PNW
Pacific Northwest
Research Station

Science
FINDINGS

INSIDE

issue seventy eight / november 2005

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

ACTING ON UNCERTAINTY IN LANDSCAPE MANAGEMENT—OPTIONS FORESTRY

Burning off the fog—bringing science to management. Options forestry is a systematic management approach that includes an experimental design to ensure a rigorous attack on uncertainty.

IN SUMMARY

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.

In the first application of options forestry, researchers at the PNW Station collaborated with managers at the Siuslaw National Forest to create the Five Rivers Landscape Management Project. Their objective was to convert thousands of acres of young productive plantations into old-growth forests—something that had never been tried at a landscape scale. Three approaches—passive management, pulsed thinning, and continuous access thinning—are now being applied simultaneously in a replicated design distributed across the 32,000-acre watershed in coastal Oregon.

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. Furthermore, by using strategies that appeal to multiple stakeholders, options forestry allows groups to see their ideas in practice, at least in part of the landscape.

"The more I learn, the more I realize I don't know."
—Albert Einstein

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 land on your head. There is just no way to see it coming.

Managing complex forest ecosystems is burdened with both types of uncertainty. The knowable uncertainties include things like the growth and yield of forest plantations. There is variability over time and space, but through measuring more trees and building better models, uncertainty can be reduced and managed. The American chestnut epidemic is an example of an unknowable uncertainty; no amount of data could have predicted it.

"Admitting uncertainty is paramount to admitting risk—and risk aversion in many public land management agencies is ingrained," says Bernard Bormann, a research ecologist at the PNW Research Station in Corvallis, Oregon. "Researchers, too, tend to be uncomfortable saying that uncertainty remains despite their best efforts." Nonetheless, uncertainty abounds in forest management—seemingly lurking behind every tree.

"What if the uncertainty surrounding the outcomes of major forest policies is actually much larger than has been apparent?" asks Ross Kiester, a retired mathematical statistician at the Station in Wenatchee, Washington. "What if overconfidence in decisions has led to unintended consequences?"

When Bormann and Kiester started defining sources of uncertainty and charting ways to confront them, they developed a new approach to forest management: options forestry. It is a simple idea really. When there is uncertainty as to how best to achieve a goal—creating old-growth structure, for example —forest managers can create management experiments to test competing ideas, complete with a rigorous statistical design, thus generating knowledge and reducing knowable uncertainty.

"It is not research," insists Bormann. "We are simply incorporating principles of science into forest management. We are making learning into a management objective, just like timber production or biodiversity conservation." Sounds reasonable, commonsensical really. Perhaps, if learning had been an explicit objective for foresters all along, many of today's questions would have answers.

Forest managers, as a rule, are farsighted and deliberate. As stewards, they have been meeting societal goals for generations—regardless if the goal was timber, deer, clean water, or spotted owls. So there is every reason to believe that if the goal is knowledge, foresters will produce.

If this sounds a bit like adaptive management, it should. Adaptive management, like options forestry, is concerned with admitting uncertainty and learning from doing; however, there are some key differences. "Options forestry is a more systematic approach that includes a strict experimental design to ensure a rigorous attack on uncertainty," explains Bormann.

Adaptive management has lost a bit of traction over the past few years, which has been frustrating to Bormann who has been a major proponent of the idea since its inception. In fact, you only need look back to the 11th issue of *PNW Science Findings* to read about Bormann's work applying adaptive management principles. But for several reasons, Bormann now believes that adaptive management has fallen short: "There has been a softening of the principles whereas now the inclusion of a small-scale research project on the side is touted as adaptive management." It seems the concept has become too ambiguous.

"It is hard for me to imagine that someone could claim they are doing options forestry when they are not," says Bormann.

Over-correction has been another major problem with adaptive management. "As soon as something doesn't turn out as expected, we change course completely before learning what's really going on," says Bormann. "We all ought to know from driving on icy roads that over-correction is one of the worst forms of maladaptation," he says.

KEY FINDINGS

- Implementing a variety of legitimate approaches—rather than the perceived "best management practice"—can keep forest managers from putting all their eggs in one basket. In the Five Rivers Experiment, the large combined uncertainties associated with re-creating late-successional habitat from young plantations, justified diversifying approaches to hedge against unexpected failures.
- Management strategies were chosen to reflect both existing science and strongly held but differing views of major stakeholders. Implementing disparate strategies that appealed to multiple stakeholders allowed groups to see their ideas in practice, at least in part of the landscape.

MANAGING RISK THROUGH DIVERSIFICATION

When grappling with contentious forest policy issues, where uncertainty abounds, land management agencies often seek the middle ground—a place where everyone's perspective is integrated. At first glance, this seems reasonable. Too often, however, the middle ground does not accurately represent anyone's views but instead creates a hybrid approach with no constituency. Indeed, this was the case when immediately upon publication of the Northwest Forest Plan, environmental groups and the timber industry both sued the Forest Service, distancing themselves from the middle ground. Furthermore, by managing through a single compromise position, policymakers may never find the best techniques.

An options forestry approach, in contrast, uses competing views as treatments in an experiment. Instead of trying to resolve conflict before starting any work by choosing a single approach—which may not satisfy anyone—conflict is put to work as a source of initial hypotheses. Competing approaches, applied across the landscape, can be used to find the most effective means of meeting a goal, thereby reducing uncertainty and spreading risk.

It is a time-tested concept: don't put all your eggs in one basket. But Kiester says "it is at odds with the idea of 'best management practices,' which are widespread in forest management."

Purpose of PNW Science Findings

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

PNW Science Findings is published monthly by:

Pacific Northwest Research Station
USDA Forest Service
P.O. Box 3890
Portland, Oregon 97208
(503) 808-2137

Send new subscriptions and change of address information to pnw_pnwpubs@fs.fed.us

Sherri Richardson Dodge, editor
srichardsondodge@fs.fed.us

Keith Routman, layout
kroutman@fs.fed.us

USDA United States Department of Agriculture

Forest Service

Science Findings is online at:

http://www.fs.fed.us/pnw

The site includes **Science Update**—scientific knowledge for pressing decisions about controversial natural resource and environmental issues.

"Diversification does not mean adding new objectives in a land-use designation; nor does it insist that widely unacceptable approaches be included. It simply means that the uncertainties are often high enough to warrant trying multiple creative approaches at the same time to reach the same goal," says Kiester. "Diversified practices make sense either when consensus cannot be reached or when scientists agree that existing evidence is insufficient to confidently distinguish between alternative approaches."

For all the same reasons, diversification is a popular strategy in another arena of high uncertainty, investment portfolios. Financial markets react to knowable uncertainties like inflation and fluctuations in the greater economy. In addition, markets react to unknowable uncertainties like the crash of 1929 and the dot-com bubble of the 1990s. To hedge against uncertainties, a prudent advisor will suggest a diverse portfolio containing some risky investments and some savings under the mattress. This way, no matter which strategy turns out to be the best, you'll have played it smart with at least some of your investments.

Options forestry is simply a diverse portfolio designed to meet a specific goal. It manages knowable uncertainties by producing better information and hedges against unknowable uncertainties and the vulnerability associated with homogeneity.

OPTIONS FORESTRY FINDS A HOME IN THE FIVE RIVERS WATERSHED

"We have been very lucky to work with the people at the Suislaw National Forest in our first application of options forestry," says Bormann. "We found real leaders and risk takers like Jim Furnish, Jon Martin, Jose Linares, and Paul Thomas, among many others."

The Five Rivers Landscape Management Project began in 1999 as an attempt to apply adaptive management at large scales. The project was designed for 32,000 acres of productive Siuslaw National Forest land in coastal Oregon. About half of the area contained 100- to 150-year-old unmanaged Douglas-fir trees; the other half consisted of Douglas-fir plantations between 10 and 50 years old. The goal, as a component of the Northwest Forest Plan, was to quickly convert the plantations to desirable late-successional habitat.

Here's where the uncertainty comes in. No one had ever converted plantations to old-growth before. After consulting with a range of managers, scientists, environmentalists, and regulators there was no consensus as to the best way to do it. There was simply no sound basis to select any one approach over another. And that is exactly what the planning team said in their environmental impact statement (EIS), a legally binding assessment required of all federal actions under the National Environmental Policy Act.

"This honest admission of the uncertainty surrounding the policy was required as a first step to put uncertainty to work to meet societal goals," says Bormann. In the spirit of options forestry, the planning team took a diversified approach by defining three simultaneous management pathways: (1) passive management, where plantations are allowed to develop into old growth with no intervention other than road closures; (2) continuous-access management, which centers on frequent light-touch thinning and road maintenance; (3) pulsed-access management, which includes a heavy thinning (down to about 40 trees per acre) followed by a 30-year road closure.

Each pathway has a constituency who believes that their approach will most effectively produce old-growth forest structure.

After conducting a landscape similarity analysis to define comparable treatment units, four replications of each pathway were randomly allocated across the landscape. "We found that the managers could be convinced to arrange the prescriptions in a way that would provide a statistically powerful design," says Bormann.

"Since we don't know which pathway is best, diversification increases the chances that at least part of the landscape will be effectively managed," says Kiester. "It also greatly increases the likelihood of learning and increases options for decisionmakers in the future."

With no consensus as to the best way to convert plantations into old growth, several thinning strategies were tried, including a pulsed thinning to approximately 40 trees per acre.

The project was designed for 32,000 acres of productive Siuslaw National Forest land in coastal Oregon. About half of the area contained 100- to 150-year-old unmanaged Douglas-fir trees; the other half consisted of Douglas-fir plantations between 10 and 50 years old.

LEARNING AS A MANAGEMENT OBJECTIVE

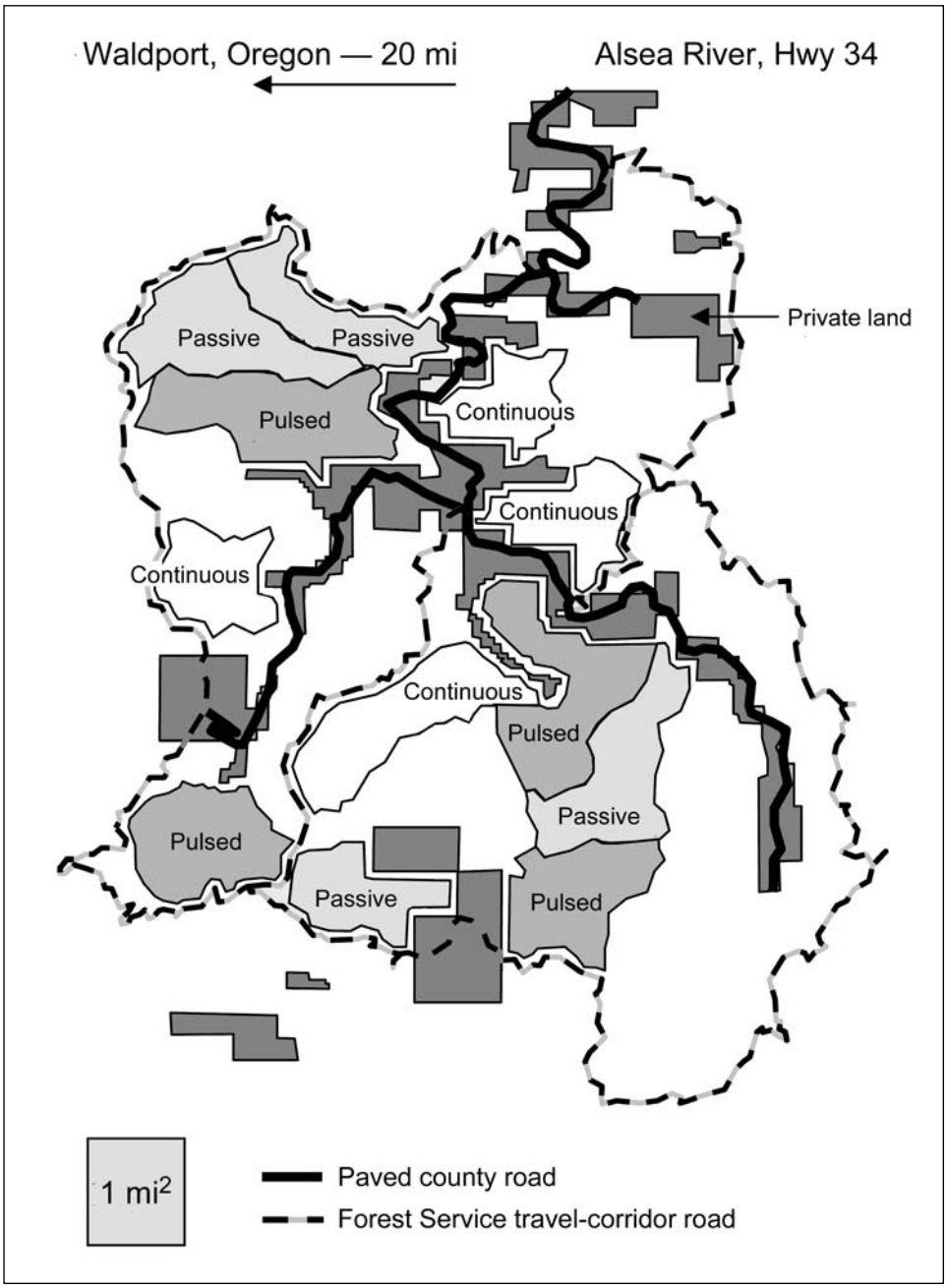
Regardless of how important new knowledge is, producing it is rarely thought of as a management goal. Options forestry changes that. "The Five Rivers EIS, which was designed largely by Martha Brookes, a retired PNW science editor and approved by local and regional line officers, actually includes 'learning to produce late-successional habitat' as the primary purpose of the federal action," says Bormann. A peer-reviewed study plan was even included in the EIS.

This formally linked researchers and managers in a two-way interchange of information. Researchers helped design experiments, treatments, monitoring and EIS strategies, and learned about the integrated nature of management problems and processes. Managers designed management to speed learning, and learned about uncertainties, alternative approaches, and new ideas that could be incorporated into silvicultural prescriptions.

This is a new model for conducting environmental analyses—integration by experimental design—and it seems to have broad support. During the early planning stages of the Five Rivers project, environmental litigants asked that the experiment be excluded from their lawsuit contesting Forest Service management practices. Similarly, timber industry representatives have often lobbied on behalf of the experiment in the USDA Undersecretary's office.

"We've received wide support, which suggests that we have created a management model where constituents have agreed to disagree while retaining their individual voices and concerns," says Bormann.

Now that the experiment is in full swing, thinning treatments and road closures are proceeding uncontested throughout the Five Rivers watershed, which is a strong endorsement in a region where logging blockades and lawsuits from all sides have become the norm.



Different management strategies, all designed to accelerate the development of old-growth structures in young plantations, were randomly distributed across the Five Rivers Landscape Management Plan.

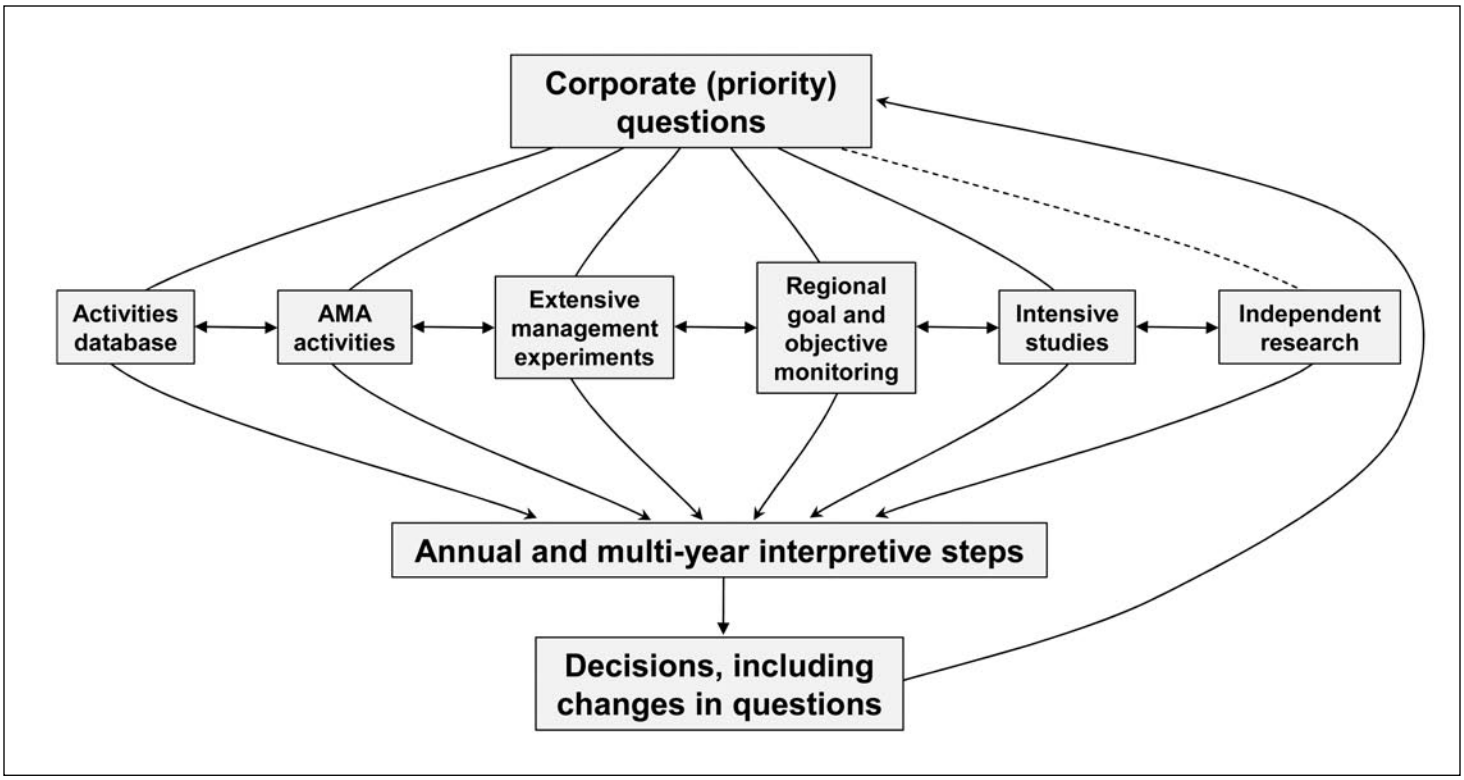
FOCUSED ON UNCERTAINTIES

It appears the options forestry approach is beginning to catch on. Recently, the Five Rivers model was fully adopted by the Rogue-Siskiyou National Forest in developing the Biscuit Fire recovery plan in southwest Oregon. "The forest added learning objectives in the EIS and asked us to develop an experimental design," says Bormann. "The experiment, if implemented, will compare three approaches to postfire recovery representing a range of views on what should be tried."

With uncertainty and confrontation increasingly coloring the Nation's response to wildfires throughout the West, options forestry is likely a major step forward.

The underpinnings of options forestry are also influencing the follow-up to the Northwest Forest Plan 10-year interpretive report. Specifically, the regional executives are focusing on institutional barriers to learning and adapting, and the need for more formally defined roles for researchers and managers—essentially including a more systematic and broad-based approach to adaptive management.

Explicitly recognizing and focusing on areas of uncertainty—whether it is in response to a wildfire or when trying to protect an endangered species—draws attention to the gaps in our knowledge. However, as Bormann is quick to point out, "There are



Options forestry is influencing the agency's follow-up to the Northwest Forest Plan 10-year interpretive report. Regional executives are considering a more systematic approach to "Plan-wide" adaptive management, where corporate questions drive learning activities, identify institutional barriers to learning and adapting, and the need for more formally defined roles for researchers and managers.

many aspects of forest dynamics that we understand well and we shouldn't play those down. We know a great deal about managing forests."

In this regard, a transition to options forestry may require a good deal of professional humility, requiring participants to focus on uncertainty in spite of all that's been learned. But, according to Bormann, that is exactly the point; "In the end, we hope that forest management can be viewed, like science, as a never-ending set of questions rather than a series of disconnected truths."

"Knowledge is an unending adventure at the edge of uncertainty."

—Jacob Bronowski

LAND MANAGEMENT IMPLICATIONS

- A major strategy for managers to reduce uncertainty is to accept that more than one approach might work. Comparing strategies at the same time—with a rigorous experimental design—greatly increases the likelihood for quick learning, and can increase options for decisionmakers over time.
- Mutually beneficial two-way interchange of information between managers and researchers is possible if both groups can simultaneously meet their original and in-common objectives. In the Five Rivers Experiment, researchers helped design experiments, treatments, monitoring, and EIS strategies, and learned about the integrated nature of management problems and processes. Managers designed prescriptions to speed learning, and learned about uncertainties, alternative approaches, and new ideas that could be incorporated into prescriptions.
- By explicitly stating areas of high uncertainty and including learning as a management objective during environmental review, societal groups with diverse perspectives can agree to disagree while also moving the project forward.

FOR FURTHER READING

Bormann, B.T.; Kiester, A.R. 2004. *Options forestry: acting on uncertainty.* Journal of Forestry. June Issue.

Five Rivers Landscape Management Project Web page. 2003. http://www.fsl.orst.edu/5rivers/.

WRITER'S PROFILE

Jonathan Thompson is a science writer and ecologist. He lives in Corvallis, Oregon.

Science
FINDINGS

U.S. Department of Agriculture
Pacific Northwest Research Station
333 SW First Avenue
P.O. Box 3890
Portland, OR 97208-3890

Official Business
Penalty for Private Use, $300

PRSRT STD
US POSTAGE
PAID
PORTLAND OR
PERMIT N0 G-40

SCIENTIST PROFILES

Bernard Bormann is a forest ecologist and team leader in the ecosystem processes program with the USDA Forest Service, Pacific Northwest Research Station in Corvallis, Oregon. He is also courtesy professor in the Department of Forest Science at Oregon State University. He received his master's degree from the University of Washington, Botany Department in plant ecology and soils and his Ph.D. from Oregon State University's Department of Forest Science in forest physiology. The focus of his work in research and application is on management impacts and natural processes controlling long-term ecosystem productivity. He has active studies in Oregon, Washington, and Alaska, including effects of pioneering plants on soil productivity, rates of mineral weathering, and nitrogen fixation; and effects of windthrow on soils and streamwater chemistry. He has a keen interest in speeding learning through adaptive management by integrating research and management to help sustain ecosystems.

Bormann can be reached at:
Pacific Northwest Research Station/
USDA Forest Service
Forestry Sciences Laboratory
3200 SW Jefferson Way
Corvallis, Oregon 97331
E-mail: bbormann@fs.fed.us
Phone: (541) 750-7323

Ross Kiester has retired from the Pacific Northwest Research Station. At the time of this research, he was a Mathematical Statistician on the Eastside Forest Health Team at the Wenatchee Forest Sciences Laboratory in Wenatchee, WA. Ross attended the University of California at Berkeley, where he received his B.A. He completed his Ph.D. in Biology at Harvard University, where he was also a Junior Fellow. He then taught at the University of Chicago and Tulane University before joining the USDA Forest Service.

Kiester can be reached at:
Biodiversity Futures Consulting
5550 SW Redtop Place
Corvallis, OR 97333-1357
E-mail: rkiester@gmail.com
Phone: (541) 231-6127

COLLABORATORS

PNW Research Station
Martha Brookes (retired), Pat Cunningham, Mike Furniss, George Stankey

National Forest System
Gloria Brown, Jim Furnish (retired), Stuart Johnston, Jose Linares, Doris Tai, Paul Thomas, Bob Zybach, Jon Martin

Oregon State University
Kermit Cromack, Jr. (emeritus), Denise Lach, John Tappenier (emeritus), Bob Zyback

Western Oregon University
Max Geier

USDA/Office of General Counsel
Owen Schmidt