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Science FINDINGS

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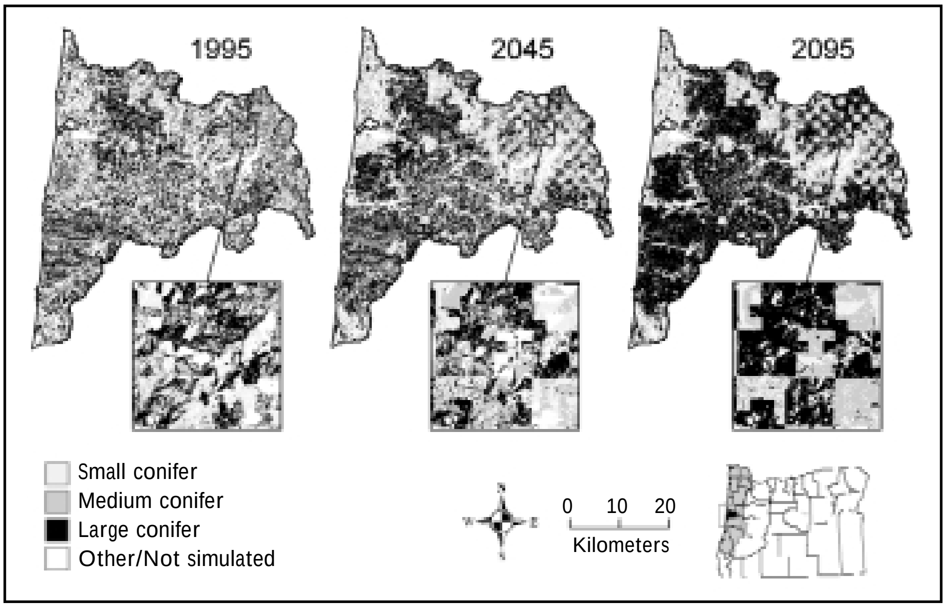
INSIDE

"Science affects the way we think together."
Lewis Thomas

CHANGING THE SCALE OF OUR THINKING: LANDSCAPE-LEVEL LEARNING



Credit: P. Ettinger and K. Olsen

Simulated change of vegetation through time in a mega-watershed of the Oregon Coast Range shows how the landscape patterns will be altered under present management assumptions and plans.

"Like the universal fascination with moving water, or the dance of a fire's flame, maps hold some primal attraction for the human animal."
Doug Aberley, 1993

In contemplating sustainability, we no longer have the luxury of thinking in terms of single issues, single timeframes, or single vegetation types. Complexity, interaction, landscapes, dynamics, and connectivity are the prevailing terms; implications and simulations are key parts of the prevailing outputs. Managing natural resources in a manner that sustains them into the future is a mind-bending exercise, as any policymaker surely knows by now.

When scientists gathered in Portland, OR, in 1993 to debate and craft with land managers what became the Northwest Forest Plan—essentially a kind of bioregional assessment—some of them came away from the experience sobered by their overwhelming concern that they did not have the right kind of data, nor the right handles on it, to do the job they had just been asked to do. The Northwest Forest Plan had grown out of a single-issue crisis—the northern spotted owl and its diminishing habitat—and they believed they needed a more comprehensive approach.

IN SUMMARY

Developing sustainable forestry practices requires a perspective that encompasses whole and large landscapes, and a broad view of time and geographic space. However, understanding and visualizing the effects of different forest policies on ecological and socioeconomic conditions at such scales is a major challenge.

Until recently, we lacked the conceptual framework and analytical tools to study the potential effects of different approaches to forest management over large areas and long periods. With advances in remote sensing, geographic information systems (GIS), and steadily increasing computing power, the ideas for taking the long and the large view can be matched with technologies capable of handling them.

This science finding describes a new approach to evaluating sustainability that helps scientists, policymakers, and the public understand the potential consequences of different forest practices at broad landscape scales.

The Coastal Landscape Analysis and Modeling Study (CLAMS) takes on the analysis of management and policy effects at broad scales. The study integrates remote sensing, inventory plots, GIS, landowner management intentions, and biophysical models to project potential ecological and socioeconomic consequences of different forest policies in a mapped format. The study is trying to anticipate future problems, rather than just focusing on resolving current ones.

The Coastal Landscape Analysis and Modeling Study (CLAMS), a new approach to understanding management and policy effects at broad scales, was the result. CLAMS takes as its field area the entire Oregon Coast Range province, from Astoria in the north, to Bandon in the south, and everything between the Pacific Ocean and the edge of the Willamette Valley.

The study integrates remote sensing, inventory plots, Geographic Information Systems (GIS), landowner management intentions, and biophysical models to project potential ecological and socioeconomic consequences of different forest policies in a mapped format. It also projects the consequences 100 years into the future based on assumptions about environmental and policy changes.

KEY FINDINGS

- Management of natural resources requires an integrated, multidisciplinary perspective, because ecological and socioeconomic processes are often closely linked. The CLAMS approach integrates remote sensing, inventory plots, GIS, landowner management intentions, and biophysical models to project potential ecological and socioeconomic consequences of different forest policies.
- A systems approach helps integrate diverse ecological and social disciplines, it helps identify critical gaps in information and understanding, and it supports an integrated science team and quantitative models.
- Simulation results suggest that novel forest patterns will develop as a result of recently enacted policies. The new landscape shows a predominance of late-successional forests on federal lands and a dominance of early-successional forests and young forest plantations on private lands. State lands will be more diverse.
- Current policies in the Oregon Coast Range province will result in a landscape where contrast and diversity of forest structure and composition will be high between major ownership groups, and low within ownerships.

"Looking at ecosystems across large landscapes is important on three levels: species and ecosystems are shaped by the space in which they occur, information across large geographic areas is crucial to policymaking, and mapped information is a powerful tool for communicating ideas," says Tom Spies, a research ecologist with the PNW Research Station in Corvallis, OR. Spies was among the original group of scientists who identified the need for new ways to analyze landscape-based data, and is co-director of CLAMS with Norm Johnson, a professor of forest policy in Oregon State University's College of Forestry.

"This is kind of a postcrisis bioregional assessment, that is trying to anticipate future problems, rather than just focusing on resolving current ones," Spies says. "The results of our research can be projected across millions of acres of public and private lands and will provide information about consequences to species, ecological communities, and ecosystems, as well as to socioeconomic characteristics of the province such as jobs, harvest value, income, and recreation."

A SYSTEMS APPROACH FOR THE STUDY

How, then, does one go about integrating the study of a landscape totaling more than 5 million acres, with a complex and diverse ownership pattern that includes federal, state, tribal, private industrial, and private nonindustrial lands including agriculture, and with policies ranging from commercial lumber production to habitat reserves? Come up with a systems model, a legacy of the worlds of engineering and ecosystems. In other words, develop a conceptual framework, using a bunch of boxes and lines, that lets you see what the inputs need to be, where the connections are, and eventually helps identify gaps in information and understanding.

"The process of putting together your systems model identifies both information and questions that might not have surfaced as rapidly under a nonintegrated approach," Spies explains. "For example, it became clear early on that we needed to come to terms with specific values for biodiversity—how people valued biodiversity on the ground, and what that valuing might mean across the landscape." The resulting valuation of biodiversity, he says, is a unique piece of work that contributes directly to the implications of other CLAMS findings.

At the heart of the method is an integrated science team, composed of ecologists, economists, fish and wildlife biologists, geomorphologists, GIS specialists and modelers, and others. The team contributes to a quantitative model that spells out a framework for linking different scientific disciplines.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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"We are all trained to narrow disciplines, and the effort to speak each others' languages is pretty intense at first, but the payoff is a much more comprehensive view of the landscape, including the human/social landscape," he says. "Small-scale scientific studies do not necessarily get at the kinds of questions we are now set up to address."

With a systems approach almost anything can be seen as a potential influence on the landscape and may be investigated in depth. Currently, climate change, changes in policy through time, and agricultural lands are outside the scope of the research, but certainly not outside the capabilities of the overall approach, he explains. Already, natural disturbance effects, not initially included in the investigations, are coming on line as a system feature.

LAND MANAGEMENT IMPLICATIONS

- Managers and landowners trying to evaluate sustainability across multiple ownerships will now have tools and information to help meet the challenge. CLAMS maps and future projections provide a powerful medium to communicate the consequences of forest management practices to diverse stakeholders.
- Late successional and old-growth forests will indeed increase over time on Forest Service and BLM lands. This analysis supports one of the key assumptions and hypotheses of the Northwest Forest Plan.
- Simulations indicate that some ownerships may be affected by conditions on adjacent ownerships as contrasts in habitat increase through time. For example, the BLM "checkerboard" lands may have less biological potential for some species than if the same lands were concentrated in large blocks.

Although some of the socioeconomic aspects of the study are not yet mappable, some are; recreational opportunities, for example, will ultimately be placed, and projected, across the landscape.

LOOKING AT NEW FOREST LANDSCAPES

Connections and complexities and known sets of assumptions (think of them as relations, conflict, and context) produce stories. What stories emerge from the CLAMS landscape simulations?

Landscape simulations as far into the future as 100 years suggest that novel forest landscape patterns will develop as a result of recently enacted policies.

"The new landscape will be characterized by a predominance of late-successional forests on federal lands and a dominance of early-successional forests and young forest plantations on private lands," Spies says. "Lands owned by the state of Oregon will have a greater diversity of forest stages than other ownerships. The policies in the province will result in a landscape where contrast and diversity of forest structure and composition will be high between major ownership groups and low within ownerships."

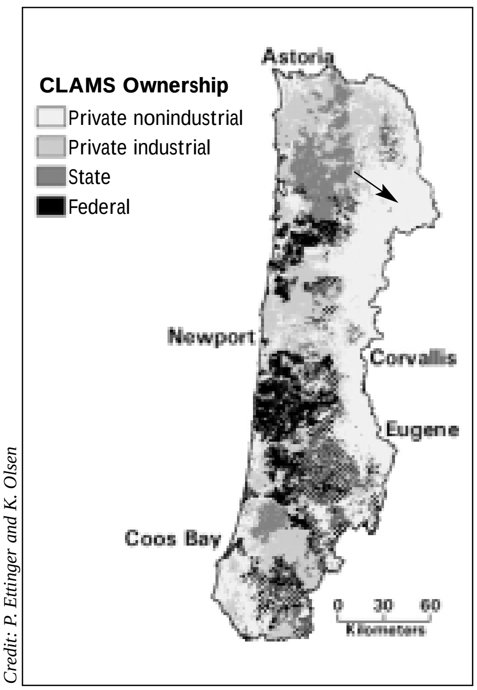
With such stark contrasts developing between different ownerships, the landscape view becomes even more crucial, he says, with a need to evaluate such consequences on scales sufficient to avoid the alarming or reassuring appearance of individual plots of land.

"The new, potentially high-contrast landscapes, with alternating patches of young and old forest, help people see the project in real terms. The visualization on a map really strikes home, and it leads more rapidly to the central question, What are the implications of these outcomes?"

For example, the Siuslaw National Forest is predominantly placed in reserve under the Northwest Forest Plan, the thinking being that it is mostly surrounded by private land, which would be logged on a regular basis. What becomes clear from looking at the simulations of the landscape through time, however, is that young, ecologically diverse forests will become rarer, and midsuccessional ages (80 to 200 years old) will eventually decline if there are no natural or natural-like disturbances.

Clearly, this raises questions about ecosystem processes and habitat availability for certain species. Will the plan ultimately fail those species and processes? What midcourse corrections might be available?

The findings will thus be of value to the scientific community and others who are looking for ways to link human decision-making with ecological consequences, and from there to evaluate the effects of certain patterns of land use on ecological processes. The tighter this link, the greater the relevance of any associated research, he points out.



Credit: P. Ettinger and K. Olsen

The Oregon Coast Range is home to millions of acres of mixed ownership ranging from large private industry, to federal and state government, tribal lands, and nonindustrial private holdings. Management across such ownerships can be extremely complex.

WRITER'S PROFILE

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ANALYZING MULTIPLE OWNERSHIPS

Policymakers and managers struggle with many different kinds of cross-boundary landscape problems, Spies notes. In the Pacific Northwest, various species of salmon spend parts of their life cycle in different ownerships in a watershed, requiring conservation actions that may affect private lands. Natural disturbances such as fire and flood, which are ultimately beneficial to diversity in a landscape, can cause severe economic losses and social upheaval in particular ownerships.

"Multiownership management problems frequently come down to finding ways to get owners and agencies to modify or coordinate their individual behaviors to achieve some aggregate values for the landscape as a whole," Spies notes. "This can be done through the stick approach—laws and policies; the carrot approach—subsidies and tax relief; and the knowledge approach—information about effects of behavior that might motivate some owners to change voluntarily. But each approach requires some assessment of the ecological conditions of a landscape, and the ecological and socioeconomic consequences of different courses of future action."

Thus, the tools produced by CLAMS can make a significant contribution to solving complex natural resource problems by identifying the various ways in which ownerships interact in a landscape.

"The mosaic of different management practices creates potential interactions across the landscape that can affect the overall ecological and social conditions of the entire province," Spies explains. "In addition, the management outcomes within individual ownerships potentially can be altered by management activities on neighboring ownerships." The results include uneven representation of various biotic communities, physical environments, and disturbance regimes across the landscape, as well as ecological interactions such as wildlife migration and distribution that move across property boundaries.

The CLAMS evaluations of these and other landscape and ecosystem management issues indicate that the greatest obstacles for continued integration of landscape ecology into multiownership planning and management are not scientific and technological, but social.

"Different stakeholders often see differences in the state and direction of ecosystems and the feasibility of new approaches," Spies says. "While our ability to visualize and understand the function of ecosystems over large areas and long time periods and to grasp the interdisciplinary linkages is typically inadequate, the technologies and knowledge used by CLAMS can certainly help."

The CLAMS partnership of landscape ecology and new technologies can facilitate shared learning about multiownership landscapes and thereby foster integration of landscape concepts into planning and management, he says. The central problem, however, is that no current policies specifically mandate multiownership planning, and no public agencies have the broad authority over it.

Some limited multiownership activities such as the salmon recovery plan in Oregon, requiring voluntary approaches to whole watershed management, will perhaps lead the way.

RECOGNIZING SCALE AND MODEL LIMITATIONS

The strengths of new perspectives offered by CLAMS work are perhaps offset by the challenge of finding appropriate scales of information needed to evaluate landscape effects, and of identifying landscape-scale ecological goals, criteria, and indicators.

"Integrated studies of large landscapes are fraught with scale problems. The space and time scales of ecological, policy, and socioeconomic processes and measures typically are not the same," Spies says. "Continuous attention to scale is needed to find ways to insure that changes in one component will not create scale or resolution mismatches with other components."

The most immediate application problem comes with pixel size on a digital CLAMS map. Watershed councils, for example, are very focused on restoration projects at the scale of their local creeks and rivers. Might they dismiss CLAMS as not useful because it is at too gross a scale?

"CLAMS is fundamentally a set of tools that can provide insights and inform debates, rather than a decision support system that can provide actual management solutions," Spies points out. "We think of it as being on the forefront of opening our eyes to larger phenomena, of changed ways of thinking about the world."

Using one of the CLAMS models—vegetation, habitat, recreation—might help a decisionmaker to understand the consequences of one decision versus another. But as yet, the finer data are not included. Not only would accurate fine-scale data take immense amounts of time to gather and validate, the model simulations would take exponentially longer to run under current computing power. Expense becomes an issue.

What about habitat issues?

It is clear now that any single approach to quantifying biodiversity will have limitations, and CLAMS researchers encountered that problem early in the project. They elected to use a suite of approaches ranging from focusing on single species, to multiple species, to whole ecosystems and natural disturbance regimes. They assess habitat quality for selected species by using "habitat capability indices" that are quantitative models based on a synthesis of previous studies and general principles of wildlife ecology.

"Of course these models can be questioned, but we can show how uncertainty affects results, and we are in a process of continually improving our information. In the absence of perfect knowledge, how else can we characterize the potential for habitat to be sustainable?" Spies asks.

A question about limitations of the fish and wildlife component of CLAMS leads Spies to a comparison of what is available via CLAMS data and what was available just 9 years ago when the Northwest Forest Plan was formulated.

"There are habitat conservation decisions being made all the time under the plan with a much less rigorous underpinning than we have developed in CLAMS," he says.

TAKING SCIENCE AND TECHNOLOGY FOR GRANTED

CLAMS findings will undoubtedly come under more close questioning than they have already faced. One interpretation is that they will always be victim of their own progress, in the sense that they have ratcheted up the expectations of research and technology, and made people somewhat impatient with the need to wait for data, or improve it, or fine-tune the way a model analyzes it.

"The technology behind what we are doing is completely invisible to the people who might become, or wish to become, potential users. It is immaterial to them that 10 years ago, even 3 years ago, the computing power to do some of this work simply didn't exist," Spies notes.

Further, his best guess is that if he didn't have to go through the rigorous peer review process of checking data and models and findings and assumptions, and if the team hadn't consciously chosen to work with landowners to establish management intentions and then verify their findings, they could have achieved twice as much. Not that he had in mind skipping these crucial steps!

"But I would suggest that the need to defend our science in the public arena takes away far more time from us than it does from advocacy organizations that may rely more on headlines than scientific research to promote their ideas." This good-natured analysis underlines the ever-present issues of trust that provide the context in which federal and state research scientists must work.

Large models, such as these, can become mistrusted or misunderstood, especially if expectations for them are too high. "We try to emphasize that our simulations are not predictions—we think of them as computer experiments under a particular set of assumptions," Spies says. "In this context the models should help scientists, managers, and the public learn what we know, as well as what we don't know, at these scales. If the models can help us identify options for achieving our goals, then we are absolutely on the right track."

"The watershed is the first and last nation, whose boundaries, though subtly shifting, are unarguable. Races of birds, subspecies of trees, and types of hats or rain gear go by the watershed. The watershed gives us a home, and a place to go upstream, downstream, or across in."

Gary Snyder

Photo credit: T. Spies

Coast Range landscape showing pattern of agriculture in valleys and intensive forest management in steep uplands.

Photo credit: T. Spies

CLAMS researchers meet with managers from Willamette Industries during a CLAMS field trip in the Oregon Coast Range. Scientists have sought cooperation with industry in verifying vegetation and other data.

FOR FURTHER READING

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STATION LAUNCHES NEW PUBLICATION

Science Update, a 12-page color publication, offers scientific knowledge for pressing decisions about controversial natural resource and environmental issues. The first issue, published in May 2002, can be found online at the PNW Research Station Website at **www.fs.fed.us/pnw**.

Science
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See the CLAMS website for more information at www.fsl.orst.edu/clams