Adaptive management of forest ecosystems: some rubber hits the road?

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Adaptability is seen by scientists as an essential element to managing complex, poorly predictable ecosystems (Walters 1986). It follows that ecosystem assessments often conclude that adaptive management is needed (Ayensu et al. 1999). But, when they look back, scientists are most often disappointed in what managers have been able to implement (Walters 1997; Stankey et al. 2003). A continued drumbeat of failure will, at some point, lead people to question whether adaptive management is a viable concept or a hollow marketing tool.

Scientists and policymakers have a long way to go in learning how to evaluate adaptive management itself. For starters, a common definition is rarely found inside or among agencies, and scientists typically define it quite differently from managers. Further, evaluators have yet to define when enough has been learned to determine whether adaptive management is working. A results-based evaluation defines success when decisions (adaptations) are made based on what

was learned, regardless of how well adaptive processes worked. Pressures for policy change, however, typically operate on a shorter time step than results-based learning does.

The regional-scale Northwest Forest Plan (USDA and USDI 1994) has just completed its first 10-year, adaptive-management cycle, providing us with an opportunity to take stock of the concept, and to pass on lessons learned (fig. 1). We evaluate how well adaptive management worked in the Plan from first hand knowledge as described in a forthcoming synthesis (Haynes et al., in press), based on science findings and monitoring assessments (Gallo et al. 2005; Lint 2005; Moeur et al. 2005; Charnley, in press; Huff et al., in press). These publications, collectively called 10-year interpretive report, were presented in a major science-policy conference in April 2005 (Stokstad 2005).

Taking stock of the experience with adaptive management in the Northwest Forest Plan

The Plan chose adaptive management as its cornerstone (Pipkin 1998, Stankey et al. 2003) because of the acknowledged uncertainties with the chosen management strategies and with the ecological and social outcomes (FEMAT 1994). The adaptive management strategy had four major elements: a place for it to happen (the adaptive management areas or AMAs), organizational strategies to apply the adaptive management process across the entire Plan area, a major regional monitoring program, and a formal interpretive step that gathered up what was learned and translated new understandings for decisionmakers' use. Perhaps the most surprising success among these elements was the interpretive step which took a **handshake approach**, comprising institutional steps to facilitate mutual respect between decisionmakers and researchers without endangering scientific credibility. The approach included a formalized regional monitoring program, an officially mandated 10-year interpretative report, and a conference to synthesize evidence for decisionmakers. The approach emerged as researchers and

managers from the full suite of participating agencies found new ways of working together over the Plan's first 10 years, by applying concepts of adaptive management in the AMAs, outside the AMAs in a few cases, and through the science-based monitoring program. The approach took form as a team of nearly 60 scientists and managers interpreted the 10-year monitoring and research results and remaining uncertainties to inform managers about the need for change. To emphasize closing the adaptive management cycle, the 10-year report was handed-off to the agency decision-makers through a series of meetings and a conference in April 2005 [http://outreach.cof.orst.edu/nwforestplan /index.php]. The approach not only facilitated passing key evidence across the science-policy divide, but also gave managers the knowledge to participate in learning more actively.

Here, we discuss our views of how well all of the adaptive management elements worked during the first decade of the Plan. Our evaluation examines the steps generally considered important to adaptive management: framing relevant questions, comparing alternative approaches in the course of managing, keeping up on traditional records, monitoring and interpreting, communicating translated information, and closing the loop by adopting what was learned (where warranted) into new directions. Here's what we think we learned and why.

Allocating land with specific adaptive-management mandates (the Plan's AMAs) is not sufficient to ensure that adaptive-management goals will be met. Looking back on the first decade of the Plan, the AMA's made important progress in exploring new roles and responsibilities for citizens, researchers, and managers, but largely failed in their primary mission to test alternate strategies, eventually becoming noncompetitive in budget allocations (Stankey et al. 2003, Bormann et al. in press). A major reason for this failure was that precaution trumped experimentation. On one AMA, a regulator told managers that they could not test

alternative riparian management to improve fish habitat until they could prove that no harm to fish would occur. The notion that nothing should be tried until proof is established contradicts researchers understanding of the extent that proof is or can be known, including the uncertain—but likely negative—consequences when actions are not taken. This society-science disconnect will likely continue to hinder adaptive management. Perhaps because of the intense scrutiny AMAs received, some of the most successful applications of active adaptive management occurred outside of AMAs.

Data from monitoring the status and trends of key ecosystem attributes are useful in both expected and unexpected ways. In addition to addressing pre-specified questions, monitoring proved useful in other ways. For example, the simple balance sheet showing a net gain in the area of forest meeting late-successional criteria—because forest growth outpaced losses to harvest, fire, and other disturbances—was what most scientists expected, but appeared to surprise and perhaps reassure some of the public ("Old-growth forests gain ground," The Oregonian, April 18, 2005). The monitoring also documented larger than expected temporal and spatial variability, and provided some real surprises for researchers and others.

New data on temporal and spatial variability is helping agencies focus on the investment in monitoring needed to detect significant trends. Annual variation in owls and murrelet populations demonstrated the need for decade-scale monitoring to detect trends. Decadal oscillation in the Pacific Ocean temperatures—related to fish populations and fire history—demonstrates the need for even longer-scale monitoring to understand other trends. A more general appreciation for the extent of uncertainty about system dynamics appears to be emerging among managers. Perhaps this appreciation was demonstrated when a Forest Supervisor—reflecting that the Plan strategy of creating late-successional reserves from extensively managed

forest had never been tried before—asked, "Why should we expect that there is only one way to do it?" He also wondered about the strength of evidence on previous approaches proposed but not chosen.

Surprises, not likely to have been discovered without monitoring, point to another benefit. In the case of the owl, the northern populations declined sharply and unexpectedly. Researchers remain pressed to explain this trend and are now theorizing that increasing competition from barred owls invading from the north and east may be involved. Some decline was expected from the continuing loss of habitat on non-federal lands, and observed increases in the area meeting minimum old growth criteria may not have added importantly to key habitat. Just as surprising, some of the spotted owl populations in the southern ranges held stable or increased, especially in areas more influenced by fire than in the north and in areas with more intense timber harvest on nearby private lands distributed in a checkerboard fashion. Again, new theories are emerging, for example, Franklin et al. (2000) suggest that owls may benefit in southern areas from less-dense, brushy hunting grounds where prey, including wood rats, can be found nearby to their older-forest nesting habitat. Owl findings reinforce the conclusion that our understanding of the interacting factors controlling population dynamics is weaker, and natural variability greater than we would like, and that managers and regulators need to be open to new alternatives for maintaining owls. Post-report decisions are now actively considering increasing fuel management in older, dryer forests as a start. Perhaps large-scale experiments could be devised to test some of the new hypotheses.

Costs of a serious regional, interagency monitoring program are substantial. Covering status and trends of northern spotted owl and murrelet populations and habitat, older forests, aquatic habitat, and social and economic conditions cost more than $50 million over 10 years

(but that's only \$0.42 ha^{-1} yr^{-1}; table 1). This magnitude of funding was needed to implement a framework for regional monitoring that included a new interagency monitoring team [www.reo.gov/monitoring], frequent scientific advice, and a formal interpretive step. The choices of how to allocate monitoring funds reflected a mix of legal requirements (owls), potential legal requirements (murrelets), and balance between ecological resources and social values. The program was generally impressive in the support it received, and in its organization and follow through. The monitoring program was aided by other governmental monitoring such as the US Census, but was limited by faltering record keeping. Record-keeping problems paralleled large, up to 70% declines in budgets and personnel in Plan Forests, as Forests lost most of the funding and revenues associated with timber programs.

Question framing by decisionmakers and researchers deserves a high priority. The questions posed by the monitoring program (USDA and USDI 1994) could have been more relevant to the unfolding decisions, and interim interpretations might have identified correctable problems. Several steps were largely missed: not choosing—as a key management decision—a limited set of core questions, not adding quantitative expectations (except for timber production) to increase the power of subsequent interpretations, and not facilitating a broader debate about the durability and answerability of the questions. These shortcomings are now better recognized, and their correction has become a focus of post-report decisions, including a new process to define core, long-term questions.

Approaches to assessment need to change in response to the amount and type of scientific knowledge available. Assembling usually scant scientific evidence to inform the choice of a management strategy—as in the original FEMAT assessment—is obviously different from informing an ongoing management strategy based in part on information collected while

implementing the strategy—as in the 10-year report. Repeat assessments can tie more easily to learning, by comparing previous assumptions to what happened, by working with stronger, more locally specific data, by better understanding system dynamics, and by linking more effectively with current and future decisions. The importance of the handshake approach was that it placed increased emphasis on closing the adaptive-management loop, by presenting what was learned in a way that influences decisions about future direction, and by institutionalizing important steps of adaptive management. Because failing to close the loop and failing to institutionalize are cited as the most common failures when applying adaptive management (Walters 1997), the Plan has made important progress, especially if report findings continue to be considered.

Effective multiscale planning, managing, and interpreting—however logical—is difficult to implement. The Plan pioneered a multiscale planning model by amending existing Forest and BLM District plans with regional standards and guides, and by requiring additional analysis at intermediate scales of 20,000- to 50,000-ha watersheds and larger late-successional reserves. However, the de facto interpretation of regional standards and guides as a rigid set of instructions, by many regulators and land-management-agency specialists (and some judges) stifled local flexibility, limiting how local societal concerns and site-specific understanding of ecosystem function could be accommodated in the standards and guides. For example, fuel reduction in late-successional reserves in drier forests did not become a priority, until the experience with the 2002 fires, including the 240,000-ha Biscuit Fire, rekindled the debate about the interactions of fire and late-successional habitat. Looking forward, we expect multiscale planning and managing to remain an important challenge.

The 10-year interpretive teams struggled with aspects of multiscale analysis, stopping at little more than describing the problem. One reason for this struggle is the underlying difficulty

of integrating disparate scientific disciplines across scales. Because managers are more experienced than researchers blending science arguments together, they have an important role helping scientists with integration. After the interpretation was presented to key decisionmakers, in the conference of April 2005 (http://outreach.cof.orst.edu/nwforestplan/index.php), a Forest Service administrator commented how necessary it was to at least boil the science down so that the varying pieces could be heard over a two-day conference. We suggest that hearing all of the pieces at once is but the first step in integrating information.

Concluding thoughts

As with any strategy never tried before, problems should be expected—after all, the Plan was and remains a remarkably bold strategy for its time:

- By shifting the focus of multiple-use forest management from timber production before considering other uses, to a focus on current and future endangered species before considering timber production and other uses.
- By pioneering regionally coherent management strategies; and
- By pioneering adaptive management at the regional scale.

A major lesson during the first decade of the Plan is that ecological and social uncertainties of trying a new approach go hand in hand with important uncertainties in the institutional processes needed to implement and review previously untried management strategies. Whether adaptive management was a success or not is difficult to assess because results are slow to emerge and alternative outcomes can only be imagined, but we think an important conclusion has emerged. More formalized and systematic approaches—applied as core agency business—will likely lead to considerably more effective adaptive management and better future decisions; decisions not

only based on stronger evidence, but decisions that also explore and possibly implement a wider array of options. When elements of adaptive management were treated as core business—as in the regional monitoring and interpretive steps—they influenced agency decisions considerably more than elements not treated as core business—as in the AMA network. Another compelling lesson is that adaptive management is less about current decisions and more about mutual learning that might lead to better future decisions. Mutual learning implores managers to consider learning as a core business and the science community to improve their performance in civic science and their delivery of integrated, science-based evidence and tools. The future speed of learning and adapting will be determined by the extent that decisionmakers can take reasonable risks in the absence of proof, and the extent that different expectations about the temporal scales for biophysical and socioeconomic systems are better matched.

The 10-year reports were released this past year and agencies have so far published three decisions [http://www.reo.gov/library/riec/2005/2089riecnote06012005.htm]. They have chosen to redesign their approaches to adaptive management to be more systematic and rigorous, to develop more active ways of reducing fuels in fire-prone, late-successional reserves, and to review changes to the monitoring plan. These initial responses breathe some hope into the attractive idea of adaptive management.

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Table 1—Plan monitoring expenditures by monitoring module

Module	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
	Million dollars												
Spotted owl	1.8	1.8	1.8	1.7	1.6	2.3	2.1	2.4	2.6	2.4	2.5	2.6	25.7
Marbled murrelet						1.5	0.9	1.1	1.0	0.8	0.8	0.7	6.8
Older forests						0.8	0.4	0.4	0.5	0.8	0.6	0.4	3.9
Watersheds						0.4	0.5	1.4	1.1	1.0	1.3	1.2	6.8
Implementation			0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.2	0.2	2.4
Socioeconomics						0.0	0.0	0.1	0.2	0.4	0.4	0.4	1.6
Biodiversity						0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.4
Tribal								0.0	0.0	0.1	0.1	0.1	0.3
Program management						0.2	0.1	0.2	0.6	0.5	0.3	0.5	2.3
Total	1.8	1.8	2.1	2.0	1.8	5.5	4.2	5.9	6.2	6.2	6.3	6.2	50.1

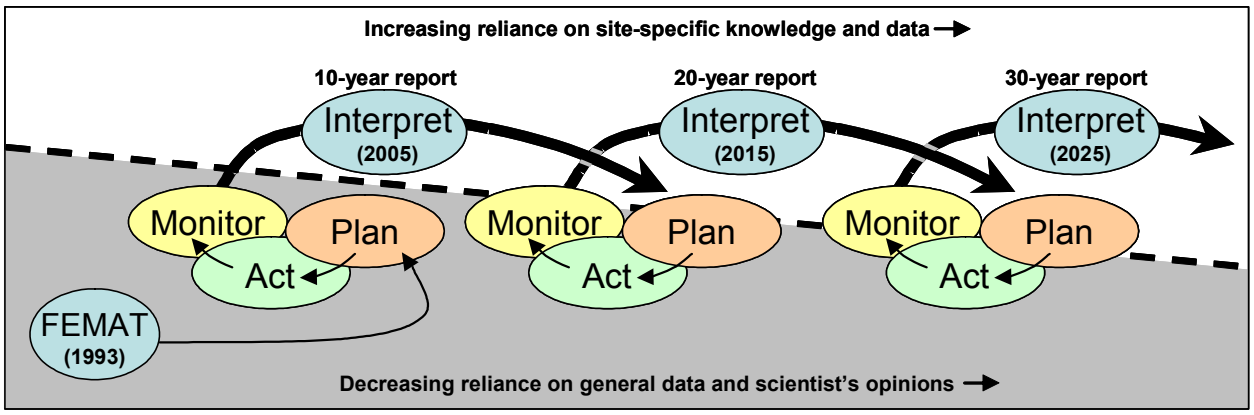
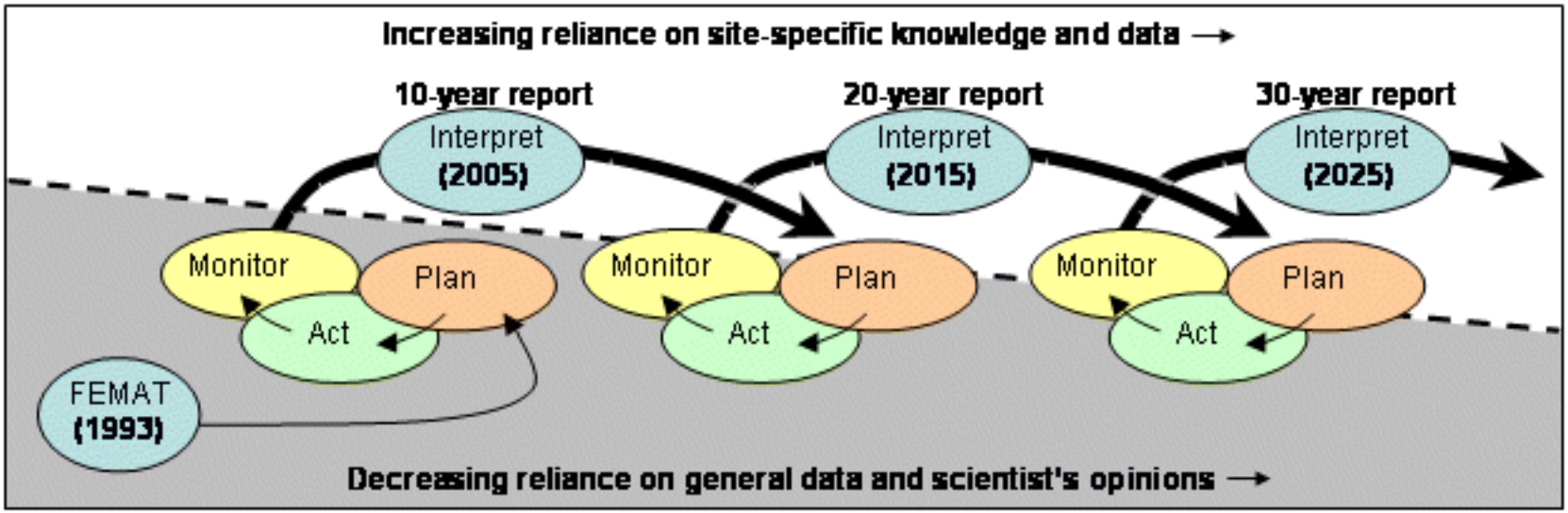


Figure 1. Time steps in the adaptive management cycle, starting with the forest ecosystem management assessment team's recommendations (FEMAT 1994) as implemented in the Northwest Forest Plan. Note that the traditional "evaluate" step has been changed to "interpret" because of the added focus on placing new evidence from monitoring and research in a broader, more integrative context as a way to better connect to and influence decisions. Also note that formalizing learning and adaptive steps is deemed essential to shifting the reliance on general data and scientists' opinions to site-specific knowledge and data.


Increasing reliance on site-specific knowledge and data →
10-year report
Interpret
(2005)
20-year report
Interpret
(2015)
30-year report
Interpret
(2025)
Monitor
Plan
Act
Monitor
Plan
Act
Monitor
Plan
Act
FEMAT
(1993)
Decreasing reliance on general data and scientist's opinions →