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ADAPTIVE MANAGEMENT AND WATERSHEDS: A SOCIAL SCIENCE PERSPECTIVE

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Abstract

Adaptive management is often proposed as the most effective way to manage complex watersheds. However, our experience suggests that social and institutional factors constrain the search for, and integration of, the genuine learning that defines adaptive management. Drawing on our work as social scientists, and on a guided panel discussion at a recent AWRA conference, we suggest that watershed-scale adaptive management must be recognised as a radical departure from established ways of managing natural resources if it is to achieve its promise. Successful implementation will require new ways of thinking about management, new organizational structures and new implementation processes and tools. Adaptive management encourages scrutiny of prevailing social and organizational norms and this is unlikely to occur without a change in the culture of natural resource management and research. Planners and managers require educational, administrative, and political support as they seek to understand and implement adaptive management. Learning and reflection must be valued and rewarded, and fora established where learning through adaptive management can be shared and explored. The creation of new institutions, including educational curricula, organizational policies and practices, and professional norms and beliefs, will require support from within bureaucracies and from politicians. For adaptive management to be effective researchers and managers alike must work together at the watershed-scale to bridge the gaps between theory and practice, and between social and technical understandings of watersheds and the people who occupy and use them.

Key terms
ADAPTIVE MANAGEMENT; WATERSHED MANAGEMENT; SOCIAL SCIENCE; SOCIAL LEARNING; INSTITUTIONAL LEARNING.

INTRODUCTION: A SOCIAL PERSPECTIVE

Watersheds are physical realities, but the perception and understanding of those physical realities are human, and in particular social, activities. It is societies which define watersheds as entities, and social processes that determine goals for, and management actions within, watersheds. Information on the physical and ecological stresses on watersheds is acted upon by environmental/ resource managers in ways shaped by their societies. To understand watersheds, therefore, it is essential to understand the values and needs of the people associated with watersheds. In this article we draw on understandings developed through our combined social research experience, and on a panel session at a recent AWRA conference, to suggest strategies to achieve truly adaptive management of watersheds.

Catherine Allan and Allan Curtis have evaluated a number of watershed scale adaptive management projects in Australia, and George Stankey and Bruce Shindler have had extensive involvement with the Adaptive Management Areas in the Forests of the Pacific North West. As social scientists we acknowledge multiple ways of knowing the world around us, including local and Indigenous knowledges. The notion of multiple forms of knowledge includes the relatively straightforward idea that assets can be viewed differently—one person's trout stream is another person's irrigation supply, for instance—but also acknowledges more profound differences in the ways in which people understand the world, the roles of humans in that world, and even the nature of knowledge and truth (eg Roe, 1996; Miller 1999). We understand planning as a political endeavour. There are social consequences from every planning decision because there are always winners and losers in some sense. "Successful" resource management programs of any sort must enjoy social acceptability in addition to their biophysical possibility and economic feasibility. Public judgements about the appropriateness (acceptability) of management activities are based on more than just physical or scientific 'facts.' Judgments are made in response to a complex suite of factors, including knowledge of alternatives and their consequences, and levels of trust in decision makers (see for example Shindler *et al.,* 2002; Howe *et al.*, 2005). We are also interested in how the watershed concept has been, and continues to be 'constructed' to serve the changing needs of our societies. Social discourse shapes the way in which watersheds are understood, valued and managed. Watersheds are an obvious unit for managing water, but currently watersheds are also considered appropriate as the frame for managing other environmental assets/natural resources. Although not a new phenomenon, using watersheds as planning units has become particularly popular in the last decade or two (Blomquist and Shlager, 2005). The current focus on watersheds appears to follow from a desire for an integrated approach to natural resource management; not only integration of different landscape features such as surface and groundwater, soil and vegetation and other discipline based knowledge of these landscape elements, but also the integration of the efforts/resources of governments, private corporations and individuals, and the roles of managers/planners, researchers and landholders (Curtis and Lockwood, 2000). Watershed organizations have been established as part of government initiatives to implement integrated natural resource management in both the US (where they are most often called watershed councils) and in Australia (where landcare groups perform many similar functions), although their organizational support structures are different in each country (Curtis *et al.*, 2002). Current discourses of 'watersheds' imply that people within a particular watershed will share

some sense of 'place', through either ownership or an emotional attachment to the land in its broadest definition (Kruger 2001). A watershed thus becomes a space that links people with their environment, and with each other. The watershed concept has been used as a means of scaling up very small, locally focussed environmental management activities in both Australia and the US (Ewing, 1999; O'Neill, 2005). Because watersheds can encourage and enable people to work together on larger scale projects while maintaining their sense of connection with the environment, watersheds also represent an important venue in which learning can be promoted and the results of that learning applied.

Watershed management occurs within the context of prevailing societal norms and practices. For the past century, scientific management, a reductionist approach to understanding and controlling activity through rational planning, has dominated Western policy making regarding natural resource management (Smith, 1997). Rational planners work from the premise that the world is knowable and predictable, that the goals of management are clear, and that there is one "right" answer that can be found through objective, technical enquiry (Rittel and Webber, 1973). 'Rational' reductionist management of water, forests, agriculture and other natural resources worked well when the goals of management were narrowly defined (exploitation, harvesting, human use, human protection), and while the ecosystem consequences of this narrow focus could be ignored (Holling, 1995). The environmental degradation that has resulted from this focus on exploitation in both the USA and Australia is sobering. For example, Australia's latest State of the Environment report notes that *"Significant areas of major inland and coastal catchments are degraded (including vegetation, aquatic habitats and water quality), the pressure on water resources continues to be high, and many indicators show that aquatic ecosystems and biodiversity are degraded across large areas of the continent. Water use and infrastructure development continues to grow and there is little indication that*
key indicators have improved in the last decade" (Harris, 2006). National reporting of this kind are still being developed in the US, but it is already noted that around one third of the USA's native animal species, including aquatic animals, are considered 'at risk' to some degree (The Heinz Center 2002). These degradation problems are likely to be exacerbated by the predicted impacts of climate change, highlighting just how little knowledge we have as a basis for rational planning of future action. In Australia, for example, we have only just begun to understand some of the complex connections between ground and surface water, and the extent and timing of flows needed to sustain ecological functioning in our rivers (eg Khan 2004).

Natural resources managers have not been idle. There have been many management responses to ecosystem collapses, and numerous attempts to reduce negative impacts on water, forests, soils and biodiversity, but these responses have, for the most part, been constrained by the growing recognition of complexity and uncertainty, and some well entrenched institutional habits. The attributes of current/ traditional natural resource management organizations (including formal structures such as Federal and State government agencies) and institutions (including informal structures such as social movements and watershed citizen groups) exert a strong influence on the responses that can be made. Current natural resource/ environmental asset managers (and the societies which encourage their employment) have a preference for activity—they like to be doing, and to be seen to be doing. In other words, this style embodies the "can do" spirit which characterizes those in the natural resource professions. This preference is supported by government programs which emphasize milestones, and targets, and rapid accountability in the form of activity audits (Allan and Curtis, 2005). Natural resource management organizations and institutions are also patently risk averse (Allan and Curtis, 2003; Stankey *et al.* 2006). Risk averse societies and their institutions and organizations fear doing, or being seen to do, something that turns out badly. This has a constraining effect on managers, making them unwilling, or even afraid, to experiment. The product of these pressures is a generation of agency staff who are always seeking to be active, but only in safe and predictable ways. Against this background is a growing appreciation of the limits of predictive models when faced with high levels of complexity and uncertainty, coupled with the challenges of dealing with a world full of surprises, secondary- and tertiary-effects, and social and political volatility (Herrick and Sarewitz 2000). Over recent decades ecosystem collapses, combined with a broadening range of accepted human expectations and understandings, have led to management impasse where, despite the strong desire to be active, in many places it seems impossible to undertake any management at all (Stankey *et al.*, 2003). Alternative management paradigms are needed to deal with high levels of complexity and uncertainty, and to accelerate the rate at which managerially relevant knowledge can be acquired. Adaptive management appears to promise to be one of those alternative paradigms.

ADAPTIVE MANAGEMENT AS A NEW APPROACH
Adaptive management deliberately sets out to learn from policy experiments to improve future practice. In a natural resource management context adaptive management involves learning from the outcomes – expected and unexpected- of implementing project activities. Adaptive management initially was conceived of and presented as a technical response to problems with ecological and social resilience (e.g. Holling, 1978; Walters, 1986, Walters and Holling, 1990), but has increasingly become as much a social and civic undertaking as a technical one (Lee, 1993, Gunderson *et al.* 1995). Although adaptive management "mimics" the scientific method, it nonetheless stands in sharp contrast to traditional reductionist scientific inquiry because of its emphasis on learning from management practice (Hillman *et al.* 2000). Adaptive management is also different from traditional incremental approaches; it is not simply another name for bumbling along because it is planned and purposeful, and has a focus on improving management through deliberate learning. While there are many different ways of interpreting and understanding adaptive management we suggest that watershed scale adaptive management involves:

- management activities specifically designed to test hypotheses through ecosystem- scale, holistic experiments;
- active reflection on the outcomes of those management activities;
- provision of mechanisms for multi-disciplinary and multi-stakeholder involvement;
- an emphasis on collaborative or participatory social learning;
- provision of mechanisms for incorporating learning into planning and management; and
- development and maintenance of appropriate communication fora for all project participants.

Adaptive management has become formally embedded in watershed planning in Australia through the bilateral agreements between the Federal and State governments that underpin the National Action Plan for Salinity and Water Quality (NAP) (Commonwealth of Australia 2003). The management of invasive plants, pest animals, flow regimes in rivers, soil health and biodiversity maintenance are all supposedly guided by adaptive management principles; as an example adaptive management theory has guided high profile environmental flow projects in South eastern Australia (Murray-Darling Basin Commission, 2005). In the US the theory of adaptive management is widely accepted, and it underpinned the development of the Northwest Forest plan (Stankey *et al*. 2006). The pervasiveness and acceptability of (the rhetoric of) adaptive management can be gauged by a casual web browser search of the World Wide Web, restricting the search to "adaptive management" and "environment" or "natural resources". This will yield hundreds of thousands of results. Yet despite all of this interest, catching adaptive management in practice, especially at watershed scales, has proven difficult (Lee 1999; Allan and Curtis, 2005; Stankey *et al.* 2006). We suggest that the scarcity of operational adaptive management of natural resources is caused by social constraints, rather than technical difficulties.

THE CHALLENGES TO SUCCESSFUL IMPLEMENTATION OF ADAPTIVE MANAGEMENT

In June 2006 the American Water Resources Association's Summer Specialty conference was devoted to discussion of adaptive management. We led a panel session/workshop in which conference participants identified a number of constraints to undertaking adaptive management. These constraints are reproduced, verbatim, in Box 1, under topic headings we
subsequently applied

Box 1 Constraints on adaptive management

Risk aversion
- Institutional aversion to learning
- Fear of being held accountable (managers)
- Legal constraints

Inadequate protocols
- Gap between theory and practice in AM
- Abuse of term adaptive management
- Trial and error as against experimentation
- Lack of follow up, what worked?
- Discussion not captured in policy arena
- Inability to evaluate science. Public uncertainty regarding the reliability of resources
- I'm right, you're wrong

Inadequate resources
- Time. Short time frames
- Hesitancy to fund planning / thinking
- Not willing to be proactive before crisis
- Funds coming too late for management of species
- Fear of losing resources
- Resources/ people
- Loss of knowledge through privatization
- Tension between need for certainty and learning

Complexity
- Integration / holistic approach
- Not involving on-the-ground participants and workers involved creates mistrust
- Search for certainty

The constraints identified through this group discussion at the AWRA conference are consistent with our experience in projects in

the US and Australia, and with existing literature on adaptive management. In the next section we explore these constraints further.

Effective adaptive management "embraces" failures and shortcomings because they provide an opportunity to learn and change (Gunderson 1999). As noted at the AWRA conference embracing, or even acknowledging, failure or surprise remains antithetical to many managers and policy makers. Wildavsky and Dake (1990) showed that cultural biases are a more powerful predictive tool for risk perception than either knowledge or personality type, and we appear to be particularly risk averse societies at present. Across society, there is a growing inability to portray the concept of risk in a socially acceptable manner (Slovik *et al.* 2004). All actions, including no action, involve risk, yet, increasingly, resource managers are called upon to avoid actions, policies, and programs that may lead to risk for species, conditions, and values. We suggest that aversion to failure also follows from the strong technological orientation developed in our cultures from over a century of reliance on the scientific method; errors are seen as the result of shortcomings, incompetence and poor planning, rather than an inevitable result of working in the face of complexity and uncertainty (Stankey *et al.*, 2006). In this cultural environment there are very few incentives and rewards to encourage risk-taking, failure-accepting behaviour. There is also the corrosive belief that adaptive approaches could reveal that past policies and practices have been flawed; publicly acknowledging such past shortcomings is anathema to many. Admitting to past 'failures' also means that conventional ways of acting need to be changed and such changes often are strongly resisted in organisations. Finally, vested interests and powers are often content with the way things are and adaptive management is viewed with suspicion and alarm because it could lead to changes inimical to those interests. Two examples from our program evaluations demonstrate how risk aversion can stifle attempts at adaptive management. In one of the AMAs in the Pacific Northwest a proposed evaluation of alternative forestry management prescriptions for enhancing old growth conditions along the riparian zone was opposed because the researcher was unable to give fishery biologists and regulators a guarantee that the experiment would not jeopardize salmon. To put that another way, the experiment would only be able to take place if the outcome was sufficiently known to be able to make guarantees, and if that was the case, the experiment would not need to be conducted (Stankey *et al.* 2003). In Australian we studied the 'Heartlands' watershed program in south eastern Australia and found clear disincentives for sharing with a funding source any lessons from the program that could be seen as a 'failure'. In 2002, in response to severe drought, many landholders chose not to plant the tubestock trees and shrubs supplied through the project in the autumn period, holding off this work until sufficient rain had fallen for the plants to survive. However, the program reporting to the funding body implied that planting had occurred in autumn to satisfy the funding agency's requirements that the funds be expended on time. This pragmatic approach resulted in the plants surviving, and the funding body was content because its books were closed off at the right time, but there was no communication of the important lessons about the need for flexible planting times (Allan 2004).

Another major constraint identified at the AWRA conference was the inadequacy of current guidelines and protocols for adaptive management. This concern mirrors the outcomes of an earlier workshop with Australian water management practitioners that identified a pressing need for information to help managers determine when, and at what scales, and in what form, adaptive management was appropriate. The Australian workshop participants also called for information on how to implement adaptive management, in particular on engaging stakeholders, developing appropriate monitoring and evaluation regimes, and how best to incorporate modelling (Allan and Curtis 2003). Complexity was also raised as an issue at the AWRA conference and the Australian workshop; this is inevitable as adaptive management is an alternative to reductionist management approaches that seek to manage complexity by reducing it. However, simply identifying the flaws in the reductionist paradigm does not make coping with complexity any easier, and practitioners need practical tools for working with and benefiting from complexity. One important tool will involve recognizing the social dynamics of this complexity as well as ecological ones (Shindler 2000). Greater public acceptance of adaptive management will come from researchers' and practitioners' capacities to help citizens understand the rationale, research questions, and potential outcomes of specific practices. This will mean genuine interaction between professionals and citizens to promote learning about protocols consistent with adaptive processes.

Finally, and perhaps most importantly, the participants of both the Australian and US workshops identified inadequate resources as constraining adaptive management. There does not appear to be the people, money or the political will to allow projects to mature, or for reflection to be undertaken. This is exemplified by the withdrawal of funding support for the Australian Heartlands project within three years of its commencement, just as the experimental design had been finalised and monitoring infrastructure established. In the U.S., a similar curtailment of funds occurred for Adaptive Management Areas in the Northwest Forest Plan. That this does not have to be the way projects run is shown by the adaptive management experiment in Canada, where Model Forests continue to receive budgets and administrative support in five-year increments (Shindler, pers. obs). Inadequate allocation of time and other resources suggests a lack of organizational commitment to some or all aspects of adaptive management, and this in turn points the way to addressing the issues raised at the AWRA conference. There is a clear need for effective organizational process to encourage and support adaptive management.

BUILDING EFFECTIVE ADAPTIVE MANAGEMENT ORGANISATIONS AND PROCESSES
Adaptive management is proposed for many different resource sectors, at many different scales and in differing social contexts, so it is inevitable that there is a variety of ways in which effective adaptive management can be accomplished. Participants in the AWRA conference identified a number of strategies for overcoming the major constraints they identified. Once again these are listed verbatim in Box 2, under headings applied by us.

Box 2 Strategies proposed by Panel session participants

Define and focus adaptive management
- need to differentiate true AM from muddling along
- how to focus energy of AM

Be purposeful
- clear articulation of where you are going (trajectory rather than target?)
- develop common visions then work backwards
- be guided by questions

Evaluate
- have ways to measure whether you have been successful
- how do you measure institutional change?

Collaboration/participation
- involve stakeholders- collaborative (but not a panacea)
- look carefully at public comments through environmental reviews and combined these with scientific risk to develop uncertainties which led to AM plan
- start small geographically and at first order linkages
- have a truly multi-disciplinary effort
- be humble and recognize difference

Integrate technical and social sciences
- formalize integration of technical and social sciences
- agree on common language and develop common vocabulary
- take small steps
- provide skilled negotiators to open dialogue between social and other sciences
- equal valuation of social and technical science
- put them all [ideas] on the   board and then all agree

And a 'black hatter…'
- Ⓙ   Is active Adaptive Management too hard [or is it unlikely that the needed organizational cultural change d litil t bft d?]

Strategy 1- define adaptive management, focus and be purposeful. The AWRA conference participants reinforced our belief that, as a pre-requisite for other actions, watershed-scale adaptive management must be recognised as a radical departure from established ways of managing natural resources. Adaptive management is not 'business as usual', nor should it be seen as an excuse to muddle through management problems. (Grint,   2005) suggests that leaders create the conditions for managers by defining the context in which appropriate management actions can occur. There is a role for effective leadership to create the institutional conditions that will enable and encourage experimental and reflective management.   Sound leadership, not just in a hierarchical sense, but throughout an organisation, is required to support this radical departure in thinking and practice (Shindler *et al.* 2002). In other words, adaptive management needs champions who have (or who have been given) the time, resources, capacities and power to influence the ways in which policy is devised and its tools are implemented. When such leadership is in place purposeful activities can be developed and implemented.

Strategy 2- Encourage and support evaluation. Evaluation, an activity that involves learning rather than mere auditing, is central to the adaptive management cycle. There is an excellent body of work on effective program evaluation (for example Cook and Shadish, 1986; Guba and Lincoln 1989; Rossi and Freeman 1993; Weiss, 1997). However, to be able to apply these or other evaluation approaches   space must be actively created to allow genuine reflection on processes and outcomes. Creating such space may require a serious reassessment of institutional rewards and punishments. There must be an acceptance of the limits of knowledge and the possibility of errors and mistakes.   Even the most rigid and conservative *status quo* management can produce major errors (i.e., there is no such thing as a "no action" alternative; no action is an action).   Acceptance of evaluation as an integral part of implementation needs to extend beyond scientists and managers to include citizens, policymakers, and politicians. Adaptive management relies on acknowledging that because we are dealing with uncertainty and complexity, it often will prove necessary to pause, reflect and maybe even start over, as new knowledge and understanding reveal that the intended course is unsuitable or undesirable.

Strategy 3- collaborate and integrate. . For multi-disciplinary, collaborative and/or participatory approaches to operate effectively there must be recognition and acceptance of multiple ways of knowing and understanding the world. Again, there is a wealth of

theory and experience available to guide managers who are willing to use participatory approaches, ranging from collaboration (eg Allen *et al.* 2001; Poncelet, 2004) through to full participatory methods (eg Spencer, 1989) and social learning (eg Schusler et al.; Roling and Jiggins 2001), as well as useful warnings about likely constraints (eg Swanson 2001; Kapoor 2001). However, these approaches cannot be simply lifted from a text and applied; ideas surrounding the creation and legitimacy of the knowledge that underpins management decisions need to be discussed, clarified and acted on in the areas in question, especially when integration of scientific and other information is proposed. For example, there are legitimate concerns with the question of local capacity in terms of the ability to interpret scientific work; if nothing else the work and language of scientists is unfamiliar to many non-scientists. There are also problems related to belief systems and assumptions about scientific inquiry; scientists (and many non scientists) might find it difficult to accept that local/experiential knowledge is both legitimate and useful. All people who create and /or use knowledge must be diligent in efforts to achieve real communication. Researchers and managers alike must work together at the watershed-scale to bridge the gaps between theory and practice, and between social and technical understanding of communities dependent on watersheds. The challenge is to use their combined knowledge and skills to engage potential supporters among administrative, legal, and political actors to build commitment to adaptive management. Underpinning all of this is the need for well informed and committed leaders.

CONCLUSION

Anyone planning to use adaptive management needs to consider the cultural contexts of the project. Firstly, it is important to understand which activities are most valued and rewarded by the wider society, as some may be conducive to adaptive management (for example questioning, reflecting, and embracing complexity) while others may constrain its use (for example achieving milestones, embracing simple solutions to manage complexity). Secondly the cultures within governments and their bureaucracies should be understood, with a commitment to modifying them if needed. Commitment to supporting the essential qualities of adaptive management within these organizations is necessary to ensure that adequate resources are available for adaptive management; this includes money, but just as importantly, time and intellectual resources. Planners and managers require educational, administrative, and political support as they seek to understand when and how to implement adaptive management.

Adaptive management encourages scrutiny of prevailing social and organizational norms and this is unlikely to occur without a change in the culture of natural resource management and research. Formal links between monitoring, evaluation and learning and policy development could be developed through formalized documentation protocols or mandatory learning summaries, much like those used effectively on the Applegate Adaptive Management Area in Oregon to capture lessons learned from each project (Shindler *et al.* 1999). New structures may be required to reduce the current barriers between 'researchers' and 'implementers'. Different power sharing structures may also need to be developed and maintained, in particular allowing power to be shared between technical and non technical experts. Finally, new educational, training and skill development structures are required, both within management institutions and formal education venues.

Once suitable structures are developed, there will be a need for appropriate, possibly new, institutional processes.

We suggest the following processes for the facilitation of adaptive management:
- Training and support for staff and other participants in watershed organizations. In Australia this may include support for staff in the new Catchment Management organizations and for Landcare participants. In the US, there is a need to make adaptive management an essential element in natural resource planning at the national, regional, and state level;
- Reflective practice should be part of natural resource management related tertiary learning and training;
- Rewards in performance management reviews for taking risks, and for taking time to learn from activities;
- A genuine commitment to evaluation as well as to mere project auditing;
- A commitment to multi-party monitoring and evaluation;
- establishment of appropriate community fora to facilitate social learning;
- Particularly in the US, there is a need for some form of relief from statutory prescriptions that act to limit experimentation, particularly under conditions of high uncertainty; and
- In both countries, there is a need to examine critically the educational curricula of natural resource management programs to encourage critical thinking skills to support professionals as we move away from a high dependence on rule-based decision making.

Finally, what of that 'black hat' question raised at the AWRA panel session? Is adaptive management simply too hard for us humans to do? This should be asked whenever a new adaptive management process is suggested. We have shown that adaptive management will not occur spontaneously, and that it will require the efforts of leaders and others to overcome entrenched social constraints and institutional structures. Mobilising resources and energy for adaptive management will not always be sensible or appropriate. When it is sensible and appropriate, however, genuine commitment to adaptive management should benefit both physical watersheds and the people who depend on them.

REFERENCES

Allan, C., 2004. Improving the outcomes of adaptive management at the regional scale. Ph.D Thesis, Charles Sturt University, Albury, New South Wales. Allan, C. and A. Curtis, 2005. Nipped in the Bud: Why regional scale adaptive management is not blooming. *Environmental Management,* 36:414-425.

Allan, C. and A. Curtis, 2003. Regional scale adaptive management: Lessons from the North East Salinity Strategy, *Australasian Journal of Environmental Management,* 10(2):76-84. Allen, W., O. Bosch, M. Kilvington, J. Oliver, and M. Gilbert, 2001. 'Benefits of Collaborative Learning for Environmental Management: Applying the Integrated Systems for Knowledge Management Approach to Support Animal Pest Control', *Environmental Management*, 27(2): 215-223.

Blomquist, W. and E. Shlager, 2005. Political pitfalls of integrated watershed management. *Society & Natural Resources,* 18(2):101-117.

Cook, T.D. and W.R. Shadish, 1986. 'Program evaluation: the worldly science', *Annual Review of Psychology*, 37:193-232. Commonwealth of Australia, 2003. Agreement between the Commonwealth of Australia and New South Wales, 2003, http://www.napswq.gov.au/downloads/pdf/nsw-bilateral.pdf. Accessed January 2004

Curtis, A. and M. Lockwood, 2000. Landcare and catchment management in Australia: lessons for state-sponsored community participation [review]. *Society and Natural Resources,* 13(1):61-73. Curtis, A., B. Shindler and A. Wright, 2002. Sustaining local watershed initiatives: lessons from Landcare and Watershed Councils. *Journal of the American Water Resources Association* (JAWRA) 38:1207-1216.

Ewing, S., 1999. Landcare and community-led watershed management in Victoria, Australia. *Journal of the American Water Resources Association* (JAWRA) 35(3):663-673. Grint K., 2005. Problems, Problems, Problems: the Social Construction of 'leadership'. Human Relations 58(11):1467-1494 Guba, E.G. and Y.S.Lincoln, 1989. *Fourth generation evaluation*, Sage, Thousand Oaks.

Gunderson, L., 1999. Resilience, flexibility and adaptive management - antidotes for spurious certitude? Conservation Ecology online 3(1). http://www.consecol.org/vol3/iss1/art7. Accessed 2003. Gunderson, L.H., C.S. Holling, and S.S. Light, 1995. *Barriers & Bridges to the Renewal of Ecosystems and Institutions*, Columbia University Press, New York.

Harris, G., 2006. *'Inland waters', theme commentary prepared for the 2006 Australian State of the Environment Committee,* Department of the Environment and Heritage, Canberra. The Heinz Center, 2002. *The State of the Nation's Ecosystems*, Cambridge University Press, Cambridge, UK, <http://www.heinzctr.org/ecosystems/report.html>.

Hillman, T.J., J.D.Koehn, D. Mitchell, D.Thompson, J.D. Sobels and D. Woodside, 2000. *The Murrumbidgee: Assessing the "health" of a working river.* Irrigated Agribusiness Taskforce and Department of Land and Water Conservation. Herrick, C. and D. Sarewitz, 2000. Ex Post Evaluation: A More Effective Role for Scientific Assessments in Environmental Policy', *Science, Technology & Human Values,* 25(3):309-332.

Holling, C.S. (Editor) 1978. *Adaptive environmental management and assessment.* Wiley, Chichester. Holling, C.S., 1995. What barriers? What bridges? In: *Barriers and bridges to the renewal of ecosystems and institutions,*

L.H. Gunderson, C.S. Holling and S.S. Light (Editors), Columbia University Press, New York, pp. 3-36.

Holling, C.S. and G.K. Meffe, 1996. Command and Control and the Pathology of Natural Resource Management. *Conservation Biology,* 10(2):328-337. Howe, G.T., B. Shindler, B. Cashore, E. Hansen, D. Lach, and W. Armstrong, 2005. Public influences on plantation

forestry. *Journal of Forestry,* 103: 90-94. Kapoor, I., 2001., 'Towards Participatory Environmental Management?', *Journal of Environmental Management*, 63:269-279. Khan, S., 2004. Integrating Hydrology With Environment, Livelihood and Policy Issues: the Murrumbidgee Model,

International Journal of Water Resources Development, 20(3):415-429. Kruger, L., 2001. What is essential is invisible to the

eye: understanding the role of place and social learning in achieving

sustainable landscapes.   In: *Forest and landscapes: linking ecology, sustainability and aesthetics*, S.R.J. Sheppard and H.W. Harshaw (). CABI Publishing Wallingford, Oxon, United Kingdom. pp. 173-187. Lee, K.N., 1993, *Compass and gyroscope: integrating science and politics for the environment*, Island Press, Washington

DC.

Lee, K.N., 1999. Appraising adaptive management. *Conservation Ecology* online 3(2). http://www.consecol.org/vol3/iss2/art3. Accessed 2001. Miller, A., 1999, *Environmental Problem solving: Psychosocial Barriers to Adaptive Change*, Springer-Verlag, New York. Murray-Darling Basin Commission, 2005. Living Murray Business Plan, Canberra.

http://www.thelivingmurray.mdbc.gov.au/__data/page/194/2005_TLM_Business_Plan.pdf. Accessed 2006. O'Neill, K.M., 2005. Can watershed management unite town and country? *Society & Natural Resources,* 18:241-253. Poncelet, E.C., 2004. *Partnering for the environment: Multistakeholder collaboration in a changing world*, Rowman and

Littlefield Publishers, Oxford, UK. Rittel, H.W.J. and M.M. Webber, 1973. 'Dilemmas in a General Theory of Planning', *policy Sciences*, 4:155-169. Roe, E., 1996, 'Why ecosystem management can't work without Social Science: An example from the Californian Northern

Spotted Owl controversy', *Environmental Management*, 20(5):667-674. Roling, N.G. and J. Jiggins, 2001. 'Agents in Adaptive Collaborative Management: The Logic of collective cognition', in

Biological Diversity:Balancing Interests through adaptive collaborative management, L.E. Buck, C.C. Geisler, J. Schelhas and E. Wollenberg (eds), CRC Press, Boca Raton, Florida, 145-170. Rossi, P. and H. Freeman, 1993. *Evaluation : a systematic approach*, Sage, Thousand Oaks. Schusler, T.M., D.J. Decker, and M.J. Pfeffer, 2003. 'Social Learning for Collaborative Natural Resource Management',

Society & Natural Resources, 16(4):309-326. Shindler, B., 2000. Landscape-level management: it's all about context. *Journal of Forestry,* 98(12):10-14. Shindler, B., K. Aldred-Cheek, and G.H. Stankey, 1999. Monitoring and evaluating citizen-agency interactions: a framework

developed for adaptive management. Gen.Tech. Rep. PNW-GTR-452. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 38 p. Shindler, B., M. Brunson., and G.H. Stankey, 2002. Social acceptability of forest conditions and management practices: a problem analysis. Gen. Tech. Rep. PNW-GTR-537. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 68 p.

Slovic, P., M. Finucane, E. Peters and D.G. MacGregor, 2004. Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis,* 24(2):311-322. Smith, G.R., 1997. Making decisions in a complex and dynamic world. In *Creating a Forestry for the 21st Century: the science of ecosystem management*, K.A. Kohm and J.F. Franklin (Editors), Island Press, Washington DC. pp. 419-435.

Stankey, G.H., R.N. Clark, and B.T. Bormann, (Editors). 2006. Learning to Manage a Complex Ecosystem: Adaptive Management and the Northwest Forest Plan.   Res. Pap. PNW-RP-567. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 194 pp.

Stankey, G.H. and B. Shindler, 1997. Adaptive Management Areas: Achieving the Promise, Avoiding the Peril. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Pacific Northwest Research Station,73 p. Stankey, G.H., B. Bormann, C. Ryan, B. Shindler, V. Sturtevant, R. Clark, and C. Philpot, 2003. Adaptive management and the Northwest Forest Plan: rhetoric and reality. *Journal of Forestry,* 101(1):40-46.

Swanson, L.E., 2001. 'Rural policy and direct local participation: Democracy, inclusiveness, collective agency, and locality based policy', *Rural Sociology*, vol(1):1-21.

Walters, C. 1986, *Adaptive management of renewable resources*, Macmillan, New York.

Walters, C. J. and C.S. Holling, 1990. 'Large-scale management experiments and learning by doing', *Ecology*, 71 (6):20602068. Weiss, C.H., 1997. 'How Can Theory-Based Evaluation Make Greater Headway?', *Evaluation Review*, 21(4):501-524. Wildavsky, A and K. Dake 1990, 'Theories of Risk Perception: Who Fears What and Why?', *Daedalus*, 19(4):41-60.