# Climate change: challenges facing freshwater protected area planning in Australia:

**JON NEVILL** 2 June 2007
*OnlyOnePlanet Consulting; PO Box 106 Hampton Victoria 3188 Australia. ph 0422 926 515.*

**Abstract:**
Temperatures are rising and rainfall declining over much of the Australian continent. Unfortunately, rainfall declines are most pronounced in areas where water resources are most heavily used. In many places the waters of our natural ecosystems have already been over-allocated for human use. Declining rainfall leads to greater declines in streamflow, and this, combined with over-allocation, is placing freshwater ecosystems under extreme pressure. State government streamflow management is now in sharp focus, highlighting issues of ethics, competency and compliance.

Against this alarming situation, Australia's network of freshwater protected areas fails to meet standards and commitments set many years ago in both international agreements and Commonwealth and State government policy, and little is being done to remedy the situation. In particular, our present system is neither comprehensive, adequate or representative. *Urgent action is required.*

Amongst the recommendations of this paper five are particularly important:

- immediate action should be taken to expand Australia's freshwater protected areas in a way which is both ethically responsible and systematic;
- a comprehensive national inventory of inland aquatic ecosystems should be developed, leading to a conservation status assessment of these ecosystems;
- using information already at hand, action should be taken immediately to increase protection of the nation's freshwater ecosystems of highest natural value. Particular attention should be given to rivers and subterranean ecosystems, partly through the creation of an Australian Heritage Rivers System;
- a precautionary approach should be applied immediately to the management of the cumulative impacts of small scale catchment developments, with the aim of capping water infrastructure development *well before* the catchment enters a crisis situation; and
- weak development approval planning provisions which are failing to protect important natural values should be replaced with stronger requirements for decision-makers to "seek to protect" identified catchment natural values.

**Key words:** freshwater, protected areas, climate change, aquatic, reserves, catchment, planning, cumulative, governance.

## INTRODUCTION

Climate projections and their likely impacts on freshwater ecosystems are briefly discussed, followed by a consideration of the problems Australia faces both in terms of protected area management, and in terms of managing the impacts of developments within the wider landscape on these protected areas. Most of this paper is devoted to consideration of the first of these later two issues.

There is, however, another issue so important that it demands immediate attention and discussion. It is the wider issue of the ethical stewardship of planet Earth. I suggest that many of the problems which the planet now faces are directly or indirectly the result of a pervasive moral attitude towards the planet: we act as if we own it. The current water crisis in the Murray-Darling has brought this ethical issue into focus.

The paper concludes with a number of recommendations, including the accelerated development of a comprehensive freshwater ecosystem inventory at the national level, and the development of an 'Australian Heritage Rivers System' mirroring Canada's long-established system. While protection of 'the best' is urgent, we should not neglect the need for widespread restoration which is long overdue (Lake 2005). The paper also recommends better planning to protect freshwater ecosystems in the wider landscape, particularly by a precautionary approach to the management of the cumulative effects of incremental catchment development, and the use of planning provisions obliging decision-makers to protect identified high-value ecosystems during the planning approval process.

**Terminology:**
In this paper I use the term 'freshwater' as shorthand for 'inland aquatic'; and 'freshwater ecosystems' encompasses the three major categories of lentic (slow moving), lotic (rivers and streams) and subterranean ecosystems. The term 'reserve' is used here as shorthand encompassing protected area categories I to IV under the IUCN protected area definition.

## THE ETHICS OF PROTECTED AREAS

The planet's biodiversity is in decline, and freshwater ecosystems are in urgent need of protection (Revenga and Kura 2003). The three great threats to freshwater biodiversity in Australia are: (a) the extraction of water from ecosystems for human use, (b) the destruction of natural values within catchments, leading to water pollution and changes to water flow regimes and pathways, and (c) the introduction of alien plants and animals. In many other nations the harvesting of freshwater plants and animals themselves presents a fourth major threat.

The creation of freshwater protected areas is usually justified in terms of utilitarian needs relating to the conservation of biodiversity, or the protection and enhancement of cultural, visual or recreational amenity. Could such reserves also be justified in terms of ethics? In spite of the general absence of discussion of ethics within areas of aquatic science or reserve management, a substantial and long-standing literature exists from which an ethical basis for the establishment of protected areas can be drawn. The landmarks within this literature are discussed by authors such as Aldo Leopold, Lynn White, and more recently JB Callicott (as well as many others).

Far from harvesting other life forms in a sustainable way, humans are gradually but inexorably killing the wild living inhabitants of our planet, and destroying the places in which they live. The time to adopt a new ethical position has already passed with some talk but no action. *We need to accord a right to 'peaceful coexistence' to at least a fair proportion of the other living residents of the planet* – an approach which in fact aligns with the scientific recommendations of many conservation biologists.

Australia's *National Strategy for the Conservation of Australia's Biological Diversity* (CoA 1996:2) underwent wide agency consultation prior to publication, and, in its final form, was endorsed by the Australian (Commonwealth) Government, all State and Territory Governments, and by Local Government's peak body. In it we find a simple but articulate ethical statement:

> There is in the community a view that the conservation of biological diversity also has an ethical basis. We share the earth with many other life forms which warrant our respect, whether or not they are of benefit to us. Earth belongs to the future as well as the present; no single species or generation can claim it as its own.

This clear expression (in a widely-endorsed government policy document) of the beginnings of a 'land ethic' provided Australian scientists and natural resource managers with an opportunity to build discussion and use of deeper ethical positions, yet almost nothing has happened, and a decade has passed now since this statement was published.

The recent water crisis in the Murray-Darling Basin, while exacerbated by climate change, is the direct result of government water management regimes which are both incompetent and unethical. Incompetent in so far as the Basin's waters (both surface and linked

groundwaters) have been grossly over-allocated for human use (Grafton 2007, Tan 2000) and unethical in the sense that adequate environmental flows, while highlighted in government policy documents, have in practice seldom (or almost never) been delivered. Ladson & Finlayson (2004) discuss problems with environmental flow delivery encountered in Victoria, and other States have similar problems.

Very recently this crisis has led to calls, tacitly endorsed by the very agencies responsible for the crisis, *for wetlands to be drained to supply 'urgent' human needs within the Basin*. This shameful position typifies the unethical, short-sighted views which, at a wider scale, lie behind the ongoing destruction of the world's natural areas and ecosystems, along with the essential life-support services they supply to planet Earth.

We must urgently promote ethics based on respect for the planet – before it is too late. "Planet Earth – love it or lose it". We must actively promote the expansion and protection of freshwater protected areas, at least partially on ethical grounds.

**CLIMATE CHANGE PROJECTIONS**

Overall, Australian surface air temperatures warmed by around 0.8 $^{O}$C over the period 1950 – 2004. Analysis of rainfall data for the same period shows significant declines over eastern and southern parts of Australia – the zones where most of Australia's human population reside. In the northwest of Australia, rainfall has increased during this period, an effect which may be linked to the long-distance transport of aerosols from forest burning in Indonesia and southeast Asia.

Looking to the future, CSIRO climate models predict that rainfall will continue to decline over much of the continent, especially the southwest (Pittock 2003). Temperature projections forecast continuing increases, especially in inland areas. Moisture balance projections predict drying trends over most of the continent, particularly in inland areas where rainfall declines are expected.

In the southwest of Western Australia, rainfall over the last three decades has been around 15% lower than historic long-term trends[1], and in some catchments this has translated into a 20-30% decline in surface runoff. Further declines are predicted – according to Berti *et al*. (2004): "… an 11% reduction in annual rainfall by the middle of this century could likely result in a 31% reduction in annual water yield." Where soil moisture is in deficit over the larger part of the year, and where surface aquifers are heavily harvested, declines in rainfall will be amplified (sometimes hugely) as they translate to declines in runoff and streamflow[2].

Where surface waters have already been over-committed to extractive use (through binding water licence entitlements) river ecosystems are placed under extreme pressure. Massive damage to freshwater ecosystems in areas of declining rainfall and high existing extractions, such as the Murray-Darling Basin, is now taking place, and increasing damage is almost inevitable[3], unless governments undertake licence buy-back to supply adequate environmental flows.

The COAG[4] Water Framework 1994 required State water management agencies to undertake integrated management of surface and linked groundwater. However, State agencies were slow to remedy legal and policy issues, and even slower to institute practical reforms. In New South Wales for example, although 'double counting' of surface water and linked groundwater entitlements has long been recognised, the State government has now been in negotiation with farmers for licence buy-back for six years, with little progress made in retrieving licensed over-allocations. It took the Tasmanian Government five years to change legislative arrangements which had divided management of surface and groundwaters between two separate government agencies. Many other examples could be found of government inertia and incompetence on these issues.

**IMPLICATIONS FOR AQUATIC ECOSYSTEMS**

Aquatic ecosystems will respond to various aspects of climate change, particularly changes to levels, seasonality and extreme events, in both temperature and rainfall. Changes to wind, temperature and cloudiness will influence evapotranspiration levels. Changes to rainfall

levels and intensity will influence erosion levels and nutrient inputs to aquatic ecosystems. Both salinity and nutrient levels are likely to increase in some areas, particularly in seasonally land-locked water bodies.

Aquatic vegetation will be reduced in many areas. In the Macquarie Marshes alone, Hassall and Associates (1998) predict that both semi-permanent and ephemeral wetland vegetation will be reduced by 20-40% of their original area by 2030 as a direct result of climate change.

Aquatic and semi-aquatic plants and animals will be directly affected by climate change in various ways. Species with limited mobility, such as obligate freshwater species, will face major problems in moving to colonize new environments as conditions change, and as a result extinctions are likely (Hassall and Associates 1998). Animals living near the limits of their temperature range will face obvious difficulties – Tasmanian galaxiids, for example, have no southerly habitats available as water temperatures rise, and alpine species are in an even worse situation. The introduced salmonids thrive in cold water and will face similar problems – perhaps this may prove a small blessing. Waterbirds and fish dependent on rising flood levels as breeding stimulus will struggle to maintain populations if flood frequency and intensity decline. Floods have many positive ecological functions, particularly in lowland ecosystems (Lake et al. 2006). Declining river flows will effect native fish (such as the Macquarie Perch) dependent on flowing water to breed. Some natives, however, are well adapted to drought[5]. The introduced carp (a major pest) while adapted to slow moving turbid waters, also benefit from high flows which expose floodplain habitat.

Rising sea levels will intrude into low-lying coastal freshwater wetlands, causing major destruction of these ecosystems. While noting multiple causes, Pittock 2003 states:

> In some areas of the Northern Territory, dramatic expansion of some tidal creek systems has occurred since the 1940s. In the Lower Mary River system, two creeks have extended more than 4 km inland, invading freshwater wetlands (Woodroffe and Mulrennan, 1993; Bayliss *et al.*, 1997; Mulrennan and Woodroffe, 1998). Rates of extension of saltwater ecosystems inland in excess of 0.5 km per year have been measured (Knighton *et al.*, 1992). The saltwater intrusion has had dramatic effects on the vegetation of formerly freshwater wetlands with more than 17,000 ha adversely affected and a further 35–40% of the plains immediately threatened (Mulrennan and Woodroffe 1998).

There will of course be winners and losers, ecologically speaking, from these climate-driven changes. Overall, however, there is no doubt that a great many of Australia's scarce and poorly protected freshwater ecosystems face catastrophic damage, hugely exacerbated by the pervasive over-allocation of the waters of these ecosystems for human use.

**AUSTRALIA'S FRESHWATER PROTECTED AREAS**

The history of freshwater protected areas in Australia is, in large part, a story of good intentions not carried through. There is also a plethora of different conservation tools that can be used to protect aquatic ecosystems – but have largely remained under-utilised (Kingsford *et al.* 2005, Nevill & Phillips 2004:ss.1.5 & 7, Nevill 2007).

Water regulations and licences have been poorly enforced in all Australian States, and the legacy of this 'relaxed' culture remains today, with unfortunate consequences. Where farmers have invested on the assumption that consumption in excess of licence limits will not be penalised, both users and governments are caught in a no-win situation.

The Australian government can establish protected areas on Commonwealth land, and can encourage or require limited protective action from the States where values of national importance (eg: Ramsar sites[6]) are threatened (Nevill & Phillips 2004:s.6.1).

Australia signed the international Ramsar *Convention on Wetlands 1971* in 1974, which requires the conservation and 'wise use' of all wetland types – which, under the Ramsar definition of 'wetlands', includes rivers and groundwater ecosystems, as well as estuaries. After 33 years, few Australian rivers[7] have been directly protected under Ramsar provisions,

although some have been listed in the *Directory of Important Wetlands in Australia* (DIWA) (DEH 2001). The DIWA contains State-by-State lists of nationally (and internationally) important wetlands, including Australia's 64 Ramsar-listed wetlands[8].

Australia's obligations under the Ramsar convention include the preparation of ecosystem inventories. Although none of the State-wide inventories are comprehensive in the sense of containing up-to-date information on value and condition, work is progressing slowly. New South Wales has digital coverage of all wetlands (including floodplains) and their protective status (Kingsford *et al.* 2004). Victoria, Tasmania and the Australian Capital Territory also have reasonably good State-wide inventories of wetlands, with floodplains variously mapped. Other jurisdictions are preparing State inventories, apart from Western Australia and the Northern Territory where the focus is on regional inventories (Nevill & Phillips 2004). Queensland has embarked on the most comprehensive inventory yet attempted in Australia.

State governments have listed[9] some wetlands as Ramsar sites or (more often) included them within the DIWA. Ramsar sites receive limited protection under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999,* as well as some State legislation such as Victoria's *State Environment Protection Policy (Waters of Victoria) 2003.* DIWA listing constitutes a referral trigger in Queensland's *Integrated Planning Act 1997*[10]*.* While the DIWA itself is not formally linked to any Commonwealth or State protection policies other than in Queensland, it is taken into account by many local government and regional resource planning bodies in making land use planning decisions. However, it does not yet include rivers or underground ecosystems in a comprehensive way, despite the Ramsar Secretariat's broad 'wetland' definition. Unfortunately, "taken into account" often means little in practice.

Ramsar sites have also been subject to deliberate habitat destruction by landholders on a large scale – sometimes followed by court action, and sometimes 'overlooked' by State authorities[11].

Several discharge springs from the Great Artesian Basin (GAB) as well as four other aquatic ecosystems[12] are listed as 'threatened ecological communities' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – another protective mechanism albeit not very effective at present. While in theory the EPBC Act can protect against major new developments that may constitute a direct threat to an area's values, it cannot force proactive biodiversity management, nor can it control a multitude of small widespread activities draining water flows from a site. Many GAB springs, known to include endemics (Ponder 2004), are already extinct as a result of drawdown resulting from over-use of artesian water[13]. Failure to effectively control the cumulative effects of incremental water development is causing major problems for biological reserves worldwide (Pringle 2001).

We are not protecting all of our most important aquatic ecosystems. Certainly the existing reserve system includes some important freshwater areas (e.g., Ramsar sites) and other freshwater ecosystems are contained within large terrestrial reserves (Nevill 2005). However the reserve system has not been created with the benefit of a systematic analysis of wetland types, and *little published information is available on the extent to which representative freshwater ecosystems are protected within existing reserves***.** Here it is worth noting the exception of studies such as those in the Wimmera[14] and northern Victoria (Fitzsimons and Robertson 2003, Robertson and Fitzsimons 2006) and in NSW where there is an analysis of the conservation status for broad wetland types (Kingsford *et al.* 2004).

A comprehensive assessment would identify the original[15] extent of different ecosystem types at a finer level, their current extent, and the degree to which they are now protected (Fitzsimons and Robertson 2005). The methodology for such studies is well established as similar investigations were undertaken for forest ecosystems some years ago, as part of the Regional Forests Agreement (RFA) process[16]. Such a study, based on a national inventory, is urgent and overdue[17].

A review of the National Reserve System (NRS) using River Environment Types as surrogate riverine ecosystem types was undertaken by Stein (2006). It is no surprise that this

analysis showed that the NRS has not yet achieved its goal of a comprehensive, adequate and representative protected area system for riverine ecosystems. While nearly 7% of the stream length (at a map scale of 1:250,000) falls within protected areas, nearly half of this protected length is potentially threatened by human activities within unprotected upstream areas. Many of these streams are seasonal or ephemeral. Few protected areas encompass entire river basins. An analysis of rivers rather than streams shows that only around 2% of total river length lies within protected areas, with upstream catchments protected, and no downstream dams. Furthermore, the assessment showed there is significant bias within the NRS. While a few river ecosystems are well protected, many others, including numerous rare and threatened types, have very limited or no protection. A recent study undertaken by the Fenner School of Environment and Society at the Australian National University (Stein et al. 2007 unpublished) similarly found many of the rivers within protected areas in NSW were likely to be stressed due to over allocation of water upstream.

A Commonwealth / State committee is currently examining options for protecting high value aquatic ecosystems. It is clear that the current reserve system is neither comprehensive, adequate or representative. While these issues should be addressed, it will also be important, in the context of climate change, to consider how aquatic ecosystems may evolve, and to try to facilitate corridors and links between protected areas.

**STATE FRESHWATER PROTECTED AREA PROGRAMS**

All States are, in theory at least, committed to the establishment of systems of protected areas which contain representative examples of *all* major ecosystem types, including aquatic ecosystems. Victoria[18] holds the earliest of these commitments (1987) and South Australia the most recent (2003) (Nevill & Phillips 2004). Such programs are in line with Australia's obligations under the *World Charter for Nature 1982* (a resolution of the United Nations General Assembly) and the *Convention on Biological Diversity 1992*. However, it is the *timing* which is at issue – there have been extended delays in implementing policy. With respect to freshwater protected areas, these obligations have not yet been carried through in a systematic way in any Australian jurisdiction other than the Australian Capital Territory[19].

Protection measures for entire rivers can be devised, but are poorly implemented in Australia. The Victorian government identified 15 'representative rivers' for protection in 1992; 15 years later, four of these rivers remain without management plans (Nevill & Phillips 2004). Victoria passed a *Heritage Rivers Act* in 1992, nominating 18 rivers and 25 'natural catchments'[20] to be protected[21]. The Act established a management sequence: (a) preparation of draft management plans, (b) public comment and review, (c) ministerial endorsement of the plans, and (d) implementation. Draft management plans for these 18 rivers were published for stakeholder comment in 1997. However, after 10 years, all river management plans remain as drafts without the required ministerial endorsement (Nevill & Phillips 2004) in spite of a government commitment to have them complete by 1998[22].

Several States have legislation in place aimed specifically at the protection of threatened species and ecological communities; however the area-protection provisions of these statutes have rarely been used to protect freshwater environments[23]. The 'critical habitat' provisions of Victoria's *Flora and Fauna Guarantee Act 1988*, for example, have not yet been used to protect freshwater habitats (Nevill & Phillips 2004). It is however worth noting that Victoria is the only State so far to extend the concept of 'no net loss' to 'net gain' in relation to developments impacting on important areas of native vegetation – including wetland vegetation (Nevill & Phillips 2004:A3.15).

In line with the international *Code of Conduct for Responsible Fisheries* (FAO 1995:6.8) Queensland, New South Wales, Victoria, South Australia and Tasmania all have fisheries legislation providing for the establishment of aquatic protected areas. However (in spite of progress in the marine environment) none of these provisions have yet been used to protect freshwaters (Nevill & Phillips 2004).

Both Western Australia and New South Wales considered legislation similar to Victoria's *Heritage Rivers Act 1992*, but there was inadequate parliamentary support in the face of opposition by farmer and fisher groups. Western Australia developed a *Wetlands*

*Conservation Policy* in 1997 which covered rivers using the Ramsar definition; however, ten years later, the protective provisions foreshadowed in this policy have not yet been put in place in a comprehensive way (Nevill & Phillips 2004). In the mid-1990s New South Wales amended the *National Parks and Wildlife Act 1974* to provide for the declaration of 'wild rivers'. No action was taken until December 2005, when the NSW Government announced the listing of five rivers, all within existing terrestrial protected areas (Nevill 2005).

The Queensland Government started work on a rivers policy in 2000, which developed into a commitment to provide legislative protection for wild rivers. Nineteen rivers were proposed for consideration in 2004, and a policy implementation paper was provided to stakeholders. The *Wild Rivers Act 2005* came into effect on 14 October 2005; it is to be hoped that wild river declarations under this statute will be fully implemented and effective. So far six rivers have been nominated and declared under the Act. The recent history of native vegetation protection legislation in several States[24], as well as Victoria's *Heritage Rivers Act*, has indicated that effective implementation can be a major stumbling-block, even with legislative protection 'theoretically' in place.

South Australia and the Northern Territory (NT) both have government policy statements committing to the protection of representative examples of all major freshwater ecosystems, however at this stage neither jurisdiction has funded a program to carry these commitments through in a systematic way (Nevill & Phillips 2004). The NT's *Parks and Conservation Masterplan* 2006 reinforces earlier commitments, and it is to be hoped that action will now be taken.

In the NT, as in northern Queensland and Western Australia, significant areas of land (around 50% in the case of the NT) are under the custodianship of Indigenous groups. The Commonwealth's long-standing Indigenous Protected Area (IPA) program has achieved successes, and could be extended to assist Indigenous groups protect freshwater ecosystems. The recent Tropical Rivers Program (a Commonwealth initiative under Land and Water Australia) is providing increased knowledge of tropical freshwater ecosystems and measures needed to protect them .

Tasmania's *Nature Conservation Strategy 2000* and the subsequent *State Water Development Plan* established a government commitment to develop comprehensive protection for all freshwater ecosystem values, and the program commenced in a systematic way. The Conservation of Freshwater Ecosystem Values (CFEV) Project undertook the design phase of this work, which, when completed, will establish the scientific basis for the identification and selection of freshwater protected areas across the State, as well as providing information for regional natural resource planning initiatives. The CFEV project was expected to produce its final report in 2005; after a long delay the final report is now (apparently) imminent. No specific funds were allocated for project implementation in the 2005/6 or 2006/7 State budgets, in spite of the fact that the project is expected to identify priority sites for protection.

The above discussion indicates that excellent scientific preparation and good policy development do not guarantee effective implementation.

**CONCLUSIONS AND RECOMMENDATIONS**

*There are solutions*. Techniques are available for managing highly connected linear reserves (Saunders *et al.* 2002). There are a variety of under-utilised 'conservation tools' for protecting and managing Australia's aquatic ecosystems, including environmental flows, protected areas, natural resource management plans and landholder incentives (Kingsford *et al.* 2005, Whitten *et al.* 2002). Governments should implement existing State policies to establish systems of representative protected areas for freshwater ecosystems, in line with our international commitments under the *Convention on Biological Diversity 1992* (Dunn 2000; Georges and Cottingham 2001; Nevill 2001). Where rehabilitation is undertaken, restoring water flows and quality must be accompanied by restoration of riparian and flood plain vegetation (Lake et al. 2007), along with control of alien species if practical. Urgent action by all three levels of Australian government should encompass:

a) **Major rivers where ecosystems remain substantially intact should be protected** (Morton *et al.* 2002; Wentworth Group 2002, 2003). Several models of protection have been proposed. These include the establishment of a four-tiered river classification, including 'heritage rivers' and 'conservation rivers' which would both receive special protection (Cullen 2002; Wentworth Group 2003). There is potential for introducing an Australian Heritage River system loosely based on the *Canadian Heritage River System* (Kingsford *et al.* 2005). This system has worked so well in Canada that there is no doubt that it would work effectively in Australia, given Commonwealth and State government commitment. Some whole catchments currently receive protection from specific agreements (e.g., Lake Eyre Basin Agreement; Paroo River Agreement). The inclusion of 'representative rivers' within the Ramsar framework should also be promoted (Nevill & Phillips 2004).

b) **Ecosystem inventories also need accelerated development**, partly to underpin protected area identification and selection, and partly to support 'sympathetic' management of biodiversity values within regional resource planning frameworks. Classification and mapping techniques must be used thoughtfully in reserve design and selection (Fitzsimons and Robertson 2005) to ensure an adequate CAR protected area system. Inventories should be constructed to support a variety of classification methods (Blackman *et al.* 1992; Finlayson *et al.* 2002; Ramsar Secretariat 2002[25]). Aquatic bioregionalisations should be developed, partly based on a national freshwater ecosystem database (xx cite Tait and the recent NZ report here).

c) **The control of cumulative effects, particularly within catchment-scale management frameworks, needs much greater attention** (Collares-Pereira and Cowx 2004; Pringle 2001). The precautionary approach, widely accepted but seldom applied, needs strong support especially where high conservation values remain intact (Nevill 2003).

d) Many State and local government planning provisions do little or nothing to protect wetland or river values from proposed developments. The use of **planning procedures where decision-makers are obliged, by law, to "seek to protect" the values of identified high-conservation status ecosystems, during the assessment of proposed developments, needs to replace existing planning requirements which merely demand that impacts "be taken into account"** (Nevill 2007).

e) As recommended by the 2004 Sydney *Conference on Freshwater Protected Areas* (WWF Australia and the Inland Rivers Network) **all Australian jurisdictions should accelerate the development of freshwater protected areas** (Kingsford & Nevill 2006)**.**

f) **The rehabilitation[26] of significant aquatic sites should remain a priority** (Koehn and Brierley 2000, Rutherfurd *et al.* 2000). Restoration of Australia's degraded aquatic ecosystems, not just significant sites, is long overdue.[27]

g) **Stakeholders with common interests need to start building consensus and raising awareness.** Adequate stakeholder consultation in the selection of protected areas is essential to allow for the inclusion of local and regional values, and to build community support for protected area programs and the wider sympathetic management of utilized ecosystems (Kingsford *et al.* 2005).

The National Reserve System (NRS) *Directions Statement* (NRMMC 2005) signalled a new emphasis on freshwater ecosystems (Direction 7): *'Review the current understanding of freshwater biodiversity in relation to the NRS CAR [comprehensive, adequate and representative] reserve system, and finalise an agreed approach, which may include future amendments of the NRS Guidelines, to ensure freshwater ecosystems are appropriately incorporated within the NRS.'* This initiative needs strong support, as does the Murray Darling Basin Commission's native fish strategy (MDBMC 2003).

**The need to establish comprehensive and representative freshwater protected areas is urgent, given increasing concerns about limited water availability for Australia's cities, industries and agriculture - and the ongoing degradation of aquatic**

**ecosystems. This should be accompanied by effective land and water management that pays more than lip service to the environmental requirements of aquatic ecosystems. State governments should act with the support and collaboration of the Commonwealth.**

The most urgent initiative appears to be a national reserve system 'gap analysis' which would identify those ecosystems most at risk. A comprehensive national assessment of the conservation status of freshwater ecosystems should be undertaken immediately[28]. Such a study would provide a platform for the systematic expansion of the nation's freshwater protected areas, as well as a catalyst for innovative 'bottom-up' conservation approaches driven by local stakeholders. This should include establishment of an Australian Heritage River system, coordinated by governments, and supported by regional communities.

**Acknowledgements:** My thanks to all those who contributed to the scientists' consensus statement on freshwater protected areas 2005 (available on www.onlyoneplanet.com.au) and especially to Richard Kingsford and Janet Stein. Special thanks too for constructive comment on this paper in draft from Sam Lake, Brian Finlayson, Tony Ladson, Michael Dunlop, Liz Dovey and Brendan Ebner.

## REFERENCES

Bayliss, B.L., Brennan, K.G., Eliot, I., Finlayson, C.M., Hall, R.N., House, T., Pidgeon, R.W.J., Walden, D., and Waterman, P., (1997) *Vulnerability assessment of predicted climate change and sea level rise in the Alligator Rivers Region, Northern Territory, Australia*. Supervising Scientist Report 123, Supervising Scientist, Canberra, Australia.

Berti, M.L., Bari, M.A., Charles, S.P. & Hauck, E.J., (2004) *Climate change, catchment runoff and risks to water supply in the south-west of Western Australia*, DEWA Department of Environment Western Australia, Perth.

Blackman J.G., Spain A.V. and Whitey L.A., (1992) Provisional handbook for the classification and field assessment of Queensland wetlands and deepwater habitats. Department of Environment and Heritage, Brisbane Queensland.

Callicott, JB (1992) 'Principal traditions in American environmental ethics: a survey of moral values for framing an American oceans policy', *Ocean and Coastal Management*, vol. 17, pp. 299-325.

Callicott, JB (2003) 'Wetland gloom and wetland glory', *Philosophy and Geography*, vol. 6, no. 1, pp. 33-45.

CoA Commonwealth of Australia (1996) *National strategy for the conservation of Australia's biological diversity*. Department of the Environment, Sport and Territories, Canberra. Also available at http://www.erin.gov.au/net/biostrat.html. Accessed May 2000.

Collares-Pereira, M. and Cowx, I.G., (2004) 'The role of catchment-scale environmental management in freshwater fish conservation', *Fisheries Management and Ecology* 11: 303-13.

Cowx IG & Collares-Pereira MJ (2002) Freshwater fish conservation: options for the future. In: Collares-Pereira, M, Cowx, IG & Coelho, MM (eds) *Conservation of freshwater fishes: options for the future*, Blackwell Science, Oxford.

Cullen, P., (2002) *The heritage river proposal; conserving Australia's undamaged rivers*. Paper presented to the World Congress on Aquatic Protected Areas, Cairns

Australia, August 14-17 2002. Australian Society for Fish Biology. Perth Western Australia.

DEH Department of the Environment and Heritage, Australia (2001) Directory of important wetlands in Australia; third edition. www.deh.gov.au, accessed 22/01/05.

Dunn, H., (2000) *Identifying and protecting rivers of high ecological value*; LWRDDC Occasional Paper 01/00. Land and Water Resources Research and Development Corporation, Canberra.

Finlayson C.M., Begg G.W., Howes J., Davies J., Tagi K. and Lowry J., (2002) *A manual for an inventory of Asian wetlands*. Wetlands International, Kuala Lumpur. www.wetlands.org/awi/AWI_Manual.pdf, accessed 12/04/05.

Fitzsimons, J.A., and Robertson, H.A., (2003) Wetland reservation status and reserve design in the Wimmera, Victoria. *Ecological Management and Restoration* 2: 140-143.

Fitzsimons, J.A., and Robertson, H.A., (2005) Freshwater reserves in Australia: directions and challenges for the development of a comprehensive, adequate and representative system of protected areas. *Hydrobiologia* 552: 87-97.

Georges, A. and Cottingham, P., (2001) *Biodiversity in inland waters: Priorities for its protection and management*. Recommendations from the 2001 Fenner Conference on the Environment. Cooperative Research Centre for Freshwater Ecology Technical Report 1/2002; University of Canberra, Canberra.

Grafton, QR (2007) 'An economic evaluation of the National Plan for Water Security', in Q Grafton, J Bennett & K Hussey (eds), *Policy Briefs: Dry Water*, Crawford School of Economics and Government, Australian National University, Canberra.

Hassall and Associates, (1998) *Climate change scenarios and managing the scarce water resources of the Macquarie River*. Hassall and Associates, NSW Department of Land and Water Conservation, NSW National Parks and Wildlife Service and CSIRO Atmospheric Research. Report to the Australian Greenhouse Office.

Kingsford, R. K. and Nevill J. (2006) Urgent need for a systematic expansion of freshwater protected areas in Australia: a scientists' consensus statement. From www.onlyoneplanet.com.au, accessed 20/5/2007.

Kingsford, R. T., Brandis, K., Thomas, R. F., Crighton, P., Knowles, E. and Gale, E., (2004) Classifying landform at broad spatial scales: the distribution and conservation of wetlands in New South Wales, Australia. *Marine and Freshwater Research* 55: 1-15.

Kingsford, R.T., Dunn H., Love, D., Nevill, J. Stein, J. and Tait, J. (2005) Protecting Australia's rivers, wetlands and estuaries of high conservation value: a blueprint. Department of Environment and Heritage Australia, Canberra.

Knighton A. D., C.D. Woodroffe and K. Mills (1992) The evolution of tidal creek networks, Mary River, Northern Australia. *Earth Surface Proc. Land*. 17, 167-90.

Koehn, J. and Brierley, G. (2000) *A framework for river restoration*. Land and Water Resources Research and Development Corporation, Canberra.

Ladson, A. R. and Finlayson, B. L. (2004) Specifying the environment's right to water: lessons from Victoria. *Dialogue* (Journal of the Academy of Social Sciences in Australia) 23: 19-28.

Lake, S (2005) 'Perturbantion, restoration and seeking ecological sustainability in Australian flowing waters', *Hydrobiologia*, vol. 522, pp. 109-20.

Lake, S, Bond, N & Reich, P (2006) 'Floods down rivers: from damaging to replenishing forces', *Advances in Ecological Research*, vol. 39, pp. 41-58.

Lake, S, Bond, N & Reich, P (2007) 'Linking ecological theory with stream restoration', *Freshwater Biology*, vol. 52, pp. 597-615.

Leopold, A (1948) *A sand county almanac*, Ballantine, New York.

MDBMC Murray-Darling Basin Ministerial Council (2003) *Native fish strategy for the Murray-Darling Basin 2003-2013*. June 2003. Murray- Darling Basin Commission, Canberra.

Morton S., Cristofani P., Cullen P., Possingham H. and Young M. (2002) *Sustaining our Natural Systems and Biodiversity*: An independent report to the Prime Minister's Science, Engineering and Innovation Council. CSIRO and Environment Australia, Canberra.

Mulrennan M. E. and Woodroffe C. D., (1998) Saltwater intrusions into the coastal plains of the Lower Mary River, Northern Territory, Australia. *Journal of Environmental Management*, 54, 169-88.

Nevill, J. (2001) Freshwater biodiversity: protecting freshwater ecosystems in the face of infrastructure development. Water Research Foundation, Canberra.

Nevill, J. (2003) Managing the cumulative effects of incremental development in freshwater resources. *Environmental and Planning Law Journal* **20**: 85-94.

Nevill, J. (2007) Policy failure: Australian freshwater protected area networks. *Australian Journal of Environmental Management* 14(1):35-47.

Nevill, J. and Phillips, N. (2004) *The Australian freshwater protected areas resourcebook.* OnlyOnePlanet, Hampton Melbourne.

Nevill, J., (2005) *Counting Australia's protected rivers*. OnlyOnePlanet Australia. From www.onlyoneplanet.com.au, accessed 29/05/05.

NRMMC Natural Resource Management Ministerial Council ( 2005) *Directions for the National Reserve System - a partnership approach.* Department for the Environment and Heritage, Canberra.

Pittock, B. (ed.), (2003) Climate change — an Australian guide to the science and potential impacts, Australian Greenhouse Office, Canberra.

Ponder, W.F. (2004) Endemic aquatic macroinvertebrates of artesian springs of the Great Artesian Basin – progress and future directions. *Records of the South Australian Museum Monograph Series* 7: 101-110.

Pringle, C.M., (2001) Hydrologic connectivity and the management of biological reserves: a global perspective. *Ecological Applications* 11: 981-998.

Ramsar Secretariat (2002) *Resolution VIII.6 on wetland inventory.* RS, Gland Switzerland. www.ramsar.org/res/key_res_viii_06_e.htm, accessed 28/03/05.

Revenga, C. and Kura, Y., 2003. *Status and trends of biodiversity of inland water ecosystems*. Technical Series No.11. Secretariat of the Convention on Biological Diversity, Montreal Canada.

Robertson, H.A., and Fitzsimons, J.A. (2006) Wetland reservation on Victoria's Northern Plains and riverine forests. *Proceedings of the Royal Society of Victoria*.

Rutherfurd, I., Jerie K., and Marsh N. (2000) *A rehabilitation manual for Australian streams*. Volume One: Concepts and Planning. Volume Two: Rehabilitation Tools. Land and Water Australia, Canberra.

Saunders D.L., Meeuwig J.J. and Vincent A.C.J. (2002) Freshwater protected areas: strategies for conservation. *Conservation Biology* 16: 30-41.

Stein, J. L. (2006) *A continental landscape framework for systematic conservation planning for Australian rivers and streams*. PhD Thesis, Centre for Resource and Environmental Studies, Australian National University, Canberra.

Stein, J. L., Hutchinson, M. F. and Stein, J. A. (2007) *Statewide modelling of natural flow and upstream water allocations*; Consultancy prepared for the Water Resources Division, NSW Department of Natural Resources. The Fenner School of Environment and Society, Australian National University, Canberra.

Tan, P. L. (2000) Conflict over water resources in Queensland: all eyes on the Lower Balonne. *Environmental and Planning Law Journal* 17: 545-568.

Wentworth Group of Concerned Scientists, (2002) *Blueprint for a living continent: a way forward.* Worldwide Fund for Nature (WWF-Australia), Sydney.

Wentworth Group of Concerned Scientists, (2003) *Blueprint for a national water plan.* Worldwide Fund for Nature (WWF-Australia), Sydney.

White, L. (1967) 'The historical roots of our ecological crisis.' *Science*, vol. 155, no. 37, pp. 1203-7.

Whitten, S, Bennett, J, Moss, W, Handley, M and Phillips, B. (2002) *Incentive measures for conserving freshwater ecosystems.* Environment Australia, Canberra.

Woodroffe, C. D. and Mulrennan M. E., (1993) *Geomorphology of the Lower Mary River Plains, Northern Territory*. Australian National University and the Conservation Commission of the Northern Territory, Darwin.

**Endnotes:**

[1] Indian Ocean Climate Initiative: http://www.ioci.org.au/what/index.html.

[2] As Brian Finlayson reminded me, the relation between rainfall and runoff is strongly non-linear, and under any circumstances a change in rainfall amount will be reflected in a much greater change in runoff.

[3] Changes brought about by agricultural or rural-residential landuse can create dramatic change to catchment hydrology – with the ability to magnify reductions in streamflow caused by climate change. The growth of farm dams, groundwater bores, land-levelling, or significant planting of fast-growing deep-rooted vegetation within a catchment (for example) can hugely reduce runoff to streams – the water is simply diverted (and ultimately transpired) before it can appear as streamflow (see pp. 305-317 of David Ingle Smith (1998) "Water in Australia" Oxford University Press, Oxford, for a discussion of these effects). Landuse can have other important effects – soil porosity in an undisturbed native forest can be much higher

than that of adjacent land which has been ploughed, planted and cropped – thus encouraging surface groundwater uptake. Across southern Australia, rivers feed from surface groundwater most of the time. Extensive forest can alter meteorological surface roughness, creating direct impacts on local climate (Pitman et al. 2004, Herron et al. 2002).

[4] COAG: Council of Australian Governments.

[5] Sam Lake notes: "Actually, we've found that carp do not survive drought as well as a number of native fish. Many native fish are pretty tough in dealing with droughts—that is provided other stresses such as pollution are not dumped on them by humans." Email 26/5/07.

[6] Ramsar sites are defined by the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as having national environmental importance – thus bringing them under the scope of the Act.

[7] Australia has hundreds of rivers, but only a handful are well protected (Nevill 2005a). The largest Ramsar-listed river is the South Alligator River in the Northern Territory, where 91% of the river catchment lies within the Kakadu National Park and associated Ramsar site. Within the Murray-Darling Basin, the Ramsar sites on rivers such as the Paroo and the Murray provide a measure of legal protection against new deleterious developments, and form five of the six 'significant ecological assets' that underpin the Murray Darling Basin Commission's *Living Murray Initiative* action program to restore some measure of environmental health to the Murray River system.

[8] Australia's 64 Ramsar sites (2004) are viewed as 'internationally significant' and cover a total of approximately 7.3 million hectares. More info: http://www.deh.gov.au.

[9] Strictly speaking, State governments do not 'list' Ramsar sites. While in practice State governments recommend areas to the Commonwealth Government, who then recommends listing to the Ramsar Secretariat, this is the result of the Commonwealth's policy of bilateral cooperation. Legally the only role of State governments (under the EPBC Act) is to be consulted by the Australian Government on proposed listings. Only the Australian Government can 'declare' Ramsar sites which the Ramsar Secretariat then lists.

[10] See Schedule 8 of the *Integrated Planning Regulations 1998.*

[11] According to Sam Lake: "Examples include Lake Corangamite in Victoria, Gwydir wetlands, Narran Lakes etc., there is quite a list." Email 25/5/07.

[12] The five listed freshwater *threatened ecological communities* (at the close of 2005) can be found at http://www.deh.gov.au/cgi-bin/sprat/public/publiclistchanges.pl. Apart from the GAB springs, the remaining four communities are lentic wetlands.

[13] Many GAB stock bores have a wastage rate of 90% or more (see http://www.gabcc.org.au/tools/getFile.aspx?tblContentItem&id=50, accessed 18/9/05).

[14] The Wimmera lies in western Victoria.

[15] "Original" in this context means pre-European (prior to 1750).

[16] According to Pressey et al. (2004): "Recent Australian guidelines for expanding forest reserves [Commonwealth of Australia 1995; Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee (JANIS) 1997] stipulated a baseline conservation target of 15% of the pre-European extent of each forest type. The guidelines also recognized that larger targets would be necessary for rare and/or threatened types and that reductions below the 15% baseline might be appropriate for extensive, secure types."

[17] This comment does not endorse the protected area target for forest ecosystem types used in the RFA, of 15%. The Commonwealth later published a target of 30% for terrestrial ecosystems in: Commonwealth of Australia (2001) *National objectives and targets for biodiversity conservation 2001-2005.* DEH website accessed 22/11/04 www.deh.gov.au. This target itself may be grossly inadequate for rare, vulnerable ecosystems, were a target of 100% might be justified on ecological grounds. The reverse side of this argument might propose a target of say 10% for common ecosystem types under low threat.

[18] Victoria was an early leader in respect to representative terrestrial ecosystem reservation, with its *Reference Areas Act 1978* and the program of systematic reservation commenced under the Land Conservation Council. Victoria's *State Conservation Strategy 1987* and its biodiversity strategy 1997 both contain commitments to the development of a fully representative reserve system. Although implementation problems have dogged freshwater protection under these policies, the commitments themselves were repeated again in the *Healthy Rivers Strategy 2003* (Nevill & Phillips 2004). There is a clear gap between rhetoric and reality in relation to freshwater ecosystem protection; nevertheless many significant

wetland additions to Victoria's Nature Conservation Reserves have occurred through land purchases over the last decade (Fitzsimons et al. 2004).

[19] Conservation in the ACT has some unusual aspects, including the large proportion (~52%) of the total land area under some form of protected area management (Nevill & Phillips 2004, CAPAD 2000 database at www.deh.gov.au.)

[20] Largely headwater catchments already protected by large national parks or reservations within utilised forests.

[21] According to A/Prof Brian Finlayson (pers. comm. 13/5/05): "The Thomson River is a Heritage River yet the Victorian government apparently had no qualms about reducing the scientifically determined environmental flow allocation. The Thomson Expert Panel process recommended an environmental flow regime of 47 GL annually. The Task Force (made up of water managers and water users) eventually agreed to an environmental flow of 12 GL/yr initially rising to 25 GL/yr in 5-6 years. The fact that it was a Heritage River appeared to carry no weight in this decision and was not mentioned in the Task Force report." According to Jon Nevill: "The Thomson River feeds one of Melbourne's major water supply dams. Given that the Victorian Government has never reported on the management of Victoria's Heritage Rivers, there appears the possibility that the 13-year delay in implementing protective management is not an administrative oversight".

[22] Commonwealth of Australia (1999) National report of Australia for the seventh Ramsar Convention on Wetlands Conference of Parties CoP7; Department of Environment and Heritage; Canberra. http://www.ramsar.org/cop7/sop7_nr_australia.htm, accessed 20/11/05.

[23] It is worth noting that that Fisheries NSW has supported the declaration (as threatened) by the NSW Government of some species and aquatic communities in the Murray-Darling and Lochlin Rivers. Recovery plans will (hopefully) be developed and fully implemented in the near future.

[24] The substantial failure of the NSW government to enforce its native vegetation protection legislation was documented on the Australian Broadcasting Commission Radio National *Background Briefing* of 14/9/2003.

[25] See clause 37.

[26] River restoration must be planned and conducted within a catchment context (Lake 2005) and should be undertaken within a framework of adaptive management over a timeframe commensurate with the catchment's ecological processes (Palmer et al. 2005).

[27] Sam Lake, email 25/5/07: "More than just rehabilitation of significant sites is needed. We need an immense restoration effort as it is evident that the scale of degradation of aquatic sites, be they wetlands or flowing waters, is immense and is continuing—in some places at an alarming rate."

[28] Australia is not alone: such investigations are needed in other nations, and ideally should be carried out in such a way that data can be assimilated globally (Brooks et al. 2004:1090).