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Social and Legal Effects on Monitoring and Adaptive Management: A Case Study of National Forest Grazing Allotments, 1927–2007

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Monitoring is a critical component of adaptive management but often weak or missing in practice. We examined grazing allotment files to identify patterns in monitoring and management practices on the Coronado National Forest from 1927 to 2007, and conducted interviews with key informants to understand the mechanisms behind those patterns. Standardized, documented monitoring occurred on a near-annual basis on all allotments until 1978; ceased abruptly from 1978 to 1998; then resumed. Before 1978, monitoring frequently indicated excessive stocking, but reductions often did not occur. Interviews revealed that monitoring ceased for this reason, as agency employees turned to more informal methods in hopes of affecting management. Monitoring resumed in response to litigation by environmental groups. Curiously, more effective adaptive management of grazing allotments appears to have begun during the period when standardized monitoring was not occurring.

Keywords adaptive management, grazing allotments, monitoring, national forests, rangelands

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Adaptive management requires that monitoring of natural resources is used to evaluate and improve decisions and practices in a virtuous feedback loop of "learning by doing" (Walters and Holling 1990). Despite widespread institutional commitments to adaptive management (Grumbine 1997; Johnson 2001; Mattson et al. 1996; Rigg 2001; U.S. Forest Service 2006; Williams et al. 2007), empirical evidence suggests that many monitoring programs are inadequate for effective conservation and management of natural resources (for a review see Biber 2011). Several authors have noted the difficulties that resource management organizations face in maintaining long-term monitoring programs (Koontz and Bodine 2008; Mattson et al. 1996; Williams et al. 2007). Scientists and public agency officials have called for greater funding of monitoring (especially long-term monitoring); improved networking among existing monitoring efforts and collaboration between researchers and practitioners; enhanced public access to monitoring data; and a more flexible, "adaptive" approach to monitoring itself (Bricker and Ruggiero 1998; Danielsen et al. 2008; Johnson et al. 1999; Lovett et al. 2007; Marsh and Trenham 2008; Ringold et al. 1996; Stem et al. 2005).

Compared to budgetary and technical issues—*what* and *how* to monitor, and how to pay for it—the other conditions that facilitate or inhibit monitoring have received relatively little scholarly attention. Gay (1990) underscored the social and political obstacles to rangeland monitoring, but he focused almost wholly on the developing world. Moir and Block (2001, 144) described "seven major reasons why monitoring plans fail," most of them rooted in "a mixture of politics, careerism, economic concerns, stressful overwork, and lack of accountability." They also pointed out that U.S. public rangeland monitoring programs in place during the mid-20th century were "mostly defunct." But their analysis was based on personal experiences rather than research. Similarly, Stem et al. (2005) reviewed the limitations and challenges of various monitoring approaches used in conservation, pointing out flaws in data quality or model assumptions. They listed "institutional resistance" as a challenge for adaptive management, but they did not explore the nature of this resistance or what might be done to overcome it.

Case studies have explored the importance and challenges of multistakeholder collaboration in adaptive management and monitoring (Allen et al. 2001; Schreiber et al. 2004), an issue to which we return later. Such studies recognize that monitoring occurs within social contexts that enable and constrain people in myriad ways, depending on legal, political, institutional, and other circumstances (Brown and Havstad 2004; Koontz and Bodine 2008). But the longer history of monitoring—which dates back nearly a century for some federal lands in the United States—has rarely been explored for empirical insights. West (2003) has reviewed this history for U.S. rangelands as a whole, summarizing the policies, institutions, and researchers responsible for various (and disparate) monitoring protocols, but with only limited analysis of whether and how monitoring actually occurred and no discussion of its effects on management.

This article reports results of a case study of monitoring and management of grazing allotments on the Coronado National Forest (CNF), in southeastern Arizona and southwestern New Mexico, from 1927 to 2007. The results of our case study are consistent with audits and reviews conducted at the national level in the 1990s, which found that three-quarters of U.S. Forest Service grazing allotments were not being monitored at that time (GAO 1991; cf. NRC 1994). We also found, however, that grazing allotments had been monitored annually for 50 years prior to

1978, and CNF archives contained detailed information about how a large resource management agency does (or does not) develop and maintain monitoring programs that effectively inform management.

Methods

Source materials were drawn from CNF allotment files and consisted of paper documentation from 1927 to 2001 and digital files for the years 2002–2007. (Allotment files are public documents; so-called permittee files, which may contain confidential correspondence and financial information, are accessible only with permittee consent and were not reviewed.) There are 185 grazing allotment files in CNF archives, providing a comprehensive record across 690,000 ha of land. The files contained monitoring records, management plans, annual letters to permittees, internal correspondence, and in some cases public inquiries and notices of public hearings relating to allotments. These details enabled us to ascertain not only whether and how monitoring occurred, but also whether it affected subsequent management of each allotment. This required close examination of the files, and due to the large volume of materials (each file was several inches thick), we chose to sample the files systematically. The CNF organizes files alphabetically by allotment name; in cases where allotments have been divided, consolidated, or removed from lease, records are filed according to the most recent administrative units. Because neither allotment names taken individually nor their alphabetical ordering as a group bore any relation to the variables being studied, we selected every sixth file, for a total sample of 31 files; all went back at least as far as 1927.

We define monitoring as ''the systematic collection of ecological data in a standardized manner at regular intervals over time,'' performed to detect change or evaluate progress toward an objective (Spellerberg 1991, 2). Standardized monitoring forms, changes and absences therein, and other detailed documentation enabled us to reconstruct the practice as well as the design of grazing allotment monitoring and management—that is, what was actually done, rather than only what was officially supposed to be done. Data were entered into a spreadsheet for analysis of patterns. We did not attempt to analyze quantitative monitoring data contained in the reports.

An unexpected pattern jumped out from the data: Standardized, documented monitoring abruptly ceased in the late 1970s and resumed two decades later. The files said nothing about why this had happened, so we conducted semistructured, open-ended interviews with four U.S. Forest Service employees (one retired range conservationist, two current CNF range officials, and one current U.S. Forest Service regional office range official) and one permittee family. Four interviewees had first-hand knowledge of CNF allotment monitoring and grazing management going back 30 years or more; the fifth had directly overseen the resumption of monitoring in the 2000s.

Results and Discussion

Allotment monitoring was documented in forms called annual inspection reports. From 1927 through 1978 these reports were filed for each allotment nearly 9 years out of 10 on average; more than half of the allotments (16 out of 31) were inspected in every year, and only one allotment was monitored less than 50% of the years from

its inception to 1978. Beginning in 1978, annual inspection reports abruptly ceased on almost all of the allotments, disappearing completely from 1990 to 1997, after which they resumed, but at about one-third to one-half the frequency of their peak in the early 1970s (Figure 1). Following development of the so-called Parker 3-step method of rangeland evaluation (Parker 1950), the CNF also completed a small number of more exhaustive allotment analyses after 1950, but these were infrequent (once per decade) and irregular (average 1.4 assessments per allotment in our sample), representing inventories rather than monitoring. Similarly, production and utilization surveys were done beginning in 1972, but infrequently and irregularly (only 44 total across the sampled allotments in 36 years). We therefore focus on annual inspections.

In the early years, annual inspections resulted in short, open-ended memoranda that described the site visit, the condition of the range, the distribution and condition of livestock and water sources, and management practices such as fencing, water development, and the placement of salt. Inspection reports were completed using standardized forms beginning in the 1930s, and the forms evolved through 14 versions between then and 1978, ranging from one to four pages in length; most (10) were two pages long. Despite these changes, the objects of inspection remained similar: All versions of the form compiled information on livestock numbers (permitted, actual, and in the early years trespass) and on dates of grazing. On early forms this was almost the only quantitative information demanded.

Through 1978, monitoring displayed two patterns over time: a narrowing of the overall focus or scope of inspections, and an increasing emphasis on quantitative measurements. Before 1960, qualitative questions predominated over quantitative ones, and inspectors were given significant discretion and space (often the whole of page 2) to answer open-ended questions or simply record observations. Inspection forms consistently included questions about permittees: Were they present for the inspection; did they have a copy of the management plan, if one was in place; were they briefed on the results of the inspection; how did they respond? In contrast, around 1960 questions about permittees dropped out of the inspection forms, replaced by matters suited to quantitative measurement, especially the composition, cover, and productivity of vegetation.

Annual monitoring revealed wide variability in forage production, principally due to variability in rainfall, and range conservationists sometimes concluded that

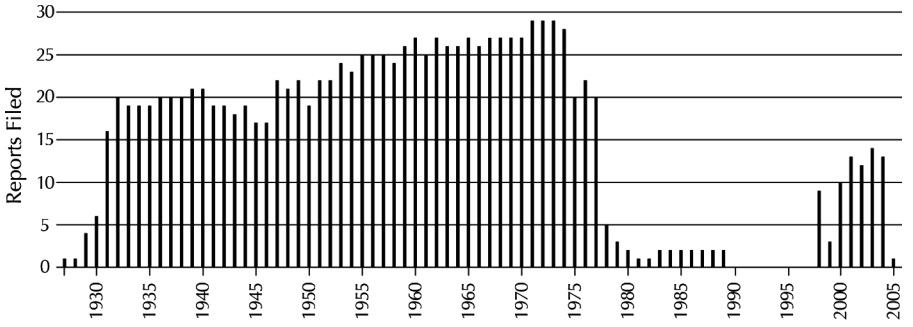

Figure 1. Number of annual inspection reports completed for sampled allotments ($n = 31$), 1927–2007.

livestock numbers were too high. But the feedback of these data into management was weak. In the period up to 1978, permitted livestock numbers were assessed as inconsistent with grazing capacity in 45 instances involving 21 (68%) of the allotments in our sample; in 41 cases (91%), stocking rates were deemed too high. Permitted stocking changed much less frequently, however, and often only when an allotment changed hands. In 19 cases (42%), no changes were made. In 21 cases (47%), permitted numbers were reduced, but in four of these they remained above assessed capacity, and in one instance, permitted numbers were *increased* despite being assessed as above capacity. In all four cases where permitted numbers were below capacity, by contrast, the permits were revised upward. Management should not be viewed as reducible to stocking rates, but that was what the monitoring was designed to inform—apparently with limited success.

Paradoxically, the cessation of monitoring was an adaptive response to these on-the-ground failings. According to a retired range conservationist who worked at the CNF from 1977 to 2000, annual inspections were abandoned because they had become unwieldy and ineffective in influencing permittees' management decisions (a claim that is borne out in the files). Incremental efforts to improve the quantitative accuracy of vegetation measurements, he said, had made monitoring so labor-intensive that "we didn't have time to talk to the ranchers anymore" (L. Allen, interview, March 2008). The disconnect between monitoring (performed by CNF staff) and management (by the permittees) is suggested by his recollection that his predecessor, Charles Ames, who completed countless annual inspections for the CNF in the mid-20th century, used monitoring strategically: If he considered an allotment overstocked, he would tell the permittee that a large cut—larger than the data supported—might be necessary; he would let this sink in for a year or more, then monitor again and conclude that only a smaller cut was needed, hoping the permittee would by then be more receptive to it. After 1978, range conservationists continued to visit allotments and examine conditions, but devoted more of their time to "sitting at the kitchen table drinking coffee" with permittees (L. Allen, interview, March 2008).

The resumption of monitoring occurred in response to lawsuits filed by environmental groups challenging CNF grazing permits under the Endangered Species Act. Current CNF employees recalled that the range program in the 1990s was dominated by "appeals and litigation," and that the absence of allotment monitoring data was a liability for the agency (R. Smith, interview, March 2008). As one employee put it, "There were lots of disparate opinions [about conditions on allotments], but little data" due to the "monitoring black hole" of the 1980s and 1990s (R. Gerhart, interview, March 2008). The revival of systematic, standardized allotment monitoring after 1998 occurred as the CNF (and the entire U.S. Forest Service) sought to implement "the ecosystem approach" based on principles of adaptive management (IEMTF 1995).

To preserve longitudinal comparability with pre-1978 data, the revived program was consciously modeled on the earlier one (R. Gerhart, interview, March 2008), but with some important changes. Qualitative data reappear: The annual reports, now called "unit examination records," include one page for narrative answers regarding livestock and vegetation, one on "effectiveness of coordination measures," and a third for "other remarks." Quantitative data are presented in tabular form based on an "ocular grazing impact analysis" that estimates production, utilization, cover, and soil conditions. Remarkably, the new forms do not require data about permitted

or actual stocking rates; this information is sometimes mentioned in the narrative section, but often not, making comparison with 1978 stocking rates difficult. The other notable difference from pre-1978 monitoring concerns the mix of participants. Not only are permittees now consistently present, but U.S. Forest Service personnel now include a wildlife biologist, as well as one or more range conservationists.

Curiously, changes in management practices on CNF grazing allotments appear to have begun during the period when standardized, documented monitoring was not occurring. According to U.S. Forest Service interviewees at the regional, CNF, and field levels, allotment management and range conditions have improved significantly since 1978; legal proceedings against the grazing program have diminished to "a trickle" since the 1990s, in part because monitoring data have demonstrated satisfactory range conditions[1]; and relations with permittees have become more cooperative. Agency officials attribute these changes to several factors, including an overall reduction of stocking numbers to more sustainable levels, more "progressive" permittees, and more stringent economic and budgetary conditions (e.g., funds for expensive range improvement projects have dried up, and "ranchers can't afford bad management anymore"). In general, recent monitoring reports suggest greater flexibility in actual stocking rates, at or below pre-1978 levels. The sequence of events suggests that standardized monitoring resumed *after* management had begun to be more adaptive; rather than causing or enabling a feedback loop, monitoring produced formal documentation of outcomes achieved informally.

The failure of the U.S. Forest Service to monitor grazing allotments in the 1980s has generally been attributed to passage of the Forest and Rangeland Renewable Resources Planning Act and the National Forest Management Act in 1974, which mandated comprehensive forest management planning and diverted staff away from monitoring tasks (GAO 1991; West 2003). It is unlikely, however, that monitoring ceased simply because of budgetary or personnel shortages. After 1974, the U.S. Forest Service's overall budget rose to historic highs, peaking in 1981; the agency's range program also saw a substantial increase in the late 1970s, albeit peaking somewhat earlier (around 1978 or 1979) before hitting a plateau for the next few years (Sample 1990). Sharp reductions in the agency's overall budget did not begin until 2 years into the Reagan Administration, around 1982 (Sample 1990).[2]

The case of the CNF suggests that the cessation of monitoring had other causes in addition to, or instead of, staffing or budgets. The fact that annual inspection forms were not filed between 1978 and 1998 does not mean that no inspections were done; rather, inspections occurred in a less formal fashion, with vegetation examined but not measured (an "ocular survey," as it is sometimes termed in the files) and results conveyed verbally to permittees and/or CNF supervisors rather than documented in inspection forms. This is supported both by our interviews (L. Allen, interview, March 2008) and by documents in the allotment files that allude to such visits. Range conservationists may have saved time by monitoring in less formal ways, but the decision appears to have been motivated, in whole or in part, by the perceived ineffectiveness of standardized, highly quantified monitoring as a means of influencing permittees' management practices.[3]

The technical adequacy of monitoring protocols also cannot explain the cessation and resumption of monitoring on the CNF, although it does relate to labor demands on CNF staff. The increasingly quantitative focus of monitoring may have enhanced its scientific accuracy, but more rigorous data were of limited value if the process of collecting and interpreting them neglected the social relations affecting

management. Historically, monitoring data (and range science more generally) were sought by the U.S. Forest Service as a means of buttressing its authority in the context of volatile political contests with permittees and their supporters in Congress, and the turn to more quantitative monitoring protocols was an extension of this (Rowley 1985). But in practice, monitoring data sometimes became a means of waging disputes as much as resolving them. Quantitative data could also be used by permittees to fight back against the agency: One family succeeded in having a proposed 44% cut reduced by two-thirds after pointing out that a much lower percentage of subunits in the allotment had actually been classified as in "poor" condition. The overall outcome was a stalemate: Even with monitoring data to support its decisions, the CNF often found itself unable to change management.

In the 1990s, lawsuits filed by environmental groups gave the U.S. Forest Service an institutional need to resume monitoring to satisfy court orders and/or avoid further litigation. Moreover, to satisfy the ESA and its enforcement agency, the U.S. Fish and Wildlife Service, required changes in the social process of monitoring more than in the technical details. CNF wildlife biologists became involved, and monitoring was transformed from a two-party process, involving only the CNF and permittees (with antagonistic interests in the single issue of stocking rates), into a more complex, multiparty interaction (including environmental groups, ranchers, range conservationists, and wildlife biologists) focused on achieving several objectives (e.g., forage, livestock, wildlife and habitat). In this new context, the CNF and permittees found reason to cooperate more than in the past. The U.S. Forest Service (acting at the regional level) also involved academic range scientists in both the design and implementation of monitoring, and it invested in extension efforts to train permittees in monitoring practices. At present, the CNF is actively encouraging permittees to monitor their allotments themselves, both to conserve agency resources and in the belief that participating in monitoring in and of itself helps to improve permittees' management (Fernandez-Gimenez et al. 2005; D. Stewart, interview, December 2008).

The U.S. Forest Service is heavily involved in the development of adaptive management and the related need for effective monitoring (U.S. Forest Service 2006). It is one of the largest landowners in the United States, controlling more than 75 million ha of land, and its management decisions have significant impacts on local, regional, and national communities. Although a much larger sample of national forests would need to be studied to draw conclusions about the U.S. Forest Service as a whole, this case can help guide further research about monitoring and adaptive management both on and beyond national forests in the United States. The social relations through which monitoring takes place may be as important to successful adaptive management as the protocols employed or the data obtained. Participating parties must have confidence in the data, to be sure, but confidence may not require ideal protocols—and conversely, it may be absent even with robust protocols. Social and legal factors must align to encourage the feedback of monitoring into management, if adaptive management is to occur.

Notes

1. Note that the decline in litigation may have had other causes as well. For instance, environmental plaintiffs may have decided for other reasons that litigation against the U.S. Forest Service grazing program in the Southwest was no longer a good strategic choice.

2. Budgets for range management on individual forests may have been cut or diverted to other activities, such as planning. But it is hard to determine whether these factors played a role on the CNF in the late 1970s because it was relatively easy, and common, for U.S. Forest Service officials to move funds between various programming accounts. Many activities could be characterized as fulfilling multiple objectives (e.g., a range improvement project might fall within range management, watershed protection, erosion control, or wildlife management), and supervisors or district rangers could reclassify an activity to maintain stable operations in the face of changing allocations of funds among different program areas (Sample 1990, 179–195).
3. Why higher level officials permitted monitoring to cease is a separate question, for which solid answers are elusive. The contemporaneous rise of intrusive judicial review, along with new federal laws that empowered environmental groups to challenge U.S. Forest Service decisions, may have made monitoring data into a potential threat to U.S. Forest Service autonomy (Biber 2011).

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