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REGIONAL POLICY MODELS FOR FOREST BIODIVERSITY ANALYSIS: LESSONS FROM COASTAL OREGON

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Abstract. The crisis in the early 1990s over conservation of biodiversity in the forests of the Pacific Northwest caused an upheaval in forest policies for public and private landowners. These events led to the development of the Coastal Landscape Assessment and Modeling Study (CLAMS) for the Coast Range Physiographic Province of Oregon, a province containing over two million hectares of forest with a complex mixture of public and private ownership. Over a decade, CLAMS scientists developed regional data bases and tools to enable assessments of the implications of current policies for biodiversity and have begun using these data and tools to test ideas for solving policy problems. We summarize here four main lessons from our work: (1) Regional ecosystem perspectives, while rewarding, are difficult to achieve. Helping policy makers and the public understand biodiversity policies for an entire province can assist in developing more reasoned policies. However, this result is difficult to achieve because needed scientific building blocks generally do not exist, few policy institutions address regional cross-ownership issues, people can find it difficult to take a regional view, and the appropriate region for analysis changes with the policy problem. (2) Interest in environmental policy analysis may come as much from a pursuit of power as a pursuit of understanding. Biodiversity policy analyses are often viewed as weapons in an ongoing political battle. Also, results that might destabilize existing policies generally will not be well received by those in power. (3) The relationship of regional analyses to civic processes remains challenging and unsettled. Communication between citizens and scientists takes real effort. Also, collaborative processes both inspire and constrain regional policy analysis, and scientific work often proceeds at a different pace than these processes. In the end, CLAMS's most important effect on the civic dialogue may be to change how people think about the Coast Range. (4) An important role exists for anticipatory assessments done independently by scientists. Independent review will be especially important as policy analyses shift to management of nonfederal forests. Our future efforts in CLAMS will focus on evaluating ideas for fundamental changes in forest management.

Key words: anticipatory assessments; mixed-owner landscapes; political processes; regional ecosystem perspectives; stakeholders.

Introduction

The Coastal Landscape Analysis and Modeling Study (CLAMS) outlined in the preceding papers grew out of frustration with the process used by the 1993 Forest Ecosystem Management Assessment Team (FEMAT; Forest Ecosystem Management Assessment Team 1993). FEMAT was charged by President Clinton to develop a plan that would provide protection of the environment and a sustainable supply of timber on 10 million hectares of federal forest in the Northwest. The FEMAT Report provided the scientific underpinning for the Northwest Forest Plan. Like other bioregional assessments around the country (Johnson et al. 1999), FEMAT was a crisis-driven process with a short-time frame of 90 days. It relied generally on subjective models and simplistic non-spatial projections of federal lands, without much consideration of other landowners. In addition, little time or political space was given for collaboration with non-scientists or land managers.

A number of us who were involved in that effort concluded that we could do better next time if we utilized a landscape modeling system and took a multi-ownership approach. In addition, scientists and others have expressed a continuing interest in "anticipatory assessments" which help policy makers deal with problems before they become crises (Gordon 1999), or in "anticipatory research" directed at sustainability problems (Palmer et al. 2005).

In a similar vein, we hoped to provide the ability to anticipate potential problems in strategies for protection of biodiversity in the Coast Range Physiographic

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Province of Oregon. Specifically, our goal was to contribute to policy discussions in two distinctive ways: (1) develop a modeling system that helps policy makers, managers, and the public understand the aggregate implications of forest biodiversity policies on a regional scale, so that they could adjust them as needed and (2) employ the modeling system to develop and test ideas for improving these policies. In other words, we wished to develop and apply tools that would allow regional policy analysis to be done at a more reasonable, thoughtful, and reflective pace.

We chose the Coast Range as our focus for a number of reasons: the area was identified as a province in FEMAT, it has a complex pattern of ownerships (see Spies et al. 2007: Fig. 1), its forests and streams are enormously productive, and some of the lead scientists had ongoing projects in the area. Finally, a major research initiative, the Coastal Oregon Productivity Enhancement (COPE) project, was just completing a decade of work there (Hobbs et al. 2003).

The assessment results and technical processes utilized in CLAMS are outlined in the preceding papers. This paper focuses on the general lessons we learned from the CLAMS project as we worked toward these goals. After a brief review of past efforts and the lessons learned there, we discuss four main lessons from our efforts.

Lessons from Past Efforts

As noted by Johnson et al. (2007), we found only a few similar efforts in the literature in which spatially explicit policy-analysis models have been applied to multi-ownership landscapes. One was developed for the southern Appalachians (Wear et al. 1996) and another was developed for the Willamette River Watershed in Oregon (Baker et al. 2004, Hulse et al. 2004). The southern Appalachians effort appears largely confined to a scientific analysis without much involvement with policy makers or stakeholders; therefore, we will not discuss it further here. Rather, we will focus on the "Willamette Futures" effort, as it did attempt to work with policy makers and stakeholders and the scientists documented the lessons they learned from that effort (Baker et al. 2004).

The Willamette Futures effort utilized extensive guidance from a selected group of local stakeholders to create three alternative future landscapes for the year 2050 and compare them to present and historical landscapes. Project scientists then evaluated the likely effects of these landscape changes on four endpoints: (1) water availability and use; (2) Willamette River channel structure; (3) ecological conditions of streams; and (4) terrestrial wildlife (Hulse et al. 2004).

The researchers saw their primary clients as two committees appointed by the Governor of Oregon which had the goals of developing a shared vision for enhancing the livability of the Willamette River Basin and designing a basin-wide strategy to protect and restore fish habitat. Thus, the Willamette Futures Project had the goal of helping shape the shared vision and the restoration strategies of these committees. While Baker et al. (2004) noted they did not have direct measures of influence on these deliberations, they also noted that people did listen, their results were used, state agencies did spin-off analyses to better understand the implications of their different scenarios, and that some of their findings, such as identifying the lack of commercially zoned land in the watershed, demonstrated the value of the analyses. Also, the spatial information from their analysis has been made available on the web by the Oregon State University library for use by the public (*available online*).[4]

Most of the lessons pointed out by Baker et al. (2004) focused on the implications of stakeholder input guiding the scenario-development process—a process requiring monthly meetings over a two-year period. On the one hand, such an approach led to greater stakeholder understanding, ownership, and acceptance of the scenarios and made sure that the scenarios were plausible in eyes of the stakeholders and dealt with their concerns. On the other hand, such an approach limited the number of scenarios that could be created, due to the time-consuming process of working with stakeholders. In addition, tying scenario design so tightly to what stakeholders considered plausible constrained the range of variation considered in the alternative futures.

Baker et al. (2004) also noted that stakeholders had a relatively small role in endpoint selection, which was largely done by the project team before discussions with stakeholders began, and that the project lacked social and economic endpoints. They felt that both these gaps in endpoint analysis potentially limited the impact of project results.

In terms of what follows, it might be instructive to compare the approaches of Willamette Futures and CLAMS. The CLAMS project has attempted to build a policy analysis system for the Coast Range that could be used on a continuing basis to evaluate policy options. The Willamette Futures project developed a policy analysis system for the specific purpose of evaluating stakeholder-based scenarios; that effort has been completed. Given our goals for CLAMS, we devoted considerable energy to developing peer-reviewed and landowner-reviewed models, integrating stand-level and landscape-level approaches, portraying the economic implications of different biodiversity policies, and retaining the fine spatial details of the projected landscapes. Willamette Futures put much less energy into these technical issues.

Also, CLAMS has taken a somewhat different approach to working with the public. Much of our effort has been devoted to working with large public and private landowners to understand how well we represent

[4] ⟨http://northcoastexplorer.info/⟩

their forests and management intentions. These landowners routinely use sophisticated forest management models to plan their operations. To meet their standards for analysis, we spent considerably more of our energy on model building than did the Willamette Futures group.

In addition, we worked with a series of stakeholder groups over the decade to obtain advice on modeling capability and scenario development. CLAMS began as the last major effort of COPE and its advisory committee of stakeholders provided our initial sounding board. After COPE disbanded, we turned to the State Board of Forestry (appointed by the Governor) and a policy advisory group of stakeholders appointed by the Board. More recently, we have held symposiums and workshops with the public to explain our approach and get feedback.

With this background and comparison as context, we cover below the major lessons that we learned from a decade of work in developing a regional analysis tool for evaluating the aggregate implications of biodiversity policies across landowners.

Lesson 1: Regional Ecosystem Perspectives, While Rewarding, Are Difficult To Achieve

In the 1990s, concerns and lawsuits over protection of at-risk species and ecosystems led to the development of bio-regional approaches to forest conservation across the United States (Johnson et al. 1999). The Pacific Northwest led the way in this new approach starting with a conservation plan for the Northern Spotted Owl (Thomas et al. 1990). This approach swept aside decades of traditional planning, especially by federal agencies, which had focused on sustained yield of commodities for local areas, and ushered in a new approach that focused on conservation strategies for large areas defined by ecological boundaries. This new approach relied on the development of scientifically credible conservation strategies for wide-ranging species and appeared to bring a permanent change to how we manage forests. In retrospect, the belief that this new approach would dominate approaches to forest management may have been overstated. As we moved from a crisis-driven, short-term approach to solving an immediate policy problem to that of institutionalizing a bioregional approach to planning, numerous problems appeared.

The needed scientific building blocks generally do not exist

Spatial information and models that characterize the relationship between management and ecosystem components were generally lacking at landscape to regional scales. As mentioned above, CLAMS effort was preceded by COPE: a seven-year, $10 million scientific analysis of the Coast Range (Hobbs et al. 2002). That study focused on clarifying basic relationships among wildlife, forests, and streams, and on how silviculture might improve both economic outputs and biological goals, but did not develop models that could be scaled to the entire area or large spatial biophysical databases that form the building blocks of broad-scale assessments. Thus, the CLAMS group had to build custom models and spatial data layers or obtain them from other sources. While this effort has been a useful proving ground for development of biophysical models that are being rapidly adopted and used by others (see Ohmann and Gregory 2002, Burnett et al. 2007, Spies et al. 2007), it greatly slowed our progress. Our challenge was increased by seeking both to publish the component models in the peer-reviewed literature and to gain acceptance of them by the landowners of the region, two very different objectives.

Few policy institutions address regional cross-ownership issues

A fundamental maxim of American democratic politics is that all politics are local. Gifford Pinchot's promise in 1905 that the Forest Service would be committed to making "local decisions by local officials on local grounds" (Dana and Fairfax 1980) eloquently captures this view. Not surprisingly, most of the political organizations that deal with forest resource policies in the Coast Range traditionally have been local: Forest Service Ranger District, Bureau of Land Management District, Oregon Department of Forestry District, cities, and counties.

In a few places across the United States, such as Chesapeake Bay and Lake Tahoe (Johnson et al. 1999), past environmental crises have led to regional governments, based on environmental boundaries across ownerships, and these entities would be natural clients for regional models such as CLAMS. Regional governance bodies are more the exception than the rule in the Coast Range of Oregon where policy institutions still organize mostly by ownership and then by various political boundaries (county or local government) without overarching regional authority.

Federal land management agencies look after their own lands as do managers of the state, private, and tribal forests. As part of the Northwest Forest Plan for federal forests, various regional agency committees were set up in the mid 1990s to help with plan implementation. Also, stakeholder-based advisory committees were set up for each province recognized within the area of the Northwest Forest Plan, including an advisory committee for the Coast Range Province. These committees, though, focused on plan implementation on federal forests rather than on developing and evaluating alternative scenarios across the multiple ownerships of a province or region.

Federal regulatory agencies, U.S. Fish and Wildlife Service and National Marine Fisheries Service, take a range-wide perspective for particular species, such as the two evolutionarily significant units for endangered salmon that span the Coast Range and the multi-province range of the Northern Spotted Owl. Within the State of Oregon, these agencies generally focus on federal lands and limit their efforts on other ownerships, although they do occasionally examine broader regional implications of forest policies.

The State Board of Forestry, which has regulatory authority for private forest lands and some state forests, might seem the logical institution to take a regional perspective across ownerships, and occasionally it has. The Board's authority, though, is limited to forest lands, and key biodiversity issues often occur at the intersection of coastal forests and non-forested lowlands. In addition, the Board has no sway over federal lands. Finally, it generally has focused on marginal changes to the state forest practice rules governing private forest management, developed through a stakeholder process.

Watershed councils, stakeholder-driven groups with State support to assist in salmon recovery, are organized by local watershed; more than 20 such councils exist in the CLAMS area. This approach, while potentially useful for salmon recovery, reinforces the natural tendency to focus on the local area.

People can find it difficult to focus on large landscapes and long time periods

Other analysts have noted that understanding is more likely to occur in the context of a meaningful personal relationship with the landscape (that is, with a place) than through some anonymous provision of information (Kemmis 1990, Tuan 1974). Further, landscape analyses that lack a connection to people's experience have little meaning for the public, and thus the results of research and management activities may not have much relevance to them (Geyer and Shindler 1994, Shindler 2000). Our CLAMS work supports these conclusions: people's most immediate interest has been in the here (local neighborhood) and now (current conditions).

As the first province-wide coverage of vegetation available for the Coast Range, the maps showing current forest condition drew considerable attention. They have been made available to the public on the CLAMS Web site (*available online*),[5] as well as by the Oregon State University library (see footnote 4).

Typically, when people see the CLAMS spatial data, their immediate reaction is to check how well it represents their own local area. What does it say about their neighborhood—the 30 pixels they own or the 2000-ha watershed in which they live? If the maps pass that test, they can move on to bigger issues in a positive frame of mind. If they do not, skepticism immediately arises, and credibility declines.

Ironically, CLAMS maps are intended to describe regional patterns rather than to describe accurate descriptions of vegetation for local neighborhoods, thus exacerbating the challenge of skepticism about local accuracy. In related findings, some scientists have suggested that people are less accustomed to "seeing" at a landscape scale than ecologists and geographers (Shindler 2000). Perhaps an entire province, such as the two million hectare forest in the CLAMS region, is too large for most people to know or care about.

The CLAMS effort rests on the premise that assessing the aggregate effect over relatively long time frames (100 years or more) is important to policy-making. In fact, many CLAMS scientists argued for still longer time frames, claiming that 100 years is too short a time to show effect, especially in terms of restoration. Thus we have frequently faced situations in which modelers who are most interested in the distant future interact with members of the public who are most interested in the present and near future.

The appropriate regional scale for policy analysis shifts with the policy problem

We chose to focus on the Oregon Coast Range, one of the provinces recognized in FEMAT. As mentioned above, its productivity, ownership pattern, and land-use history make it a fascinating subject to study. Also, the Coast Range seemed, for all these characteristics, to be a logical area for future policy development. After closer examination, however, our experience suggests that the province will only rarely be the focus of policies addressing biodiversity issues. Policy issues that address the Willamette River Basin will only include our eastern portion. Coastal salmon issue will address watersheds on the western portion. Other policy issues might address all of western Oregon or, once again, address the three state area of the Northwest Forest Plan. To be useful in all these different situations, a regional policy analysis system must be capable of contributing to policy discussions at larger scales and also to those focused on a geographic subset of the region.

Lesson 2: Interest in Environmental Policy Analysis May Come as Much from Pursuit of Power as Pursuit of Understanding

We believe that the CLAMS detailed spatial simulations vastly increase the potential for joint learning about coastal forests and their alternative futures. We do not want to overestimate, however, the power of this approach in leading to solutions jointly shared by all the policy participants in the Coast Range. Our work may point out the soundness of existing policy and its shortcomings, along with the major gainers and losers of policy change and how much they might gain or lose. In the contentious political environment of the Coast Range, such information will not always be well received.

Biodiversity policy analysis is often viewed as a weapon in an ongoing political battle

As noted by Morgan and Henrion (1990), motivations for policy analyses are diverse, and learning is only one of them. Often policy analyses are used to gain political advantage, especially where there is an ongoing policy

[5] ⟨www.fsl.orst.edu/clams⟩

dispute, as in the debate over forest biodiversity policies in the Coast Range. King and Kraemer (1993), for example, found conflict to be a key factor in why decision support models (such as CLAMS) were used much more in the USA than in Germany: "put simply, the models were used because they were effective weapons in ideological, partisan, and bureaucratic warfare over fundamental issues of public policy." Further, as pointed out by Yosie (2001), if a policy analysis supports the views of some groups in a policy dispute, the groups tends to use it, promote it, and praise the people who created it. If it does not support them, the natural tendency is to ignore it or, if that is not possible, to criticize the assumptions, the science, or the people who carried out the analysis.

For the past 30 years, environmental groups have used federal law to force change in their favor, especially the National Environmental Policy Act, the National Forest Management Act, and the Endangered Species Act. While the first two laws primarily apply to federal agencies, the Endangered Species Act applies to everyone to some degree. Since the early 1990s litigation based on these laws, and others, has caused intense policy ferment in the Coast Range, keyed to protection of specific elements of biodiversity, and the emergence of new diversity policies on most ownerships. In addition, initiatives designed to change the management of state and private lands have come to the ballot every few years. Scientific results that contradict conventional wisdom or reinforce some point of view can be expected to appear in the next lawsuit and ballot initiative.

In such a contentious political environment, the players in the forest policy arena—landowner groups, conservation groups, government officials, federal regulators—understandably evaluate the utility of any CLAMS policy analysis as to whether it can help support the policies they advocate.

Results that might destabilize policies will not be well received by those in power

We believe that CLAMS should be useful to policy makers and resource management agencies as a "platform for discussion." However, as Lee (1993) discussed in his book on adaptive management, learning is never entirely comforting to power, because learning identifies error. With the identification of "error" comes the potential for loss of face and the need for change. Thus, the CLAMS platform can be perceived as an uncontrollable, perhaps threatening, entity: it enables people to ask new policy questions, and it is also capable of proposing new answers, thus destabilizing management plans and policies.

Policy makers and managers spend most of their time implementing policies that were forged through the give-and-take of the political process: they are trying to make the policies work. Understandably, they have little time for evaluations of whether the policies might be failing. Yet that is a major purpose of regional policy analysis. A few years ago, after the political struggle that led to the adoption of the Northwest Forest Plan, CLAMS scientists asked federal forest planners which alternatives to the plan they would like to see evaluated, with the idea that these alternatives might reveal ways of improving it. The planners made clear that they did not want alternatives examined: the Plan had been adopted, and their task was to implement it. Notions that the policy might not be ideal would only confuse the issue.

In addition, concern over violation of the Federal Advisory Committee Act limits the interaction of policy makers with non-federal scientists and analysts. Under that Act, policy advice from outside federal agencies needs to go through a fairly arduous set of administrative procedures. The FEMAT process, as an example, was judged to be a violation of the Federal Advisory Committee Act. The federal agencies, understandably, are reluctant to have that happen again.

Finally, the events of the 1990s in the Pacific Northwest have made managers and policy makers skeptical of groups that suggest "we are a science team and we are here to help." During the 1990s, proposals from scientists for the management of federal forests in the region overwhelmed the traditional decision-making processes then in place for creating forest plans. Understandably, concerns about the "power of scientists" can make people leery of encouraging analyses that could create forces for change that cannot be controlled.

Lesson 3: The Relationship of Regional Policy Analyses to Civic Processes Remains Challenging and Unsettled

As discussed above, CLAMS grew out of dissatisfaction with the technical and scientific basis of previous policy analysis (Forest Ecosystem Management Assessment Team 1993) and the desire to create the ability to undertake assessments that would help people anticipate future environmental problems in the forests of the Coast Range. It is a classic example of attempting to "speak truth to power" through a technical and scientific analysis.

A number of social scientists, such as Lee and Field (2005), question this approach. They note that forestry's foundations were laid during an era in which rationality and the application of science were presumed to be sufficient for directing political action and that, "... the messiness of politics, passions, and human emotion were to be replaced by the rule of reason" (Lee and Field 2005:291). Instead, they believe that, "The modernist assumptions of its dominant institutions are a poor fit for a pluralistic culture in which emotion takes its place beside reason, nature is re-enchanted with spiritual meanings, and broad consensus collapses in the face of localism and particularistic values and beliefs" (Lee and Field 2005:305).

The Forest Service, as an example, has recognized fundamental shifts in how decisions are made in forest management, with the decision to make collaboration the keystone of its future planning in the newly adopted 2005 regulations (U.S. Department of Agriculture 2005). More than ever before, natural resource managers have embraced the "wisdom of crowds."

How will CLAMS fare in this "post-modern" world? How will its scientists, models, and data function in an age of stakeholder deliberation and collaborative processes?

Communication between citizens and scientists takes real effort

The challenges of effective communication between scientists and stakeholders are legion and well studied (Priest 1995, Johnson and Campbell 1999, Weber and Word 2001). They include distrust of scientists' motivations; doubts about sources and neutrality of data; concerns regarding accuracy and certainty in data sets; confusion over technical terminology; dismissal of non-empirical, "anecdotal" data; concerns on both sides about the role of scientists in advocating any particular resource management approach; and the legacy of the scientific method and its frequently misunderstood approach to inquiry.

Typifying what amounts to a clash of worldviews, it is not unusual to see scientists advocate approaches to "public communication" that focus on getting scientific information "to the people" (Mills and Clark 2001). However, this approach, by itself, will not solve the problem of understanding (Irwin and Wynne 1996, Sturgis and Allum 2004). Epistemological differences, i.e., differences in how people perceive what they know and what they think they know, can be deeply embedded, and ignoring them can have its own perils (Benda et al. 2002).

We found these barriers and challenges in the CLAMS work. As an example, we met one evening with a group of people in the timber industry, real estate, and business in a little community near Corvallis that had been hard hit by the reductions in timber harvest due to changes in federal forest policy. We started through our usual talk about finding relationships between species and habitat in the Coast Range. As we covered our understanding of habitat needs for the Northern Spotted Owl, a member of the audience asked "Why do you base all of your work on lies?" The scientist speaking to the group was taken aback for a moment but recovered and said, "We call them hypotheses." This comment was emblematic of the dialogue we have encountered in public meetings: a spectrum of fundamental questions that help illustrate the gulf between the way scientists and non-scientists tend to approach the world.

Indeed, it might be productive to ask some different questions (Duncan 2006*a*): What do scientists and non-scientists perceive differently when they look at outputs such as GIS maps from a bioregional assessment? Do the expectations of science interfere with joint learning? Is it possible to trust CLAMS outputs and tools as a learning or policy-development platform, even as we quibble over the implications of the content?

Collaborative processes both inspire and constrain regional policy analysis

Collaborative approaches to natural resource problems have proven effective in many situations (Wondolleck and Yafee 2003). The power of understanding problems from many different perspectives, of joint learning and joint fact-finding, and of a mutual search for solutions has increasingly been recognized in recent years. The ability of such approaches to develop "win-win" solutions to problems cannot be overlooked. Relative to regional policy analysis, the Willamette Futures Project, discussed above, demonstrates the power of collaboration in scenario development.

We found, as did Johnson and Campbell (1999), that detailed spatial simulations can significantly increase the potential for joint learning about coastal forests and their alternative futures. When we can go to a local picnic in the Coast Range, put up our maps, and find ourselves in the midst of intense discussions with total strangers, we feel that we have a wealth of joint-learning opportunities.

The paradox of collaboration in regional scenario analysis, though, is also shown by the Willamette Futures analysis. While stakeholders developed ownership and acceptance of the scenarios in the Willamette Futures Project, their involvement limited the futures examined to those with which they are comfortable (Baker et al. 2004). Yet, as pointed out by Baker et al. (2004), examination of "uncomfortable" alternatives can be the most informative of all.

An example from the Coast Range might illustrate the difficulty of collaboration groups looking much beyond the status quo where trade-offs exist. A group of scientists in Oregon were empowered almost a decade ago to provide scientific advice to the state's effort to help recover salmon. Toward that end, they recommended a set of changes in the state's forest practice rules for private lands (Independent Multidisciplinary Science Team 1999). Their primary recommendation was for the rules to take a "landscape approach" instead of the existing site-by-site approach. These recommendations were then passed to a group of stakeholders to develop a proposal to take to the Board of Forestry, but the issue proved too controversial for them to tackle. Rather, they focused on marginal changes in the site-by-site approach (Forest Practice Advisory Committee 2000).

CLAMS researchers encountered similar group dynamics when it worked with an advisory committee of stakeholders to the State Board of Forestry in the late 1990s on changes in forest policies to protect biodiversity. Most of the people or groups who might be affected by forest policy change were part of the committee. Understandably, their advice on scenario development focused either on proposals in which everyone (in the room) was better off or proposals in which major gains could be achieved at slight cost.

We analyzed in depth two of these scenarios (Johnson et al. 2007): (1) Our analysis supports the idea that thinning in plantations can increase structural diversity, although effects were hard to see at broad scales in the time-frame that we examined. Nevertheless, thinning can improve ecological conditions while producing commercial volume and employment—truly, a win-win outcome at the local level. (2) Our analysis suggests that "slight" increases in the number and size of trees left at regeneration harvest on private lands can make a significant contribution to the habitat for certain bird species of interest. Even this "slight" increase in leave trees (approximately 5–7% of the trees that would be harvested), though, would reduce revenue to landowners by tens of millions of dollars and further restrict their property rights. Thus, this scenario would be difficult for the broad-based stakeholder group to endorse without a policy crisis. In other words, a lawsuit or scientific study that convincingly argues for the biological necessity of such action would probably be needed before policy action would be taken.

Scientific work and collaboration often proceed on different time frames

We made a decision early in CLAMS that we wanted both model components and the overall effort to withstand scrutiny from two sources: (1) the scientific community through the peer-reviewed literature and (2) landowners, whose actions provide our major agents of landscape change, through back-and-forth discussions. As might be expected this duel approach takes time, especially since the criteria for credibility differ so much between the two sources, with the scientific review focused more on methodology and the landowner review focused more on accuracy of results.

It has taken us almost a decade of effort to produce a modeling system that we feel has passed enough of these tests to be ready for use in policy analysis. In the process, we have worked through a number of stakeholder groups, as mentioned above, who were willing to assist us in scenario development. While we tried to fold their ideas into the simulations discussed above, their members, understandably, have gone on to other projects and problems. Our basic scientific work took too long to fit into their time frames. Yet, truncating the time frames substantially would have caused us to fall short of the critical review we believed was fundamental to our methodology.

That is not to say that new or different stakeholders might not be interested in our work—we seek them out episodically as we test new ideas for forest policies. Still our time frames for producing results seem markedly different from those of most stakeholder groups we have encountered.

CLAMS most important effect may be to change how people think about the Coast Range

As other efforts have found (Feldman 1989), we must look beyond the direct and obvious potential effects of efforts like CLAMS to understand their impact. Recent research suggests that as familiarity with the CLAMS GIS technology and outputs increases, the ability and willingness of non-technical stakeholders to engage in technical discussions also increases (Duncan 2006*a*). Such quiet change over time inevitably expands the dialogue among scientists and non-scientists, in what may be a form of "transparent" joint learning. In other words, while the technical side of learning is there for all to see, the incremental adjustments and advances taking place between scientists and stakeholders as they interact over CLAMS data and maps of the Coast Range may be less visible, but will continue to alter the way each of these groups and their subgroups perceive themselves, each other, and the landscape.

The indirect effects of a project like CLAMS, such as the increasing familiarity of interested non-scientists with GIS maps and databases, can change the way people think about natural resources across large landscapes such as the Coast Range (Duncan 2006*b*). In addition, by increasing the accessibility of information about the Coast Range, CLAMS helps shift the power balance between scientists and stakeholders in how environmental challenges are framed and in how new knowledge is created (Duncan 2006*b*).

Lesson 4: An Important Role Exists for Anticipatory Assessments by Independent Science Teams

The previous sections point out both the potential and the difficulty of working directly with policy makers, managers, and stakeholders in developing and evaluating regional policy scenarios. On the one hand, their knowledge, advice, and support are needed for new policies to be successfully formed and implemented. On the other hand, our experience suggests that they can have difficulty with the regional perspectives we have described here. Also, policy makers and managers (understandably) can look with skepticism at proposals of alternative policies and will try to control their development and evaluation should they be needed. Stakeholder groups (again, understandably) will tend to limit scenario development to choices that will not harm members of the group.

Where do paradigm-shaking, out-of-the box, "wild science" (Franklin 1999) ideas for the conservation of biodiversity come from? We include here ideas such as the regional conservation strategy for the northern spotted owl (Thomas et al. 1990), the aquatic conservation strategy for northwest forests (Forest Ecosystem Management Assessment Team 1993) and strategy for conservation of old growth forests in eastern Oregon and Washington (Perry et al. 1995). More recently, reports by groups of scientists have taken aim at redefining the issue of post-fire salvage logging and recovery (Beschta et al. 2004, Sessions et al. 2004). Looking at the policy history of the Northwest, such as the policy development influenced by the studies mentioned above, we argue that new ideas or breakthroughs often come from independent science teams: teams working on their own or at arm's length from policy makers and stakeholder groups. Usually these groups have worked at times of political crises or slightly in anticipation of them. Sometimes they have been commissioned by policy makers and sometimes they have been the result of concerns expressed by a group of scientists about a policy problem manifesting itself in an analysis or report. They have the common trait of greatly enriching the political debate and bringing new ideas and ways of thinking into civic discourse. As Baker et al. (2004) argue, there should be room for expert-based scenarios that incorporate ecological principles in creative ways and that can play a critical role in broadening the debate and altering entrenched thinking.

Independent assessment will be important as attention shifts to nonfederal forest management

Much of the science assessment on forests in the last 15 years has focused on the national forests. Their management has shifted from timber production to protection of biodiversity, especially of endangered species (Thomas et al. 2006). Further efforts to conserve biodiversity may focus on other landowners; analysis of private land management to protect endangered species will be especially contentious. Such efforts may call for changes in forest management regulations that affect income to landowners, their property rights, and the overall approach taken to achieve public values on private lands. While findings of the need for change usually lead first to volunteer efforts, sometimes with incentives, regulation often will follow if these efforts prove insufficient. In such a difficult political environment, independent science teams can play an important role in alerting people as to the adequacy of existing policies to protect different aspects of biodiversity and in evaluating policy alternatives suggested to overcome these problems.

Our future effort will focus on ideas for fundamental shifts in forest management

The CLAMS group has worked for this last decade to be in a position to develop and evaluate ideas for conservation of biodiversity in the management of coastal forests and to do it in a way that anticipates policy problems. We now have a sufficiently mature system to undertake such work.

Three recently initiated examples of our approach are (1) applying historical disturbance regimes to guide management to approximate historical structures and patterns, while allocating responsibilities in such a way as to minimize the change in each owner group's current management (Thompson et al. 2006); (2) improving the efficiency of riparian management systems in providing large wood to streams by reconfiguring riparian protection areas across owners following the work of Burnett et al. (2007); and (3) increasing wood production on the 300 000 ha of forest administered by the Bureau of Land Management (now mostly in biodiversity reserves) to better reflect their sustained yield mandate while meeting federal environmental laws.

Each of these three strategies would require major shifts in the management of the forests of the Coast Range. We feel it could be difficult to develop and evaluate these strategies within a stakeholder group or under the affected policy makers: the changes are just too great and the potential costs to some groups just too high. Nonetheless, they each address intriguing questions or issues and each case attempts to anticipate a future policy problem. Therefore we plan to do this work, publicize it, and make it available to policy makers, managers, landowners, and the public.

Conclusions

Our two major goals in CLAMS were (1) to develop a modeling system that helps policy makers and the public understand the aggregate implications of their biodiversity policies and (2) to employ the model to develop and test new ideas for forest policies. We believe we have made substantial progress in meeting the first goal and are shifting our attention toward the second goal.

We have successfully employed the modeling system to identify strengths and weaknesses of current policies (Spies et al. 2007), and our spatial maps and submodels are in use by different agencies. In the early stages of our project, we envisioned making the entire modeling system available to federal and state policy makers. However, we since have realized that such a hand-off would be difficult, given the complexities of the systems and the variety of expertise that will be needed.

We have only recently begun to suggest that land management and regulatory agencies use our system for policy analysis: we have been focused until now on building the systems to the point that they pass scrutiny by other scientists and the landowners of the region. Like all scientists, we have agonized over whether the accuracy of our simulations is high enough to suggest use for policymaking. With the publication of these papers and with the distribution of the policy analysis mentioned above, we have signaled that we feel our work is ready for use.

CLAMS began as independent science assessment, independent of particular agencies, policies, or political actions. And so it remains. Independence has its costs, in terms of remoteness from particular agencies and power structures, but it also has its rewards, in terms of the ability to chose problems and pursue analyses wherever they lead. Our special niche in the policy process appears to be in the development and testing of ideas about alternative policies for biodiversity conservation. With the models now sufficiently vetted and validated, and with a growing number of stakeholders becoming comfortable with technical aspects of the CLAMS work, we plan to undertake analyses of policy problems and potential solutions, contributing a nonpartisan assessment to the forest policy debates in the Coast Range as best we can.

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