OREGON FOREST
RESOURCES INSTITUTE

Oregon Forest Resources Institute
317 SW Sixth Avenue, Suite 400
Portland, Oregon 97204
971.673.2944
800.719.9195
www.oregonforests.org

Leslie Lehmann, Executive Director
Dave Odgers, Director of Communications
Mike Cloughesy, Director of Forestry

Acknowledgements:
The Oregon Forest Resources Institute is grateful to the following experts for their assistance in the preparation of this report: Tom Spies and Eric Forsman of the Pacific Northwest Research Station in Corvallis; James Agee of the University of Washington; John Hayes and Tom Manning of the Oregon State University College of Forestry; Sara Leiman of Coast Range Conifers; Larry Irwin and John Cook of the National Council for Air and Stream Improvement; Steve Mealey of Boise Cascade (retired); James Rochelle of Rochelle Environmental Consulting; Chris Maguire of the Oregon Department of Transportation; Steven Buttrick of The Nature Conservancy and Ted Lorensen of the Oregon Department of Forestry.

Project Management:
Feinstein Group, Ltd.
Design: Joseph Erceg
Photography: All photography by Michael and Josh Feinstein with the following exceptions:
page 3 (bottom) Gerald and Buff Corsi © California Academy of Sciences;
page 4 (bottom) James Rochelle;
page 6 (top right) Courtesy of NCASI.

#0206

On the Cover: Tom Manning, an OSU senior research assistant, monitors bat activity on the site of the 2002 Davis Lake fire on the east slope of the Cascades with the aid of a bat echolocator. This new technology enables scientists to learn the effects of post-fire logging on bats in ways that would not have been possible a decade ago.

♻ Printed with soy-based ink on recycled paper, 0406

WILDLIFE AND ECOSYSTEM DYNAMICS

Protecting Wildlife in Dynamic, Unpredictable Ecosystems

A Special Report of the Oregon Forest Resources Institute

Unraveling the complexities of wildlife behavior and the relationships of animals to their habitats has always presented formidable challenges to scientists. Researchers, aided by sophisticated computer models and new technological advances, continue to improve our understanding of how animals interact with their habitats and with other species. The work of these biologists and ecologists is important to forest managers because science forms the basis for the most effective management practices that aim to create and conserve desirable habitat for forest-associated species.

For decades now scientists have understood wildlife/habitat relationships in the context of ecosystem dynamics – that is, the constantly changing nature of how plants, animals and natural forces interact. Dynamic nature is a paradigm familiar to scientists but not yet well understood by the public at large. This report describes the current state of wildlife research in light of ecosystem dynamics and its implications for the practice of forestry. Its length and complexity reflects both an attempt to capture the nature of discussions that are still taking place among scientists and the complexity of the subject itself. As a result, this special report, unlike others in the OFRI series, is somewhat more technical and directed more to professionals as they look toward examining forest protection laws in the context of dynamic nature.

Highlights

- Forest ecosystems are highly complex and difficult to fully understand or predict, especially since they are constantly shifting and delivering "surprises." This is the basis of the dynamic theory of nature.
- Most ecologists have long understood that ecosystems are dynamic rather than static – something that is not well understood by the general public. While scientific understanding of these interactions has grown considerably, even at their best, scientists still only partially understand how ecosystems work at any point in time.
- Ecosystem dynamics have enormous implications for forest management and conservation of diverse forest wildlife habitats.
- New technologies and tools in wildlife research have enabled dramatic advances over the past decade, to the benefit of science and forest management.
- Many public expectations as well as state and federal natural resource policies continue to be based upon a static view of ecosystems – that there is some balance or equilibrium condition that stabilizes ecological change. This has resulted in some unintended and adverse consequences to the ecosystems that we are trying to "protect."
- The Oregon Board of Forestry will soon begin a methodical evaluation of the Oregon Forest Practices Act in the context of dynamic ecosystem theory. New scientific insights are leading to a re-examination of the whole concept of forest "protection" and how it can be achieved most effectively in dynamic ecosystems.

Eric Forsman, a research wildlife biologist with the U.S. Forest Service Pacific Northwest Research Station in Corvallis, is one of the nation's leading experts on the northern spotted owl. He is pictured here in OSU's McDonald-Dunn Forest outside Corvallis, a teaching, research and demonstration forest that also is managed to produce revenue for the OSU College of Forestry. Forsman and other researchers are studying the implications of finding some owls and owl habitat in these forests.

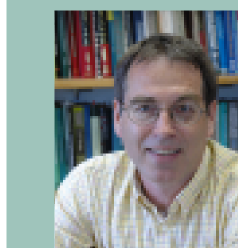
The Riddles of Wildlife Diversity

At first inexplicably, willows began growing profusely in Yellowstone National Park after decades of being so heavily browsed that they appeared to be absent, according to an article in the October 18, 2005, *New York Times.* The apparent cause of the earlier decline was overuse by a growing elk population. When wolf biologist Douglas Smith began piecing the puzzle together, he found a relationship between the reintroduction of wolves into the park 10 years earlier and both the growth of willows and the movement of elk. His hypothesis was that the wolves' presence set off a number of changes, among which were a gradual reduction in elk numbers due to a decline in calf survival and the movement of elk to higher ground for self-protection. That left willows – which previously had grown profusely along stream edges and whose shoots are eaten by elk – free to grow again.

Much of Smith's wolf hypothesis was based on the groundbreaking Yellowstone research of Oregon State University's William Ripple and Robert Beschta. In the late 1990s, Ripple and Beschta, professors in OSU's College of Forestry, began to study the disappearance from Yellowstone of aspen and cottonwood, which had stopped regenerating in the 1920s. After eliminating other logical causes, like climate, fire suppression and natural stand dynamics, they noted that it was during the 1920s that wolves were shot, poisoned and eliminated from the Yellowstone ecosystem, thus enabling populations of elk, which eat the young aspen and other woody vegetation, to increase. It was Ripple, Beschta and OSU graduate student Eric Larson who employed the "trophic cascade" hypothesis referred to in the *New York Times* article to describe this syndrome. While not all biologists concur with this conclusion, the hypothesis was that wolves triggered far-reaching ecological effects on ecosystem structure and function, including effects on other vegetation types, stream channel stability and predator/prey dynamics, as well as changes in habitat for beaver, fish, birds and other species. A range of other factors – such as winter weather, drought, flooding, fire and the interacting roles of other resident large carnivores and herbivores in Yellowstone National Park – likely affected relationships between wolves and elk as well. How and when these factors come into play and to what extent has not yet been definitively determined.

Ecosystems at Work

The article goes on to state, "Wildlife biologists and ecologists are stunned by the changes they have seen." In fact, many biologists had anticipated that the introduction of wolves would reduce the elk numbers and the browsing pressure.



Tom Spies
Research Forest Ecologist
Pacific Northwest
Research Station
Corvallis

"Managing dynamic ecosystems requires a landscape view and recognition that shifting public values affect what we demand from our forests – from timber to clean water, a diverse wildlife community and more. There is much we don't know, but we're learning how animals 'read' a landscape and how landscapes themselves behaved under the natural disturbances that native species are adapted to. For example, we have learned that fire and wind disturbances created a natural fragmentation of edges and patches of various sizes. This may be one reason that many native species do well where landscapes are a mixture of old and young forest and why fragmentation effects appear less in forested landscapes than in landscapes where forests are broken by agriculture and development."

Eric Forsman
Research Wildlife Biologist
Pacific Northwest Research Station
Corvallis

"Until 1990, discussion in the scientific community focused on old growth, but since then the emphasis has been on dynamic ecosystems and the effects of disturbance such as fire, wind, disease and timber harvest. Most scientists today understand the dynamic nature of ecosystems and try to incorporate that historic variability. Inherent in the genesis of the Northwest Forest Plan was the sentiment that we all needed to stop for a while and catch our breath and think about the issues, knowing that we would be able make changes to the strategy over time.

According to Tom Spies, a forest ecologist with the Pacific Northwest Research Station in Corvallis, most ecologists have long understood ecosystems are dynamic, something that is not well understood by the general public. But, even at its best, scientists only partially understand how ecosystems work at any point in time.

Ecologist Daniel Botkin's landmark 1990 book, *Discordant Harmonies,* described the difference between "static" and "dynamic" theories of nature and ecosystems. The static theory is based on the supposition that there is some ideal state of equilibrium where nature is "in balance" and at which it will "climax" and remain unchanged if left undisturbed. Under the static theory, if there is some disturbance, nature repairs the damage and returns to the climax state, which can be predicted. While the scientific community has been learning about the dynamic and sometimes unpredictable nature of ecosystems for decades, this paradigm shift is occurring more slowly in the public mind, which commonly views the world as both "static" and "predictable." In the recent past, this "static/predictable" view has been the basis for many of the laws applying to natural resource management.

The Implications of Dynamic Nature

Scientists still have an incomplete understanding of ecosystem dynamics. Its implications, when applied to forest management and protecting forest wildlife and its habitats, are enormous. Ecosystems are highly complex and thus difficult to fully understand or predict, particularly when those "dynamics" are constantly shifting and delivering "surprises." This inevitably leads to incomplete understanding and conclusions. Take, for example, the case of the Northern spotted owl. More than a decade ago, the Northwest Forest Plan was instituted to protect the owl and other old-growth-dependent species by establishing specific areas in federal forests for that purpose based on what science knew about the owls and other wildlife at the time. The plan used adaptive management to fill key gaps in knowledge over time.

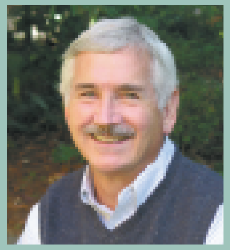
It was assumed that some of the old forest reserves would eventually burn and that other non-old-growth stands would mature and replace them. In younger stands, it was anticipated that thinning and other silvicultural actions would routinely take place to speed development of desired habitat conditions and preclude stand-replacement fire on the drier sites. In this way, it was theorized, late-successional forest reserves would always be available to provide spotted owl habitat. According to Jack Ward Thomas, former chief of the U.S. Forest Service, team leader on all the "old growth efforts" and the highest-ranking Forest Service research scientist in modern times, implementation of these planned actions to date has been disappointing — but they were called for based on the scientific understanding of ecosystem dynamics in the 1990s.

Thomas and other scientists who worked on the plan knew that spotted owls generally nest in old-growth ecosystems. While research has shown that individual tree characteristics and forest structure, not age, are the key factors, these attributes are found primarily in older forests. However, in limited portions of the spotted owl range, tree stands with desirable characteristics for owls can be found in younger forests as well.

While research has not confirmed the long-term implications of protected owls and owl habitat in these younger forests, their presence creates a management dilemma if these are forests managed for wood production. For example, during the last decade, biologists for the former Boise Cascade in south-central Oregon found owls nesting in stands they harvested in the 1960s because, though they didn't realize it then, foresters were conducting logging operations in a way that left in place some large trees that would develop the characteristics of habitats selected by owls when the young forest grew up around them.

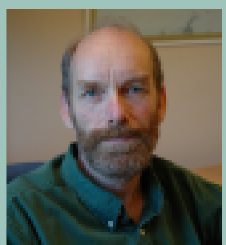
In addition, according to wildlife biologist Larry Irwin, principal scientist with the National Council for Air and Stream Improvement (NCASI), we have learned that in the eastern Washington Cascades, partial harvesting has occurred around 40 percent of spotted owl nest sites, suggesting at least some compatibility between the owls and forest management activity. Research also has found that owls in previously disturbed younger forests in the eastern Washington Cascades actually have a higher reproduction rate than those inside the late-successional reserves set aside by the Northwest Forest Plan. Again, scientists do not know the long-term implications; only that

The Northwest Forest Plan is an attempt to protect the northern spotted owl and other species associated with old-growth forests. It was developed based on conservation biology and other scientific knowledge available at the time. Spotted owls typically nest in old-growth forests, where they are most likely to find the tree characteristics and forest structure they seek. However, since the Plan was developed, research has found that in some areas of the spotted owl range, owls use habitats in younger forests as well. And some newer research indicates these owls may have higher reproduction rates than those found in late-successional reserves containing only old-growth forests, illustrating the complexity and variability of relationships between wildlife and their habitats.



James Agee
Virginia and Prentice Bloedel Professor of Forest Ecology
University of Washington
Seattle

"The static or 'hands-off' management prescribed in the Northwest Forest Plan is working acceptably well in the wetter, Douglas-fir forests west of the Cascades and north of Eugene, because those areas still look essentially the same as they did 100 years ago. But it won't work — and didn't at the inception of the Plan — on the east and south sides. In those areas fires historically were much more frequent, and suppression has altered them considerably. We're going to have to thin and conduct controlled burning in order to restore them. Ironically, the long-term future of owls may depend on altering some of their habitat in order to protect them."



John Hayes
Wildlife Ecologist,
Professor of Forest Science
Oregon State University
Corvallis

"The dynamic nature of forest ecosystems creates a patchwork of habitats for wildlife that varies through time and space. People sometimes lose sight of this and advocate management strategies based on a more static ecosystem perspective. Over broad spatial scales, disturbance is critical in providing the habitat diversity required for wildlife, and many species are associated with the early seral habitat created by disturbance. The cause of disturbance, whether fire or chainsaw, is not critically important. What is left after disturbance — especially snags and downed wood — and how stands then develop determine the value of an area to wildlife. We've learned how to tweak forest management practices so that managers can leave the right things behind."

new knowledge challenges old assumptions and creates a management dilemma.

Old-growth habitat — including large old trees, downed and standing dead wood, and complex forest structure and composition — is closely associated with a large array of plant and animal species and takes a long time to develop. This habitat must be available to conserve diversity. However, the new research suggests that the conservation task is more complex than many people think, especially those outside the scientific community. Another factor is that some old growth is found outside the late successional reserves designated in the Northwest Forest Plan. These stands are expected to disappear over time, as there is no attempt underway to replace them. The rationale behind the large reserves in the Plan is to maintain older forests and develop replacement stands.

Also, at the time owls were listed as threatened, forest fragmentation was considered by some scientists to be a threat to owls and other wildlife. At its most extreme, forest fragmentation describes a condition where a block of forest habitat is broken into smaller isolated pieces ("patches") surrounded by areas of non-habitat, as it often is in the East and Midwest where woodlots are left in a landscape converted to agricultural or urban uses. An intermediate form of fragmentation can result from clearcutting, too, but it is a relatively short-term condition. Fragmentation also may be caused by forest roads that create barriers to the movement of some species. The effects of fragmentation are different for different species, depending on their habitat needs. For example, creation of patches through harvest creates "edge effects" that are positive for some species and detrimental for others.

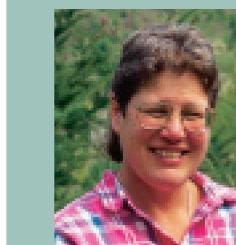
Forest fragmentation, a condition where a block of forest habitat is broken into smaller, isolated pieces ("patches"), has been considered a threat to some forest wildlife. The most negative effects of fragmentation (e.g., increased predation, inadequate habitat patch size, nest parasitism, etc.) occur when patches of forest are left in a landscape converted to urban, agricultural or other non-forest use. Research indicates that going from older forest to younger forest (through timber harvest or other disturbance) is less of a problem as long as diverse forest age classes of appropriate patch size and connectivity are present across the landscape. Also, some species benefit from the "edge effects" created by disturbance. While the effects of fragmentation are complex, including "winners and losers," what *is* problematic for forest wildlife everywhere is outright loss of forest habitat.

The assumption that timber harvest in the Northwest — particularly clearcutting — has the same negative effect on some wildlife (e.g., increased predation, nest parasitism, inadequate home range sizes, etc.), as forest conversion to non-forest use, has been challenged by recent research.

At a major 1998 conference, *Forest Fragmentation: Wildlife and Management Implications,* and in peer-reviewed conference proceedings, noted wildlife biologist Fred Bunnell of the University of British Columbia stated that the concepts of forest fragmentation derive from the theory of island biogeography, in which patches of forest habitat are considered to be like islands, separated and isolated from each other by a sea of hostile land. According to Dr. Bunnell and Dr. James Rochelle, also a widely respected wildlife biologist, the information presented at the conference provided little evidence of negative effects from timber harvest-related fragmentation in western forests. While increased predation and nest parasitism that are common when forest is surrounded by agricultural or suburban development are evident for a period, they are not as problematic or long-lasting where forestlands remain in forest use. What is problematic for forest wildlife everywhere is outright loss of habitat.

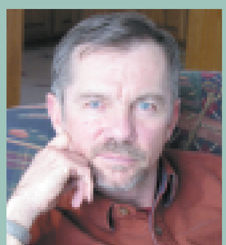
According to the National Commission on Science for Sustainable Forestry's First Findings Report — *Science, Biodiversity and Sustainable Forestry* — the greatest threat to forest sustainability and biodiversity is conversion of forests to other land uses. Going from older forest to younger forest is less of a problem because some type of forest habitat remains as long as a mix of age classes of appropriate patch size, arrangement and connectivity is present across the landscape. However, fragmentation can occur when patch sizes are too small — and some species require very large patch sizes. Once again the solution is complex, involving "winners" and "losers."

For example, research has confirmed that "edges" between mature and younger forests are important to successful owl reproduction but are a "sink" or "trap" for some species. Not long ago we were managing for edge effect in western Oregon to support increases in deer and elk populations. But, like any single-focus approach, it had unintended consequences. Adding to the complexity, the recent arrival of barred owls in the Pacific Northwest appears to present a major threat to spotted owls through competition for habitat, and the barred owl may have crossed the continent through the fragmentation of Canadian forests.



Sara Leiman
Co-Owner
Coast Range Conifers
Monroe, Oregon

"'Thorny,' 'dilemma,' 'complex,' 'riddles,' 'conundrum,' 'unanticipated changes,' 'action-reaction,' 'pluses and minuses' — these are all good words to help us understand the implications of dynamic ecosystems for responsible, active forest management. I've learned that wildlife and habitat are not static. We cannot make them 'stuck in time' no matter how hard we try. We are doing things differently than we used to, but the regulations and laws have not changed to keep up with the new knowledge. We need to manage using different strategies and then monitor the results and adapt as needed."



Larry Irwin
Wildlife Biologist,
Principal Scientist
National Council for Air and Stream Improvement
Stevensville, Montana

"Forests are rich in biological diversity, and forest managers must play a significant role in maintaining it. New research must focus on developing a fundamental understanding of how various forestry practices influence wildlife habitat conditions and population dynamics in various settings. We need to focus on the interactions between the physical environment and changes in wildlife habitat and population. Those relationships, along with the protection measures already embedded in our forest practices laws, will help demonstrate the benefits of the mix of forest conditions to wildlife diversity, and enable the modern forester to manage more effectively."

Recent studies of elk populations in Oregon and Washington also have confirmed the complexity of wildlife/habitat relationships. Here scientists are measuring body fat as a means of determining the general nutritional health of elk under various forest conditions. As with all animals, good food produces healthy elk.

Again, problems resulting from fragmentation can be minimized by providing a diversity of habitats across the landscape. One thing that is clear: fragmentation will grow as a concern in the Pacific Northwest as forestland is sold and converted to other uses, increasing the number of forest patches surrounded by non-forest habitat.

The Case of the Elk

A similar misunderstanding occurred with the habitat needs of elk in forest ecosystems shaped by fire. Studies from the 1960s through the 1980s suggested to some biologists that elk benefited most from dense forests with closed or near-closed canopies to provide shelter during harsh winters and hot summers ("thermal cover"), so they did not expend as much energy regulating their body temperatures. As a result, habitat-planning models were developed and used in fire-adapted ecosystems throughout the West to prescribe increased amounts of thermal cover, and timber harvesting was restricted accordingly.

The response, however, was inconsistent. Elk populations went up in some places and down in others. Declines occurred primarily in areas with comparatively productive forests where vegetation grows and changes rapidly. A variety of factors having little to do with thermal cover likely contributed to these declines, including more predators, reductions in acreage under active forest management, over-hunting, etc. Finally, in the early 1990s, NCASI, the U.S. Forest Service and Boise Cascade began a rigorous, four-year experiment in eastern Oregon near LaGrande to test the thermal cover theory. Using three different treatments for the forest — clearcutting, partial cutting and no cutting — NCASI biologist John Cook directed the monitoring of the elk in each of the treatment areas, measuring their body fat through the winter months.

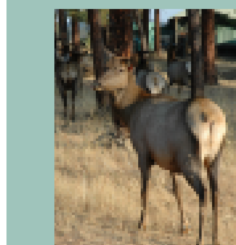
The NCASI report shows that elk *do* use thermal cover disproportionately to its occurrence in the landscape, although why they do is not clear. However, their use of thermal cover did not contribute to their energy balance. In fact, elk wintering in the clearcut area actually lost less weight than elk in either of the other two groups. Biologists concluded that the quantities and nutritional quality of plants grown in open conditions were key contributors to elk condition and productivity. Since that time, NCASI research has been focusing on nutritional dimensions of elk habitat, particularly in the summer and fall. While it had been assumed their winter range was the nutritional bottleneck, the research is showing that even minor improvements in the nutritional quality of summer and fall diets create disproportionately positive influences on elk survival. In these ecosystems, forest management appears to benefit elk nutrition when timber harvesting opens up the landscape and promotes the growth of low-lying vegetation. One might draw a parallel here with the effects of nutrition on offspring survival in all mammals during late pregnancy and nursing.

"There are lessons to be learned from this," said Hal Salwasser, dean of the Oregon State University College of Forestry and a nationally respected wildlife biologist. "Forests are complex. They change over time and so does our understanding of those changes and complexities. The more we understand about forests the more aware we become of what we have yet to understand."

Fire, the Owl Dilemma and Risk Assessment

One of the thorniest challenges for spotted owl conservation is one that we have created ourselves through more than a century of fire suppression in forests that historically experienced frequent fires. Eastside pine and mixed-conifer forests in particular were characterized historically by frequent low- to moderate-intensity fires (every 10 to 50 years). This is in contrast with westside forests dominated by Douglas-fir, which had historically experienced severe "stand-replacement" fires, but typically only in intervals of 200 to 400 or more years.

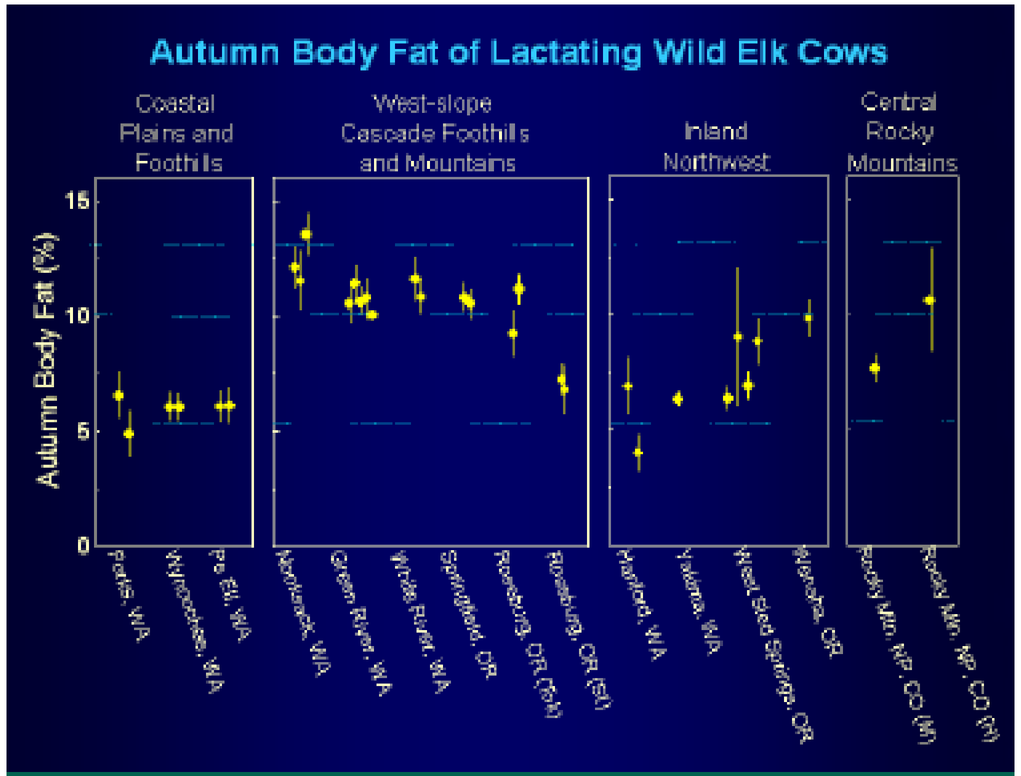
Much has been discussed about the severity of forest fires in recent years, and it is abundantly clear that a good deal of mixed conifer forestland in the drier central and southern areas of Oregon is dangerously overstocked with trees compared with the forests of a century ago. As a result, these forests are at high risk of fires of greater intensity than before fire suppression policies were adopted. To make the problem and solution even more difficult, the spotted owl has found some of these "unnaturally" dense stands to be desirable habitat. While the



"Many biologists have accepted the concept that the weather-sheltering effect of dense forest cover (i.e., thermal cover) reduces energy expenditure of large ungulates and therefore enhances survival and reproduction. Providing thermal cover for ungulates has become a key habitat objective for western elk ranges. However, it remains uncertain that thermal cover significantly influences the nutritional condition, survival, or productivity of wild ungulates. ...We found no significant, positive effect of thermal cover on condition of elk during any of the six experiments."
- John G. Cook, Larry L. Irwin, Larry D. Bryant, Robert A. Riggs, Jack Ward Thomas, *Wildlife Monographs* 141, 1-61

Steve Mealey
Retired Manager of Wildlife, Watersheds and Aquatic Ecology
Boise Cascade
Springfield, Oregon

Steve Mealey has taken a strong interest in the relationship of protective laws like the Endangered Species Act to risk assessment. As he views the problem: "The focus of such laws is almost exclusively centered on prevention of harm from a particular action, while virtually no consideration is given to the potential harm from inaction. For example, while risk assessment might come down strongly on the side of thinning as a course of action for preventing catastrophic fire and providing the best long-term benefits for wildlife, federal regulations prevent it because of the short-term risk to habitat. This has contributed to the decline of the very resources the laws are intended to protect."



By studying elk body fat, scientists in a NCASI/Forest Service/Boise Cascade research project are helping forest managers learn more about good habitat for elk to help in their planning. Results to date have helped researchers see the effects of good forage areas versus thermal cover on elk populations and what forest conditions help elk meet their nutritional requirements.

Northwest Forest Plan calls for vigorous thinning in such stands to reduce the risk of stand-replacement fire, not much thinning has taken place due to the unwillingness of some biologists and citizens to do anything that alters current habitat conditions.

Fire ecologists make a strong case for thinning and prescribed burning as a means of returning to vegetation conditions more consistent with natural fire regimes. In the short term, however, extensive applications of that prescription would be detrimental to some spotted owl habitat. The question then becomes one of evaluating risk. On the one hand, indiscriminate thinning now in those forests that we have altered by fire suppression would most likely result in short-term risk to owl habitat. On the other hand, if we take no action, we must accept the long-term risk of catastrophic fire, perhaps rendering the existing forest completely inhospitable to many old-forest species for a very long time. And, of course, at that point the owl habitat we are trying to protect today would be lost for many generations as well. As a result of this conundrum, risk assessment has become an important tool for forest managers.

'Static' Versus 'Dynamic' Management

As pointed out in *Science Findings,* published in November 2005 by the U.S. Forest Service Pacific Northwest Research Station: "Uncertainty comes in two flavors: knowable and unknowable. Knowable uncertainty is measurable and, to some degree, predictable. Consider a coin toss; you don't know if it'll land heads or tails but you know the likelihood of each. Then there is unknowable uncertainty. This is like flipping a coin and having a piano fall on your head. There is just no way to see it coming."

Added Bernard Bormann, a research ecologist at the PNW Research Station, "Admitting uncertainty is paramount to admitting risk – and risk aversion in many public land management agencies is ingrained." Of course, risk aversion is not limited to federal land management agencies. Any rational entity, up to a point, is risk averse. The trick is to know when and how to take risks.

When it comes to federal environmental protection regulations, risk-assessment methodology quickly reveals that many of these laws remain rooted in the old static theory of nature. Jack Ward Thomas says that when the landmark environmental laws like the Endangered Species Act were created in the early 1970s, they were steeped in preservationist strategies known as static management, meaning "hands off" to utilizing some management actions to protect listed species. As a result, when forest thinning is proposed to mitigate a long-term fire-risk problem that we created, thinning is usually ruled out because of the immediate or short-term risk to wildlife habitat. So in effect, any proactive action is thwarted.

The problem, then, is that even though scientists know that forest ecosystems are only partially understood and that they are dynamic and change over time, most protection laws remain based in the older "static and predictable" paradigm. While forests historically have been shaped by fires, some of them large and severe, fire suppression has interfered with natural processes for more than a century to the point where overstocked forests have become candidates for fires that are larger and more devastating than the historical norm. In such cases, regulations designed to "protect" the environment actually put it at greater risk when they result in the prevention of certain management actions.

According to Thomas, "These protection strategies likely contributed to the creation of spotted owl habitat east of the Cascade crest. In order to protect the 'new' habitat created by fire exclusion, we must thin to prevent stand-replacement fire. But thinning could alter owl habitat adversely. So, likely the answer is to thin to protect habitat knowing full well that the condition will return as we thin other habitat for short-term protection (i.e., some degree of protection is provided in a rotating fashion). In other words, the management is dynamic and protective at the same time." And if we use research and monitoring to learn how habitats and wildlife respond to these treatments – that is, to improve our understanding of

James Rochelle
Wildlife Biologist, Principal
Rochelle Environmental Consulting
Olympia, Washington

"Fire was a historical source of disturbance in the forest, and wildlife species have adapted to particular fire regimes over long periods of time. Stand-replacing fire reinitiates the process of forest succession and corresponding changes in wildlife communities. Individual species of wildlife will be winners or losers depending on the stage of stand development with which they are associated. Some benefit, others are harmed and some are unaffected by habitat change. Fire creates some critical habitats, as with the spotted owl in east-slope Cascade forests. Fire exclusion puts them at risk by increasing the likelihood of stand-replacing fire."

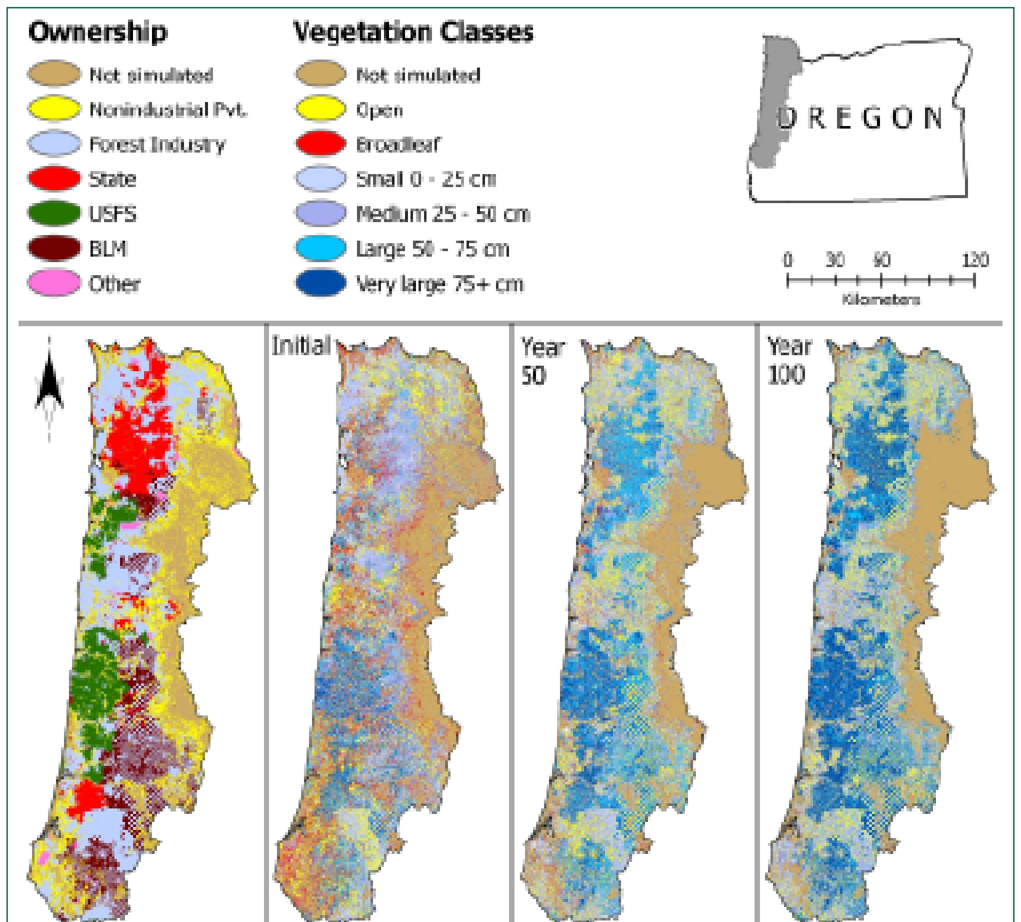
Tom Manning
Senior Research Assistant
Oregon State University
Corvallis

Senior Research Assistant Tom Manning adjusts the microphone of a highly sensitive Anabat II bat detector. Manning is monitoring this equipment regularly at the site of the Davis Lake fire near Bend as part of a major research project. Created by an Australian company about a decade ago, the unit turns itself on automatically when it detects the echolocation call of a bat. This new technology enables Manning and wildlife biologist John Hayes of OSU's College of Forestry, lead investigator, to study the effects of post-fire logging on bats with an accuracy not before possible.

ecosystem function and dynamics — we can adapt our management over time for better outcomes.

The Viability of Older Forests

Thinking about "dynamic management" leads to questions about old growth and older forests in general. Most ecologists agree that to sustain certain plant and animal species associated with old forests we must ensure the availability of old-growth habitat — the most rare and slowest to develop of all successional stages — within the forest landscape. Old-growth habitat once covered more of the landscape than it does today, and the challenge is how best to protect existing old growth and plan for stands to replace them when they die. Land set aside in the Northwest Forest Plan for late-successional reserves may remain in an old-forest state for a very long time — even for centuries — providing considerable time for growth of replacement stands and for increasing knowledge. But it won't stay there forever. Ecologist Tom Spies said we must remember that forest succession means



Planning for Future Wildlife Needs
Computer technology and new modeling capabilities are enabling scientists to project forest conditions far into the future. This projection that shows Oregon's coastal forests a century from now was done as part of a massive landscape analysis by ecologists and other researchers from the U.S. Forest Service Pacific Northwest Research Station and the OSU College of Forestry. See the fuller description of the CLAMS (Coastal Landscape Analysis and Modeling Study) on pages 14-15.

that all older forests will eventually submit to change brought about by wind, fire or disease and begin again as young forests. "There is also confusion in the public mind about old growth," he said. "Some people really don't understand that even before large-scale logging — or before European settlement, for that matter — old growth did not completely cover the landscape." Furthermore, some types of old growth, such as ponderosa pine, were dependent on frequent surface fires.

Wildlife biologists know that the common publicly held notion that old-growth forests are universally ideal for wildlife — or the equally misguided notion that forest openings and "vigorous young forests" are universally ideal — are both false. Some species thrive best in older, mature forests while others thrive best in openings and younger forests. In our dynamic world, these old and young forests move around the landscape over time. Therefore, a holistic "time and space" management approach that addresses the needs of all species is warranted.

According to Fred Bunnell: "The worst possible approach to maintain vertebrate diversity would be to manage every acre the same way or to have a large forest of a single class." Over centuries, disturbances are followed by forest succession (changes in plant species, size, structure, etc.). However, forest succession can take a number of pathways or be interrupted at any point in time by another disturbance. Some wildlife species have adapted to these changes by becoming highly associated with certain types and age classes of forests. Other wildlife species are less highly adapted. For example, a fire or clearcut in an older forest means that a whole range of species associated with open spaces and younger forests will find that area to be suitable habitat. But animals dependent on older forests must move to find their habitat elsewhere — if and where such habitat exists — or perish, and old growth is rare today compared with amounts that were present historically.

The forest "stages" that are now most rare are those between the stand age of 80 and the beginning of the "old-growth" stage at approximately age 200. Those stages can be expected to develop in reserves — wilderness areas, roadless areas and late-successional reserves — and, likely, nowhere else.

Providing "protection" status in reserves does not prevent change in old growth forests, but it slows it dramatically relative to the human-caused changes of the last 100 years. And we have to start with what we have, which tends to be old growth in higher elevation and lower productivity sites. However, as recognized in the Northwest Forest Plan, we need to acknowledge that these "protected" reserves are certain to change regardless. Fire, wind, landslides, climate change, invasive species and disease, for example, join the natural process of forest succession as certain agents of change. Again, according to Jack Ward Thomas, "That is the reason that the reserves contain considerable younger forests that should be managed to even-

Options Forestry
"In response to the highly uncertain outcomes inherent in forest management, 'options forestry' has been introduced as a novel approach that includes an honest appraisal of uncertainties and learning as a specific objective. The strategy is unique in that it uses a variety of management pathways, all designed to reach the same goal, and structures them in a rigorous statistical design to reduce and spread the risks associated with failure. By implementing a variety of legitimate approaches, managers can keep from putting all their eggs in one basket, and they may also discover more than one way to achieve their goal."
- *Science Findings*, November 2005, Pacific Northwest Research Station, Portland, Oregon

Chris Maguire
Terrestrial Biology Team Leader
Oregon Department of Transportation
Salem

"ODOT has a tremendous impact on big animals and connectivity, so road crossings are a major issue. We must know wildlife behavior and movement patterns to do our work effectively and avoid danger to motorists and wildlife alike. A good deal of work goes into planning new roads or changing existing ones – whether, for example, to use bridges over streams rather than culverts so that deer and elk can pass beneath without having to cross a road. And it's not just large animals. Oregon will be replacing or refurbishing hundreds of bridges in the next decade, and migratory birds nest on and bats roost in many of them. We need to know how to address those kinds of issues as well."

tually replace old growth. Otherwise it is unlikely that much old growth will exist over the next few centuries outside of reserves." Spotted owl expert Eric Forsman, a wildlife biologist with the Pacific Northwest Research Station in Corvallis who was on the team of scientists that devised the Northwest Forest Plan, added that he never personally thought of the Plan as written in stone. "I hoped eventually the Plan would morph into a more dynamic approach in which the entire landscape would be managed to produce the desired mix of forest types." For this to occur, the entire array of ownerships in a forest landscape must play distinct yet complementary roles.

The Fine Art of Wildlife Protection

Recognizing the complexity of wildlife/habitat relationships, scientists have continued to push forward the frontiers of our knowledge of animal behavior and habitat needs. Forest managers have learned to recognize potential problems and wildlife impacts, and often call on experts from ODF and ODFW as well as researchers at the OSU Colleges of Forestry and Agricultural Sciences for advice on sensitive issues. They also, of course, are guided by the regulatory protection framework of federal agency plans and the Oregon Forest Practices Act, the nation's first such act containing comprehensive rules governing forest management.

To help landowners better protect wildlife, the environment and Oregon's natural resources, the Oregon Department of Fish and Wildlife recently published the *Wildlife Conservation Strategy*. The Strategy also aims to improve public awareness of wildlife concerns and engage people in habitat restoration and conservation activities. Wildlife experts who worked on the Strategy include (from left, above) Charles Bruce, Gail McEwen and Martin Nugent.

A New Conservation Strategy Takes Shape

In a bit of fortuitous timing, the Oregon Department of Fish and Wildlife (ODFW) has researched and drafted the *2006 Oregon Conservation Strategy* to provide a long-term guide for conserving the state's plant and wildlife species and their habitat.

The Strategy takes each of the state's ecoregions and identifies species and habitats, outlining in the process any particular issues, data gaps and research needs. There is no regulatory component, and the strategy hopes to engage the public by making local citizens aware of problems, providing a wide range of conservation tools and demonstrating how local conservation actions fit into the broader regional and statewide perspective. The Oregon Plan for Salmon and Watersheds, a statewide salmon recovery strategy, demonstrated the potential power and effectiveness of a strong volunteer component, and its promising achievements were very much in the minds of its ODFW creators as they developed the Strategy document. In some sense, the Strategy aims to extend the concept of the Oregon Plan from ridge top to ridge top.

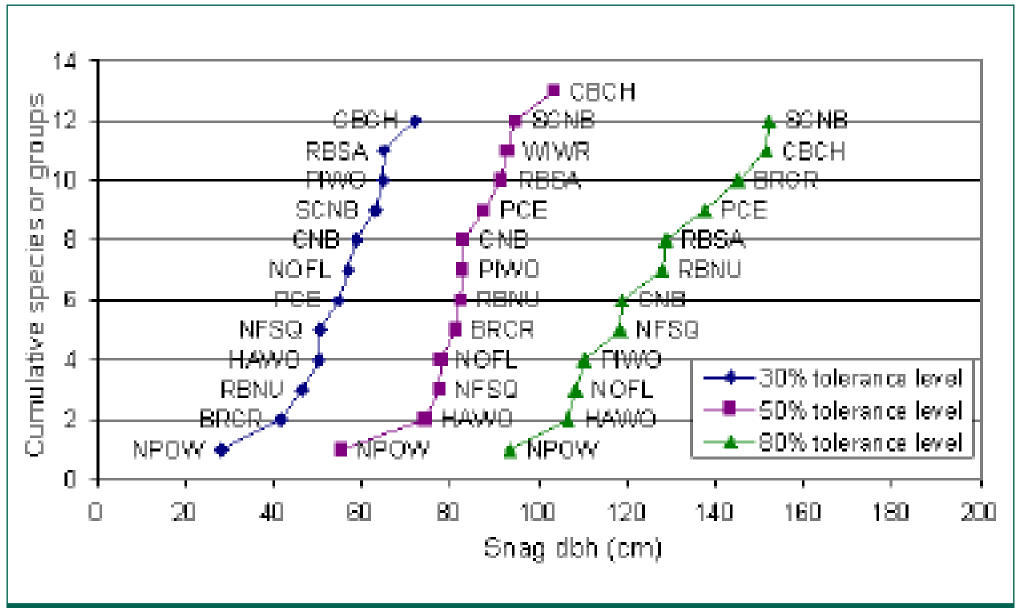
Collaboration on wildlife issues in Oregon actually extends beyond familiar natural resources agencies like ODF and ODFW. In this wider landscape view, even unlikely agencies like the Oregon Department of Transportation (ODOT) have an interest in wildlife. Biologist Chris Maguire recently moved from a research role at OSU to join ODOT and now lends her expertise to road projects. For example, ODOT is straightening a section of Highway 20 west of Philomath, a popular route to Newport and the coast. The new road sections will have an impact on connectivity for wildlife. Maguire researches the location of new bridges and their impact on terrestrial wildlife mobility or fish at stream crossings. Because roads and road traffic have at least some adverse impact on most wildlife, it is not uncommon in her work to consult with ODFW or the National Marine Fisheries Service in addressing the needs and behavior of wildlife.

The Nature Conservancy – Active Land Managers

Besides agency collaborators like ODF, ODFW also had cooperation and help from such non-governmental organizations as The Nature Conservancy (TNC). TNC has developed a sophisticated, computer-based ecoregional assessment process, which it provided to ODFW for use in developing its own conservation strategy. Recognizing the dynamic nature of ecosystems, TNC actively manages its own lands. Steven Buttrick, director of Conservation Science and Planning for TNC in Oregon, says that the organization some time ago realized that the dynamic nature of forest ecosystems demanded the need to think beyond the stand level. This awareness of ecosystem dynamics has led TNC to promote active management of dry-site forests that have been modified from their historical range through

Steven Buttrick
Director of Conservation Science and Planning
The Nature Conservancy in Oregon
Portland

"The Conservancy does not buy land and just set it aside. We actively manage our land to restore or maintain natural composition, structure and function. Land acquisition can prevent or stop a land-use change that would negatively impact the conservation value of the parcel, but without active management invasive species can take over, and composition, structure and function can still be compromised by past land management practices. Maintaining or improving the condition of ecological systems often requires restoration of natural processes such as fire. Nationally, for example, the Conservancy manages more land with fire than any other organization outside of the Forest Service and the Bureau of Land Management. In Oregon two-thirds of our staff are involved in on-the-ground management – working with our neighbors to find effective ways of maintaining species health and diversity."



A Computer Aid to Foresters
The chart above from the DecAID advisor – a new tool developed for forest managers to help meet wildlife goals – displays wildlife species' use of snags by diameter at breast height (dbh) in a specific structural condition class in Oregon's western Cascades. The three curves are "tolerance levels" – 30, 50, and 80% of wildlife populations observed to use various snag diameters – and each point is a wildlife species, e.g., CBCH is Chestnut-backed Chickadee.

fire suppression, logging and grazing practices. Because habitat management for some species can be detrimental to other species, the goal should be management for a natural range of variability.

New Technology, New Tools

New technologies and tools in wildlife research have made dramatic leaps over the past decade, to the benefit of scientists and forest managers. The computer, along with sophisticated satellite imaging technology, has given forest managers an ability to look into the future that was only a dream a decade ago. Modeling programs now enable planners to enter proposed timber harvest plans and see how specific prescriptions might affect the landscape for decades and even centuries into the future. In this way, managers have better tools to work toward a mix of forest types and structures across the landscape that will in turn promote wildlife diversity. Although severe fire, insects, disease, changes in markets and ownerships, and other unanticipated changes will still create uncertainty, the computer has become an increasingly important tool in the forester's toolbox.

To cite another example of the advancement of technology in forestry, a group of vegetation ecologists, fish biologists, wildlife ecologists, economists, policy experts and social scientists centered at the OSU College of Forestry and the PNW Research Station in Corvallis has been working since 1993 on a major, multidisciplinary research project known as the Coastal Landscape Analysis and Modeling Study (CLAMS). Under the leadership of ecologist Tom Spies of the Research Station and Professor Norman Johnson of OSU, the group has taken five million acres of forestland under many ownerships in Oregon's Coast Range and subjected that whole landscape to close scrutiny using Geographic Information System (GIS) and computer modeling technology.

The result has been the most accurate and detailed picture ever made of the forest today in all its complexity. The scientists also have the capability to project the model years into the future to get a picture of forest age, structure and yield and to assess the impacts of management activity and succession to the ultimate benefit of wood production and vegetation and wildlife diversity. In other words, timber production can be modeled in detail to the extent that inputs are accurate, and now the picture can include a whole range of environmental indicators and other measurements as well. For example, researchers learned that under the current policies on public and private lands, the intermixing of successional stages will be less than under the historical natural disturbance regime.

Another forestry tool is an online resource known as the DecAID Advisor, a joint project of the U.S. Forest Service (Pacific Northwest Region and the Pacific Northwest Research Station) and the U.S. Fish and Wildlife Service. DecAID is an advisory tool to help managers evaluate effects of forest conditions and existing or proposed management activities on organisms that use snags, downed wood and other wood decay elements. The value of snags and downed wood to wildlife is well known by forest managers, and its retention following harvest is mandated by forest protection laws. DecAID also can help managers decide on snag and downed wood sizes and numbers needed to help meet wildlife management and other objectives.

New Wildlife Monitoring Tools

In addition to technologies the computer has made possible, other new technologies have enabled wildlife biologists to monitor populations on a temporal and spatial scale never before possible. A good example is the Passive Integrated Transponder tag technology utilized in the landmark Hinkle Creek Paired Watershed Study, a 10-year project in Douglas County. Tiny tags are implanted in resident fish, and their movement is tracked in both time and space as they travel from one part of the watershed to another. For the first time, scientists can instantly assess fish response to stream changes, nearby timber harvest or other disturbance. This would not have been possible a decade ago.

A similar leap forward has occurred in bat research with the development of highly sensitive microphones that can pick up calls of bats that are inaudible to the human ear. Wildlife biologist John Hayes of the OSU College of Forestry is presently using these bat detectors in the area of the Davis Fire on the east slope of

Painting the Big Picture

Policies to achieve bio-diversity goals have been implemented across many different forest ownerships in the last 10 years. Surprisingly, little research has been done to examine how well those policies might achieve their goals, how they might change landscapes in the future, and how the policies affecting different owners add up to a total picture of forest bio-diversity in a large, multi-owner landscape.

To fill this void, the Coastal Landscape Analysis and Modeling Study (CLAMS), a multidisciplinary research project centered at the Pacific Northwest Research Station in Corvallis, Oregon, recently completed a set of different analyses that paint a picture of how forests of the Oregon Coast Range look today, how they might change over the next 100 years, and what the implications are to forest biodiversity and forest management.

- *Science Findings*, September 2005, Pacific Northwest Research Station, Corvallis, Oregon

Ted Lorensen
Assistant State Forester
Oregon Department of Forestry
Salem

"It's really hard to get into the mindset of dynamic ecosystem theory because in forest practices we're so used to the notion of managing to prevent change and the simplicity of treating everything the same way. Streamside protection rules, for example, use fixed tree retention targets based under a single desired condition of mature forest. But this approach reduces variability and provides limited incentives to manage poorly stocked or non-stocked stands. A more dynamic option could promote delivery of more woody material to streams while also providing more variable canopy conditions consistent with the range of successional stages likely under normal disturbance regimes."

the Cascades. His research should shed new light on the way some species of wildlife re-inhabit burned-over forestland, again in a way not possible a decade ago.

The Implications for Forest Management

All of this research and discussion about the dynamic ecosystems is aimed ultimately at determining the best ways to manage our forests, depending on landowner objectives, site characteristics and ecological requirements. Sustainability goals used to mean just being certain that the amount of wood harvested in Oregon did not exceed growth, a concept that is questionable to the public because a few large trees that are removed could be replaced in volume with many small trees, resulting in a very different-looking forest. Now it has expanded to include many other values associated with forests, such as a wider range of environmental, social and economic criteria — which include, of course, habitat protection for the myriad wildlife and fish species that make their homes in the forest. The question always becomes how these goals and objectives are translated into responsible forest practices, who will lead the effort and what processes will be employed.

Policy and the Dynamic Ecosystem Theory

While the Northwest Forest Plan covers management of federal forests in western Oregon and Washington, policies and laws affecting management of state and private forestlands in Oregon are set by the Oregon Board of Forestry.

The board will soon begin a methodical evaluation of the Oregon Forest Practices Act in the context of dynamic ecosystem theory. Preliminary examination showed that a static perspective based on the old paradigm presently dominates existing policy. This discovery is leading to an examination of the current debate in the scientific community over the whole concept of forest "protection" and the forms and levels of protection that are deemed adequate. It is clear that some forest practices laws are rooted in the belief that protection means "prevent change," a goal antithetical to ecosystem dynamics, where change is understood as inevitable and desirable. There also are questions about the extent to which "management actions" are the same as changes induced by natural processes.

The board then asked the Oregon Department of Forestry (ODF) to draft a white paper on the subject. The paper, prepared by Assistant State Forester Ted Lorensen, states: "There is emerging scientific evidence that the basic underlying premises about forest protection are flawed. Based upon this evidence, there is a strong argument to be made that by better considering key ecosystem processes and cause/effect relationships, we may be able to achieve less costly and more efficient and effective protection strategies." This is a hypothesis that needs to be tested.

Looking at our existing forest protection laws through the lens of dynamic, partially predictable ecosystems unveils the need for what the ODF white paper calls "a revolutionary change in nearly 100 years of how forest protection is perceived." Just as difficult, it says, is recognizing that a real effort will be needed to think outside the box and avoid falling back into the more comfortable static approach of equating protection with preventing change. It calls for forest protection to become an adaptive, continual learning process that is ready for change and surprises.

Even the notion of returning forest ecosystems to their historical range of variability, a common goal in forest management, is rooted in static management thinking and, of course, is unlikely as current and future circumstances are different from those of the past. In the case of salmon recovery, for example, some have called for returning to the historical range of ecological conditions. But the dynamic theory advocate might ask if this is a viable objective given that we now have 10 times more people occupying the salmon range than just 150 years ago. We also have imposed somewhat permanent structural changes on many salmon migration routes and have gone from a cold glacier-friendly climate a mere 200 years ago to one that is ever warming and where glaciers are in retreat.

The same is true of our goal of returning the forestland burned in the 2002 Biscuit fire in southwest Oregon to its historical range. The dynamic nature theorist might say that the forest burned in the Biscuit fire began to form several hundred years ago in the little ice age, a climate that favored conifer growth. The burned forests also had undergone fire suppression for many decades. The Biscuit fire may have burned with greater intensity and severity in some places and now that the climate is also warmer, nature may favor a different composition of vegetation species than what burned in the fires of 2002. Only time will tell, and only long-term research and monitoring will let us learn about the new conditions and their implications for conservation of forest diversity. In the face of such large unknowns, adaptive management, a common practice in forestry and the oldest "management practice" in existence, will be all the more important as we learn more about our ecosystem. It will require significant investment in monitoring for the long-term for good learning to result. It also will require strong commitments from both managers and researchers.

What is of key importance is that the Oregon Board of Forestry already is responding to the latest scientific research and listening intently as ecologists and biologists wrestle with the complex issues raised by this paradigm shift in our view of nature. The same spirit that created the country's first forest practices act nearly four decades ago is maintaining Oregon's leadership role in enlightened and responsive forest policy by addressing head-on the issues raised by our ever-advancing knowledge of forest science.

Examining Forest Protection

What does forest protection mean and how should protection be accomplished in dynamic forested landscapes where different ownerships are dedicated to different purposes? To develop a new approach in response to this question is not a trivial task as it involves a revolutionary change in nearly 100 years of how forest protection is perceived. A static perspective dominates the existing policy and science frameworks under which "protection" is applied. There is considerable debate in the scientific community and a tremendous diversity of views among scientists and interests about what is protection and what forms and levels of protection are "adequate."

- Oregon Board of Forestry, White Paper – Forest Practices "Protection" on Forestlands in the Context of Dynamic Ecosystems

A Paradigm Shift

It may be ironic that we describe forests within a context of disturbance, followed by "recovery" through succession to mature forest. ...terms like protection and recovery reinforce the thought processes that have created and maintained a static view of forests and reinforce the view that protection means preventing change. There is a very strong and legitimate ongoing scientific debate around this issue. There is a lot of research that is pointing the way to a paradigm shift. However, the process to collect and synthesize this research and to force meaningful dialogue has not yet occurred. Creating the scientific foundation for this change is critical and strong leadership is needed.

- Oregon Board of Forestry, White Paper – Forest Practices "Protection" on Forestlands in the Context of Dynamic Ecosystems