Chapter 4
Using Adaptive Management to Meet Multiple Goals for Flows Along the Mitta Mitta River in South-Eastern Australia

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Abstract In this chapter we reflect on a relatively small but influential example of adaptive management which seeks to enhance the environmental benefits of the flow regime in the highly regulated Mitta Mitta River in Australia's Murray-Darling Basin. In 1999 an operational review recommended the reintroduction of greater in-stream flow variability in the Mitta Mitta River in an attempt to improve river health. The river managers have worked towards this through managed variable releases from Dartmouth Dam. These variable releases have been trialled four times from 2001–2008, with the explicit intention of learning more about the ecological impacts of variable flows while still achieving operational goals for the River Murray System overall. The ecological impact of the variable releases was studied via a series of consultancies by a University freshwater ecology team. They concluded that variable flow improved ecological condition compared with the condition after periods of relatively constant flow for greater than 1 month, although the benefits of it are relatively short-lived. Principles were developed over time through discussions between river managers and the research team. These principles are being progressively refined and incorporated into the current operational plan for the river, and learning continues. We suggest that three key ingredients enabled and supported adaptive management in this particular case; aspects of the operational context, the people involved and the trusting relationships that developed.

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Background

Water management has come to be recognised as one of the Earth's 'wicked' issues. What was an apparently tame project of storing and redistributing water has spawned numerous ecological, social and economic challenges that require increasing levels of interdisciplinary collaboration and integration of different types of knowledge (Freeman, 2000). Australia's Murray-Darling system exemplifies the complexity of water management as numerous governments and citizens work to balance the wealth and well-being gained from the waters of the Basin (Department of the Environment Water Resources, 2004) with the serious degradation that has put the Murray-Darling Basin into World Wildlife Foundation's top ten international rivers at risk list (Wong et al., 2007). Choosing appropriate management actions is further complicated by uncertainties related to climate change (Khan, 2008).

The management of water resources in Australia has been undergoing reform since 1992, when the heads of all Australian governments adopted the National Strategy for Ecologically Sustainable Development, which is a commitment to more effective and integrated water management policies and practices (Pigram, 2006). In recognition of the complexity and uncertainty of water management the National Water Initiative, launched in 2004, aims to "*provide for adaptive management of surface and groundwater systems in order to meet productive, environmental and other public benefit outcomes*" (National Water Commission, 2005).

In this chapter we reflect on a relatively small but influential example of adaptive management occurring within the broader context of Australian water reform. The management aim in this case is to enhance the environmental benefits of the flow regime for the highly regulated Mitta Mitta River. Regulation has impacted on this river to a greater extent than most others in the Murray-Darling Basin (Jacobs et al., 1994). Opportunities for variable release exist during transfers of water from Dartmouth Reservoir to Hume Reservoir, and also during periods of 'minimum release' when inflows to the dam are being stored. We provide a brief description of the context of the variable release trials since 2001, before exploring what we have learned about undertaking adaptive management in this particular case.

Case Study

The Murray-Darling Basin, a catchment of over 1 million square kilometres in the Southeast of Australia, is an important source of wealth and wellbeing for Australia. The huge area covers numerous social and physical landscapes, and jurisdictions, which prompted the creation of the River Murray Commission (RMC) in 1917, and its successors the Murray-Darling Basin Commission (MDBC) in 1988 and the Murray-Darling Basin Authority (MDBA) in 2008. This unique organisation is a partnership of the Australian, New South Wales, Victorian, South Australian, Queensland and Australian Capital Territory governments. The purpose of this partnership, enabled by the Murray-Darling Basin Agreement 1992, is to "*promote*

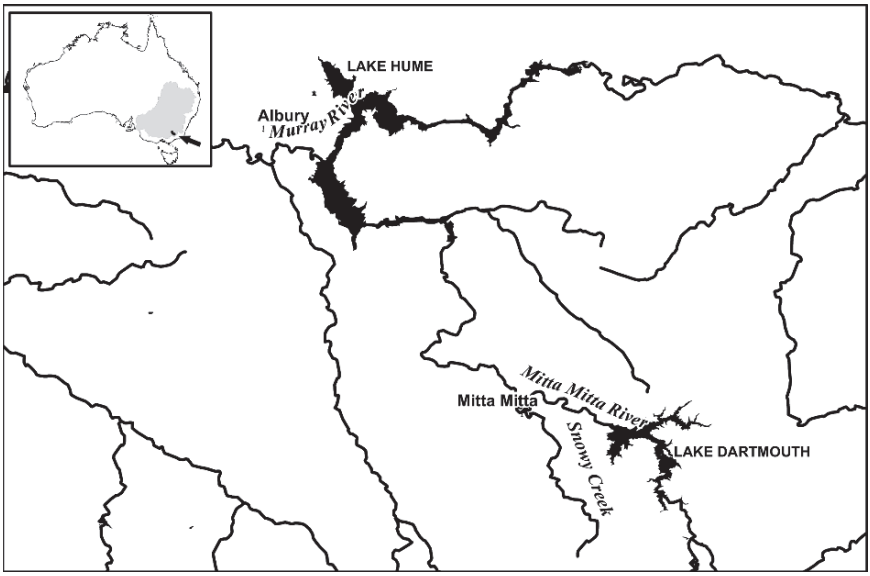

Fig. 4.1 Lakes Dartmouth and Hume, located in the south east of the Murray-Darling Basin (shown in grey in inset). Map courtesy of MDBC

and coordinate effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin" (Murray-Darling Basin Commission, 2006). The Mitta Mitta River is a tributary of the River Murray and is an important source of water within the Murray-Darling Basin (Fig. 4.1).

Hume Dam, on the Murray River was constructed between 1919 and 1936, and enlarged between 1950 and 1961 to re-regulate additional water from the Snowy Mountains Scheme. Dartmouth Dam was constructed between 1973 and 1979 on the Mitta Mitta River, a major tributary entering Hume Reservoir. Dartmouth Reservoir has a larger capacity (3908GL) than Hume Reservoir (around 3000GL) and is primarily used as "drought reserve" to supplement storage in Hume, the primary regulating storage for the River Murray system. Dartmouth Reservoir can take several years to fill because of its large storage capacity relative to its catchment size. Hume typically fills and empties more frequently, sometimes annually (Hume and Dartmouth Dams Operations Review Reference Panel, 1999). Although the primary purpose of Hume and Dartmouth Reservoirs is to store water for irrigation, and stock, domestic and town use, dam operations also mitigate flooding in the valleys below these reservoirs. Both dams are operated as part of the River Murray System by the River Murray Division of the MDBA.

Soon after Dartmouth's completion, downstream Mitta Mitta farmers reported declining pastures and reduced milk production, attributed to reduced floodplain watering (Allan et al., 2006). The public discussion over the operation of the dams

continued for some time. In early 1997 the MDBC undertook a review of the operation of Hume and Dartmouth Dams, establishing an independent stakeholder Reference Panel to assist with this task. The Reference Panel consulted widely with impacted communities and the Review gained wide community acceptance (Hume and Dartmouth Dams Operations Review Reference Panel, 1999).

One of the many issues considered in the Review was relatively steady flows being maintained for long periods of time in the Mitta Mitta River immediately downstream of Dartmouth Dam, to which some of the ecological deterioration of that section of the river was attributed. This echoed similar concerns from regulated river systems around the world, including the Colorado River in the USA, where it was suggested that some variation be reintroduced through managed flow patterns (for details of that well-represented case see, for example, Jacobs & Wescoat, 2002; Light, 2002). When the Hume and Dartmouth Dams operation Review was completed in 1999 it recommended addressing the impacts of Dartmouth operation on river health by reintroducing greater in-stream flow variability in the Mitta Mitta River, viz: "*Strategies to increase the variability of in-stream flows below Dartmouth should be developed, and should not await solution of the water temperature problem*." The Scientific Reference Panel on Environmental Flows also commented that "*introduction of variability would have some value even if the water temperature issue was not addressed immediately. It will reduce the current level of bed and bank erosion and should create more bank habitat for bank vegetation to re-establish*" (Hume and Dartmouth Dams Operations Review Reference Panel, 1999).

In response to this recommendation, MDBC have worked towards increasing the variability of flows in the Mitta Mitta River through managed variable releases from the Dartmouth Dam. These releases have been trialed four times in the 8 year period 2001–2008 with the explicit intention of learning by doing; i.e. adaptive management.

The first trial of variable releases from Dartmouth Dam was during late spring/early summer 2001/2002. This trial consisted of three successive large volume (approaching bankfull) 'pulses' over approximately a month, following an extended period of water transfers with low variability. The MDBC commissioned ecological monitoring and evaluation of the event via an open tender. The tender documents suggested a suite of environmental indicators based on previous reviews (e.g., Fairweather & Napier, 1998) that could be examined to provide an indication of ecosystem response to the variable releases. This tender was won by researchers from Charles Sturt University (CSU) and included field and laboratory experiments and monitoring at four sites on the Mitta Mitta River and at a reference site in the nearby unregulated Snowy Creek. The monitoring program was devised to test multiple hypotheses for suites of indicators and the findings were documented in a 150 page report (Sutherland et al. 2002). A further trial took place in the 2004/2005 summer, which consisted of a single large pulse following an extended water transfer period. The CSU research team was again contracted to monitor and evaluate the trial from an ecological perspective (Watts et al., 2005). The CSU team monitored and evaluated a variable low flow trial during a period of minimum release in autumn 2006 (Watts et al., 2006), and a single larger flow pulse in late spring 2007 following an extended period of low constant flow (Watts et al., 2008b).

The first study monitored the response of a comprehensive set of environmental indicators which included water quality, water column microbial activity, biofilm composition and metabolism and macroinvertebrates. For efficiency and effectiveness, successive monitoring was progressively refined to use only water quality, and biofilm biomass and composition as ecological indicators of the success of variable flows in improving the ecological condition of the river.

Key conclusions of the four flow trials were:

- Variable flow is ecologically more beneficial than relatively constant flow.
- The benefits of variable flows are relatively short-lived (one or two weeks), if relatively constant flow resumes.
- Some environmental dis-benefits start to become apparent if flows are relatively constant for more than one month.

The outcome of the adaptive management process is clearly evident when we compare hydrographs for a water transfer period preceding the variable flow trials (e.g. in 1987/1988) with the proposed water transfer plan for 2008/2009 which incorporates variable releases Fig. 4.2. Traditionally, operational practice was to delay water transfers from Dartmouth Reservoir for as long as possible to minimise the risk of unnecessarily transferring water to Hume Reservoir. Consequently, when transfers were required the river managers were compelled to manage releases near bankfull flows with limited variability, often for extended periods of time (Fig. 4.2). The river operators incorporated the learnings and principles developed from the four flow trials into the 2008/2009 flow plan to 'mimic' some elements of the natural flow regime (Fig. 4.2). In the case shown in the Fig. 4.2 the 'design' of the pulses fully complies with existing operating rules, for example the maximum rate of rise and fall in water level, as well as meeting the fundamental requirement to transfer a given volume of water to Hume Reservoir that season.

Post the variable flow trials (2001–2008) the University research team continue to work collaboratively and iteratively with MDBA to develop operational principles and recommendations. This consolidates the substantial financial and intellectual investments in this work. A feature of the series of trials was the openness, honesty and transparency in communication among the researchers and operators. For example, before and during the trials the researchers and MDBC discussed, informally, the emerging results and possible implications. The close contact between the research team and the dam operators also enabled the researchers to be informed of changes to proposed discharge patterns, allowing better preparation for research. Following each trial the CSU researchers presented their results at seminars for MDBC, and formal meeting were held to discuss findings and future directions and potential activities. MDBC engaged CSU to prepare a written "Synthesis" to consolidate key findings and operational recommendations arising from the trials, an exercise that added significant value to the river managers' prior investment in this work because it facilitated the adoption and extension of outcomes. Central to the sense of shared commitment that developed among the researchers and the river managers was that the work was mutually beneficial to both parties.

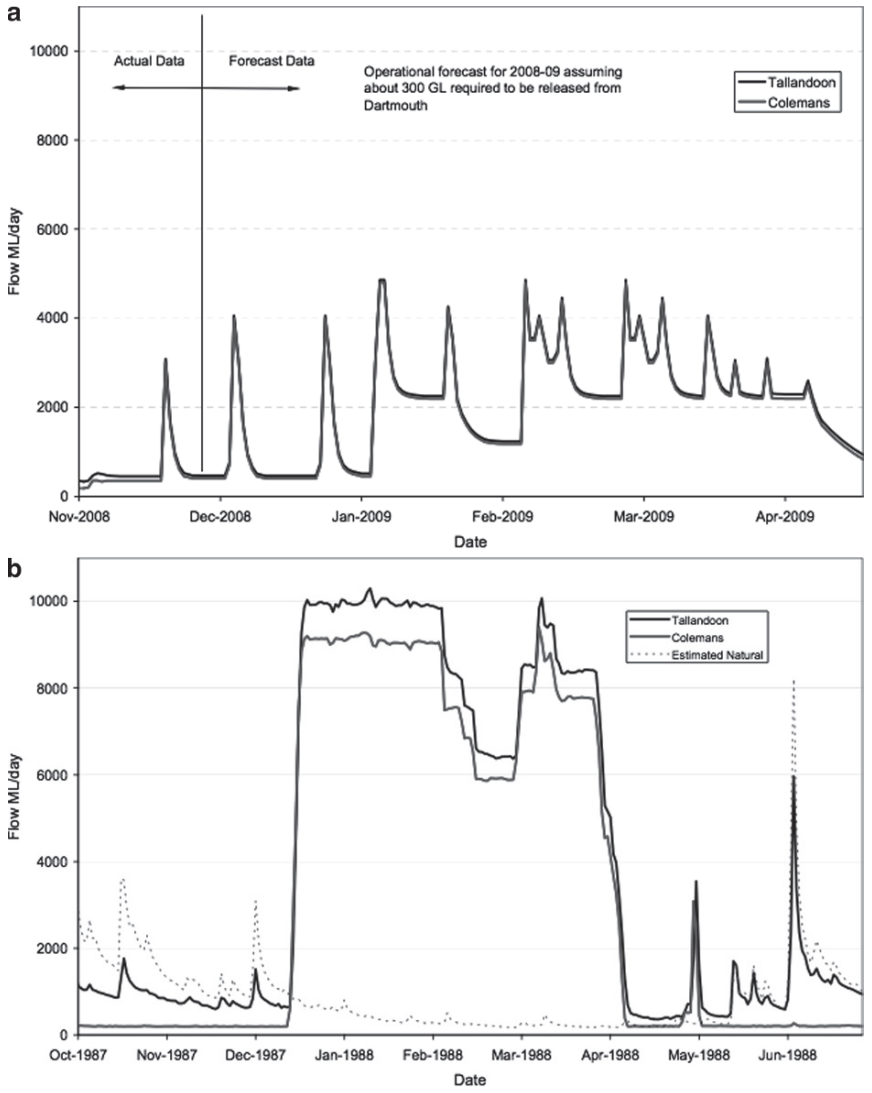

Fig. 4.2 Flow in the Mitta Mitta River below Dartmouth Dam. The top figure shows near regulated channel capacity flow (around 10,000 ML/d) for an extended period. The bottom figure shows that when average flow rates are lower than this there is greater operational flexibility to vary flows. Courtesty of MDBA

Honesty and transparency were also features of the communication with the local community. For instance, Mitta Mitta landholders were regularly informed during trials through "Flow Advices" sent by fax or email from MDBC so they could prepare as necessary by, for example, moving pumps. Informative articles, written jointly by MDBC and CSU, were published in a local newsletter, the "Bush

and Bulldust", to provide context for the trials. This open communication facilitated the maintenance and further building of trust during this time.

This case study provides an example of the classic form of active adaptive management described in Chapter 2, with a cycle of learning from a series of monitored and evaluated variable releases and their outcomes. These cycles of "*Learn what? Do what*? and *What have we learned from doing*?" have led to sufficient understanding of the situation in the Mitta Mitta River for managers to now be asking *How do we decide what to do, from what we have learned*? However, this case varies from the description in Chapter 2 in this volume in its understanding of the type of problem being addressed. The variable release trials had a simple focus, in a bounded environment, and in this respect the trials are very like traditional scientific enquiry. Allan (2008) notes that reduction and simplification of complex problems is part of traditional scientific inquiry rather than adaptive management. However, this case study is clearly adaptive because the lessons from the Mitta Mitta variable flow case study are not *confined* to answering the simple, tightly focused question, but rather are being incorporated into the broader system operation and water reform framework, including the system wide review of River Murray Systems operations which commenced in 2007/2008. This Mitta Mitta case study is also informing a recently commissioned NWI report (Watts et al., 2008a) which reviews extant understandings and knowledge of pulsed flows in Australia. This case study, then, provides an example of how an operational review can initiate research to inform changes to local and system wide management, and national water management policy development.

Learning to Operate Differently

Reflecting on this case study, we suggest that learning and informed changes to management practice can occur even without a long-term, neatly articulated, all encompassing 'adaptive management' project. In this instance, the river operators, supported by a larger organisation, used University expertise in focused bursts to provide scientific information to guide their adaptive management. The ecological research projects themselves are indistinguishable from countless other studies – what makes them part of adaptive management is the framework within which the studies are viewed and used.

We suggest three key ingredients fostered the adaptive management in this particular case; aspects of the operational context, the people involved and the trusting relationships that developed.

Operational Context

The regional context and the nature of the issue each enabled and encouraged adaptive management in this case. The regional context (itself part of the larger water reform context in Australia and globally) was strongly influenced by the nature of

the review of operations undertaken in the late 1990s. The consultation process for this review was genuinely inclusive, so the desire to learn about the impacts of variable flows had some local legitimacy and relevance. The inclusive nature of the review and the acceptance of its outcomes also created a social climate in which local people were at least not antagonistic, and were often supportive, of activities undertaken by MDBC, including these trails of variable flows.

The issue itself – centred on the environmental impacts of dam to dam water management – was tightly bounded in both its intellectual and physical scope. This is because the learning was narrowly focused on impacts of variable flows on in-stream parameters, and because the trials were exploring flexibility within the current operating rules and changing variability not volume. A far more elaborate process of negotiation and approvals would be required for testing hypotheses outside of current operating rules. The issue in this case was also one in which action in response to learning could be taken fairly quickly, as those who commissioned and received the scientific reports were the people with the authority and capacity to act on them.

People

The role(s) of individuals and their institutional arrangements have also clearly played an enabling role in this case study. A key point is that people within MDBC were committed to learning – both about the impacts of their activities, and about how to do things better. Their desire to learn was supported and championed by key people within MDBC. This enthusiasm for learning was matched by that of the University research team, who were more committed to the long-term learning than might be implied by noting that a series of consultancies was undertaken. Discussion among water managers and members of the research team is ongoing, with mutual benefits and learning continuing to accrue to both parties. All of this was facilitated greatly by the continuity of involvement of key personnel in both the University research and MDBC teams over the eight years. Reflecting on the importance of the people involved suggests a key role for structures and processes to enhance and protect organisational memory, and the importance of nurturing and encouraging adaptive people within organisations (see Chapter 18, Fazey and Schultz, this volume, for discussion on ways to support adaptive people).

Trust

The trust between individuals and organisations that developed in this case is related to the individual people involved, but it seems to be such an important enabling factor that we have highlighted it in its own section (refer also to Box in this chapter for a general discussion of trust). The initial open tender process facilitated the commissioning of a competent research team. Trust was then developed over time as each party delivered anticipated outcomes and, most importantly, developed shared questions and approaches. Trust almost invariably needs time to develop between people, and within and between organisations, so people remaining in their

professional positions, and their organisations remaining stable, were clearly factors that enabled 'internal' trust to develop. However, in this case the wider public must also have trust in the process, via trust in the key organisations. Local trust in the MDBC was facilitated by the history of the inclusive consultation processes associated with the Hume and Dartmouth Dams Operations Review, and by the regular communication of river operations as described above. However, trust in the process could be threatened by perceptions of the nature of the internal relationships that developed. Cynical 'readings' of the case study could conclude that the researchers were feathering their own nests by always concluding their reports with recommendations for future work. The maintenance of transparent records (relating for instance, to why the subsequent tenders were awarded to CSU) is thus important, as is explaining the nature of adaptive management and continuous learning to people who may be impacted.

Trust is also developed through shared language, and this is taking longer to play out in this case.

It is becoming clear that the language of the ecological reports does not necessarily provide everything that is needed by operations managers to usefully inform their everyday decisions. A feature of this case study is the willingness for linguistic ambiguity to be raised and discussed among the parties. The statement of need for the "Synthesis report" is an expression of genuine desire on the part of the river managers to improve their operations and to consolidate previous investment. That the work is scientifically rigorous and undertaken by respected practitioners provides a sound basis to proceed as required to effect permanent changes to river operation rules.

Potential Risks with Incremental Approaches to Adaptive Management

The enabling factors discussed above suggest some potential risks with approaching adaptive management in small stages. The paradigms and adaptive capacities of the people involved in the project will impact on how inquiry is undertaken and how the results of that enquiry are understood and incorporated, and unsuitable people may inhibit adaptive management at many points in the cycle. An even greater risk of an incremental approach is that funding is not guaranteed, and must be secured at every stage. A supportive operational context is clearly necessary for the approach to adaptive management described in this case study; in an institutional context that is hostile to long-term learning, or is undergoing change, individual research projects may be isolated, and be confined to one off inquiries. Without a larger learning framework information from such inquiries is likely to remain local and restricted.

Conclusion

Effective adaptive management of flows from Dartmouth to Hume Reservoirs has occurred through a series of small research consultancies that reflect a broader desire by water managers to provide environmental benefits from river operations, which

in turn fits into the longer-term decision for water reform in Australia which seeks multiple benefits from every drop of water. The success of this project (in terms of improving understanding the system, informing operational activities, and informing the wider water reform process) results from factors which combined to promote a desire to learn, to listen and to change behaviour. Some of these factors may be specific to this case and the people involved, and may seem fortuitous, but many should be reproducible in other projects where goodwill and capacity for trust reign.

Acknowledgments The work presented was enabled by a number of people whose enthusiasm and skills have supported the trials since 2001 to the present. Trevor Jacobs, Bruce Campbell, Neville Garland and Damian Green (MDBC) and Peter Liepkalns (Goulburn Murray water, Dartmouth Dam) are key personnel in operational planning and implementation, and Mac Paton, a local landholder has facilitated local information exchange.

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Building Trust in a Distrustful World

George H. Stankey

Hardly any aspect of human relationships is more fundamental than trust. Luhmann (1979) writes "trust, in the broadest sense of confidence in one's expectations, is a basic fact of social life." Trust is multi-faceted, involving competency, reliance, and integrity and is the glue that ensures society acts coherently and with purpose. In its absence, conflict and contention reign, with social action dominated by adhocracy and self-interest.

Given its centrality to effective social action, one would expect that understanding of the concept of trust was highly refined. Yet, the literature reveals a notion of complexity, disparate dimensions and meaning. Rousseau et al. (1998, 394) conclude there is "no universally accepted scholarly definition of trust." However, these authors recognize the conditions necessary for trust to arise. First, there must be a condition of risk; trust would not be necessary if actions could be taken with complete certainty. Second, trust requires a state of interdependence; the interests of one party cannot be achieved without reliance upon another. Taken together, these conditions produce definitions such as "undertaking a risky course of action on the confident expectation that all persons involved in the action will act competently and dutifully" (Lewis & Weigert, 1985, p. 971).

In addition to risk and interdependence, other assumptions regarding trust include:

- Trust is dynamic and can move through cycles of building, stability, and dissolution. A state of trust is always tenuous and provisional.
- Trust exists as multiple variables; it can occur as an independent (causal) variable, as a dependent (effect) variable, or as an interaction variable (a moderating condition for a causal relationship).
- Trust occurs at different scales; trust exists among individuals (e.g., citizens and resource managers) as well as at the institutional level (e.g., between citizens and the government agencies). Trust at one level does not necessarily translate to other levels.
- Trust manifests itself in different forms. It can arise from the commonality between individuals or groups that "serve as indicators of membership in a common cultural system" (e.g., race, gender, "good old boys"). It can develop from repeated exchanges over time, perhaps initiated by self-interest

or imposed by external requirements, but which "become overlaid with social expectations that carry strong expectation of trust and abstention from opportunism." Finally, trust can arise from institutions that have become accepted social facts; e.g., we place trust in the presence of professional credentials or in the rules and regulations that government imposes.

How can trust be developed (or, if necessary, restored)? First, it is important to acknowledge that trust cannot be created in a mechanistic manner; restoring trust is not equivalent to restoring riparian conditions. Trust is earned, based on action and outcomes, not rhetoric. It derives from long-term relationships in which there is a continued demonstration of good faith and follow-through. A recurring message in the literature is "do what you say you will do." In their study of partnerships, Wondolleck and Yaffee (2000, p. 149) report "Quite simply, successful partnerships kept their promise to one another in a variety of ways."

Second, trust is a provisional quality of any relationship, requiring constant tending and attention. It is also asymmetric; while the building phase can be lengthy, it can be diminished in a moment. Also, it is not a dichotomous condition (I trust you or I don't). Trust and distrust can exist simultaneously. We must also distinguish between personal trust, grounded in honesty, benevolence, and reciprocity and organizational trust, founded on concerns with fairness and equity. Trust can exist between individuals – e.g., local citizens and the ranger – but if the organization is perceived as untrustworthy, then it will be difficult to fashion productive relationships.

Institutions can make a difference in trust building. For example, they can demonstrate an openness and willingness to engage in self-criticism. They can promote organizational stability and clear role expectations for employees; however, turmoil generated by downsizing and re-engineering act to diminish both. Although regulations provide one means of building shared understanding regarding appropriate and expected behavior, they also undermine trust by substituting formalization for flexible, context-specific management approaches. But the bottom line remains straightforward: organizations that operate openly, transparently, and honestly and that strive to follow through on their promises have an opportunity to foster the trust needed to do their job and to survive politically. Those that don't, won't.

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