Biodiversity Planning and Forest Management at the Landscape Scale

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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.

[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.

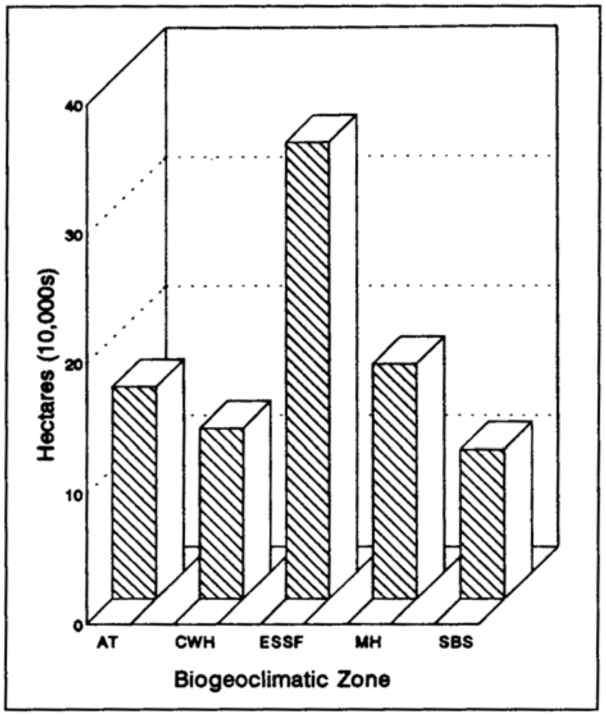

Figure 1—Biogeoclimatic units of the 80 000-hectare (200,000-acre) Copper River landscape, Bulkley Timber Supply Area, west-central British Columbia. AT=Alpine Tundra; CWH=Coastal Western Hemlock; ESSF=Engelmann Spruce-Subalpine Fir; MH=Mountain Hemlock; SBS=Sub-Boreal Spruce (Meidinger and Pojar 1991).

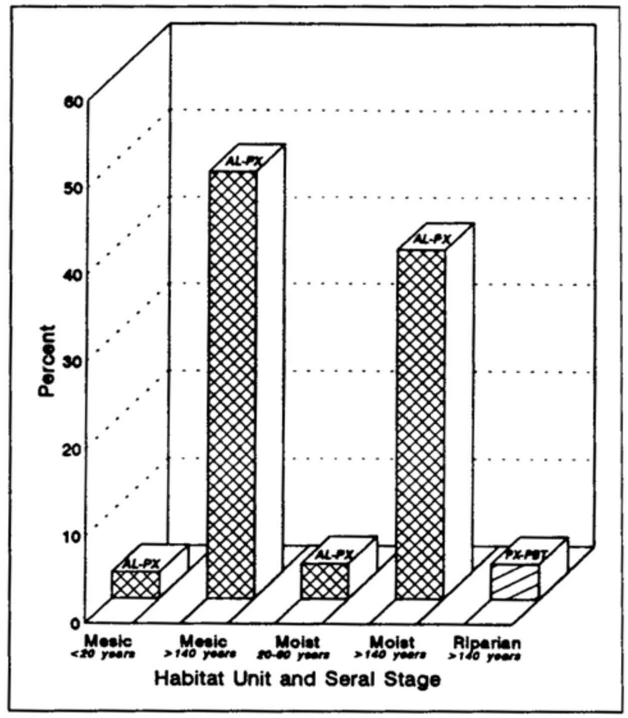

Figure 2—Generalized habitat units and seral stages in the Sub-Boreal Spruce Zone, Copper River landscape. AL=*Abies lasiocarpa*; PX=*Picea glauca x engelmannli*; *PBT=Populus balsamifera ssp. trichocarpa*.

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).

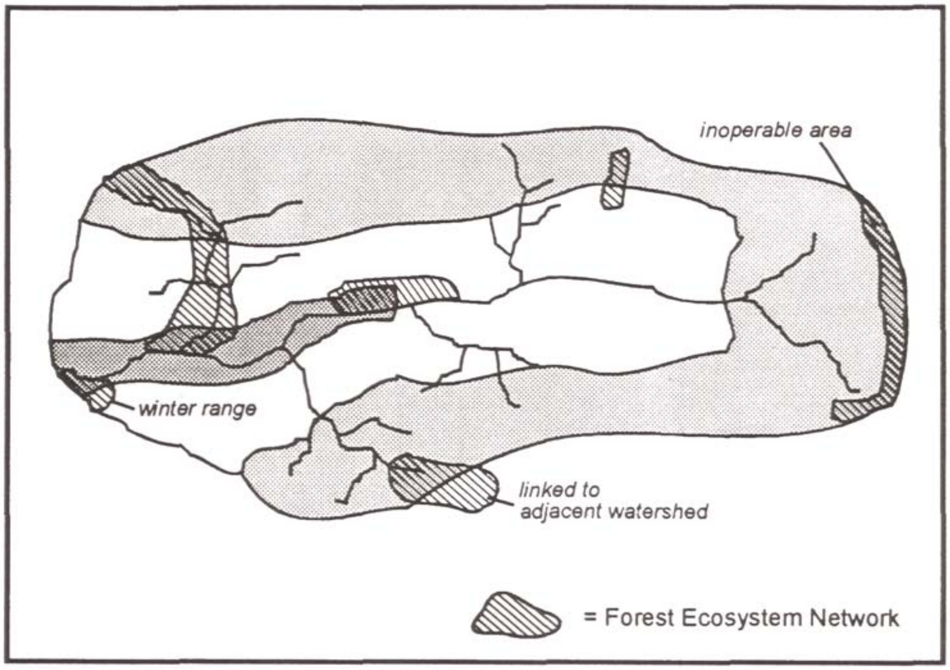

Figure 3—Distribution of a Forest Ecosystem Network within a hypothetical landscape with three biogeoclimatic zones.

- 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.

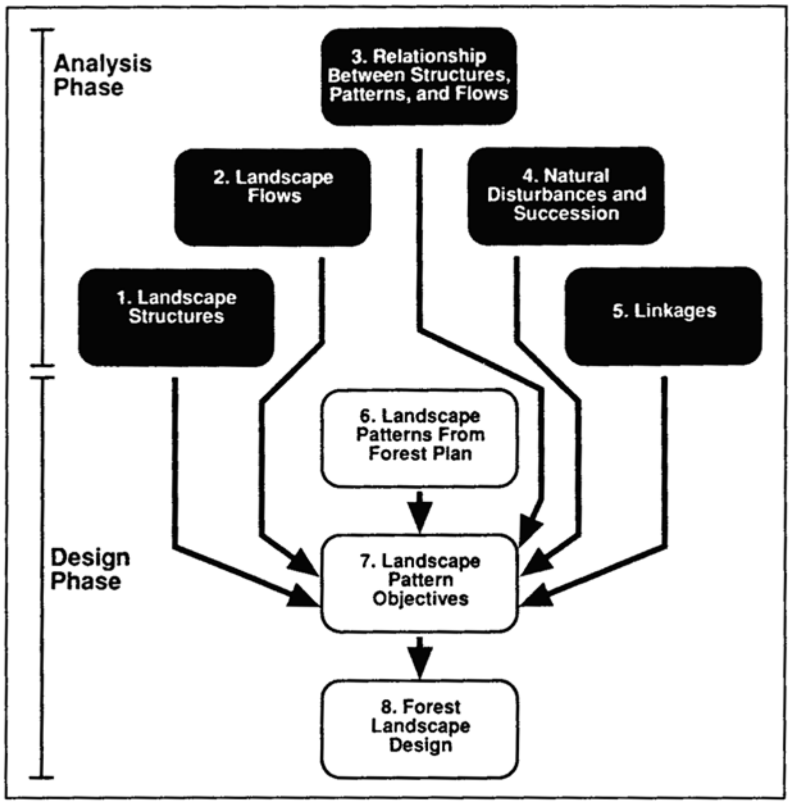

Figure 4—Hypothetical example of development plan incorporating landscape considerations for biodiversity.

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).

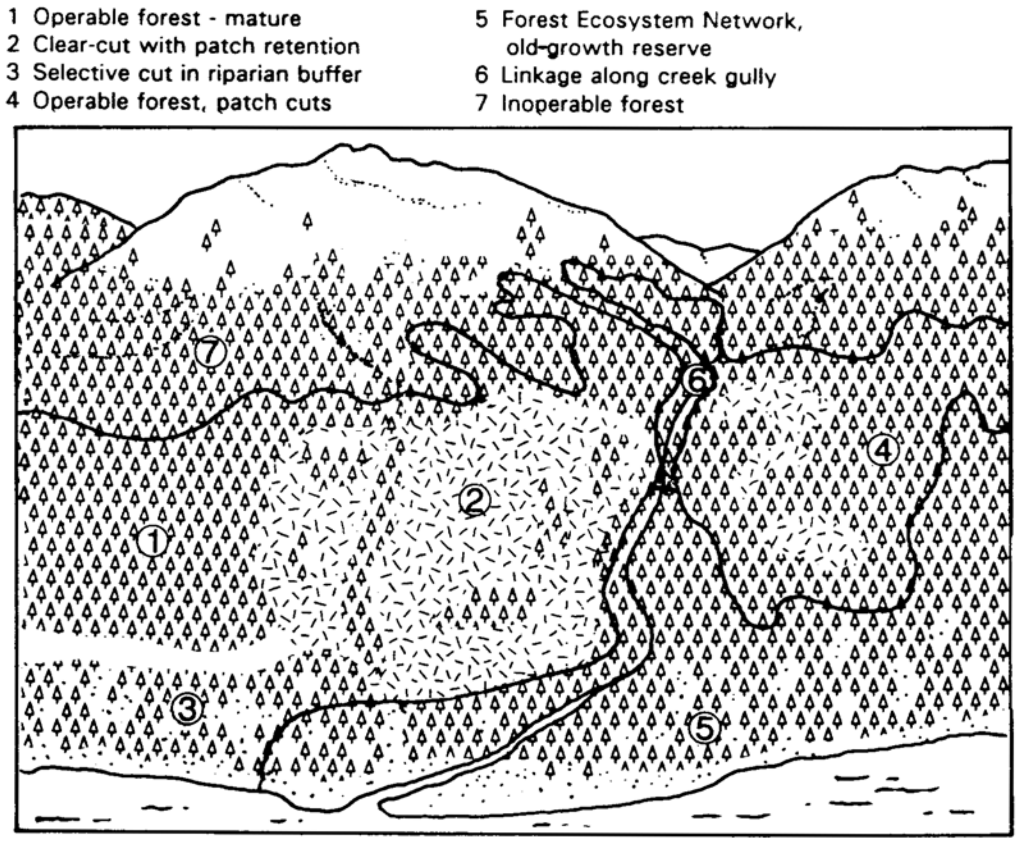

Figure 5—Steps of the Forest landscape analysis and design process.

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

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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.

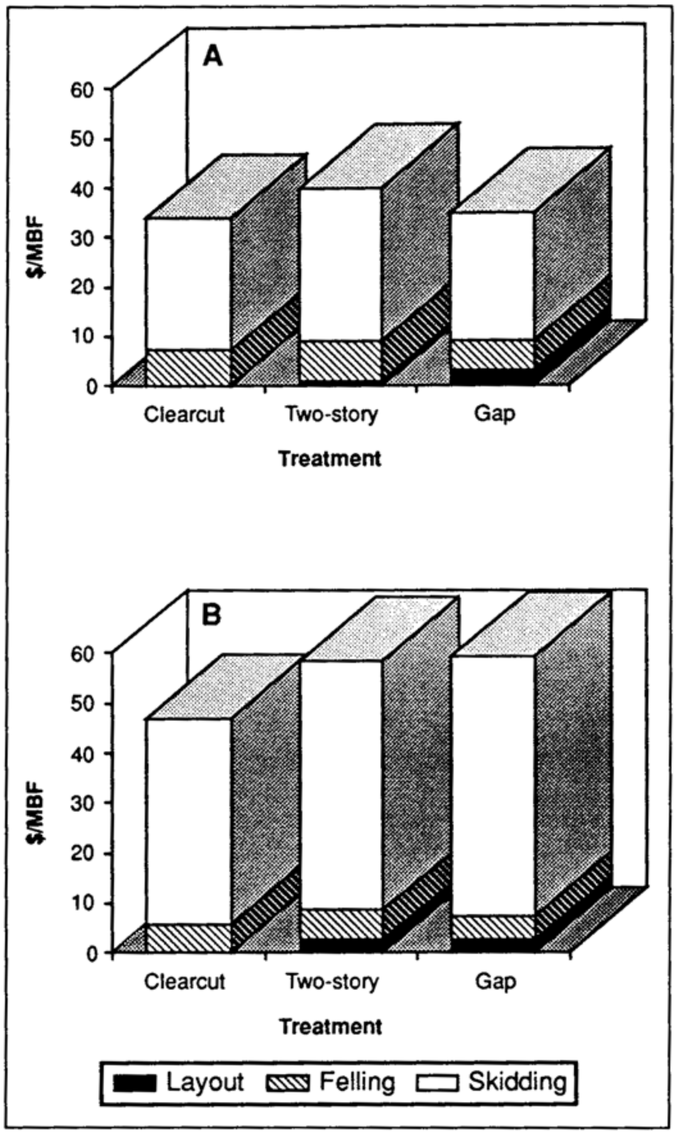

Figure 1—Comparison of harvesting costs among three silvicultural treatments in an east-central Oregon Coast Range forest, 1990 (from Kellogg and others 1991).

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 windfirmness, 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

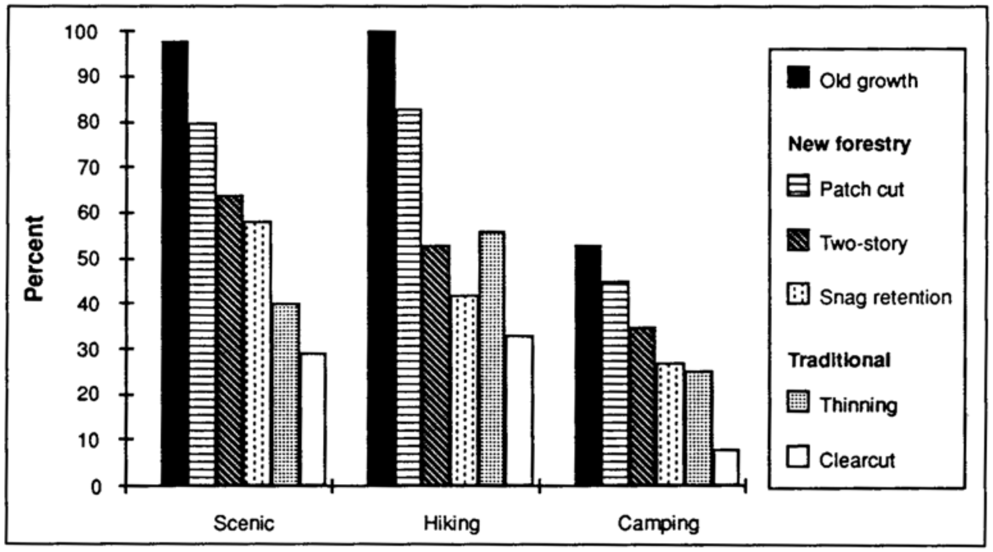

Figure 2—Comparison of acceptability of five silvicultural treatments and an old-growth stand for viewing, hiking, and camping (from Brunson and Shelby 1992).

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

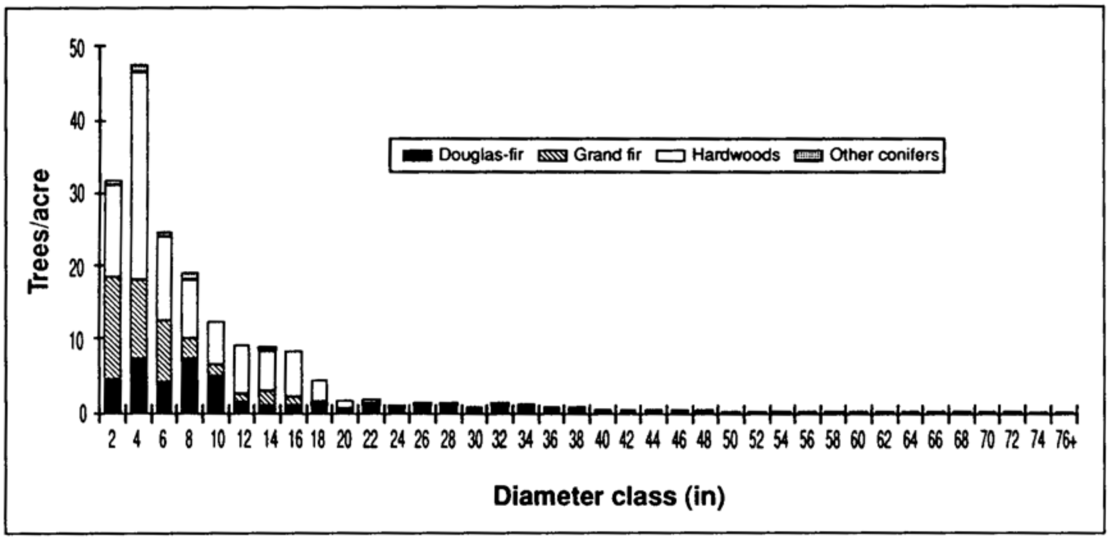

Figure 3—Diameter distributions of stands > 200 years old in McDonald-Dunn forest, Oregon Coast Range.

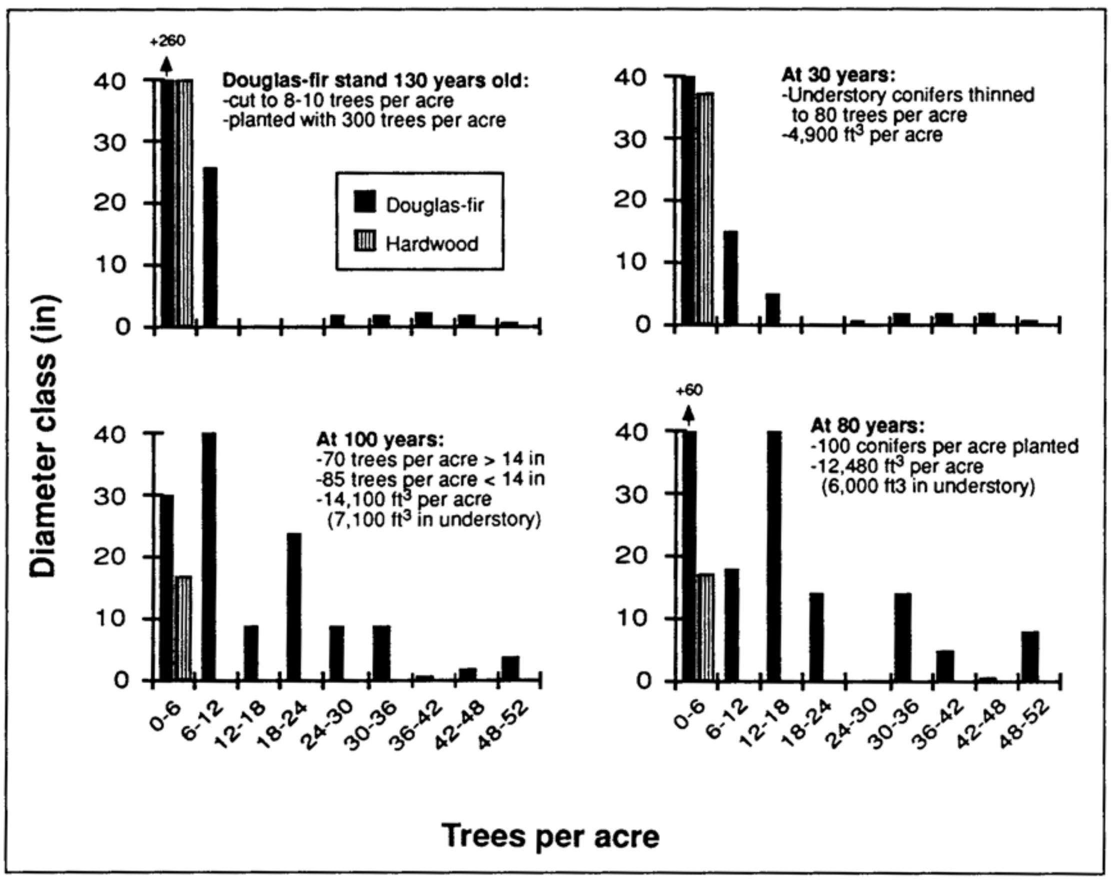

Figure 4—Predicted growth and development of two-story stands using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

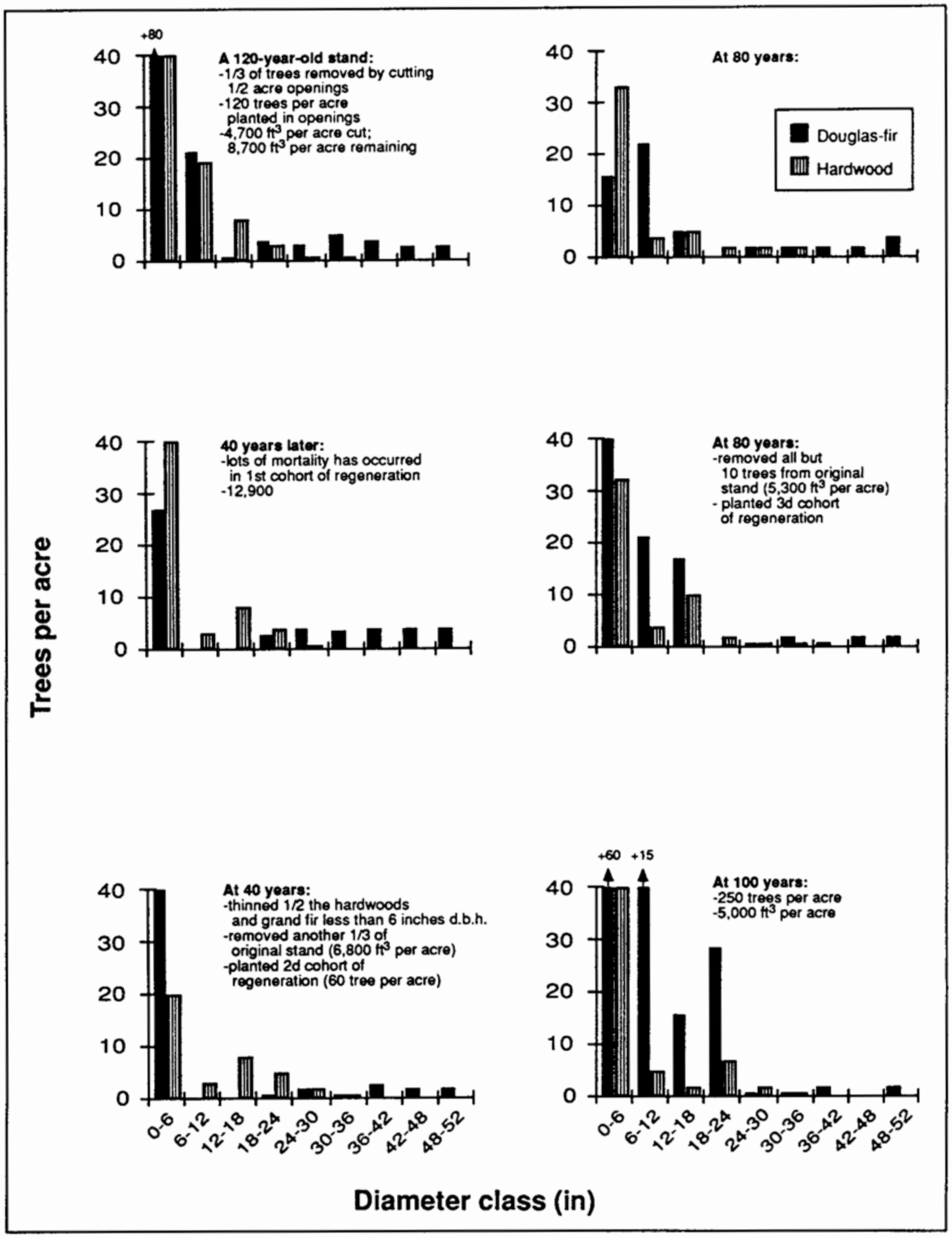

Figure 5—Predicted growth and development of gap stands using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

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.

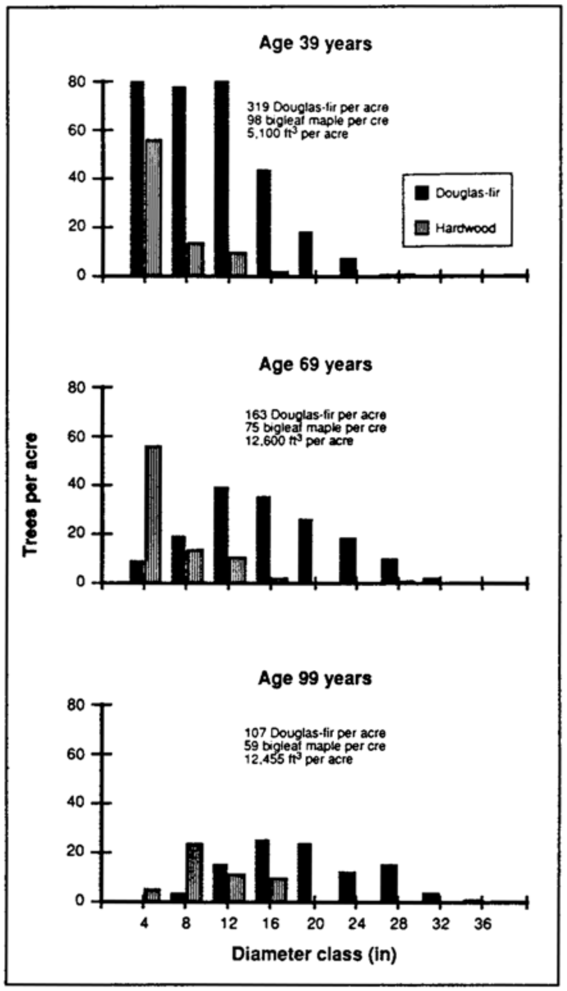

Figure 6—Predicted growth and development of a 39-year-old plantation using ORGANON, McDonald-Dunn forest, Oregon Coast Range.

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

	Treatment[a]			
Value	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

Mike Geisler, Paul Glover, Elaine Zieroth, Geraldine Payton

Abstract

Geisler, Mike; Glover, Paul; Zieroth, Elaine; Payton, Geraldine. 1994. Citizen participation in natural resource management. In: Huff, Mark.; 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: 87-100. (Huff, Mark H.; McDonald, Stephen E.; Gucinski, Hermann, tech. coords.; Applications of ecosystem management).

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.

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[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.

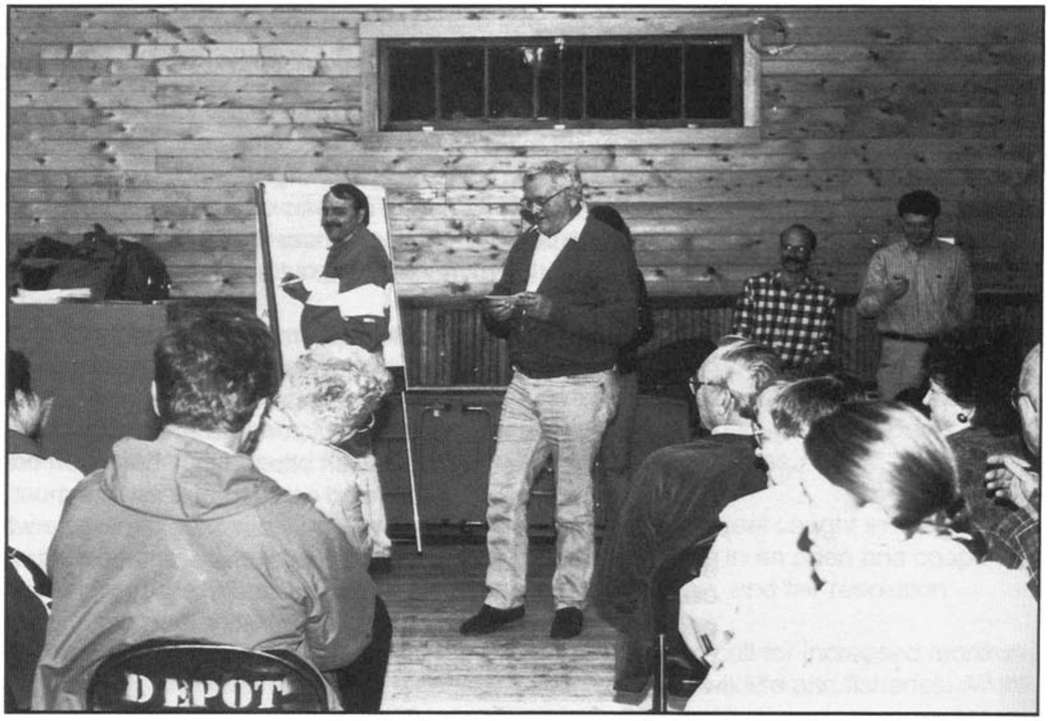

Figure 1—Public meeting. Meetings should be informal and comfortable but have established ground rules (photo courtesy of Omak-Okanogan County Chronicle).

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.

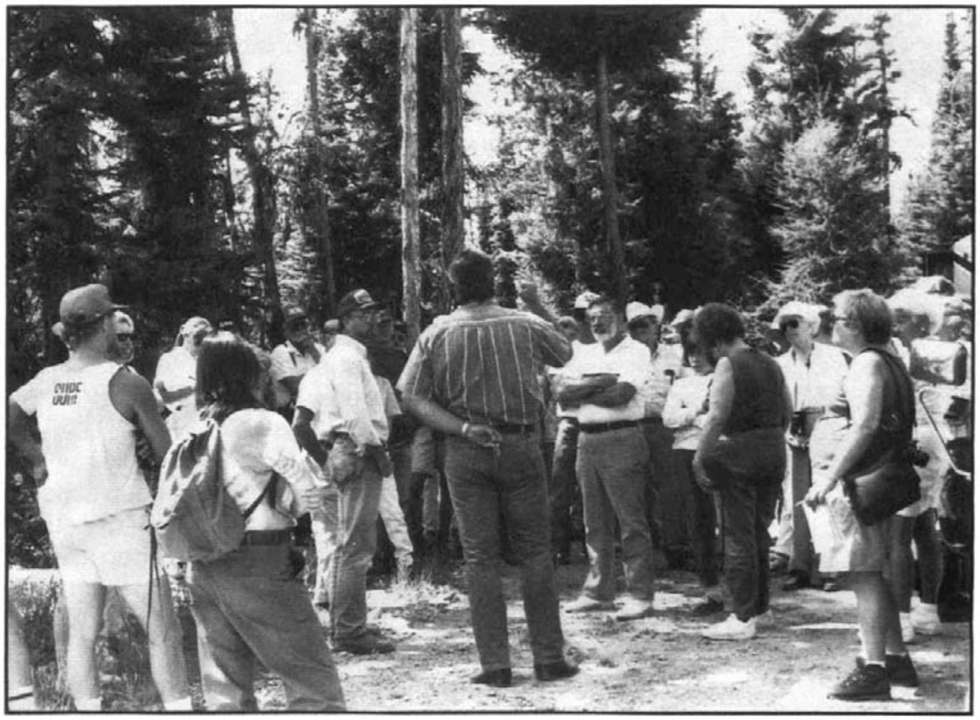

Figure 2—Tours are extremely valuable in gaining common understanding of the resources.

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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