Reverse Technology Transfer: Obtaining Feedback from Managers

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ABSTRACT: *Forestry policy, planning, and practice have changed rapidly with implementation of ecosystem management by federal, state, tribal, and private organizations. Implementation entails new concepts, terminology, and management approaches. Yet there seems to have been little organized effort to obtain feedback from on-the-ground managers on the practicality of implementing ecosystem management. We convened a colloquium in Forks, WA, in 1997 to assess the state of ecosystem management. We used a recent interagency modeling exercise to formulate six concepts and questions to present to small working groups of practitioners and listening groups of a scientist, regulator, and conservation group member. Concepts and practices varied in a degree of development and sophistication; practitioners varied in sophistication and comfort with concepts. Many expressed dissatisfaction with new terminology they perceived as abstract and not operational. Research and technology transfer needs were identified. Organizational culture, structure, and centralization of decision making appeared to have influenced the creativity, systems thinking, and professional development of managers. Some practitioners, however, demonstrated narrow focus apparently arising from traditional disciplinary allegiances. Implications for organizations are discussed. West. J. Appl. For. 14(3):153-163.*

The 1990s were a decade of rapid change in forest management paradigms-high quality forestry, new forestry, ecosystem management. Various planning and regulatory processes prompted new approaches to managing forests for multiple purposes. Policy makers, scientists, regulators, and planners provided managers with substantial direction based on ecological theory, re-search results, public concerns, personal opinions, legislation, and court actions. But few opportunities have been provided to managers to collectively relate back either their experiences in implementing novel practices or their reactions to the new concepts, terms, and direction.

We chose a group of scientists, managers, planners, regulators, and representatives from federal, state, tribal, and nongovernmental organizations to "take the pulse" of on-the-ground ecosystem management in western Washington. We chose western Washington simply because it was convenient for us, not because it appeared different from the rest of the Pacific Northwest or the western United States, and we wanted to limit geographic scope to avoid focus on intraregional and interregional differences in forest ecology. We convened a colloquium for the most experienced forest managers we could identify to provide feed-back to policy makers, scientists, planners, and regulators based on their practical, operational experiences that were relevant to ecosystem management. Our goal was to initiate a feedback process; part of that goal was achieved through the colloquium. Here, we summarize our impressions from the colloquium. First, we relate the terms of the colloquium. Then, we provide details about the six topics assigned to the participants. Finally, we provide a subjective evaluation of the state of ecosystem

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management in western Washington with examples drawn from working group records.

Terms for Working Groups

The colloquium was convened to evaluate acceptance of ecosystem management principles and to obtain experience based feedback on the feasibility and efficacy of land and vegetation management practices pertinent to ecosystem management. Neither we, nor the participants, wanted to debate laws, regulations, or policies. Thus, we set the following terms:

1. Only topics that could be addressed with operational experience were chosen.

2. Topics were aimed at ecosystem-multipurpose management, not single-focus management.

3. Group members would discuss topics based on (a) direct experience with application of one or more approaches being proposed, (b) a range of experiences that incorporate the kinds of things being proposed, and (c) contrasts they had observed between disparate approaches.

4. Topics were posed as three-part questions: proposition (what is/has been suggested); rationale (what the proposition is expected to accomplish in its totality); and queries (about the experiences and conclusions of the working groups).

5. Working groups were composed of five to seven professional managers from federal, state, tribal, and corporate land-managing organizations, chosen on the basis of their experience and astuteness as judged by their peers and scientific and regulatory colleagues, and by their willingness to participate.

6. Each working group had a facilitator and an audience of a recorder, scientist, regulator, conservation group member, and a member of the organizing committee. These observers could be called upon to comment at the request of the working group.

A keynote address set the stage for the colloquium. Toby Murray, of Murray-Pacific Corp., related the history of his family-owned firm in harvesting and managing forests in Washington. The Murray family pioneered many changes in forest management, including developing the first species-specific habitat conservation plan for the spotted owl, *Strix occidentalis,* and the first multispecies habitat conservation plan approved by the U.S. Fish and Wildlife Service in the Pacific Northwest.

Questions Posed to Working Groups

Topics were drawn from a recent modeling exercise (Carey et al. 1996) that had attempted a synthesis of ecosystem management practices. The topics included management of (1) biological legacies, (2) mixtures of tree species, (3)stocking and rotation length for growing large trees and stimulating understory development, (4) operations to protect and maintain long-term site productivity, (5) tree cavities for wildlife, and (6) riparian areas for water quality, wildlife, and fish. Each summary and rationale statement for a topic was followed by queries about the practitioners' experience in implementing similar practices (ease, relative cost, and success of implementation), observing the consequences of similar practices (efficacy in meeting goals), observing consequences of a variety of practices that had implications for the recommended practice (feasibility of implementation, likelihood of success in meeting goals, and likelihood of unintended consequences), and formally monitoring the results of similar practices. Summaries and rationales (edited for brevity) follow.

Legacy Management

Leaving green trees and snags, singly, in clumps, or in patches, is recommended frequently. Purposes include shelterwood for regeneration; seed trees for regeneration; providing corridors across the landscape; providing snags and cavity trees for wildlife in clearcuts and future stands; providing large coarse woody debris in future stands; and providing refugia for various organisms in the 5-15 yr post-clearcutting, nonforest period.

Minimizing site preparation, foregoing intensive burning, and planting widely spaced trees are recommended often. Purposes include conservation of soil organic matter and mycorrhizal fungi to maintain site productivity; conservation of coarse woody debris as a source of nutrients, for retention of moisture in the soil, to inhibit erosion, as nurse logs for trees and shrubs, and as shelter for wildlife; conservation of ericaceous shrubs to maintain mycorrhizal networks, nitrogen levels, and cover for wildlife; retention of other shrubs as understory in the developing stand; retention of advance regeneration of shade-tolerant species; and reduction of carbon emissions and impacts on air quality.

Mixed-Species Management

Managing for a mixture of conifer species or a mixture of coniferous and deciduous species is recommended frequently. Species frequently mentioned include Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), and bigleaf maple (*Acer macrophyllum*). Management practices that promote species diversity include reduced site preparation, encouraging natural regeneration in combination with planting, and new approaches to precommercial and commercial thinning. Precommercial thinning can be used to shape the composition of the developing forest by maintaining a mix of tree species and understory shrubs (e.g., *Gaultheria shallon, Vaccinium* spp., and *Corylus cornuta*). Precommercial and commercial thin-nings, particularly variable-density thinnings, with multiple thinning entries are recommended for forestalling stem exclusion stage by harvesting trees for wood products; maintaining a diversity of species while promoting the growth of large Douglas-fir; providing opportunities for enhancing coarse woody debris on the forest floor when needed; providing understory cover for wildlife and for marketable floral greens; and encouraging regeneration of shade-tolerant species. Purposes include production of a spatial pattern in conifers that leads to a diversity of microclimatic conditions and diversity of vegetation site types in the understory; production of a variety of wood products to meet various market conditions and provide jobs in forest related industries; provision of diverse seed sources for wildlife; development of multilayered vegetation for restoration of late seral forest condition; and reduction of the adverse impact of *Phellinus* root-rot infestations on forest function. Red alder and western redcedar provide special nutritive benefits to the soil; Douglas-fir is a major mycorrhizal former, benefiting other conifers.

Growing Large Trees

Commercial thinnings, particularly variable-density thinnings with multiple entries, often are recommended. The purposes of the practice include forestalling stem exclusion stage by harvesting trees for wood products; maintaining a diversity of species (including development of a diverse understory) while promoting the growth of large Douglas-fir, in particular; providing the opportunity and funding for augmenting the cavity tree resource when needed; providing understory cover and forage for wildlife and floral greens; and, in the long run, leading to a variety of wood products and employment opportunities in forest-related industries.

Extended rotations (80–130+ yr) are recommended. Purposes include capitalizing on the productivity of the land (retaining trees to the culmination of mean annual increment); producing high- quality wood products; and providing late-seral forest conditions that include large live trees; large dead trees; diverse, layered vegetation; and large coarse woody debris. Long rotations have added benefits of reducing cumulative impacts of clearcutting on watersheds and landscapes; eliminating need for special corridors; and providing wildlife habitat, including habitats for spotted owls, elk, and deer.

Maintaining Site Productivity

Concerns over maintaining forest site productivity have grown with our understanding of the functioning of forests and our intensity of management, including new harvest technologies and utilization standards. Providing coarse woody debris that covers 10% of the forest floor on dry-mesic Douglas-fir sites and 15% on mesic western hemlock/redcedar/ Douglas-fir/Sitka spruce (*Picea sitchensis*) sites or silver fir (*Abies amabilis*)/hemlock sites is a recommended ecosystem management practice. The purposes include providing sheltered sites on the forest floor for certain plants, fungi, and wildlife; providing a continuous input of nutrients and organic matter to the forest floor; providing nurse logs for trees and shrubs; providing habitat for insects important to forest floor function and to woodpeckers (*Picidae*); and increasing efficiency of wood extraction (by leaving low quality and defective wood). Coarse woody debris can be provided at final harvest (e.g., clearcutting) by leaving defective trees, sections of trees with defect and rot, large butt swells left as stumps, and other low quality wood that might otherwise be left at the landing or chipped and burned at the mill. Similarly, during thinning, tops and defect can be left in the woods. In some cases, perfectly good, large logs may have to be retained to meet ecosystem management objectives if natural recruitment of coarse woody debris and retention of defective or low quality material have not provided sufficient material.

Managing the Cavity Resource

Providing shelter for cavity-using wildlife is, perhaps, the most commonly recommended ecosystem management practice. The purposes include not only providing shelter for the cavity-users, but providing prey for the spotted owl and promoting the growth of the populations of cavity-using birds that prey on insects deleterious to forest health (almost all cavity-using birds are year-round residents and insectivorous). Techniques range from snag retention, to green tree retention, to blasting tops out of trees, to inoculating trees with decay fungi, to creating cavities in trees.

Riparian Silviculture

Restoring conifers to riparian areas dominated by secondgrowth deciduous trees is a recommended ecosystem management practice. The purpose is to eventually provide large trees that would provide coarse woody debris to streams and enhance stream structure. Growing large conifers on mass-wasting areas is also recommended as a riparian ecosystem management practice. The purpose is to have large conifers present when the site eventually fails; the large conifers, combined with mineral and organic debris input, then help to rejuvenate fish habitat.

Methods for Assessing the Colloquium

The facilitator group from Triangle and Associates (Seattle, WA) distributed and compiled its standard questionnaire about the colloquium format and the performance of the facilitators. Steering group members circulated among working groups to evaluate the colloquium as a whole. Steering group members and scientists observed working-group deliberations and reviewed transcripts of working groups to determine the degree of the state of ecosystem management in Washington. We developed four categories with which we could summarize working group deliberations: concept, systems thinking, management successes, and policy implications. Concept consists of ecological facts and rationale underlying particular approaches to ecosystem management as expressed by the practitioners. Systems thinking, as evaluated by scientist observers and steering group members, includes (1) viewing forests as complex ecological systems of abiotic and biotic components, as opposed, for example, to stands of fiber-producing trees, viewsheds, or wildlife habitats; (2) mindfulness of the hierarchy of systems (for a simplified example-a tree is but one element of stand of vegetation that is one element of a forest biotic community, that is one element of a landscape); (3)

interdisciplinary and multifactorial thinking that focuses on interactions of ecosystem components, management actions, and natural events; (4) recognition that forest management is part of a larger system with ecological, economic, and social components and that society benefits and demands diverse services from all forestlands, -regardless of ownership or charter; and (5) recognition that there is substantial uncertainty and unpredictability associated with forest management. Examples of success were provided by the practitioners. Implications for organizations were drawn by the authors.

Results

The majority of participants were satisfied with the two-day meeting and the facilitated working-group process. There was some dissatisfaction about the lack of specificity for the working-group tasks; this lack of specificity was deliberate-the steering committee decided not to present information or detailed guidance to the participants beyond the questions and brief overviews prepared by the scientists. We wanted the participants to define the issues of importance. Many participants would have liked more specific direction or more concrete tasks. The participants also reported they could have benefited from receiving the questions, overviews, and participant lists earlier (e.g., up to 30 days before).

It was readily apparent that the majority of the practitioners were well versed in systems thinking. Some, however, were narrowly focused, within a particular discipline. Others exhibited disciplinary bias at odds with their employer's management direction. For example, several industry and Department of Natural Resources specialists were strongly supportive of practices that fostered biodiversity and sustainability even though their management mandates might emphasize net present value or return on investment over biodiversity. There was considerable variability in the use of terminology; working groups often had to formulate a common set of terms and concepts before proceeding with their deliberations. There also seemed to be a common antipathy for “faddish” and abstract terminology now commonly used in the science, planning, and policy communities. Working groups differed markedly in degree of experience and sophistication, suggesting some ecosystem management practices were more widely accepted and practiced than others.

Legacy Management

Concept

Discussion centered on snag and green tree management, suggesting that managers had incomplete knowledge on what legacies are and how they should be managed. Thus, participants focused on needs of species (spotted owl and marbled murrelet, *Brachyramphus marmoratus*) or wildlife groups (cavity-nesting birds) more than system needs. Practitioners reported that scientific information was insufficient to justify complex prescriptions and that many new land management guidelines were lacking in depth.

Systems Thinking

Discussion evolved into systems thinking for implementation, including consideration of soil, season, wind, elements versus patches, site, region, natural events, natural processes, time, longevity, multiple spatial scales, and multiple elements and functions. The participants identified needs for careful site-specific design of legacy projects and sale contracts for implementation. Regulatory barriers make legacy management difficult. There seems to be excessive rigidity in some agency contracting procedures and safety guidelines that makes retention of snags in areas of forest operations difficult. These guidelines were perceived as unnecessarily inflexible. Practitioners believed it is possible to ensure worker safety and provide cavity trees more efficiently than is allowed now.

Successes

Participants have learned how to implement prescriptions for some legacies; good practical knowledge for implementation exists for snags and green-tree retention. Attempts to provide for individual components, such as snags or green trees, frequently were made at the stand level, whereas larger spatial scales (e.g., subbasins) were used in landscape planning. Examples of evaluation of success of green tree retention in meeting ecosystem management goals were not provided, however.

Implications

Legacy management is important in systems where disturbance events are intense. Legacies provide temporal continuity in ecosystem processes and set the stage for the development of the stand for a substantial future period. Yet, legacies available for retention or management vary markedly from site to site. Thus, legacy management would benefit from scientist-manager interaction in seven steps:

1. Clearly defining social goals and managerial objectives related to legacies.

2. Identifying functions of legacy components relative to goals.

3. Establishing time schedules to maintain and restore ecosystem functions through legacies.

4. Incorporating legacy management at multiple scales into landscape management plans.

5. Identifying or developing operationally feasible techniques for legacy management.

6. Implementing legacy management adaptively, with on-the-ground flexibility.

7. Monitoring results of implementation to provide feedback for adaptive management.

There are significant challenges to overcome before legacy management becomes operationally feasible and managerially acceptable. Legacy-management schemes must be designed that will contribute to ecosystem function rather than accomplishment of short-term policy or regulatory direction. In particular, green-tree retention practices must be modified to avoid loss through blowdown and theft. In many cases, sufficient information exists on individual tree characteristics, effects of topographic position, and distribution of leave trees (single trees vs. clumps or patches) on susceptibility and probability of windthrow to tailor management to sites to ensure longevity of leave trees. Revised safety guidelines and careful planning can eliminate much of the perceived conflict between residual trees and worker safety.

Operationalizing legacy management requires clear communication at four levels: capturing the essence of the plan in contracts and stand-level prescriptions; communicating requirements and goals to the on-the-ground operator and monitoring for compliance; documenting plans and activities scheduled for the future in media accessible to future managers; and documenting successes and failures for communication to other managers. Flexible and adaptable contracting procedures, improved record keeping, planning software, information-sharing systems, and operator training and certification procedures will facilitate legacy management and other aspects of active ecosystem management as well.

Mixed-Species Management

Concept

Concepts of mixed-species management were well developed. Managers had moved beyond managing two to three species of trees to managing by plant association for a diversity of plants for diverse purposes-stand structure (randomness, patchiness, simple vs. complex structure), life form (understory vs. overstory, evergreen vs. deciduous), and site function (riparian vs. upland). In practice, however, most managers managed for two to three species of trees for economic diversification, cost effectiveness, and public acceptance, and because multiple species of trees were inevitable consequences of natural regeneration, even when a single species was planted. Some managers reported use of multiple tree species to reduce risk of insects or disease or plantation failure due to frost or wet sites. Some management was sophisticated-landscape corridors, visual effects, protection of sensitive soils, and consideration given to biological, social, and economic factors in design and implementation.

Systems Thinking

Multifactorial thinking was well developed. Discussions, all with seeming cohesion, included: microsites; marketability; diverse portfolios; spreading risk; effects on disease, fire, and insects; wildlife values; aesthetics; visual screening; site productivity; nutrient management; erosion control; genetic diversity; biodiversity; product value; form; market cycles; operational logistics; spatial scales; nurse logs; animal damage; green-tree retention; and patch versus landscape.

Successes

Participants reported substantial experience in mixed-species management, both in planting multiple species and in managing for mixed species by planting the species least likely to seed in naturally and expecting natural recruitment of other species. Intentional management of two to six species per site was reported by all land managers present (Merrill and Ring Corporation, Rayonier Timberlands, Olympic National Forest, Washington Department of Natural Resources, and Plum Creek Timber). Even success in restoration of conifer components to riparian areas dominated by deciduous trees has been achieved with operational feasibility incorporating multiple steps (Merrill Ring Corporation): (1) multiresource riparian survey; (2) multiresource objectives planning; (3) regulator consultation and permitting; (4) vegetation management (removal of current overstory, placement of logs in stream, planting of multiple conifer species, control of herbivory, and control of competing vegetation); and (5) multiyear monitoring with elements of vegetation management repeated as necessary.

Implications

With increasing emphasis on ecosystem management, the concept of mixed-species management has evolved from one of stands of simple structure with more than one dominant tree species to stands of complex structure and diverse species. Nevertheless, specificity is needed in objectives before management prescriptions can be written effectively. Ecosystem management objectives include biological, economic, and social components. Biological reasons for mixed-species management include matching management to site conditions; resilience to insects, disease, windthrow, and fire; restoration of ecosystem functions and health (e.g., improving soil fertility); providing wildlife habitat; restoring plant communities (special communities or special sites); and maintaining biodiversity. Economic reasons include market diversification, risk spreading, and improved product form or value. Social reasons include visual screening, aesthetics, mitigation to meet legal or regulatory requirements, and gaining of public acceptance for active management.

Vegetation composition can be managed at all stages of stand development. Each entry into a stand proffers an opportunity for molding vegetation composition (intentionally or not). Harvest methods, site preparation, vegetation management, precommercial thinning, and commercial thinning all result in changes in vegetation composition. Thus, it is necessary to clearly define objectives and ensure that objectives are tracked through time to achieve the full benefits of mixed-species management. Research is needed on (1) costs and benefits of mixed-species management, including effects on growth and yield of forest products; (2) opportunity costs of not managing for a mixture of species; (3) how to manage overstory, midstory, and understory vegetation through time; and (4) methods for restoring specific plant communities and seral stages.

Growing Large Trees

Concept

An ecosystem-management concept for growing big trees was not well developed. Discussions revolved around dichotomous objectives of income versus wildlife, two different purposes, instead of system management. Discussions did not go very far ecologically or economically despite the importance of culmination of mean annual increment in federal land management and the effects of rotation age on landscape character.

Systems Thinking

There was extensive discussion of the role of spacing in developing big trees with moss-covered branches for late-successional reserves with developed understories and large trees for non-industrial forestland. The experiences of practitioners is that management goals must be well formulated because techniques to grow big trees can simplify the forest ecosystem or contribute to its diversity, increase or decrease risk of exogenous disturbance, and favor some species over others.

Successes

Practitioners have had substantial experience in growing large trees with a variety of intentional practices including planting genetically superior planting stock, fertilization, pruning (for wood quality), vegetation management, spacing control, and use of long rotations, and in managing stands with big trees resulting from unintentional management in the past.

Implications

Growing big trees is a facet of ecosystem management that needs to be developed more fully as a concept, and additional information on the role of large trees in ecological, economic, and social systems needs to be provided to land managers. The practitioners' discussion illustrated well that single-focus or oversimplified management can have unintended consequences.

Maintaining Site Productivity

Concept

The group's ideas about sustained productivity in forests arose from (1) observations and measurements of natural systems and (2) experience in creating and maintaining agricultural (agroforestry) systems. The practitioners' orientations to natural or agricultural systems had a fundamental impact on their concepts of forest long-term site productivity.

At a basic level, all the participants recognized the antecedents of long-term site productivity. There was difficulty, however, in recognizing the difference between the inherent, sustainable productivity of a site and the production of wood volume through management. Those viewing site productivity as a synonym for volume production focused on stand tending as a means to increase stand productivity. Those recognizing the maintenance of natural soil processes as the foundation of site productivity focused on ways management could emulate natural mineral and energy cycles. Changes in the long-term site productivity, however, are difficult to measure, and some agroforestry practitioners were skeptical of claims of long-term negative impacts of land management on forest site productivity.

Systems Thinking

Conceptualizing the potential impacts of land management on long-term site productivity requires both abstract and hierarchical thinking. Abstraction is required because of both the long-term and the process—level changes that could be induced by management. Hierarchical thinking is required because changes in organic matter capital occur in amounts of coarse woody debris, forest floor structure, and amounts of mineralizable nitrogen in the soil. Practitioners find it easier to deal with observable changes in large structures than with changes in chemical processes-the former changes can be shown to contract loggers, the latter can not.

Practitioners began their deliberations by organizing their thinking into three categories: (1) site productivity factors uninfluenced by forest management, (2) site productivity factors partially under the influence of forest management, and (3) site productivity factors largely controlled by the forester. Such classifications clarify thinking about site-specific susceptibility to productivity loss, as well as loss from existing site impacts. Site-specific management is the most powerful way foresters can directly manage the factors that control productivity.

Successes

Economic forces often act indirectly to the benefit of site productivity. Stump-side bucking has helped maintain biomass and nutrient distributions and significantly reduced yarding costs. Efficient shovel logging virtually eliminated soil-damaging rubber tired skidders from yarding on most western Washington forestlands. Increasing costs and liabilities associated with burning have led to development of harvesting methods that reduce disturbance and loss of nutrient capital. Cut-to-length and small cable-logging systems are being designed to return branches to the site as an alternative to burning at landings. Soil and ecosystem classifications have proven valuable for assessing potential for negative site impacts.

Implications

Lack of quantitative information on the impacts of forest management on inherent forest productivity creates an environment of uncertainty about the consequences of management and how to evaluate impacts. Models can help to evaluate impacts of management decisions. Few existing decision-support models are employed by managers. Use of models would help managers understand how their actions might influence site productivity. Soil disturbance ratings have provided managers with a reliable, low-technology tool for monitoring potentials for negative impacts on forest soils.

The forest industry is undergoing a major shift in utilization as dictated by markets for small wood. New management strategies have increased wood utilization and frequencies of stand entries. At the same time, there is increased interest in the role of organic matter in forest functioning for long-term site productivity and habitat. Managers are moving toward increased flexibility in harvest scheduling and logging-contract language to tailor operations to specific soil types and to safeguard long-term site productivity.

Managing for Cavities in Trees

Concept

The concept of cavity-resource management was well developed and included the need for short-term creation and maintenance of cavities and long-term development of sustainable production of cavities through management of forest ecosystem processes. Participants discussed (1) creation of cavities by manipulating trees (killing, topping, or injecting with heart-rot fungi) and installing nest boxes and surrogate snags; (2) cavity requirements (target vertebrate species; number, size, and distribution of cavity trees; and state of decay); (3) selection of living trees to manage for future cavities; (4) costs of cavity creation; (5) monitoring use of cavities; and (6) obstacles to cavity management (safety concerns and regulations). There appears to be ample research fodder for managers to consider, and much of the discussion centered on how managers have applied research results. It is evident that managers are adaptively managing the cavity resource as they evolve improved ways to manage.

Systems Thinking

Systems thinking was natural and obviously practiced by participants. Although a cavity resource was simply defined as "a hole in a tree, live or dead, large enough for a vertebrate animal to nest, roost, or shelter in," all participants noted that cavities provide for biological diversity. Practitioners were quick to point out that cavity management is influenced by the particular management objecttives of each landowner, which, in turn, are reflective of economic, ecological, and social constraints. The need to manage "adaptively" and monitor treatments was a common theme in the recognition of the uncertainty of forest management. All practitioners of cavity management had a clear understanding of ecological complexity, especially the connection between abiotic conditions, fungal development, cavity production, and turnover in cavity use by a succession of species. Cavity managers were especially cognizant of temporal hierarchy: cavities must be provided now, but forests must also be managed to provide a continual flow of cavities in the future.

Successes

All participants reported success with providing cavities on their lands. Providing cavities was relatively inexpensive and produced quick, tangible results, namely nesting activity in heavily harvested landscapes. Managers were able to (1) inexpensively and effectively create snags by topping live trees with chainsaws or inoculating live trees with heart-rot fungi; (2) reduce cost of cavity management by saving trees with low economic value but with important biological features (scars, defects, and multiple tops); (3) leave clumps of snags to minimize subsequent loss in windstorms and minimize safety hazards to field crews working at later dates in the harvested area; (4) recognize that nontraditional snags, such as high stumps, can be important cavity resources in heavily managed areas; (5) provide nest boxes, "plant" cut sections of trees, or top trees with a feller-buncher with little cost to provide cavity trees during clearcut operations; and (6) convince contractors to fulfill complex cutting prescriptions that include leaving snags, creating snags, and leaving live trees for future snag recruitment. Successful implementation of prescriptions, however, requires clear instructions on how and why particular prescriptions should be fulfilled and monitoring during the cutting process.

Implications

Management of the cavity resource is an endeavor that should occur throughout the forest management cycle of planting, thinning, and harvesting. Each entry into the stand for management should be viewed as an opportunity to manage the cavity resource. Management is possible and necessary at each step, but is most cost effective and most likely to benefit wildlife if it begins prior to harvest (by identifying current cavities and important legacies) and is augmented during thinning by leaving trees with low economic but high snag value. Cavity resource management can produce snags and cavities with a wide range of useful life spans. The specific lifespan depends on the tree species, its initial condition, and its location on the landscape. Careful planning in western Washington forests can provide a variety of cavities beginning shortly after harvest that are expected to last approximately 50 yr. Live trees left untouched during harvest might then begin to be recruited as snags to perpetuate the cavity resource between harvest cycles.

Participants noted that snags less than 10 in. dbh, snags created by girdling, and snags resulting from root rot were short-lived and of little use to wildlife. Small snags may be important early in cavity management projects but provide little after 5 yr. They also noted that leaving too many snags in an area was of little use because many cavity nesters are territorial; optimal dispersion of snags was also rarely possible because of safety and wind concerns. Despite advances made in cavity management, much learning has been foregone because monitoring of cavity use and snag longevity is rare.

Field safety is an important consideration when managing the cavity resource. Safety can be increased by saving snags away from roads and recreational areas, leaving snags within clumps of live trees, removing root wads from "planted snags," and most importantly, working with state Labor and Industries (L&I) inspectors to meet L&I and federal Office of Safety and Health Administration (OSHA) requirements from the onset of management. Developing good working relationships with L&I inspectors cannot be overstated; they should be viewed as full partners in cavity management. However, recent responses by inspectors to proposed cavity creation activities (topping trees and cutting cavities in them) by the Olympic National Forest are not encouraging. There, inspectors were concerned about an array of proposals from the forest to create snags with techniques that forest workers believed safe. Fostering good working relationships with inspectors may improve their understanding of the importance of cavity-management activities, differences in risks associated with different cavity-creation techniques, and managers' insights into safety concerns. Improved communication and joint monitoring of demonstration projects may help resolve conflicts between natural-resources and labor-safety practitioners.

Working with landowners is important to successful cavity management. Stewardship incentive programs exist to promote cavity management on nonindustrial private forests less than 5,000 ac. These programs have been successful in getting small landowners to maintain cavities and install nestboxes. Practitioners noted that guides to cavity management exist, but none present a simple checklist for cavity management. They developed one that has five basic components: (1) familiarize yourself with the land and management activities; (2) set cavity management goals; (3) find, protect, and maintain existing snags and cavities; (4) safely create new cavity trees; and (5) identify future cavity resources and manage for their recruitment.

Much information important to cavity management is lacking. Participants said they needed more information on (1) how long leave-trees and snags of different origins last in natural settings; (2) how the number and the distribution of snags affect use by cavity nesters; (3) what management practices will eventually produce the desired number of snags through recruitment; and (4) nesting success of animals using high stumps or short snags. Answers to these questions could be obtained readily by monitoring the many snags and cavities that have already been created by state, federal, and private landowners.

Riparian Silviculture

Concepts

Discussions were sophisticated, addressing risks and significant unknowns, balancing short-term risk against short-term and long-term benefits, and incorporating the importance that society places on healthy streams in assessments of costs and benefits. Practitioners discussed multifaceted, complex interactions of plant communities, soils, geomorphology, engineering systems, and disturbances in the context of stream reaches, watersheds, and landscapes. Disturbances were seen as the basis for complex biotic communities. Mass-wasting events were considered inevitable and in the context of complex abiotic and biotic interactions. Riparian values included economic return on investment through wood and other forest products; conservation of wildlife, fish, and special plant communities; recreation; and production ofhigh quality water.

Throughout the workshop, practitioners continued to refine their working definition of riparian areas. The group defined healthy riparian areas as ones that maintained cool water temperatures, clean water, stable banks, aquatic diversity, wildlife habitat, landscape connectivity, and water flow while providing wood, other forest products, energy, fish as food, and recreation for people. They concluded that, given a focus on biological and physical riparian processes and traditional utilitarian uses, silviculture can be used to increase, maintain, or accelerate the production of many riparian values. With objectives clearly defined, a silviculturist can develop prescriptions that move riparian plant communities towards desired future conditions and outputs. Competing, unreconciled interests for use and outputs of riparian areas, complicate management.

Practitioners were concerned that many coastal streams in western Oregon and Washington are dominated by hardwood and shrub plant communities. They felt optimal function of riparian forests occurs with a mixture of conifer and hardwood species that contributes diverse organic inputs and substrates to both aquatic and terrestrial food chains. Large conifers provide coarse woody debris that creates both complex stream and terrestrial habitat. Conifer regeneration, however, is lacking in extensive reaches of coastal streams because earlier timber harvesting and homesteading removed, but did not reestablish, large conifers and large hardwoods.

Systems Thinking

Systems thinking was pervasive, perhaps because of the composition of the group: engineer, hydrologist, fisheries biologist, forester, silviculturalist, marine/fisheries regulator, conservationist, marine/estuary attorney, and a scientist who specialized in riparian ecology and silviculture. Four dimensions of riparian management were discussed: function, geomorphology, risks, and regulatory policy. Managing for intended riparian functions was cited as being more efficacious than imposition of arbitrary boundaries. Management for function, rather than for arbitrary boundaries, allows flexibility and creativity in pursuit of multiple riparian values.

Geomorphology was emphasized as key to understanding function and determining feasabilities of improvement projects. Functions vary with riparian structure, and management should vary appropriately. This was a recurring theme: headwaters versus large perennial streams, areas prone to mass movement versus those that are not, terraces versus flood plains, hardwoods versus conifers-different characteristics and functions call for different management approaches. Practitioners believed that improved technology transfer that helps people conducting field operations understand functions will also contribute to management success. Thus, it is important not to rely on cookbook prescriptions.

Participants emphasized that risk assessment should be part of standard management protocols. Risks associated with the management of riparian areas include (1) maintaining current unsatisfactory conditions or allowing current condition to deteriorate (e.g., doing nothing), (2) increasing water temperature, (3) decreasing bank stability and increasing sedimentation, (4) interrupting natural recovery processes, (5) destroying human life or property, (6) removing interim sources of large woody debris, (7) using counterproductive techniques-with a one-size-fits-all approach, and (8) unintentionally impacting other parts of the watershed (upslope or downstream). Practitioners concluded that effective practices both enhance riparian function and mitigate risks.

Successes

Riparian enhancement projects are proving successful, especially those (1) establishing forested buffers as riparian habitat and filter belts for water quality; (2) increasing tree species diversity by planting large conifer seedlings with well developed roots in gaps, with control of competing vegetation and animal damage; (3) using harvests on adjacent uplands to provide opportunities for thinning and mixed-species management in riparian areas (Weyerhaeuser Corporation); (4) improving forest engineering, road construction, and road maintenance; (5) promoting growth of large trees; (6) stabilizing slopes; and (7) encouraging dam-building by beavers *(Castor canadensis)* by placing screens in stream reaches where dams are desired and away from areas of tree regeneration (Weyerhaeuser Corporation).

Strategies for reducing risk that have been successful include (1) conducting riparian silviculture activities only with appropriate equipment and under conditions that will have the least unintended impact, (2) acting early to maintain various options, (3) involving stakeholders in identification of risks, (4) not experimenting upstream of land improvements and valuable resources, (5) restricting engineered solutions to low energy streams, and (6) timing treatments to minimize effects on potentially sensitive species such as the spotted owl, marbled murrelet, amphibians, and fish. Most managers said it was premature to evaluate strategies aimed at maintaining species diversity and viable populations on a watershed level.

Implications

The participants agreed that active management in riparian areas can help achieve ecosystem management goals. Establishment of conifers in riparian areas is a crucial step in enhancing habitat for fish and wildlife, particularly in providing for large wood. Silvicultural treatments may have short-term, transitory impacts (e.g., increased solar warming, exposure of mineral soil, removal or reduction in some plant species, windthrow, and shifts in animal activity). Tradeoffs between short-term and long-term ecological goals may be necessary. Achievement of long-term goals may be delayed when riparian reserves do not lead to adequate conifer regeneration and desirable riparian plant communities.

Management is severely restricted on 40-90% of watersheds covered under the Aquatic Conservation Strategy of Northwest Forest Plan. Management of riparian areas on private and state lands is becoming increasingly restricted. Current policy favors buffer strips (with some > 500 ft on each side of a stream) for protecting habitat for fish. Establishing buffers, however, may not achieve desired results. Information is lacking about the efficacy of riparian reserves along previously managed (or heavily disturbed streams). Restoration is a long-term process that must be based on a good understanding of how short-term disturbances and long-term successional trends influence riparian forest structure and function.

Managers emphasized that riparian area management should begin quickly after a major disturbance (anthropogenic or natural). Special attention should be paid to riparian management in second-growth plantations. Plantations are capable of responding rapidly and provide good opportunities for management of tree density and species composition to contribute desired characteristics. Variably spaced thinnings and feathering of buffers should be employed in riparian areas. Unmanaged buffer strips may grow large trees slowly—dense stands of trees in these strips will grow more slowly than in areas that have been thinned. Managers emphasized that riparian area management should be based on favoring or restoring intended functions in riparian areas, not one-size-fits-all solutions such as fixed buffers.

Discussion

Managing forestlands has become increasingly complex; highly skilled individuals are needed and regular training is necessary to keep skills current. In addition, there seems to be considerable variability in use of ecological terms and concepts across agencies, institutions, and disciplines— standardized definitions do not exist. Many practitioners expressed disdain at fuzzy or faddish terminology and concepts. Discussions among the practitioners led us to believe that organizational structure and level of top-down control within the organizations represented influenced practitioners' confidence and their assessment of their success in implementing ecosystem management.

Practitioners differed in their roles in implementing aspects of ecosystem management based on the organization within which they worked. A shift in land management policies, resulting from federal and state legislation and litigation, toward ecosystem management usually was accompanied by changes in management structure. From the discussions among practitioners, we concluded that skills required to implement ecosystem management were substantially different from those previously required; these differences in knowledge, skills, and abilities caused organizations to redefine their definition of practitioners. Practitioners recognized ecosystem management required (1) multidisciplinary approaches not required previously and (2) site-specific application of integrated scientific principles. These new requirements challenge both practitioners and organizations. Specialized knowledge, integration of disciplines, and application of professional judgment to ever-changing situations are now essential elements of successful practice. Two organizational approaches to this challenge were described. One approach favored delegation of decision making to the professional on the ground. The other was toward interdisciplinary project planning, centralized direction, and top-down decision authority. Practitioners with more authority to interpret management objectives and make and implement on-the-ground decisions seemed more comfortable with ecosystem management than those implementing decisions of others. For example, practitioners from tribal organizations reported the most success in implementation of ecosystem management. Tribal practitioners identified several reasons why this might be so. Tribal natural resource organizations are relatively small, and participation in decision-making is broad. Once tribal objectives are understood, freedom to make specific decisions on the ground is delegated to the field worker who then may formulate creative operational solutions to achieving management objectives.

Roles of practitioners within the USDA Forest Service are evolving. When conference organizers tried to identify potential practitioners from this agency, specialists in diverse disciplines were presented. Project planning is done by interdisciplinary teams. The planning process is, at times, adversarial and lengthy, with consensus or compromise eventually resulting in mutually acceptable (sometimes grudgingly so) projects or practices. In addition, multiple constraints on various land management

management activities often lead to standardized approaches based on practices that had previously received favorable administrative and regulatory reviews. On-the-ground workers relegated to implementing prescriptions developed by interdisciplinary teams often do not have (and could not have) the same breadth of knowledge or experiences as the team. Thus, communication of intent becomes as important as communication of actions to be implemented.

Practitioners within the Washington Department of Natural Resources have less on-the-ground decision-making authority to implement ecosystem management than they had in the past to implement timber management. Some agency practitioners believe that their actions are being constrained to the detriment of effective management. The agency which is currently developing guidance to implement two recent, major forest management plans-has intentionally adopted a deliberative, centrally directed approach to implementing ecosystem management. For the time being, this posture limits individual decision making. For example, one practitioner noted that current programmatic direction is to establish "no entry" riparian buffers even though the agency's habitat conservation plan allows harvest activity to take place within the buffers when such activity is consistent with habitat management objectives. While frustrating for practitioners, this situation can be viewed positively—agency practitioners are eager to exercise judgement and creativity in ecosystem-oriented decision making, the long-term direction in which the agency is heading, albeit more cautiously than practitioners would prefer.

Decision making in the corporations participating in the colloquium ranged from centralized to decentralized. Larger companies tend to centralize while smaller ones tended to delegate, according to the practitioners. This suggests that degree of centralization, in the current social climate of conflict over natural resources, reflects organization size and position in the public eye (degree of social contracting). Federal agency policy arises from Presidential and Congressional consensus-building that reflects social contracts with constituents from across the nation and from litigation by citizens dissatisfied with the degree to which that consensus and its implementation meets the laws governing management of federal natural resources. Centralization of technical direction and decision making in the USDA Forest Service was the highest among the organizations represented at the colloquium. Naturally, the Washington Department of Natural Resources had the next greatest centralization, followed by large corporations. Tribes, naturally, had the least centralization, given their autonomy and small "strategic apex" (the body that sets vision and mission for an organization).

Managerial and Policy Implications

Like all other contemporary institutions, natural resources organizations have found themselves responding to rapidly changing cultural, economic, and political environments. Not only do these organizations have to adapt to their environments, uncertainty and unknowns in ecosystem management mandate adaptive management of natural resources. Did our observations of the colloquium provide us with any insight on how organizations might best become adaptive learning organizations (Senge 1990, Rummler and Brache 1995)? We think so. First, it was apparent that the managers at the colloquium exhibited, on the whole, preferences for analytical and integrative thinking styles, similar to those reported for USDA Forest Service scientists, managers, and administrators (Carey 1997). Emphasis on analytical thinking is essential for task (goal)-oriented managers to achieve success in managing complex systems to meet multiple objectives under multiple constraints. Emphasis on interdisciplinary integrative thinking might well be the long-term result of the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA), and other legislation, regulation, and litigation that unexpectedly have brought to a grinding halt the best-laid plans of narrowly focused managers (Carey 1997). Second, forest management practitioners are professionals. In organizations, professionals often exhibit loyalty primarily to their discipline (as many professional societies demand by their code of ethics) and secondarily to their employer (Robbins 1990). Thus, systems thinking must be reinforced in all professionals. Third, successful managers must be pragmatic and must learn from their experiences. This learning, however, does not necessarily transfer up the organizational line (Rummler and Brache 1995). There is a great deal of knowledge held by management and science practitioners, and there need to be various methods for information sharing, storage, and retrieval. These findings and contemporary management theory suggest:

1. Organization leaders should formulate clear visions, goals, ethics, and operating principles that develop successful managers, managerial procedures, and management plans.

2. Organizations should recognize that scientific paradigms, concepts, and terminology arise from interactions of culture, science, and practice and are not immutable (Worster 1994); institutionalization of poorly developed terms and concepts may impede organizational learning.

3. Organizations should foster and reward continual learning and diversity of experience on the part of their on-the-ground managers and provide opportunities for such, including interorganizational exchange to broaden perspectives and ability in systems thinking.

4. Organizations should provide easy access to technical information and research results and gather feedback on the sufficiency and practicality of information being supplied to managers.

5. Capacity (knowledge, learning, experience) should be developed at the front line (area-district manager level), not just in a technostructure (centralized technical staff).

6. Decision making and planning should concentrate at the front-line level when interdisciplinary experience, pragmatism, and site-specific knowledge can be brought to bear there.

7. Organizations must provide diverse disciplines at the front line of management, foster and reward interdisciplinary collaboration and problem solving, and reinforce accomplishment of each and every organization goal presented to managers. Unbalanced reward systems unequally reinforce various desired behaviors and produce various unintended consequences.

8. Organizations must recruit and develop effective resource managers, allow them to exercise their professions and make decisions using their combined experience, and hold them accountable for the outcomes of their actions and desired future conditions.

9. Organizations need to develop monitoring arms to evaluate managerial success and efficiency and to feed back results to managers at all levels, regulators, and society.

10. Organizations will have to collaborate in effectiveness monitoring to evaluate watershed, landscape, and regional outcomes and cumulative impacts if society's legislative mandates are to be met efficiently.

It is becoming apparent that traditionally conservative natural resource management organizations, like other institutions, must begin to see themselves in a global context. Practitioners should realize that the degree of authority and flexibility accorded to them by their organization often are a direct response to the on-the-ground conditions. Practitioners who, collectively, have not yet demonstrated consistent, widespread ecosystem management successes should expect that their activities may be constrained and scrutinized not only by their organization but also by regulatory agencies and public interest groups. Organization leaders must become acute sensors of rapidly changing sociopolitical environments and exhibit leadership outside their organization. We wonder if interorganizational collaboration will become as preeminent as competition as resource bases shrink, populations and demands for resources increase, and conflicts among competing groups intensify.

Literature Cited

CAREY, A.B., ET AL. 1996. A pragmatic, ecological approach to smalllandscape management. Washington For. Landscape Manage. Proj. Rep. No. 2. Washington State Dep. of Natur. Resour. Olympia, WA. 98 p.

CAREY, A.B. 1997. Cognitive styles of Forest Service scientists and mangers in the Pacific Northwest. USDA For. Serv. Gen. Tech. Rep. PNW-GTR-414. 22 p.

ROBBINS, S.P. 1990. Organization theory: Structure, design, and application. Prentice-Hall, Englewood Cliffs, NJ. 552 p.

RUMMLER, G.A., AND A.P. BRACHE. 1995. Improving performance: How to manage the white space on the organization chart. Jossey-Bass Publ., San Francisco, CA. 226 p.

SENGE, P.M. 1990. The fifth discipline: The art and practice of the learning organization. Doubleday, New York. 423 p.

WORSTER, D. 1994. Nature's economy: A history of ecology ideas. Cambridge University Press, Cambridge, England. 505 p.