturally disturbed sites, should not exceed 50 percent of the landscape or habitat unit. For seral stage objectives, two adjacent 20-hectare (50-acre) clearcuts 5 to 10 years apart in age will, in most respects, function as one 40-hectare (100-acre) early seral patch. A 30-percent limit is preferable in coastal forests, or if species (such as marten (*Martes americana* Turton) Lofroth and Steventon 1990) dependent on mature forest are emphasized in the landscape objectives.

For both coastal and interior forests, we also recommend that a minimum of 30 percent of the landscape or habitat unit be maintained in mature forest, which should be defined structurally not merely by age. This figure would include reserved areas and stands where partial cutting systems maintain the mature forest structure.

Coastal forests (CWH, MH) and high-elevation interior forests (ESSF) have fewer dramatic disturbances and a greater proportion of older forests than do lower elevation, drier interior forests (SBS; refer to table 1 for definitions). Landscape structure and stand attributes reflect disturbance regime; we therefore recommend that a greater proportion of mature forest be maintained in forest zones that experience less frequent, less extensive disturbances.

In addition to a range of seral stages, the array of stand and habitat types should be maintained. For example, if deciduous forest is a natural component of the landscape or habitat unit, it also should be a component of the managed landscape. Or, if deciduous trees are components of natural stands, they also should be maintained in managed stands.

6. Maintain biodiversity elements that are at risk or of special management concern.

Some species, ecosystems, or habitats are too sensitive, significant, or threatened to entrust to the “coarse filter” management outlined above. In British Columbia, numerous species of plants and animals are considered endangered, threatened, vulnerable, or sensitive. Government agencies and conservation groups are cooperating to inventory and compile information on vertebrates, plants, and ecosystems, so that actions can be taken to maintain the rarer elements of biological diversity.

7. Minimize the negative effects of fragmentation due to timber harvesting.

In even-age management, we should attempt to impose a variety of patch sizes and shapes in each seral stage. More smaller than larger blocks should be applied, but we need some large patches in early and mid-seral stages to ensure a continuing supply of large patches of mature forest for those organisms that rely on such habitat. A checkerboard pattern of equal-sized harvest units uniformly spaced across the landscape is generally not desirable, because this cutting pattern accelerates fragmentation, especially at high rates of cut with small (for example, 10-hectare [25-acre] blocks. For the same proportion of landscape cut, clustering of small cutblocks reduces total edge and maintains larger patches of older forest (Franklin and Forman 1987). Clustering small blocks, or opening larger blocks with some sort of partial cutting or patch retention, can provide opportunities for varying the effective unit size while meeting visual and other cutblock size objectives. Late seral stages should be distributed, if possible, so as to link reserved areas in the Forest Ecosystem Network.

U.S. Case Study

Landscape Analysis and Design Process

The Landscape Analysis and Design Process (LADP) Was developed to provided a means for understanding forest landscapes as ecological systems, and to synthesize this knowledge with objectives and policies from Forest plans, thereby creating a more purposeful approach to landscape pattern management (Diaz and Apostol 1992). The following description is a summary of the steps in the LADP. The reader is encouraged to consult Diaz and Apostol (1992) for application of the step to an example landscape and more detail before implementing the LADP.

The LADP waS designed to be more holistic than the traditional single-commodity approach. The basic logic of the LADP is (1) to describe the landscape as an ecological system (rather than separate resources), in terms of structure, function, processes, and context within the larger landscape (LADP—Steps 1 through 5); (2) to identify existing policies regarding landscape pattern and objectives (step 6); and (3) to combine knowledge of the landscape ecosystem, existing policies, and local concerns to describe (step 7) and spatially array (step 8) the landscape pattern that individual projects will create.

The process is flexible in level of detail, size of area, scope of analysis, and degree of quantification, to fit the needs and circumstances of individual projects. The LADP has been applied in different forms in several planning areas in the Pacific Northwest Region of the USDA Forest Service.

Figure 5 illustrates the LADP. Steps 1 through 5 constitute the analysis phase, where information is gathered that is used to understand the character and function of the analysis area as a landscape ecosystem. Steps 6 to 8 make up the design phase, consisting of two distinct tasks: (1) describing objectives and (2) spatially arraying those objectives on the landscape.

Step 1: Landscape elements—Identify, map, and describe the elements of the landscape (patches, corridors, matrix), and the landscape pattern.

Because the relation between structure and function is the keystone of understanding landscapes as ecological systems, identification of the landscape elements present and their arrangement is fundamental to implementing the LADP.

The process of delineating landscape elements is one of identifying areas homogeneous in (1) plant community or vegetation type; (2) stage of succession, stability; (3) within-patch structure; and (4) ecological capability or productivity. Other patch attributes, such as origin, likelihood of repeated disturbance, or “naturalness,” also may be included. It probably is not necessary to distinguish between two similar but not identical patches if they contribute in the same way to landscape function. In general, areas of vegetation that are discernible from aerial photographs (1:12,000) make logical landscape patches.

Step 2: Landscape flows—Identify and map landscape flows.

Flows are those things that move across or through landscapes, in the air, over land, or in the soil (Forman and Godron 1986). They may be energy or materials, expressed through living or nonliving ecosystem components. Flows may be generalized over large sectors of the landscape, or confined to distinct corridors of a particular patch type or landform feature (for example, stream corridors). The landscape flows of greatest pertinence to the LADP are water, wind, fire, animals (flying and ground based), plants (particularly noxious weeds and alien species), and humans (recreationists, commercial users, and so forth).

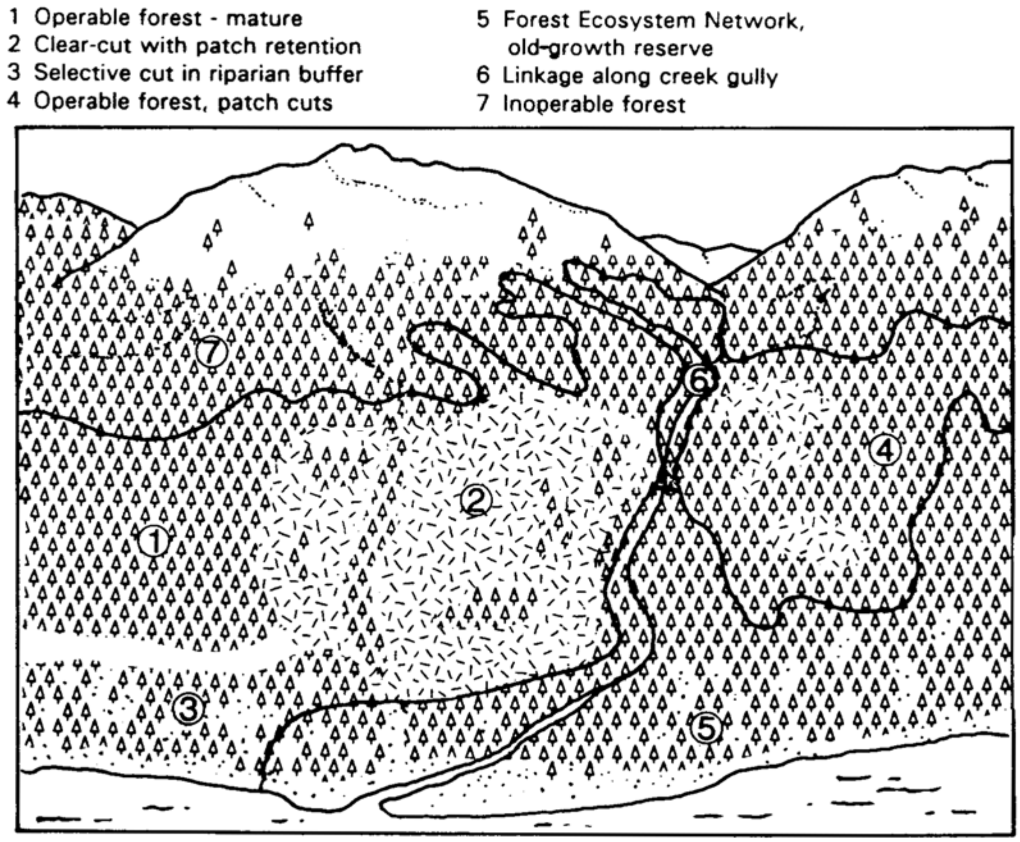

Figure 5—Steps of the Forest landscape analysis and design process.

Because the LADP is intended to produce a landscape pattern fostering function of important landscape flows, two central questions are (1) In the future, what flows will be critical in this landscape? and (2) Which flows are most likely to be affected by human activities? Some flows may not be responsive to changes in landscape pattern and thus are not as critical to the analysis. To keep the LADP efficient, only a few flows of greatest importance may need to be considered.

The next phase of this step is to describe in spatial terms (on a map if possible) how the landscape flows are occurring. The following questions should be addressed: (1) Where in the landscape does a particular flow occur? (2) Is it dependent on a particular landscape element (matrix, corridor, or network)? (3) What is the direction of the flow? (4) What is the timing (for example, is it seasonal)?

Step 3: Relation between landscape structures and flows—Describe the interaction between elements or pattern and flows for interpretation of landscape function.

The goal of LADP iS to use the ecosystem model (structure and function) as the basis for designing and analyzing landscapes. In this step, the model for a particular analysis area is defined. The central question for this step is, How do the individual landscape elements, as well as the landscape pattern, interact with (foster, inhibit, increase, direct, and so forth) individual landscape flows?

Out of this grows an understanding of how the landscape functions as an ecological system. Sometimes it is useful to think in terms of the five basic categories of functions (capture, cycling, production, storage, and output). For example, areas of habitat connectivity between adjacent landscapes perform capture, cycling, and output functions; and wetlands provide a storage function for water.

Empirical data about the relations between flows and elements often are lacking, and understanding of some conceptual aspects is still rather rudimentary. For example, the mechanism of connectivity for various groups of organisms is not well understood; thus, this step often involved piecing together a hypothesis of landscape functional relations from fragmentary observations and inferences.

Step 3 can be displayed in numerous ways. One approach is a simple two-way matrix with landscape elements on one axis and flows on the other. This approach may not work well if there are a large number of element types or flows; maps or simple descriptive paragraphs may communicate the information better.

Step 4: Natural disturbances and succession—Describe how natural disturbances and succession processes operate, and how they interact with and produce changes in landscape patterns.

Natural processes, particularly large-scale disturbances and succession, provide a significant background for prescribing landscape patterns that are created in National Forests. To understand landscapes as ecological systems, the following questions should be addressed: (1) What agents of change at the landscape level would have existed in the natural ecosystem? (2) What would their effect have been on the landscape pattern (for example, arrangement, composition, size and shape of patches, and connectivity? (3) How might natural landscape patterns have influenced the behavior of disturbance phenomena?

Answering these questions frames the possibilities of the landscape—what might be. It helps define “natural-appearing” for a particular area, and what natural landscape-level diversity is. Finally, through an understanding of the rate and nature of change, it reflects the stability of a particular configuration of landscape elements.

The rate of succession of vegetative communities after a disturbance is of interest because the functions (wildlife habitat, hydrologic function, visual appearance) of the various communities differ significantly. The successional state of patches in a landscape determines how well particular objectives will be met at a point in time; the successional process itself, played out across the landscape, determines how well those objectives are met **through** time.

Complete information about disturbances and their effects often is difficult to obtain. Historic records of fires or outbreaks of insects or pathogens, maps of stand age classes (to determine historic fire patterns), and panoramic photographs predating timber harvest are of significant value for envisioning natural landscape patterns.

Step 5: Linkages—Describe functional links to adjacent areas.

Step 5 in the LADP is to determine how the analysis area fits into the context of the larger landscape. A first step is to examine how the most important flows interact with areas outside the analysis area, and what landscape elements contribute to or affect that interation. In other words, What things cross the borders? and How do they do it? The other aspect of linkages is the arrangement of landscape elements in relation to the larger landscape. For example, Does the analysis area represent an island of unfragmented old growth in a highly fragmented landscape? Does it contain a portion of a critical migration route for a particular species? Does it contain an important node in a larger network?

Step 6: Landscape patterns from the Forest plan—Determine what landscape pattern objectives already exist, from the Forest plan.

This step, setting objectives from which design elements are derived, begins the design phase of LADP. Step 6 is a look at landscape pattern objectives established through the Forest planning process.

Forest plan direction may not specifically address landscape pattern but instead may refer to it indirectly. Things to look for include (1) specifications for harvest unit size, composition, and dispersal; (2) designation of priority landscape flows for a particular management area (for example, deer and elk or dispersed recreation along river corridors); (3) expectations of how the landscape will look and feel (visual quality objectives); and (4) statement about proportions of an area within certain age or structural classes, or certain wildlife habitat categories that tie to specific landscape flows or functions.

Step 7: Landscape pattern objectives (narrative)—In this step, information gathered in previous steps and from other sources is used to refine landscape pattern objectives for the analysis area. Specifically, the future landscape is described by the types and arrangement of landscape elements (patches, corridors, matrix). These statements constitute the “design elements” of the future landscape and may refer either generally to the pattern of individual elements or to location-specific phenomena.

Once important landscape functions and resource issues have been identified, the information from the analysis phase (steps 1-5) is used to clarify what structural elements and landscape patterns are needed to provide for them. The following questions are useful in setting landscape pattern objectives: (1) Are there rare, unusual, critical, or unique landscape elements desirable to protect or enhance; for example, wetlands, travel corridors, or blocks of old growth with interior habitat? (2) Are there patches of areas of the matrix among which connectivity should be maintained? (3) Is there anything missing that should be introduced or restored (for example, “naturalize” square patch shapes or restore native community composition to disturbed areas)? (4) To what extent, and where, do we want to emulate certain elements of natural landscape patterns? and (5) Are there areas of the landscape where minimizing fragmentation is desirable?

Landscape pattern objectives from the Forest plan are then combined with the answers to the questions above to develop statements about desired future landscape patterns; that is, What kinds, sizes, shapes, and arrangements of patches, corridors, and matrix are desirable in different parts of the landscape?

The existing pattern of the landscape may be quite different from what is desired, and restoration of desired landscape patterns may take a long time to achieve. It therefore may be desirable to describe "interim" landscape patterns that eventually will lead to the desired end. These interim patterns act as near-term checkpoints and help give focus to management activities that will take place in the near future.

Step 8: Forest landscape design—Using landform analysis and spatial design techniques, map the areas within which a particular landscape pattern is desired, based on the objective statements from step 7.

Designing at the scale envisioned in the LADP is by necessity coarse grained. A broad brush approach is appropriate; one must think in terms of groupings of landscape elements rather than single stands. The goal is to create general desired vegetation patterns to set the stage for more detailed work to follow.

The first task is to conduct a landform analysis. An analysis of the topography is essential because it largely defines the operational environment of the landscape. Landforms are more permanent than vegetation or plant communities; by 'reading" the landforms, one can postulate how vegetation patterns might be placed in a manner promoting connectivity, or what "mixes" of patch types reflect natural landscape diversity. Landforms must be analyzed in both two and three dimensions to clearly understand their role in the landscape.

The second task is to create a comprehensive **"opportunities and constraints map"** showing the important form-giving influences, such as where forage openings are needed, where connectivity should be improved, and which areas should be protected or restored.

Once a concept design is agreed on, it is further developed and refined to a level of resolution appropriate to the area. Individual harvest units may be proposed, roads or trails suggested, and potential projects identified. Generally the goal of this step is to paint a picture of the large-scale landscape pattern that is clear enough for people to visualize and interpret, and for further development of site-specific projects to occur.

The human movement system (roads and trails) is an integral part of step 8. Human access routes can have both negative and positive effects on landscape flows. "Access and travel management" is a planning method that can be easily integrated into the LADP to help determine access needs.

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Stand Management Alternatives for Multiple Resources:
Integrated Management Experiments

William McComb, John Tappeiner, Loren Kellogg, Carol Chambers, Rebecca Johnson

Abstract

McComb, William; Tappeiner, John; Kellogg, Loren; Chambers, Carol; Johnson, Rebecca. 1994. Stand management alternatives for multiple resources: integrated management experiments. In: Huff, Mark H.; Norris, Lisa K.; Nyberg, J. Brian; Wilkin, Nancy L., coords. Expanding horizons of forest ecosystem management: proceedings of third habitat futures workshop; 1992 October; Vernon, BC. Gen. Tech. Rep. PNW-GTR-336. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 71-86. (Huff, Mark H.; McDonald, Stephen E.; Gucinski, Hermann, tech, coords.; Applications of ecosystem management),

We describe the conceptual approach, logistics, and some preliminary results of an experiment designed to compare costs and biological and human responses among three stand management strategies along the east side of the central Coast Range of Oregon and in the central Oregon Cascade Range. In the Coast Range study, we are testing (1) clearcut with reserve green trees, (2) two-story, and (3) group selection systems. In the Cascades, we are beginning a study in young plantations in an attempt to restore old-forest structure and composition. Stand treatments were based on the sizes, frequencies, and intensities of natural disturbances found in western Oregon Douglas-fir (*Pseudotsuga menziesii*) stands and were designed to produce stand structure (based on tree diameter distributions), species composition, and dead wood levels that might support species of vertebrates found in natural unmanaged stands ≥ 80 years of age. The structural development of the stands and the species of wildlife that they support will be the basis for deciding if, when, and where these types of stand management approaches should be attempted over large spatial scales to meet the needs of species' individual territory sizes larger than a stand. Stands developed by using these techniques should be considered the potential building blocks for a designed landscape.

We describe how the development, implementation, and particularly monitoring of prescriptions can be coordinated among harvesting specialists, silviculturists, wildlife biologists, recreation specialists, and professionals in other disciplines.

Keywords: Silviculture, forest wildlife habitat, integrated management.

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Problem Analysis

Until recently, management objectives for public forest lands in the Pacific Northwest have been mainly timber-driven. Areas once dominated by large sawtimber and old-growth forests (average diameter at breast height [d.b.h.] > 21 inches [> 53 cm]; Brown 1985) have been clearcut and are now dominated by plantations < 30 years old. The point in stand development when plantations might meet the needs of animal species associated with unmanaged large sawtimber and old-growth stand conditions (Brown 1985, Ruggiero an others 1991) probably will differ among wildlife species and geographic locations. With harvestable tree size declining to 7 inches (18 cm) d.b.h. for commercial thinning (Sessions 1990), there is the opportunity to manage these stands at young ages and thereby hasten the development of some characteristics found in older unmanaged stands, such as large dead wood, large trees, and multiple canopy layers.

Public demand and recent legislative initiatives have caused a shift toward a more balanced set of land management objectives that include wildlife, fisheries, aesthetics, and recreation (Behan 1990). Legislation and judicial decisions have virtually stopped timber harvest on public lands in western Oregon and Washington. If timber harvest is to be resumed, then landscapes should be designed to meet these goals throughout the region by aggregating stand conditions over space and time. There is a need to begin to test silvicultural practices that can provide a range of conditions on landscapes that have a high probability of allowing a designed landscape to function as intended.

Silvicultural alternatives should be tested to determine if timber production can be accomplished in concert with maintaining habitat needs of wildlife species associated with old forests, and also provide acceptable aesthetic conditions and recreational opportunities. These systems must be operationally feasible. We describe a basis for development of silvicultural systems that integrate mature-forest wildlife habitat, timber, harvesting logistics, and human values in managed Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) forests of western Oregon. Specifically we address how existing stands may be entered to produce habitat typical of old-forest conditions or to maintain existing old-forest structure while producing some timber.

Historical Perspective of Silviculture in the Region

Although clearcutting began as the regeneration method adopted by most forest managers in the Pacific Northwest, partial cutting (a form of selection cutting) was tried in the region (Isaac 1956). In the early 1930s, the Forester for the Pacific Northwest Region of the USDA Forest Service and a researcher from Oregon State University stated that there should be a shift away from clearcutting and toward selection cutting (Lord 1938, Munger 1950). Diameter-limit cutting that removed about 35 percent of the volume in old-growth stands produced mixed results in western Oregon and Washington Douglas-fir forests (Isaac 1956). Some stands sustained high damage to residual stems, especially to thin-barked species such as western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), and some stands had high levels of windfall after harvest (Munger 1950). Some stands exhibited decreased or stable growth rates after cutting (Munger 1950). Because of the apparent failure of partial cutting to meet timber objectives, the efficiency of logging clearcuts on steep ground, and risks of failure in relying on natural regeneration (Cleary and others 1978), clearcutting and planting became the accepted technique for rapid replacement of the original stand, primarily with Douglas-fir.

Following legislation such as the National Forest Management Act of 1976, land managers on National Forests were presented with a new set of management objectives, including the maintenance of biological diversity. Hence special treatments (for example, 1 to 2 trees and snags per acre [3 to 5/ha]) were designed to mitigate loss of mature forest habitat, but these treatments were often resource-specific (for example, snags for cavity-nesting birds). More recently "new forestry" practices have been used (Franklin 1989) in which trees, snags, and logs are retained during harvest with the intent of carrying these features through the next rotation. This approach and other alternatives to traditional plantation management need extensive testing to evaluate how effective they will be in providing habitat for mature-forest wildlife. Taking a proactive approach to producing old-forest conditions through management may lessen the social and economic impacts associated with reliance on natural succession.

Wildlife Habitat, Forest Disturbance, and Stand Development

We assumed that species associated with old, unmanaged stands use certain key structural and compositional features (Ruggiero and others 1991), and that some of these features also add to the aesthetic quality of stands (Brunson and Shelby 1992): large trees of several species, multilayered canopies, large snags and logs, and deep forest floor litter and soil. To meet the needs of forest wildlife associated with old forest structure, these habitat features should be considered as part of silvicultural systems employed in stands over large areas in a complementary, integrated design.

Knowledge of natural disturbances in Douglas-fir forests can help during development of silvicultural systems that might meet the needs of wildlife associated with old, unmanaged stands. Natural disturbances occurred over a broad range of sizes (0.01 - > 25,000 acres [0.01 - 10 000 ha]), shapes (irregular), intensities (little to all trees or dead wood retained), pattern (scattered to clumped), and frequencies (single-tree gaps may form once per year in stands but stand-replacement fires may occur once every 200 years; Spies and Franklin 1988). Coarse-scale disturbances typically occur over tens to thousands of hectares both within homogenous forest conditions (stands) and among them (landscapes), and they often create large pulses of dead wood and initiate a new age class of tree regeneration following the disturbance (Hemstrom and Franklin 1982, Spies and Franklin 1988, Spies and others 1988). Fine-scale disturbances occur within stands at a scale of < 1 tree height in width, and they may initiate regeneration of small patches of regeneration and provide small patches of dead wood. Species composition of the regeneration may differ between fine- and coarse-scale disturbances; shade tolerant tree species dominate with decreasing gap sizes (Spies and others 1990).

Before forests were managed for timber, natural disturbances shaped the structure and dynamics of the forests for hundreds of years. The scales, frequencies, intensities, and patterns of disturbances imposed by timber management deviate from natural disturbances to various degrees (Hansen and others 1991), with implications for forest wildlife, aesthetics, and recreation. Traditional approaches to timber management for Douglas-fir in western Oregon and Washington produced disturbances within a relatively narrow range of sizes (often 10 to 100 acres [4 to 40 ha], shapes (regular), intensities (few residual trees or dead wood), pattern (scattered), and frequency (rotations of 60-120 years).

Stands that have developed after natural disturbances can have high biological values (for example, Ruggiero and others 1991) and social values (for example, Brunson and Shelby 1992). No single stand management system will precisely match the variability inherent in natural stands that resulted from a variety of disturbances. Some of the variation can be incorporated into managed landscapes by using various silvicultural systems. The choice of these systems will depend on the biological, social, and economic objectives for the stand and the landscape, and they will imitate natural disturbances to different degrees.

The degree to which a managed stand might imitate natural, old stands can be estimated, in part, by comparing the diameter distributions of conifers, hardwoods, and dead wood in a natural, old stand currently meeting biological and aesthetic objectives to the diameter distributions of a managed stand. We assumed that tree diameter distributions also are related to vertical foliage structure. Community similarity indices (for example, Morisita's index, Brower and others 1990) can be adapted to assess whether improvement toward a desired future condition is achieved (that is, moved closer to 100 percent; McComb and others 1993).

Examples of Stand Management Experiments

We used the characteristics of natural disturbances and the structures that they produce as the basis for testing silvicultural systems designed to (1) initiate a disturbance in a sawtimber-sized stand that would allow regrowth of the stand into one with old-forest structure (two-story stand; coarse-scale disturbance); (2) initiate disturbances in a sawtimber-sized stand that would allow some timber extraction, but allow the stand to continue to function as an old stand while developing the vertical and horizontal complexity in the stands (gap stands; fine-scale disturbance); and (3) restore old-forest structure by using both two-story (coarse scale) and gap (fine-scale) approaches in managed plantations created primarily with timber objectives.

We used an integrated, deductive approach to test hypotheses regarding the costs of harvesting and responses of vegetation, habitat features, wildlife populations, and human use to silvicultural treatments. Stand-level studies can provide information on harvesting system approaches and costs; regeneration and residual tree responses; local assessments of aesthetics; and responses of species with small home ranges. Large manipulations (thousands of hectares) should be the basis for testing responses to treatments for species with large home ranges, recreation, and visual resource values. Traditional divisions between research and management must be minimized and managers should be an integral part of the design, implementation, and monitoring of the experiments that we describe. Monitoring of implementation and effectiveness of the prescriptions will be critical if managers are to take an adaptive management approach.

We describe two experiments. The first involves management of existing sawtimber stands, the second involves restoration of old-forest characteristics in pole-timber plantations. In both experiments we attempted to retain or enhance development of large conifers and hardwoods, snags (based on Marcot 1991), logs, and vertical complexity in the stands, because these features seemed to be important to species of wildlife associated with old, unmanaged forests (Ruggiero and others 1991).

Silvicultural Alternatives in 70- to 120-Year-Old Douglas-Fir Stands

We are comparing the harvest planning and logging costs; growth of residual trees, regeneration, and shrubs; population responses of small birds and mammals; use of snags by cavity-nesters; aesthetic quality; and recreational use of stands managed through traditional clearcut, two-story, and gap-cut approaches in a forest along the east side of the central Oregon Coast Range. McDonald-Dunn forest is about 11,000 acres (4300 ha) and currently is dominated by Douglas-fir associated with lesser amounts of grand fir (*Abies grandis* (Dougl. ex D. Don) Lindl.) and bigleaf maple (*Acer macrophyllum* Pursh). Most old stands in the forest are 70 to 130 years of age and began after the end of frequent burning of the Willamette Valley by Native Americans. The stands we worked in contained an average of 60 trees per acre (148 trees/ha), and tree d.b.h. averaged 23 inches (58 cm). The entire forest was heavily salvage-logged during the 1950s and 1960s, leaving a forest that had low snag and log abundance. Clearcutting and planting have been used on this forest for the past 15 years. McDonald-Dunn forest is adjacent to Corvallis, and residential housing occurs along much of the east boundary of the forest.

This east side of the forest is visible to Corvallis residents and to those traveling two major highways into the city. The forest is closed to public vehicular traffic. Over 50,000 visitor days of recreation occurred in the forest in 1990, primarily as hiking and mountain biking.

We designed a replicated experiment that was implemented over 3 years after 1 year of pretreatment data collection on birds and mammals in each stand (see below). Bird community similarity was quite consistent among stands before treatment and over time within controls. Eleven stands, each 20 to 30 acres (8 to 12 ha), were distributed among four treatments in each replicate (33 total stands): (1) one unmanaged control (no treatment, used as for baseline monitoring of wildlife populations and habitat conditions); (2) two clearcuts in which 1.5 snags per acre (3.7/ha) were created and 0.5 green trees per acre (1.2/ha) were retained (snags were scattered in one clearcut and clumped in the other); (3) two two-story stands in which 6 to 10 green trees per acre (15 to 25/ha) were retained and 1.5 snags per acre (3.7/ha) were created (snags were scattered in one stand and clumped in the other), and six gap-cut stands in which 30 percent of the area was harvested in scattered 0.5-acre (0.2-ha) openings (snags were scattered in three stands and clumped in the other three).Gap stands were triple replicated because we wished to determine if there were cumulative effects of gap removal on animal abundance (were populations in three gap stands equalizing populations in one clearcut). One replicate was harvested each year for 3 years. Slash was piled and burned in some stands where needed; there was no broadcast burning. Douglas-fir were planted in all clearcuts (360/acre [890/ha]), two-story stands (330/acre [815/ha]), and gaps (240/acre [600/ha]). Grand fir (240/acre [600/ha]) were planted experimentally (small plots) in all three systems. Most snags were created by topping trees at 60 feet (15 m) because few residual snags remained in these stands. Tops of snags were left on the site as coarse woody debris.

Harvesting approaches—Assignment of treatments to stands was coordinated to allow comparisons of the costs and logistics of ground skidding and cable logging among the three treatments in two of the three replications (Edwards and others, in press; Kellogg and others 1991). In one replication (Kellogg and others 1991), unit-level planning and layout time, and logging shift-level time and volume were recorded for felling, ground skidding, cable yarding, and loading in each treatment. Harvest planning in the two-story and gap cut stands was not only for the initial entry but also for all future entries. Maps of skid trails were valuable not only to loggers and skidder operators but also to timber markers and reforestation specialists.

Skid trails covered < 8 percent of the ground in stands harvested with ground skidding equipment. Planning and layout time were two to five times longer in two-story and gap cuts than in traditional clearcuts, respectively. Total logging costs when ground skidding equipment was used were 23 and 2 percent higher on two-story and gap cuts, respectively, than on traditional clearcuts (fig. 1). Felling efficiency and skidder costs were lower in gap stands than in two-story stands or clearcuts. Total logging costs with cable systems were 23 and 25 percent higher on two-story and gap cuts, respectively, than on traditional clearcuts using cable logging systems.

In a second replication (Edwards and others, in press) 2.5-acre (l.0-ha) wedgecuts, 2.5-acre (l.0-ha) strip cuts, and 1.5-acre (0.6-ha) gaps were attempted to decrease the logging costs while establishing small openings in the stands. Compared to the 0.5-acre (0.2-ha) gaps, 1.5-acre (0.6-ha) gaps were easier to plan and log. Total logging costs using skyline systems were 7 percent higher in wedge cuts, 16 percent higher in strip cuts, 22 percent higher in 1.5-acre (0.6-ha) gaps, and 27 percent higher in 0.5-acre (0.2-ha) gaps than in clearcuts.

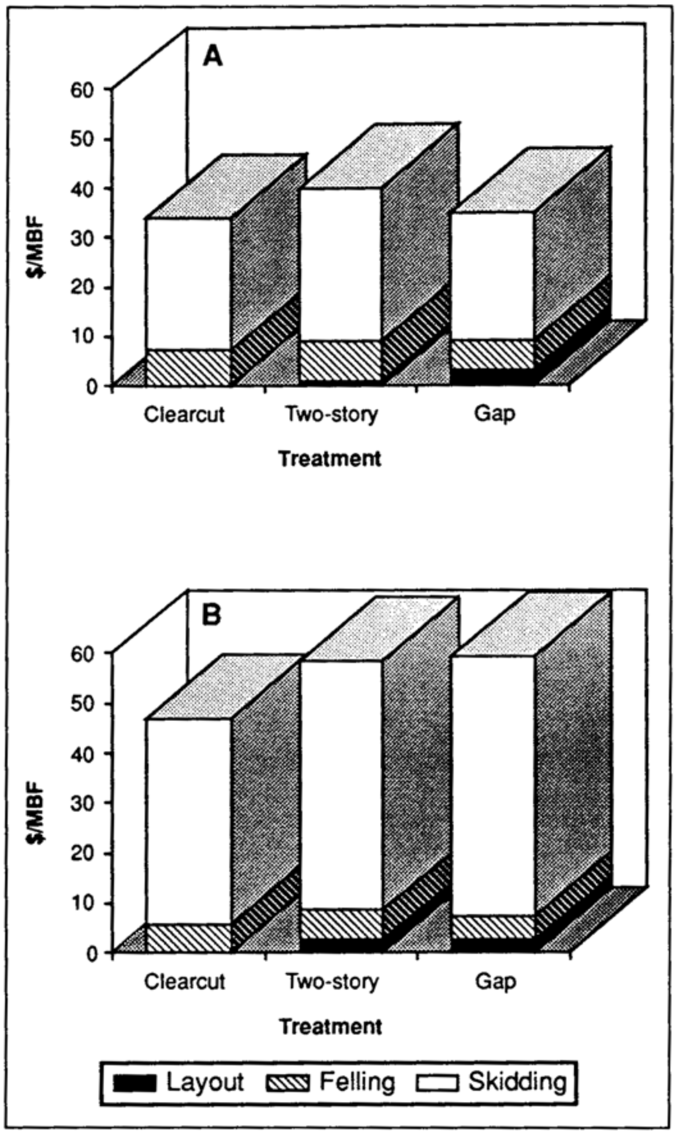

Figure 1—Comparison of harvesting costs among three silvicultural treatments in an east-central Oregon Coast Range forest, 1990 (from Kellogg and others 1991).

Vegetation responses—Growth and survival of planted and natural regeneration is being monitored annually in all treatments as is the growth of residual green trees. Within each stand type in each replicate, 0.1- to 0.5-acre (0.04- to 0.2-ha) subplots were established and randomly assigned one of four vegetation management treatments: (1) no treatment (control), (2) mechanical control of competing vegetation, (3) herbicidal control of competing vegetation as needed, and (4) intensive herbicidal control of competing vegetation and plastic tubes to protect seedlings from browsing. The latter treatment was used to assess the effect of overstory cover on seedling growth and survival in the absence of confounding effects of understory competition and browsing. Basal diameter, height, and animal damage are measured twice each year. Growth and survival of planted seedlings was highly variable among gaps in the gap stands. Natural regeneration in the first two replicates, although variable, was more abundant in two-story than in clearcut or gap stands.

Trees marked for retention in two-story stands were either ones of high timber value with deep crowns and high diameter-to-height ratio (for continued rapid growth and wind-firmness, respectively) or they were of poor quality, limby, or with decay (for replacement snags).We hypothesize that the former types of trees will respond rapidly to release, grow to a large size and be both ecologically and economically valuable at the end of the next rotation. We are measuring survival, diameter growth, and height growth of residual trees in three stands in each treatment. It is too early to determine if these trees are growing more rapidly than they were before treatment. Costs of regeneration and vegetation management are being maintained by the regeneration forester at McDonald-Dunn forest. To date, there are no obvious differences among treatments in site preparation, planting, or vegetation management costs, although vegetation management is continuing.

Wildlife responses—Species of vertebrates with home ranges small enough to be fully encompassed within the boundaries of the stands were sampled for 1 year before treatment and each year since treatment. Small birds were sampled at three randomly located variable circular plots (VCPs) (Reynolds and others 1980) established in each stand at least 330 feet (100 m) from an edge and 330 feet (100 m) from each other. All birds seen or heard within the stand from each VCP (except repeat observations) were recorded by sound or sight six times each spring. Only observations < 165 feet (50 m) from the VCP were used in preliminary analyses. The relative abundance of small mammals and forest floor amphibians was sampled by using 45 Sherman live traps and 45 pitfall traps (double-deep no. 10 tin cans; McComb and others 1991) in each stand (15 of each trap type at each VCP) for four nights each summer.

Based on data from two of three replications, birds seemed to respond to the treatment in one of four ways: (1) linear reduction in abundance proportional to the volume removed from the stands (for example, brown creeper [*Certhia americana*]), (2) absent in clearcut and two-story stands but present in the gap stands and controls (for example, Pacific slope flycatcher [*Empidonax difficilis*]), (3) absent from the control and gap stands but colonizing the clearcut and two-story stands (for example, white-crowned sparrow [*Zonotrichia leucophrys*]), and (4) no response (for example, dark-eyed junco [*Junco hyemalis*]). Although the relative abundance of species of birds associated with uncut sawtimber stands seemed unaffected by gap creation, questions remain regarding their reproductive success and territory sizes. A pilot study examining predation of artificial nests was conducted in 1992. Preliminary examination of the data indicated that nest predation rates seemed higher in the clearcut and two-story stands than in the gap-cut and control stands. Territory mapping of brown creepers and white-throated sparrows was conducted in 1993, but data analyses are incomplete.

The relative abundance of mammals was highly variable from year to year, but general trends indicate that the abundance of deer mice (*Peromyscus maniculatus*) and creeping voles (*Microtus oregoni*) increased with volume removal and the relative abundance of Trowbridge's shrews (*Sorex trowbridgii*) decreased with volume removal. We hope to begin efforts to trap northern flying squirrels (*Glaucomys volans*) and dusky-footed woodrats (*Neotoma fuscipes*) (prey for the northern spotted owl, [*Strix occidentalis caurina*]) in these stands in 1994-95.

The longevity, decay, and use of about 1,000 snags retained or created in these stands is being monitored annually. It is too early to assess the use of created snags in these stands, but residual snags have been used by nine species of primary and secondary cavity-nesting birds.

Aesthetics, recreation, and adjacent landowner responses—One replicate of the study was selected in an area receiving a high level of recreational use, that also was near suburban communities. A second replicate was used heavily by hikers. Thus, three types of human responses to treatments were assessed. In one study, 95 individuals toured one stand of each treatment as well as a nearby traditional clearcut and a recently thinned stand (Brunson and Shelby 1992). Over 75 percent of the visitors ranked the gap stands as acceptable for viewing and hiking, and over 50 percent ranked the two-story stands and snag-retention clearcut as acceptable for viewing (fig. 2). Respondents identified values such as “natural,” “colorful,” and “quiet” as important for high scenic quality.

In a second study, the number of recreationists, their activities, and their perceptions of their surroundings were assessed through onsite and mailed questionnaires. Recreationists were surveyed in the year before the harvests to assess recreational travel patterns, attitudes, and preferences. Motorized vehicles are not allowed in the area, so all recreationists were on foot, horseback, or bikes. They were stopped as they were leaving the forest and asked to mark their travel route on a map. They also were asked to identify positive or negative aspects of their visit. Names and addresses were recorded and a more detailed mailback survey was used to gather information on attitudes and preferences for forested landscapes. The same procedure (onsite followed by a mailback survey) was repeated one summer later, after the harvests were completed in the area. Differences between the two years are now being analyzed.

In the third study, 41 homeowners adjacent to McDonald-Dunn forest were interviewed to assess their perceptions of the effects of different silvicultural systems on aesthetics in a general setting and in their own backyards. Research questions were, (1) Do scenic quality ratings differ among silvicultural treatments? (2) Are residents willing to pay for scenic easements that would compensate forest landowners for timber value foregone? and (3) Are any of the silvicultural practices acceptable by affected neighbors? Photos of four types of treatments (clearcut, two-story, gap, and thinning) were shown to the sample of homeowners. Respondents were asked to rate the scenes on a nine-point Likert-type scale. The four stand types were then superimposed onto a picture of the respondents’ backyards using “image capture technology” (ICT), which “captures” a slide into a computer file, and then other “captured” images can be combined with that file. The process can “cut and paste” different images together by using the computer images. Respondents next were shown the computer-generated scenes of their backyards with each of the four stand types in the background. They were asked again to rate the scenes on a nine-point scale. Finally, they were asked if they would be willing to pay the neighboring forest owner to refrain from “clearcutting” their “backyard” scene (that is, purchase a scenic easement). The payment depended on the intensity of timber removal compared to clearcutting: no cutting (most expensive), thinning, gap, or two-story (least expensive).

Thinning was most preferred, clearcuts were least preferred, and gap and two-story stands were of intermediate preference in both settings (original photo of the practice and the ICT photos of backyard scenes). In the same type of harvest, the ratings of backyard settings were lower than in unspecified settings. Only thinning was acceptable to $>$ 50 percent of the respondents in backyard settings. A majority of the landowners were willing to pay for scenic protection measures that would restrict timber harvest options on the adjacent forest property.

Tree genetics, forest insects, and forest floor vegetation—Since the experiment began, several additional studies have been added. One will assess the genetic variability

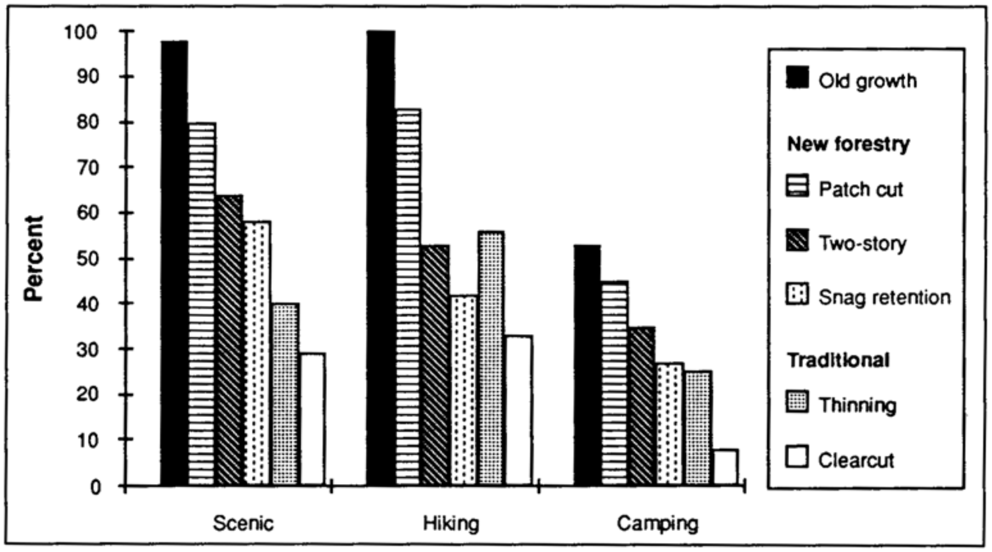

Figure 2—Comparison of acceptability of five silvicultural treatments and an old-growth stand for viewing, hiking, and camping (from Brunson and Shelby 1992).

among residual green trees and regeneration in each stand condition following treatment (project led by W. T. Adams, S. Martinson, and S. Aitken). Another will examine the role of volatile chemicals in attracting Ambrosia beetles to fallen logs (project led by R. Kelsey). Finally, another will document the responses of forest floor shrubs and forbs to clearcut, two-story and gap-cut treatments (project led by J. Zasada). The sites have been used for two senior projects for students in the Oregon State University (OSU), Department of Fisheries and Wildlife, have served as field laboratories for at least three forestry classes, and have been visited by > 1,500 professionals during field trips in connection with OSU Continuing Education activities.

Achieving the desired future condition—An inherent limitation in the results obtained thus far is the short period of time that has elapsed since treatment. The greatest change in human and other vertebrate use of the sites will probably be realized during the first few years after treatment. As stands grow and begin to more closely resemble the desired future condition, we hypothesize that differences among treatments will decrease. We used a composite of inventory points from unmanaged > 200-year-old stands in McDonald-Dunn forest as the basis for developing a diameter distribution that describes a desired future condition (fig. 3). We chose these types of stands because they were rated highest by people for viewing and recreation and because they contained many of the species identified by Ruggiero and others (1991) as associated with old-growth forests. Currently, our managed stands increase in similarity with the desired future condition (McComb and others 1993) from clearcuts (89 percent) to two-story stands (90 percent) to gap stands (92 percent). A version of the growth and yield model ORGANON was recently developed based on forest inventory data from McDonald-Dunn forest. We used ORGANON to predict development of these stands (figs. 4 and 5).

Alternative Silvicultural Practices in Plantations

Perhaps a pertinent question in much of the region is how one might manage existing Douglas-fir plantations, initially established with timber objectives in mind, to have them develop an old-growth-like desired future condition. We are starting a fully replicated experiment in cooperation with managers of three Districts in the Willamette National Forest in which we will compare harvesting logistics and costs, residual tree and regeneration

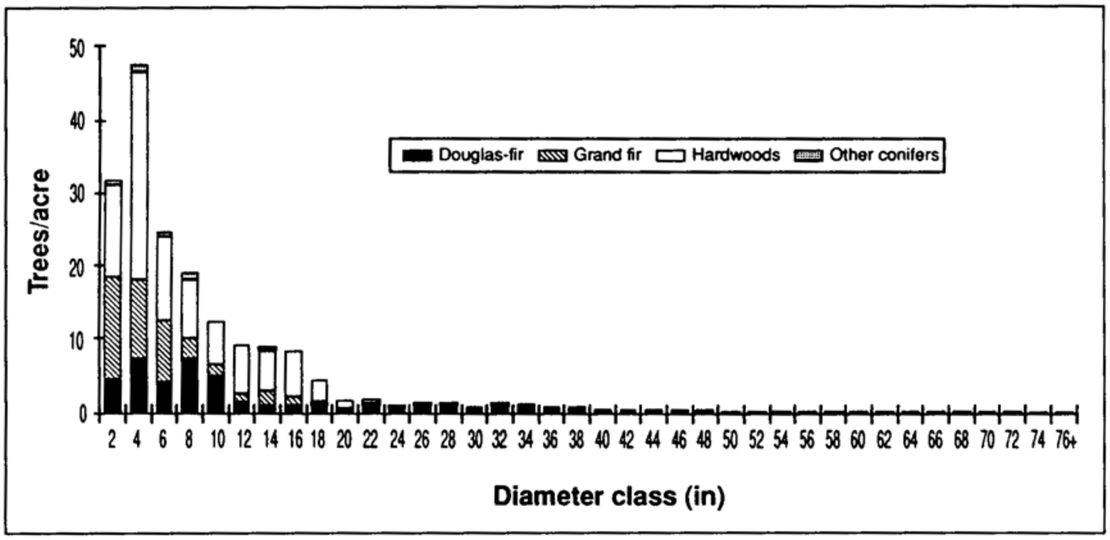

Figure 3—Diameter distributions of stands > 200 years old in McDonald-Dunn forest, Oregon Coast Range.

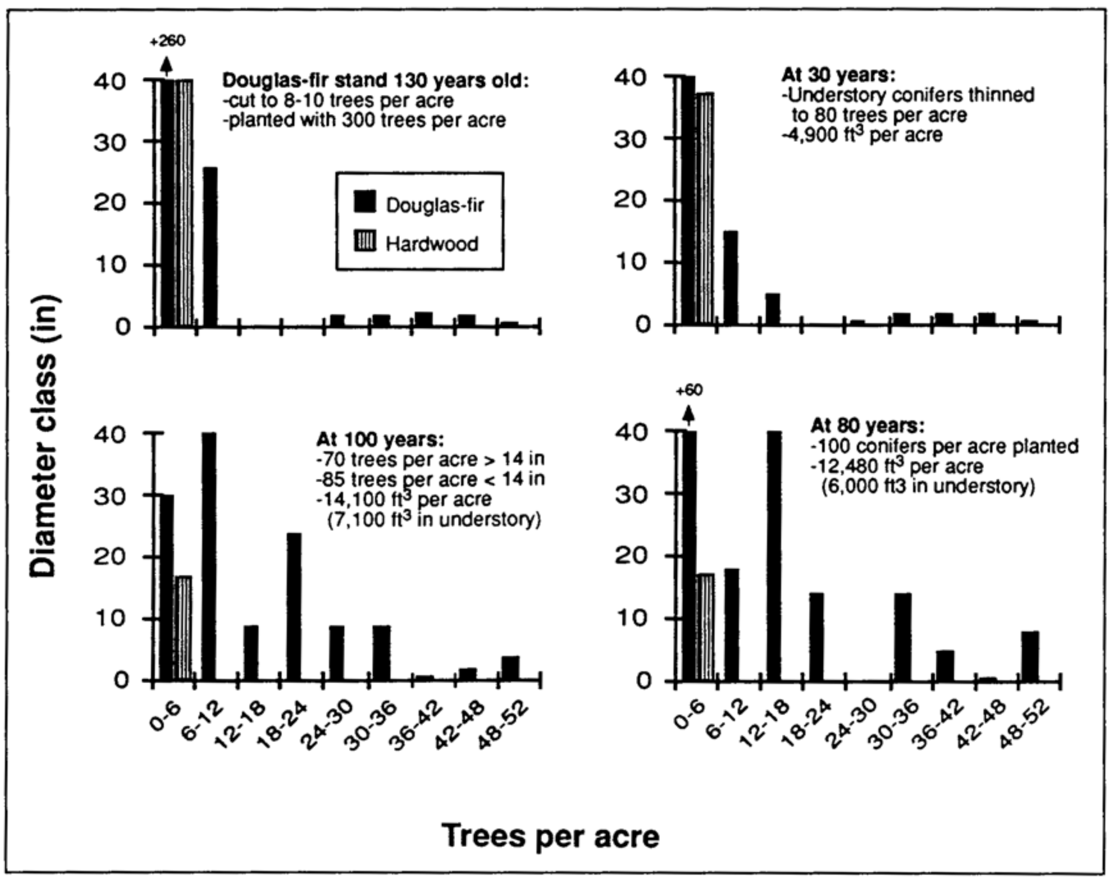

Figure 4—Predicted growth and development of two-story stands using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

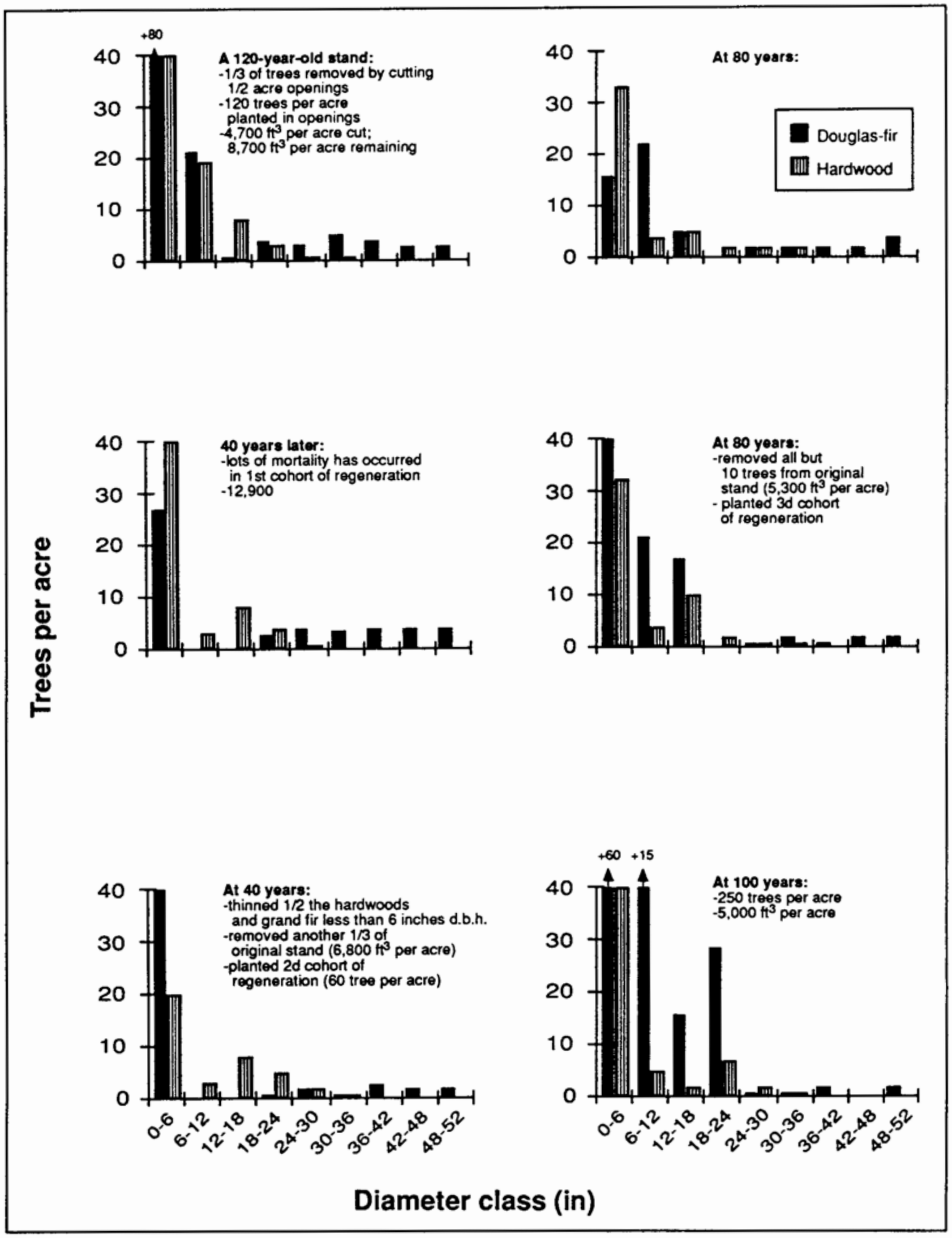

Figure 5—Predicted growth and development of gap stands using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

responses, small vertebrate responses among three management treatments and a control. Stands are 30 to 50 years old and located in low to mid elevations of the Oregon Cascades. All sites were clearcut before stand establishment, hence there are no large residual trees in these stands and few remnant snags > 20 inches d.b.h. > 50 cm).Stands are > 80 acres (32 ha) and contain 169 to 334 trees per acre (417 to 825 trees/ha) with average tree d.b.h. of 10 to 12 inches (25 to 30 cm).

The experimental design contains an uncut control and three treatments, each replicated four times: light thinning (typical of commercial thinning for timber production), heavy thinning and underplanting (development of a two-story stand), and light thinning with gap cut (light thinning interspersed with 0.5-acre [0.2-ha] gaps scattered through 20 percent of the stand. The latter two treatments will be imposed to begin development of large conifers, hardwoods, snags, and logs and a multilayered vertical structure. All three thinning treatments will include retention of snags > 12 inches (30 cm) d.b.h., creation of one snag > 14 inches d.b.h. (36 cm) per acre and creation of a clump of four snags > 14 inches (36 cm) d.b.h. per 10 acres (10 per 25 ha). Slash will be retained on all sites. The heavy thinning treatment will consist of thinning to about a 30-foot (10-m) spacing leaving the largest and fastest growing trees, including hardwoods. The stands will be underplanted with Douglas-fir, western hemlock, and western redcedar (*Thuja plicata* Donn ex D. Don). These same species will be planted in the gaps created in the gap cut stands. No underplanting will be conducted in the light thinning (residual of 120 trees per acre [296 trees/ha]). Silviculturists at the three Districts are developing detailed prescriptions for each stand (in coordination with the researchers), marking stands, underplanting, undertaking subsequent vegetation management, and reinventorying stand exam plots.

Harvesting approaches—The study is designed to include conventional ground-based harvesting, cable harvesting, and mechanized harvester and forwarder harvesting in stands in each treatment. Costs and logistics associated with unit layout, felling, yarding, and site preparation will be assessed. Timber staff officers from each District will work with research personnel to collect data and coordinate activities.

Vegetation responses—The survival and growth of planted and naturally regenerated seedlings in the gaps and under the residuals in the heavily thinned stands will be monitored. Survival and growth of overstory trees will be monitored by researchers in the treated stands and by silviculturists in the control areas (using stand inventory data).

Wildlife responses—Breeding birds, small mammals, and amphibians will be monitored for 2 years before treatment and at 5-year intervals (for 2 years during each interval) after treatment. Monitoring is currently being coordinated between Forest Service biologists and university researchers, with a Forest Service research coordinator leading the effort.

Four VCPs were established to monitor birds in each stand. Plots are > 330 feet (100 m) apart and > 330 feet (100 m) from a stand edge. All birds seen or heard (except repeat observations) are recorded. Small mammals are being monitored by using a 10 by 10 trapping grid (50-foot intervals [15-m]) in each stand with one Sherman live trap at each point. Amphibians are sampled in a 5 by 5 grid of pitfall traps located > 330 feet (100 m) from the live trap grid. All trapped animals are identified, marked, and released during one 8-day trapping session each fall. All four treatments per replication are sampled simultaneously. Replicates are sampled sequentially.

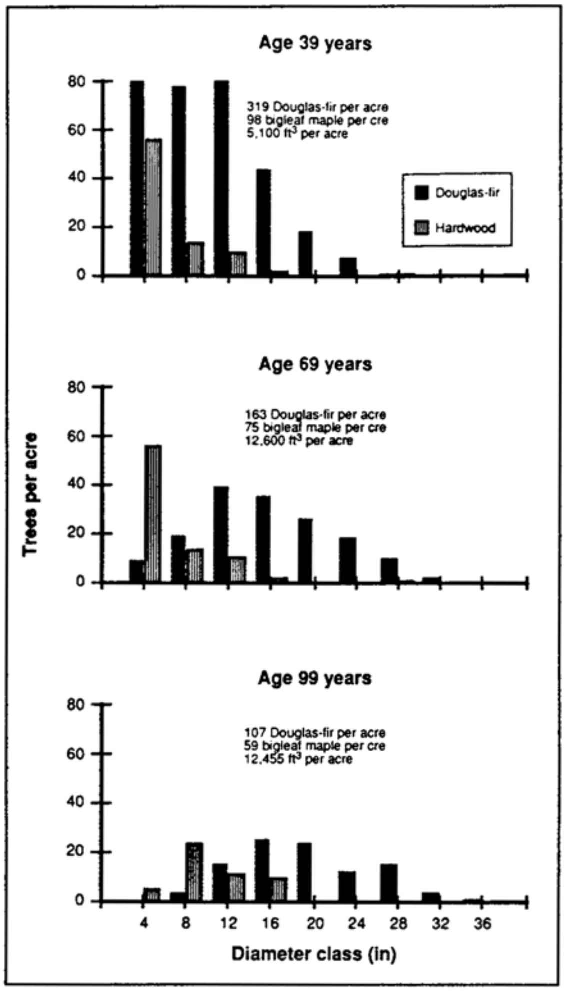

Figure 6—Predicted growth and development of a 39-year-old plantation using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

Achieving the desired future condition—We will choose an old-growth stand sampled in the central Oregon Cascades during the Old-Growth Habitat Relationships program (Ruggiero and others 1991) as the desired future condition for these stands. We will use ORGANON to grow these stands and predict when they should begin to function as the desired future condition. Currently the stands similar to these on McDonald-Dunn forest represent a consistently low level of similarity with old-growth stands on McDonald-Dunn forest (42 percent). We expect the level of similarity to decline initially after treatment but then recover to approach the desired future condition most rapidly in the heavy thinning and the gap stands. Similarity between unmanaged plantations and old-growth stands may remain low well into the future (fig. 6). Because the treatments will be implemented during 1994-95, there are no results. Monitoring of harvesting, vegetation responses, and wildlife responses will continue to be accomplished in a coordinated manner between the Forest Service managers and the university researchers.

Table 1—Comparison of costs and benefits of 4 stand management alternatives based on preliminary information from McDonald-Dunn forest

Value	Treatment[a]			
	Clearcut	Two-story	Gap	Uncut
Economic:				
Harvesting	-	- - -	- -	0
Timber production	+ + +	+ +	+	-
Site preparation	-	- -	- -	0
Regeneration	-	-	- -	0
Vegetation management	-	- -	- -	0
Ecological and human:				
Aesthetics	- -	-	+	+ +
Hiking	- -	-	+	+ +
Brown creeper	- - -	- -	-	+
Pacific slope flycatcher	- - -	- - -	+	+ +
White-crowned sparrow	+ +	+	-	-
Creeping vole	+ + +	+ +	+	-
Trowbridge's shrew	- - -	- -	-	+

[a] + = benefit, - = cost, 0 = no effect; actual values will be provided at the completion of the work.

Conclusion

There are new scales (both time and space) of interest and new knowledge about the function and dynamics of Douglas-fir and western hemlock forests that need to be considered in the design of new stand management approaches. We describe two experimental attempts at managing stands that collectively may produce a variety of values over time. The current and future challenge to researchers and managers involved with these project will be the synthesis of the information to assess tradeoffs. In a very simple approach, consider the information in table 1. By accounting for the economic costs and benefits in one part of the table and for noneconomic values in another part, the economic costs associated with production of these values can be examined. Unfortunately, such an approach is always an underestimate of the noneconomic values produced or foregone, because we can only measure a subset of those values (for example, we did not measure invertebrate or nonwoody plant diversity). Despite this drawback, it is a tool for decisionmakers to use when deciding what stand management strategy to employ within a landscape having certain objectives. As additional information is gained on the changes in value production in these stands over time, dynamic modeling of landscapes may allow prediction of the ability of landscapes to produce a sustained set of values (both economic and ecological).

Society is demanding more from resource managers than harvesting wood and replanting seedlings. Forest managers should respond to these demands by working with researchers to design stands and landscapes that meet goals for multiple resources and then test their effectiveness, or they risk losing control over management of forest resources. We have provided two examples where forest managers are working with researchers to meet that challenge.

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Citizen Participation in Natural Resource Management

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Abstract

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People in several areas of the United States and Canada are experimenting with collaborative negotiation and shared decisionmaking concepts to bring interest groups together to reduce and sometimes eliminate resource-use conflicts. The two examples presented here are the Kispiox Resource Management Planning process in British Columbia and the Tonasket Citizen's Council in Washington State. Citizen participation in natural resource management for these two cases is examined from the perspectives of both the resource manager and the individual citizen. Neither process was perfect, but improved communication and understanding between citizens and managers was accomplished and acceptable products were realized.

Keywords: Public participation, resource conflicts, management planning.

Introduction

Managers of public lands historically have been the decisionmakers and experts in natural resource management. Early attempts to involve the public in resource planning consisted of meetings to tell the public what was being planned (Magill 1991). Even now when public comments and ideas are sought, the input often is dismissed or poorly integrated into plans. It is difficult to keep up with what the public wants, and there is a need for more public information and education. Public land management decisions were and often still are made too far from the local community, which results in a feeling of a lack of control over management by the citizens.

Until the mid-1980s, it was difficult to get citizens not affiliated with major environmental groups involved in land management decisions. In the last few years, increasing numbers of citizens, from various interest bases, have demanded an active role in resource planning and decision making. Letter campaigns, lawsuits, appeals, demonstrations, and

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ecological sabotage reflect a growing sense of conflict and frustration by the users of public lands. What once seemed to be an endless resource base where all demands could be met, now appears to be a limited land base where user and interest groups fight over the allocation of resources Whitelaw and Niemi 1990).

Many small communities in the western United States and Canada historically have been dependent on natural resources for their existence.[1] In recent times, reduction in resource outputs has created economic hardships for resource-dependent communities. Growing numbers of urban citizens are now interested in public lands as well, but not necessarily for the commodities and products they produce Whitelaw and Niemi 1990). They appear to be interested in recreation, scenery, solitude, and an assurance that there is an unaltered and unpolluted place in the world. Land managers often are caught in the middle in a battle between interest groups that have been polarized and entrenched in their positions Whitelaw and Niemi 1990). The following examples of collaborative negotiation reflect the changing ways in which resource-use conflicts can be resolved. Each example is described from the perspective of a resource manager and a citizen who were active in the process.

The Kispiox Resource Management Planning Process, British Columbia

Manager's Perspective: Mike Geisler

Forest management is changing not only in the field but also around the planning table and in the decisionmaking process. The public is becoming more involved in all phases of forest management. This change is happening neither easily nor without some frustration. These are not happy times. Let me describe how we have coped with this change in the Kispiox Timber Supply Area (TSA).[2] I believe the process became quite bearable and reasonably satisfying to many involved.

The resources—The Kispiox TSA is about 1.2 million hectares (3 million acres). About 25 percent is operable, in terms of timber production. From the perspective of the fishery resource, it has several Provincially significant rivers; the Kispiox, Babine, Kitwanga, Suskwa, and Skeena. There is a substantial amount of high-value wildlife habitat (notably grizzly bear [*Ursus horribilis*]). In the rugged mountains, the potential for mining is high. The tourism industry is growing through a broadening awareness of the wilderness and native cultural values in the TSA.

The community—This forest area contains many small communities. The largest is New Hazelton, with a population of about 800. The total population of this region is about 6,000 and is split culturally—about 50 percent aboriginal and 50 percent nonaboriginal. The major employers in this TSA are related to government, timber harvesting, and timber processing.

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[1] Leomard, George. November 17, 1987. The role of the Forest Service in promoting community stability. Speech delivered to Conference on Community Stability in Forest-Based Economics. Portland, OR. On file with: E. Zieroth, Tonasket Ranger District, P.O. Box 466, Tonasket, Wa 98855.

[2] Forest land management planning as a land use consensus building process. September 4, 1992. Unpublished report. On file with: M. Geisler, Ministry of Forests, Nelson Regional Office, 518 Lake Street, Nelson, BC V1L 4C6.

The issues—The dominant forest management issues within the Kispiox TSA revolve around:

1. Aboriginal ownership and jurisdiction.
2. Rate, amount, and method of harvest and how these affect the environment, other forest resources, and the economy.
3. Land ethics or the relation of people to the environment.

The process—Three years ago, I was given the job of working with other agencies and local stakeholders to develop a new forest management plan specifically addressing the issue of rate, amount, and methods of harvest. My challenge was to ensure the timely development of a broadly acceptable plan and, if possible, to build British Columbia Forest Service credibility. To meet this challenge, the planning team established to facilitate this process applied the following strategy: before making decisions, ensure that all participants have viewed the issues from each others' perspective, and after this was accomplished help concerned citizens (stakeholders and government agencies) write a forest management option that they could recommend to Provincial authorities. I felt as many others did, that if the first part of this strategy could be accomplished successfully, the second part would be much easier. The planning team therefore spent substantial time and energy collecting and summarizing data, documenting discussions, distributing information to all interested parties, arranging convenient meetings, providing updates and generally being available to all the interest groups. This strategy is close to being fulfilled through the successful completion of three major steps.

Step one included going out, gathering, and documenting the values, interests, and objectives of all interest groups as they relate to both the planning process and the desired management practices. Members of the planning team requested to be placed on the agendas of meetings called by the individual groups (for example a regular monthly meeting of the Farmer's Institute), to explain what was about to happen in the planning process and to solicit their views. This was done before there was a draft plan, before there was an option to review, and even before there was a formal "Terms of Reference." Essentially we started with a blank map and a blank page. This allowed both the process and the products to be developed and revised as a result of public participation.

A major drawback at this point, and throughout the process so far, was the lack of participation by one major interest group-the natives. The process attempted to build in native participation through contacts with individual Chiefs, House groups, as well as Tribal Councils, Bands, and the Federal Department of Indian Affairs. Some progress was made, but the products still lack native contribution.

Step two involved holding a workshop in which the community participants, representing the full range of interests, developed their own set of management options. Before this workshop occurred, a design for the workshop process was proposed and revised by a subgroup of the participants to ensure its acceptability. This first workshop had to produce a range of options to analyze. To facilitate this, the participants were split into four groups, consisting of three advocates (for the option), three sounding boards (favouring another option but willing to help the advocates work on theirs), a recorder, and a facilitator. The recorder and facilitator were previously uninvolved people, therefore more likely to be neutral. In this way, most of the participants were placed in particular groups. The others were free to choose the group they wanted to be in. One of the advocates, the principle, had "power of the pen." This meant the person was responsible for drafting the option produced by the group during the workshop. The recorder kept a written account of the discussion, and the facilitator kept the discussion in line with the workshop objectives.

The key objective of this workshop was to arrive at a few options that would describe or contain the range of interests and values of this community. These were analyzed for their impact on all the forest resources and the local communities. This step was an exploring stage: at this point, no individual or agency had to compromise their interests or objectives. It was a nonthreatening situation, and potential conflict and distrust therefore was reduced. Understanding and respect for each other's values and interests was promoted. Information from this exercise was fed into step three.

Step three sought to gather the participants together again in a workshop, but with altogether different objectives, to develop a preferred option. To facilitate this, the participants were divided into three groups. Each was assigned a portion of the Kispiox TSA for which to negotiate a single option based on the four previous options. The groups were balanced; that is, a full range of personalities, skills, and interests was represented, and each had a recorder and facilitator who managed the consensus-building process.

In both workshops, the role for agency personnel-biologists foresters, and managers—was one of technical advisor and not one of author or censor. This was done to allow the development of a "pure" community consensus, to ensure that the participants understood each agency's objectives and constraints, and to provide the technical implications or the suitability of suggested management prescriptions.

Following each workshop, there was a debriefing session. Results and future processes and products were reviewed and discussed with a subgroup of the participants.

Results—We now have what we called, for lack of a better term, a "consensus option"[3] (not a true consensus because of little native involvement and some unresolved but relatively small issues). The next steps in the process involve approval of the consensus option, the selection of target products (particularly an annual allowable cut), and the writing of the formal forest land management plan. These steps also will have involvement from the public or citizen participants.

Overall, the Kispiox planning process has and still is providing for significant, constructive involvement of citizens seeking greater control and participation in the management of natural resources.

Citizen's Perspective: Paul Glover

In this portion of the paper, comments, advice, and recommendations about public participation in land management decisions will be discussed. Public participation in resource decisions is emerging as an important and common theme and is the direction that resource planning should be heading. From the public's point of view, collaborative participation has a rather poor record. When new attempts are made at public involvement in resource decisions, the public can be critical.

[3] Resource management consensus report for the Kispiox timber supply area: an integrated resource management strategy. Edition 1, November 1991. Unpublished report. On file with: M. Geisler, Ministry of Forests, Nelson Regional Office, 518 Lake Street, Nelson, BC V1L 4C6.

In northwest British Columbia, several exercises in public participation were undertaken in the past 10 to 15 years. Following these exercises, participants generally felt that their input and recommendations were ignored and that the considerable time and energy they put into the process had been wasted. But the lesson had been learned that these processes were mainly a means of channeling opposing energy into a meaningless and fruitless exercise. Many said they would nat be fooled again.

In recent years, my own experiences have been more positive. These include a committee established to study vegetation management and recommend a vegetation management plan for the Kispiox Forest District, and another committee established to develop a cooperative noxious weed control strategy for all of northwestern British Columbia. But still there is mistrust that must be overcome. Credibility and trust must be established and reinforced throughout the process. To help achieve this goal, I offer several recommendations. Firstly, participants must be shown what is different about this process compared to past attempts. Secondly, suggestions and advice from participants must be used throughout the process to show that their input will make a difference and that it is, in fact, their process. Thirdly, public participation and input must be actively sought. The public should be met with on their ground and at their convenience. Finally, a public participation process must not be a public relations exercise. it must be real, and participants must be willing to act on the recommendations and guidance received.

The Kispiox process was constantly plagued by the question of credibility. How could the process be credible when the final decision ultimately rested in the hands of British Columbia's Chief Forester, far away in Victoria? The best answer we could get was that if we could not reach some sort of consensus, then the decision would be shipped to Victoria anyway. Our best chances lay in reaching some sort of general agreement that would carry a strong message from the whole community, or at least a large portion of it, and better guarantee adoption of the plan.

It is very important that a process like this be flexible. The structure of the process must allow change and evolution as it proceeds. From the start, it must be made clear to all participants that the process is flexible. People are not used to flexibility when dealing with governments or government agencies. It was to my surprise that I learned that I could affect the structure and course of the Kispiox planning process. But it took more than just complaining, as there was much complaining coming from all directions. Helping to shape the process took initiative, some perseverance, and the energy to work constructively to bring about the suggested changes.

The process should be periodically reviewed, criticized, and changed as desired by a selection of its participants, in conjunction with process planners. Meeting over lunch worked well. Planners should not be defensive when they receive criticism. It should be accepted and looked at seriously. This will help with credibility as well as showing value neutrality. Participants must be honest and critical but also accept that no process will be perfect.

Who should participate?—I believe that input and participation should be sought from all sources, groups, and interests. Questions of geographic area representation and relative importance of groups or interests also must be addressed.

In the Kispiox process, some industry representatives complained that a bicycle club should not have a say in decisions relating to forest land planning. As well, participation by people living outside the district boundaries was questioned. Would these groups not be affected by water flow, weather patterns, and the economics resulting from changes to or maintenance of current resource use and development? these can be challenging questions, but they must be looked at. Obviously no forest, landscape, or community exists in isolation from the rest of the world.

Participation by women at all levels of the process should be sought. Different perspectives and different ways of thinking will be gained and there will be a fuller and stronger idea bank to draw from. This point is strongly emphasized in the recommendations made by the participants at the United Nation's Conference of Resources and Development held in Brazil in 1992.

Participation by native peoples is also very important to seek out. In the Kispiox process, this was not possible at the time. The native community refused to participate for various reasons. Specifically, they felt that their involvement could prejudice the outcome of their land title court action.

Background information for participants—In the Kispiox planning process, a resource library was created but little used. Bringing speakers in to address management issues and impacts would be a better way to convey information and ideas and stimulate discussion. Such speakers should be chosen, however, by a subgroup of participants and planners to ensure a balance of perspectives.

A lack of inventory information was a recurring complaint from participants of all sides. This points to the need for involvement of community members from all levels, for it is here that some of the missing inventory information can be found. Timber, recreation, water, wildlife, trail locations, wild plants, cultural sites, and more can be identified through local knowledge. As well, there exits the potential to accomplish the necessary integration of this information.

Language—Agencies must be prepared to exchange their usual working vocabulary for language that is understandable and meaningful to the public. The public will learn concepts and terminology through its involvement in the process. All sides can work towards developing a common language.

Language can have a subtle but important influence on proceedings and the outcome of a process. Language and wording in all writing submitted during the process must be carefully monitored. One person (preferably, several people) who uses language well should scrutinize and criticize everything written. It also would be good to use sounding boards with different perspectives to challenge subconscious paradigms that come through language. For example, the three options originally formulated by the B.C. Forest Service in the Kispiox TSA were titled, "timber," "nontimber," and 'integrated." It was pointed out that these titles suggest values and could prejudice peoples' preferences even before they learned about the contents of the options. The preliminary options then were relabeled "A," "B," "C," and so on.

The term "interest group" should be avoided, unless it is applied to all parties involved, including industry, governments, and agencies.

Time frame—The Kispiox resource management planning process started in 1990 and is not over yet. This is a long time, but I have come to see that there are certain advantages to a long, slow process. Participants have more opportunity to learn, change, modify, their positions, and develop a fuller understanding of the whole picture during a long process. Also, over a long period, less serious or committed participants will drop out, there by leaving a group that while smaller, is more dedicated and patient and therefore likely to work harder to reach agreement.

On the other hand, there is, understandably, some realistic pressure to get results before the resources in question have been eroded, degraded, or eliminated through continued status quo practices.

Options—A process like this often will create several options or strategies to consider. The public should be included in the process of designing preliminary options. This was something that was missing from the Kispiox process, and it drew some criticism. These options also should represent a wide spectrum of possibilities. When the planning team came back to our community association with their three preliminary options, we pointed out that the options were clustered too closely in one corner of the spectrum. A fourth option was then developed, which differed markedly from the others in amount of wood cut, forestry practices, protection of other values, preservation of wild lands, managing for old growth and biodiversity, economic and marketing strategies, and overall philosophy. Although it was never anticipated that this option would be chosen over the others, many people were attracted to parts of it, and aspects of it were included in the final option, which was submitted to British Columbia’s Chief Forester.

Reaching consensus—A cooperative planning process like this must be creative from start to finish. Solutions often are not obvious. Establishing common goals, both short and long term, is essential. When this has been done, everyone is standing in the same place and facing more or less the same direction, rather than being on opposite sides. Draw up ideas to achieve these goals. Daring to be idealistic, bold, and innovative can actually help to bring about consensus. On the other hand, you may approach consensus without formulating an array of options.

Set disagreements aside for the time being; move along to other points. Some of the outstanding issues will fall into place on their own, and others will be easier to reach agreement on as the bigger picture gets filled in. After going through the Kispiox planning process, I strongly believe that a trained mediator would have helped the process a great deal, and I recommend that one be used in any similar undertakings.

Intensive sessions, such as day-long meetings or weekend workshops, can be very productive. These may not accomplish as much actual work as hoped, but during long and sometimes stressful meetings we may come to see each other more as people than as positions, especially as we meet in different groups, and get acquainted over meals. Then a flexibility can emerge that encourages creative solutions and consensus.

It was felt by many in the Kispiox process that some forest industry representatives were sometimes hard to budge from their positions. In other situations, it could as well be individuals representing any perspective that did not work well in the give and take required for a successful consensus-building process. In the Kispiox planning process, many People, including myself, felt that reaching consensus sometimes required disproportionate movement from nonindustry participants. A mediator would have been helpful in some of these instances, especially when critical or controversial points and issues were on the agenda.

Maps and photos—High quality, current maps should be available to participants at all times during meetings and discussions. Satellite photos are indispensable, perhaps even more important than maps. Many differences of opinion on “facts” can be resolved easily by referring to photos during discussions.

Role of scientists—How do these comments of public participation apply to those who are scientists and technicians? Scientists, such as biologists, should be involved as advisors and consultants throughout the planning process; that is, during discussions, when formulating and evaluating options, when monitoring and evaluating final products (plans), and as members of the public with personal opinions and positions.

In resource conflict situations, scientists and managers often feel caught in the middle. Therefore, it is also their role to help the process move along in an open and cooperative manner that encourages dialogue, meaningful exchange, and fair resolution.

Monitoring—Almost all decisions coming from this process call for increased monitoring, scrutiny, and enforcement by agencies concerned with wildlife and fisheries. All the representatives from these agencies who participated in the Kispiox process said many times that they were already too busy and that their budgets were actually decreasing. This situation presents a big challenge for the Kispiox Forest District. Implementing the plan so that it is actually put in place on the ground level, and enforced, may be difficult. It is therefore important that scientists join the public in seeking adequate personnel and funding to properly monitor and enforce the conditions of these agreements. The public can play a part in monitoring the implementation of the plan.

Thanking participants—I believe it is important to make some gesture of appreciation to everyone who donated their time and energy in participating in a process such as this. In the case of the Kispiox planning process, everyone who participated received a satellite photo of the area, which was both meaningful and relevant, and not prohibitively expensive for the Ministry of Forests. The participants should be kept informed on an ongoing basis as advisors to further developments and to evaluate the success of the plan.

Conclusion—At a time when the impact of our activities are threatening the very systems that support life on Earth, it is very important that we work together to find solutions. This working together is an important end in itself. The process, and the act of going through it, is itself a product, separate from management plans, reports, and whatever other tangible products come of it.

If we can learn to work together sincerely and cooperatively, the solutions may be easier to find than we expect. Successfully working together with our fellow humans in difficult times is probably more important than getting just what we want, even if we are “right” or really do know “what is best.” If your process can, through its sincerity, foster this kind of attitude among its participants, you stand a good chance of making real headway.

The Tonasket Citizen's Council, Washington State

Manager's Perspective: Elaine Zieroth

The year 1988 was marked with conflict for the Tonasket Ranger District of the Okanogan National Forest in Washington. A large overstory removal harvest brought public frustration over the timber program to a head. Earth First! demonstrations, petition campaigns, and letters to the newspapers proved that people were tired of being ignored and were frustrated with the planning process. Once each year, the District had been holding a meeting to explain the projects for that year. No scoping was being conducted on individual projects. After a flood of appeals on projects, the USDA Forest Service held a 3-day consensus-building workshop to hear the concerns of the public.[4] The workshop was seen as a solution to the problem but it was actually just a start.

In the months after the workshop, small groups organized to provide input to the Forest Service. As the Agency attempted to meet with the narrowly focused interest groups, more groups arose to protect their interests. It became obvious that there is no one public. The public that we interact with actually forms a spectrum of values, beliefs, and affiliations. When people meet in groups with others who share common beliefs, they find support for their thoughts and values and come to believe that most people think like they do. Natural resource agencies frequently are caught in a trap when working with one interest group at a time. An agency often defends or represents the interests and needs of the citizens not present and may be accused of siding with the absent groups. Meeting with one group may alienate other groups. More than one manager has been called a timber beast and an environmentalist in the same day.

I started my job as District Ranger at the Tonasket District in 1988, amidst all the conflict and turmoil. I had little direct involvement in consensus-building or conflict management and was not familiar with any successful models within the Forest Service. As the District Ranger, I was looked to by the public and the Agency to take the lead in the situation. The fact that both my parents are psychologists gave me an understanding of human behavior and group dynamics, which was very important. My role in the Tonasket Citizen's Council (see next paragraph) was to form the group, facilitate many of the meetings, and help guide the course when the process bogged down.

The only way that conflicting interests can be discussed and negotiations can begin is to bring the interest groups together. The agency becomes the facilitator or catalyst rather than the antagonist, which is a far more positive role. In November 1988, the Tonasket Citizen's Council was formed, consisting of 40 representatives from a wide range of interests and values in the local communities. The Forest Service contacted local environmental groups, ranchers, loggers, timber companies, outdoor enthusiasts, and other groups and individuals, and they as a group decided on representation to the meetings. Going into the process, the Forest Service goals were simple: improve communication and information exchange with the public, and help citizens work together to find cooperative solutions to conflicts. The group was not formed to give input to a specific plan or product. The group was envisioned as a long-term discussion group and sounding board to assist in management of all resources in the Ranger District. The Citizen's Council or committees of the council did provide detailed input for the Forest plan and other specific projects, but rather than meet for a few months and disband, the council continues to operate after more than 4 years. The council is an information-sharing group, not an advisory board.

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[4] Chadwick, Robert. March 10-12, 1987. Community involvement workshop on management of Mt. Bonaparte. Consensus Association. Boring, OR. Unpublished report. On file with: E. Zieroth, Tonasket Ranger District, P.O. Box 466, Tonasket, WA 98855.

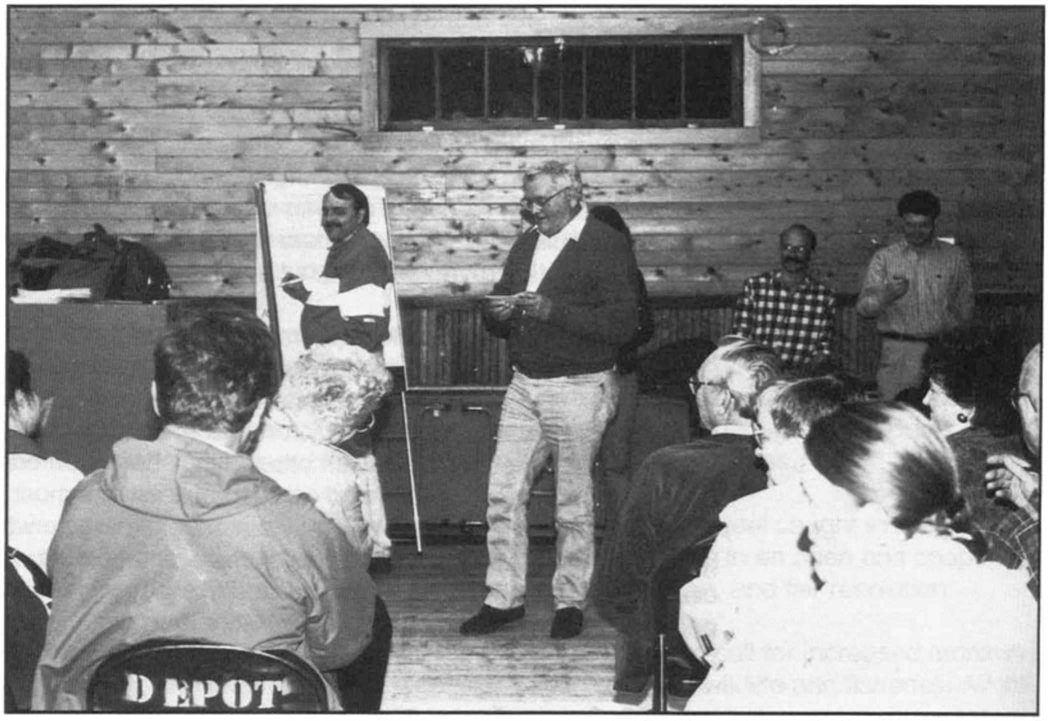

Figure 1—Public meeting. Meetings should be informal and comfortable but have established ground rules (photo courtesy of Omak-Okanogan County Chronicle).

The first few meetings were volatile and difficult, especially with several members on different sides of a lawsuit against the Agency timber sale program. In those first meetings, members were asked to share their visions and ideas for resource management, as well as their fears. The meetings helped to draw the members closer together, as people found common threads in the discussions and got to know the people behind the labels. The District Ranger and individuals from the District staff attended every meeting. People began to build relations with District personnel and got to know them as interested, concerned people. Forest Service employees also learned to listen ta people and became more comfortable with public involvement. Many citizens commented over time that their trust and confidence in the District employees and planning process increased significantly. An important element in the success of the council was the support and openness of upper level management to allow the process to develop and change over time.

The Forest Service shared in and facilitated the meetings, and one of the members was paid a small amount to keep notes and produce a newsletter (fig. 1). Ground rules, agreed on by the council, included no personal attacks, everyone allowed to speak, the council to suggest and vote on future meeting topics, and observers at meetings could ask questions but could not present topics unless the council agreed. Members of the council then acted as linking pins to the groups they represented and to friends and neighbors. In the small communities served by the Ranger District, information from the council meetings spread quickly, and a much larger group of people was informed and involved.

As the monthly meeting progressed, members and observers began to realize that there were many sides to the issues and that they must use their energies to work on common solutions rather than attacking the Agency. They understood that a collaborative solution is more likely to be accepted and lasting, and because the participants developed the product, they would take some responsibility for the outcome.

Many of the meetings focused on information exchange and natural resource topics. Meetings usually centered around the subjects of timber and silviculture, and members often facilitated or presided over the meetings. Some meetings were used to analyze specific projects or plans and provide indepth comments on a timber sale, range allotment, proposed trail, or other plans. With the wide range of interests in the group, consensus on each plan or project was not always achieved, but better understanding by the citizens and the Agency coupled with the social, economic, and aesthetic values provided by the group were valued products. Members of the group spent several weeks preparing a citizen's alternative to the Forest plan, complete with standards and guidelines and management areas allocated on maps. Many aspects of this alternative were added to the chosen alternative.

Many field trips have been conducted and have been especially valuable in bringing reality and common understanding to the issues. For one meeting, the timber industry members of the group chartered a bus to show the group some work they were proud of and explained what contractual requirements they had to meet. The Forest Service personnel were there as observers.

After the group met together for years, the members became well educated in resource issues and became good sounding boards for project proposals. District employees often attended the meetings and learned as much or more than the citizens. The District wrote better planning documents and went from 18 appeals and 2 lawsuits in 1988 to no appeals or lawsuits for 3 years. The positions of the council members gradually became less polarized as they began to understand the interests of other people and realized how difficult it is to make resource decisions. Miniplanning exercises were conducted at meetings, and council members attended project interdisciplinary-team meetings. These exercises improved understanding and also increased the trust and credibility of the agency. After 4 years, the group has seen members come and go and has lost some energy, but it still meets. The group recently went to every-other-month meetings with the alternate months available for any member to organize their own meeting. In recent meetings, topics included mining, a forest health tour, lynx (*Lynx canadensis*) habitat management, and a member's tour of a roadless area. As long as there is interest, the meetings will continue.

Additional techniques that have been successful in improving public education and involvement include holding town hall-type community meetings, distributing clipboards throughout the District where information is mailed and posted, sending out information packets on each project with preaddressed response forms, and holding weekend resource tours (fig. 2). The increase in citizen involvement is evidenced in the written responses from over 500 people for each of the two projects in 1992.

I learned a few lessons from my experience. Agencies need to train managers in consensus-building and conflict management skills. Due to the resource conflicts in the Pacific Northwest and other areas, more is being written on the subject of community involvement and conflict resolution (Chess and others 1990, Crowfoot and Wondolleck 1990, Fisher and Ury 1981, Lee and others 1991). The agencies need to recognize and publicize the success stories in community involvement to help give other managers the information and incentive they need to take the risks necessary to involve citizens in resource planning.

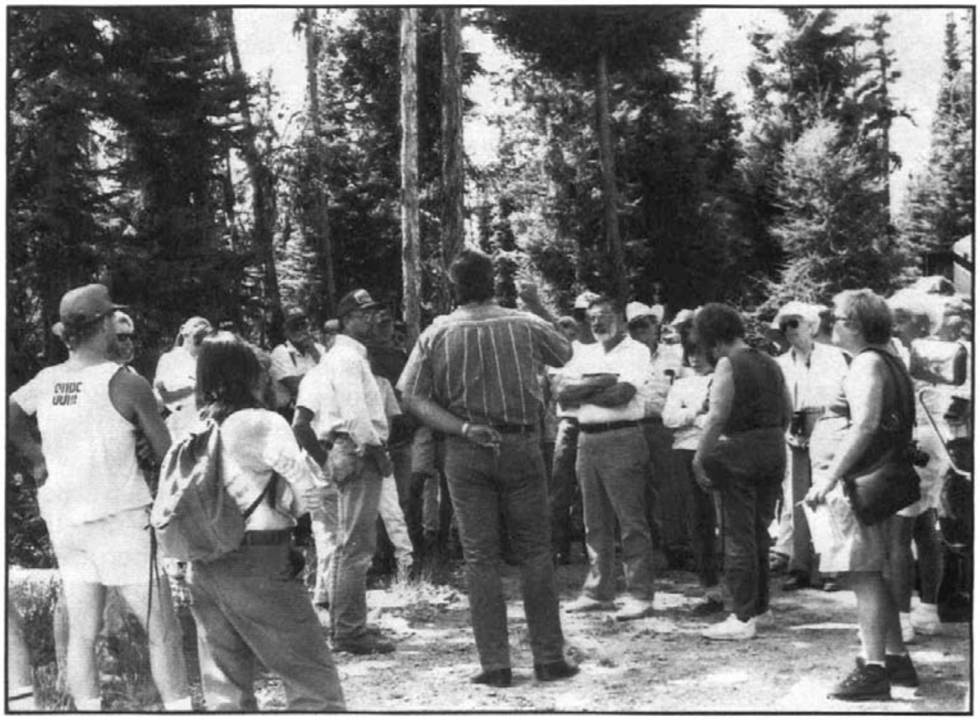

Figure 2—Tours are extremely valuable in gaining common understanding of the resources.

Citizen's Perspective: Geraldine Payton

I have been a citizen activist on forest issues in the Tonasket Citizen's Council for 5 years. As a staff person for a rural nonprofit environmental education center, I have made a commitment to the public involvement process as an essential aspect of our work.

The Columbia River Bioregional Educational Project grew out of a recognition that, as urban migrants to a pristine rural area, we needed to advocate our values and perspectives to the wider citizen community and to the agencies responsible for the maintenance of the character of the land.

We have experienced a range of Forest Service reactions to our demands for involvement from outright rejection of our ideas, to a gradual accommodation, and finally incorporation of these ideas into actual management plans. We have learned not to expect an immediate answer or action on behalf of our requests. A year may pass before we see our concerns integrated into Forest Service policy or action.

Overall, we credit the openness of the Forest Service for allowing and facilitating citizen involvement. We have been told that we are helping to "turn the big ship around," and we get the impression from higher level management that this is an inevitable course for the future of the forests.

We all believe that there are many within the Agency who are as concerned with conservation of native forests as we are. We see these professionals as our 'natural allies," and we highly value our working relations with them.

In times of crisis, we sometimes find ourselves acting as intermediaries between the Forest Service and newly initiated activists. We cannot prevent initial antagonisms; however, we can, by example and counseling, advise these people on the protocol of respect and cordiality. We also can explain the political realities and processes governing how our resource management officials are able to respond to our demands.

Accountability is built into our role of acting on behalf of a constituency. In the interactive setting of the rural community, peer pressure provides a check on excessive self-interest. Interactive conservation leadership is the challenge of facilitating growth at the frontiers of changing perspectives.

I do this work because I believe that ecology is the foundation of culture, and I serve the future not only by protecting native ecosystems but also by establishing good working relations with the people involved in natural resource management.

My personal belief is that the public involvement process, which has been created by the Forest Service to implement the National Environmental Policy Act (NEPA 1970), is the most dynamic forum for democracy in our country today, and it should serve as a model for citizen involvement at all levels and spheres of government.

Conclusion

Effective public involvement is often difficult, frustrating, and costly for all parties. It is, without a doubt, time consuming. Despite these drawbacks, time spent working together will pay off handsomely with increased trust, understanding, and credibility. Conflict and litigation can be reduced. Over time, the public and agencies are better educated and informed and all therefore can make better decisions integrating the social, economic, and environmental values of society. The key elements leading to success in the Kispiox and Tonasket experiments can be summarized in the following statements.

Early involvement by the public in the planning process is important. Clear ground rules must be set up at the start so that everyone is treated with respect and no misunderstanding occurs over roles or missions. Participants must know they are involved in and responsible for the process as well as the product.

Participation should be scheduled at the convenience of the public. Going to the public and meeting with them early on in the process was essential in these cases, as it allowed both the process and products to be revised as a result of public participation. In both examples, meetings were held at times convenient for the public participants.

Agencies remained value-neutral as providers of technical information for all interest and user groups. This takes the agencies out of the middle. In cases of critical or controversial points and issues, a skilled mediator, although not used in these examples, may be necessary to facilitate an agreement. Negotiations must be based on interests and values, not positions or labels. In Tonasket, ground rules were established so that every participant would be treated with respect, allowed to speak, and not be identified with a label.

Continued involvement in citizen’s groups, after the initial task, helped to maintain relations and monitor implementation or adjustments to the project. Citizen groups also can become permanent discussion groups and sounding boards. The continued involvement in Tonasket significantly reduced appeals and lawsuits.

Public involvement and consensus building help to keep planning and decisionmaking power at the local level rather than exporting decisions.

Language must be accessible and meaningful to all participants. Communication must be simple, open, and honest. Jargon and technical language impede communication and cause suspicion.

Public land management agencies must learn to adapt to changes demanded by society or society will see that the changes are made politically. It is critical that we listen and learn from our citizens while involving and educating them. The forest is not just a biological organism, it also has social and economic values.

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New approaches and technologies to evaluate wildlife-habitat relations, implement integrated forest management, and improve public participation in the process are needed to implement ecosystem management. Presented here are five papers that examine ecosystem management concepts at international, national, regional, and local scales. Two general management problems were addressed: how to incorporate different components of ecosystem management into specific forestry and wildlife management practices, and how to resolve conflicts and involve citizens more effectively in the management process. These papers are examples of new concepts and procedures being tested for use in managing resources by using an integrated ecosystem basis.

Keywords: Biodiversity, conservation planning, forest plantations, forest structure, land management planning, landscape, Pacific Northwest, British Columbia, protected areas, public participation, regional planning, resource conflicts, silvicultural treatments, sustainable forest development.

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