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Editorial

Determining change in aquatic ecosystems

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This issue of *Marine and Freshwater Research* contains two papers that address trends in flow-dependent ecosystems in the Murray–Darling Basin in south-eastern Australia. Colloff *et al.* (2015) provides an analysis of ~300 ecological time series, with the results showing only partial support for the prevailing assumptions of recent ecological decline in flow-dependent ecosystems across the Basin. Instead they revealed a pattern of fluctuating stability, with declines during droughts and recovery after flooding. They further reported that this was consistent with the historical decline of these ecosystems to a hybrid ecosystem followed by slow and more recent decline for some components and stability for others.

Kingsford *et al.* (2015) expressed concern about the findings of Colloff *et al.* (2015) that the river and floodplain environments of the Basin were so degraded before major diversions that restoring water to the environment would not alleviate or reverse such declines, even though the latter had cautioned against this interpretation of their analyses. Kingsford *et al.* (2015) also provided comments about the analytical approaches, quality of data and interpretation of the outcomes. This included the use of some additional data that were not available to Colloff *et al.* (2015). They also considered survey effort and detection efficiency and looked at the precision that was achievable with increased sampling periods from 5 to 10 years, the latter having been identified as likely to provide increased confidence that a population was actually in decline.

The detail and interpretations can be explored in the individual papers, including the cautionary message provided by Colloff *et al.* (2015) about the interpretation of their results. The issues raised directly in these two papers provide food for thought when considering how we address change in aquatic ecosystems and, to my mind, lead also into a discussion about the wider issue of whether the data that guide decision making on important environmental initiatives, such as those associated with the water planning in the Murray–Darling Basin, are adequate. Colloff *et al.* (2015) and Kingsford *et al.* (2015) both point to the inadequacies in the datasets available for the Basin. Inadequacies with our databases and monitoring are not new – we have known and complained about them for some time, and researchers have 'raised their voices' for many years about data deficiencies and data needs nationally as well as internationally (for example, see Finlayson *et al.* 1999; MEA 2005; Junk *et al.* 2006; Davidson 2014).

When looking at the issues of ecosystem decline it would make things a lot easier for decision makers if they had unequivocal evidence that showed the cause and effect relationships, but how often do we have all the evidence that we need to 'prove the point'? It is a rhetorical question, but also incredibly important. Assessments at multiple scales have made this point before, and will probably make it again given shortfalls in the investment in inventory and monitoring worldwide, including by countries who have joined the Ramsar Convention on Wetlands and committed to making wise use of all wetlands (Finlayson 2012).

A question I have in mind is whether greater articulation of the hypotheses behind our monitoring will help to improve the monitoring, as well as the validity of using data from one monitoring program to extrapolate to other issues? Global assessments, such as the Millennium Ecosystem Assessment (MEA 2005), do attempt to provide some confidence in the certainty of the information they synthesise, usually as a subjective statement, but how widely does this occur when it comes to trying to assess change or impact by extrapolating from spatially or temporally piecemeal datasets? The Murray–Darling analyses point to these issues, and I would be extremely surprised if they were not as equally important in many other basins. Quite simply, we can question the adequacy of our datasets, but do we do so sufficiently well when extrapolating from such data to more generic assessments or to areas where data are scarce? When doing this do we adequately consider the sampling design and analytical methods that were used and how these may affect the outcome at the time as well as future extrapolation or synthesis? I see this as a question for researchers as well as for consultants and advocates.

The Ramsar Convention on Wetlands, when considering steps to ensure the ecological character of wetlands is maintained, or restored, has identified the links that exist between adequate inventory, assessment and monitoring. It has also noted that the collection of time-series information that was not hypothesis driven should be termed surveillance (Finlayson *et al.* 1999), a situation also adopted by the long-running Mediterranean Wetland Program (Finlayson 1996). I have not specifically looked but I do wonder how much of our monitoring would be better classed as surveillance and hence, how much more rigour is needed in order to ensure that our monitoring does enable us to test the questions we are asking, let alone synthesise or extrapolate to answer other questions?

Finlayson and Mitchell (1999), in addressing the challenge of effective monitoring of Australian wetlands, also thought more care was needed as shown by the following statements.

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Inventory and monitoring information are intricately linked and at the heart of successful wetland management. Monitoring addresses the extent of change in the environment, yet, for wetlands, it is rarely based on valid scientific principles. Monitoring is also a research tool, but has not, until relatively recently, been accepted as integral to the research effort in environmental management, in part because the questions that may be answered have not been well defined or articulated. The absence of rigorous scientific input to monitoring design has contributed to the devaluing of past long-term monitoring effort. To turn this around and to ensure that wetland managers receive adequate and timely data we need to enhance the scientific rigour applied to monitoring.

The analyses undertaken by Colloff *et al.* (2015) and the response from Kingsford *et al.* (2015) suggest that this situation may not have changed greatly, and further, that well planned and hypothesis-based monitoring is still needed.

I am sure that there will be opposition to insisting on more complex approaches on the basis of costs, and the timeliness, and usefulness of the collected data for management purposes. There is no doubt that costs and time are important factors when designing and implementing hypothesis-based monitoring, especially within the context of complex and emotively charged environmental issues (Finlayson 1996; Finlayson and Mitchell 1999). An example where the investment in science and time has, in my opinion, proven successful is the assessment and monitoring of possible pollution from uranium mining in Kakadu National Park in northern Australia. In this instance there has been a large public investment in establishing a multifaceted monitoring program that incorporates time and space controls, early assessment, and long-term bioaccumulation (Humphrey *et al.* 1999) and is ongoing (Supervising Scientist 2015). It has been further complemented by risk assessments of the importance of other agents of adverse change in the same environment (Bayliss *et al.* 2012).

When we are looking at monitoring or the need for monitoring we usually have an end point in mind for the relevant management or restoration program. This is often described as a baseline or reference condition against which we intend to compare our data. Kopf *et al.* (2015) have noted that while it is recognised that global ecosystems have shifted from historical conditions it is unclear from what baseline change should be assessed. The difficulty or even impossibility of returning ecosystems to 'pristine natural conditions' has been increasingly accepted yet historical conditions remain the cornerstone for restoration and management. This is the situation for many wetlands listed as internationally important under the Ramsar Convention on Wetlands, although in many instances there is some doubt about what is meant by a historical condition, as raised by Finlayson *et al.* (2015) when introducing a discussion on the role of paleao-ecological approaches for assessing historical change in wetlands.

Kopf *et al.* (2015) have proposed Anthropocene Baselines as a concept to provide an improved basis for the maintenance of human-dominated ecosystems. This concept recognises the conservation value of the remnants of historical ecosystems and confronts the reality that many ecosystems cannot or will not be restored to historical ranges of variability. They further suggested that the management of human-dominated ecosystems must, or even has in instances, moved beyond the constraints of managing for a historical condition with a view of moving towards new points of reference that can only be determined by socio-ecological sustainability. Such baselines are already being used in the Murray–Darling Basin. Given the change that has occurred across the Basin, as outlined by Colloff *et al.* (2015), over a long time period it surely stands as an example that while large-scale and costly restoration is underway it is not intended to return the system to a condition that predated European settlement and degradation of the landscapes of south-east Australia. In this respect the data analyses have helped illustrate the difficulty or even futility of trying to establish historical conditions in greatly modified ecosystems.

The above does not mean that I see remediation as not needed, rather it raises the point that the targets and outcomes need to be carefully determined, and agreed, including by affected stakeholders. We can then argue who is an affected stakeholder, and who should have a say, or the greater say – in the case of the Murray–Darling Basin there are multiple views on this, but perhaps not as disparate as some protagonists may state – see the example of the Macquarie water management committee within the Murray–Darling Basin from an earlier round of water planning (Finlayson 2001). There is also discussion as to whether the expected outcomes meet the requirements of the Ramsar Convention on Wetlands (see Pittock *et al.* 2010). Overall, I consider this one will run for some time, and with lessons for others involved in restoring or remediation of complex riverine systems that have undergone major changes driven by agricultural and water resource development, and are still changing.

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