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Rethinking Social Barriers to Effective Adaptive Management

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Abstract Adaptive management is an approach to environmental management based on learning-by-doing, where complexity, uncertainty, and incomplete knowledge are acknowledged and management actions are treated as experiments. However, while adaptive management has received significant uptake in theory, it remains elusively difficult to enact in practice. Proponents have blamed social barriers and have called for social science contributions. We address this gap by adopting a qualitative approach to explore the development of an ecological monitoring program within an adaptive management framework in a public land management organization in Australia. We ask what practices are used to enact the monitoring program and how do they shape learning? We elicit a rich narrative through extensive interviews with a key individual, and analyze the narrative using thematic analysis. We discuss our results in relation to the concept of 'knowledge work' and Westley's (2002) framework for interpreting the strategies of adaptive managers—'managing through, in, out and up.' We find that enacting the program is conditioned by distinct and sometimes competing logics—scientific logics prioritizing experimentation and learning, public logics emphasizing accountability and legitimacy, and corporate logics demanding efficiency and effectiveness. In this context, implementing adaptive management entails practices of translation to negotiate tensions between objective and situated knowledge,

external experts and organizational staff, and collegiate and hierarchical norms. Our contribution embraces the 'doing' of learning-by-doing and marks a shift from conceptualizing the social as an external barrier to adaptive management to be removed to an approach that situates adaptive management as social knowledge practice.

Keywords Adaptive management · Narrative · Qualitative · Practice · Knowledge work · Learning

Introduction

Adaptive management (AM) is an approach to environmental management based on learning-by-doing where complexity, uncertainty, and incomplete knowledge are acknowledged and management actions are treated as experiments (Holling 1978; Walters 1986). Since its inception in the 1970s, AM has evolved into many distinct varieties, including active and passive (Williams 2011), resilience-based and decision-theoretic (Johnson et al. 2013), strategic and evolutionary (du Toit et al. 2003, Walters and Holling 1990). All varieties share an emphasis on the epistemic dimensions of environmental management practice: they attempt to introduce scientific logics and acknowledgement of complexity to the 'doing' of management. Yet they also share a decidedly patchy implementation record, which has produced a growing gap between AM theory and practice. Part of the frustration on behalf of ecologists and resource scientists is the 'improper use' of AM—practitioners claiming they are adaptively managing when, allegedly, they are actually doing something else—and the proposed route to amending this situation is to be precise when using the term (Rist et al. 2012). But while there is certainly value in being clear in AM

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research, terminological precision will not necessarily furnish greater clarity about enacting a phenomenon that carries inherent tensions, contradictions, and multivalent interpretations (e.g., Cairns and Stirling 2014). Indeed, over-emphasis on precision may obscure the real ambiguities and pluralities that exist in practising AM. The extant uncertainties about the relationships between different types of learning and doing across all types of AM (Fabricius and Cundill 2014) suggest that the key challenges may lie, rather, in reconciling epistemologies of science with the logic and epistemologies of practice (e.g., Sandberg and Tsoukas 2011). Consequently, another route to understanding the meaning(s) of AM is to closely explore the experiences of practitioners tasked with enacting AM—what people actually do and how do they interpret their experiences of enacting AM?

A Social Science of Adaptive Management

The gap between AM theory and practice has prompted calls for a social science of AM (Johnson 1999). So far, social science contributions can be grouped into two broad research streams. One stream has explored the social contexts and cultures of AM (Lee 1993; Gunderson et al. 1995; McLaughlin and Krantzberg 2012). Here the concern is with broad 'pathologies' or 'barriers' to successful implementation, such as risk aversion, procrastination, lack of leadership, and difficulties with experimentation (Allen and Gunderson 2011). In Australia, Stathis and Jacobson (2009) have examined attempts to nurture a 'learning culture' in the New South Wales National Parks and Wildlife Service. Allan and Curtis (2005) compared two regional AM projects in New South Wales and Victoria, using qualitative, interpretive techniques to identify seven imperatives—including 'got to keep moving,' and 'got to have control,' among others—that were considered representative of organizational cultures that constrained the use of AM.

A second stream has focused on the social structures and functions required for the emergence of AM. Olsson et al. (2004a, 2004b) and Folke et al. (2005) emphasize the importance of individual agency, trust, leadership, social networks and bridging organizations in adaptive comanagement and adaptive governance. The emphasis in this literature on complexity and self-organization has produced concurrent research that highlights the role of individual agency in AM implementation, focusing on aptitudes, strategies, and skills (Fabricius and Cundill 2014; Schultz and Fazey 2009; Westley et al. 2013). For instance, Westley (2002) used extensive, in-depth interviews with an individual manager in the Great Lakes, USA, to identify four distinct strategies for implementing AM: 'managing through' (applying 'good science'), 'in'

(ensuring influence within the management organization), 'out' (involving stakeholders), and 'up' (sensitivity to political context).

Toward a Practice Perspective on Adaptive Management

Despite these valuable bodies of work, the gap between AM theory and practice remains a prominent concern. The literature has tended to diverge along technical and social pathways, where the technical literature—comprising largely of experimental design and mathematical modeling of ecosystem dynamics—is considered mature and theoretical, while the social literature—comprising the implementation of premade scientific designs—is considered to be underdeveloped and relevant primarily for practitioners. Johnson's (1999) characterization of AM as "scientifically sound, socially challenged" appears to remain a widespread sentiment. For instance, in Westley's (2002) categorization, doing 'good science' is accounted for in managing through, while managing in, out and up relate to the implementation of this science. Few studies closely examine the ways in which doing the science of AM—for instance, through the technical practices of ecological monitoring, modeling, and experimentation—is conditioned by, and interwoven with particular social contexts. We suggest that a practice lens may be useful for shedding light on how the technical and the social intertwine in 'real-world' enactments of AM (Beilin and West 2016). AM is explicitly framed in terms of bringing scientific logics to bear on the practice of environmental management; however, embracing the logic of practice may be necessary to bridge the gap between the theory and practice of scientifically informed learning-by-doing.

Practice perspectives encompass a wide range of empirical and theoretical commitments (Feldman and Orlikowski 2011). For our purposes, a practice perspective foregrounds the everyday actions of people as a way to understand social phenomena, including the production and use of knowledge (Gad and Jensen 2014). Practice perspectives have been most extensively developed in those disciplines—such as public administration, organization studies, policy studies, and science and technology studies—that examine how scientific knowledge is produced and deployed within particular management paradigms, policies, and strategies, and how these are implemented in particular organizational, management, and governmental contexts (Pickering 1992; Blackler 1995; Feldman and Orlikowski 2011). Because they highlight the complex factors that condition how management paradigms are enacted, practice perspectives are considered especially useful for addressing "gaps" between management theories and practitioner experiences of implementation (Weick

2007; Yanow 2007; Sandberg and Tsoukas 2011). In an environmental context, practice perspectives have increasingly been used to examine the actions, procedures and processes through which stable informational artifacts about complex ecological relationships are made (e.g., models, maps, and images), and how these artifacts subsequently shape action and circulate within management regimes (Latour 1999; Eden 2008; Wagenaar and Wilkinson 2015). The term 'knowledge work' has been used to situate such knowledge practices in the context of broader shifts in the types of work performed by scientists operating across academic, corporate, and public realms (Schultze 2000; Kleinman and Vallas 2001; Pyöriä 2005).

In this paper, we explore the practice of learning-by-doing by following the development of an ecological monitoring program ('the Program') within an AM framework, in a public land management organization in Australia ('the Organization').[1] We present a qualitative study of a single individual, June, responsible for developing and implementing the Program. We elicited a 'rich narrative' of June's practice through consecutive, in-depth interviews (Kvale 1996; Wagenaar 2004); a method uniquely positioned to capture the "relational totalities" of practitioner experiences (Sandberg and Tsoukas 2011: 351). We analyzed the rich narrative using thematic analysis (Braun and Clarke 2006). Here, we present the key themes produced in the analysis, and discuss our results in relation to the concept of knowledge work and Westley's (2002) framework for interpreting the strategies of individual adaptive managers—'managing through, in, out and up.' As our research is qualitative and tied to the subjective experiences of an individual in a specific context, we aim for depth not breadth and make no claim to generality. We do, however, claim that our research is valid according to criteria established for narrative research, which makes claims about "how people understand situations, others, and themselves" (Polkinghorne 2007: 476), and furthermore that our research contributes to pervasive but understudied concerns within the AM literature. Moreover, by bringing practice perspectives and knowledge work together with AM through a narrative approach, our research opens up exciting avenues for future research and collaboration between qualitative, interpretive social science, applied ecology and complexity perspectives in environmental management.

Case Selection and Methods

In this study, we specifically wanted to inform the literature on social barriers to AM. We therefore identified an organization that aims to provide a world-class land management service based on AM. We established contact with June, the key individual responsible for developing the monitoring program intended to underpin AM in the Organization, and conducted seven interviews totaling approximately eleven hours over a three-week period. Producing valid narrative research requires attention to two primary aspects of the research process: the validity of the collected narrative texts (e.g., the interviews) and the validity of the conclusions drawn by the researcher (Polkinghorne 2007). Threats to the validity of collected texts arise from (a) the limits of language to capture the complexity of the interviewees' experienced meanings, (b) the limits of reflection to reveal the layers of meaning present outside of the interviewees' awareness, (c) resistance on behalf of the interviewee to reveal fully the "felt meanings of which they are aware," and (d) the ways in which the texts are "often a co-creation of the interviewer and the interviewee" (Polkinghorne 2007: 480). We addressed these issues in a number of ways. First, the interviewer addressed the limits of language by encouraging figurative expressions—e.g., "off the hoof" and "Rolls-Royce science"—and then attempting to locate these expressions in concrete actions, examples, and descriptions of particular situations (Polkinghorne 2007; Wagenaar 2011). Consecutive interviews allowed June and the interviewer to revisit complicated issues, to explore ambiguities and examine contradictory meanings. Second, the potential resistance of June to reveal felt meanings was ameliorated by ensuring personal and organizational anonymity, and by conducting consecutive interviews in a familiar café next to June's workplace, enabling June and the interviewer to build trust and confidence (Seidman 1991). Finally, the 'co-created' nature of the process was embraced in order to foster focused reflection on the practice of AM. June was familiar with the theory of AM prior to the interviews and the interviewer sought to explore how these understandings played out in June's work. The interviews were recorded electronically and transcribed verbatim by the first author, and then checked by June to ensure that her meanings had been captured appropriately.

The second aspect of narrative validity concerns the analysis of collected texts. We analyzed the interview transcripts through a process of thematic coding. Coding involves interpreting the meaning of sections of text and "assigning a label and category to them" (Allan and Curtis 2005). Because this research is concerned with the 'doing' of AM, we followed the strategy outlined by Charmaz

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[1] All personal and organizational names and locations have been changed to protect confidentiality.

(2006), where transcripts are coded in terms of actions. Action codes helped us to stay close to June's experience, and ensured that our interpretations remained grounded in June's narrative rather than our own preconceived categories (Wagenaar 2011). However, because we wanted to inform and build upon existing theory, we also included Westley's (2002) categories of 'managing through, in, out and up' as coding categories. When we were finished coding, we had a set of inductive codes that emerged from June's narrative alongside Westley's categories. In the analysis, we moved back and forth between each set of codes, searching for ways in which June's experience challenged or supported Westley's categories. In the following sections, we introduce June, the Organization, and the Program, before presenting June's narrative through the thematically organized inductive codes. We then discuss these codes in terms of Westley's framework and the concept of knowledge work.

The Context

June: An Ecologist Monitoring for Adaptive Management

June obtained her PhD in ecology, and is particularly interested in using scientific monitoring to affect practical change. "The sort of research and science that really appeals to me is the sort of project where you've got that clear line of sight from the methods that you use and the question that you're trying to answer all the way through to the on-ground application, and you're already pre-empting of how this research can change management." June's first job out of university was evaluating community-led conservation and monitoring programs for a prominent Australian NGO, before taking a position in a large public land management organization ('the Organization') about ten years ago.

### The Organization: Aspiring to Provide World-Class Adaptive Land Management

The Organization is responsible for a regional network of several thousand sites comprising a broad variety of ecosystem types. With a head office in the regional capital, a number of regional work centers, and facilities in the individual sites, the Organization aspires to provide a world-class land management service and a workplace that emphasizes learning, innovation, adaptation, leadership, teamwork, and high performance. June is responsible for the design and implementation of an ecological monitoring program ('the Program') that forms the basis of the Organization's adaptive and "evidence-based"

management approach. This role includes designing the strategy of the Program, as well as initiating, designing, and guiding individual monitoring projects throughout the network. June works from the Organization's head office, in a Department of less than ten staff responsible for research and monitoring.

The Program: The Basis for Adaptive Management

June describes monitoring within the Organization when she arrived as consisting of "[lots of] little hobby projects … There might have been a staff member who was really interested in snakes; he would have gone out and counted snakes under logs and sheets of iron every few weeks." The data from these projects were rarely collated or used to inform management. June remembers this time as one of pervasive cynicism among the scientific staff in the Organization, who considered senior management to be dismissive of the value of science. However, June's departmental manager initiated a monitoring program that aimed to integrate science into site management and decision making, enable assessment of ecological health and the efficacy of management actions, provide early warnings of emerging threats, and provide an evidence base for reporting and evaluating progress on site objectives. In the early workshops, June's manager was convinced that getting the Organization to "officially sign off" on and publish the initiative was essential for the long-term existence of the Program. "A lot of people in the room had been in [the Organization] a long time, and they had seen attempts like this come and go before. And I think from that experience they knew what might happen, and that's why they tried to force the issue a little bit." But in the end, the high-level corporate sign off and public release never materialized. Nevertheless, over the past seven years or so June and, for several years, a single colleague have attempted to enact the Program.

The parameters of the Program emerged in a series of planning workshops. A 'stock-take' would gather existing data on the sites in the network, including academic research, management plans, and staff monitoring data, in order to identify the important values in each site. This information would then be used to devise monitoring projects for the identified values, which would provide data to site management to assess and potentially amend management practice. These steps were scrawled into a "complex and horrendous" flowchart, which, after June had sat down and tried to fit it into "logical compartments and sequences," resolved itself into "what we see today in our organization that gets presented as the 'adaptive management framework.'" (See Fig. 1). From these broad parameters, a number of crucial questions arose, the resolution of which would define the knowledge generated
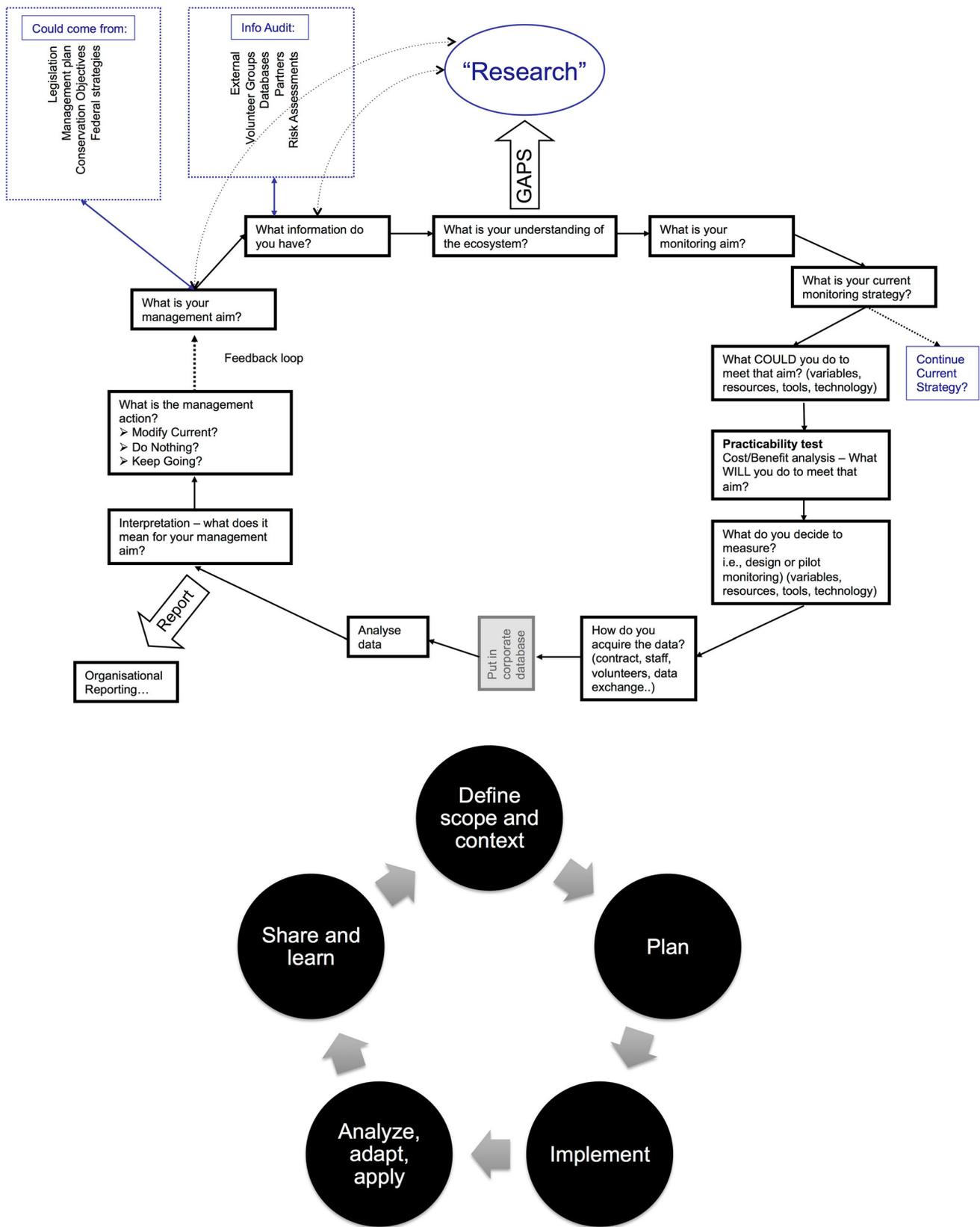
Fig. 1 The *upper* image is June's initial version of the AM framework, and the *lower* one is the version currently presented on the Organization's website (both amended to preserve anonymity)

through the Program and shape consequent learning. Would the Program launch monitoring at all sites in the network or a subset? Would the indicators chosen to monitor be consistent or would they reflect the priorities of each particular site? What could feasibly be monitored with current scientific methods and organizational budgets? Who would be responsible for doing the monitoring and what would be their capacities and skills? What would the data be used for and how would it be reported? In the following sections, we follow June's experience of resolving these questions.

Results

June's narrative reveals a complex range of practices employed to enact the Program. We have organized these practices into three metacategories: 'producing a scientific program,' 'making room for scientific practices,' and 'learning from experience' (Table 1). In the narrative text that follows, we describe each practice in turn (the italics in the text correspond to the subcategories in Table 1).

Producing a Scientific Program

Developing the Monitoring

When the Program began, there were few preexisting management objectives, conservation plans, or monitoring priorities for the sites. June and her colleagues therefore derived many objectives and priority values "from scratch" together with the 'technical' aspects of monitoring: "We had no really clear strategies and guidelines about what to monitor. So we sort of tried to implement this program in the absence of that, and we did a lot of thinking on our feet just to try and catch up." This remains a source of discomfort to June and she foresees an ideal scenario where her work will entail purely "the provision of technical advice" to monitoring projects initiated by site or regional staff. As it is, technicalities about how to monitor and values about what to monitor have coproduced one another within the affordances and constraints of practice.

An initial task was *defining the scope and scale* of the Program. June foresaw a "comprehensive" monitoring regime that would apply equally to every site in the network, but it quickly became clear that this would be impossible. June (and, for several years, a support staff member), was solely responsible for implementing the Program with little financial support from the Organization. Looking at similar organizations in Canada, the U.S., and New Zealand, June and colleagues "became aware that even these—what appeared to us to be exceptionally well resourced agencies—weren't capable of monitoring everything, and they were pretty strategic about what they did, and we thought, 'well, we'd better go down that path too.'" This marked a switch toward choosing 'priority' sites for monitoring. In June's terms, these choices were

Table 1 Working practices of AM identified in June's narrative

Producing a scientific program	Making room for scientific practices
Developing the monitoring	Translating between logics
Defining the scope and scale	*Pursuing small wins*
Choosing ecological indicators	*Organization-proofing*
Designing methods and protocols	*Weaving coherent stories*
Doing the monitoring	Exploiting opportunities
Compromising and contextualizing	*Flexible priority-setting*
Maintaining the quality	*Back-door routes for site-staff*
	Negotiating alignment
Using the data	Building relationships
Getting a flavour for what is going on	*Nurturing collegiality in the Department*
Assessing efficiency and effectiveness	*Identifying and supporting likeminded people in the Organization*
Creating legitimacy	*Branching out*
Contributing to public and corporate reporting	
	Learning from experience
	Seeing the bigger picture
	Getting the right answer
	Refining existing practices

"reasonably objective" as they were informed by existing landscape and ecosystem classifications, ensuring a "pretty even spread" of sites across the network representing "different landscapes, different ecosystems, and different scales," avoiding "clustering or biasing towards one particular area or ecosystem."

It became increasingly difficult to maintain this reasonable objectivity, however, when *choosing ecological indicators* to monitor in each site. The choice appeared to June as either engaging in 'blue-sky monitoring,' "where you just monitor everything, everywhere," or monitoring for site-specific management issues. At the time June was facing this choice, public and corporate reporting processes were underway within the Organization, and ecological monitoring frameworks were also being developed at the state and national levels. "Consistency was king. Everything had to be measured in the same way [so that] you could easily compare it … there was quite a lot of pressure to make sure that everything aligned with … pre-existing framework[s]." June and colleagues therefore set out to monitor a consistent set of indicators across the priority sites. However, they increasingly found the organizational, state, and national reporting indicators (such as air and water quality) irrelevant to the management issues of particular sites, and unsuited to existing skills within the Organization. "We got really hung up that at all costs our monitoring had to conform with those broad categories. So it took us a while to realize, 'well, no, not really!' You can still go out and monitor all sorts of things on the ground as long as they're relevant to you and as long as you do it properly, and we can amalgamate them ourselves to fit into whatever reporting requirements need to happen down the track." June and colleagues therefore selected different indicators to monitor in each site, interpolating multiple priorities from biodiversity legislation, existing state guidelines and policies, individual site management plans, academic research, the budgets of particular sites, the particular interests and capabilities of site staff, and finally considering what indicators the staff would actually be capable of manipulating and controlling. June reflects, "I think it was a real mash of subjective and objective values combining there."

The move to a more context-sensitive approach was not only influenced by the variability of ecological values across the network but also by the inherent variability of ostensibly the same indicators between sites. Professional scientists at universities and research institutes were initially tasked with *designing monitoring methods and protocols* for the Organization that were "consistent" and "repeatable." These procedures were duly delivered, but as June explains, "the more we thought about it and the more we actually tried … we soon realized that the one size fits all approach didn't work." June and colleagues developed

a range of practices to get the protocols to 'work' in the field, and as a result, the same indicator was measured in different ways across the network.

Doing the Monitoring

The practical work of doing the monitoring is generally performed by site staff alongside their other responsibilities such as servicing visitor facilities and managing fires. Consultants are contracted for monitoring that requires advanced technical skills or that is needed quickly, and citizen science groups have been engaged to carry out exploratory surveys that are more scientifically "forgiving." Site staff have found it difficult to enact the university-developed protocols, because of (a) the variability of the targeted phenomena, (b) the difficulty of fitting monitoring protocols, as proposed by professional scientists, into the existing routines of site staff, (c) the sizable financial and human resources needed to implement the protocols as received, and (d) incomprehensibility of the protocols to site staff.

June and her team have negotiated these challenges by, firstly, *compromising and contextualizing.* For instance, rabbits are considered a pest in many sites, and one protocol recommended surveying rabbits over three consecutive nights in order to derive an average population. June explains that while "theoretically that's a very sound approach in terms of getting good data quality," it was very difficult to find local staff willing to work after midnight. Moreover, staff hours spent monitoring rabbits reduced the time spent on other tasks. The benefits conferred on sites by monitoring were balanced against the benefits of conducting existing management activities efficiently. "Quite often the argument that we did get was, 'OK, well you tell me. I could either roster my staff on to do the monitoring for the rabbits, or I could roster them to do the actual control work for the rabbits. Take your pick, we can't do both!'."

In these cases, "compromises" were made to the particularities of context. At one site, for instance, rabbit spotlighting took place on one night rather than three. In many cases, the protocols were extensively rewritten to make the academic language comprehensible to site staff. Indeed, the ongoing revision of what June calls "Rolls-Royce science" has been a key part of her work. "[We were provided] the Rolls-Royce model of how to conduct a scientifically flawless census technique for pest plants or for rabbits or whatever it was. And basically that was developed to a standard that you might use if you wanted to do very high-end science and get it published in a top journal. So that's … what you'd need to do to get to that end. And we adopted it, rolled it out, and […] it nearly fell flat on its face." For June, amending the protocols represents "that compromise of still respecting the assumptions

and limitations of the science, but coupling that with achievability and feasibility."

In order to respect the "assumptions and limitations" of science while simultaneously *compromising and contextualizing*, June engaged in a further set of practices to *maintain the quality* of the information gathered. Building relationships with scientists and 'lay' volunteers experienced in designing and implementing monitoring programs enabled June to find out "what worked" for them. These contacts checked monitoring protocols and provided "rules of thumb" and "innovative analytical techniques" in order to overcome deficiencies in the quality and/or quantity of data. As experience implementing monitoring projects has grown, rules of thumb have also emerged within the Department. For instance, one project entailed performing wildlife inventories at a site with very high staff turnover, significant fire and flood events, and high public popularity, where staff were primarily occupied with maintaining visitor services, campsite bookings, walking tracks and car parks. June entered the research design workshop thinking about numbers. Her statistician had recently complained that low sample sizes in a previous project had precluded findings of statistical significance. "I was thinking, 'what would this look like if we were to map species richness and only had forty sites, fifty, sixty or a hundred sites—how complete a map would we get?'" June derived forty locations as her minimum offer, based on experience at another site where forty had been "enough to give us results … it was just a rule of thumb rather than a robust statistical test." When negotiations began, June argued 'the more the better,' suggesting eighty or one hundred locations. The site staff, taking into account the time required to set up sites, the particularities of the terrain in their area, the accessibility of proposed locations, and the length of time required to analyze the results, suggested a number nearer to forty. June, however, managed to barter the final number up to sixty. "I thought from a statistical point of view I know the statistician will be happy. From a practical point of view the local [site staff] have told me that they can do that on the ground, so yeah—we settled on that."

June also restrains and conditions the practices of enthusiastic site staff. "There's that old saying, 'a little bit of knowledge can be very dangerous' … sometimes they'll get ahead of themselves and contact us and say, 'aw, you know how we set this process up? … Well it went really well and now I've done it here, here and here, and I've expanded it to here!' And I'll [say], 'whoa, whoa, hang on!' Because while their intentions and their general concepts are good they just lack that bit of extra refinement around survey method and statistical assumptions that need to be maintained." However, the lack of human and financial resources available to the Department has stymied the revision of protocols in general. "As a result we sort of try to promote the monitoring of things that we have the best protocols for at the moment. So for example the pest plant one is a good one, and as a result we've been doing quite a lot of pest plant monitoring [in the last few years]." Particularly, problematic protocols therefore tend to go unrevised and unused, and monitoring data tends to accumulate around those things easiest to monitor (and easiest to fit around the existing practices of site staff).

Using the Data

For June, the compromises required to enact the Program have three major consequences that affect how the data is used. First, the confidence intervals of the data are broader and the data more uncertain. Second, the extra time needed to achieve findings of statistical significance delays management application. Third, June accepts that the monitoring enacted in the Program will never be able to invoke causality, only identify 'patterns.' These consequences are problematic for June: the inability to infer causality has made Department staff reluctant to recommend changes in management actions, and much data have not been analyzed because of low financial and human resources. The compromises also jeopardize June's scientific reputation: "given the fact that we are taking certain shortcuts to deliver some of this monitoring, it does open you up to criticism … [from] pure statisticians or theoretical scientists, if they were to critically assess our methods they'd probably find a lot of instances where they could suggest major improvements." June reconciles herself to this situation by keeping in mind the various purposes for the data.

First, the Organization tightly links the use of science to improving 'management effectiveness,' rather than research per se. "So in our case we're not going to be publishing [the data], it's not going through scrupulous peer review," but is intended to produce *a flavour for what is going on*. Rather than developing causal inferences, "the best we can do is roll out the kind of monitoring that allows us to look at patterns. So for example, we do a certain [management] activity, does the variable respond in a certain way?" If it does, it is not possible to know with confidence whether the response was caused by the action: "we just make an assumption." Sacrificing the ability to infer causality by amending the protocols received from scientists is a necessary component of June's practice. "Because if we were stuck with those rigid detailed protocols, one of two things would happen. Either they wouldn't have happened anyway, or if we'd resourced them properly we'd have been able to pull them off in maybe ten percent of the sites in which we actually want to implement monitoring."

Second, as a public entity and a 'body corporate,' the Organization is expected to be financially efficient. Many monitoring projects are designed to *assess the efficiency and effectiveness* of management tools in achieving particular predefined goals, and to "fine-tune" when and how tools are used. For instance, one project compared the efficiency and effectiveness of different weed control methods. "So we had plots established where different methods were used. And another one would be a control one where we didn't do anything. And we kept coming back to them over time just to see how the different weed control methods were impacting on the weeds and also on the native vegetation."

Third, monitoring is used a means of *creating legitimacy*. As a public entity the Organization is expected to make accountable and legitimate decisions. June describes public opinion as the most disturbing form of risk for the Organization, and a key purpose for monitoring is to produce "a bit of cushioning" for controversial management actions such as culling native animals. "Just saying, 'because I reckon,' or 'because I've got a gut-feel,' isn't good enough … you need to tell people that this has been carefully measured, carefully considered, it's not a knee-jerk reaction […] yeah, providing a bit of a justification for the actions that you take." Furthermore, June uses monitoring data to legitimize the use of science *within* the Organization by employing 'success stories,' where monitoring has produced a tangible outcome, to sell the value of the Department to senior management and site staff.

Finally, monitoring *contributes to public and corporate reporting*. The primary "customers" of the monitoring data are the public and corporate reporting mechanisms of the Organization. The public reporting mechanism is used to assess progress toward achieving long and short-term objectives (e.g., preservation of 'natural values' and improvement of 'organizational governance'). June describes the process of contributing data as "[essentially] all about the collation of complex environmental information and synthesizing it into something very simple and very concise." The final product is a set of "smileys" for different indicators, which receive a happy, neutral, or sad face on account of whether they are good, indifferent or bad. For June, this disguises and "averages out" the complexity of many ecological processes. For example, when reporting on the status of birds in a certain habitat where some are doing well, others terribly, "logic would suggest that you put in a neutral face—but you lose the information that for some of those species the situation is very dire, so it kind of hides the urgency by lumping things up into these convenient reporting units." The corporate reporting mechanism rewards high numbers of completed projects and money spent, but does not assess the sustainability or usefulness of the monitoring projects, acting as an incentive for June to contract out monitoring projects to consultants.

Making Room for Scientific Practices

Translating Between Logics

June views the Department as providing an "ecological rationale" to organizational practices. Doing monitoring work in the Program, couched in terms of AM, therefore entails producing data that can speak to the different logics that guide 'doing' in the Organization: scientific logics emphasizing experimentation and learning, public logics insisting upon legitimacy and accountability, and corporate logics prioritizing efficiency and effectiveness. These logics are sometimes but not always congruent, and points of tension in June's narrative revolve around discrepancies between them. For instance, political fears of duplication between public bodies prompted the removal of the word 'scientific' from the name of the Department, compromising June's sense of academic integrity and focusing the monitoring on contributing to 'management effectiveness.' Likewise, a staff conference produced the mantra that the Organization is 'client-oriented,' which, for June, rubs uneasily against the Organization's legislatively defined mandate to prioritize conservation: "The question was raised whether our ecosystems and our wildlife are clients too—but that was laughed off and they were told, "nah, nah, don't be silly." Which I reckon shouldn't be dismissed. Some of the key stakeholders of the sites are the species whose existence depends on them, and yet they have the weakest voices in the whole equation."

Enacting the Program entails (often literal) translation between the scientific logics expressed in the expert-derived monitoring protocols, and the corporate and public logics expressed through the site staff focus on visitor services, emergency management and value for money. "This is often where we have arguments with our statistician—they try and push us down the pure, theoretical stats line, all 'you have to do this!' And we're always asking, 'well, what shortcuts can we have here without compromising the data? Where can we gain efficiencies?" An equally difficult task is to translate publicly derived responsibilities into practices acceptable on academic and corporate terms. June recounts how a government department, eager to allay public concerns about bushland recovery after a major fire, provided substantial funds to conduct postfire monitoring. June and two colleagues were tasked with spending the money over four months in winter. With little time to embed monitoring procedures in the routines of site staff, they employed consultants to complete the monitoring, often bypassing site staff completely. With few Department staff to manage the contracts

and explain inarticulate protocols to the consultants, the data collected were often incomplete or incoherent. June's task was to ensure the long-term sustainability and value of the projects. This often entailed arguing on ecological grounds for the funding to be rolled over: "it was pointless surveying for an orchid in the middle of winter when it's underground and you can't even find it." While June was successful in preserving some funding, the emphasis in the corporate reporting mechanism on spending money ensured that "the message from higher up was, 'nah, look, just do it. Just get this money out and just get it done.'"

Processes of translation also occur when using science—most obviously not only when translating "complex ecological data" into simple public and corporate reporting criteria, but also when translating scientific results back into the practices of site staff. While June reconciles herself to the reporting process by referring to the 'good science' that underlies the smileys, she remains concerned that the 'end product' obscures the process of translation that brought it into being—paradoxically making scientific logics even more difficult to maintain within the Organization. "So I kind of wonder if, in the long term, we're shooting ourselves in the foot by presenting this final, simple, nearly clear-cut product, and then when it comes down the track to arguing for resourcing and funding, they don't see the level of research and complexity that is involved behind this issue. They just see the smileys and think it's cheap, simple and quick." Indeed, an overriding feature of June's narrative is a concern that the Organization at large proceeds according to public and corporate logics that are ambivalent, or even openly hostile to the value of science.

To build support for scientific practices within the Organization, June *pursues small-wins*, where projects that appear to offer "quick results" that site staff will "stand behind" are developed. Advocating on the back of existing results appears to change the attitudes of senior managers: "what we've found in nearly all cases is resistance at the start, not support, but once we've finished a little project and presented the results they say, 'oh, this is fantastic, this is great!'" June has also occasionally engaged in *organization-proofing* emergent projects, by removing them from the oversight of organizational structures, procedures and personalities. Senior managers are often, in June's view, under severe pressure from corporate and public logics—such as ensuring sites are "safe for people, that we're not going to be susceptible to any legal action, that we respond to emergencies in a timely manner"—and consequently do not make staff available to do monitoring. June argues that removing the projects from the Organization's control reduces the risk that they will succumb to removal of budgets, changing priorities or 'political meddling.' Tasks within such projects may be performed by enthusiastic site staff under the noses of their managers ("staff have had to be fairly creative as to whether or not to tell their managers what they were doing or reclassify what they were doing. So for example if they're going out to put small mammal traps in the [site], they'll say, 'oh, I'm doing a patrol'"), or they may be embedded in networks of volunteers.

Competing organizational logics make communication an uncomfortable but necessary task for June and her colleagues. "We've got this unofficial motto of, 'let the science do the talking.' But of course in an organization like [ours] it doesn't resonate very strongly—it still needs someone to beat the drum, to popularize it and get it out there." June encourages her colleagues to speak for the science by *weaving coherent stories* for internal communications channels such as the staff newsletter. Communications work is also a principal component of using the science. "Weaving a coherent story … with a beginning, a middle and an end"—rather than simply "presenting people with graphs, charts and tables"—is necessary to explain the implications of the monitoring to site staff. At the same time, when communicating the science to senior staff, June and colleagues aim to "tart up" the data: "So produce really colourful maps, charts, tables and present them in nice, well-written, succinct reports, so that people—especially senior managers—could all of a sudden see, 'wow, this is really useful for my [site]!'."

Exploiting Opportunities

The unpredictability of organizational life prompts June to adopt a "structured but opportunistic" approach to make space for scientific practices. This is essential in a context where scarce and unpredictable financial and human resources affect what can be done: "Ostensibly I think we still want to achieve everything that we've identified in these plans, but realistically it's not going to happen. It's nearly like an unsaid rule: 'Here's the plan, this is what we're doing.' But deep down we know that we will be lucky if we achieve a third of all this across the whole [network]."

First, June and her team engage in *flexible priority-setting*. This entails identifying a number of indicators that can potentially be monitored in the Program's priority sites in order to ensure that the Department is able to respond to, for instance, windfalls of funding following fires and flooding. "So we just want to make sure that we're ready to take advantage of that rather than fluffing around trying to set priorities and arguing over methods and what's going to be monitored." However, these priorities are deliberately not ranked—so June is able to, in turn, respond to the ecological and management opportunities present within each site: "So if we've got a staff member that's got experience in freshwater monitoring, we might start to

monitor freshwater condition. If we've got a lot of money to monitor bushweed invasions, we'll do the weed one."

Second, when June needs to select sites for monitoring projects, e.g., to spend windfall influxes of money, she provides *back-door routes for site-staff* to suggest projects outside of Organizational priorities. "Because in reality, unless you've got the backing and enthusiasm of your local staff, you're really pushing things uphill to get things going. So those rare opportunities where you get the call coming from the site staff rather than vice versa, I'll nearly always prioritize that, to make sure that I devote enough time to those people, that I go out to their work centre for a day or two, talk to them, have a look at the site where they work, and then start thinking about what we can implement and how we can help."

Finally, June's ability to "get things going" depends on *negotiating alignment* between a temporally dynamic and sometimes bewildering array of factors, including the vagaries of funding cycles, changes in organizational personnel, public politics, community perceptions, changing technologies and emergencies like fires and floods. June depicts her understanding of the changes affecting opportunity in what she calls an "opportunity meter" (see Fig. 2). The meter portrays four cycling domains—'the [Department] converts,' the 'rest of the Organization,' 'Government,' and 'the Public'—each consisting of multiple variables. For June, 'alignment' of these domains represents the moment when "[we can] really get good mileage out of the resources that we have." In June's experience alignment is rare ("it's like alchemy or something"). For instance, when June was first given responsibility for the Program, she describes the "good personnel" within the Department, "reasonable budgets," and a government disposed favorably to science. However, at the same time an influential individual in the Organizational leadership was dismissive of science, and the Department lacked a collective understanding of its practice. "We probably weren't ready … [We were] still getting our act together thinking, 'oh shit, what do we monitor? How do we go about this?' And we probably didn't realize how good it was that these two things aligned for once, and now we're all out of sync." June describes a situation now where the Department is confident about its approach, the dismissive individual has been replaced with an advocate for science, but where a new Government has dramatically reduced the Organization's budget and personnel.

Building Relationships

The intricacies of building relationships within and beyond the Organization constitute important practices for implementing the Program in the context of multiple organizational logics, the small internal pool of scientific expertise and resources, and the limited number of organizational staff committed to using science in decision making. While relationships are instrumentally necessary to gain access to particular expertise and monitoring labor, they also provide emotional support to June and colleagues. Indeed, achievement of the Program's instrumental ends, couched in terms of developing good science to enhance management effectiveness, is intimately linked in June's narrative to *nurturing collegiality within the Department*, where shared logics and ethical values provide emotional as well as professional affirmation.

June defines relationships within the Department in opposition to those maintained within the Organization at large. The Department, consisting of what June terms "the converted," operates according to "collegial" norms including sharing of information, open critical evaluation of work constituting a "de facto peer review system," and a nonhierarchical management approach that affords June and colleagues significant autonomy. Communication between colleagues takes place on a continual, informal basis. "You'll walk up to someone and say, 'What do you reckon about this? Do you think it'll work? What's wrong with it? What's good about it?'" Moreover, Department staff—almost all of whom share tertiary qualifications— are afforded freedom to follow up on their own leads and contacts. These practices are shored up by a shared commitment to the value of science for securing biodiversity conservation and the "greater public good" of better land management. June describes the staff mentality as methodical, meticulous and thorough. By contrast, June perceives relationships in the Organization at large to operate according to 'corporate' norms (strict hierarchical structures, competition between colleagues, and restriction of information) and behaviors (self promotion; an attitude of "near enough is good enough"), where managers exercise much tighter control over staff work patterns. For June, the greater public good of better land management is subsumed to corporate performance: "it's basically a question of, 'what is in it for us an Organization?'"

However, fulfilling the aims of the Program also requires that June *identifies and supports likeminded people in the Organization* at large. June builds relationships with individuals, particularly site staff, who share a commitment to science and biodiversity conservation—those with whom she can "do business." Often these people have formal tertiary qualifications, yet they may also simply have "the right mind-set"—an analytical approach and an "aptitude for casting a question and assessing what they're doing." June has fostered an organizational "clique" of such staff, one element of which has been to create an internal learning network: "We were just moaning about the fact that there are pockets of good people [in the Organization] but by and large you wouldn't know where

Fig. 2 June's "opportunity meter" for AM monitoring within the Organization (amended to protect anonymity). 'The converts' represent June's Department
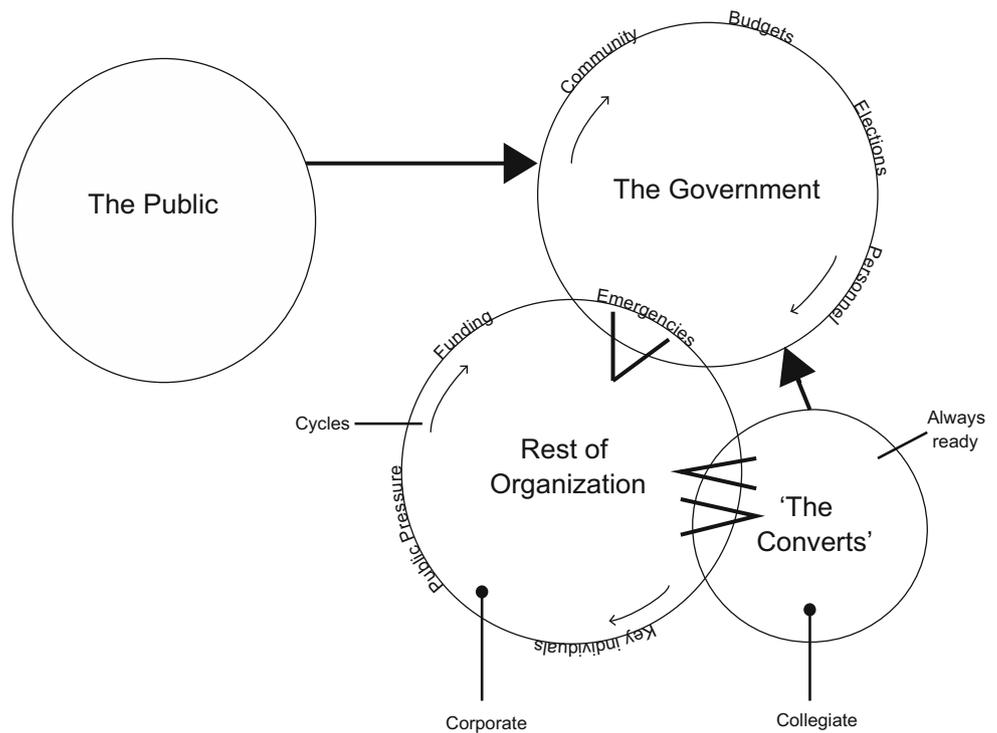
they are or what they're doing." The online network was designed for staff interested in conservation and monitoring and encouraged them to post stories and requests for information. June recounts that senior managers outside of the Department, worried that it would become a "gossiping network," wrested control and have overseen the communication that takes place. Nevertheless, June considers the network important for supporting staff that feel their environmental work is swamped by fire management and visitor services. "When they can plug into this network and see that there are other likeminded people it helps to keep morale up, it helps with ideas, it encourages people to share stories." However, this clique-based approach can also negate relationships. For instance, June's Department does not engage at all with the citizen participation department because of disagreement about the purpose of participation. While June views participation as a means toward a given end, the citizen engagement department considers participation an end in itself. "And that's what they report on—they stop short of reporting on what those volunteers have actually achieved, so you know, how many weeds were pulled up, how many hectares of park were surveyed, that sort of stuff. Which is what we're a lot more interested in." Indeed, external relationships feature significantly more in June's narrative than relationships with other departments.

June has intermittent access to a statistician and less than ten staff with credentialed scientific expertise in the Organization, so much monitoring work is achieved

through *branching out* and collaborating with external partners. Collaboration may consist of formal partnerships with research institutes or universities to implement an entire monitoring project (including codesign of the monitoring question, methods, collection of data and analysis), to perform specific tasks in a project (e.g., the development of weed management methods), or to participate in 'technical advice panels' that run alongside monitoring projects. However, not just any expert will do. A crucial task is to identify "realistic, on-ground, can-do types of academics … that understand the applied nature of the sort of science we want to roll out and they also have a pretty good understanding of the limitations we operate under." June also uses 'lay' contacts to serve as "a bit of a reality check," ensuring June and colleagues are not getting "too hung up with the science and making the actual technique of gathering the information too convoluted or too unpleasant for ordinary people to come along and help us with." These relationships also provide emotional support: "[it's a] morale booster, because you feel as if you're not in it on your own, you feel that there are other people with similar concerns, similar experiences."

Learning from Experience

June expresses ambivalence about the kinds of 'learning-by-doing' that occur within the Organization. On the one hand, "people seem to like procrastinating—we like

planning, we like reviewing, we like assessing. But people seem reluctant to get out there and do. And to my mind you can't have learning-by-doing if you're not doing the doing." On the other hand, June notes that the main thing preventing learning within her Department is "just how overworked we are—it's all about getting more projects up and running, finalizing reports, ticking it off and moving onto the next thing." These apparent contradictions suggest that the 'doings' taking place in the Program are not necessarily the doings June equates with scientific AM. Indeed, structured learning processes and learning 'outcomes' are rare in June's narrative; rather, action often appears sporadic, unpredictable and rushed. Nevertheless, a process of learning can be tracked that proceeds unplanned and unstructured as June 'does work' in the Program, and attempts to bring the situations she finds herself into satisfactory conclusions in terms of the various logics at play within the Organization.

Seeing the Bigger Picture

Seeing the bigger picture recurs throughout June's narrative and constitutes a progressive process where layers of complexity are added to June's understanding of the context in which her practice plays out. June initially sees "the bigger broader picture of how things operate" after emerging from university with a PhD and learning about the complexities of ecological relationships. She again obtains a bigger picture working within the Organization, where she discovers the multiple public logics that affect funding for conservation of ecological processes, such as healthcare, education, and emergency services. Seeing the bigger picture further extends into the design of the Program, when June realizes that a 'blue-sky' monitoring approach will be impossible given the financial constraints, and when she accepts that, given the logics of efficiency and effectiveness, each monitoring project must be geared to a specific land management question. For June, seeing the bigger picture appears to entail getting a better grasp of the complex contexts in which she finds herself.

Getting the Right Answer

Comprehending the successive degrees of complexity that affect her work, perhaps paradoxically, enables June to achieve a satisfactory progression of action in the Program according to the various logics at play in the Organization. This is the ability to get the right answer. June initially views 'doing good science' as the means of getting the right answer: "we could go out, get some observations, do some clever statistics, some formulas, and get the right answer: problem solved, there's your solution." But this is progressively refined throughout her narrative. She learns where she needs to compromise the science with the monitoring projects ("where can we gain efficiencies?"); about the need to establish common values and objectives before the monitoring projects ("otherwise you spend time trying to convince people that what you are doing is important"); and how to "pump projects out" according to the dictates of corporate performance and public accountability while also, in the case of the vegetation monitoring projects, developing a scientifically defensible method for them. 'Getting the right answer' requires of June that she know how the differing logics of the Organization become manifest in her work practices.

Refining Existing Practices

Where learning does occur through more formal processes of experimentation it is refracted through the processes involved in getting the right answer—and therefore is generally learning about the relative effectiveness of management tools to achieve particular, predetermined goals (e.g., efficient removal of a pest species), and about the most efficient and effective use of these tools on particular sites. While the formal strategy of the Program foresees the potential for monitoring data to revise the goals and values of the sites, the learning June describes tends to relate to refining existing practices: "we'll look and see what worked and what didn't, and we'll adapt based on that." Nevertheless, some relatively simple practices have changed management actions and perceptions substantially, such as developing fauna and flora lists for sites that have revealed the presence of threatened species.

Discussion

Here we interpret June's narrative in light of Westley's (2002) four strategies for implementing AM: managing through, in, out, and up. Westley's categories emerged from extensive interviews conducted with a single environmental manager, focusing on the implementation of several distinct AM projects. By contrast, our data reflect the experiences of a scientist responsible for implementing a monitoring program within an AM framework. Our cases and methods are sufficiently similar for the analysis to benefit from bringing them together. However, at the same time, there are some crucial elements of June's experience that Westley's strategies do not help us to explore. For this, we introduce the concept of knowledge work. Interpreting June's experience in light of managing through, in, out, and up, and the concept of knowledge work, help us to maintain a focus on June's working practices while situating June's experience within the broader (and changing) contours of

contemporary knowledge production across scientific, corporate, and public realms.

Managing Through

Managing through refers to a "scientific approach to management, treating management interventions as experiments to learn from, as opposed to solutions to be implemented," and encouraging this approach in others (Westley 2002: 337). June is scientifically trained, responsible for designing a program of scientific monitoring, and expresses a broad commitment to maintaining a scientific approach in her work, the Organization at large and in the management actions of site staff around the network. However, managing through is not simply a case of applying a self-evident 'science' to the sites; rather, an ambivalence about what constitutes 'good science' is ever-present in June's narrative. Her AM practices are conditioned by distinct expectations placed on science by competing logics at play within the Organization, by certain regularized (yet still unstable) procedures of academic science, and by the ecological and management contexts of particular sites. Overhanging all of these are the perennial shortages of time, money and people. Successfully 'managing through' in this context—i.e., applying experimental scientific logics to management practice—therefore requires continuous translation between competing organizational logics, scientific procedures, and the contingencies of the sites themselves. The centrality of translation to June's job can be more fully grasped by interpreting June's practices as 'knowledge work.'

Schultze (2000) examined the practices of knowledge workers in the Information Technology (IT) industry, and concluded that the production of 'informational artefacts' (in Schultze's case reports on the IT industry) required the reconciliation of the 'internal' organizational world of questions and requests with the 'external' world of potential answers. This reconciliation entailed translation between 'objective, procedural' knowledge, which bestowed authority, credibility, and reputation, and more subjective, idiosyncratic and situated knowledge, which enabled knowledge workers to effectively 'add value,' 'achieve outcomes,' and respond to the particular imperatives of their organization (Schultze 2000: 28). June's work suggests similar translation processes to Schultze's IT workers. To develop the monitoring in the Program, June first needs to comprehend the logics guiding the 'questions' from the Organization, including public logics of accountability and legitimacy, and corporate logics of efficiency and effectiveness. As June engages with the sites in the network, composed of complex ecologies and management regimes, and goes about the job of doing the monitoring that can satisfy these logics, translation again

becomes a central component of her work as she seeks to *compromise and contextualize* and *maintain the quality.* For instance, we have seen how June translates between the demands of her statistician and corporate demands for efficiency, and between the long-term sustainability of monitoring projects and the incentives embedded in corporate reporting procedures.

In these processes, there are no purely objective standards of 'acceptable quality' or 'unacceptable compromise.' To bring them to satisfactory conclusions, June draws on her situated knowledge of organizational logics and the procedural knowledge embodied in, for instance, "pure stats"—in the context of the contingencies and dynamics (existence of funding, staff, particular ecologies, technologies, and organizational priorities), the affordances and constraints of a particular moment. It is this imperative to make effective translations between different logics and different knowledge that guides much of June's work. Consequently, June fears losing reputation among the different 'customers' for the informational artifacts produced by her Department, e.g., her reputation for 'good science' in the eyes of academic scientists, for providing useful data to site staff, and for providing clear results for corporate reporting. These diverse constituencies or customers for the informational artifacts produced by the Program indicate the importance of 'managing in' and 'managing out.'

Managing In

Managing in refers to the need to manage "position and influence within the department or organization" (Westley 2002: 338). June's perception that the Organization at large is generally antagonistic toward science—even as organizational documents increasingly embrace the rhetoric of 'learning' and 'evidence-based' approaches—make position within the Organization a central feature of June's narrative. June's rank makes it difficult for her to directly 'manage' colleagues in the sense described by Westley (2002). Rather, managing in for June takes the form of nurturing and participating in the collegial atmosphere within the Department, identifying likeminded people to work with in the Organization, and pursuing a communications strategy designed to strengthen organizational support for scientific practices. While June's value as a knowledge worker, in the sense illustrated by Schultze (2000), rests on the access she provides the Organization to the 'objective' procedures of science, she is continually required to justify their utility.

Kleinman and Vallas (2001: 451) identify an apparent paradox in contemporary studies of knowledge work: studies of scientists in university settings indicate increasingly corporate practices that pose "a significant threat to the autonomy of academic researchers," while research on

scientists working in corporate contexts suggests "a trend towards increased levels of autonomy and control as corporate bureaucracies adopt more flexible practices and thus defer to these workers' technical expertise." Kleinman and Vallas resolve this paradox by suggesting that a mutual but asymmetric process of convergence is taking place between science and the corporate world, in which "the codes and practices of industry are infiltrating the academy, even as academic norms are increasingly governing the work practices of selected knowledge workers in high technology firms and industries" (451). This convergence is asymmetric because, for Kleinman and Vallas, the financial power wielded by the corporate sector gives it the upper hand. This changing landscape of knowledge production is rife with "anomalies, tensions and contradictions." For instance, scientists operating in corporate realms "face ongoing struggles with corporate managers in their efforts to infuse corporate life with academic norms and practices" (Kleinman and Vallas 2001: 452–453).

The Organization embraces learning, innovative and evidence-based management approaches in its strategy documents. However, the collegial atmosphere of June's Department where colleagues freely share information, collaborate and openly critique others' work, is nurtured in opposition to a generally hostile atmosphere in the Organization at large where these norms rarely find succor. For instance, June's learning network was considered a potential gossiping network by a senior corporate manager and removed from her control. In this uneven environment June *identifies likeminded people within the Organization*, consciously creating cliques. This occurs at the expense of engaging with "corporate types" and manual workers to whom the usefulness of the informational artifacts produced through the Program is not immediately apparent. June and colleagues concurrently pursue a communications strategy designed to market the value of the artifacts to the Organization, *weaving coherent stories* to explain how the knowledge can benefit site staff and senior managers alike. While June and colleagues intend to "let the science speak for itself," appealing to perhaps heroic ideals of what science represents, they frequently find themselves speaking and advocating for the science they have produced. Paradoxically June worries that these practices—i.e., producing smileys—concurrently *devalue* the scientific work that lies behind them.

Managing Out

Westley (2002: 338) describes managing out as "the commitment to involve external groups or stakeholders in management processes and decisions," in the context of citizen interest or stakeholder groups making contributions to site management. Managing out for June refers more obviously to the engagement of universities, consultants, and citizen science groups to help design and implement ecological monitoring regimes and contribute to site management through research. The struggles June encounters trying to "infuse corporate life with academic norms and practices" (Kleinman and Vallas 2001: 453) prompt her to work extensively with people outside of the Organization. Nevertheless, managing out in this way can undermine practices congruent with managing in. Using experts and consultants has sometimes excluded site staff from projects, producing reports "too scientific" for use by site staff and negating the integration of monitoring with existing site management activities. Likewise, June's fears about losing (external) scientific credibility have restricted relationships with the Organization's citizen participation department. Building external and internal relationships is therefore conditioned by different expectations of science and what it can do.

June claims that wide engagement with external actors is what differentiates her Department from many other more "inward-looking" components of the Organization. Partnerships with research organizations, citizen science groups and consultancies furnish access to knowledge, expertise, and labor unavailable within the Organization. External connections have also stimulated informal friendships that enable June to engage in *organization-proofing*, protecting projects from the vagaries of organizational priorities and finances. Here, managing out is considered an effective long-term strategy to manage in—creating a portfolio of "small wins" that can be fed back into the Organization to build support for AM. However, managing out in this way creates challenges as June attempts to make expert knowledge relevant for the Organization by *compromising and contextualizing* and *maintaining the quality*. While June tries to work with "realistic, on-ground, can-do types of academics," that understand June's imperative to compromise, there remain some academics that "just don't get it." These tensions are significant: June defines her role within the Organization on the basis of her scientific expertise, but the *compromising and contextualizing* practices required to enact science in the Department can destabilize these claims when made to scientists in the academy. At the same time, *maintaining the quality* of the monitoring projects pursued by enthusiastic site staff serve to implicitly establish and reinforce knowledge hierarchies within the Organization.

The occasionally contradictory process of moving back and forth across organizational boundaries structures June's work. "That's basically what a lot of our work is all about—connecting the people with the knowledge versus the people that can actually deliver something on the ground, and then the people that report back on it in the final instance." June therefore tends to work with people

she knows and trusts. These practices of managing in and out, conditioned by competing scientific, corporate, and public logics, indicate the micropolitics of knowledge at the heart of AM in the Organization. While the (patchy) Organizational embrace of the 'the learning organization' promotes 'evidence-based management,' June's work is defined by her access to credentialed scientific expertise *and* her ability to produce informational artifacts that can speak to the competing logics of corporate performance and public accountability.

Managing Up

Managing up refers to the need for AM practitioners to pay attention to "the larger political context" within which their practices unfold (Westley 2002: 338). In relation to the Great Lakes, Westley (2002: 338) notes that "unless actions taken at the community, organizational or scientific level were considered from the point of view of the larger political arena, much excellent effort could be ended with the slash of a pen." While again, June's rank prevents her from actively managing up in Westley's sense, she is acutely aware of the way the larger, rapidly changing political context affects her work, describing how electoral processes, crises such as floods and fires, and intergovernment conflict have transformed funding, monitoring opportunities, and attitudes toward science. June and colleagues navigate these temporally dynamic contexts by *negotiating alignment* and *flexible priority-setting*. However, these practices are not employed, nor were they developed, at the same time, for instance prior to implementation. Rather, they are developed in response to particular convergences of events at particular times. In June's narrative, design and implementation of the Program are ongoing, informed by each other, and interwoven in the continual flow of work within the Department. The emergent present of June's narrative indicates the interpretive dimensions of tracking context. Assessment of context often occurs retrospectively, and it is only then that opportunities appear as such. As June notes in relation to her early days in the Program when political support and funding for science was relatively high, she was thinking, "oh shit, what do we monitor? How do we go about this?" rather than, 'this is a window of opportunity.'

Managing up also occurs in more subtle way. June's narrative evinces a progressive understanding of how these contexts shape practice in a recurrent process of 'seeing the bigger picture.' This bigger picture emerges as June produces informational artifacts within the Organization and comprehends how the logics that condition the use of science within the Organization, and the contingencies of practice, connect to particular types of scientific design. Grasping this bigger picture enables June to 'get the right

answer' according to the different realms placing claims on the knowledge produced in the Program. Introducing the concept of knowledge work adds to this by refining our understanding of context. Schultze (2000) describes knowledge work in terms of practitioners' ability to translate between organizational demands and the external world of potential answers. It is through these processes of translation—for instance, between statistical logics and logics of financial efficiency—that context can be understood as constitutively bringing knowledge into being, rather than simply acting as an external 'facilitator' or 'blocker' of AM. In this sense, then, 'managing up'—understood as a temporally dynamic sensitivity to context—is an essential component of practice for June, and suggests that attention to the practices of situated knowledge production is crucial in reducing the gap between AM theory and practice.

Conclusions

In this paper, we have employed a narrative approach to illuminate the interactions between the meanings and doings of a single practitioner tasked with enacting AM, and have brought together Westley's (2002) framework, 'managing through, in, out and up,' with knowledge work and practice to analyze our results. We find that enacting the AM program is conditioned by distinct and sometimes competing organizational logics—scientific logics prioritizing experimentation and learning, public logics emphasizing accountability and legitimacy, and corporate logics ensuring efficiency, effectiveness, and organizational performance. A key task facing the practitioner we interviewed is to translate the ecological and management vagaries of the sites into informational artefacts that speak to these multiple (and dynamically evolving) logics. There are no purely objective criteria for what constitutes acceptable translation—rather, the Program comes into being through the objective and subjective contingencies of particular moments. 'Managing through' in this case entails interpolating scientific procedures with the competing demands upon knowledge exercised by the Organization, in so doing carefully negotiating expert and situated knowledge, external and internal relationships, and collegial and corporate norms in processes of 'managing in' and 'managing out.' In order to successfully navigate these tensions in rapidly changing contexts, 'managing up' is a central component of practice.

Previous research has illuminated the importance of individuals and particular traits or skills that are crucial for productive enactments of AM, and the existence of aggregate traits such as risk aversion or procrastination that are observed to obstruct active experimentation and

learning. However, existing approaches fail to link these 'doings' (or lack of) and situate them within the dynamics and processes of knowledge production. This means that the 'technical' and 'social' aspects of AM continue to be separated and the gap between research and practice is exacerbated. Adopting a practice perspective is one way of exploring how science is produced and used in AM, and opens up opportunities to enact creative applications of science in environmental management that may help bridge the gap between AM theory and practice.

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