The last 10 years in the Pacific Northwest have seen the greatest turmoil in forest policy since the National Forest System was established in the early 1900s. Science, politics, and society are playing new, changing, and often pivotal roles. Conflicts over meeting ecological, economic, and social demands on forests have produced widespread anxiety.

Sweeping changes in policies for Federal lands have caused a dramatic shift toward protecting biodiversity; state forests in the region are refocusing management to improve the compatibility of species protection with timber production. Policies for managing riparian areas of private forest lands have been modified as well, and may continue to be as species listings pose difficult challenges. Both scientific and economic uncertainty raise concerns, which are then exacerbated by fear of further policy changes; viewpoints on the issues are loudly vocal; opinions are passionate. We are far from being finished with debates over forest policy.

CLAMS

CHANGING THE WAY WE LEARN:
CLAMS and the future of land use

What is the availability of timber across the landscape? What will contribute to quality fish habitat? Will policy change affect owl and murrelet habitat? How can I manage simultaneously for wildlife and timber goals? What is happening on my neighbor's property that might affect, or be affected by, what happens on mine?
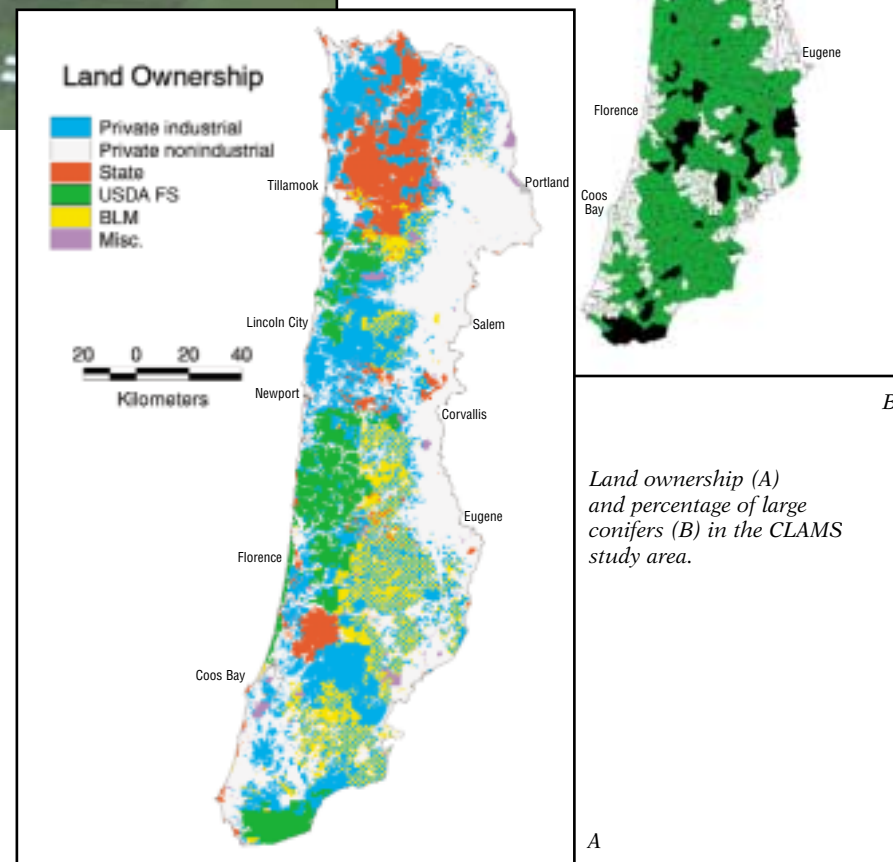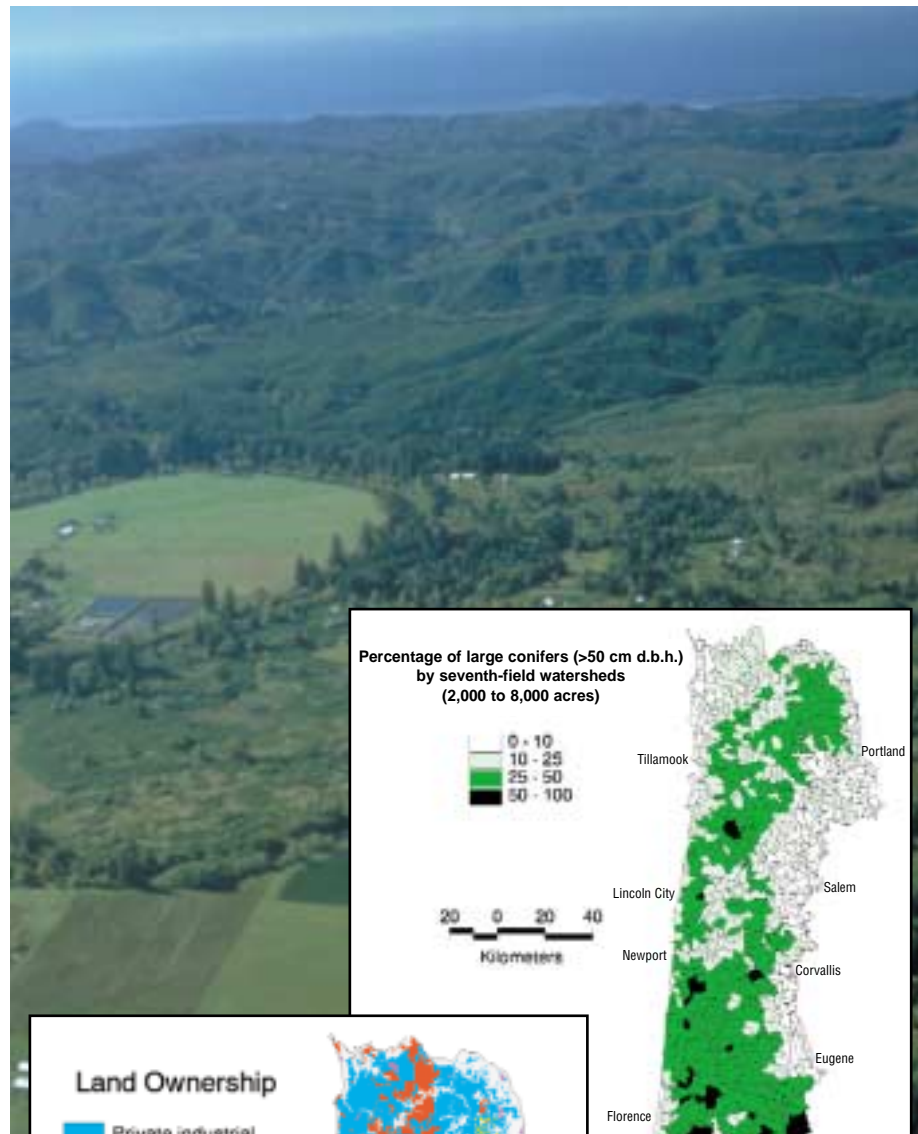
Such questions are the difficult stuff of land management and, until recently, were usually approached on an owner-by-owner, species-by-species basis, with limited information, despite the demands of new forest policies and regulations. Two related questions: How do we learn about the Coast Range and its potential? and Can integrated research help develop a credible means to evaluate policies?

Enter, the coastal landscape analysis and modeling study, or CLAMS, a joint research project of Oregon State University (OSU), College of Forestry; the USDA Forest Service, Pacific Northwest Research Station; and the Oregon Department of Forestry. The research focuses on the Oregon coast, from the ridge of the Coast Range to the ocean, from Astoria to Port Orford—an area containing the state's most productive forests and streams and covering a diverse and complex mix of ownerships.
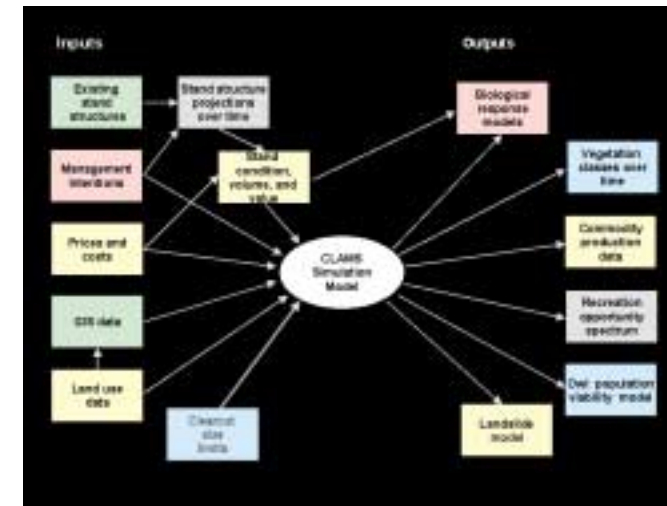
Ultimately, CLAMS will produce a set of tools for use in assessing sustainability of different forest and land use policies through time for visualizing how both social and ecological change will affect the landscape; in other words, detailed dynamic mapping of the **whole** landscape, including human decisions made across that landscape.

It also provides tools for the imagination. "We are part of a new way of thinking," says Norm Johnson. "The CLAMS work enables us, at last, to think of the entire landscape, not just our own small piece of it, and consider how our actions will affect it. These tools encourage us to learn about effects together, rather than considering them from only our own viewpoints."

Not only that, he says, but the effort to integrate social and ecological data has profoundly influenced how the research gets done: "There is an extremely important social process of 'joint learning' from the maps we

Percentage of large conifers (>50 cm d.b.h.) by seventh-field watersheds (2,000 to 8,000 acres)

0 - 10
10 - 25
25 - 50
50 - 100

B

Land ownership (A) and percentage of large conifers (B) in the CLAMS study area.

A

CLAMS uses a systems modeling approach to establish the relation among forest policy, landowner behavior, forest succession, landscape or watershed condition, and biological and socioeconomic outputs.

progressively produce, which leaves behind the notion that science knows best, and takes a more broad-based approach to finding policy answers." Johnson is professor of forest resources in OSU's College of Forestry and a lead investigator on the CLAMS project. "In essence, it could change the whole debate," he says. "It could lower the level of rhetoric and raise the level of understanding."

As many as 40 different researchers and graduate students, with specialties in ecology, economics, forest management, social sciences, hydrology, wildlife biology, modeling, geographic information systems (GIS), remote sensing, and more, have been involved in CLAMS. Data for the project come from satellite remote sensing, GIS layers, and field plots. In an unusual "joint-learning" step for private forestry and public research, landowner evaluation of modeling assumptions and simulations are used to improve the utility and accuracy of CLAMS tools.
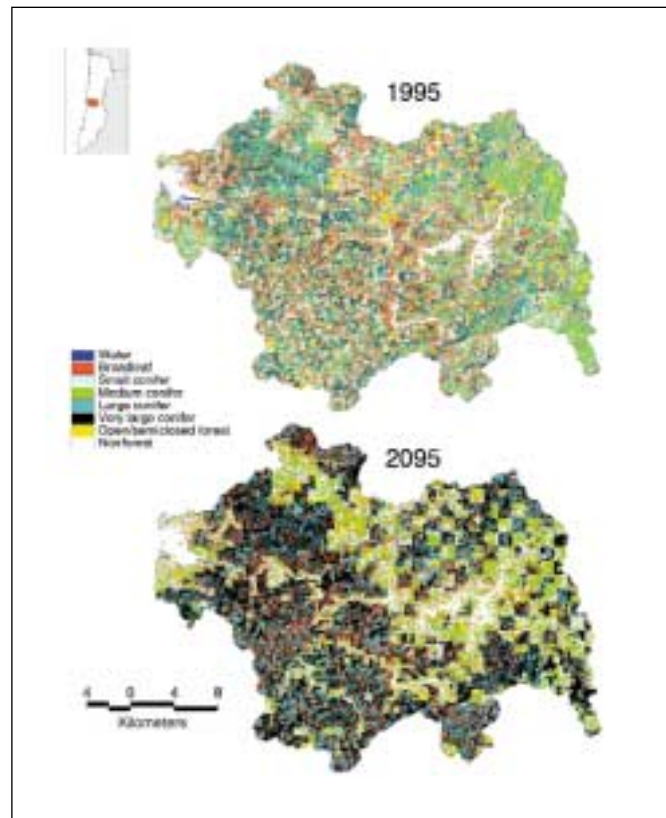
How Might CLAMS Be Used?

The tools emerging from CLAMS—most notably detailed watershed maps depicting landscape change through time but also several models and a "braintrust" of interdisciplinary researchers—offer a wealth of assistance for various players. The Oregon Board of Forestry has reshaped its Forestry Program for Oregon (FPFO), and the CLAMS models should be very useful for its next statewide forestry assessment. The board has regulatory authority for state and private lands but considers all of Oregon's forest land in its assessments. Johnson believes that the CLAMS models and analysis could form the analytical backbone for part of the board's next analysis of Oregon's forests.

"One objective added to the most recent FPFO (1995) could greatly influence how assessments of sustainability are done in the future," says Johnson. It reads: "Successful policies and strategies must be based on an assessment of forest ecosystem conditions at a landscape scale to assure the sustainability of natural resource-based economies and the ecological integrity of Oregon's forests."

The CLAMS models and maps also could be useful for technical assessment work that must be done by watershed councils; for baseline assessments on Federal lands; to cities and counties looking at the current and future conditions of their lands; to private landowners, industrial and nonindustrial, trying to foresee the effects and implications of various management options on their lands; to OSU Extension faculty working with landowners to consider best restoration efforts at a landscape scale; and to the Governor and his natural resource advisors to steer the Oregon Plan for Salmon and Watersheds.

The CLAMS maps and models will play a key role in helping Federal land managers evaluate and monitor the Northwest Forest Plan. And they will, by offering the whole landscape view, encourage partnerships, collaboration, and the kind of "visioning" process that some cities are already trying.

The CLAMS study area includes more than 5 million acres in Oregon, extending from the ridge of the Coast Range of Oregon to the ocean, from Astoria to Port Orford.

Draft of projected vegetation in the Alsea basin, Oregon.

Building Better Tools for Assessing Sustainability

The CLAMS project grew out of the coastal Oregon productivity enhancement program, which promoted integrated management of Oregon's Coast Range forests. The project reflects the desire of researchers to improve the process that was used by the Forest Ecosystem Management Assessment Team leading up to the Northwest Forest Plan.

"The process was subjective and nonreproducible, an imperfect way to analyze policy," says Johnson. Adds Tom Spies, "All we had to work from were general zoning maps. We had no models to show spatial relations—how things fit together over a large area with diverse ownerships. Certainly nothing dynamic through time." Spies is a research forest ecologist with the Pacific Northwest Research Station and a lead investigator with CLAMS.

The policies that now exist in western Oregon were put in place without the benefit of simulations of likely landscape conditions, outputs, and effects associated with the policies for different ownerships through time, Spies and Johnson say. Rather, they were based largely on a mixture of data from stand-level studies, intuition, and subjective judgment, focusing on one ownership at a time, and without the ability to consider explicitly the landscape dynamics caused by natural disturbance forces, such as fire, flood, and landslides.

The two central goals of CLAMS are (1) to develop and evaluate concepts and tools for understanding the patterns and dynamics of provincial ecosystems of the Coast Range and (2) to analyze the aggregate ecological, economic, and social implications of different landowner policies there.

How Does the CLAMS Model Work?

An enormously complex undertaking, the general CLAMS model has been built from existing knowledge of ecosystem dynamics, which addresses such questions as, How do trees grow and yield both timber and other ecosystem products under varying landscape conditions? Which wildlife habitat is most productive, and what interactions affect its status? How and when do landslides occur? How does the landscape respond to different management prescriptions, from clearcut to no cut? and How do streams and flooding influence landscape and vegetation?

Each of these relations will be quantified mathematically in order to run a model that will simulate what could happen under certain conditions. There are, of course, no guarantees that any component of the landscape will behave exactly as projected. Existing knowledge of ecosystem dynamics is constantly improving but never absolute—"all models are wrong because they are simplifications of complex reality," as Spies points out. "The act of modeling helps us identify where our understanding and information are incomplete."

Add to this the human element of management decisions over time, and the complexity becomes stratospheric. He notes that the CLAMS team is developing modeling protocols as they do the research, it is so new.

"We cannot claim 100-percent accuracy, and people need to understand that these projections are akin to long-term weather forecasts: they are highly educated guesses, but skepticism is well-founded," says Spies. "What they do give us, however, is a good look at the overall big picture. They give us a method for weighing and comparing alternatives. They give us common currency and understanding, to work toward common ground and agreement." Johnson likes to compare the maps to Impressionist paintings: perfect for conveying the overall impression, a little hazy up close.

What Does CLAMS Show Happening on the Ground?

Projections of what happens to the landscape under different management strategies will be done at the large river basin scale, with smaller subwatersheds (3,000 to 5,000 acres [about 4828 to 8046 km]) also recognized. The Alsea and Nehalem watersheds were selected first to illustrate contrasts among different ownerships, with much of the central coast Alsea being Federal lands, and much of the north coast Nehalem being state and forest industry lands. Preliminary results will be refined through discussions with landowners.

In the Alsea basin watershed, the amount of old forest increases over time, Johnson says, especially conifer-dominated old forest, largely because of the new policies on Federal land and because the boundaries of Federal and non-Federal land become clearer. The patchy nature of past Federal harvest policy of small clearcuts significantly decreases. The total area of hardwood forest stays about the same.

In the Nehalem basin watershed, the amount of old forest also increases, largely because of emerging state lands policies, with the boundaries between state and forest industry lands becoming clearer. The total area of hardwood forest also stays about the same over 100 years. An index of old-growth forest structure rises over time on Federal and state lands. On forest industry lands in both basins, amount of old growth stays constant, or decreases.

Total harvest volume per year—largely softwoods—would come mostly from the forest industry in both basins, with some thinning of Federal stands anticipated in the Alsea. In the Nehalem, the state harvest increases over the next 80 years. In both basins, clearcutting would provide most of the volume from private lands, whereas thinning would provide most wood coming from Federal and state lands. Under these simulations, however, less than 1 percent of each basin each year would be clearcut.

Additional Features Planned for CLAMS

"We currently report just the board feet of harvest by hardwood and softwood," Johnson says. "We plan to recognize the types and quality of wood products that will be produced, even estimating the distribution of the harvest volume among different lumber grades and by species."

There will be habitat models for several wildlife species, reflecting the range of habitat conditions available in the Coast Range. These will include the northern spotted owl, the marbled murrelet, elk, and salmon. A map-based description of recreation opportunity is planned, along with a means for estimating economic effects of timber harvest, based on log-flow relations and an economic impact model.

"We hope that using an approach that considers social, economic, and ecological issues in an integrated form will become the norm rather than the exception," Spies says.

With the maturing of the research, CLAMS also now has communication goals: providing information about the project to diverse audiences not normally considered as research recipients (watershed councils, city and county planners, nonindustrial private foresters, and business and environmental groups) and "ground truthing" the data by seeking feedback from government and private landowners on the accuracy and utility of the models.

For example, meetings with Oregon Forest Industry Council members helped researchers better understand how private foresters make their land use decisions, thereby enabling the CLAMS models to more closely represent management intentions across the landscape and into the future. The meetings also allowed the private foresters to see how the CLAMS model was built and what kinds of assumptions are behind the CLAMS view of the future.

"The value of these meetings is significant in helping both researchers and industry people to understand each other's world views, in building trust, and in bringing our modeling projections as close to reality as the technology will allow," says Spies.

What Stories Does CLAMS Tell So Far?

Most importantly, CLAMS will show us how the resource conditions of the Oregon coast might develop through the 21st century under current policy—location of resources, remaining old growth, forest fragmentation, the complex ownership mosaic, wildlife, streams and aquatic habitat, potential for timber production, recreation opportunity, and biodiversity. Starting with the current condition, the models project into the future in 5-year increments, to suggest what might be the outcomes of current (or other designated) land use policies.

Some historical work is also available through CLAMS, with images of how vegetation has looked over the last 20 years, and even a long-term "snapshot" as far back as 3,000 years ago.

Built into the models are assumptions about the management intentions of five landowner groups—Forest Service, Bureau of Land Management, state, nonindustrial private, and forest industry. An assumption also is made that modeling errors are not significant enough to alter the overall, "big picture" outcomes depicted.
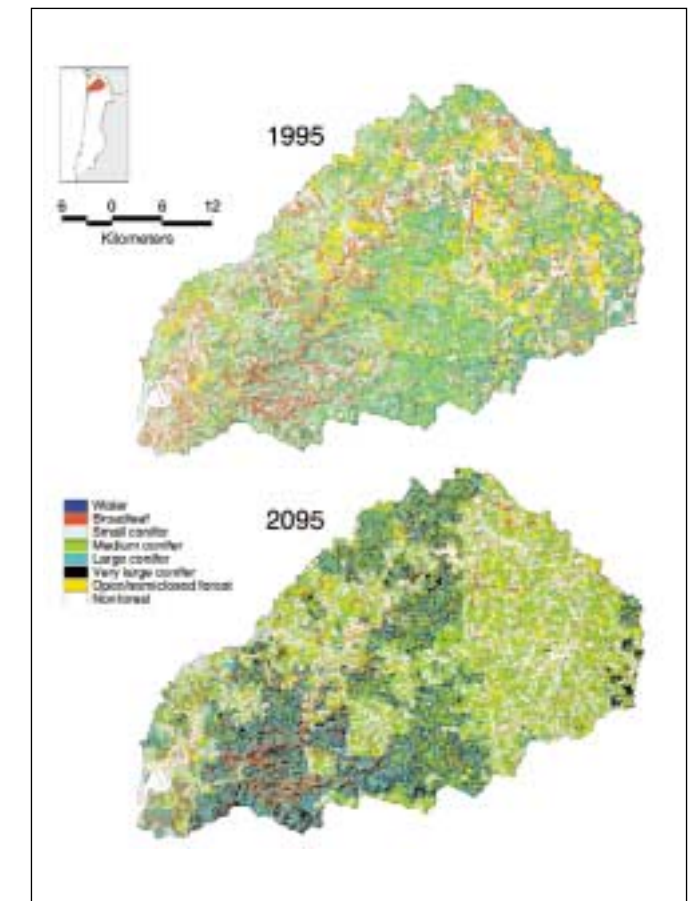
Draft of projected vegetation in the Nehalem basin, Oregon.

Critique of the models, with input from the state, Federal agencies, industry, and extension faculty, began in early 1999.

With its ability to show how landscapes may change in somewhat predictable ways in the future, the CLAMS work will contribute to decisions about conservation, restoration, and timber management. Projections of different levels of management, from intensive to very little (e.g., on reserves), could be used to estimate whether management practices are sustainable across whole landscapes through time.

The watershed-habitat quality models, once completed, will locate watersheds with high and low salmonid habitat potential, based in part on locations where there are big trees and where unstable areas with high likelihood of landslides exist. Other fish-related stories come strikingly clear when represented spatially. First, Federal lands alone do not control all fish habitat. For example, in some parts of the Coast Range, steelhead and chinook may do as much as 100 percent of their spawning on Federal lands, but smolting often occurs in streams flowing through private agricultural lands. Thus the fish story unfolds on agricultural as well as forested lands, thereby highlighting the need for a whole-watershed perspective.

Water resource management will move more dramatically into the spotlight as tourism and population expand. Municipalities in the Coast Range and along the coast already face a tenfold increase in water demands during summer. With limited water storage facilities in the Coast Range, sustainability and management of water resources will become central issues.

How Will People Interact With the Landscape?

The people stories developed under CLAMS cannot all be mapped, but they flesh out our understanding of present conditions and future trends. Just as the state of the watershed clearly affects fish numbers, so it affects human choices within the region.

The three key factors affecting resource use by people in the coast are the attraction of beaches, the rivers and their abundant salmon. and the forests and their abundant timber. "Although timber now plays a lesser role in coastal economies because a lot of processing has moved inland, the land area encompassed in the CLAMS model is the most productive 5 million acres of timberland in the United States," says Johnson. "Fully half of Oregon's future timber supply is scheduled to come from the sparsely populated area between the beaches and the Willamette Valley."

Land use will change most around urban fringes, which are located in a narrow strip along the coast and the edge of the Willamette Valley; retirees and inmigration may change the overall social and aesthetic values along the coast, particularly because a higher proportion of the coastal population than that in Oregon or the United States as a whole is over 65; thus outside capital is now fueling a service economy, with recreation and tourism growing in importance in an area once dominated by primary industry. And one more discovery: in most parts of the Oregon coast, you cannot get farther than 1.5 (2.4 km) miles from a road.

"When we combine our social and ecological information and put it together in map-based simulations, it draws people in; it lets them put themselves in the landscape, and they thereby become more willing to think through what the future will actually look like," says Johnson. Soon CLAMS will review the results of a survey to find out how coast residents view and value biodiversity.

"I see the results of this attitude survey as potentially establishing an important link between the socioeconomic aspects of our work and the ecological side," says Johnson. "This is where we find out whether people care enough about sustaining biodiversity to actually pay for it."

The compilation of ecological, social, and economic data indicate that planning **must** evolve beyond the traditional project-by-project, species-by-species scale. It is conceivable, according to Johnson and Spies, that by working with the entire landscape as context, management activities can be designed across ownerships, thereby increasing the potential for compatibility between all those competing forest uses.

The CLAMS team has significant research and technical work yet to complete. "Fine-scale features such as down wood often have not been captured and, in fact, have been ignored in our forest inventories because they were not considered important," says Johnson. "However, we know now how crucial they are to wildlife habitat, so we are committed to including them in CLAMS as accurately as possible."

Other challenges include incorporating the best possible elevation maps of the Coast Range, to help establish which are the stable slopes for landslide and fish models. The representation of forest inventory may have "overaggregated" diverse elements of the landscape, including management decisions. Modeling of nonindustrial owners is problematic, as is portrayal of agricultural lands. Finally, much is yet to be learned about how this kind of technical-visual information influences decisionmaking about natural resources. Providing access to it for landowners and managers of all kinds remains a challenge, but is a primary communication goal.
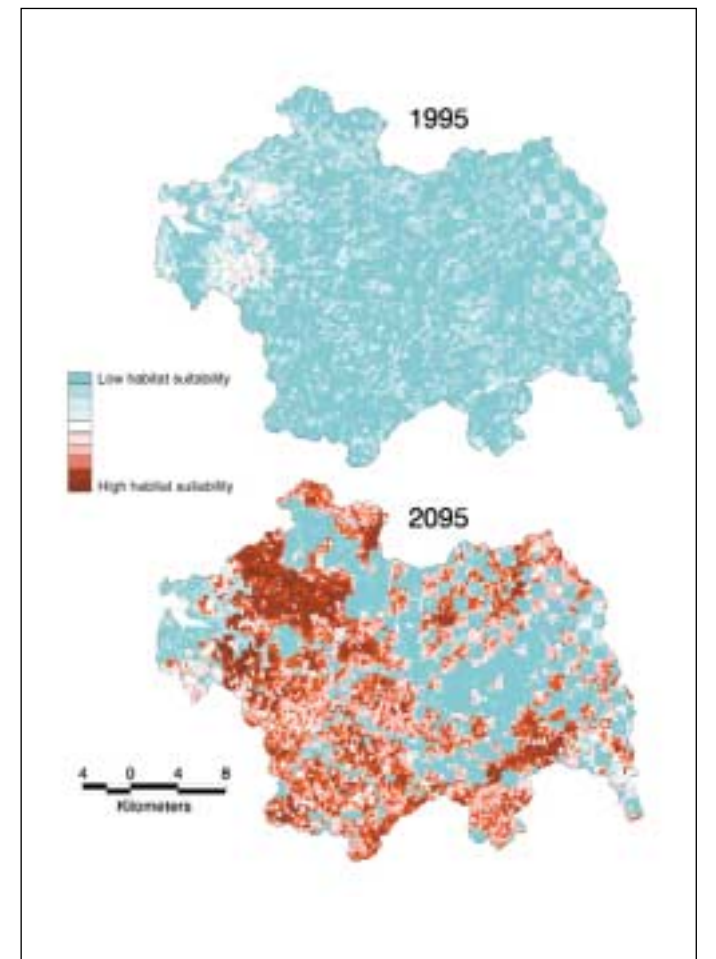
Draft of pileated woodpecker habitat in the Alsea basin.

For more information contact:
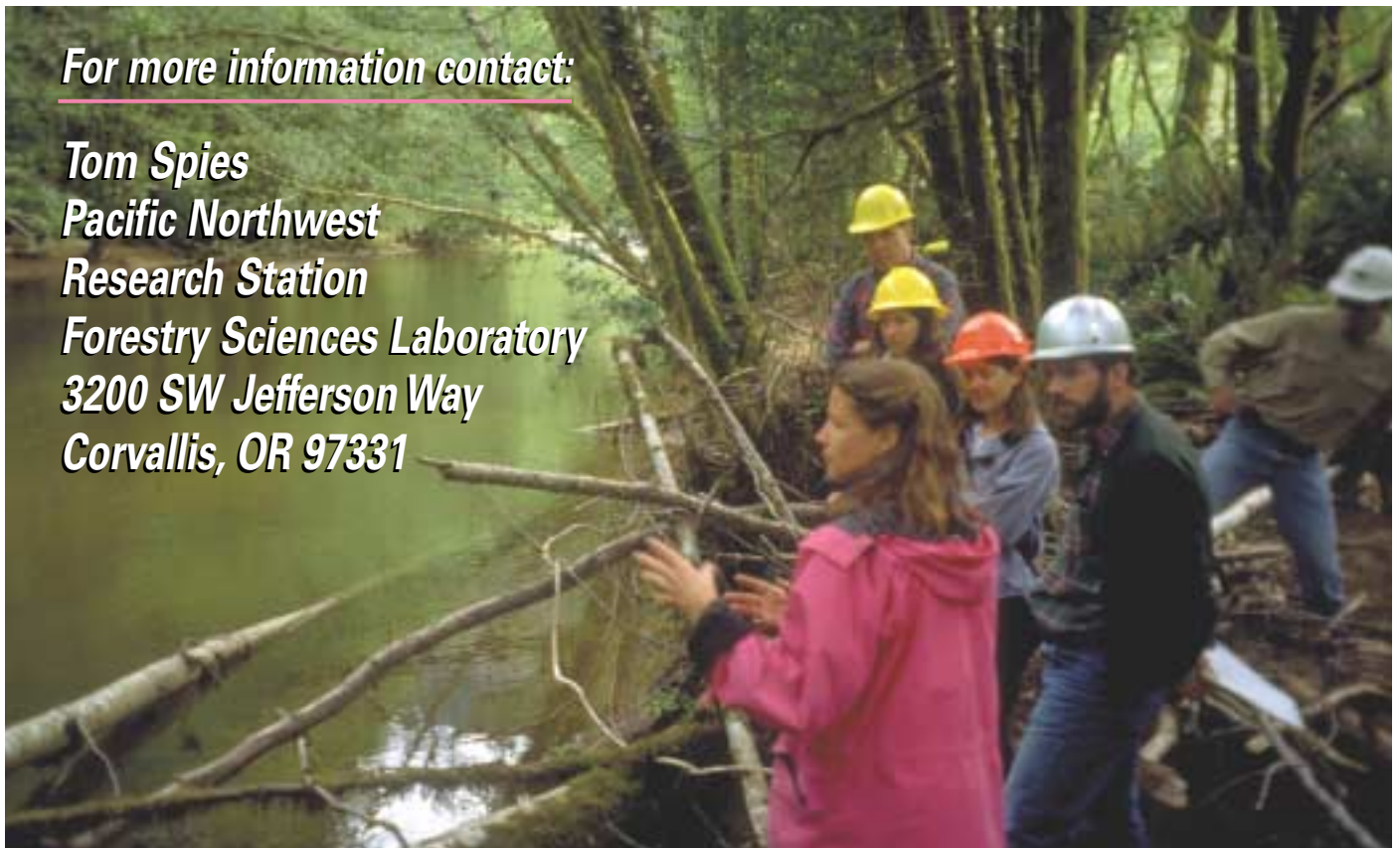
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