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Robert L. Fischman

Indiana University Maurer School of Law, rfischma@indiana.edu

J. B. Ruhl

Vanderbilt Law School, j.b.ruhl@vanderbilt.edu

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Judging adaptive management practices of U.S. agencies

Robert L. Fischman* and J.B. Ruhl†

*Maurer School of Law, Indiana University, 211 S. Indiana Avenue, Bloomington, IN 47405, U.S.A., email rfischma@indiana.edu

†Vanderbilt University Law School Nashville, TN 37203, U.S.A.

Abstract: *All U.S. federal agencies administering environmental laws purport to practice adaptive management (AM), but little is known about how they actually implement this conservation tool. A gap between the theory and practice of AM is revealed in judicial decisions reviewing agency adaptive management plans. We analyzed all U.S. federal court opinions published through 1 January 2015 to identify the agency AM practices courts found most deficient. The shortcomings included lack of clear objectives and processes, monitoring thresholds, and defined actions triggered by thresholds. This trio of agency shortcuts around critical, iterative steps characterizes what we call AM-lite. Passive AM differs from active AM in its relative lack of management interventions through experimental strategies. In contrast, AM-lite is a distinctive form of passive AM that fails to provide for the iterative steps necessary to learn from management. Courts have developed a sophisticated understanding of AM and often offer instructive rather than merely critical opinions. The role of the judiciary is limited by agency discretion under U.S. administrative law. But courts have overturned some agency AM-lite practices and insisted on more rigorous analyses to ensure that the promised benefits of structured learning and fine-tuned management have a reasonable likelihood of occurring. Nonetheless, there remains a mismatch in U.S. administrative law between the flexibility demanded by adaptive management and the legal objectives of transparency, public participation, and finality.*

Keywords: conservation planning, law, North America, politics and policy

Evaluación de las Prácticas de Manejo Adaptativo de las Agencias de los EUA

Resumen: *Todas las agencias federales de los EUA que administran las leyes ambientales afirman practicar el manejo adaptativo (MA), pero se conoce poco sobre cómo implementan realmente esta herramienta de la conservación. Se ha revelado un vacío entre la teoría y la práctica del MA en las decisiones judiciales que revisan los planes de manejo adaptativo de las agencias. Analizamos todas las opiniones de las cortes federales de los EUA, publicadas hasta el 1 de enero de 2015, para identificar las prácticas de MA de las agencias que las cortes encontraron más deficientes. Las limitaciones incluyeron la carencia de objetivos y procesos claros, el monitoreo de los umbrales y las acciones definidas activadas por los umbrales. Esta triada de atajos tomados por las agencias para evitar pasos críticos e iterativos caracteriza a los que nosotros llamamos MA ligero. El MA pasivo difiere del activo en su carencia relativa de intervenciones de manejo a través de estrategias experimentales. En contraste, el MA-ligero es una forma distintiva de MA pasivo que falla en proporcionar los pasos iterativos necesarios para aprender del manejo. Las cortes han desarrollado un entendimiento sofisticado del MA y continuamente ofrecen opiniones instructivas en lugar de opiniones críticas. El papel del poder judicial es limitado por la discreción de las agencias bajo la ley administrativo de los EUA, pero las cortes han anulado algunas prácticas de MA ligero de las agencias y han insistido en análisis más rigurosos para asegurar que los beneficios prometidos del aprendizaje estructurado y el manejo bien calibrado tengan una probabilidad razonable de ocurrir. Sin embargo, todavía persiste una desigualdad en la ley administrativa de los EUA entre la flexibilidad exigida por el manejo adaptativo y los objetivos legales de la transparencia, la participación pública y la finalidad.*

Palabras Clave: leyes, Norte América, planeación de la conservación, políticas y normas

Introduction

Adaptive management (AM) is an almost universally acclaimed conservation tool. Uncertain climate-change effects, ignorance about the causes of imperiled species declines, and the stochastic behavior of ecosystems are common justifications for using AM. In the 1990s, U.S. federal agencies began adopting AM in their plans and permitting processes. It is now standard practice (Williams et al. 2009; 36 C.F.R. § 219.12[d][2]), as are lawsuits challenging agency decisions. Although few other nations subject public decisions to as much judicial scrutiny as the United States, AM is now widely incorporated in statutes and rules around the world (Schramm & Fishman 2010).

We surveyed all U.S. judicial opinions that resolved legal disputes involving federal government AM. The court decisions highlight especially controversial projects but also unveil a cross section of agency practice. In particular, they show how agencies facing resource, political, and legal constraints respond by pulling together AM plans that often neglect key steps in the process. We call this kind of adaptive management AM-lite, a watered-down version of the structured-learning-based theory that “resembles ad hoc contingency planning” (Ruhl & Fischman 2010:426). Understanding this pragmatic approach of agencies offers important lessons for improved conservation. Specifically, AM-lite falls largely outside the framework in the literature that distinguishes passive from active AM. Instead, it represents a different version of AM that raises questions about whether the tool’s theoretical advantages may be realized in the various forms of practice that diverge from the process described in the literature. This analysis of judicial opinions reveals AM examples that might spur researchers to recalibrate their thinking to better match what actually happens in natural resources administration.

Forms of Adaptive Management

Adaptive management is supposed to be an iterative process in which decision outcomes are continually monitored and evaluated to determine whether they are achieving objectives. The feedback loops rely on goal establishment, model building, performance standard setting, outcome monitoring, and recalibration. Over time, feedback and adjustments provide flexibility in the face of uncertainty while simultaneously reducing uncertainty through systematic learning (Nie & Schultz 2012). Although the basic theme of learning by doing pervades all forms of AM, there is wide variation in practice. The most common distinction in the literature separates active from passive AM along a continuum of management inter-

ventions, particularly the use of experimental strategies (Walters & Hilborn 1978; McCarthy & Possingham 2007; Williams 2011; Williams & Brown 2012). The disparate literature includes a more mathematical framework that focuses on whether anticipated learning is considered when making each decision as a basis for distinguishing the two approaches (Williams et al. 2002). The algorithmic framework for quantitative optimization has practical application in waterfowl management and other tasks for which substantial data are available (Williams & Johnson 1995). But the conflicts courts have evaluated involve decisions for which biostatistical models gain little traction.

In the active form of AM, managers deliberately probe for information to evaluate testable hypotheses about the effects of intervention. For example, managers might evaluate the effects that a chosen habitat alteration and its alternatives have on invasive species by running small-scale test plot experiments. Active AM can identify optimal budget allocations to achieve the maximum area of successful revegetation, as defined by a certain density of vegetation present 20 years after planting (McCarthy & Possingham 2007). The normative ideal for strong inferences from experiments is closely associated with active AM involving replication, controls, and randomization (Prato 2005; Grantham et al. 2009). However, resource management, particularly over small areas, often involves a single system where replication and controls are infeasible. In that situation, active AM would provide structured decision-making tools that seek to optimize both management success and learning (Nichols & Williams 2012).

Passive AM can be any variation of AM that falls along a decreasing continuum of scientific rigor for hypothesis testing. It has thus been characterized as “nonexperimental” and “nonscientific” (Aldridge et al. 2004), “incomplete” and “haphazard” (Gregory et al. 2006), “unreliable” (Prato 2005), and “nonlearning based” (Williams 2011). Typically, managers make a decision based on the known historical behavior of the system and “a single best estimate or model for response” (Walters & Holling 1990). They then monitor the system to gather information for future learning but treat learning as a byproduct rather than an essential component of the management decision (Gregory et al. 2006; Nichols & Williams 2012; Williams & Brown 2012). Although passive AM is often described as incremental or sequential (Halbert 1993; Bormann et al. 1999), it is not experimental. Over enough iterations, and with enough monitoring, the passive approach may produce the same level of rigor as active AM (Williams 2011), as illustrated by the decades-long annual adjustments of Mallard (*Anas platyrhynchos*) hunting regulations (Nichols & Williams 2012).

Federal resource management agencies in the United States have all adopted policies that promise implementation of AM (Ruhl & Fischman 2010). Many of the agencies have led the way in developing the theory of AM, building on earlier scholarly work (e.g., Williams et al. 2009). Because the agency policies promise implementation of AM theory (e.g., 33 C.F.R. §332.2), the conflicts between agency implementation and agency promise reflect the tension between practice and theory.

Adaptive Management in U.S. Courts

Seminal scholarship characterized most examples of AM in practice as passive (Walters & Hilborn 1978), particularly because the complexity of dynamic optimization frustrates decision makers seeking to reduce uncertainty while also achieving management objectives. We find that the practice of many U.S. agencies, while generally a form of passive AM, diverges from the theoretical literature in other, seldom-noted dimensions revealed in the litigation. Although it is feasible to build into final agency actions some AM flexibility, it remains a challenge many agencies struggle with, particularly in circumstances of high uncertainty and little prior information. This has been the focus of the judicial decisions criticizing agency AM and recent agency initiatives to better mold adaptive plans to legal constraints.

Public agencies must operate within the structure of administrative law, built on a model of comprehensive rationality: all factors influencing a decision and its consequences must be considered before making a final decision. Once made, an agency must stick with final decisions until it reengages the administrative process to alter them. Adaptive management, in theory, is more open-ended and considers no decisions beyond revision to improve outcomes or learning. If the decision is adopting a long-term plan, the agency cannot adjust it without going through the arduous administrative process of amendment. Also, substantive laws (e.g., the Endangered Species Act [ESA]) require findings (e.g., that an action authorized by an agency will not jeopardize the continued existence of an imperiled species [16 U.S.C. § 1536(a)(2)]) before federal actions (e.g., an oil and gas leasing plan) may proceed and each time a plan is revised.

Fiscal and political constraints also complicate AM implementation by public agencies. Both generally encourage agencies to defer determining whatever is not absolutely necessary for a final agency action. They lead agencies to employ AM-lite, which frequently fails even to structure a learning procedure, whether through experimentation, historical research, or modeling (NRC 2004; Nie & Schultz 2012). It lacks a priori hypotheses. It is similar to “evolutionary adaptive management,” defined as trial and error, or learning from management without purposeful direction (Walters & Holling 1990). Trial and

error might lead to learning, but it is not the structured learning promised in AM. In its most extreme form, AM-lite is essentially open-ended contingency planning or on-the-fly management that promises some loosely described response to whatever circumstances arise. Implementation of AM-lite may be suitable where the range of possible variations in actions and outcomes is small and where the system is not experiencing novel stressors. But many of the AM decisions reviewed by courts consist of “basic trial and error learning in which explicit hypotheses are absent or vague” (Gregory et al. 2006:2412). The upshot is that AM remains largely an aspiration—achieving even passive AM has proven challenging enough.

Judicial Decisions

To gain a deeper understanding of how courts treat instances of AM-lite and what can be learned from the judicial commentary, we examined all federal court opinions containing the phrase *adaptive management* as of 1 January 2015 (Supporting Information). Of the 216 opinions with this term, 102 separate opinions (47%) involved a challenge to an agency’s AM of environmental or natural resources. In most (75%) opinions overall, and almost half (48%) of the opinions in cases directly challenging an AM element of an agency record, courts used the phrase *adaptive management* merely to describe some aspect of the administrative record not relevant to the judgment.

However, 53 judicial opinions applied relevant law directly to some aspect of AM. These are the cases we evaluated in our examination of U.S. agency practice of AM-lite (Supporting Information). In this group of 53 opinions, 45% of decisions overturned the agency decision as “arbitrary and capricious,” a legal standard deferring to any permissible agency interpretation. In U.S. administrative law, if a court overturns an agency record as failing to rationally support a decision (arbitrary and capricious) or finds some violation of a specific legal standard (e.g., failing to avoid jeopardy to the continued existence of an endangered species), then it generally will suspend and remand the agency decision (send the decision back to the agency for a new determination). Procedural violations of law (e.g., failure to complete an adequate environmental impact analysis) may result in remands under which an agency cures the defects in its record but reaffirms the substantive decision. A court upholding an AM approach does not necessarily endorse the practice as effective conservation. It merely finds that the approach did not violate any specific legal mandate. Additionally, an opinion upholding a particular AM approach does not necessarily resolve the overall legal dispute in favor of the agency.

We focused mostly on cases overturning AM-lite because the resulting opinions identify friction points in

the administrative process, where AM implementation often falls short of theory and effectiveness. An arbitrary-and-capricious finding is not a direct comment on the rigor of the AM process. A court may reject an agency decision that is a paragon of active AM because of an unrelated violation of law. But, when an agency relied on AM to meet a legal standard (e.g., ensure no jeopardy to an endangered species) and a court finds fault in that line of reasoning, the judicial opinion may reveal AM-lite shortcomings.

We extracted lessons from the cases in which the adversarial process unveiled problems with translating AM into practice. The court decisions paint a troubling picture of agencies cloaking their desire to defer decisions or dodge difficult calls under the AM label. This conclusion stems from a close reading of the 53 judicial opinions. Here, we present example cases in which judges clearly evaluated some aspect of adaptive management in an agency's record of decision. In many cases, judicial evaluation of AM is murky. A thorough canvass of agency AM practice is beyond the scope of this article. The difficulty of funding and litigating cases filters out disputes with low stakes. Agencies lose litigation only if they perform particularly poorly in justifying their decisions. Court decisions overturning agency actions are a useful window into the problems associated with translating AM theory into administrative practice. But, they cannot reveal the full extent or frequency of the shortcomings.

AM-lite

Courts that rejected agency AM plans cite a number of problems that correspond to commonly defined steps in the iterative process. Although courts evaluated the plans against legal standards and not AM theory, they often cited problems in the AM process as reasons to believe AM-lite will not deliver on its promise. These weak links in the chain of activities implementing AM roughly correspond with some of the barriers to successful AM discussed in the literature (Moser & Eckstrom 2010; Nie & Schultz 2012; Lindenmayer et al. 2013; Meretsky & Fischman 2014). Passive AM is distinctive in its relative lack of experiments or other structured forms of management intervention for hypothesis testing. In contrast, AM-lite is a particular form of passive AM that skips some iterative steps necessary to learn from management.

Although pathologies—including lack of stakeholder engagement, procrastination, and weak leadership—have been identified as impeding the progress of AM (Allen & Gunderson 2011), 3 shortcomings in AM implementation recur in judicial cases overturning agency decisions: failure to establish objectives or failure to describe monitoring protocols for a plan or project; failure to define decision thresholds in monitoring; and failure to identify specific actions that will be triggered when

thresholds are crossed. We characterized AM-lite along this chain of failures in the order in which iterative decision making should engage these steps. In practice, many public decisions involve weaknesses in these categories rather than total failures. But courts grant agencies the benefit of the doubt in judicial review. Agencies have discretion to craft poor AM approaches—a court will overturn only those that have glaring problems.

Clear Objectives and Process

The first and most critical decisions in devising AM strategies are formulating specific objectives and a process for monitoring (Stein et al. 2013; Fischman et al. 2014). Although they are separate steps in AM, establishing objectives and describing monitoring programs are two decisions that agencies now usually make to the satisfaction of courts. Without specific objectives and monitoring, goals may slip and actions designed to achieve one aim ultimately drift toward different outcomes. Objectives establish benchmarks against which to measure progress or indicate when program revision is necessary (Williams et al. 2009). Although AM-lite generally calls for monitoring, some applications avoid defining objectives or the means of monitoring them (Nie & Schultz 2012).

Litigation over grazing on the North Sheep allotments of the Sawtooth National Forest and Recreation Area illustrates how courts both uncover and shape agency implementation of AM-lite. A conservation organization challenged the agency's sheep and goat grazing allotment plans as contravening the mandates of the National Forest Management Act and the National Environmental Policy Act (NEPA). The Forest Service lost the first round of litigation when a court found that the plans' AM strategy failed to explain how they would achieve the Forest Service's objectives to allow grazing only on lands suitable for and capable of sustaining grazing. They also did not explain how the agency would monitor conditions. The environmental analysis in the administrative record stated that a monitoring plan "will be developed and implemented through an iterative process" but did not describe the process (Western Watersheds Project 2006:10). The agency responded with a supplemental analysis the court subsequently upheld as aligning grazing with forest plan goals by committing to monitoring "annual indicators" of range conditions at designated sites. The indicators for the suitability and capability objectives included numerical criteria (e.g., >4 inches of stubble height and <30% sagebrush cover at the end of the grazing season) (Western Watersheds Project 2011). Failure to meet the criteria under the supplemental commitments triggers specific actions, such as closing areas and reducing numbers of livestock.

Decision Thresholds in Monitoring

Thresholds are signals that something must change (warnings of problems) or can change (confirmations of achievements) in the management regime. But AM-lite often neglects to define these decision thresholds that trigger mitigation actions or reevaluation (Martin et al. 2009). The AM literature emphasizes the importance of activating intervention in response to observations (Lindenmayer et al. 2013), but thresholds are often absent in public plans (Meretsky & Fischman 2014). In contrast, decisions that contain quantitative standards for the deployment of review, mitigation, or some other adaption action harness the benefits of AM and help prioritize the key monitoring tasks (Gregory et al. 2006; Nie & Schultz 2012).

The same court that upheld the supplemental North Sheep allotment plan invited further litigation if the promised benefits of AM amount only to “a burst of monitoring” with no consequences for grazing practices that do not meet the numerical objectives (Western Watersheds Project 2011:1124). The following year it overturned a different agency’s renewal of grazing permits for failure to meet a regulatory requirement that noncompliance with rangeland health standards result in “appropriate action” to make “significant progress toward fulfillment” of the standards (43 C.F.R. § 4180.2[c][2]). The agency set goals and committed to monitoring, but, if the goals were not met “over time,” then the agency merely promised adaptive adjustment of grazing restrictions (Western Watersheds Project 2012:1129). The court found that “the amorphous definition” of “over time” afforded the agency “a nearly unreviewable discretion to wave off failures to comply for an unspecified number of years” (Western Watersheds Project 2012:1129). Specific triggers for changes in management practices (the decision thresholds) would have improved AM and secured legal compliance.

In contrast, a court allowed a coal mine fill permit employing an AM plan with “specific timelines for corrective actions if monitoring reveals noncompliant scores” (Ohio Valley Environmental Coalition 2012:637). Similarly a court upheld a decision not to designate the dunes sagebrush lizard (*Sceloporus arenicolus*) for protection under the ESA based, in part, on a plan that bound developments in the lizard’s habitat to minimize and mitigate impacts. The agreement required monthly reports to track habitat and established a threshold to trigger adaptive reevaluation if habitat loss came “within 7.5% of the allowed 1% loss in total habitat” (Defenders of Wildlife 2014:8).

An unusual comparative AM evaluation illustrates the role of AM thresholds in meeting substantive legal standards. In a series of decisions, Judge Wanger reviewed ESA compliance in the operation of California’s Central Valley irrigation system regularly between 2006 and

2011. One issue in the litigation was how agencies may rely on AM to ensure that water operations will not “jeopardize the continued existence” of any listed species (16 U.S.C. § 1535[a][2]). Judge Wanger’s decisions compared the conservation approaches of the Interior Department’s Fish and Wildlife Service (FWS) (responsible for the Delta smelt [*Hypomesus transpacificus*]) with the Commerce Department’s National Marine Fisheries Service (NMFS) (responsible for anadromous fishes). Both agencies employed AM, but Judge Wanger upheld the NMFS approach and remanded the FWS plan. The NMFS AM protocol contained definite, substantive criteria (e.g., temperature thresholds) that triggered revision of the water system operations to avoid jeopardy (Pacific Coast Federation of Fishermen’s Associations 2008). In contrast, the FWS approach failed to provide enforceable, precise criteria to serve as thresholds (NRDC 2007).

Specific Actions Triggered by Thresholds

Thresholds identify when action is necessary to adjust management practices or mitigation. But, AM-lite often neglects to specify just what that action should be. This may be because an agency wants to retain its future discretion or because an effective response is not yet known. In either event, failure to specify actions triggered by thresholds can lead to dead ends in what should be the continuing adaptive iteration cycle.

Courts have identified this missing element in AM-lite as a basis for remanding inadequate agency decisions. In Judge Wanger’s ESA review of California Central Valley water management, he overturned the FWS decision to adopt a procedurally elaborate AM protocol identifying danger thresholds for the Delta smelt. The triggered action would be convening a working group to “consider” a range of operational changes in the water system (NRDC 2007:341). Judge Wanger found the mandatory protocol failed to identify what changes to the system could improve conditions for the smelt. In contrast, the NMFS approach identified the enforceable requirements to be imposed if the system crossed thresholds for the anadromous fish. In remanding the FWS approach, Judge Wanger distinguished the Central Valley plan from an ESA permit for land development in California’s Natomas Basin that employed “well-defined mitigation measures” such as conservation land purchases, adjustment of conservation reserve size, and modification of agricultural practices (NRDC 2007). The Central Valley plan lacked such specificity of responsive actions, even though the protocol was much more elaborate. Complexity and detail in AM design does not necessarily assure substantive legal criteria will be met by triggering mitigating actions.

Another court set aside an FWS decision to remove the grizzly bear (*Ursus arctos horribilis*) from the list of species receiving ESA protection. The delisting decision

relied on AM-lite to respond to the decline in whitebark pine (*Pinus albicaulis*), an important food source for the bear. While the agency identified specific monitoring criteria (i.e., thresholds) to detect changes in mortality, litter size, and cub survival, the action triggered would be a study team effort to “recommend appropriate management responses” (Greater Yellowstone Coalition 2011:1029). Without explanation of what the responses might be or their effectiveness in the face of whitebark loss, the administrative record did not meet the ESA requirements for finding that the grizzly bear is not threatened by the decline in its whitebark food source.

Courts have interpreted mitigation mandates under several environmental laws to require a showing that conservation actions be “reasonably specific, certain to occur, and capable of implementation” (Center for Biological Diversity 2002:1152). Plans employing AM-lite often fail to meet this standard even when agencies commit to achieve “specific, numerical improvements in habitat quality and survival” (NWF 2011:1126). Promises to achieve specific goals are not self-executing, and expressing numerical thresholds in monitoring does not alone advance goals. Successful AM depends on a plan for what to do when thresholds are crossed. In remanding an agency’s no-jeopardy finding for operation of the Pacific Northwest’s Columbia River dams, a court criticized the common AM-lite approach of neglecting specific actions triggered by monitoring in favor of “vague” promises to act in an unspecified manner when thresholds are crossed (NWF 2011:1128):

It is one thing to identify a list of actions, or combination of potential actions, to produce an expected survival improvement and then modify those actions through adaptive management to reflect changed circumstances. It is another to simply promise to figure it all out in the future.

Even laws with weaker substantive requirements, such as NEPA, present courts with questions about triggered responses. One case overturned an agency environmental analysis under NEPA for failing to provide enough detail in its AM plan about mitigation actions for expansion of a gold mine (South Fork Band Council 2009). The agency’s AM-lite approach to the plan described a water monitoring regime with thresholds that would trigger a “detailed, site-specific plan to enhance or replace the impacted perennial water resources” (USDOJ 2008, § 3.2). The court found that this mitigation approach, which specified no particular action or technology, did not provide enough evaluation about the ability to avoid adverse impacts from the mine.

But other courts reviewing NEPA analysis have upheld similarly vague mitigation promises. For instance, the first large-scale use of AM to manage oil and gas lease development deferred both the establishment of quantitative criteria for thresholds and the selection of mitigation

measures (Theodore Roosevelt Conservation Partnership 2010). Nonetheless, a court upheld the plan against a NEPA challenge, in part because subsequent approvals of individual drilling permits would be subject to environmental analysis and could adopt site-specific criteria and mitigation. The court relied on the AM-lite approach in concluding that the agency took the required “hard look” at environmental impacts. This look-before-you-leap requirement distills NEPA’s comprehensive rationality approach. But the court responded that “allowing adaptable mitigation measures is a responsible decision in light of the inherent uncertainty of environmental impacts, not a violation of NEPA” (Theodore Roosevelt Conservation Partnership 2010:517).

Learning from AM-lite

Although federal agencies commit to AM, litigation reveals approaches that fail to produce a structured learning process. Practicing passive AM more effectively is a practical improvement that is within reach of U.S. agencies, and courts sometimes insist on it. Otherwise, AM-lite will lead to iterative dead ends and possibly discredit AM as an approach with a poor stewardship record.

Courts grasp the aims and elements of AM. They seek to impose the constraints of administrative law, which emphasizes finality and comprehensive rationality. But courts also appear eager to accommodate the conservation imperatives of AM (Ruhl & Fischman 2010). The perception that lawsuits are an impediment to AM (Koontz & Bodine 2008) is unsupported by our review. One court has even suggested that AM may be necessary where an agency will likely have to respond to unforeseen circumstances (Southwest Center for Biological Diversity 2006). Courts have rejected arguments that plans built around AM are mere “untested” hypotheses that cannot satisfy the rational-basis test of judicial review (SLDMWA 2011:913). But, courts sometimes reject agency rationales based on hypotheses when the proposed action is not accompanied by a plan to collect data to evaluate the accuracy of the hypotheses (Lands Council 2008). Courts aid AM when they insist on a plan to learn through management.

As agencies have established quantitative objectives in their AM plans, courts have dived deeper into the structure of the decisions to ensure that the promised benefits of structured learning and fine-tuned management have a reasonable likelihood of occurring. Federal courts are now unpacking AM-lite to reveal where agencies stumble along the way to successful iteration and learning. This dynamic provides agencies an opportunity and incentive to learn how to improve their practice of AM. Courts are most likely to reject AM plans that fail to specify clear objectives and processes, establish monitoring thresholds, and define actions triggered by thresholds,

thus suggesting how agencies can most effectively improve their AM practices. Agencies have learned from their past litigation losses; today they seldom stumble over the first steps of establishing specific objectives and processes.

But the courts and agencies working together can advance the practice of AM only so far. No major federal statute explicitly authorizes agencies to practice AM, much less spells out its requirements. Agencies have compiled detailed manuals for practicing AM (Williams et al. 2009; Williams & Brown 2012), but courts accord the manuals only moderate deference. This leaves agencies uncertain about whether their prescriptions for AM, even when met, satisfy judicial review when weighed against the requirements of environmental and administrative law (Benson & Stone 2013). Legislative standards for AM would provide agencies and courts more guidance and certainty.

Beyond providing substantive authority and standards, some AM scholars have suggested that the iterative decision-making process can also be promoted through administrative law reform (Karkkainen 2002; Craig & Ruhl 2014). Conventional administrative process requirements impose extensive front-end requirements on agency decisions, including impact analysis and public participation, and subject final agency decisions to judicial review. Although these requirements are meant to promote agency transparency, public participation, and legitimacy, they do not necessarily facilitate iterative decision making. This mismatch has prompted proposals for alternative procedural tracks for agencies to follow when they are authorized to employ AM, designed primarily to change the ways and times when public participation and judicial review are available in the AM process. For example, one proposal would allow agencies to adopt AM plans after public participation, impact assessment, and judicial review processes based on special, statutorily prescribed criteria designed to avoid the AM-lite shortcomings. If the plan fulfills the criteria, its implementation, including adjustments to actions called for under the plan, would not be subject to additional rounds of administrative process (Craig & Ruhl 2014). This latitude to practice AM would ameliorate the legal requirements many agency practitioners of AM identify as barriers (Benson & Stone 2013) but would retain the basic procedural safeguards of administrative law. Implementing such a procedural regime has thus far been untested.

Consistent funding is also necessary to support AM in practice, particularly its nerve center—monitoring. This does not necessarily mean that AM costs more than conventional management regimes, which also need monitoring to be effective. But conventional management seldom follows through with much monitoring (Karkkainen 2002). The judicial acceptance of AM should come at the price of more durable monitoring strategies. Courts may spur legislatures and agencies to better match funding to the continual needs of AM. Appropriations for

AM projects could establish endowments or annuities to assure that the back-end activities (especially monitoring, triggered actions, and reevaluation) deliver on the promise of reducing uncertainty. In the long run, the promise of AM practiced at its fullest—not the AM-lite version that has prevailed thus far—should be worth the investment.

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Supporting Information

Methods and results of our examination of cases (Appendix S1) and a spreadsheet of coding (Appendix S2) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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