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Watering wetlands

Impediments and challenges to the transfer of knowledge between wetland managers and scientists



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Impediments and challenges to the transfer of knowledge between wetland managers and scientists

Written by Mark Siebentritt (2007)
for Land & Water Australia

The content in this paper is produced in part from in-depth surveys with wetland managers and wetland scientists as well as proceedings from a Land & Water Australia facilitated panel discussion presented at the 2007 *RiverSymposium* in Brisbane, Queensland.

Panellists at the 2007 *RiverSymposium* **Watering Wetlands: Putting Plans in to practice** session are (L to R): Howard Jones, Christine Schweizer, Mark Siebentritt, Paul Boon, Greg Raisin and Richard Kingsford.



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The key findings of an earlier draft of this discussion paper were presented as part of a feature session run by Land & Water Australia titled “Watering Wetlands - putting plans into practice” at *Riversymposium* in Brisbane, Australia on 4 September 2007.

Information from the presentations and discussion at the feature session has been used in this report to build on issues raised during the surveys. An audio recording of the feature session is available upon request by contacting the coordinator of the Environmental Water Allocation R&D program at Land & Water Australia

The feature session was chaired by Ms. Chris Schweizer, Assistant Secretary, Environmental Water Branch, Department of the Environment and Water Resources (DEW) and featured presentations by:

- ▶ **Mark Siebentritt**, CEO, Waterfind Environment Fund
- ▶ **Howard Jones**, Chairman, NSW Murray Wetlands Working Group
- ▶ **Greg Raisin**, Manager Aquatic Sciences, Water Utilities and Science Division, Department of Water and Energy NSW
- ▶ **Richard Kingsford**, Professor of Environmental Science, School of Biological, Earth and Environmental Sciences, University of New South Wales
- ▶ **Paul Boon**, Professor, Institute for Sustainability & Innovation, Victoria University, Melbourne

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Executive summary

The degradation of Australia's wetlands has brought into sharp focus the need to manage factors such as altered flow and water regimes. Exchanging knowledge between wetland managers and wetland scientists and putting knowledge into practice is an essential part of this management.

Yet environmental watering of wetlands is a relatively new type of intervention, especially where engineering infrastructure is used. It is largely restricted to south eastern Australia. Thus, while there is considerable knowledge about biophysical responses to water regimes in wetlands, there are few specific examples of wetland watering from which we can draw practical experience.

This paper examines the effectiveness of knowledge exchange between scientists and wetland managers regarding watering and the practical impediments that can govern the application of that knowledge.

In preparation for this paper, 32 wetland managers and 19 wetland scientists were surveyed about the use of scientific knowledge in wetland watering. The study blended traditional concepts of knowledge exchange with a model of consumer behaviour, a branch of marketing, and assessed:

- factors that influence attitude;
- knowledge seeking strategies;
- barriers to knowledge exchange;
- the context for management decisions; and
- the decision making process.

The survey was followed up with in-depth telephone interviews with 5 managers and 2 scientists.

Findings

Attitudes can be impacted by motivations and perceptions. With respect to motivation, scientists – particularly those who are university based – are typically rewarded for publishing peer-reviewed papers whereas managers are rewarded for achieving management outcomes.

Finding 1

The reward structures for managers and scientists differ with the result that, without appropriate incentives, there may be little motivation for them to work together.

Managers perhaps have the most to lose by not attracting quality researchers to investigate their management challenges.

There were some similarities but also stark differences in the perceptions of managers and scientists.

Finding 2

Nearly half of managers said that good scientific information had a high impact on their wetland watering decisions; yet 89% of scientists believed that good science had only a moderate or low impact on wetland watering decisions.

When knowledge seeking strategies were assessed, most wetland managers said that they were most likely to gain their scientific information from another person rather than, for example, academic reviews, handbooks or computer based tools.

Finding 3

When faced with a wetland watering decision managers were most likely to consult another person, typically wetland scientists or managers from other agencies, to obtain their scientific information. Knowledge brokers or extension officers were seldom the source of scientific information.

There were a variety of factors that influenced why managers sought the opinions of others, including the desire to look for an independent view, help identify potential problems or workshop ideas. One of the reasons managers looked beyond their own agencies to consult scientists was because scientific positions were no longer present in their own agency. This places additional importance on strengthening networks between managers and scientists and their institutions, as has been found for other studies of this type.

Finding 4

Lack of time was a major constraint on knowledge acquisition.

Time has a number of dimensions with respect to wetland watering. One of these is the short timeframes that managers and therefore scientists sometimes operate to when floods travel quickly down river systems.

There was concern among some of the respondents about the gap between generic scientific knowledge and the specific knowledge needed to support management decisions.

Finding 5

More than half of managers believed that the greatest barrier they faced in implementing recommendations from scientific syntheses was that the information was not relevant to their site specific circumstances. Countering this, many scientists were of the view that managers were not specific enough about their knowledge needs.

The way to address this challenge may not necessarily be in producing more synthesis products or more reviews, instead there is a need to understand how available information can be applied to specific management contexts.

There was only one unanimous result from the survey.

Finding 6

Managers agree that scientists need to be more aware of the context of management decisions.

Both scientists and managers believed that physical and operational constraints played the greatest role in setting the context for wetland watering decisions. Yet few opportunities exist for scientists to gain direct or indirect access to knowledge about these factors.

Where once individuals in single agencies had the bulk of management responsibility, participatory decision making is now dominant. The consequences for scientists are that:

Finding 7

Decisions that might emerge based on wetland science alone may not always be adopted, given that committees must also take into account social, economic, cultural and various other considerations.

A number of scientists and managers cited successful examples of knowledge exchange leading to good management outcomes under participatory approaches. One of the keys to success was adequate time to build relationships. Long term relationships build trust and mean that knowledge can be transmitted over a long period of time, feeding in to multiple stages of planning and operational cycles. Both professions supported adaptive management as the direction for future evolution of decision making processes.



Introduction

1.1 Background and Objectives

A diverse array of wetland types¹ straddle the Australian continent. These include rivers and floodplain depressions, groundwater fed systems and estuaries. The understanding of the value of wetlands and the ecosystem services they provide from an anthropogenic perspective has grown in recent decades (e.g. Millennium Ecosystem Assessment 2005). This has led to an increased desire to either maintain or restore wetlands, focussing on features such as biodiversity, health and condition.

“Wetlands have never been more challenged, ignored and misunderstood”

MR HOWARD JONES, CHAIRMAN, NSW MURRAY WETLANDS WORKING GROUP²

Yet in many places in Australia the number and condition of wetlands has declined because of factors like exotic species, eutrophication and altered water regimes (Boulton and Brock 1999). The impact of changed flow and water regimes is well established in the scientific literature (e.g. Lloyd *et al.* 2004) and also understood from the field experience of natural resource managers.

Wetland watering has become a major tool in the management of wetlands. The term “watering” covers a number of actions that seek to manipulate flow or water regimes, most using some form of engineering infrastructure. Many of these management actions remain relatively untested in Australia and overseas because:

- 1) the opportunities for wetland watering are infrequent due to variability in availability of water resources and
- 2) social and economic concerns about the balance of water distribution between environmental and human use.

¹ Under the Convention on Wetlands (Ramsar, Iran, 1971) “wetlands” are defined by Articles 1.1 and 2.1 as shown below:

Article 1.1: “For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.”

Article 2.1 provides that wetlands: “may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands”.

² This quote is sourced from a presentation given by Jones to a Land & Water Australia feature session titled “Watering Wetlands - putting plans into practice” at Riversymposium 2007 in Brisbane, Australia.

Wetland watering should be based on best available scientific knowledge but acquiring and then applying this knowledge is a significant challenge. Much of the limnological research to date has focussed on understanding the relationship between water regime and ecological patterns and processes. This same information is also being used to formulate advice on how to optimise wetland watering regimes, particularly in regulated river systems.

In a traditional sense, using scientific knowledge to inform wetland watering decisions relies on the transfer of knowledge between scientists and managers. However, this transfer is not always simple for a number of reasons – different objectives between managers and scientists, lack of understanding of management constraints, discipline-specific jargon and ever-evolving decision making processes all contribute to the complexity of knowledge exchange and implementation. These difficulties are international (Box 1).

BOX 1 The Clash of Cultures

In a paper that considered how to “Bridge the Science-Management Divide” Roux et al. 2006 noted at a recent conference in South Africa the comments of a prominent aquatic scientist: “Scientists have all of the knowledge and managers should just ask; they have no excuse for making wrong decisions”. This was followed two weeks later at a strategic review of river research by a South African agency where a senior manager said: “ Scientists have failed to provide any useful solution to current management challenges and managers have no options but to implement policy on their own”.

This discussion paper examines impediments to the uptake of current scientific knowledge relevant to actively watering freshwater wetlands. It starts by providing a brief review of the current scientific knowledge³ with respect to watering wetlands. This is followed by an assessment of the extent to which water resource and wetland managers have access to this scientific information and the impediments they face in putting the information into practice⁴. The latter two objectives have been tackled by undertaking a series of surveys and follow up interviews with wetland managers and wetland scientists. The discussion paper concludes with a series of recommendations on how to improve the way that scientific information can be used to inform wetland watering decisions.

³ This paper does not draw a distinction between scientific knowledge and scientific information, although such a case could be mounted.

⁴ The issue of impediments has been tackled by first proposing a model to describe the behaviour of managers and scientists when decisions have to be made. The model draws on concepts proposed in the discipline of consumer behaviour, a branch of marketing strategy. This model is then used to explore issues about knowledge exchange as they relate to the factors that influence attitude, knowledge seeking and the decision making process itself.

1.2 The Survey

Surveys were completed by 32 wetland managers and 19 wetland scientists from across New South Wales, Victoria, the Australian Capital Territory and South Australia. Follow up phone interviews were conducted with 2 scientists and 5 managers.

The managers surveyed included executive managers, senior managers, project managers and project officers. While some managers indicated that they were no longer directly involved with wetland management, they were included in the survey for their relevant, recent experience. The managers worked at a variety of spatial scales⁵:

- local scale - individual wetlands (15 respondents)
- regional scale (sub-catchment) - large numbers of wetlands within areas of a catchment (16 respondents)
- catchment scale - wetlands across an entire catchment (10 respondents)
- basin scale - wetlands across an entire river basin (9 respondents)
- national scale (1 respondent).

The spatial scale at which managers worked was mostly determined by the management agency by which they were employed e.g. employees of catchment management agencies tended to work at a catchment, regional or local scale.

Wetland scientists also operated across a range of spatial scales:

- local scale (15 respondents)
- regional scale (sub-catchment) (15 respondents)
- catchment scale (11 respondents)
- basin scale (10 respondents)

The survey questions are summarised at Attachment A. The questions were targeted at professionals working in the fields of wetland watering or undertaking scientific research on wetlands with managed water regimes.

The survey responses were subjected to qualitative analysis and where relevant, data is summarised throughout the paper.

The key findings of an earlier draft of this discussion paper were presented as part of a feature session run by Land & Water Australia titled "Watering Wetlands - putting plans into practice" at *Riversymposium* in Brisbane, Australia on 4 September 2007. Information from the presentations and discussion at the feature session has been used in this report to build on issues raised during the surveys. Where panellists are quoted, the text refers to the 'LWA feature session'.

⁵ Most wetland managers operated across a number of spatial scales

The session was chaired by Ms. Chris Schweizer, Assistant Secretary, Environmental Water Branch, Department of the Environment and Water Resources (DEW) and featured presentations by:

- **Mark Siebentritt**, CEO, Waterfind Environment Fund
- **Howard Jones**, Chairman, NSW Murray Wetlands Working Group
- **Greg Raisin**, Manager Aquatic Sciences, Water Utilities and Science Division, Department of Water and Energy NSW
- **Richard Kingsford**, Professor of Environmental Science, School of Biological, Earth and Environmental Sciences, University of New South Wales
- **Paul Boon**, Professor, Institute for Sustainability & Innovation, Victoria University, Melbourne



Wetland near Jerilderie, NSW. Top photo shows the wetland before receiving water, and lower image shows the same site 12 weeks after receiving an environmental water allocation.





Knowledge dynamics for wetland watering: a conceptual model

2.1 A model for the knowledge dynamics of wetland watering

A model of consumer behaviour developed by Neal *et al.* (2001) can be adapted to describe the dynamics of knowledge exchange and utilisation between wetland managers and scientists (Figure 1). The model encompasses the need to periodically seek knowledge.

The decisions made by natural resource managers are influenced in part by their attitudes. Attitudes consist of three components – cognitive (beliefs), affective (feelings) and behavioral (response tendencies). Marketing strategies often focus on one of these components in the hope that it will influence the other two (Neal *et al.* 2001). The surveys conducted with managers and scientists provided insight into two of these factors: perception and motivation.

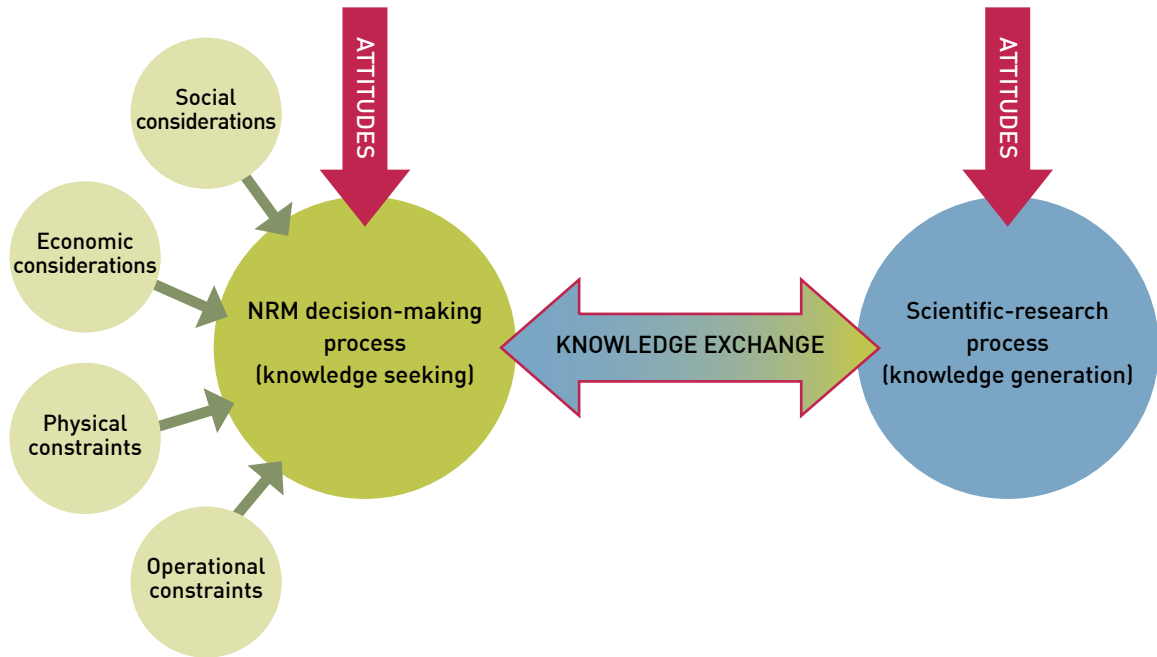
There are a variety of other factors that also influence NRM decisions (i.e. the management context), including physical and operational constraints; social, economic, cultural and political considerations; risks; financial and economic factors. Regardless of how these apply, there is always the need to seek knowledge to support management decisions.

The transfer of scientific knowledge can be heavily influenced by the knowledge seeking strategies adopted by managers. These strategies are also relevant to scientists if they are seeking to understand where they should target their knowledge distribution. Barriers also exist to knowledge exchange. They include factors that impact on when and how a knowledge seeking strategy can be implemented (e.g. lack of time) as well as factors that influence the type of knowledge sought. Consideration should also be given to the role that the decision making process itself can have on the dynamics of knowledge exchange.

The model outlined at Figure 1 provides the structure for this paper. The following sections ask:

- ▶ What is the current scientific knowledge with respect to wetland watering? (Section 3);
- ▶ What attitudes are relevant to wetland watering (Section 4);
- ▶ What are the preferred knowledge seeking strategies of managers? (Section 5);
- ▶ What are the barriers to knowledge exchange, from the perspective of managers and scientists? (Section 6);
- ▶ What is the context for NRM decision making? (section 7);
- ▶ What role does the decision making process itself play in knowledge dynamics? (Section 8).

Figure 1 Conceptual model of how attitudes influence managers and scientists and in turn the natural resource management (NRM) decision making and scientific processes. Knowledge exchange occurs along various channels and may be impacted upon by impediments.





Scoping Current Scientific Knowledge

This section first assesses the evolution of wetland watering as a management action and then considers how the relevant scientific knowledge has been built and then synthesized for application to management issues.

3.1 Wetland watering as a management action

Even though managing water levels in wetlands has occurred in the past, the broad scale manipulation of flow - environmental flow management - to water wetlands is a relatively new phenomenon. Wetland watering in this paper is defined as the use of engineering infrastructure to manipulate flows or water levels and includes:

- managed flood releases,
- use of regulators on wetlands to either wet or dry a site,
- use of weirs to raise or lower water levels at a reach scale,
- use of dam storages to modify flow.

This definition excludes management of groundwater fed wetlands, such as occur in Western Australia on the Swan Coastal Plain (Davis *et al.* 2001).

Given that many major wetlands lie on regulated river systems governed by a water access entitlement regime, watering wetlands is often accomplished through the use of environmental water allocations (EWA). One of the first wetland EWAs was the 1987 Victorian Murray Wetlands EWA. This was followed by the Barmah-Millewa Forest EWA, approved in 1993. There are at least 9 EWAs now available for wetlands in the southern Murray-Darling Basin. The largest will ultimately be the Living Murray EWA, which by 2009 will provide on average 500 GL per annum for six iconic wetlands (referred to as "icon sites").

The evolution of wetland watering within the Murray-Darling Basin (MDB) can be seen by tracking reviews to the MDB agreement. The River Murray Waters Agreement was adopted in 1915 and outlined a set of water sharing principles between New South Wales, Victoria and South Australia (Baird and McLeod 2004). However, it was not until 1992 that an entirely new agreement, the *Murray-Darling Basin Agreement*, was adopted providing an expanded role for the Murray-Darling Basin Commission⁶ to monitor and consider River Murray water quality objectives. Baird and McLeod (2004) argue that the MDB Agreement is only now entering into a phase of environmental management, which commenced in 2003 with the signing of the Living Murray First Step decision.

⁶ Prior to this time the River Murray Commission was responsible for implementing the River Murray Waters Agreement.

The timeframes that apply in the Murray-Darling Basin to the evolution of wetland watering, especially with respect to the use of dedicated EWAs, are broadly similar to elsewhere in Australia.

Opportunities to study wetland watering events are also often limited because the conditions that trigger watering events occur infrequently and often with little notice. The application of the Barmah-Millewa Forest EWA is a case in point. It has been used on only three occasions since it was approved in 1993⁷. The first in 1998/99 (97 GL), the second in 2000/2001 (341 GL) and most recently 2005/2006 (513 GL).

3.2 Where does wetland watering occur?

Wetland watering, as defined in section 3.1, largely occurs in south-eastern Australia, primarily in the MDB. Along the River Murray, the focus is currently on the Living Murray icon sites, which are:

- 1 Barmah-Millewa Forest
- 2 Gunbower-Koondrook-Perricoota Forest
- 3 The Hattah Lakes
- 4 Chowilla Floodplain and Lindsay Walpolla Islands
- 5 Murray Mouth, Coorong and Lower Lakes
- 6 River Murray Channel

With the exception of the River Murray Channel, all of the icon sites will be the target of flood enhancement and in the case of the non-Coorong sites, isolated watering through use of pumping (recognised as a temporary measure during the current drought) and operation of regulators to hold back some flood water and prolong flooding. For the River Murray Channel, especially the sections dominated by continuous stretches of weir pools, drawdown or raising of river levels using weirs is an option along with wetting and drying of individual wetlands through use of regulators.

In addition to the icon sites, areas like the Kerang Lakes are the focus of wetland watering along the Murray using the Victorian Flora and Fauna Entitlement. Wetland watering has also occurred further north in the MDB in areas such as the Macquarie Marshes (north-west NSW), Lower Gwydir Basin Wetlands (northern NSW), and wetlands of the Lachlan River Valley (southern inland NSW) (Davis *et al.* 2001). Perhaps the most significant watering outside of the MDB by way of a managed flow release was from the Mowamba Weir on the Snowy River on 28 August 2002, although this was largely to increase in-channel flows.

There are numerous examples of the management of wetland water levels through the use of regulators outside of the MDB, one being at Bool Lagoon in South Australia (Box 2). Constructing levees or raising and lowering wetland outlet heights can also influence water levels, as has been done for some wetlands on the New England Tablelands.

⁷ Use of the Barmah-Millewa Forest EWA is largely determined by a set of operating rules based on hydrological triggers that have been developed from an understanding of the ecological requirements of the forest.

BOX 2 Water level management in Bool Lagoon

The active management of water levels in Bool and Hacks Lagoons occurs primarily in response to water levels reaching or exceeding “agreed levels”. The agreed levels aim to achieve conservation and flood mitigation objectives. The primary conservation objective is to retain water in the lagoons for as long as possible into the summer period to maintain vegetation communities and provide breeding habitat and refuge for waterbirds.

SOURCE: Department for Environment and Heritage (2006)

Intermittently closed and opened lakes and lagoons occur mostly on the eastern sea board. These wetlands can be watered through artificially opening the entrance of a lake to force a connection with the sea. Such management events are beyond the scope of wetland watering as identified here.

Wetland watering using infrastructure also occurs in other countries, although there is still only limited experience. Managed flood/dam releases have occurred in the United States to re-form sand bars on the Colorado River (Webb et al. 1999) and on a number of African rivers such as the Logone (Scholte et al. 2000), Senegal and Phongolo (Acreman 2003). Other examples of international wetland watering projects include an initiative to revive the Northern Aral Sea through dyke construction and sluice gate operation (Roll et al. 2005) and dredging and revised barrage operating rules for Chilika Lagoon in India (Ghosh and Pattnaik 2005).

3.3 Scientific knowledge behind wetland watering: from research to synthesis documents and management texts

Australian limnologists have built a substantial knowledge base about the relationship between water regime or flow regime (i.e. covering lentic and lotic systems) and the biological, physical and chemical responses of wetlands. However, this does not mean that ecologists understand all of the potential patterns and processes that are driven by water regime. Many of the fundamentals are known but areas for improvement, based on the response of survey respondents, are likely to be inter-taxa relationships; basic phenology; features that confer resistance or resilience; and from a physical perspective, the relationship between flow and geomorphology.

Various synthesis documents are available that summarise much of this knowledge as it applies to wetland biota, including fish (Russell and Harris 2004), birds (Scott 1997), vegetation (Roberts and Marston 2000), sediment and soil nutrient dynamics (Baldwin and Mitchell 2000). Such syntheses tend to draw heavily on the scientific literature, for example, 45% of the 184 references in Russell and Harris (2004) are from the peer reviewed literature.

Apart from scientific reviews, tools such as the Murray Flow Assessment Tool developed for the Murray-Darling Basin Commission as part of The Living Murray initiative (Jones et al. 2003) also draw together substantial scientific knowledge on water regime-flow relationships.

There are comparatively few peer reviewed papers that draw on the results of wetland watering. Gippel (2003) described 20 wetland watering actions of varying types and cited 146 references, only three of which were 1) from the peer-reviewed scientific literature and 2) reported results from one of the watering events cited. These were:

- Jensen (2002a, 2002b) who reported on the application of an adaptive management approach to the problem of restoring the hydrology of privately and publicly owned floodplain wetlands in the South Australian Riverland; and
- Leslie and Ward (2002) who reported on the hydrological and bird breeding responses to flooding the Barmah-Millewa Forest in 2000/2001.

A limited number of additional papers have been published since the Gippel report regarding actual watering events in the MDB (e.g. Siebentritt et al. 2004). Other examples of peer reviewed literature on wetland watering outside of the MDB come from Bool Lagoon in South Australia through the work of Ganf and others (e.g. Rea and Ganf 1994).

There is a growing literature about calculating environmental flow requirements for river and wetland systems, with over 200 methodologies in existence across the world (Tharme 2003). These perhaps contain some of the greatest accumulations of understanding of flow-ecology relationships, yet typically do not provide information in a form that could be applied in the active management of a wetland watering project or that is perhaps relevant to site specific circumstances.

Guidelines are a form of synthesis product that aims to provide direct management advice. While there are guidelines for water quality issues, there are few for wetland watering. Interestingly, one of the guidelines sighted as useful by some respondents (Tucker et al. 2002) is largely based on the results of monitoring undertaken at lower Murray wetlands rather than from a synthesis of peer reviewed literature. Furthermore, the results of this monitoring have never been published in a peer reviewed journal. Their attractiveness to managers lies in their direct relevance to sites being managed by local wetland managers and in the development of 'golden rules' and management risks that relate to water level parameters that can be influenced by managers e.g. rate of water level rise.

Scientific knowledge is also synthesized into management plans for watering specific wetlands and supporting texts (Box 3). While these are not scientific documents, they are reviewed by management agencies and have legitimacy within these agencies.

Although scientific papers are cited to a lesser degree in some management texts, this does not necessarily imply that managers have little interest in accessing the science behind wetland watering. Instead it is more likely to mean the science is heavily digested by the time it gets to such reports and is contained in other management texts cited. One of the problems in developing site specific watering plans is that there is often little published science about that particular site.

BOX 3 References to scientific literature in management texts

One example of a management text is “The Living Murray - Foundation Report”, which provides a background of the scientific knowledge behind this environmental flow management initiative. While it contains 406 references only 73 (18%) are from the peer reviewed scientific literature. With respect to a management plan, the Bool Lagoon Game Reserve and Hacks Lagoon Conservation Park Management Plan contains 2 references to peer reviewed scientific papers out of a total of 43.



Wetland near Wakool, NSW. Top photo shows the wetland before receiving water, and lower image shows the same site 15 weeks after receiving an environmental water allocation.





Influences on Attitude

This section of the paper focuses on two factors that influence attitudes - perception and motivation - and how they may influence knowledge flows.

4.1 Motivations

Motivation can be described as “a force that stimulates and compels a behavioral response and provides specific direction to that response” (Neal *et al.* 2001). Managers and scientists share some motivations, such as the desire to maintain, protect or restore a healthy environment. However, other motivations differ, a number of which were identified in the surveys:

- scientists by virtue of their training seek to test hypotheses, whereas managers seek to determine whether management objectives have been met;
- managers are driven by the need to comply with legislation and policy whereas scientists may seek to push and challenge the boundaries of this legislation;
- scientists have a desire to continue to build knowledge about ecosystems, managers may only seek enough as is needed “to get the job done”; and
- scientists are rewarded through writing peer reviewed papers, whereas managers are rewarded for achieving “outcomes”.

Many of these individual motivations are heavily influenced by institutional culture, which in the case of managers can vary significantly between jurisdictions. Such jurisdictional differences may be political or more simply an artifact of historical practices. While not specifically commented on by scientists, it can be hypothesized that institutional culture would also differ across scientific bodies.

Motivations regarding reward structures of managers and scientists are worthy of further discussion. Scientists are rewarded for publishing peer-reviewed papers, with the value of the papers being judged by a journal impact factor. Despite a genuine interest, some scientists commented that:

- there was limited value in undertaking management oriented research because many management journals have low impact factors; or
- the community interactions they were involved with were given no or little formal recognition by their research institution.

Concern was expressed by one respondent that the lack of recognition would only be exacerbated by the advent of frameworks to assess the quality and impact of research in Australia.

Finding 1

The reward structures for managers and scientists differ with the result that, without appropriate incentives, there may be little motivation for them to work together.

In contrast to scientists, managers were seen to be employed to achieve outcomes – whether in the form of new policy, management plans or on-ground actions – and have little incentive for assisting scientists to generate peer reviewed papers. Even if they were to do so out of personal interest, there is no incentive to be concerned with journal impact factors.

One avenue to address this is for natural resource management agencies to provide greater incentives for peer reviewed papers to be produced from the collaborative work of managers and scientists, either by funding such activities or providing access to necessary data. However, such activities must give credit to all parties involved. One interviewee identified an instance where managers contributed to a peer reviewed paper, only to find that they were not recognised with authorship. This is likely to provide little incentive for managers to engage in future collaborative work to develop papers.

4.2 Perceptions

Perceptions form the initial activity in information processing and include exposure, attention and interpretation (Neal et al. 2001). The survey revealed at least two types of perceptions about wetland management and science.

4.2.1 How much do we know?

Wetland managers were asked to indicate how much of the information needed to support their management decisions already exists. The majority (81%) believe that only some of the information exists to support management decisions and further research is needed. Wetland scientists were asked the same question, with 89% also suggesting that only some of the information exists.

While perceptions about the availability of knowledge are similar, there appear to be different drivers. Some managers believe that the basic science was available to support their management decisions but that wetland management was becoming more and more complex, insofar as integrating diverse information about the non-scientific or ecological factors that inform decisions. For example, one manager said that: *“Wetland ‘science’ is only one small part of the equation. The social and economic dimensions are increasingly crucial factors to take into account.”*

The other perception, held by both managers and scientists, is that science is only scratching the surface of wetland ecology, especially the interactions and synergies between different species. At first this may appear contradictory with the view of some managers that the basic science exists to support their management decisions. However, it more likely reflects the view that management decisions can still – and in some cases must – be made with incomplete scientific knowledge.

Importantly, these drivers will lead managers and scientists to seek out more information or generate new information through research. The risk is that the differing origins of the drivers may force information seeking in different directions. For example, wetland managers may start to seek out more information about social and economic considerations at the expense of learning more about the ecology of wetland systems.

4.2.2 What influences management decisions?

Managers were asked to rate the influence of the following on their decision making:

- (a) financial or economic constraints;
- (b) social and cultural impacts;
- (c) operational issues (e.g. dam operating rules, sharing channel capacity);
- (d) physical constraints (e.g. geographic barriers);
- (e) good scientific information;
- (f) political implications; and
- (g) risk factors (e.g. using water now that may be needed for environmental watering later in a season).

Scientists were then asked how they thought managers rated these factors. The responses of managers and scientists are summarised in Figures 2 and 3.

There was a striking difference in perception between scientists and managers regarding the role of good science in management decisions. Forty seven percent of managers said that good science had a high impact on their management decisions; all but one of the remaining managers indicated a moderate impact. In contrast, only 11% of scientists believed that good science had a high impact on management decisions compared with 39% who believed it was of low importance.

Finding 2

Nearly half of managers said that good scientific information had a high impact on their wetland watering decisions; yet 89% of scientists believed that good science had only a moderate or low impact on wetland watering decisions.

There were other differences in the perceptions of scientists and managers as well, with 72% and 56% of scientists believing that, respectively, (a) financial or economic constraints and (b) political implications had a high impact on management decisions. The majority of managers rated these factors as having only a moderate or low impact. As observed by one manager, recent investment in the Living Murray means that at least in the near future, financial resources are not the most limiting factor in that area – instead it is often finding the human resources to undertake the work that is limiting.

A source of common ground was the recognition of the importance of operational and physical constraints, of which 78% and 56% of managers rated as high importance, respectively, compared with scientists at 71% and 63%, respectively.

Figure 2 The percentage of managers that rated the factors on the x-axis as having a high, high-moderate, moderate or low impact on their wetland management decisions.

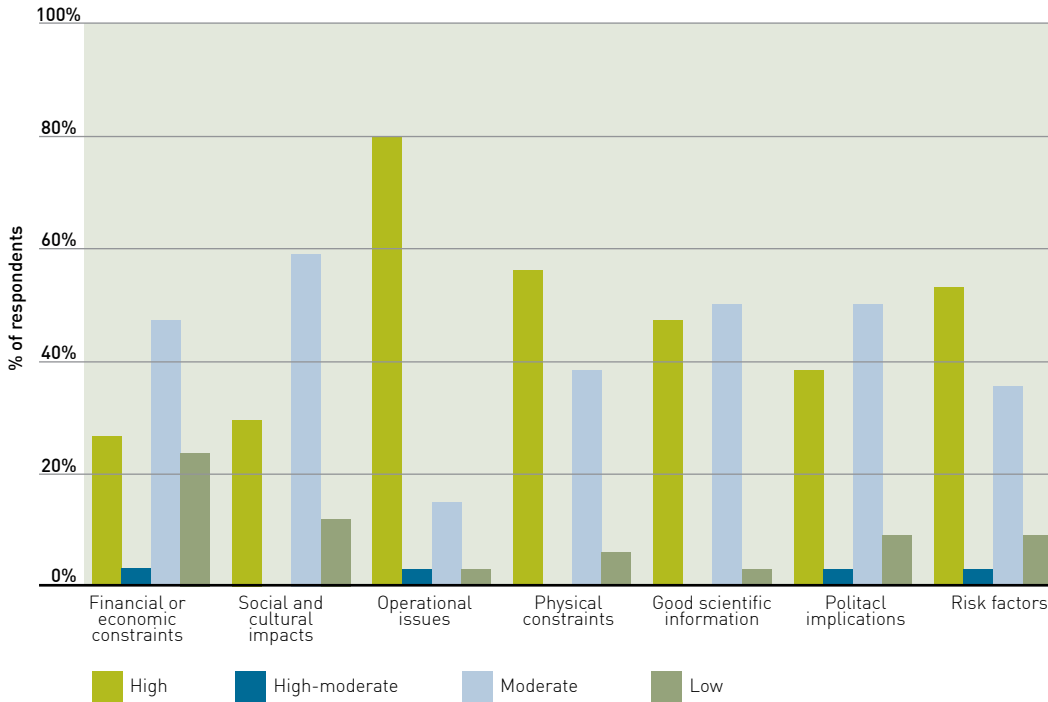
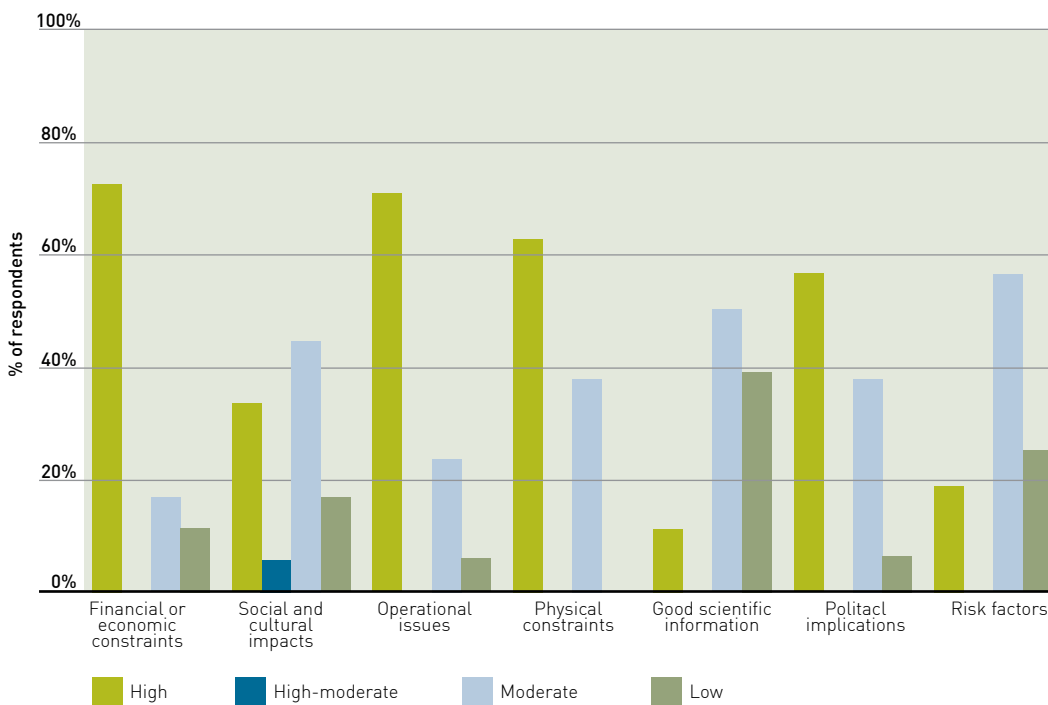


Figure 3 The percentage of scientists that believed the factors on the x-axis as having a high, high-moderate, moderate or low impact on managers wetland management decisions.





Knowledge Seeking Strategies

Knowledge flow between managers and scientists occurs in two main ways: push strategies, whereby scientists push knowledge across the divide between science and management, and pull strategies used by managers to obtain their information (Roux *et al.* 2006). There are a number of factors that influence the type of strategies adopted and their success.

5.1 Where do managers obtain their knowledge?

Most wetland managers indicated that when faced with a wetland watering decision they were most likely to consult another person (56% gave this a score of 1) to obtain their scientific information. Personal experience and sourcing information from management oriented texts were only half as popular. The least popular sources of scientific information were academic reviews or handbooks and computer based tools.

Personal experience as a source of scientific information was rated most highly among managers who either had substantial on-ground management experience or strong field based science backgrounds. Those with substantial on-ground experience often had a knowledge base that was built through their relationships with wetland scientists. Interestingly, a number of wetland scientists suggested that relationships with these types of managers were often the most rewarding because they felt that their scientific knowledge had a real impact on management decisions.

5.2 Which people do managers seek their advice from?

So who do managers seek advice from about their watering decisions? What was clear from the survey was that they were not knowledge brokers or extension officers (Figure 4). Half of the wetland managers surveyed said that they never sought advice from knowledge brokers or extension officers from their own agency, and 37% said that they did not seek advice from such professionals from other agencies.

Wetland scientists or managers from another agency were the most common source of information. Their advice was sought at least most of the time by more than 60% of managers. Also important were wetland or natural resource managers from their own agency, whose advice was sought at least *most of the time* by nearly 50% of managers.

Finding 3

When faced with a wetland watering decision managers were most likely to consult another person, typically wetland scientists or managers from other agencies, to obtain their scientific information. Knowledge brokers or extension officers were seldom the source of scientific information.

Interestingly, some managers suggested that their first choice would be scientists from their own agency, but in some instances such positions were no longer present as a result of structural reforms in natural resource management agencies. Views on the desirability of this trend were varied: some managers lamented the loss of agency-based scientists, others recognised it was part of the evolving structure of government agencies and simply placed greater importance on building networks with scientists and between institutions.

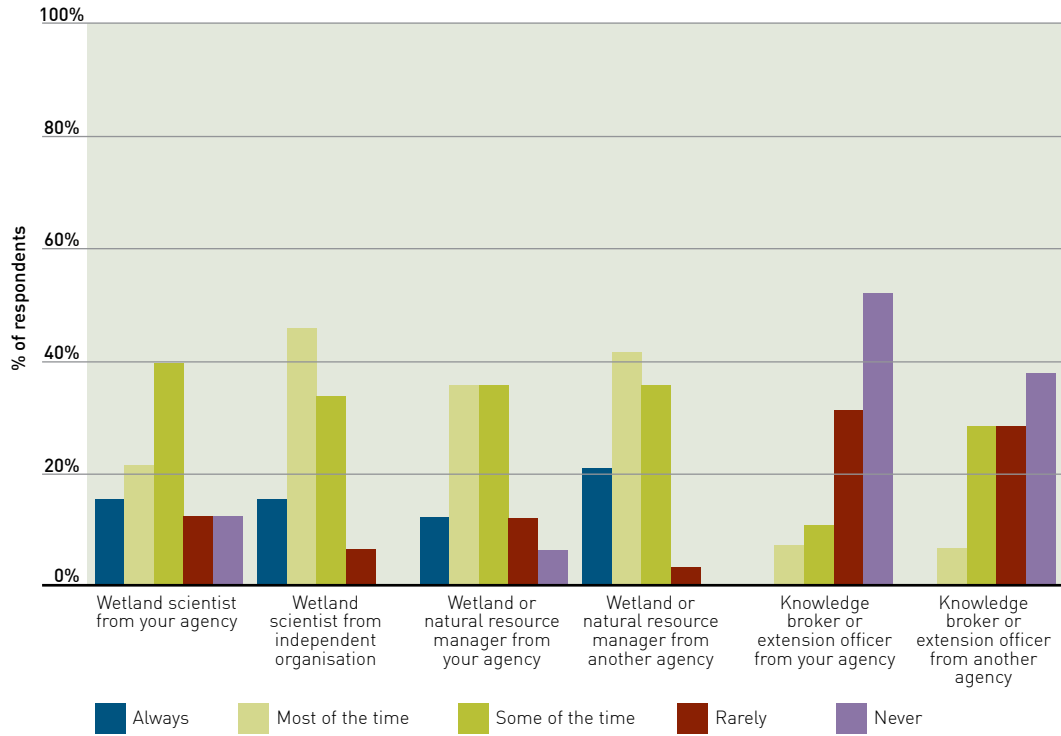
5.3 Why are the opinions of others sought?

There were a variety of factors that led managers to seek the opinions of others. Eighty percent of managers were looking to obtain an independent view with some indicating that this was for scientific validation. There was also a strong desire to access expert scientific knowledge to help identify potential problems and to workshop ideas. It was recognised that while this might be a drawn-out process on occasions, it was often productive and provided sound outcomes.

Fifty seven percent of respondents indicated that they did not have enough time to find scientific information themselves to support their management decisions, (explored further in section 6.2), while 44% said that they did not fully understand the available science. While this latter finding points to differences in scientific understanding among managers, one manager did indicate that he “did not presume to know everything” rather than not understanding the science per se.

Most of the factors identified here help to explain why managers seek out the views of scientists rather than other managers. While not specifically tested, it is hypothesized that when managers do seek out the views of other managers it is because of their relevant experience in making similar wetland watering decisions.

Figure 4 Rating of which professions managers consult when seeking scientific information. A – always, M - most of the time; S - some of the time; rarely (R); never (N).





Barriers to Knowledge Exchange

6.1 Overview

The barriers to successful knowledge exchange are numerous. Cullen *et al.* 2001 described them as including:

- Information overload;
- Lack of time;
- Don't want to appear ignorant;
- Poor access to infrastructure;
- Poor searching skills;
- Feeling that there is enough information to do the job;
- Poor grasp of existing knowledge base.

To test some of these barriers, the managers surveyed were asked the question "What are some of the most significant barriers that inhibit you as a natural resource manager seeking and gaining information?".

By far the most significant was "lack of time to seek relevant information", with 60% of respondents rating this as their greatest impediment. This was followed by "lack of time and energy to synthesise knowledge for themselves". The issue of time is explored further in section 6.2.

Finding 4

Lack of time was a major constraint on knowledge acquisition.

The feeling that there is enough information to do the job has been discussed under "perceptions", with the vast bulk of managers and scientists drawing similar conclusions that only some of the knowledge exists.

Poor access to knowledge infrastructure was rated as a major impediment by only one manager out of the 30 respondents to this question, whereas one third of respondents rated it as a low barrier to gaining information. This suggests that either knowledge infrastructure is adequate within management agencies or that managers do not often rely on knowledge infrastructure for their scientific information. The survey did not seek to differentiate between these possibilities and hence a firm conclusion as to which is dominant cannot be made. The latter conclusion is supported by the results of section 5 that more than half of managers seek out the views of another person when searching for scientific information.

6.2 Time-related issues

Over 60% of managers indicated that a lack of time was the most significant barrier to them seeking and accessing knowledge. While this is likely to be a real effect, it was also the view of at least one manager that managers can find the time to research a specific area if the matter is important enough because of the implications of making uninformed decisions, particularly in the long term.

Time constraints are not equal in duration or cause. They can arise from the requirement to make a decision as part of a management or planning process over the period of 6-12 months, or the need to respond quickly when an opportunity arises for flow enhancement⁸. One example of the latter is for the Barmah-Millewa Forest where the travel time for floods – and hence the management decision window for determining how to enhance a flow - from Hume Dam or the Ovens River is less than a week. While such time constraints exist for managers, scientific research is ideally longer term in nature and may take a number of years to deliver results. In the words of one manager “*sometimes you have to go for it whether you have all the scientific info you want or not*”.

The time constraints for real time watering events also pose a challenge for scientists and managers in attempting to build the knowledge base about the biophysical response to watering events. One possible answer is to prepare event-ready monitoring plans that enable managers and scientists to respond rapidly when such short timeframes arise. Such plans would include pre-agreed hypotheses for testing under a range of flow scenarios (these could be adjusted prior to field sampling) and field equipment on standby or available at short notice.

6.3 Information packaging for managers

The notion of information packaging for managers is discussed by Roux *et al.* (2006) and describes how scientific messages are translated for managers. There are a number of ways in which this can act as an impediment to accessing knowledge.

When asked about the greatest barriers they face in implementing the recommendations contained in synthesis products, most managers said that the information was not relevant to the site specific circumstances they faced as a manager. This is explored further in section 6.4.

Conversely, it was put to scientists that managers may at times say that the scientific advice they receive is too complex and not tailored for their specific management context. When presented with this statement via the questionnaire, wetland scientists were strongly of the view that managers were not specific enough about their knowledge needs.

⁸ Flow enhancement is a type of wetland watering action which occurs when environmental water managers boost the size of an existing natural flood by releasing additional water from a dam or other water storage. The volume of water used to enhance the flood is typically much less than the volume of water in the flood itself.

Finding 5

More than half of managers believed that the greatest barrier they faced in implementing recommendations from scientific syntheses was that the information was not relevant to their site specific circumstances. Countering this, many scientists were of the view that managers were not specific enough about their knowledge needs.

Furthermore, when asked “Are managers able to provide the accurate guidance that scientists need to undertake relevant research?”, 58% of respondents said this occurred some of the time, 32% said rarely. Only one scientist of the 19 surveyed said that they received accurate guidance *most of the time* and none said they *always* received accurate guidance. Scientists in some cases felt that they had to guess what managers wanted to know and one reported that specific questions only arose at the completion of a study during the review of reports.

One scientist drew a useful distinction between managers providing guidance by way of a steering committee compared with managers assisting to develop a research question. In the case of steering committees consisting mostly of managers, there was seen to be a risk in the process being too focused on providing answers in the short term and making “no contribution to the intellectual capital of the future”. On the other hand, managers were seen to be well placed to know what the practicalities are of management decisions, although they needed support to translate this into a scientific question.

6.4 Gap between scientific knowledge and the requirements of management decisions

As section 6.3 highlighted, an oft-cited concern of managers is the gap between generic scientific information and the requirements for a specific wetland. The view of one manager was that scientific knowledge needed to be presented in more practical management terms:

“Water application rates are a good example where technology and science need to be better used or developed. Currently I know of no scientific formulae for water application rates in practical management terms, i.e. ML/ha, for different types of wetlands and under differing climatic, soil water deficit conditions, depth and duration requirements.”

Producing site-specific information is difficult though because of the challenge of transferring knowledge between river systems as recognised by Kingsford at the LWA feature session:

“Science is not easily transferable ... if you are managing the River Murray it is quite different to managing the Murrumbidgee. There are principles ... but there are structures [physical] that will determine quite different outcomes in terms of environmental flows”.

Arthington and Pusey (2003) found that in the case of defining ecosystem water requirements, there was a reluctance or inability by some ecologists to provide rapid or precise statements for individual rivers. This led to tensions and indecision. In an effort to provide immediate advice on flows for river ecosystem protection, Arthington *et al.* (2006) suggest that some scientists are using hydrological “rules of thumb”. There was a mix of views on the merits of general principles among survey respondents.

While such general principles can be readily applied, some survey respondents indicated that at the detailed management level the requisite information has to be generated for each case. On the other hand, one manager praised Tucker *et al.* (2002) for their “golden rules” and list of water level management risks. The difference would seem to be that when setting the general bounds for wetland watering, general principles may be of value (e.g. don’t kill long lived vegetation, don’t salinise your wetland). However, when specific management decisions are required site specific data is needed e.g. how long should river flows be maintained at a certain height to inundate half of the floodplain?; what water height should be maintained to prevent breeding water birds from abandoning their nests?) .

One scientist who responded to the survey suggested that it was up to managers to know what methods are available to liberate the information they need for making decisions – essentially bridging the science-management divide – and then apply them. It is true that most of the hydrological information required for application of models is available and continually improving through measurement rather than research.



Establishing the Context of Management

7.1 Overview

Every manager surveyed – the only survey question for which this occurred – believed that it was important for scientists to understand the context in which managers make their decisions. There was recognition by one scientist that managers are often not specific enough about their knowledge needs but likewise, scientists need to understand more about management decisions.

Finding 6

Managers agree that scientists need to be more aware of the context of management decisions.

Schofield *et al.* (2003) reported that a number of factors can impede the development of 'ideal' environmental-flow regimes, such as:

- ▶ infrastructure constraints;
- ▶ hydrological constraints;
- ▶ ecological constraints;
- ▶ industrial competition;
- ▶ social capacity;
- ▶ political commitment;
- ▶ institutional issues.

These same impediments operate for wetland watering. This section of the paper expands on the issue of physical and operational constraints, which were rated by managers as the most significant influences on their management decisions. Also considered are institutional settings⁹, which shape the context for management decisions. While not specifically targeted in the survey, they arose in comments provided with surveys and during phone based interviews.

Social and economic considerations are playing an ever increasing role in the decisions of managers, although there is a wide divergence of opinion amongst managers about their importance. Twenty eight percent of managers rated financial and economic

⁹ Institutional settings relate to the structure and functioning of government agencies, which are shaped by the specific legislative and policy framework within which they operate. Institutional settings can differ across jurisdictions and between agencies in the same jurisdiction.

constraints as being of high importance, 23% rated it as low. With respect to social and cultural issues, 31% rated them as being of high importance, 13 % of low importance. The role that such considerations can play is highlighted by the vandalism of pumps at the Hattah Lakes in 2005 (Box 6) and another case of vandalism of a scientific experiment in Gippsland for what were believed to be local concerns about what results might emerge.

BOX 6 Vandalism prompts security for Hattah Lakes pumps. ABC (2006)

“Security officers were in place to protect pumps at the Hattah Lakes overnight, after an attack by vandals on Wednesday night. Graffiti was painted in the area and there was minor damage to two pumps, but the others resumed pumping environmental flows to the lakes yesterday. Some irrigators are angry the environmental watering is continuing, despite forecasts the Murray River could be dry by May.”

A news bulletin extract posted on the *Australian Broadcasting Corporation* website.

7.2 Operational and physical constraints and considerations

There are complex operational and physical constraints in wetland and especially river management. Operational constraints relate to management of major dams and weirs and require an understanding of the interaction between these structures and the role they play in regulating and delivering flows. Physical constraints are primarily major geological features, such as the Barmah Choke on the River Murray (Box 7), which place limits on how flow can be managed, either for delivery of water allocated to human use or for environmental management.

BOX 7 The Barmah Choke

Approximately 25 000 years ago an earth movement created what is now known as the Cadell Tilt Block. The uplift altered the flow of the River Murray, eventually leading the river to break through the section between Picnic Point and Barmah, creating what is known as the Barmah Choke because of its limited capacity to carry flows. During major floods, large volumes of water are temporarily banked up behind the Barmah Choke, reducing the height of flood peaks downstream. The capacity of the choke (i.e. before channel capacity is exceeded) is approximately 10,000 ML/day, compared with the Murray just upstream of Lake Mulwala with a capacity of at least 25,000 ML/day. To deal with the restricted flow, management techniques have been developed to move water around the Choke.

SOURCE: (MDBC 2007)

It was the view of a number of managers that understanding the role of physical and operational constraints on management decisions requires at least 1 year of direct exposure to river operations or 5 or more years working closely with managers on river operations or wetland management committees. Even then, at least one manager was of the view that it is not possible to replace the value of real field experience. It is not uncommon during real time flood events for experienced river operators to compare the behavior of a current high flow (or drought) with a flood 10-15 years ago to gain a better understanding of how the hydrograph will develop.

Knowledge of operational and physical constraints is also dynamic, with river operators acknowledging that no two floods are the same. This is because flood behaviour is influenced by multiple tributary inflows and their interaction with features of the river and floodplain. Opportunities to learn about such “watering behaviour” are complicated by the high flow variability within and between years in most Australian rivers and the lack of training programs.

River Murray Water, a business unit of the Murray-Darling Basin Commission, is the only known water resource management agency in Australia with operational responsibilities that has trained ecologists in river operations. To date three candidates have successfully completed training and acted as river operators. Such training was provided because of the belief that environmental managers need to better understand the realities of river operations in order to make effective management decisions. Opportunities to participate in management committees may also be limited as they are few in number compared with the number of scientists that may be working in a particular region. Furthermore, positions for scientists on such committees will often be held by those with expert knowledge.

Some managers expressed the view that there is a risk that new managers will not be taught about previous management actions, especially the role that operational and physical considerations play. This may be overcome by the development of “road maps” based on technical reports produced by many agencies but that are rarely published. Such road maps could also be to the benefit of scientists wishing to learn more about operational issues.

7.3 Understanding the institutional setting

The structure of government agencies partly defines the institutional setting for wetland watering. The seemingly constant evolution of these structures which sees responsibilities shift between government agencies is a source of frustration for wetland managers and wetland scientist alike. This is compounded by generational change, which relates not just to the retirement of natural resource managers with significant experience, but the trend for the average employee now to be less likely to remain in the same position for more than 4 years (McCrimdale Research 2007).

This evolution makes it difficult to establish and maintain relationships, which as found in the surveys, are the primary channel of scientific knowledge for managers.

Such changes to the structure of government agencies have implications for the agencies themselves with the loss of corporate knowledge. This can in turn impact on the science community because there may be fewer agency staff with knowledge

of the operational and physical constraints they should be aware of for certain types of wetland watering events and also what previous observations have been made regarding ecological responses (Box 8). Of the management literature that has been published some has been found to be archived and not easily accessed. This is in contrast to scientific literature which is catalogued and independently peer reviewed.

BOX 8 Corporate, ecological knowledge

One manager surveyed indicated that the knowledge about the breeding habit of one species of duck is still drawn largely from observations of its responses to flooding in 1989. None of this information is captured in the peer reviewed literature and instead forms part of corporate, ecological knowledge within some agencies.

Wetland watering is a complex process with multiple layers of bureaucracy and planning timeframes. The management planning timeframes form part of the complexity of the institutional setting and scientists may not understand these timeframes.

In the case of a site like the Barmah-Millewa Forest (Box 9), annual management plans for a season need to be drafted by no later than June of a given year i.e. at the start of the water season. Wetland watering events will quite often continue until late summer. While managers need data available to develop annual watering plans for the coming season, the process of analyzing data and producing reports may not be complete until well after the plan must be completed. For reports that span multiple years, the final report and data analysis may not be available until the end of a project that runs for a number of years.

BOX 9 Planning layers and timeframes

There are multiple levels of planning for management of any wetland. For the Living Murray icon sites, there will ultimately be a long term, strategic management plan in addition to the current annual plan which directs distribution of water. For an individual site such as the Barmah-Millewa Forest, there will also be a long term strategic plan in addition to an annual watering plan. This will all need to be nested within the Basin Plan, a requirement of the recently introduced Commonwealth *Water Bill 2007*.

Once a real time watering event is initiated, an event plan is developed, as occurred for the 2005-06 use of the Barmah-Millewa Forest environmental water allocation. Management of this particular event also required meeting of an operational committee, initially once every 3-4 days then less frequently as flows reduced. The event itself ran from October 2005 to February 2006. The annual plan for 2006-07 had already been drafted by June 2006.



The Decision Making Process

The decision making process includes the integration of the various factors that influence, impede or modify the flow of knowledge between managers and scientists such as time and relationships, both pivotal in building trust between stakeholders. The way in which decisions are made has evolved substantially over recent years, with significant implications for knowledge transfer.

8.1 The individual operator

Prior to the last decade, wetland managers were often individual people with responsibilities under a single government agency such as national parks. They made management decisions without the need for formal consultation of numerous agencies and stakeholders.

A number of scientists stated that they believe their impact on wetland management decisions has been greatest when dealing with managers or decision processes of this type. The reasons were not explored in detail, but these beliefs are possibly held because such relationships provided opportunities for shared learning and understanding, were based around respect for different types of knowledge and were able to mature through time, which ultimately built trust. Furthermore, the sole responsibility of these managers may have meant that scientists could clearly see their recommendations being put into practice.

8.2 Participatory decision making

Participatory decision making now dominates the NRM landscape, due largely to a formal recognition of the diversity of stakeholders that have an interest in the outcomes of NRM decisions. The interest of the broader community in river management and wetland watering was illustrated by community meetings held in 2003 on the River Murray (Box 10).

Such participatory models typically involve multiple agencies plus community and sectoral representatives. Some managers interviewed by phone recognised that participatory mechanisms provided greater transparency on how decisions were made to the broader community.

One of the features of participatory decision making discussed in phone based interviews was that the decisions may not be what would be recommended by a scientist based on the available scientific information alone. This is because decisions made in this manner must make trade-offs between economic, social and environmental factors (Box 11).

BOX 10 Community concerns over river management

In September 2003, two community meetings were arranged to allow for consultation on issues relating to the management of the River Murray. The first was at Yarrawonga, where major concerns had been raised by local people relating to the Lake Mulwala on-water management plan. Up to 4,000 people marched across the bridge from Yarrawonga to the Mulwala Service Club, where 1,000 entered the main auditorium to hear addresses from various government officials, including the then CEO of the MDBC. A second meeting was attended by over 300 people at the Cobram Civic Centre to discuss issues primarily relating to the Living Murray. The Victorian Hansard reported that the strong message given by the local community was the need to protect irrigators and water users.

SOURCE: Parliament of Victoria (2003)

Finding 7

Decisions that might emerge based on wetland science alone may not always be adopted, given that committees must also take into account social, economic, cultural and various other considerations.

Scientists may feel more isolated from such participatory processes compared with the level of involvement they experienced with sole operator managers. This may be overcome somewhat by explaining to scientists why certain management decisions have been made and discussing the decision making process that has been adopted.

Participatory decision making can lead to fruitful relationships when the scientist is a committee member or involved with providing advice directly to the committee for a number of years. This provides time for scientists to understand physical and operational constraints and the opportunity for shared learning (Box 12). As a scientist on such a committee, one respondent believed they were “in the right place at the right time for influencing management”. Long term relationships mean that knowledge is transmitted over a long period of time, feeding in at multiple stages of planning and operational cycles.

BOX 11 More than just science

From a wetland watering policy development perspective, expert scientific advice (Jones *et al.* 2003) provided to the Murray-Darling Basin Ministerial Council at the time of the Living Murray First Step decision was that:

- ▶ 350 GL environmental allocation, however operationalised, would provide little 'whole of river' ecological benefit;
- ▶ if fully optimised from an operational perspective, a further 750 GL may provide some whole of river ecological benefits;
- ▶ a further 1500 GL can provide considerable whole of river and local ecological habitat benefits.

The decision in November 2003 to recover 500 GL as a 'first step' toward achieving a healthy working river is seen by many as a pragmatic, political decision based on the desire to balance social and economic impacts while still achieving some environmental outcomes.

Another example is that of weir pool manipulation. From an ecological perspective increased water level variability in weir pools can have a beneficial environmental impact, yet there are few examples where this occurs on a regular basis. Experience suggests that this is largely because constant weir pool levels are often desired by local stakeholders rather than because the environmental benefits have not been articulated.

BOX 12 Involving scientists in participatory decision making

Scientific advice was sought over a long period of time to develop the Lake Mokoan Restoration Strategy. This eventually synthesized into a strategy to manage the water levels of the lake in an effort to rehabilitate it. Although the project ultimately was not implemented because of changed objectives for the site* the process stood out because:

- ▶ scientists were incorporated in the process and became part of the team;
- ▶ there was time to process knowledge and build relationships (project ran for 5+ years);
- ▶ conceptual models were used to guide knowledge acquisition and were reviewed in light of knowledge and experience gained;
- ▶ good models of the lake and its ecology were developed;
- ▶ there was regular expert review using eminent scientists or experts in their field;
- ▶ the idea of restoration as an experiment, or adaptive management, was adopted and maintained.

* Lake Mokoan has since been identified as a site to implement a water savings project



Discussion and Recommendations

9.1 Scoping the knowledge about wetland watering

Wetland watering, while drawing on existing knowledge about the biophysical responses to water and flow regime, also opens up new opportunities for research. This is because wetland watering with the use of dedicated environmental water allocations is still in its infancy with few peer reviewed papers reporting on actual watering events.

Numerous knowledge synthesis products exist from summaries of the scientific literature to handbooks targeted at managers. They vary widely in their use and value for wetland managers. The importance of peer reviewed scientific knowledge though is unclear with at least some documents that are valued by managers drawing heavily on non-peer reviewed, local experience and data (e.g. Tucker et al. 2002).

Recommendations

- Conduct a review with a representative sample of agencies responsible for wetland watering to identify what handbooks or guidelines are used most commonly for guiding wetland management with specific attention given to the balance in these documents between peer reviewed papers versus non-published, site-specific monitoring data and experience.

9.2 Observations on attitude

The perceptions of managers and scientists are both aligned and divergent on different issues. The question arises “When perceptions are closely aligned, does it mean that the knowledge exchange process is working well?” If this is the case monitoring perceptions could become a barometer of the relationship between managers and scientists.

Perhaps of greatest concern was the stark difference between managers and scientists with their views on the role that good science plays in influencing decision making. The underlying causes of this difference were not explored in this survey. But they bear following up.

Motivations were also found to differ, with reward structures being raised by a number of respondents. Fundamentally, managers and scientists are rewarded for different outputs, which may reduce the benefits they see in working together. The lack of

peer reviewed papers that result from work on management issues is likely to be a disincentive to some scientists being more involved in advising managers. This is likely to be especially important for university based scientists. For their part, managers perhaps have the most to lose in not addressing this issue by not attracting quality researchers to investigate their management challenges.

Other factors known to influence attitude, such as demographics as expressed through generational change, also arose in the survey and interviews indicating that there may be additional factors that influence attitude that could be uncovered by further, more targeted surveys and interviews.

Recommendations

- Undertake a more complete and targeted analysis of the factors that influence the attitudes of managers and scientists toward one another during wetland watering decision making processes;
- Develop new reward structures that provide appropriate incentives to encourage scientists and managers to work together

9.3 Knowledge seeking strategies

An analysis of the communication channels that managers use suggest that knowledge exchange relies heavily on interpersonal relationships. Managers seek out wetland managers or scientists from other agencies largely to provide an independent view but also to workshop ideas. Some managers indicated that they did not seek out people from their own agency because restructuring in some jurisdictions had meant that professionals with the relevant skills and expertise were no longer being employed. This places even greater importance on networks between scientists and managers and their institutions.

The importance of relationships is well understood, with a recognition that long term relationships can allow knowledge to be transmitted over a long period of time, feeding in at multiple stages of the planning and operational cycles. An important result of long term relationships that was brought out in the LWA Riversymposium feature session discussion was that of trust. A question during the discussion asked “How can trust be transferred in organisations where those who have built it move on to other roles?” In response, Raisin said that “I don’t know whether you can transfer trust; you earn trust. But you can also engender trust by cultures. If different stakeholder groups develop cultures which are working toward solutions rather than attacking their opponents, that will go a long way”.

While trust is important, Kingsford noted that the shifting focus of funding sources often does not permit scientists to develop these relationships. The LWA feature session discussion also made the observation that it is a slow process for scientists to build trust as they cannot commit for longer than their funding arrangements.

Given the importance of strong relationships one may ask “should relationship building skills be enhanced in scientists across the board?” This may not be easy or desirable and the solution instead may be to highlight the success of those who do succeed in building relationships and the benefits of this being done. It will also be important to tie in such successes to the reward structures for scientists.

Recommendations

- Scientific institutions should work to further develop strategies to help scientists build and maintain strong networks with management agencies, including celebrating scientists who are already successful at bridging the science management divide.

9.4 Barriers to knowledge exchange

A lack of time to obtain relevant scientific knowledge was identified as the most significant barrier to knowledge exchange. Yet it was recognised that if the implications of the management decision are important enough, managers will make time.

Insufficient time is particularly important for wetland watering because such events can occur with little warning for the manager or scientist. This is as much a barrier to knowledge generation as it is to knowledge exchange. To take advantage of these events, managers and scientists need to have pre-agreed hypotheses and plans for how data will be collected.

A further time related issue reiterated at the LWA feature session was that while managers inevitably have to operate to short planning time frames, science takes longer to produce results, especially when passed through the filter of the peer reviewed literature. This may in part be reconciled by ensuring that the results of scientific research continually feed into management committees throughout a research project's lifespan.

There are strong views about how scientific information should be packaged. On the managers' side, it is often thought that scientific recommendations are too complex or not relevant to their specific management circumstances; on the other hand at least half of scientists said they received accurate guidance only some of the time and another third indicated it was rarely provided.

There continues to be a gap between scientific knowledge and particular management decisions. The challenge is not necessarily producing more synthesis products or reviews, it is about understanding how these can be applied to specific management contexts. In fact, every manager was of the view that scientists need to understand the context in which managers make their decisions.

Recommendations

- Wetland scientists be encouraged to develop event ready research programs, with pre-defined hypotheses for a variety of watering scenarios and easily adaptable study designs, that are suited to the short timeframes of wetland watering events such as flow enhancement.

9.5 Is the context of management understood?

Every manager surveyed said that scientists should understand the context within which managers make their decisions. Yet in reality few scientists have the opportunity to spend a year working for a water resource authority or participate in a wetland management committee for some five years in order to better understand the context of management decisions, like physical and operational constraints. The constantly changing institutional setting for decision making can also act to muddy the waters as to appropriate communication channels.

Accessing knowledge about physical and operational constraints is made all the more difficult by the observation that most of the knowledge about river operations is retained by individuals, often as “corporate knowledge”, or when it is written down it may only be in the form of internal technical reports. While some managers suggest that this reinforces the need to “invest in individuals”, the impact of generational change may mean that new natural resource managers do not stay in the role long enough to develop an understanding of the physical and operational constraints that apply to watering specific wetlands.

Recommendations

- Training opportunities, sabbaticals or scholarships be developed for wetland scientists with wetland management agencies to provide greater hands-on-exposure to the realities and hence context of management decisions
- Management “road maps” be developed that combine citations and abstracts of the grey literature for major wetlands and the corporate, ecological knowledge that resides in government agency staff.

9.6 Making the decision

The decision making process is perhaps the most important off all issues discussed in this paper as it integrates all of the challenges and barriers identified thus far.

Modes of decision making that are applied to wetland watering have evolved in recent decades from sole operators to participatory decision making, either involving agency staff and community representatives or only agency staff. While some scientists believe that the sole operator model resulted in the most effective communication of scientific knowledge, participatory decision making is now by far the norm.

An observation of some managers was that participatory decision making may not always result in the management decision that would arise if wetland science alone was the driver. The result is that wetland scientists may need to temper their expectations about the role of scientific knowledge in decision making, recognizing that it needs to be considered along with other factors like physical and operational constraints and social and economic values.

While the scientists interviewed were often frustrated with current decision making processes, they were not alone as similar views were expressed by community representatives at the LWA feature session. One can hypothesise that this is a function of the transition from old to new decision making models as stakeholders learn to operate under new approaches and understand what is expected of them. Frustration may also be a consequence of differing models between catchments and jurisdictions and what Rogers (2006) describes as compromise negotiation rather than consensus building decision making models

The most successful participatory decision making processes appeared to be those that involved some element of knowledge sharing or what Rogers (2006) might describe as collective learning. Yet many of the concepts explored in this paper are based around traditional concepts of what Roux et al. (2006) describe as “push” or “pull” strategies. There is evidence though to suggest that there is now a movement away from this approach.

Adaptive management is a prime example of an approach to decision making that is built on shared learning and perhaps more importantly, consensus decision making. Based on the frequency with which it was mentioned by managers and scientists, the role of adaptive management approaches are likely to grow as wetland watering decision making processes continue to evolve.

Rogers (2006) suggests that learning is central to the adaptive management process but that it is more than just “learning by doing in large-scale management experiments”. He identifies three different learning frameworks: social learning, learning communities or communities of practice and learning organisations. The latter being a concept previously raised by Cullen et al. (2001). Another important aspect to adaptive management is development of a shared vision. This was highlighted at the LWA feature session where Boon and Kingsford identified the need to better define objectives and Raisin promoted the importance of assisting communities to develop a vision for the future.

Adaptive management jumps many of the hurdles to knowledge access and adoption because it places scientists, managers and the broader community in a setting where they jointly assess and develop new knowledge and understanding. This avoids knowledge being treated as a commodity that can be bought or must be acquired by a group from “experts”.

While popular, there are barriers to adaptive management progressing. There are reports that in a number of instances, funding for adaptive management has not been forthcoming. Another issue is that the interpretations and definitions of this approach can vary substantially.

Recommendations

- Develop a series of case studies to a) identify where different decision making models are being applied and the successes and failures of each and 2) assess under what conditions adaptive management approaches are succeeding in the management of wetland systems.

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Attachment A

The following provides an abridged version of the surveys conducted with wetland managers and wetland scientists. The full versions of the surveys present a number of options in answer to the questions below and an 'other' section if the suggested answers did not adequately address the respondent's views.

Respondents were asked to answer the questions in a number of ways: 1) using a numerical scale, 2) indicate whether an answer was applicable or not, 3) using other qualitative measures (e.g. high importance, moderate importance, low importance).

All respondents were asked to offer additional observations where relevant.

Full versions of the survey are available on request from Land & Water Australia.

Wetland manager survey

- 1 At what level (i.e. spatial scale) do you make management decisions?
- 2 Please describe a situation where you sought scientific advice and it had a large impact on your management decision. What made this stand out?
- 3 When faced with a wetland watering decision, where does your scientific information come from?
- 4 When you do consult another person for scientific information, who are they?
- 5 For what reasons do you seek out other people?
- 6 To what extent do you believe the information already exists to support most of your management decisions?
- 7 Which factors have the greatest impact with respect to their influence on your wetland management decisions?
- 8 Is it important for scientists to understand the context in which managers have to make their decisions?
- 9 Please rate how well you believe scientists understand the factors that may impact on your management decisions?
- 10 What are some of the most significant barriers that inhibit you as a natural resource seeking and gaining information?
- 11 What are the greatest barriers you face in implementing the recommendations that are presented in synthesis products for wetland watering (e.g. fact sheets, handbooks)?

Wetland scientist survey

- 1 At what spatial scale do you undertake research?
- 2 Please describe a situation where you provided scientific advice and it had a large impact on a management decision. What made this stand out?
- 3 When faced with wetland watering decisions, how effective are wetland managers at tapping into your scientific expertise?
- 4 To what extent do you believe the information already exists to support most of your management decisions?
- 5 Please indicate what you believe to be the importance of different factors that influence management decisions (various factors were identified in the survey)?
- 6 Are managers able to provide the accurate guidance that scientists need to undertake relevant research?
- 7 How receptive in general are natural resource managers to receiving scientific input?
- 8 Based on your experience, please rate the effectiveness in communicating scientific material to managers operating at a variety of scales.
- 9 What factors influenced the success of these interactions (i.e. at question 8)?
- 10 Managers may at times say that the scientific advice they receive is too complex and not tailored for their specific management context. What do you believe are the reasons for this?



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Wetland near Deniliquin 18 weeks after receiving an environmental water allocation.