

Decision-Making Triggers in Adaptive Management

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Abstract: *We analyzed whether decision-making triggers increase accountability of adaptive-management plans. Triggers are prenegotiated commitments in an adaptive-management plan that specify what actions are to be taken and when on the basis of information obtained from monitoring. Triggers improve certainty that particular actions will be taken by agencies in the future. We conducted an in-depth, qualitative review of the political and legal contexts of adaptive management and its application by U.S. federal agencies. Agencies must satisfy the judiciary that adaptive-management plans meet substantive legal standards and comply with the U.S. National Environmental Policy Act. We examined 3 cases in which triggers were used in adaptive-management plans: salmon (*Oncorhynchus* spp.) in the Columbia River, oil and gas development by the Bureau of Land Management, and a habitat conservation plan under the U.S. Endangered Species Act. In all the cases, key aspects of adaptive management, including controls and preidentified feedback loops, were not incorporated in the plans. Monitoring and triggered mitigation actions were limited in their enforceability, which was contingent on several factors, including which laws applied in each case and the degree of specificity in how triggers were written into plans. Other controversial aspects of these plans revolved around who designed, conducted, interpreted, and funded monitoring programs. Additional contentious issues were the level of precaution associated with trigger mechanisms and the definition of ecological baselines used as points of comparison. Despite these challenges, triggers can be used to increase accountability, by predefining points at which an adaptive management plan will be revisited and reevaluated, and thus improve the application of adaptive management in its complicated political and legal context.*

Keywords: Endangered Species Act, monitoring, National Environmental Policy Act, planning, policy

Detonadores de la Toma de Decisiones en el Manejo Adaptativo

Resumen: *Analizamos si los detonadores de la toma de decisiones incrementan la responsabilidad de los planes de manejo adaptativo. Los detonadores son compromisos negociados previamente en un plan de manejo adaptativo que especifica las acciones a tomar y cuando se tomarán con base en la información obtenida del monitoreo. Los detonadores mejoran la certidumbre de ciertas acciones que implementarán agencias en el futuro. Realizamos una revisión cualitativa profunda de los contextos políticos y legales del manejo adaptativo y su aplicación por agencias federales de E.U.A. Las agencias deben satisfacer la judicatura para que planes de manejo adaptativo reúnan estándares legales y cumplan con el Acta Nacional de Política Ambiental de E.U.A. Examinamos 3 casos en los que se utilizaron detonadores en planes de manejo adaptativo: salmón (*Onchorhynchus* spp.) en el Río Columbia, desarrollo petrolero y de gas por el Buró de Manejo de Tierras y un plan de conservación del hábitat bajo el Acta de Especies en Peligro de E.U.A. En todos los casos, los aspectos clave del manejo adaptativo, incluyendo controles y puntos de retroalimentación identificados previamente no fueron incorporados en los planes. Las acciones de monitoreo y mitigación estuvieron limitadas en su coercitividad, que fue dependiente de varios factores, incluyendo las leyes aplicadas en cada caso y el nivel de especificidad de los detonadores incluidos en los planes. Otros aspectos controversiales de estos planes giraron alrededor de quien designaba, conducía, interpretaba y financiaba los programas de monitoreo. Temas polémicos adicionales fueron el nivel de precaución asociado con los mecanismos*

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Paper submitted October 10, 2011; revised manuscript accepted April 30, 2012.

detonadores y la definición de las líneas de base ecológicas utilizadas como puntos de comparación. A pesar de estos retos, los detonadores pueden ser utilizados para incrementar la responsabilidad, mediante la definición previa de puntos en los que un plan de manejo adaptativo serán vueltos a visitar y reevaluados, y por lo tanto mejorar la aplicación del manejo adaptativo en su complicado contexto político y legal.

Palabras Clave: Acta de Especies en Peligro, Acta Nacional de Política Ambiental, monitoreo, planificación, política

Introduction

The language and ideas of adaptive management are pervasive in natural resource management in the United States. For example, the U.S. Department of the Interior issued technical guidance on the subject for all of its agencies (USDI 2009), and the U.S. Forest Service promulgated regulations defining *adaptive management* and explaining its potential use in planning (USFS 2008). Agencies typically view the approach as a way to promote learning and proceed with actions in light of uncertainty about potential resource effects and future conditions. In some cases, agencies have interpreted adaptive management in a way that prioritizes flexibility, discretion, and expedited decision making and deemphasizes aspects of adaptive management that allow for knowledge generation or favor cautious decision making (e.g., Doremus 2001; Camacho 2007/2008; Ruhl 2008). The flexibility and discretion purportedly needed by agencies to practice adaptive management may make it difficult to hold agencies accountable (Doremus 2001).

Focusing on natural resource management in the United States, we examined whether accountability can be built into adaptive management through the use of decision-making triggers. As used here, a *trigger* is a prenegotiated commitment within an adaptive-management or mitigation plan that specifies what actions will be taken if monitoring results reveal particular resource outcomes. Triggers are being used in natural resource management as a way to provide an adaptive, yet more structured, decision-making framework by identifying in advance the circumstances in which plans will be altered on the basis of monitoring information. We examined 3 cases in which triggers were used in an adaptive-management framework. Our primary goals were to examine how triggers are being applied, to determine whether they build accountability into adaptive-management plans, and to identify major questions and challenges regarding their use.

Theory, Practice, and Legal Requirements

Adaptive management has dual but interconnected purposes: to promote learning, or advance scientific understanding, and to adjust policies on the basis of this information in an iterative process. Adaptive management is

designed to proceed in spite of, and at the same time reduce, the inherent uncertainty of environmental management. It is a systematic, iterative, incremental approach that requires continuous monitoring, evaluation, and adjustment of management actions (Holling 1978). Adaptive management also requires identification of clear and measurable management objectives to measure progress toward those objectives and indicate when a change in management direction is necessary (USDI 2009). In the context of management of federal lands, a standard definition of the approach is as follows:

Adaptive management promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing (USDI 2009: v).

Ruhl and Fischman (2010:426) characterize what most agencies call adaptive management as "a watered-down version of the theory that resembles ad hoc contingency planning more than it does planned 'learning while doing.'" Such approaches may not have an experimental framework or research design that allows for learning, may not be designed to proactively track effects of management on resources, and may not include clear feedback loops that indicate how information will be used to evaluate or change management actions. In effect, these approaches fail to incorporate basic principles of adaptive management.

Implementation of adaptive management is affected by numerous factors, including organizational goals, values, and priorities. One of the most universal biases shared by agencies is their long-standing and well-documented pursuit of administrative discretion in various forms, from open-ended statutory mandates to flexible budgets (Nie 2008). The result is that agencies have adopted parts of adaptive management and not others. For example, they often do not predefine monitoring protocols or clearly define management standards and goals that could constrain decision making in the future. For instance, in its 2005 and 2008 proposed forest-planning rules, the U.S. Forest

Service emphasized the need for flexibility and adaptability of plans, and, at the same time, it reduced the role of environmental impact analysis done in accordance with the U.S. National Environmental Policy Act (NEPA) and removed other substantive legal obligations in the planning regulations that have historically constrained the agency (USFS 2005). Some critics suggest the rules used the rhetoric of adaptive management to remove binding legal standards, undermine NEPA and the National Forest Management Act, and maximize agency discretion (Flournoy et al. 2005; SCB 2005; Lawrence 2009).

Another key tension in the politics of adaptive management is the widespread search for managerial and economic certainty by political actors, whereas adaptive-management plans necessarily include flexibility to respond to the uncertainty inherent in resource management. For instance, in the case of habitat conservation planning under the U.S. Endangered Species Act (ESA), nonfederal property owners seek certainty about what actions they can and cannot take under an incidental take permit, which is required when nonfederal activities result in the take, defined broadly as any kind of harm, to threatened or endangered animals. To receive the permit, a nonfederal property owner writes a habitat conservation plan (HCP) designed to minimize and mitigate the effects of the authorized take, which occurs incidentally to otherwise lawful activities. To balance the inherent ecological uncertainties and the desire for regulatory assurances, the U.S. Fish and Wildlife Service promotes the use of adaptive management in HCPs (USDI & USDC 1996). However, such adaptive-management provisions are often more rhetorical than substantive and do not provide specifics or guarantees as to how adaptive management will be applied, a clear role for citizen oversight, or basic frameworks for how monitoring and plan adjustments will take place (Wilhere 2002; Camacho 2007/2008). Without specifics, the adaptive management aspects of plans may not be enforceable. Thus, in seeking to strike a balance between regulatory certainty and management flexibility agencies may use the language of adaptive management in such a way that favors open-ended, discretionary decision making (Doremus 2001).

A general concern is that agencies are not always held legally accountable for their commitments to monitor and adapt management activities. Agency definitions of *adaptive management* are generally vague and often do not provide guidance on how to actually implement the approach (Ruhl 2008). Without provisions that allow citizens to legally challenge plans, mandated monitoring, or prenegotiated commitments to add a degree of accountability or enforceability, agencies may not meet monitoring and mitigation commitments due to a greater emphasis on other priorities, political pressures, or funding shortfalls.

There is some question as to whether adaptive management can be effectively implemented in the context of

U.S. administrative and environmental law (Ruhl 2008). Adaptive management is conceptually different from the NEPA or NEPA-based planning, which is a required and foundational facet of natural resource planning in the United States. The NEPA requires environmental impact assessment before undertaking major federal actions. Assumptions and predictions are made before federal actions are taken, but predictions and actions are not necessarily adjusted on the basis of postimplementation monitoring data, which may not be collected (Karkkainen 2002; NEPA Task Force 2003).

Despite these paradigmatic differences, when pursuing an adaptive management approach, agencies must adhere to NEPA requirements, comply with other agency-specific planning mandates, and meet substantive legal standards. In the United States, a body of case law is beginning to outline the parameters under which adaptive management can be lawfully implemented (Schultz & Nie 2012). Statutes such as the ESA, which includes substantive requirements, for example section 7 of the act under which federal agencies cannot jeopardize the continued existence of a listed species, more tightly constrain agencies than do more procedural laws such as NEPA.

For example, the case of *Center for Biological Diversity v. Rumsfeld* (2002) revolved around the adequacy of monitoring and mitigation strategies in an adaptive-management plan. At issue were the U.S. Army's Fort Huachuca 10-year operating plan and the associated biological opinion from the U.S. Fish and Wildlife Service regarding water savings and monitoring of species' status. A biological opinion is part of the ESA's consultation process whereby the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration (NOAA) Fisheries, or both analyze whether a proposed action by another agency is likely to jeopardize the continued existence of a species or adversely modify its critical habitat. The court found the U.S. Army's plan for future management actions ambiguous and unsatisfactory in light of ESA requirements; it explained, "Mitigation measures must be reasonably specific, certain to occur, and capable of implementation; they must be subject to deadlines or otherwise-enforceable obligations; and most important, they must address the threats to the species in a way that satisfies the jeopardy and adverse modification standards" (p. 1152, internal citations omitted). These requirements are repeatedly cited in adaptive management case law.

A pair of cases reviewing adaptive management plans for operation of water projects on the Sacramento and San Joaquin Rivers is also instructive. At issue in *Natural Resources Defense Council v. Kempthorne* (2007) was the biological opinion issued for the delta smelt (*Hypomesus transpacificus*), a species listed as threatened under the ESA. In this plan, if monitoring data indicated smelt trigger points had been reached on the basis of a number of factors (e.g., risk of smelt entrainment in water facilities or estimated length of the spawning

period on the basis of water temperatures), a working group could meet and submit recommendations for actions that could potentially be undertaken by a separate management team. The court agreed with plaintiffs that this language was too uncertain and unenforceable in a plan devised to support the conclusion that operation of these water projects would not jeopardize the continued existence of the delta smelt. But the same judge upheld the biological opinion for the anadromous fish species affected by these water projects (*Pacific Coast Federation of Fisherman's Associations v. Guitierrez* 2008). In this case, the court determined that mitigation measures were specific and included under the terms and conditions of the incidental take permit, which is enforceable by law and therefore binding. The court was satisfied because mitigation measures were based on an enforceable standard, in this case a measurable change in temperature, which triggered a nondiscretionary mandate to reinitiate consultation before proceeding.

Large-scale adaptive management plans have survived legal review in other situations, including cases involving the Northwest Forest Plan and the Sierra Forest Framework (Ruhl & Fischman 2010). Each of these management plans acknowledges uncertainty and includes monitoring, adaptive management, and tiering, a process whereby project-level NEPA analyses may reference more broad NEPA analyses that have already been completed. Tiering and supplementation of analyses under NEPA allow managers to balance the desire for a broad planning framework with the need for site-specific analyses. Therefore, it is possible to pursue adaptive management within the context of administrative decision making and environmental law. Even where substantive standards are relevant, adaptive management can survive judicial review but only when mechanisms are built into the plan that require clear and meaningful actions that are triggered when specific conditions are met.

Methods

We conducted an in-depth, qualitative review of a small sample of natural resource management cases in which triggers were used in adaptive management plans. We used our professional judgment in choosing a purposive sample of high-profile cases involving different agencies and resources to determine whether approaches to the use of triggers and the challenges therein were common across cases. We studied the Federal Columbia River Power System Adaptive Management Implementation Plan (NOAA Fisheries 2009); the Pinedale Anticline Oil and Gas Exploration and Development Project in Wyoming (BLM 2008); and an HCP by the Plum Creek Timber Company (2000).

In each case, numerous interested parties were familiar with how triggers are used, and their positions could be

identified in administrative and legal documents. For each case, we identified the protected resource; examined the monitoring and mitigation plan; identified the decision-making document in which triggers were delineated; and determined what conditions would signal a trigger point had been reached and what predefined actions would be taken as a result. For each case, we also examined critiques and opinions in the administrative record, case law, submitted court materials, public-comment letters, and material written by participating interest groups. We did not examine the science used to determine trigger points; rather, we focused on their policy-related dimensions.

Results

The design, specificity, and enforceability of triggers varied. Plans specified that various mitigation or contingency actions be triggered if monitoring results showed a protected resource, often a protected species or its habitat, was in decline. For example, to supplement the most recent biological opinion associated with operation of the Federal Columbia River Power System, NOAA Fisheries (2009) designed an adaptive management implementation plan (AMIP) that included triggers for various anadromous fish species. The plan included "biological triggers that when tripped, [would] activate near and long-term contingency actions, should the agencies detect a significant decline in the species' condition" (NOAA Fisheries 2009: 8). The AMIP was intended to be more precautionary than the previous biological opinion, which did not survive judicial review. The AMIP included both early-warning indicators, which would indicate that a significant decline may be reached in 1 to 2 years and significant-decline triggers, which, if detected, initiate a series of rapid-response actions that may be applied to hydro-operations, predator control, harvest, and hatchery programs.

Although the AMIP received support from several states that argued it comported with adaptive management theory and case law, other interests challenged the plan, arguing that the contingency measures were not mandatory or specific enough and that the timeframe of their future implementation was unclear. In the most recent round of litigation (2011), plaintiffs challenging the AMIP argued that critical aspects of the monitoring plan and contingency actions had yet to be designed and that the plan lacked clear performance standards, and meaningful actions that "shall" take place if triggers are tripped. They also wanted the plan to be far more precautionary. They argued the triggers were not sufficiently conservative to ensure species conservation. Although triggers were used in this case to provide greater certainty and precaution than in earlier biological opinions, the AMIP met the same fate as previous management plans. It failed

to survive judicial review because it improperly relied on future actions that “are not reasonably certain to occur” (*National Wildlife Federation v. National Marine Fisheries Service* 2011).

The Pinedale Anticline Project was the Bureau of Land Management’s (BLM) first major effort to use adaptive management in oil and gas development (Benson 2009). The plan (BLM 2008) included a wildlife monitoring and mitigation matrix in which population and behavior changes in wild animals serve as triggers for mitigation measures. Triggers were designed to be initiated before consequences of oil and gas development became severe or irreversible. The trigger point for mule deer (*Odocoileus hemionus*), for example, was a 15% decline in abundance in any year or cumulatively over all years relative to a reference area. If such a decline occurred, BLM was required to select a preidentified mitigation response listed in the matrix, which included a range of possible on-site and off-site responses (e.g., voluntary lease suspensions, lease buyouts, habitat enhancements, or purchase of conservation easements). Monitoring and mitigation were to be paid for out of a designated fund financed by the largest oil and gas operators in the region.

The BLM’s use of triggers and adaptive management on the Pinedale Anticline has had a mixed reception. For instance, The Wilderness Society (2010:3) contended the approach “has potential as a model for how BLM can include concrete thresholds of changes that will trigger adaptive management actions to ameliorate or mitigate wildlife impact,” but that, “this model has not been realized.” What was unclear from the plan was whether the model required action to be taken at a certain time and whether such action was enforceable. The Theodore Roosevelt Conservation Partnership (2009) considered the model insufficient because the triggered responses were recommendations that were to be approved by industry rather than secure and binding commitments. They also took issue with industry’s role in designing and implementing the required responses in the mitigation matrix. Despite these concerns, a district court found the BLM’s discussion of mitigation measures satisfactory for the purposes of NEPA and its procedural requirements (*Theodore Roosevelt Conservation Partnership v. Salazar* 2010).

Triggers can be legally binding commitments made in contract form, such as an incidental take permit (ITP) issued as part of an HCP under the ESA. Habitat conservation plans are written to avoid harm to species listed under the ESA by private parties and include mitigation measures so that private landowners can proceed with otherwise lawful activities on their land. One of the most controversial provisions in HCPs are the inclusion of “no surprises” assurances, which promise a landowner that the terms of an ITP will not change except when preidentified “changed circumstances” occur (Wilhere 2002). The provision is predicated on the belief that sev-

eral changed circumstances can be adequately planned for in an HCP, such as the listing of a new species or a catastrophic event in an area prone to such events. Although not always labeled as such, triggers are built into HCPs through the negotiation of these changed circumstances. A nonfederal property owner will commit to taking prenegotiated actions if these preidentified circumstances change. For instance, a detected decline in a population or habitat quality could be a changed circumstance and trigger required mitigation actions or other changes to an ITP.

In the Plum Creek HCP, triggers activate a range of contingency or mitigation actions. A 30-year ITP was issued to Plum Creek Company in their Native Fish Habitat Conservation Plan in exchange for a set of “conservation commitments.” These were specified in matrix form; a column of triggers was followed by a column of applicable management responses. For example, if a “statistically significant increase of 1.0° C in stream temperatures relative to pre-treatment conditions is observed,” the management response was to “revise or create riparian prescription enhancements” on the basis of an earlier evaluation (Plum Creek Timber Company 2000:2). Although often vague, these sorts of triggers and conservation commitments satisfied the U.S. Fish and Wildlife Service when it issued an ITP to Plum Creek. Critics contended the triggered conservation commitments were biologically insufficient, vague, and uncertain to occur. For instance, Trout Unlimited (2000) wanted more sensitive triggers and more-developed quantitative parameters and was concerned that adaptive management was being used as a substitute for a more precautionary approach to species conservation.

Discussion

The cases we examined lacked some basic characteristics of adaptive management and are more appropriately characterized as contingency planning, with an emphasis on monitoring conditions and adapting mitigation measures as necessary. This is in part a reflection of the cases that we selected, which were designed to protect species in light of ongoing resource use. Although these cases emphasize uncertainty and monitoring, they were generally not designed as hypothesis-driven experiments and did not have monitoring frameworks, controls, and replicates that would actively further scientific understanding of the ecosystem. In some cases, the feedback loop between monitoring information and adapting management actions was unclear. Plans did not always make explicit what would happen exactly once a trigger was pulled. Instead of specific actions and timelines, triggers often only required agencies to consider a range of vaguely stated mitigation measures that might be taken in the future.

If an agency advances something that is really contingency planning, but is packaged as adaptive management, this could appear disingenuous and erode trust in already-contentious contexts. Furthermore, if so-called adaptive-management plans fail to make the link between management actions, monitoring information, and learning, the opportunity to reduce uncertainty about the ecosystem likely is lost. Adaptive-management plans will be more effective if they are designed to facilitate learning and include a clear feedback loop for adaptive planning, which ties lessons learned from monitoring information to actual management changes. Without this, unfocused monitoring and mitigation may lead to inefficiencies and wasted resources. The lack of a preidentified feedback loop also reduces the likelihood that adaptive mitigation measures will be implemented over time.

In the cases we examined, whether monitoring and triggered mitigation were enforceable and certain to occur depended on how and where such commitments were made. Agencies are not required under NEPA to implement mitigation measures that are discussed in an environmental impact statement. Mitigation commitments may be scrutinized more closely when they are used to justify a finding of no significant impact (FONSI) under NEPA, but even in these cases, mitigation measures only need to be reasonably certain to occur (Owen 2009/2010). Furthermore, one cannot take an agency to court simply because it did not do what it said it would do in a NEPA document. However, agencies may be required to supplement their NEPA analyses if they significantly change their planned actions, environmental conditions change, or monitoring information shows actions are having effects outside the range of what was predicted in an NEPA document (CEQ 2008).

Enforcing monitoring and mitigation commitments made in land-use plans is particularly challenging. The U.S. Supreme Court ruled that commitments to monitor in federal land-use plans are not discreet actions warranting judicial review or legally binding commitments enforceable under the parameters of administrative law (*Norton v. SUWA* 2004). Even when commitments are made outside a land-use plan, the courts are reluctant to force agencies to conduct monitoring. Often courts neither consider monitoring a final agency action that is reviewable in court nor see it as their role to review the quality and degree of compliance with monitoring commitments (Biber 2011).

These challenges notwithstanding, monitoring commitments can be made enforceable if they are written such that monitoring is required as a precondition for future agency action. For instance, the survey and manage requirements under the Northwest Forest Plan required that some species be surveyed before ground-disturbing activities (USDA Forest Service and USDI Bureau of Land Management 1994). As in the case of the biological opinion for anadromous species on the Sacramento and San

Joaquin rivers, clearly outlined commitments to monitor also may be written into legally binding agreements, such as ITPs, such that they are legally enforceable.

To ensure monitoring and mitigation actually take place, the Council on Environmental Quality (CEQ) (2010) recommends that agencies identify funding for monitoring up front and specify measurable performance standards to inform whether mitigation measures are needed or are effective. The CEQ also highlights Department of the Army NEPA regulations that make commitments in decision documents legally binding and require that funding for mitigation and monitoring be fully addressed in NEPA documents (U.S. Department of the Army 2008).

In general, enforceability increases if the details and timelines of the monitoring and mitigation responses are prespecified. It is necessary to identify what will be monitored and when, how and when monitoring information will trigger a change in management action, and what activities can continue while monitoring or mitigation decisions are ongoing. Although enforceability of mitigation and monitoring commitments is contingent on several factors, such commitments can be made binding and enforceable if agencies choose to make them so.

The use of triggers also raises some familiar scientific and technical challenges associated with monitoring. Historically, there has been a chronic absence of monitoring information feeding back into land-use plans and projects (Moir & Block 2001; Bear 2003; Doremus 2008). Scientific disagreements about what and how to monitor were a dominant theme in our case studies. Environmental groups regularly question and legally challenge the scientific underpinnings of monitoring programs (e.g., design, sample sizes, geographic area). Part of the challenge is the time needed to make short-term management decisions compared with the time needed to obtain valid and reliable monitoring data. In the Pinedale case, for example, some believe that by the time effects of oil and gas drilling on mule deer populations in the region are detected through monitoring, it may be too late to remedy these effects. The challenge goes beyond the set point of the trigger and involves the level of statistical certainty required to set off a trigger. The choice of the level of statistical certainty, or more importantly the lack of such a choice, is one way triggers could be designed strategically to be more or less precautionary or enforceable.

Other important political questions related to monitoring also surfaced: what value or resource is measured, who does the monitoring, and what activities are permitted or disallowed while the monitoring is being done? Because future agency budgets are inherently uncertain, future monitoring and mitigation are difficult to ensure. Agencies typically conceded that funding for future monitoring and mitigation is uncertain, but they nonetheless committed to trying to secure requisite funds. This approach often appears sufficient to CEQ and the courts,

but it is possible to do more. For instance, instead of a pay-as-you-go funding program, HCPs often outline a priori how mitigation measures will be funded, even if such funds are not always set aside at the onset (Kareiva et al. 1999). Army NEPA regulations provide another example; they state that a “project cannot be undertaken until required mitigation efforts are fully resourced, or until the lack of funding and resultant effects, are fully addressed in the NEPA analysis” (U.S. Department of the Army 2008).

To address the contentious issues regarding who holds the responsibility for designing, conducting, interpreting, and funding monitoring, agencies could establish a multiparty monitoring oversight board to ensure transparency and accountability. Strategic decisions could be made in early stages of planning to determine where uncertainty is prevalent, what the monitoring priorities are, what can be effectively monitored, and how the monitoring will be funded. Agencies and other parties could identify a realistic funding strategy before an adaptive-management plan is implemented and be explicit about what will happen if envisioned funds do not materialize.

Another critical issue is where to set triggers. One may question the assumption behind the use of triggers and ask whether agencies and scientists know enough about a given problem to predetermine and then correctly set trigger points. This valid concern should be considered in the political context of adaptive management. Triggers can help provide structure and regulatory sideboards to adaptive planning and thus limit the amount of discretion afforded to agencies that might otherwise fail to follow through on their commitments. Instead of paralyzing all parties, uncertainty can be managed by focusing on a relevant and mutually agreeable set of triggers and responses. Over time, the assumptions behind trigger points would be adjusted on the basis of monitoring data. However, there is the question of how flexible such measures should be. Rather than creating a system in which an agency could change trigger points with limited oversight, the process for adjusting triggers also could be strategically designed to ensure transparency and accountability.

Several groups involved in our cases endorse the idea of triggers in theory but disagree on how they should be used in practice. At the core of these conflicts are different political opinions about what to do in the face of uncertainty and risk—a pervasive question in environmental governance. Who carries the burden of proof and what value gets the benefit of the doubt when it comes to making decisions that may cause harm to the environment? Shall a precautionary principle be used in setting trigger points, or should regulations not be imposed without unequivocal scientific justification? What probability of success should plans with triggers provide? These questions were posed frequently in the case-study documentation. Generally speaking, the conservation or-

ganizations involved urged that more caution be used in setting trigger points. They wanted greater levels of confidence that an action would not cause harm to species or habitat.

Another common conflict in our case studies was how baselines are used in conjunction with triggers and mitigation responses. Often a reference point is needed to measure and evaluate change, and we found that the selection of a baseline date and level can be highly contentious. For example, for mule deer in the Pinedale case, the BLM chose 2006 as the baseline year, but oil and gas development intensified in the region in 2000. This was challenged by environmental groups who understand how easily baselines can be used strategically to influence how changes in population status are interpreted and contextualized in comparison with a selected baseline (Theodore Roosevelt Conservation Partnership 2009; Ruhl & Salzman 2011). In the Pinedale case, some groups wanted baseline information collected before development so that “appropriate standards and thresholds” could be developed to “warn of environmentally damaging trends before” declines to species are substantial (The Wilderness Society 2010:2).

Determining trigger points requires political judgments be made regarding acceptable levels of risk to species. Again, this could be a topic to be handled by a multiparty monitoring board. To be transparent and explicit about such choices, management plans could explain choices that were made about risk, how baselines were used to set the trigger points, and how goals and outcomes were identified.

Triggers are sometimes used to help ensure the mitigation of environmental harm, often due to resource development. But triggers could also be used in the context of ecological restoration, to identify progress toward specific goals or determine whether restoration activities are having undesirable effects. In either situation, agencies could incorporate a continuum of trigger points, instead of a single red-light trigger that must not be crossed. Triggers can be used to prevent the crossing of ecological and regulatory thresholds, which often correspond with values of ecological variables that, once reached, may not be reversible, and more cautiously to serve as warning signs that a resource is in decline.

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