Regional scale adaptive management has become part of the rhetorical landscape of natural resource/environmental management. It is now unremarkable, even expected, that strategies programs and plans contain a section detailing how implementation will fit within an adaptive management framework (for a recent example, see State Water Corporation 2007). Adaptive management has become attractive because acknowledgement and acceptance of complexity and uncertainty in environmental management has prompted questioning of conventional natural resource planning (Lachappelle, McCool et al. 2003). This questioning of conventional planning and management has taken on an urgent air as many environmental/ natural resource management problems, including water management (Freeman 2000) and ecological sustainability (Durant and Legge 2006), are apparently becoming so complex and unknowable they are called 'wicked'. In this chapter I discuss 'wicked' problems, and suggest that understanding managers' responses to them can illuminate aspects of adaptive management as it is practiced. To illustrate my nascent proposal I revisit my empirical study of the CSIRO/Murray-Darling Basin Commission Heartlands initiative which operated in NSW and Victoria between 2000 and 2003.
Reviewing adaptive management through a wicked lens

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*Simplex, complex and multiplex...*  
(Samuel R. Delaney, Empire Star)

Introduction
Regional scale adaptive management has become part of the rhetorical landscape of natural resource/environmental management. It is now unremarkable, even expected, that strategies programs and plans contain a section detailing how implementation will fit within an adaptive management framework (for a recent example see State Water Corporation 2007). Adaptive management has become attractive because acknowledgement and acceptance of complexity and uncertainty in environmental management has prompted questioning of conventional natural resource planning (Lachappelle, McCool et al. 2003). This questioning of conventional planning and management has taken on an urgent air as many environmental/natural resource management problems, including water management (Freeman 2000) and ecological sustainability (Durant and Legge 2006), are apparently becoming so complex and unknowable they are called ‘wicked’.

In this chapter I discuss wicked problems, and suggest that understanding managers’ responses to them can illuminate aspects of adaptive management as it is practiced. To illustrate my nascent proposal I revisit my empirical study of the CSIRO/Murray-Darling Basin Commission Heartlands initiative which operated in NSW and Victoria between 2000 and 2003.

Wicked problems
Some social and biophysical scientists now speak of ‘wicked’ problems when describing issues which are so complex they are difficult even to define. In their seminal (1973) paper Ritter and Webber used ‘wicked' to distinguish problems which are not only complex, but which are tricky to define and manage because efforts to solve them create new, unexpected and possibly worse, situations. Wicked problems also present evidence that can be judged in contradictory ways by different stakeholders (Horiuchi 2007). Involvement of multiple players from many disciplines, and possessing many forms of knowledge, is required to cope with this combination of complexity and uncertainty (Ludwig 2001). The current focus on wicked problems may be because our problems have actually become more uncertain and complex as the human population increases and diverse needs and desires are acknowledged, or it may be that we are simply recognising and acknowledging the wickedness that has always been there. Whatever the cause (which I suspect is all of the above and more) wicked problems are a current topic of discussion and debate (see for example Australian Public Service Commission 2007).
Responses to wicked problems

One common response to complexity and uncertainty/wickedness is to reset the discussion by choosing to view issues through a narrow lens that forces an appearance of simplicity; in other words to seek what Gunderson (1999) called ‘spurious certitude’. Examples of denying wickedness through careful framing of issues are present at many scales, and simplification is so habitual that it is considered normal behaviour. If this sounds a little far fetched consider our current social construction of science and scientists. While Enlightenment thinkers could apparently venture into any areas that interested them, scientists today work within separate, narrow boundaries protected by specialist knowledge and language; for example (Light 2002) notes that natural resource management issues are kept narrow by defining them in primarily natural science terms. Within these boundaries further narrowing occurs, as regardless of their discipline scientists, - ecologists, hydrologists, political scientists, sociologists and more- continually strain against complexity by seeking to carefully control their real world experiments with narrowly defined goals and learning opportunities. Sometimes this involves simplification of the issue to be studied, such as the focus on a few “icon” sites in the Living Murray Project (Murray-Darling Basin 2005) or the decision to learn about the impacts on wetlands from single environmental watering events in the Murray Valley (Nias 2005). At other times the process of enquiry itself is simplified. For instance, Richter and Thomas (2007) suggest that institutionally complex management process prevent river restoration projects from being managed adaptively, and their solution is to simplify the process into a series of generalisable steps.

Examination of the last three examples suggests that ‘projects’ provide a mechanism for denying inherent wickedness. Projects delineate biophysical or social boundaries, and they also bound the duration of potential work. Projects of one or two years must be sharply focused if they are to achieve their goals. Longer term projects are constrained in their scope by requirements to meet pre-determined milestones, which often make the longer project into a series of short projects. It is perhaps not coincidental that, despite the context of a world wide move to pluralism and post modern thinking, projects have become increasingly important in management. Since the 1980s Australia's governments have sought to achieve natural resource/environmental management outcomes via projects, with an increasing reliance on Commonwealth funding (see for example Head 2005).

Projectification of natural resource management is not a uniquely Australian phenomenon. Kovách and Kučerová (2006) report on the creation of a ‘project class’ in central Europe, whose “general function is one of mediation in the redistribution of public…funds and the transfer of materials, ideas, knowledge and power”. The transfer of funds, material, power and knowledge is facilitated partly through the evaluation and reporting mechanisms embedded in the project management process. Evaluation is a broad term for a number of activities including forms of summative assessment which are focused on determining if project goals and milestones have been achieved, and if expenditure was correct and timely. Summative evaluation asks ‘did we do what we said we would do, and in the way we said we would’. Evaluation can also be formative, focused on understanding such things as client needs, the implications and side effects of implementation, and the program logic (or theory) of the project (Cook and Shadish 1986). Formative evaluation is always a variation on the question ‘what have we learned?’ The short term, bounded nature of most projects promotes a reliance on, and preference for, summative evaluations.

All of the above responses to wicked problems could be described, following Churchman (1967), as hiding the teeth of the wicked problem so that you won’t see how severely it can bite. An alternative response is to acknowledge and accept the inherent wickedness of socio-
environmental systems, and to develop ways work with, rather than deny, complexity and uncertainty. Numerous approaches for working with complexity and uncertainty are being developed and tried in different disciplines, and different geographical regions. Some of these approaches use simplification and controlled experiments to tackle system components in a logical sequence in the full expectation that further work will be needed to address unanticipated secondary problems and opportunities (see for example Chapin, Trainor et al. 2008). Other approaches focus on understanding socio-environmental resilience as a key to working with wickedness. Folke, Carpenter et al. (2002) stress the importance of combining local resource based knowledge with ecological scientific enquiry to provide sufficient information for managers to maintain social-ecological resilience. Indeed, participatory or social learning has been a key focus of much of the research that embraces, rather than denies, complexity. Although Dewulf, François et al. (2007) note that trans, multi and cross disciplinary research alliances are often difficult to achieve in practice, there are effective examples such as the use of the Social Learning for the Integrated Management approach for water management planning in Scotland (Ison and Watson 2007) and social learning in the European project HarmoniCOP (Pahl-Wostl, Craps et al. 2007). These and similar programs stress the need for building and maintaining stakeholding in the governance processes.

The discussion of the different responses to wicked problems could and should continue, but for this chapter it is most useful to summarise the emergent themes, and I have done so in Table 1.

Table 1 Comparison between management arrangements which work with inherent wickedness, and management arrangements which attempt to deny wickedness

<table>
<thead>
<tr>
<th>Focus</th>
<th>Attempt to tame or deny wickedness</th>
<th>Accept inherent wickedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>What time boundaries are determined</td>
<td>Bounded by short time frames</td>
<td>Medium to long time frames are allowed</td>
</tr>
<tr>
<td>How complexity is managed</td>
<td>Management treats the problem as solvable</td>
<td>Management accepts that secondary problems are inevitable</td>
</tr>
<tr>
<td>Stakeholder involvement</td>
<td>Narrow range of players involved</td>
<td>Participatory/inclusive management</td>
</tr>
<tr>
<td>Form of evaluation</td>
<td>Summative evaluations are required</td>
<td>Management team develops complex evaluations with both formative and summative aspects</td>
</tr>
</tbody>
</table>

The practices summarised in the first column of Table 1 should be familiar to most readers, as they are part of the conventional approach to natural resource management problems. As noted earlier, however, there have been increasing calls for a different, more reflective and responsive type of management in recent times- adaptive management.

Adaptive management

By seeking to use adaptive management we acknowledge that our understanding of ecosystems is incomplete, that what we knew in order to exploit ecosystems systems is not enough to enable us to manage long term use and protection, and that we need to learn (Lee 1999). Adaptive management promotes learning from the implementation of policies and
strategies (Gunderson, Holling et al. 1995) and as such it complements other forms of knowledge creation. Bormann, Haynes et al. (2007) note that adaptive management is more than simply changing management in the face of failed policies, and is actually a planned approach to improving policies and practices over time. Adaptive management was initially articulated in the context of ecological resilience (see Holling 1978; Walters and Holling 1984) but has since developed to encompass the related concept of social resilience (Gunderson and Light 2006). While there are many different ways of describing adaptive management it generally involves some mix of:
- management activities designed to enable learning;
- reflection on the outcomes of those management activities;
- provision of mechanisms for multi-disciplinary and multi-stakeholder involvement; and
- provision of mechanisms for incorporating learning into planning and management.

Encouraging the use of adaptive management became common Australian government rhetoric in the 1990s, and adaptive management formed a central tenet of the Natural Heritage Trust (see for example PPK Environment & Infrastructure Pty Ltd 1999) and the National Action Plan for Salinity and Water Quality (NAP) (Australian Government NRM Team 2003). The promise of adaptive management is that it allows management of socio-ecological systems, despite their complexity, despite gaps in understanding, and despite multiple and changing social goals. However, evidence of the adoption of adaptive management as a standard operating practice is elusive (Lee, Geisler et al. 2001). High profile examples from the US Everglades (Gunderson and Light 2006) and Glen Canyon (Jacobs and Wescoat 2002) and a handful of others notwithstanding, there are comparatively few examples of managers and their bosses fully embracing an adaptive regime for the management of socio-ecosystems.

One of the many problems facing adaptive and would be adaptive managers is that of evaluating the process of adaptive management. As adaptive management is evoked as a response to wickedness, it seems logical to use a 'wicked' problem response framework to learn lessons about the practice of adaptive management. In the following section I explore this idea further with reference to the Billabong Heartlands project.

**Heartlands and the Billabong Catchment**

‘Heartlands’ was a joint initiative of the CSIRO and the Murray-Darling Basin Commission. Operating between 2000 and 2003, the Heartlands project aimed to design and implement landscape scale land-use change, both as an end in itself, and as a means to learn; as such the project team defined Heartlands as an adaptive management project (CSIRO Heartlands Core Group 2000). Heartlands combined implementation of on farm land management works with scientific enquiry into farm forestry, catchment hydrology and biodiversity. A Steering Committee (which included senior representatives from CSIRO, MDB and state and Federal natural resource/environment agencies) guided the overall project, which was based in four physical areas; the Honeysuckle Creek and Ovens Basin Catchments in Victoria, and the Kyeamba Creek and Billabong Creek catchments in NSW.

The Billabong catchment is located in the NSW South-western slopes, a foothills environment which currently supports forestry and grazing enterprises in the east which grade into predominantly cropping enterprises in the west of the catchment. A number of landcare groups existed in the catchment when Heartlands commenced, including the Holbrook, Culcairn and Alma Park Groups. The Holbrook Landcare group had been particularly active since its formation as the Holbrook Trees on Farms Group in 1988, and had maintained a
strong focus on community participation (Earl 2003). The other groups in the Billabong
Catchment, though newer, were also active, so numerous landcare associated activities had
occurred across the Billabong Catchment before Heartlands commenced there. These
Landcare activities had focussed mainly on biodiversity management and farm productivity,
which aligned with the Murray Catchment Blueprint. The Blueprint, a target driven
Integrated Catchment Management Plan developed by the Murray Catchment Management
Board under the authority of the NSW Catchment Management Act 1989, was endorsed by
the NSW government in late 2002 (Department of Land and Water Conservation 2003).

The Billabong Heartlands project aimed to build on, and enhance, the landcare/ Blueprint
related land management activities in the area, with a particular focus on better understanding
and managing dryland salinity. The on ground works component was funded by the
Commonwealth Natural Heritage Trust (NHT), augmented by contributions from the NSW
Salinity Program, Integrated Tree Cropping Pty Ltd., and the participating landholders, for
two years. Funding for research component came from the MDBC (Heartlands Core Group
2001).

A group was created to manage the Billabong Heartlands project. The Billabong Operations
Group (BOG) comprised landcare staff and members from the existing groups in the area,
CSIRO scientists, landholders, and representatives of the State Department of Land and
Water Management (DLWC) and Riverina Farm Forestry (RFF). Charles Sturt University
was also involved, and the BOG gave permission for me to be a participant observer at their
meetings and events in order to see and understand the process of adaptive management in
action. Participant observation involves a researcher making systematic examinations of
social situations in which they are involved (Spradley 1980). The following discussion draws
on field notes taken during more than two year’s observation of BOG operations, further
details of which are provided in Allan (2004). There is also additional material from semi-
structured interviews with four former BOG participants in 2006, following the methods of
Patton (1990). Thematic content analysis was used to identify categories of information and
ideas within the notes and interview transcripts, as per Silverman (2001).

Operations and outcomes

The Billabong Heartlands project involved three key activities; administration of on ground
works incentive money, scientific research associated with the catchment and specific
management activities, and information sharing. The BOG co-ordinated these activities, and
moderated the involvement of other researchers who sought to be associated with Heartlands
as news of its successes in each of its three key activity areas spread. Outputs of the project
included the Billabong Land Information System (BLIS), an easily accessible computer
storehouse of scientific information (McKenzie, Gregory et al. 2002), the establishment of a
number of farm forestry trials, and numerous on-farm plantings of pasture and native trees
and shrubs. Of particular note was increased information sharing among and between
landholders, agency staff and scientists. As one former landcare staff member of the BOG
noted in an interview in 2006:

I felt so proud to be working in it as well, and that we formed that sort of relationship.
We brought farmers together that might not necessarily have had anything to do with
one another…Those people would come together and talk to each other, and I think
that was the real benefit too.

2006 Post Heartlands Interview 2
There are many ways of understanding an ambitious project such as Heartlands in the Billabong, but of interest here is assessing the practice of adaptive management. I suggest one way to do this is to examine the project management team’s response to the wicked nature of the problems it addressed, using the headings from Table 1 as a guide.

Focus

Although developed as part of ongoing enquiry into the sustainability of agricultural landscapes Heartlands was in name and activity a ‘project’. The project enabled the funding bodies to provide their money and guidance to particular physical areas. Mapping the physical boundaries of the Billabong area was of great importance to the BOG, especially in the first year of its operation. Each meeting included discussion of boundaries, and effective mapping of them, as well as conversations about who was ‘in’ and ‘out’ in relation to receiving money for on-ground works.

Initially the design of the Billabong Heartlands embraced biophysical and social complexity by attempting to working across the whole catchment with a mix of biodiversity, hydrology and farm forestry activities. However, while implementation activities continued to be available across the entire catchment, scientific enquiry was soon limited to studying hydrological changes within the two mall subcatchments of the Simmons and 10 Mile Creeks, and some specific farm forestry trial sites in other parts of the Billabong.

Billabong Heartlands project operations were constrained by directions from the Heartlands Steering Committee, by the rules and requirements of the various funding programs, and by the targets in the Murray Blueprint.

Time boundaries

The Heartlands project, including that in the Billabong, was a grand vision that was to have involved medium to long term evaluation of implemented activities. However, initial funding for the project was only for three years, guaranteed one year at a time. In 2003 shifts in priorities for environmental management led to the end of funding, and the project. This came as a disappointment to many people in the Billabong catchment:

...what a great project it was, and I think the promise that it would be ongoing for so many years, and the disappointment in the end...You know, I've heard some farmers... say 'I can't believe that this has happened. We were promised this. We were promised this back up support.' Just that ongoing collaboration relationship, and it's all gone now, and it has all gone you know...I think that the scientists built up a tremendous relationship with the farmers, even on the ground, ...those scientists tried very hard to speak at a level that I could understand or anyone could understand, and the actions that were the on ground works. You know things were actually happening, and they could see visibly...

2006 Post Heartlands Interview 2

Regional natural resource management processes in NSW were undergoing great change at this time. The transformation of the Catchment Management Boards to Catchment Management Authorities, and rearrangement of agency structures and support for landcare precipitated a wholesale loss of intellectual capital and goodwill in the former Heartlands project area

...basically of the New South Wales coordinators we’ve five, essentially we had five plus we had another two people who were providing farmer forestry support and all
those people have lost their jobs, they all lost their jobs within about 12 months or so I guess of the Heartlands money finishing, it was 100% turnover.

2006 Post Heartland Interview 1

The intent of the Heartlands project was to provide long term stability and focus on the catchment ecosystems, but because of external factors it became just another in a series of short term projects.

**How complexity is managed**

The complexity of the issues they were trying to address was acknowledged by BOG members and other Heartlands participants, but this was countered by a strong desire for clarity and certainty, for example

..there hasn’t been, to my way of thinking, any earth shattering results come out of it to say go in this direction, that’s the way to go... but you always hope it’s going to happen don’t you really?  It would be nice if it did, if something just clicked inside and said right, we’re going this way...

2006 Post Heartlands Interview 3

BOG members used much of their operational planning time to determine ways to reduce complexity and uncertainty, speaking particularly of the value of predictive tools and good communication. BOG members interpreted farmers’ aversion to change as a concern with unproven options, and they felt that many farmers had, based on previous experience, little confidence in technical options. Uncertainty and risk aversion were addressed partly through selecting works with multiple potential benefits for the landholder and the district. For example, native tree planting was often promoted as a recharge management measure, but it was noted that even if the trees had no impact on water tables they would attract native birds for insect management, and would provide weather protection for stock. The other strategy was to develop trust in a variety of communication networks so that allowed information to be shared, and incremental learning to be undertaken

…it sort of reinforces a lot of ideas and yeah, just gives you a bit more background and knowledge I guess too which is good to know.  It’s good to know that, I don’t know if it changes things overnight, but it’s like a lot of things, it all builds up over time.

2006 Post Heartlands Interview 3

**Stakeholder involvement**

Including a diverse range of players was part of the project brief for Heartlands, and from early on the BOG sought to include a variety of people and views. Initially the formation of BOG was a kind of polygamous marriage of convenience, with each of the members representing their own constituency. The BOG initiated a Participatory Rural Appraisal (PRA) of the Billabong catchment early in the project life. PRA is a suite of approaches, methods and behaviours that help people share and reflect upon their social and physical environment (Chambers 1994; Chambers 1999). By undertaking the PRA the BOG developed a shared understanding of the catchment and some of its residents, but equally importantly, the BOG developed cohesion as a group in its own right. Readers interested in a detailed discussion of the PRA process and findings should refer to Allan and Curtis (2002).
The Heartlands project also built on the good will, trust and record of landcare in the district. I think because initially it was Landcare groups – a few years ago when it started were held in fairly high esteem, and the local Landcare groups were working very, very well in their areas, and the Landcare group and the landholders – I think because the landholders felt they had real ownership with those groups, and once CSIRO came on board, it was primarily through those Landcare groups, and I think that that was what really helped that confidence happen. …It really took off in the area and people embraced it really I think.

2006 Post Heartlands Interview 2

Once the BOG was acting like a single entity a structure for wider engagement was developed through the idea of ‘core’ and ‘fringe’ membership. Some of the BOG discourse revolved around who should be allowed near to the core group, and how close they should be allowed to get, but the foundation of the project management remained inclusive and participatory over its life.

Form of evaluation

Evaluation was initially only cursorily addressed in the Heartlands project. The BOG members, who were very busy and focussed on implementation, appeared to view project evaluation as a way to maintain a future for the project through summative assessment to meet the needs of funding bodies, and though providing evidence of excellent practice.

Some summative assessment was undertaken by the Murray-Darling Basin Commission, involving a questionnaire and a subsequent visit to the Billabong catchment by the reviewer. The questionnaire focused on progress toward ‘project objectives’, ‘verifiable indicators’, ‘project milestones’, ‘project budget’ and ‘project outcomes’ in relation to approved catchment plans, with a clear emphasis on process (Lyle 2002). Regular reports of progress against milestones were also required fro the various funding bodies.

Towards the end of the project, and at the special insistence of some of the CSIRO members, the idea of identifying and passing on the lessons learned was embraced more thoroughly by the BOG. Although no specific funds had been set aside, a Heartlands position vacancy provided an opportunity to commission a formative assessment of the entire Heartlands project. The result was a publication which provides key lessons from the Heartlands experience (Earl and Cresswell 2005).

Focusing on the management response to wickedness in the Heartlands project provides some indication of how adaptive the project could be. From Table 2, which summarises the discussion above, it is apparent that adaptive management in the Billabong Heartlands was only partially functional. It is also apparent that those aspects of the project which were more adaptive than conventional were those over which the local management group had the most influence or control, namely who they involved and how they evaluated themselves.
Table 2 Summary of the Billabong Heartlands response to wicked problems

<table>
<thead>
<tr>
<th></th>
<th>Attempt to tame or deny wickedness (conventional management)</th>
<th>Accept inherent wickedness (adaptive management)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus</strong></td>
<td>Project focused, AM reduced to small physical areas within larger area. Project funding constrained scope and duration of activities</td>
<td></td>
</tr>
<tr>
<td><strong>What time boundaries are determined</strong></td>
<td>Bounded by short time frames- 2 years</td>
<td></td>
</tr>
<tr>
<td><strong>How complexity is managed</strong></td>
<td>Some aspects of management focused on treating a solvable problem</td>
<td>Some aspects of management accepted uncertainty of future impacts</td>
</tr>
<tr>
<td><strong>Stakeholder involvement</strong></td>
<td>Participatory/inclusive management, including PRA and other participatory approaches.</td>
<td></td>
</tr>
<tr>
<td><strong>Form of evaluation</strong></td>
<td>Management team developed complex evaluations with both formative and summative aspects</td>
<td></td>
</tr>
</tbody>
</table>

The project clearly had the capacity to begin to address complexity and uncertainty through its commitment to participation and evaluation, but this was undermined by wider institutional and structural issues which reduced time frames and sought summative rather than formative assessments. Institutional (in its broadest sense) constraints in the Billabong and a Victorian project have been discussed in greater detail in Allan and Curtis (2005), and institutional constraints are also apparent in other assessments of adaptive management (for example Stankey, Bormann et al. 2003). However, the analysis in this chapter emphasises the particular constraints imposed by projectification. It is unlikely that Australian governments will abandon projects as mechanisms for directing and supporting natural resource/ environmental management. However, it is well that the trappings of projects- short time frames, sharp focus, targets, intellectual leakage and limited opportunities for broad participation- are considered if adaptive management is the intent. The Billabong Heartlands project shows that some of the constraints imposed by projects can be managed, and clear articulation of these constraints could make this management more efficient or effective. However, some of the constraints on adaptive management are beyond the reach of people working within the project structure, and it may be that fully adaptive management and projects as we currently know them are simply incompatible.

**Conclusion**

If adaptive management is to become a viable alternative to conventional practice in Australia and elsewhere managers and policy makers need ways to understand and assess it.
In this chapter I have proposed one way of doing this, by focusing on the nature of the problems that adaptive management is called on to address. Using a wicked response framework enabled us to see which aspects of the Billabong Heartland project most facilitated adaptive, rather than conventional management. It also focused attention on the tension at the core of the notion of achieving adaptive management through projects.

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