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Submission to the Senate Select Committee on the Murray-Darling Basin Plan

Save the Murray: Think About the Fish, and Thank the Farmers

Contents

1. Summary

An almost exclusive focus on the quantity of water that can be taken from agriculture is a feature of the Murray-Darling Basin Plan. This has obscured a proper assessment of environmental need, and continues to result in the misallocation of resources in the Murray-Darling Basin.

Before the Murray-Darling Basin Plan came into effect many key indicators of environmental health showed improvement (Marohasy, 2003). The Red Gum forests, decimated in the late 1800s, had regrown. Significant quantities of environmental water had already been set-aside to ensure their regular watering. Salinity levels had more than halved, and water levels in the Murray River remained high, despite the Millennium drought. Native fish stocks, however, showed little or no improvement.

Contrary to popular perceptions we show that the demise of the fishery was not caused by agriculture, and that its rehabilitation is *not* dependent on more water, but on addressing issues of cold water pollution, predation from introduced salmonids, and the restoration of the Murray River's estuary. We illustrate this through a consideration of the interventions identified as necessary in the original *Native Fish Strategy for the Murray-Darling Basin 2003-2013*, and also the need to restore the Murray River's estuary.

2. Introduction

2.1 Over allocation as an hypothesis

The Basin Plan is a requirement of the *Commonwealth Water Act 2007*, giving effect to international agreements, and ostensibly establishing a long-term adaptive management framework for the Basin's water resources. The Basin Plan, that became legislation in November 2012, specifies a maximum quantity of water that can be used for irrigated agriculture. This was developed from the assumption that historical levels of water extraction are unsustainable, and that this was causing environmental degradation.

This assumption, however, has never been proven. For example, consider the following quote from a key technical paper by Sheldon et al. (2000) that provides the rationale for contemporary government hydrological modeling including the modeling that underpins the Basin Plan: "Not all the observed ecological impacts can be attributed to hydrological change alone; each catchment has also undergone extensive agricultural development and vegetation clearance, both of which may disturb riverine ecology. However, hydrological change is known to have an overriding and long lasting effect on ecological processes in large rivers. Thus, it would be fair to attribute a large proportion of the observed ecological change to changes in aspects of hydrology."

The concept is then demonstrated by way of computer modeling, and the output from the model is then used as evidence that there is a problem with water infrastructure development that has caused the hydrological change. So the argument is circular.

Furthermore, ecological response curves are not based on the modeling of empirical data but as explained by Sheldon et al. (2000): “Ideas for the shape of the ecological response curves came from technical advisory panel discussions”.

The concept of over allocation in the Murray Darling Basin is thus a hypothesis.

The final Basin Plan identified 10,873 GL as the maximum amount of water that could be "sustainably" extracted from the Basin on average each year; again a product of computer modelling. In arriving at a single number of 10,873GL and then extrapolating to suggest that this means an additional 2,750 GL must be taken from irrigators, the Basin Plan reinforces the perception that irrigators always take a set volume of water from the system. In reality the amount of water diverted for irrigation is highly variable with most irrigators receiving only a small fraction, or none, of their license entitlement during periods of drought.

Schedule 1 of the Basin Plan acknowledges the highly variable nature of inflows, explaining annual inflows to the Basin in the past 114 years have ranged from a high of 117,907 GL in 1956 to only 6,740 GL in 2006. The Basin Plan also notes this natural variability of flows is important to Murray Darling Basin ecology. Yet this variability is then ignored in arriving at the sustainable diversion limit of 10,873 GL based on a calculated average inflow to the entire Murray Darling Basin of 31,599 GL.

2.2 Evaporation from the Lower Lakes

The Murray River is the longest river in Australia, and with the Darling River, defines the Basin. The Murray River begins on the western slopes of the Great Diving Range, flows south west across the rich black soils of the Riverina, then cuts its way through a limestone escarpment, before entering Lake Alexandrina just below Wellington in South Australia, Figure 1. While Captain Charles Sturt, the first European to explore the area, considered this place, where the River enter Lake Alexandrina, the “termination” of the Murray, the lakes below Wellington are now considered part of the actual River system.

The termination of the Murray River, the Murray’s mouth, is now defined as a narrow entrance between sand dunes beyond Lake Alexandrina, Figure 1. Between the Murray’s (sea) mouth and Lake Alexandrina, a series of sea dykes, known locally as barrages, were built in the 1930s, Figure 1. These sea dykes were constructed to stop salt water intrusions into Lake Alexandrina, which typically occurred each year in autumn, and much more often during period of low river flow i.e. drought in the Basin (Marohasy, 2012).

Lake Alexandrina and Lake Albert are often simply referred to as the Lower Lakes. The Lower Lakes are very shallow, and with the Coorong, cover an area of approximately 140,000 hectares, Figure 1.

During the Millennium drought, in an article in *The Australian* newspaper, Australian of the Year Tim Flannery is quoted suggesting that opening the barrages (the sea dykes) and letting the area flood with seawater would save 1,300 GL of freshwater that would otherwise be lost to evaporation (Akerman, 2008). This is more water than diverted from the Snowy River each year, and almost three times the amount of water in Sydney Harbor. In short, this is a very, very significant quantity of water, particularly so during periods of water shortage, during periods of drought.

Figure 1. Lower Lakes and Coorong, a region of about 142,500 hectares in size. Map from Murray Darling Basin Commission.

This level of evaporation from the Lower Lakes is controversial with publications from the South Australian government claiming the “often-stated losses of 1,000 to 1,400 GL are incorrect” (South Australian Government, 2009).

The Basin Plan includes as its focus “restoring end-of-system flows”, and current management of the Lower Lakes is based on maintaining this vast water body at 0.75 AHD (pool level). So it is relevant to ask how much of the water once delivered as an allocation to food producers in the Riverina, could now potentially be lost to evaporation at the Lower Lakes.

Evaporation rates vary with temperature, humidity, solar radiation and wind velocity. Pan evaporation has historically been used as a proxy for actual evaporation with a coefficient of 0.75 applied when calculating for natural water bodies.

Nowadays relatively simple computer models that import relevant meteorological data are increasingly used and give a more accurate measure of evaporation (Lowe et al., 2009).

As part of the federally funded Sustainable Yields Project, CSIRO has estimated evaporation rates for Lakes Alexandrina and Albert using what is known as the Penman-Monteith model with an inclusion for water body heat storage combined with observational data from earlier published studies (McJannet, et al. 2008).

Output from the CSIRO model and also three earlier studies of evaporation from the Lower Lakes which used different techniques including pan evaporation indicate evaporation rates from the Lower Lakes are in the order of 1,171 to 1,445 mm per annum (Kotwicki, 1994; Raupach, 1976; Shepherd, 1971), see Table 1. This rate can be converted to gigaliters per year by multiplying the rate by the surface area of both lakes, which is approximately 750 kilometers squared, and then dividing by one thousand.

Period of study	Place of study	Evap. mm	Reference	GL pa
1967/68	Alexandrina & Albert	1280 pa	Shepherd 1971	960
5 days in 1975	Lake Albert	3.21 pd	Raupach 1976	878
1990 to 1992	Lake Alexandrina	1445 pa	Kotwichi 1994	1,083
Various between 1971 & 1993	Alexandrina & Albert	1323 pa	McJannet et al	992

Table 1. Estimated rates of evaporation from the Lower Lakes.

These published studies which take into account meteorological variable and lake characteristics are in reasonable agreement and give an annual volume evaporated of between 878 and 1083 GL.

The higher evaporation volumes, including the often quoted figure of 1,300 GL, may be based on the simple multiplication of annual evaporation rates for the Lower Lakes area by the surface area of the lakes divided by 1,000, for example (750 *1750)/1,000 = 1,312. A scientist familiar with the technical literature would insist this figure be multiplied by the relevant coefficient for natural water bodies (0.75).

2.3 Australia’s environment generally undergoing renewal, not collapse

When the Basin Plan was in its development, Australian poet and novelist Kate Jennings, writing for popular magazine *Monthly*, made the point that the demonising of Australian farmers had become insidious, and was reaching a crescendo (Jennings, 2011).

Many events have contributed to this general loathing in the urbanized western world of modern, sustainable high yielding agricultural practices, particularly the application of pesticides and the damning of rivers.   There are popular books by leading science writers successfully promoted on the basis of stories of such stories with a theme of environmental destruction.   Consider, for example, Pulitzer Prize-winning author Jared Diamond and his book, *Collapse: How Societies Choose to Fail or Succeed*. It states that Australia is unsuitable for agriculture, is the most unproductive continent on earth with low crop yields, and extensive land degradation including rising salinity and deteriorating water quality (Diamond, 2005).   In his concluding remarks, the American geography Professor recommends that the Australian government phase out agriculture, in particular in the Murray Darling Basin, before the situation worsens including as a consequence of climate change.

There are many examples where in the past there has been over-exploitation of the land and water resource resulting in environmental damage. But the dust storms of the 1940s, for example, are now history because of the soil conservation and revegetation works beginning in the 1950s (Scott and Olley, 2003). Then in 1983 the National Soil Conservation Program was established, followed by The Decade of Landcare from 1990.

Continued repetition of the slogan that Australia farm soils are generally barren and eroded has no basis in fact. Indeed, in a rebuttal specifically of Diamond's thesis, Jennifer Marohasy presented fact after fact for an invited journal article (Marohasy 2005a) to show that Australian farms are generally amongst the most productive and sustainable in the world, and in some situations have successfully broken natural cycles of low fertility. Yet when the Professor made his Australian tour, lectures were sold-out and the message of continued environmental degradation was meet with rapturous applause to audiences in Brisbane, Sydney and Melbourne (Marohasy, 2005b).

While many environmental issues within the Murray Darling Basin have been addressed (Marohasy, 2003), the evidence does show that native fish stocks have not recovered to pre-European settlement levels.

2.4 Native fish stocks: a neglected issue

It is only in Schedule 1 of The Basin Plan that reference is made to the serious decline in the distribution and abundance of native fish. This is considered a reflection of the continuing poor state of the river system and the impacts of agriculture.   There has been significant government funding to address the associated issues, beginning with the development and implementation of *The Native Fish Strategy for the Murray-Darling Basin 2003-2013*. This strategy (Murray Darling Basin Ministerial Council, 2004) was based on many of the same assumptions underpinning the Basin Plan and administered by the same Murray Darling Basin Authority (MDBA).

The Fish Strategy, now superseded by the Basin Plan, explained that only through a combination of interventions could native fish communities be restored to 60% of pre-European (before 1788) levels. The Strategy also detailed how specific interventions alone, and in combination, could make a significant positive impact.

Several of the interventions have been successfully completed and the amount of water recovered for the environment is now more than double the highest reference value of 1,500 GL annually that was proposed in April 2002 when The Strategy was being developed. Edition 34 of *RipRap*, a publication of the Australian River Restoration Centre, details many of the achievements of The Strategy. The many and varied articles in this publication laud The Fish Strategy as providing a coordinated and scientific approach to the rehabilitation of fish populations. But it is also stated that native fish populations are still in decline and remain at only about 10% of estimated levels before European settlement (Koehn, 2012). This is the same percentage estimated in 2003, when The Fish Strategy was launched.

If native fish populations are to be restored, we contend that emotive issues with a political dimension will need to be addressed: issues not even identified in the Basin Plan.

3. What the Fish Need, Not Always More Water

The *Native Fish Strategy for the Murray-Darling Basin 2003-2013*, launched in 2003, explained that, only through a combination of five interventions, could native fish communities be restored to 60% of pre-European levels. We consider two additional issues, not listed in the strategy or the basin plan: predation by introduced salmonids, and the need to restore the Murray River's estuary. This combined assessment is based to some extent on a 2013 conference paper (Marohasy and Abbot, 2013), and journal article recently published in *The International Journal of Sustainable Development and Planning* (Marohasy and Abbot, 2015).

The five interventions, also referred to as priority works, are considered, here with particular reference to Murray cod, *Maccullochella peelii*. This species is endemic to the Murray-Darling and is one of the largest freshwater fish in the world reaching a highest recorded weight of 113.6 kg and an age estimate between 74-114 years.

Murray cod was once part of a significant commercial fishery. However, there are currently no commercial fishing licences for Murray cod in Australia. The wild catch industry had ceased by 2004 in all Australian states, following intense lobbying from recreational fishers and environmentalists.

The Murray River's estuary was destroyed in the 1930s with the building of 7.6kms of sea dyke, known locally as barrages, across the five channels that converge on the Murray River's sea mouth. As Bourman et al. (2000) explain: "Originally a vibrant, highly productive estuarine ecosystem of 75,000 ha, characterised by mixing of brackish and fresh water with highly variable flows, barrage construction has transformed the lakes into freshwater bodies with permanently raised water levels; freshwater discharge has been reduced by 75% and the tidal prism by 90%."

Denying the Murray River a functioning estuary has significant implications for restoration of native fish species. Milang, a town on the shores of Lake Alexandrina that was once part of the Murray River's vast estuary, was once home to a thriving Mulloway fishery routinely sending off several hundred tons to the Adelaide and Melbourne fish markets (Olsen, 1991).

A mature Mulloway, *Argyrosomus japonicas*, can be 25 years old and weigh 90 pounds. This fishery collapsed in 1940 when the last of sea dykes was sealed, converting the tidal lake into an artificial freshwater reservoir. Yet there was no mention of Mulloway in The Fish Strategy, or the Basin Plan.

3.1 Cold water pollution abatement

Cold-water pollution occurs when water is released from the bottom of deep reservoirs that are thermally stratified. Most native fish species in the Murray Darling, including Murray cod, require relatively warm water temperatures to induce spawning. Studies undertaken during the 1980s, and 1990s (e.g. Ryan et al. 2001), indicate that frequent large releases of water for irrigation from the Hume and Burrinjuck dams occur in spring and early summer, which is also a critical time for spawning of key native fish species. Temperatures downstream of Burrinjuck dam on the Murrumbidgee River seldom approach levels required for spawning of key native species (Lugg, 1999). Releases from the Hume dam on the Murray can lower water temperatures by up to 7 degree Celsius (Lugg, 1999).

The expert panel that oversaw development of the Fish Strategy were confident that the abatement of cold water pollution was the most tangible and achievable of all the proposed interventions (Phillips, 2002), suggesting that this “threat could be largely removed from the Murray-Darling Basin within 10 years” i.e. before 2013. The strategy included comment: “it [cold water pollution abatement] appears to be a clearly definable, tangible, cost-effective intervention that can be completed for the major storages in the Basin within ten years, through a combination of engineering and operating changes.” Many workshops, technical papers and government reports have been written since the launch of the strategy (Koehn and Lintermans, 2012) with none of these contradicting this advice.

The Hume and Burrinjuck dams, like most of the dams through the Murray Darling, have the outlets for irrigation positioned at depth creating jets of cold water. Government-commissioned reports (e.g. Sherman et al., 2000) have considered different techniques for cold water abatement including retrofitting with multi-level outlets, artificial destratification through mechanical mixing, trunnions (pipes hinged at the outlet drawing water from different levels), surface pumps (large fan-like propellers that pump water surface water into existing outlets), and submerged rubber curtains to stop the flow of cold water to the outlets.

A study by Sherman et al. (2007) published in the journal *River Research and Applications*, estimated cold-water abatement downstream of Hume dam could be achieved for between $5 and $20 million. This is a fraction of the money already spent on implementing the Fish Strategy. However, not a single initiative that will, in practice, address the issue of cold-water pollution downstream of Hume Dam was completed during the ten years of The Fish Strategy’s implementation.

In June 2013, the New South Wales Government awarded a contract for cold-water pollution mitigation works at Burrendong Dam on the Macquarie River upstream of Wellington. There are still no plans in place to mitigate cold water pollution from the Hume dam.

3.2 Habitat restoration

The Fish Strategy explained that through habitat restoration alone, native fish populations could be restored to 25% of pre-European levels. Specifically it stated: “A diversity of habitats is needed for a diversity of species and life stages. In-stream and riparian habitats within the basin have been severely degraded by factors such as river desnagging (removal of dead tree trunks and branches), loss of wetland, floodplain and river connectivity, bank erosion and sedimentation”.

An initial focus of the Fish Strategy was resnagging 194 kilometres of river immediately down stream of Hume dam with 4,500 new snags (logs with embedded microchips). Seven years of data collection suggests that this effort has resulted in the migration of native fish into this area, including Murray cod. However, it is unclear whether there has been successful breeding of Murray cod in this stretch of river (Lyon, 2012). In fact given the cold-water pollution issues, the resnagging of this stretch of the river could have caused net migration of Murray cod into an area unsuitable for reproduction.

In the northern catchment, there have been many ‘Demonstration Reaches’ established with work in the Namoi, for example, including the reintroduction of 300 snags, 5,700 aquatic plants, 9,000 native trees and shrubs, 33.4 kilometres of woody weed management, 33.5 kilometres of riparian fencing, installing 20 off-stream watering points and 8 in-stream gully and erosion protection works (Hobson, 2012).

3.3 Environmental flows

The Fish Strategy explains that environmental flows alone could return native fish to 35% of their pre-European level, yet no benefit has been reported from this intervention.

Environmental flows are a focus of the Basin Plan that has as its target the recovery of 2,750 GL. In 2002, at the time the fish strategy was being developed, the environmental flow target was much more modest. Indeed in April 2002, when the Murray-Darling Basin Ministerial Council called for social, economic and ecological assessments of the costs and benefits of returning additional environmental water to the River Murray the three flow volumes of 350, 750 and 1,500 GL per year were chosen as 'reference points' for assessment.

Significant lobbying underpinned by a group sponsored by the World Wide Fund for Nature resulted in the higher final target of 2,750 GL being adopted.

Adoption of the higher target was aided by claims that because of human-induced climate change there was an overall decline in rainfall in the Murray Darling Basin. This decline, however, is not obvious in the official rainfall data and total annual rainfall during 2010 was the highest on record, Figure 2.

As at 30 September 2012, the MDBA reported that the water purchase program had already secured entitlements that will deliver, on average, 1,094 GL. This quantity of water in September 2011 had a market value of between $0.8 billion and $2 billion depending on where in the Basin it was purchased.

The MDBA has also reported that more than 1,327 GL of Commonwealth environmental water has been delivered. In October 2005, the Victorian government reported that 513 GL of water was delivered into the Barmah-Millewa, red gum forest in one watering “triggering large reproductive events in important native fish species such as golden perch and the threatened silver perch”.

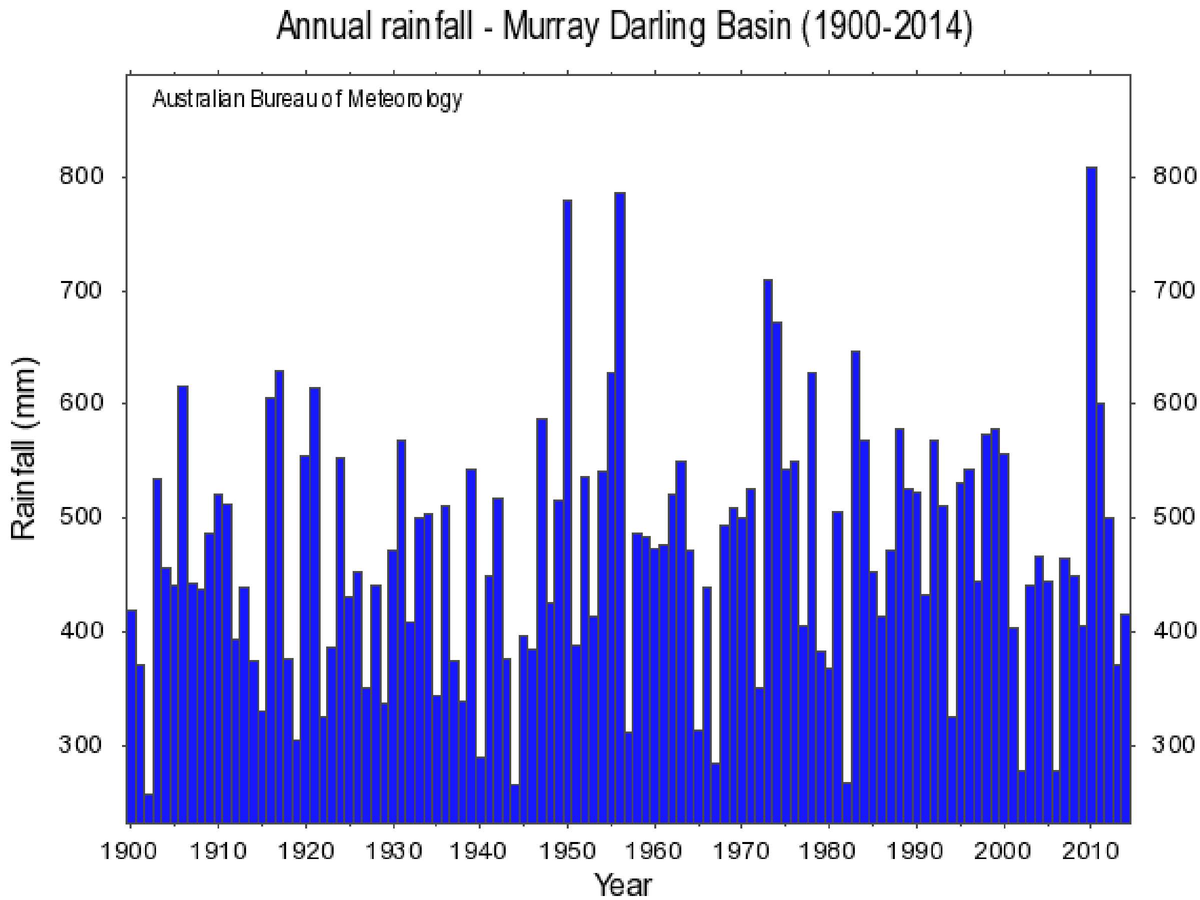

Figure 2. Annual rainfall in the Murray Darling Basin, 1900 -2014. Sourced from the Australian Bureau of Meteorology

Environmental waterings are not, however, always beneficial to native fish species because the inundation of forested floodplains can cause blackwater events that have resulted in massive fish kills. Blackwater is the name given to water flowing out of flooded forested areas that is high in dissolved organic carbon. When this organic matter is rapidly consumed by microbes, the water can be depleted of dissolved oxygen (hypoxia) with drastic consequences for native fish species. For example, in late 2010, when widespread heavy rainfall and flooding occurred throughout much of the southern Murray–Darling up to 2,000 km of the Murray River was affected by blackwater. A study of the impact of this event in the Central Murray Valley concluded that affected sites had: “significantly higher abundances of emerged Murray crayfish that were vulnerable to desiccation, predation and exploitation; large numbers of dead or dying shrimp and yabbies; significantly reduced abundances of native fish; but contained similar abundances of alien fish species (particularly common European carp, *Cyprinus carpio*)" (King et al., 2012).

The MDBA has suggested that the incidence of blackwater will decrease with more frequent flooding of forests in the Murray Darling because there will be less time for the built up of organic matter on the flood plain (MDBA, 2013), and the Basin Plan suggests that blackwater can be mitigated through the delivery of larger volumes of water. These recommendations, however, contradict advice from King et al. (2012), that specifically states increasing the volume of water in the river during a hypoxic blackwater event does not necessarily help to dilute or lessen the severity of the event, and that follow-up floods may increase the severity or prolong the blackwater event.

3.4 Carp management

The Fish Strategy explained that the pest European carp, *Cyprinus carpio*, make up an estimated 60 to 90% of the total fish biomass at many sites, with densities as high as one carp per square metre of river surface area. Through the combination of environmental flows, habitat restoration and carp management the fish strategy suggested that native fish could be returned to 45% of their pre-European levels.

If stretches of river within the Murray Darling had been allowed to completely dry out during the recent Millennium drought, carp numbers could have been dramatically reduced.

Before the development of extensive water infrastructure the Murray River occasionally ran dry. There are photographs, for example Figure 3 of the Central Murray Valley showing such a dry river bed. In a recorded oral history of the region, the late Russell McDonald claimed: "Water was never more than two feet deep while we carted timber, and for a long time in autumn 1915 was perfectly dry, the river having stopped running in February or March."

Murray cod, and other native species, can survive extended periods of drought by retreating to billabongs, with anecdotal reports that cod can even burrow and hibernate in dry riverbeds. Carp, in contrast, will be stranded in a dry riverbed and die.

The successful restoration of wetlands in the Murray Darling involves their periodic drying out in order to mimic natural wet and dry cycles (e.g. Butcher, 2009). In the case of Banrock Station in South Australia, when the flow of water from the Murray River was first stopped in 2008, native fish swam back to the river as the wetlands dried, while carp congregated in shrinking pools of water with tonnes of the pest species eventually stranded, many gorged on by tree goannas (Butcher, 2009; Crouch, 2013).

During the recent protracted Millennium drought (2001-2009) there was a continual supply of water from the Hume reservoir all the way to the most southern lock on the Murray River at Blanchetown, which is 270 km upstream from the Murray's sea mouth.

Below the lock at Blanchetown, carp could have been completely eliminated by letting the Southern Ocean penetrate the main channel of the river as once happened naturally during drought before construction of the sea dykes. There is a photograph in the State Library of South Australia taken in

1927 of a porpoise caught at Tailem Bend, which is approximately 100 km from the Murray's sea mouth. Salty water once extended this far upstream, before the estuary was dammed.

During the worst of the recent Millennium drought, water levels were allowed to fall in Lake Alexandrina to below sea level ostensibly to 'protect' existing freshwater habitat in Lake Alexandrina (Brice, 2010). This government policy was supported by the significant commercial carp industry in the Lower Murray. Hundreds of tonnes of carp are commercially harvested every year from Lake Alexandrina and converted into plant fertilizer with the commercial catch in the Lower Murray in 2008 and 2009 reported as 792 tonnes, worth $863,000 (Econsearch, 2010). Restoration of the estuary, and a Mulloway fishery would potentially provide a more lucrative outcome.

Figure 3. The middle section of the Murray River once ran dry during extended periods of drought.

3.5 Predation from introduced Samonids

There are glaring omissions in the Fish Strategy which have carried over into the Basin Plan. While it is well documented in the technical literature that introduced trout and salmon are having a significant impact on native fish populations in the Murray Darling Basin through predation and competition, this issue is not canvased in any of the official documents concerned with environmental protection, specifically the conservation and rehabilitation of native fish species.

Galaxiids, also known as jollytails, only occur in the southern hemisphere. There are 22 species in Australia, most living in freshwater, and many have been exterminated from rivers and streams by the introduction of these Samonids, in particular brown trout, *Salmo trutta* (Cadwallader, 1996). Salmonids actively prey on galaxiids and also larger native fish species including trout cod and Macquarie perch (Cadwallader, 1996).

Cold water releases from the Hume dam that inhibit breeding of native fish species are beneficial to the introduced salmonids. Brown trout, for example, has an optimum temperature range of 4-19 degree Celsius, significantly cooler than the natural temperature of the Murray River.

Brown trout are native to Europe, and were introduced into the Murray Darling, now existing as self-sustaining populations supplemented by hatchery-releases. The value of brown trout, and also rainbow trout (*Oncorhynchus mykiss*), as sport-fish and in aquaculture has overshadowed consideration of their effects on native fauna including native fish, frogs, crayfish and crabs. Cadwallader (1996) suggests that some waters be set aside specifically for the management of native fauna and that salmonids be excluded from these waters.

The Basin Plan, while ostensibly focused on environmental protection and restoration within the Murray Darling, fails to acknowledge the existence of salmonids and their value as sport-fish or detrimental impact on native fish species. This approach has enabled politicians and government officers to avoid confrontation with the significant recreational fishing lobby.

The Victorian Fly Fisher's Association states on its website that it is an historical association with considerable influence in the promotion of the sport and the propagation of trout (Victorian Fly Fishers 2013). Apparently the trout and fly-fishing lobby were initially opposed to the Fish Strategy. However, this opposition softened when it was agreed that the issue of cold-water pollution would no longer be addressed in, and was removed from, the publicity associated with rehabilitation of key demonstration reaches.

3.6 Fishways

Like many native Australian fish, Murray cod make an upstream migration to spawn. These migrations were interrupted with the construction of the dams, weirs and locks along the Murray River. According to The Fish Strategy, adding fishways as an intervention in addition to environmental flows, habitat restoration and carp management would result in the rehabilitation of native fish communities to about 55% of pre-European levels.

The Sea to Hume Dam project was a $60 million initiative with the objective of providing a continuous passage for fish from the sea mouth of the Murray to the Hume Dam, a distance of 2,225 km (Phillips, 2002). The project was due for completion in 2010 at which time it was anticipated that there would be 14 new fishways on 12 weirs and 5 sea dykes along the main stem of the Murray River (Craik, 2008).

It is believed that the fishways, all installed by June 2013, are now successfully providing continuous passage to native fish along the main stem of the Murray River for 2,200 kilometres (Towers, 2013). There has been no evaluation, however, of the overall contribution of the fishways to the rehabilitation of native fish numbers.

Monitoring of the fishways in the sea dykes, including the Tauwitchere large vertical-slot, Tauwitchere small vertical-slot, Goolwa vertical-slot, Hunters Creek Vertical slot, and the Tauwitchere rock ramp, have shown that 10,900 congolli moved through these structures during 2010 and 2011, with half of these fish using the rock-ramp. But the overwhelmingly dominant species using the fishways and rock-ramp were the pest red fin perch and tiny ubiquitous Australian smelt (*Retropinna semoni*) with 442,675 and 455,089, respectively, recorded entering or leaving the fishways and rock-ramp over this period (Zampatti, et al. 2012).

In June 2014, additional to the fishways already provided through the Sea to Hume Dam project, the South Australian Minister for the River Murray, Ian Hunter, announced an additional $2.9 million funding for more fishways for the sea dykes. However, a fishway will be of limited benefit to many estuarine fish species because they usually also need a salt water gradient. Such a gradient is dependent on tides, which were stopped from influencing the Murray River with construction of the sea dykes in the 1930s.

3.7 Estuary restoration

Before the sea dykes, when the south westerly wind picked up, the sea would often pour in through the Murray's mouth and work its way across the lake. So Lake Alexandrina was often fresh in spring and summer, but salty by autumn. In his book *Poor man river: memoirs from the River Murray estuary* Alastair Wood, a fisherman from this region, tells how the Mulloway would spend winter to the west amongst the mangroves of the Gulf of St Vincent. When the new season's winds wafted up the gulf the Mulloway returned to the Murray mouth.

The schools lead by large fish, forty pounders and heavier, would settle in the offshore underwater canyons, which are relics from a time when sea levels were much lower and the Murray River extended an additional 100 kms or so further south. Within sight of the Murray's mouth and smell of the river, Wood describes how on a full moon and a big tide, large females would swim through the surf, in through the Murray's mouth, and along the channels to the lake proper where they would gorge on the little bottom-dwelling fish, the congolli (*Pseudaphritis urvillii*).

Research from the Shoalhaven estuary in NSW, where there are no obstructions to fish movement, shows that Mulloway use the entire 48 km long estuary with high flow events driving fish downstream towards the mouth at Shoalhaven Heads (Taylor *et al*., 2014). The fish follow the shift in the location of the saltwater wedge. Of course, such a wedge is absent from the lower Murray River, because the estuary was destroyed with the construction of the sea dykes.

Studies of mulloway in the 12 km long Great Fish Estuary in South Africa show they move up and down that estuary corresponding with the speed and direction of the falling tide or, the fish remain stationary in deeper and structured habitat within the estuary (Naesje *et al*., 2012).

The Basin Plan, ostensibly about restoring the Murray River's natural environment, does not include any program of works to restore the Murray River's estuary. Battarbee *et al.* (2012) writing in *The Sage Handbook of Environmental Change* have commented that the natural state of Lake Alexandrina was tidal, has been *incorrectly* listed as freshwater in the International Ramsar Convention, and that until this natural estuarine character is recognized, it will be impossible to reverse the long-term decline in its ecological health.

The word estuary is absent from the Basin Plan. There is this idea, as an embedded assumption that the Murray River should run fresh to the sea all year, and every year. This idea, however, is not realistic or sustainable.

Water levels upstream of the sea dykes have a nominal full supply level of 0.75 meters above mean sea level, all the way upstream to Lock 1 at Blanchetown, which is 274 km upstream from the dykes. This nominal pool level, however, is varied through the operation of the gates within the dykes in accordance with seasonal inflow and evaporation. The level generally begins to increase during late winter, reaching 0.75 meters by early summer. During summer and into autumn the level will fall, with operations aiming to prevent levels below 0.35 m AHD. During the most severe periods of the most recent drought (particularly during 2008 and 2009) the water levels in Lake Alexandrina fell to 1.10 metres below sea level, with the sea stopped from flowing into the lakes by the dykes. There was simply not enough water in upstream storages to supply Lake Alexandrina with freshwater. As the lake waters receded, potential acid sulphate soils were exposed with the pyrite in the soils oxidising to form sulphuric acid. In an attempt to neutralize the soils, millions of dollars was spent liming the exposed lakebed and channels.

History will repeat itself unless something is done before the next drought, and of course there will be another drought. The government's purchase of water entitlements cannot guarantee water during years of extended drought. There was very little water available to grow rice or cotton during the Millennium drought. While many of these water licences are now the property of government, there will still be limited water for the Lower Lakes during the next long drought. A water entitlement can only facilitate a water allocation when there is water in the upstream reservoirs.

If the sea dykes were modified, or removed, however, then during periods of drought the Lower Lakes could be supplied with water from the Southern Ocean.

It is popular to claim that the Mulloway fishery was destroyed by inadequate environmental flows, rather than the sea dykes. The claim is repeated in the peer-reviewed literature, for example, by Ferguson et al. (2008). Yet their own data shows that the collapse of the Mulloway fishery occurred in the 1940s with the completion of the sea dykes (barrages). Prior to the sea dykes, good catches occurred even in drought years as shown in Figure 4.

Indeed, the year with the highest recorded mulloway catch, exceeding 600 tonnes, was 1938. This was a drought year during a dry decade in the Murray Darling with low flow to South Australia. The following year 1939, despite the persistent drought, 595 tonnes of mulloway were harvested, Figure 4.

Ignoring these early records, Ferguson et al. 2008 claim annual flow down the Murray River can explain 43 percent of the variability in the mulloway catch in the Lower Lakes and Coorong fishery.

Conveniently, at least in terms of the politics, they choose to restrict their analysis to the years 1984 to 2005. But a longer record, that precedes construction of the sea dykes, shows that after the sealing of the Goolwa barrage in February 1940, the mulloway fishery never recovered to previous levels despite the extraordinary large flows to the Lower Lakes and Murray mouth in 1956 and 1974, Figure 4.

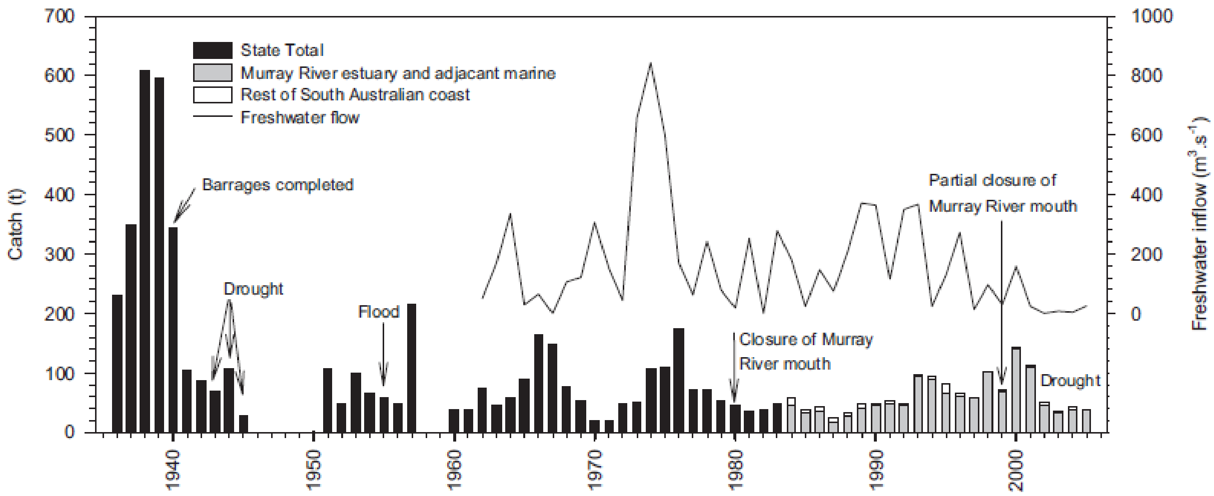

Figure 4. South Australian total catch of Mulloway from 1936 to 2005, and freshwater inflows to Lower Lakes, from Ferguson et al. 2008.

4. Conclusions and Recommendations

The Basin Plan is essentially a political document that reinforces false perceptions that over allocation of the water resource is a key issue contributing to environmental degradation in the Murray Darling Basin. The reality is quite different. Because of the historical investment in water infrastructure in the Murray Darling Basin, the Murray River no longer runs dry during periods of extended drought, and the river has on average more water than at any time in its history.

There were problems of land degradation including over-clearing of Red Gum Forests, soil erosion, dryland and irrigation salinity. These issues have, however, been largely addressed (Marohasy, 2003). Acknowledging that these issues have been addressed, would make it easier to identify important remaining environmental issues which include depressed native fish stock.

While hundreds of millions of tax payer dollars have been spent on in-river habitat restoration and the provision of fishways, these initiatives need to be complemented with cold water pollution abatement, and estuary restoration.

It is disingenuous and un-Australian for the community and government to make water buy backs the focus of the Basin Plan, when common sense and the scientific literature, clearly show there are other more pressing environmental issues.

It is also somewhat obscene to let approximately 1,000 GL of freshwater evaporate each year from the Lower Lakes during periods of drought.   Furthermore, the buyback of irrigation licenses cannot drought-proof the Lower Lakes, allocation of water to these licenses was always contingent on rainfall and snowfall in the catchment which is highly variable.   If the estuary were restored the Lower Lakes would be supplied with sea water from the Southern Ocean during periods of extended drought at no cost to the Australian taxpayer.

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This submission was compiled by Dr Jennifer Marohasy, on behalf of:
Myth and the Murray Group, PO Box 692, Noosa Heads Q. 4567.
Tel. 041 887 32 22. For more information please visit

www.MythandTheMurray.org.