Submission
No 87

INQUIRY INTO RATIONALE FOR, AND IMPACTS OF, NEW DAMS AND OTHER WATER INFRASTRUCTURE IN NSW

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Date Received: 21 September 2020

Submission to the NSW Legislative Council Inquiry into the rationale for, and impacts of, new dams and other water infrastructure in NSW

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21 September 2020

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1. Sections of the Terms of Reference this submission addresses

This submission mainly addresses the environmental and cultural impacts, and alternative solutions to the Western Weirs Project and the Macquarie River re-regulating storage. I also provide a brief comment on the rationale for the new dams.

2. Personal Background and CV

I am an aquatic scientist that has worked in the Murray-Darling Basin for 35 years. I completed my PhD on fish ecology on the Murray River in 1996. I was a government scientist (NSW Fisheries) for 10 years and have been an independent consulting scientist advising on fish ecology, fish migration, river and floodplain rehabilitation for over 25 years. I have worked on over 100 projects across the Basin in that time, including projects at every weir and most floodplains along the Murray River; and many weirs along the Barwon-Darling River and tributaries.

Much of my present work is advising the governments of the Mekong River, especially Laos PDR and Cambodia, and the Mekong River Commission on fish ecology, fish migration and balancing the development of hydropower with food security, livelihoods and biodiversity. I include a CV in Appendix 1 and can provide further details if required.

3. Ecological Background

3.1 Flowing water and stillwater habitats

There is a fundamental division in river ecology between *flowing water* (lotic) and *stillwater* (lentic), which is *river hydraulics*. This concept is fully explained in a paper I wrote with a colleague in 2018[1], and is attached in this submission (Appendix 2) as background. *Flowing water* is typified by "riffles" but includes any flow that is visibly moving (e.g. "runs"), while *stillwater* includes pools and lakes.

It is well known that there are different animals in these two habitats, including natural biofilms (fungi, algae, protozoa, bacteria), diatoms, plankton, aquatic insects, snails, mussels and fish. That is, there is a *flowing water* ecology. In the Barwon-Darling river and the NSW tributaries flowing from the Great Dividing Range, *flowing water* is a key nursery habitat for Murray cod and a key habitat for River Mussels.

Murray cod are a valuable recreational fish and both species have high cultural and totemic value in aboriginal culture. Many River Mussels died in the last drought in the Darling River because there were no flowing water habitats for many, many months. Although adult Murray cod can survive in large pools, where there is good water quality, the survival of larvae and young fish is dependent on flowing water habitats and the diverse food webs that these provide.

This is a critical concept for the present Inquiry – and river management across the Murray-Darling Basin because dams and weirs create backwater and pool-like conditions; where this happens, *flowing water* habitats are reduced and biodiversity declines. In many cases, species become locally extinct – they cannot survive in the permanent or semi-permanent

[1] Mallen-Cooper, M., and Zampatti, B.P. (2018) History, hydrology and hydraulics: rethinking the ecological management of large rivers. *Ecohydrology* **11**(5), DOI: 10.1002/eco.1965.

pool-like conditions. This applies to any new or enlarged dam or weir, which all increase backwater and inundate flowing streams

3.2 Flow and hydraulic impacts in the Barwon-Darling River

Of specific relevance to the present Inquiry is a scientific paper[2] on the Barwon-Darling River I just published with a colleague last week (Appendix 3) which provides significant background for the following submission. Please note that this submission uses the science from this paper but is my own opinion and does not necessarily reflect the opinions of the co-author of the paper.

The major points from the Barwon-Darling paper are:

Historical flows in droughts

- River flows in the worst historical droughts (Federation Drought 1895-1903, World War II Drought 1939-45) were compared with recent droughts (Millennium Drought 2001-09, 2013-2020).
- There is a perception that during historical droughts the Darling River formed a series of pools until the drought broke, which could be years. This is not true. In droughts it flowed over 85% of the time. From 1885-1950 the Barwon-Darling River flowed over 90% of the time.
- In historical droughts there were high baseflows most of the time, and large in-channel flow pulses (e.g. river rising 3 m) every 15 months.
- In recent droughts, baseflows in the Darling River have decreased by 98%, while near-annual flow pulses have decreased by 90%, due to capture and storage of flow in large dams (Burrendong, Keepit, Copeton, Pindari, Glenlyon) [see published data in Appendix 3]. Fish and other aquatic animals need these flows to survive and reproduce.
- Baseflows are now so low in droughts they are often a trickle and are insufficient to provide *flowing water* habitat (data in Appendix 3). Hence, fish, river mussels and aquatic biodiversity in general, are declining.

Present Water Management

- While there was zero flow in the Darling River for 433 days in 2018-19 - and there was a crisis at Menindee - over 900,000 megalitres was released from NSW dams: 800,000 for irrigation; 100,000 for the environment. Total storage went from 34% to 4%.
- In the same period, with zero flow in the Darling, 30,000 megalitres flowed into the upper reaches of the Barwon-Darling but it was captured in weirpools that are used for town water supplies.

[2] Mallen-Cooper, M., and Zampatti, B.P. (2020) Restoring the ecological integrity of a dryland river: why low flows in the Barwon-Darling River must *flow*. *Ecological Management & Restoration*, DOI: 10.1111/emr.12428

- Weirs along the Barwon-Darling River back water up for 40% of the river thereby eliminating *flowing water* habitats – and Murray cod nursery areas and River Mussel habitats - and reducing biodiversity. These weirpools compound the problem of low baseflows that reduce *flowing water* habitat. Weirpools also provide more carp habitat.
- The Barwon-Darling receives 99% of its water from tributaries. Under NSW Water Sharing Plans, there is no requirement to pass any water that flows into the upstream dams, to the Barwon-Darling.

4. Barwon-Darling River and Western Weirs

There is little detail on the Western Weirs Project available to the public and it is likely that options are still being considered at the time of this submission. In the present situation the weirs back water up, reducing *flowing water* habitats and capture small rainfall events that would otherwise pass downstream and keep the river alive (data in Appendix 3).

There is theoretically a spectrum of options in the Western Weirs Project. At one end of the spectrum the project presents a significant opportunity to rationalise weirs along the Barwon-Darling. Old weirs that provide little function could be removed and *flowing water* habitat increased. Weirs that provide high amenity at major towns would be kept.

Town water supplies could be moved to off-steam storage, so that all low flows in droughts stay in the river. This provides higher quality, higher security water for towns and eliminates the competition between people and the environment for water at very low flows. It can also save water because off-stream storage can be covered to prevent evaporation, while storing water in weirpools can lose 75% to evaporation.

Off-stream storage would be a major rural investment. A 700 megalitre storage for one town, similar to the recent Nyngan storage in NSW, would cost $10 million.

At the other end of the spectrum of options for Western Weirs are new, more numerous or upgraded weirs that may be higher and store more water. This would further inundate *flowing water* habitat, leading to further loss of Murray cod nurseries, River Mussel habitat and Aboriginal cultural values.

These new weirs could be gated to provide better delivery of environmental flow and more transparency of flow, and have fishways to provide for fish migration, BUT the environmental impacts of more or larger weirpools would be devastating and lead to permanent damage to the Barwon-Darling ecosystem.

In summary, the Western Weirs project presents an opportunity to rehabilitate the river and align with the current values of the community which would like a healthier river with abundant fish; and it also presents a major risk that could lead to the permanent decline of the river.

Solutions

- Provide off-stream storage for town water supplies and other users, so that all low flows in droughts stay in the river. Cover these storages to reduce evaporation and blue-green algae risk.

- Rationalise weirs. Keep some for amenity and remove or lower others to increase *flowing water habitats* to restore Murray cod nursery areas and Aboriginal cultural values.
- Broader solutions are also required to address water supply and balancing environmental and social needs. These include:
  - Connecting Water Sharing Plans so that all low inflows in droughts are linked to flow objectives in the Barwon-Darling River. Note that providing a baseflow for town water supply for Wilcannia would have extensive environmental benefits along the river length – these objectives are not necessarily mutually exclusive.
  - Engage with the community to rehabilitate river habitats (e.g. large timber snags, rocks, bankside vegetation, fencing for cattle and sheep to prevent dung and nutrients fouling the water). The community is showing they are committed and very willing to volunteer their time to do this.

5. Macquarie River re-regulating weir

The proposed re-regulating weir is located immediately downstream of an existing old fixed crest (i.e. no gates) weir, called Gin Gin Weir.

Modelling of flow and how the proposed new re-regulating weir would function on a daily or seasonal basis is not available to the public. There is a generic objective of capturing "rain rejections", which is water that is ordered from the Burrendong Dam and then cancelled. I will make two assumptions for this submission: that the re-regulating weir could be used to capture rain rejections, as proposed, or tributary inflows downstream of the Burrendong Dam catchment.

5.1 Impact of capture of rain rejections and tributary flows

All environmental water is not equal. River flows that are uninterrupted by dams and weirs have extremely high ecological value, compared to flows that are stored in dams and weirs and re-released.

Uninterrupted river flows pick up nutrients (especially carbon such as dead eucalyptus leaves) and generates natural productivity of plankton, which is the essential food source of fish larvae. This is the fundamental process of river ecosystems that sustains native fish populations.

If flow is uninterrupted over long distances, it has even greater ecological value as this enables fish that are a long distance downstream to detect the increasing flow (fish can sense the slightest increase in water velocity and have an extremely acute sense of smell) and migrate upstream to spawn so their larvae have greater survival.

The advantages of uninterrupted river flow are that: it occurs with a natural season; it has a natural rise and fall in river level; and it has natural, flowing water, hydraulics. It also has no thermal pollution. All these aspects contribute to these flows having high ecological value.

"Rain rejections" combine local rainfall and released flow from the dam. These also have high ecological value combining the advantages of local runoff with increased discharge.

In the Macquarie Valley, tributary flows, rainfall events and rain rejections downstream of Burrendong Dam are one of the most valuable ecological assets that are presently sustaining native fish populations. If the proposed regulator captures and re-regulates these tributary flows and main-stem flows that result from rainfall downstream of Burrendong Dam, native fish populations will have less successful breeding and populations will certainly decline. Because these rain rejections and rainfall events flow into the Barwon-Darling, any reduction in these flows would then impact the health of that river system. Logically the Sustainable Diversion Limit (SDL) must remain the same in both river systems; this assumes, however, that all water is of equal environmental value but this is a case where maintaining the same SDL would produce a lesser environmental outcome.

Solution

- The mitigation for this impact is to provide full transparency of tributary flows and rainfall downstream of Burrendong Dam. However, this largely eliminates the need for the re-regulating weir.

5.2 Impacts of variable water levels on river-edge and channel habitats

Tributary rivers of the northern Murray-Darling Basin have highly variable river levels, from floods to droughts. However, these water levels vary over a very consistent regime over time – rising in floods but spending a lot of time at a low level with varying baseflows. The time-scale and season of this variation is very important for fish. Nesting species such as catfish and Murray cod establish a nest in spring and if the water level drops too much and/or too quickly they abandon the nest and there is no spawning that season[3]. This is an insidious impact as it does not become apparent until many years later as old fish die out and are not replaced by young fish.

The Macquarie River in spring would typically increase in water level but not suddenly decline. Gin Gin Weir presently has a stable water level, while the new regulator could have highly varying water levels that would vary over short times scales within an irrigation season. These are likely to impact breeding of Murray cod and catfish.

Under natural conditions in non-flood times, there are relatively stable water levels with occasional pulses of flow. These conditions enable aquatic plants to develop in rivers, especially along river-edge habitats. These contribute to the basis of the food chain, and ultimately fish survival and ongoing populations. Regulators with highly varying water levels have weirpools that are characterised by barren banks and river channels, devoid of aquatic plants. This breakdown of the aquatic food chain results in less food for native fish, reducing their health, resilience, and survival.

Solution

Maintain the water level in spring to ensure nesting species do not abandon nests. Manage water levels to maintain instream aquatic habitats - however, this is not likely to be compatible with delivery of water for irrigation and a barren river-edge habitat is likely.

[3] Stuart I., Sharpe C., Stanislawski K., Parker A. and Mallen-Cooper M. (2019) From an irrigation system to an ecological asset: adding environmental flows establishes recovery of a threatened fish species. *Marine and Freshwater Research* **70**, 1295-1306.

5.3 Impacts on **flowing water** *habitats*

The proposed weir would inundate *flowing water* habitats upstream, in addition to the present weir. As discussed earlier in *Ecological Background*, this is a significant impact. Capturing rain rejections would also reduce flowing water downstream of the weir site.

Solutions

- Reduce the level of the weir to ensure no additional *flowing water* habitat is inundated.
- Provide discharge downstream of the weir to maintain *flowing water* downstream.

5.4 Assumptions for the project

There appear to be three key assumptions for the project which have not been addressed in the documents available to the public:

1. Irrigator behaviour stays the same

The project appears to be assuming that past irrigator behaviour predicts future behaviour. "Rain rejections" is a good example, where irrigators order water and then cancel after it has been released from Burrendong Dam. Firstly, weather predictions have got more accurate over the last 20 years and it would seem likely that they will continue to improve. Hence, so rain rejections could become less likely. Secondly, if there was more financial incentive to avoid cancelling a water order, behaviour could change and there could be less rain rejections.

2. Off-stream storage technology stays the same

A detailed analysis of options is not available, so it appears that options such as covered off-stream, on-farm, storage have not been evaluated. The Business Case needs to evaluate these options. Although little used in Australia, new covers are coming on the market for small storages that reduce evaporation by 90%. If, for example, irrigators were not able to cancel an order – that is, no rain rejections - then they could use efficient on-farm storage.

3. The Commonwealth Environmental Water Holder will not purchase rain rejections

As discussed earlier "rain rejections" have high ecological value because they are combined with local runoff. There is a scenario to consider that rain rejections could be purchased by the Commonwealth Environmental Water Holder to pass to the Marshes and Barwon-Darling. If this were the case, then the new re-regulator would not serve any purpose and the Business Case would not be very robust.

Summary

There are three key assumptions that significantly influence the Business Case and need further investigation.

6. Proposed new and upgraded dams

The impacts of dams are well-known, such as changes to flow and water temperature regimes. One impact that is often overlooked is the permanent loss of *flowing water* upstream as the river or stream is inundated by the dam. That habitat is not replaceable. I will leave it to other submissions to comment in detail on these impacts.

There is a high-level question that the Inquiry needs to consider regarding the rationale of the dams. If the Sustainable Diversion Limit (SDL) has been determined for the catchment then no more water can be diverted. The dam does not generate more water – it can only store water for use at a later date. Storing water also loses water through evaporation, so that needs to be considered as a loss to the SDL and water available for industry. A new dam could potentially store water for a much higher value crop but that has not been mentioned in any public documentation.

Summary

New dams do not generate water. Under the SDLs they can store it for use later but there is a loss in the SDL available for industry, due to evaporation.