Healthy river ecosystems: vision or reality?

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**RIVER ECOSYSTEM HEALTH**

Ecosystem health is a relatively new field that brings together our biophysical understanding of how natural systems function with societal goals and human values (Rapport et al., 1998). Its central theme is the essential services provided by ecosystems that are vital to human welfare. There are obvious tensions that arise from this mix of medical, social and ecological disciplines and the emerging field of ecosystem health is often a topic of considerable debate (Fairweather, 1999).

Despite these tensions, there are several good reasons why this broader ecosystem approach has merit. There is no doubt that the human health analogy strikes a chord with the wider public and helps to promote awareness of what are serious environmental issues. There are also obvious direct relationships between river health and human health and it is now well recognised that rivers and wetlands provide essential ecosystem services that also benefit humans. Furthermore, many other human uses of rivers and associated wetlands are dependent on them being in a healthy state. Throughout this paper, I use the term ‘healthy’ to describe ‘in good condition’, acknowledging that in the case of ecosystems desired endpoints can be set from either an ecocentric or anthropocentric perspective (Karr, 1999).

**The human health analogy**

Rivers are often portrayed as the ‘ecological arteries’ of our landscape (strictly speaking, they are more like veins in terms of direction of flow but this does not quite convey the same image of vigour and vitality). Symbolically, it is worth noting that the distinctive dendritic branching pattern of rivers is similar to that of blood vessels.

If rivers are ecological arteries, then the aquatic weeds that infest and choke degraded channels can be likened to cholesterol plaque that can obstruct our own arteries. Invasive weeds can reduce channel capacity, increase flooding of adjacent farmland, decrease water quality and eliminate aquatic habitat (e.g. Bunn et al., 1998). The consequences of this are little different from the outcome of a blocked artery. Building dams and weirs is a far more effective means of blocking river channels. The viability of populations of many species of riverine organisms depends on their ability to move freely through the stream network. Loss of longitudinal (and lateral) connectivity through construction of barriers can lead to isolation of populations, failed recruitment and local extinction (Bunn & Arthington, 2002).

If we wish to stretch the ‘ecological artery’ analogy still further, we could liken the abstraction of water for irrigation to the ancient practice of bloodletting. While extracting small volumes of blood is unlikely to cause serious harm, excessive bloodletting (historically performed by barbers and not, as one might imagine, by doctors) was more often the cause of death rather than an effective treatment for supposed overabundance of bodily humors. George Washington died shortly after the removal of several pints of blood, reportedly to treat a throat infection! Many of our rivers are near death from over-extraction of water. Perhaps in the past we have relied too often on ‘barbers’ to make decisions about how much is acceptable.
Such analogies aside, there are clear direct links between human health and the health of rivers (e.g. Lunquvquist, 1998; Gleick, 1998; 2001; Postel, 2001).

**Other essential services**

Rivers and their associated wetlands perform many other ecosystem services. Subsistence and commercial fisheries sustained by healthy rivers and wetlands are relatively easy to quantify in terms of direct economic and social benefit. There are other less obvious services. For example, floodplain wetlands filter sediment and trap and transform contaminants that are carried down our rivers. Beneficial flooding enriches floodplain soils, maintaining their high productivity, and provides the recruitment trigger for floodplain plant species. The provision of these and other essential services by rivers does have an obvious economic value, estimated at several trillion $US each year (Postel & Carpenter, 1997). When such systems become degraded by human activity, they can no longer provide the same level of service and the capacity of the environment to sustain economic activity (and human health) is diminished (Rapport et al., 1998).

Other beneficial uses of rivers, such as recreation (swimming, boating, fishing) and conservation are perhaps more difficult to quantify in dollar terms. Nevertheless, all of these services are dependent on healthy river ecosystems. River health is much more than a metaphor and the links between healthy river ecosystems and human health should not be understated.

**WHAT DOES A HEALTHY RIVER LOOK LIKE?**

Given that river health is a value-laden term, it is hardly surprising to find divergent views among different sectors of the community (and even among aquatic scientists) as to what a healthy river should look like. A healthy river for biodiversity conservation is likely to be quite different from a healthy river for irrigation and different again perhaps from a healthy river for fishing or for domestic water supply (Karr, 1999).

However, I suspect that most sectors of the community would find agreement when they see a truly unhealthy river. The Cuyahoga River, which flows through Cleveland into Lake Erie, would once have clearly fallen into this category. The river was so polluted in the 1930’s to the 1960’s it caught fire on several occasions (Time Magazine, 1969). The spectacular fire in 1969 initiated an avalanche of pollution control activities in the US, resulting in the establishment of the Clean Water Act, the Great Lakes Water Quality Agreement, and the creation of the federal and state Environmental Protection Agencies. Flammability aside, what might be some less obvious symptoms that a river is unhealthy? The presence of floating dead fish or thick scums of toxic blue-green algae would surely raise doubts in most people’s minds about the quality of the water for drinking, swimming or fishing. It is important, however, to be able to reach agreement on the preferred state for our rivers as well as the undesirable.

**Reference condition**

A key approach to determining the health status of a river is to establish a reference condition. To return to the human health analogy, if you are ‘relatively healthy’...
According to your doctor, you would probably like to know in relation to what or whom. Being of ‘average fitness’ for your age is of little consolation when you realize that the average person in your age group, from which the statistics are drawn, is unfit and grossly overweight.

Depending on the specific values society wishes to set for the preferred state of its rivers, we can take an ecocentric or anthropocentric view. Given the strong direct links between healthy river ecosystems and human health, and the other essential services provided by rivers, it would be foolish not to set our reference condition from an ecocentric perspective. Most of the values we place on rivers are dependent on ecological attributes that are associated with healthy rivers (as opposed to their limited function as drains and conduits). Without significant public education of these issues, reliance on anthropocentric values alone is likely to lead to degradation of ecosystems (Rapport et al., 1998).

The best we can do from an ecocentric perspective is to base our reference condition on the least disturbed rivers. That is, systems that have experienced little influence of intensive human activity (high ‘integrity’, sensu Karr, 1999). We are indeed fortunate in Australia to still have places like this.

Characterizing river ecosystem health

Having decided on what values to base the reference condition, how do we then characterize river ecosystem health? There is growing agreement that our measures should include aspects of organization (e.g. biodiversity, species composition, food web structure), vigour (e.g. rates of production, nutrient cycling) and resilience (e.g. ability to recover from disturbance) (Rapport et al., 1998; Bunn & Davies, 2000).

A key outcome of recent research is the recognition that there can be no single reference condition for healthy rivers, even when defined purely from an ecocentric perspective. Patterns of biodiversity and species composition are often region specific, reflecting differences in climate, topography, geology and evolutionary history. Significant differences also exist in the natural rates of ecosystem processes, such as production and respiration, for similar reasons.

Healthy rivers look like … ?

In summary, we must recognize that comparisons of river ecosystem health are relative and that what is considered to be healthy is value-dependent. This aside, it is important not to set the bar too low and, where possible, to take an ecocentric view and ensure reference condition is based on the least-disturbed systems. Once reference streams or rivers have been identified, it is essential to understand how such systems function – how are they organized, what are the rates of major fluxes of energy and nutrients (vigour), how resilient are they to natural perturbations? Without this biophysical information, we cannot determine which are the key attributes to protect and what are the important things to monitor as indicators of health.

TOOLS TO QUANTIFY RIVER HEALTH?

River health monitoring has progressed a long way from the traditional dependence on chemical and physical indicators. There has been widespread adoption of the use
of biota, with a particular emphasis on aquatic macroinvertebrates but also including other major taxa (e.g. fish, algae) (Bunn, 1995).

One of the problems in developing an ecosystem health monitoring program for rivers is that we have too many potential tools from which to choose. With the exception of established national protocols for invertebrate monitoring (e.g. AusRivAS in Australia, Schofield & Davies, 1996), there is little consensus on specific methods for other indicators, and often-unashamed advocacy that ‘my indicator is best’. This has proven to be a difficult matter to resolve and has impeded the development of a comprehensive monitoring program that can be standardized across Australia. A potential solution to this dilemma can be found in the recent collaborative project to develop a practical, cost-effective ecosystem health monitoring program for streams and rivers in Southeast Queensland (SEQRWQMS, 2001). This study has evolved from a research project into what is now the freshwater component of the Ecosystem Health Monitoring Program for Southeast Queensland.

HEALTHY RIVER ECOSYSTEMS: VISION OR REALITY?

Given what we do to rivers and their catchments, is there any hope of achieving healthy river ecosystems? Could it ever be a reality or simply a vision – a fantasy? The major threat to achieving this of course is ‘us’ (6 billion of us!). We will soon pass the point of using 50% of all the stuff plants produce each year and we already use about 50% world’s annual renewable freshwater (approximately 4000 km$^3$ yr$^{-1}$) (see Postel, 1998; Gleick, 2001).

We do know that there is much we can do to protect river systems from unnecessary degradation. For example, we can protect streams and rivers by protecting and better managing their riparian zones (Lovett & Price, 1999). It is also clearly possible to improve ecosystem health in degraded streams by restoring riparian vegetation (Bunn et al., 1999a; b) and there is considerable interest and activity in riparian restoration across Australia (Price & Lovett, 1999). Unfortunately, catchment groups and individual landowners have been largely left to their own devices to undertake these activities, often on a piecemeal basis.

Having said this, it is important to acknowledge that riparian protection and restoration is not the silver bullet to cure all river ailments. It is at best the last line of defense for protecting rivers and wetlands and should never be used as an excuse for poor land management. Riparian restoration alone is likely to be quite ineffective in improving river ecosystem health in the face of catchment-scale problems such as dryland salinity. It is also a pointless activity if we continue to allow our rivers to be bled dry (Bunn & Arthington, 2002).

Despite the obvious environmental, social and economic costs of wilful neglect of some of our rivers (e.g. the Murray), the ‘freshwater buccaneers’ of this country have their targets set on new spoils. Plans to tap the floodplains of our northern rivers and to finally address the “tremendous wastage” of river water that goes into our northern estuaries and wetlands are a recent example. A major challenge for society is to satisfy the growing demands for water, without degrading aquatic ecosystems and the services they provide.

I would like to think that a vision of healthy river ecosystems is one that is shared by the wider community, recognizing the strong links with human well-being. Our
livelihoods will depend on our ability to protect and, where necessary, repair these ecological arteries of our landscape. I believe this is a vision that can be made a reality. However, it will require an enormous effort to address the problems we have already created and the political will not to repeat the mistakes of the past.

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REFERENCES


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