

Cold Water Cod – Forgotten, but not gone

Authors:

¹ Andrew Briggs, Senior Project Officer, North East Catchment Management Authority;
andrew.briggs@necma.vic.gov.au

² Michael Broughton, Project Officer, North East Catchment Management Authority;
michael.broughton@necma.vic.gov.au

1. Introduction

Rising from it's headwaters of the slopes of Mount Bogong in north east Victoria, the Mitta Mitta River is one of Victoria's largest waterways, contributing some 10% of total Murray inflows, around 900 gegalitres, from only 0.3% of the total area of the Murray Darling Basin (Murray Darling Basin Authority, 2021). Like most of the Basin's major rivers however, it is heavily regulated via Dartmouth Dam, delivering water and hydroelectricity for downstream users. Constructed in the 1970's, Dartmouth Dam has a total capacity of over 3.8 Gegalitres, and when full can store over 40% of the total River Murray system's storage capacity, making it the largest capacity storage in the Murray system (Murray Darling Basin Authority, 2021).



Image 1 Lower Mitta Mitta River, extending from Dartmouth Dam to Lake Hume on the Murray River

Located roughly at the midpoint of the river's length, Dartmouth Dam effectively divides the Mitta Mitta River into two starkly different waterways. Upstream of the dam, the Upper Mitta Mitta is highly regarded for its naturalness and the many social, economic and environmental services it delivers. Much of its length is a truly “wild” river, flowing through very remote terrain that is frequented by white-

water rafters, fishers and other recreational pursuits. The headwaters are of such significance due to their relatively pristine state, that they are formally classified as the Mitta Mitta River Heritage Area under the *Heritage Rivers Act (1992)*.

Downstream of Dartmouth Dam however, as far as it's confluence with the Murray River near the township of Tallangatta, the river is a very typical 'tail-race' river, and experiences many of the common symptoms of highly regulated waterways, such as:

- reversed high/low flow seasonal cycles,
- cold water pollution,
- altered sediment balances,
- operational channel-management geared towards facilitating bulk water transfers for downstream uses, and
- impacts on bank/riparian stability due to sustained high flows.

Being such a large body of water, and of such critical importance to the supply of water throughout the River Murray system, the operational requirements of the river are of paramount importance to be maintained. In most irrigation seasons, this effectively means releasing up to 10,000ML per day (channel capacity) from Dartmouth Dam, commencing around October each year, and then running through until Autumn after the peak irrigation demand has passed.

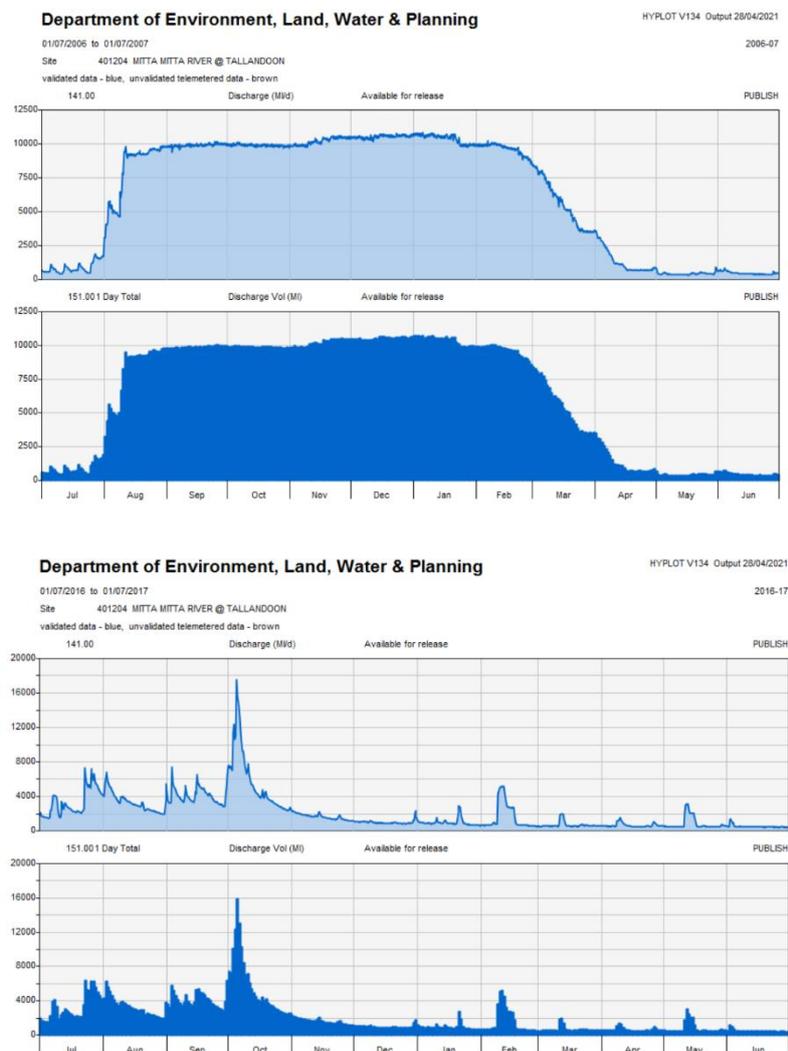


Image 2 & 3 Hydrographs for the Mitta Mitta River downstream of Dartmouth Dam. Top: 2006-07 is a typical year of sustained bulk water transfers. Bottom: shows the flows during 2016/17, that mimicked more natural flow conditions and contributed greatly to the success of native fish recruitment in that year; see discussion below for detail. Source: Department of Environment, Land, Water and Planning, 2021

Such sustained high flow results in extensive bank slumping, erosion and undermining/collapse of riparian vegetation (heavily dominated by large Crack Willow, *Salix fragilis*). Consequently, a major structural works program (the Mitta Mitta Channel Capacity Program) is implemented each year by the North East Catchment Management Authority (CMA) for the stabilisation of these issues. Funded by the Murray Darling Basin Authority via an operational agreement with Goulburn-Murray Water (the river operators), this program has been ongoing for over twenty years. The nature of these works has typically been focussed on the installation of rock armouring (or rock beaching), livestock exclusion, revegetation and, where required, management/removal of collapsing and destabilised willows.



Image 4 A typical rock beaching erosion repair work site on the lower Mitta Mitta River. Extended fencing offsets and revegetation accompany all work sites.

2. Mitta Mitta River Cod – fact or fiction?

The combination of channel degradation and high-volume cold-water pollution, coinciding with the peak spawning period for many native fish, has led to a common perception that the lower Mitta Mitta River is no longer suitable habitat for native fish populations, and really only viable as a trout fishery. In addition to these issues, it is estimated that large woody habitats in the lower Mitta Mitta are 60-70% less than what they were prior to European settlement (Tonkin et al. 2016).

Despite this, persistent (and often closely guarded) rumours of large Murray Cod still being present in the river continue, complete with a local angling group coming together with the rather suggestive name of the “Cods of Anarchy”. Working with the angling club and adjoining landholders, in 2015 the North East CMA was successful in securing a large, multiyear project via the Victorian Recreational Fishing Licence Trust (RFL) for:

- Incorporating Instream Woody Habitat (IWH) in parallel, and complementary to, the operations of the Channel Capacity Program.
- Using local knowledge (citizen science) to identify known strongholds of Murray Cod and also areas where Cod seem to be absent.

- Carrying out formal scientific surveys to ascertain the size and strength of the cod population and their response to targeted management interventions.



Image 5 “Cods of Anarchy” fishing club members talk over known Murray Cod “hot spots”, and areas requiring additional habitat based on member catch reports & observations.

This RFL funded project ran for 3 years, and over the life of the project saw over 250 pieces of large hardwood timber sourced and placed into the lower Mitta Mitta River. By the end of program, the local community were reporting captures of cod at most sites of habitat augmentation.

Direct input from anglers proved to be a major driver for the success of the program; their knowledge and understanding of the river (and the local cod population) was invaluable to the early planning of works. Further to the siting of works, the angling club’s outreach amongst the local farming community was also extensive (many of the members being Mitta Mitta valley farmers in the own right). This resulted in a willingness amongst the community to allow access for CMA works, and even the donation of hardwood timber/root balls for the works.

Building on the success of the initial 3-year program, the Mitta Mitta River has now had six years of funding for Instream Woody Habitat improvement, and over 500 pieces of timber have now been sourced and placed in to the river with input on locations from the local community and the river operators.

3. Instream Woody Habitat and Stability – mutual benefits

With the long-term management objectives for the lower Mitta Mitta River being so strongly focussed on bank stability and the bulk transfer of water for economic purposes, installing large quantities of IWH into the Mitta Mitta River for the benefit of native fish populations had to be carefully considered against the primary objectives of the Channel Capacity Program.

Courtesy of similar programs implemented elsewhere by the North East CMA and the pioneering of new techniques for incorporating IWH into structural interventions, it could be demonstrated that even a relatively large quantity of timber would not only have a negligible influence of flow behaviour, but also that in many instances it could reduce, or even replace, an equivalent volume of rock. Thus, no net loss of channel capacity would result. The benefits of utilising timber as part of structural solutions (outside of the obvious habitat gains) were also becoming more widely accepted as a legitimate river management intervention.



Image 6 Timber being installed in conjunction with rock armouring, providing habitat gains whilst reducing reliance on rock.



Image 7 Truck loads of hardwood timber awaiting placement. Much timber is now donated to the CMA by local farmers, or salvaged from other infrastructure projects carried out by other local agencies and Local Government.

Through programs such as this, the use of timber as part of engineering solutions has gained great acceptance within the region, and is now common place when responding to damage from natural disasters (flood, fire), as well as for strategic river health programs.

4. Did it Work?

From the outset, a key element to this program was being able to demonstrate the outcomes based on a scientific approach to monitoring and reporting of the findings. To this end, the Arthur Rylah Institute (ARI) was engaged to carry out electrofishing surveys of intervention and control sites (including pre-intervention survey).

A full write up of the survey findings is available (Tonkin et al. 2017) – a precis of the key findings follows, and the survey results are provided in Table 1, below:

Electro fishing survey was carried out in 2015 and 2017. In the 2015 and 2017 sampling events 5,215 fish were recorded, including six native and five exotic species. Significantly, in 2015 only 596 fish were captured, compared with some 4,690 in 2017. This massive increase in fish can primarily be accounted for due to a large increase in Australian Smelt (*Retropinna semoni*), which made up over 74% of total fish captured. Importantly, as it relates to the resident Murray Cod population, there was also a significant increase in numbers (78 in 2015 compared to 135 in 2017), including Young-of-Year (YoY) fish, which had previously been unobserved. With respect to Instream Woody Habitat interventions, whilst an increase in numbers was recorded at all sampling sites, the increase of Murray Cod at works sites was significantly higher than the increase at control sites.

Common name	Species name	2015 Collected (observed)	Range (mm)	2017 Collected (observed)	Range (mm)
<u>Native</u>					
Two-spined blackfish	<i>Gadopsis bispinosus</i>	2(2)	186-258	6 (5)	72-197
Murray cod	<i>Maccullochella peelii</i>	78 (15)	112 - 1100	135 (49)	49-1100
Golden perch	<i>Macquaria ambigua</i>	22 (3)	354 - 502	3 (3)	405-491
Murray crayfish	<i>Euastacus armatus</i>	0 (24)		0 (47)	
Australian smelt	<i>Retropinna semoni</i>	0 (70)		0 (3766)	
Galaxiid species	<i>Galaxias spp.</i>	1 (4)	82	0 (0)	
Flat-headed gudgeon	<i>Philypnodon grandiceps</i>	0 (1)		3 (3)	45-71
<u>Exotic</u>					
Common carp	<i>Cyprinus carpio</i>	28 (268)	395-586	30 (274)	300-610
Brown trout	<i>Salmo trutta</i>	24 (49)	115 - 530	4 (2)	94-257
Redfin perch	<i>Perca fluviatilis</i>	4 (1)	94 - 195	117 (212)	38-220
Goldfish	<i>Carassius auratus</i>	0		1	144
Eastern gambusia	<i>Gambusia holbrooki</i>	0		30	
TOTAL		159 (437)		329 (4361)	

Table 1. Species collected, observed and size range (total length, mm) during electrofishing surveys of the Mitta Mitta River during 2015 and 2017 (from Tonkin et al. 2017).

Survey has also recently occurred in April 2021. Unfortunately, at the time of writing the results have not been finalised, however initial examination of the results supports the results from the earlier work (further discussion below).

Several important observations can be made from the survey data:

4.1 Significance of flow regime

Largely due to the wet season of 2016 leading to high water reliability in the Murray system, there were no major bulk transfers from Dartmouth Dam during the spring/summer periods of 2016/17. It is hypothesised that this may have contributed greatly to the successful recruitment events observed in native species in the lower Mitta, reflected in the catch data. Such increases in small native fish (e.g. small bodied fish such as Smelt, or juvenile Murray Cod) cannot be explained through habitat improvement alone. This evidence has led on to discussions with the river operators to try and minimise cold water releases during this period where possible. Recent survey (April 2021) in the study reach

has similarly shown YoY survival, with seasonal conditions of low volume releases mirroring those of 2016/17.

4.2 Age of Instream Woody Habitat intervention

Works sites that had been completed only a matter of weeks prior to survey showed relatively low abundances of Murray Cod, however those structures that had been in the river for longer periods showed the greatest positive influence on abundance. This is not unexpected, and speaks to the long term, cumulative value of habitat installations. It also highlights the benefits of repeat sampling efforts, and the timing of that effort to demonstrate the long-term success of Instream Woody Habitat interventions (i.e. sampling too soon post construction may not accurately reflect the benefit of the works).

4.3 Location of work sites.

There was a strong relationship of works carried out on deeper, higher energy outside bends of the river to increased occupation of sites by Murray Cod when compared to longer, slow moving pools or low energy areas. It was also noted that some work sites that had been completed earlier in the program were sitting in shallow water (or even exposed) at the time of sampling, and so did not return a strong positive result. This poses an interesting conundrum for future site selections. Generally, preference should be given to areas that will remain under water at all flows, and thus provide maximum benefit. However, in a river with such a drastically altered flow regime that effectively mimics flood-conditions for months at a time, there is a case for the siting of works in areas of the river channel that may be exposed during low flows. These structures provide valuable areas of velocity refuge during high flows. Unfortunately, safety considerations make survey of the river impossible during high flows to truly test this hypothesis – it remains unknown as to what parts of the channel Murray Cod occupy during high flow events.

4.4 Fitness

All Murray Cod sampled were in peak physical condition and showed no signs of stress or ill-effects of the altered flow regime. Anecdotal evidence from the “Cods of Anarchy” members suggests that there is a clear physical differentiation between “Mitta Cod”, compared to Cod that are thought to have originated from fingerlings stocked into Lake Hume (situated at the junction of the Mitta and Murray River). According to local fishers, the belief is that fish spawned in, or that have lived in the Mitta Mitta River for a long time, are fatter and darker in colour than fish that have immigrated into the lower reaches from the lake. There is no evidence to verify this theory, and further sampling and DNA analysis is required. Certainly, it is highly likely that there is immigration and recruitment into the river from stocked fish.



Image 8 & 9 Young of Year Murray Cod (left); Cods of Anarchy member about to release a 1m+ Murray Cod



*Image 10 & 11 Another beautiful Mitta Cod about to be released by a keen young fisherman (left); Australian Smelt (*Retropinna semoni*) are abundant in years with a more natural flow regime and are likely a major food resource for young Murray Cod.*

4.5 Recruitment

Given that YoY fish have only been sampled in the river twice, and only in those years when flows could be classed as being close to “natural”, it may be safe to assume that the Mitta Mitta for many years has relied at least in part on immigration of fish into the river from Lake Hume to sustain fish stocks. Increases in overall abundance of cod, particularly at sites of Instream Woody Habitat intervention, demonstrates that these types of works may be fundamental in both attracting and holding fish in the river despite the altered flow regime.

5. Conclusion

The lower Mitta Mitta River has been proven to hold a large, healthy population of Murray Cod, of mixed ages and size classes, despite the negative impacts of being a ‘tail-race’ river. The incorporation of Instream Woody Habitat into the annual Channel Capacity Program has now become entrenched as being of value for the long term structural integrity of the river, as well as being of great benefit to the local Murray Cod population. Increases in abundance of other native species is also highly significant, although may be driven more by years of low (natural) flows rather than Instream Woody Habitat alone.

Continuing to work with river operators to try and minimise cold water releases during key spawning times is definitely optimal, although it has been shown that there is sufficient recruitment, either locally or through immigration of stocked fish, to sustain and grow the overall cod population in the lower Mitta Mitta. In addition to spawning success, years of low flow are also likely to be of great significance to the survivorship of juvenile fish. Further work on the genetic composition of the Mitta Murray Cod population, in order to gauge the significance of Lake Hume stocking to their long-term viability will be important.

The Cods of Anarchy remain highly engaged in the program, and consistently report local catches/observations and suggestions for future works areas. This engagement has flowed over to the wider Mitta Valley community, and the North East CMA often receives offers from landholders and other agencies working in the area of hardwood timber for more Instream Woody Habitat works.

Overall, this program has shown that it is possible to carry out habitat interventions for the benefit of native fish in a ‘tail-race’ setting, without compromising the overall operational and economic drivers for waterways of this type. It has also clearly shown that Murray Cod (and certain other species of native fish) are highly resilient to these impacts and can even thrive under these conditions as adult fish,

however recruitment and survivorship of juvenile fish remains a challenge requiring further investigation.

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