

How fish kills affected traditional (Baakandji) and non-traditional communities on the Lower Darling–Baaka River

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Abstract. In the summer of 2018–19 mass fish kills occurred in the Lower Darling (*Baaka*) River in south-eastern Australia. The fish kills received national and international attention and have been the focus of numerous government agency and independent assessments. Although fish kills have previously been recorded in the Lower Darling region, the size and rapid succession of the 2018–19 ‘Menindee’ fish kills made them unprecedented in the Murray–Darling Basin, placing significant pressure on the native fish community. Although the deaths of millions of fish were documented, the significant negative effect that the fish kills had on local communities, particularly the traditional Baakandji people, was largely ignored. The social and cultural aspects of such events can have major non-economic effects on local communities. In this paper we document heart-felt feelings conveyed by local community members. Their sense of loss, despair and helplessness is compounded by frustration regarding water management and policy decision making in the Murray–Darling Basin. However, these tragic events have increased understanding of traditional Baakandji connection to the river and its fish and, together with local recovery efforts, now provide prospects for enhanced community and agency cooperation to improve the health of the lower Darling *Baaka* River and restore its native fish populations.

Keywords: Australia, cultural values, fish deaths, Indigenous, recreational, social, water management.

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Introduction

Despite fish kills being a reasonably common occurrence, fish kill investigations are rarely comprehensive (La and Cooke 2011) and many economic costs are generally not fully accounted for (Southwick and Loftus 2017). Moreover, many non-economic values are often not recognised at all (Koehn 2021). This leads to an underestimate of the true losses and the full cost to the communities to whom the fish belong. Indigenous communities have long traditions of harvesting freshwater fishes, and so these fish become embedded within their cultural identity and belief systems (Ginns 2012; Noble *et al.* 2016). In the case of the communities of the Darling River in south-eastern Australia, the river has provided food resources for over

30 000 years (Dargin 1976; Humphries 2007). In addition, non-traditional communities hold strong connection to their river system and their fishes, particularly in remote, semi-arid environments. Recreational fishing is a significant pastime in Australia (Henry and Lyle 2003), particularly in rural communities. Fishing for large, iconic trophy fish such as Murray cod *Maccullochella peelii* provides not only social and recreational opportunities, but also substantial economic benefits through tourism and travel expenditure (Ernst and Young 2011).

The Darling River forms the western components of the Murray–Darling Basin (MDB), which is deemed Australia’s ‘food bowl’. The MDB is highly regulated and there is competition for water between agriculture and the environment (Koehn

2015). In this paper we refer to the lower Darling River as the Darling *Baaka* River (DBR) in recognition of the traditional custodians of the region. The lower DBR consists of the Menindee Lakes, ~600 km of the Darling River downstream to the junction with the Murray River at Wentworth, New South Wales (NSW), and the ephemeral Great Darling Anabranch to its west (Fig. 1). The lower DBR is significant for native fish species in the MDB, including iconic species such as Murray cod, golden perch (*Macquaria ambigua*), threatened silver perch (*Bidyanus bidyanus*) and freshwater catfish (*Tandanus tandanus*), as well as a suite of small and medium-bodied fish species (Lintermans 2007). The river and its flood plains also support myriad aquatic and riparian plant and animal species (including crustaceans, molluscs, birds, reptiles, mammals and

aquatic and terrestrial vegetation), many of which are important to the survival and culture of the region's traditional Indigenous people (Dargin 1976; Balme 1995).

Flow in the lower DBR is derived predominantly from rain events in upstream tributaries of the Barwon–Darling River system. Prior to river regulation (i.e. before the 1960s), the DBR flowed for more than 90% of the time and was characterised by short spells (generally less than 1 month) of zero flow (Mallen-Cooper and Zampatti 2020). The cumulative effects of drought and historic patterns of water extraction in the northern Basin over the past two decades have led to a higher risk of conditions that can lead to fish deaths during droughts (Vertessy *et al.* 2019). This is evidenced by the increased frequency and duration of very-low-flow or cease-to-flow periods in the lower DBR (Fig. 2).

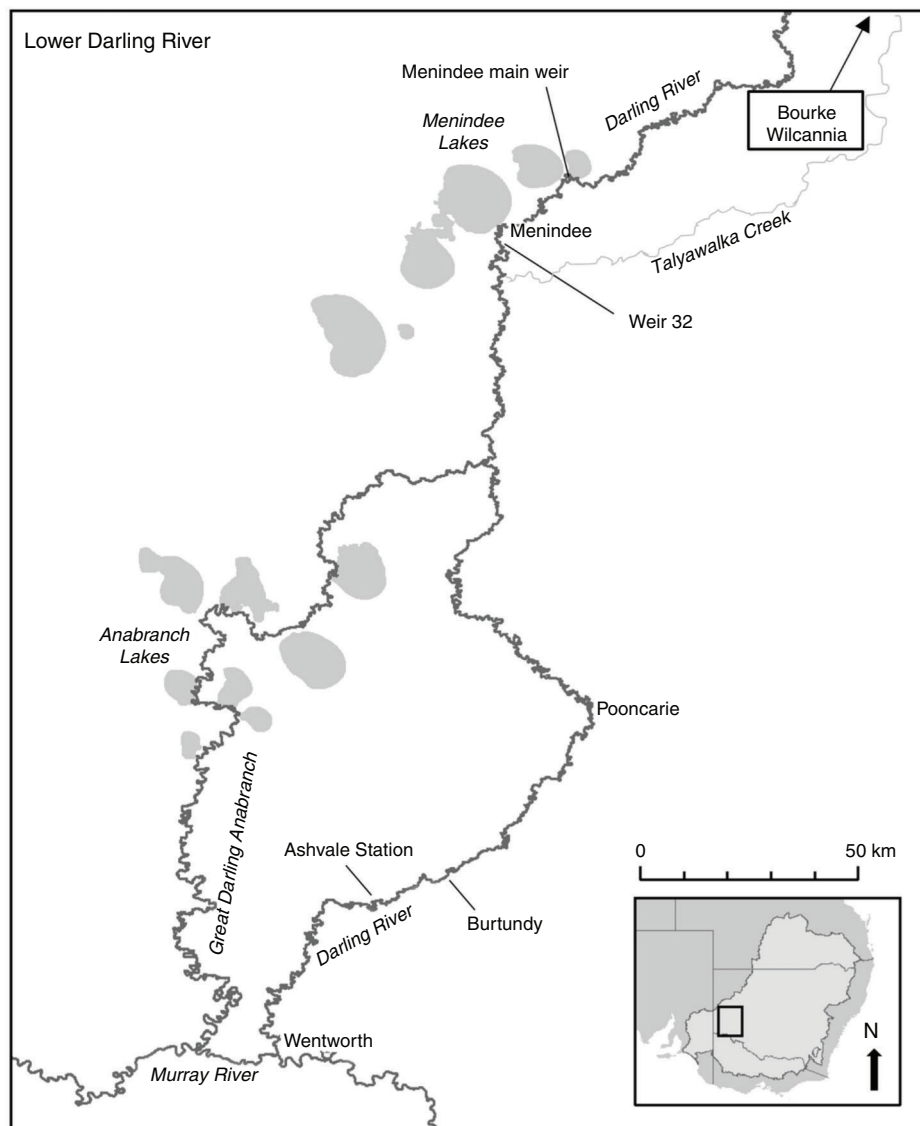


Fig. 1. The lower Darling Baaka River region in far west NSW that flows from north to south. The mass fish kill events of the summer of 2018–19 occurred throughout ~40 river kilometres from Menindee Main Weir downstream to Weir 32. Subsequent fish kills occurred along the Darling *Baaka* River downstream of Weir 32 throughout 2019 and early 2020 as refuge pools contracted.

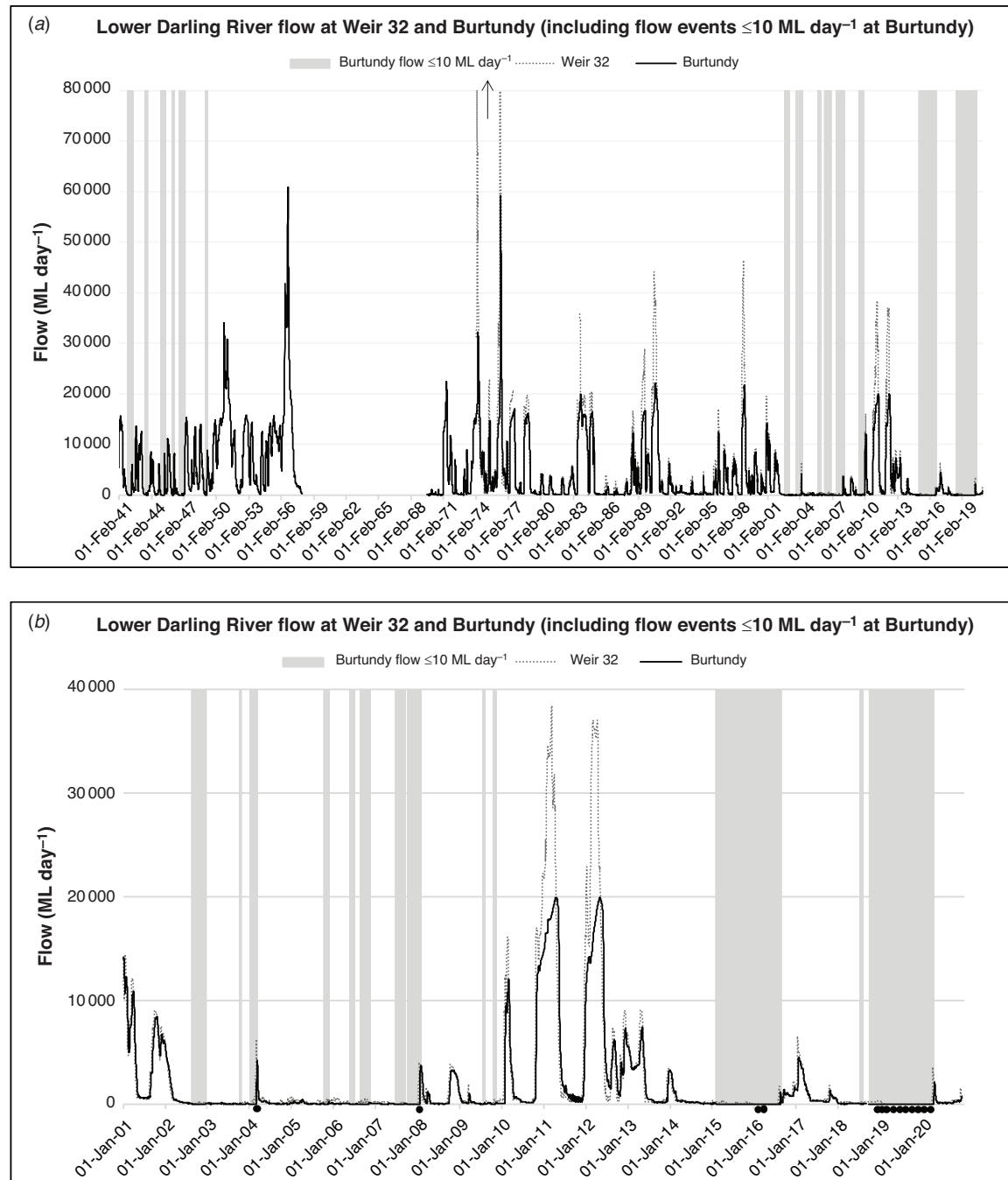


Fig. 2. Historic flow in the lower Darling *Baaka* River recorded just downstream of the Menindee Lakes at Weir 32 and in the lower reaches at Burtundy (a) and for the past 20 years (b). Low- and no-flow events at Burtundy (i.e. flow ≤ 10 ML day⁻¹) are shown as grey vertical bars. Bank full is $\sim 10\,000$ – $14\,000$ ML day⁻¹. Small circles represent reported fish kills. Note that the y-axes differ between plots. Data courtesy of Water NSW.

Until recently, the fish community of the lower DBR was considered to be in good condition, with robust populations of Murray cod, golden perch and other native fish that generally exhibited large numbers of juveniles as well as a range of adult size classes (Wallace *et al.* 2008; NSW Department of Primary Industries 2016). In a whole-of-basin context, the region is

important for the breeding and recruitment (i.e. growth and survival) of golden perch. Following flow-cued spawning in upstream catchments and reaches of the Barwon–Darling, larval and juvenile golden perch can drift as far downstream as the Menindee Lakes, where they exhibit strong growth and survival in food-rich waters (Sharpe 2011). On subsequent flow events

that reconnect the Menindee Lakes with the DBR, fish that are now well developed may return to the river channel and disperse both upstream and downstream (Stuart and Sharpe 2020). Recent research also demonstrates that current golden perch populations in the lower and mid-Murray system contain a considerable proportion of fish that began life in the Darling River (Zampatti *et al.* 2018).

In the summer of 2018–19, and through the subsequent 12 months, these populations were affected by the occurrence of unprecedented mass fish kills involving the death of millions of fish. In this paper we document the significant negative effects of these fish kills on social and cultural aspects of local communities. The social impacts of the fish kills were felt widely, particularly within the traditional Baakandji community, but also within non-traditional communities. We document the stories of individuals (with their informed consent) that convey a mutual sense of loss and despair felt throughout local communities, as well as a shared frustration regarding water management and policy decision making in the MDB. In doing so we highlight the inherent linkages between environmental and social objectives or outcomes (socioenvironmental outcomes). It is important that these non-economic (i.e. social and environmental) losses are recognised.

No animals were used in this research. The authors deem negligible risk of human harm or discomfort in association with this work and informed consent was provided by all voluntary contributors. As such, this work meets the requirements of the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018) (National Health and Medical Research Council *et al.* 2018).

Materials and methods

Information regarding the extent and details of fish kills in the Lower DBR between 2018 and 2020 was collated by NSW DPI Fisheries staff during fish kills site inspections, as well as through correspondence between the authors and community members (e.g. station owners and managers, recreational fishers and town residents) that attended fish kills first hand. In response to the fish kills of 2018 and 2019, the lead author was assigned the role of heading native fish engagement and communication activities in the lower DBR, providing opportunities for the collection of the perspectives from a range of community stakeholder groups and individuals. We also include recollections and perspectives in this manuscript from two of the authors (who are both lower DBR residents and community leaders) which reflect wider sentiments of sadness and frustration that prevailed throughout lower DBR communities following the Menindee Fish Kills.

Background

Lower Darling Baaka Fish Kills

The fish community of the lower DBR has suffered multiple significant fish kill events over the past two decades, culminating in the deaths of millions of native fish near Menindee in the 2018–19 summer (Fig. 3), with subsequent further kill events in drying pools along the lower DBR downstream of Menindee through 2019. Each fish kill was linked to prolonged low- or no-flow conditions, or low-magnitude recommencement flows

following no-flow periods, which caused sudden deterioration in water quality.

Fish kills are not entirely uncommon in areas such as semi-arid river systems. For example, in February 2004 (Austral summer), thousands of Murray cod died in association with a low-magnitude flow resumption event when the arrival of hot, carbon-loaded water caused mixing of thermally stratified pools and resulted in hypoxia (Ellis and Meredith 2004). Many smaller-scale kills (tens of larger Murray cod) were reported to the NSW DPI Fisheries by farm owners, farm staff and community members that visited the river (NSW DPI, unpubl. data), during low- or no flow-periods in the summers of 2007–08 and 2015–16 as refuge pools contracted to shallow stagnant ponds. It is likely that, given the scale and remote nature of many reaches in this river system, fish kills in the lower DBR are under-reported.

In the summer of 2018–19, a protracted period of low flow in the DBR culminated in the mass deaths of millions of native fish near Menindee (Australian Academy of Science 2019; NSW Department of Primary Industries 2019; Vertessy *et al.* 2019). Over three separate events (15 December 2018, 6 January 2019 and 28 January 2019), fish died along a 30- to 40-km weir pool reach of the lower DBR between Weir 32 and the Menindee Main Weir (the ‘Menindee fish kills’).

In each case, a period of high temperatures and low- or no-flow conditions led to thermal stratification of the weir pool above Weir 32 (NSW Department of Primary Industries 2019; Baldwin 2019; Baldwin *et al.* 2021). During periods of thermal stratification, a warmer surface layer of water sits above a cooler, deeper layer (hypolimnion) in which dissolved oxygen can become depleted. In the case of these fish kills, a mixing event resulting from a sudden weather change drove a decrease in temperature, resulting in the hypolimnic water mixing with the surface layer and causing hypoxia throughout the water column (Baldwin 2019; Baldwin *et al.* 2021). After the first fish kill event, air temperatures in the region increased again, and remained high for ~2 weeks (resulting again in thermal stratification), before another cold weather change resulted in destratification of the weir pool. This sequence was also repeated ahead of the third fish kill at Menindee.

Estimating the number of dead fish after each of the three fish kills was problematic given the remoteness and large area over which the event occurred, the rapid removal of smaller individuals by scavengers and predators (raptors, cormorants, foxes etc.) and the decomposition and subsequent sinking of fish carcasses. NSW DPI Fisheries estimates that affected native fish were bony herring *Nematalosa erebi* (millions dying across the three events), Murray cod (several hundred), golden perch (potentially tens of thousands) and silver perch (potentially tens of thousands). Hundreds of non-native carp *Cyprinus carpio* were also reported by community members to have died. These estimates were based on information and photographs or video collected during fish kill investigations by NSW DPI Fisheries staff, and discussions with community members that observed the fish kills in person (many of whom also provided photographs of the fish kills). These reports in conjunction with accompanying photographs and video enabled a conservative scaling up to attain an estimate of the scale of the fish kills for each species affected. We acknowledge this is not a



Fig. 3. (a, b) Large Murray cod and (c, d) bony bream or herring that perished near Menindee on the lower Darling *Baaka* River in the summer of 2018–19. The Murray cod (*parntu*) is a creation ancestor of the river to the Baakandji, a sought-after angling species and a (usually) accessible source of protein for disadvantaged Indigenous communities. Bony bream (*nhaampa*) is recognised by traditional and non-traditional communities as an important part of the food chain and is the totem of many Baakandji families. Photographs provided by the authors (P. Heath, G. McCrabb and I. Ellis).

quantitatively robust method for estimating dead carcasses. However, the scavenging or rapid decay and sinking of carcasses (in extreme summer heat), expanse of the affected reach (30–40 km of river) combined with the remoteness of the affected reach, present considerable limitations in achieving more robust estimates of mortalities, as it does in most remote circumstances. A range of size classes from each species was affected, albeit with larger individuals dominating observations for Murray cod, golden perch and silver perch. This is likely due to either a higher susceptibility to hypoxia among larger fish (greater oxygen requirements) or removal of smaller individuals by rapid decay and sinking in the summer heat, or scavenging.

In the 14 months after the Menindee fish kills (i.e. January 2019–March 2020, austral summer and autumn), zero-flow conditions were experienced in the lower DBR downstream of Menindee. Over 30 fish kills were reported to NSW DPI Fisheries from the lower DBR between Weir 32 downstream to Ashvale Station before a flow returned in March 2020. Reports ranged from 1 to 30 Murray cod dead or dying in drying pools as the river contracted and water quality deteriorated, with the death of only a few larger golden perch reported. The death of hundreds of larger carp was reported towards the end of the 2019–20 summer. Again, it is likely that many incidences of fish

deaths went unnoticed or unreported given the scale (~500 river kilometres) and remoteness of the reach, removal by scavengers and decomposition. NSW DPI Fisheries estimate hundreds to thousands of Murray cod perished in the lower DBR downstream of Menindee throughout 2019 and early 2020 (NSW DPI, unpubl. data).

The Menindee fish kills attracted national and international attention. Images of masses of dead fish and experiences from residents or visitors to the region were quickly circulated via social media as each fish kill event unfolded. Opinion concerning the causes of the kills, and the blame for them, circulated equally quickly, pre-empting efforts by government agencies to provide commentary on likely causes and response plans. Although the rapid social media responses resulted in cases of the widespread dissemination of incorrect information (e.g. speculation regarding the age of the affected fish, accusations of pollution or intricate conspiracy theories), social media nevertheless provided a platform for almost real-time notification of these events and appreciation of the devastation felt by affected communities. Traditional media stories on the fish kills followed soon after, often stemming directly from the social media posts or individuals within them. These communications naturally led to considerable online and media

discussion regarding the proximate causes of the kills, as well as, perhaps more importantly, broader topics of water extraction and management, water sharing arrangements, climate change impacts and social values and equity. The deaths of millions of native fish became a catalyst to promote serious discussion about such topics that were of vital importance to regional communities, but often unappreciated by wider society. Although these discussions may be uncomfortable at times, they need to continue to ensure lessons learnt from events or disasters such as the Menindee fish kills lead to meaningful improvements in policy and water resource management.

People of the River: Baakandji

Through thousands of years of stewardship, Indigenous peoples around the world have developed deep cultural connections to fresh waters and the freshwater animals that help maintain their cultural, social and economic health and well-being (Noble *et al.* 2016). The word 'Baakandji' means 'people belonging to the *Baaka* or Darling River' (Hercus 2011). For millennia, the *Baaka* from Bourke to Wentworth has been the 'centre of existence' for the Baakandji people, providing food, resources and medicine. A hearth in a complex archaeological site on the edge of Lake Menindee is ~45 000 years old (Copper and Duncan 2006). Balme (1995) conducted a large archaeological survey of the mid- and lower Darling River and associated lakes and anabranches, documenting that four larger fish species (Murray cod, golden perch, silver perch and eel-tailed catfish) and the smaller bony bream were caught by Baakandji people throughout the Pleistocene and Holocene. Balme (1995) recorded midden sites on the Pleistocene-aged Menindee Lakes and the Talyawalka Creek–Darling River anabranch system (ranging from *c.* 27 000 to 5000 years BP) and more recent midden sites along the modern *Baaka* channel (5000 years BP and more recent). These middens contain components of the same suite of native fish and shellfish that persist in the modern river today (Balme 1995).

Badger Bates, a Baakandji Elder, community leader and renowned artist who grew up in a tin hut on the banks of the *Baaka*, says:

... when the river is healthy, everything flows and Baakandji people are happy. However, when the river is sick the Baakandji people are sick both physically and socially. Crime rates, family violence and mental health issues rise when the *Baaka* doesn't flow.

These are vitally important, non-economic values of a healthy river to the Baakandji people.

Badger notes that the river reinforces connections to Country and culture. Fishing and camping are important for mental and physical health and wellbeing, and reinforce the kinship relationships that are a critical surviving aspect of Baakandji culture. Cultural teaching occurs when on the river. Traditional stories, such as the creation of the *Baaka* by *Ngatji* (Rainbow Serpent), ecological knowledge, family history and language are passed on while on the river. Rivers and wetlands also provide plant foods, wood for making traditional artefacts such as *wanna* or boomerangs and reeds for weaving.

Excerpts from Badger Bates' statement to the South Australian Murray–Darling Royal Commission (Walker 2019) outline additional components of Baakandji cultural values:

[The river] is where we teach our children and speak our language. It is where we do our artwork, take photos, make videos, make songs and dances. We walk along the river and see where our ancestors cooked mussels or cut out a coolamon (carrying vessel) or a canoe, and we connect with them and use this to interpret and understand our landscape. For example, a shell midden means there is a stony bank in the river where the mussels live (this might be under water so you can't see it), and then you know that the deep bend up or down from the shell midden is where the cod will be hanging out 'cause they eat the mussels. So, you know where to put your cod line in. We have many stories like this. The river is our memory, we walk along it and remember our history and our ancestors by looking at the marks and places.

[The river] makes me who I am. Without water in our river the trees will die and there will be no more roots to cut out and make boomerangs. At night on the river I listen to the fish jumping up and I am happy. Or I hear the sound of swans, flying north to meet the fresh water coming down. From this I know when the fresh water is coming and how much, I feel life is right.

Fish and the Baakandji

Baakandji are acutely aware of food chains and the way the plants and animals (including people) are connected: all rely on each other. The Baakandji understand that the ecosystem requires connectivity along and between the river, the flood plains and the shallow freshwater aquifers.

The Baakandji used stone, wood and earthen fish traps and weirs to collect fish as an everyday food source for local groups of people (S. Martin, pers. comm.). Furthermore, there is evidence that fish trapping structures were also used to store supplies of aquatic resources for large gatherings. This indicates that Baakandji people living along the DBR had a sophisticated understanding of the hydrodynamic processes relating to their in-stream constructions (S. Martin, unpubl. data). Today, fish from the river continue to provide a necessary source of good-quality protein and fish oil (used in traditional medicines) for many 'disadvantaged' Aboriginal communities along the *Baaka*. However, for Baakandji people, fish represent more than a resource; they are considered family:

- *Parntu* (Murray cod) is a creation ancestor of the river and an ancestor of the Baakandji people. Cod is the river and the people, and the people are the river and the cod. Baakandji can tell which tree a cod was born under, and the journey it has taken along the *Baaka* by a 'map of veins' inside the fish.
- *Kunpali* (yellowbelly or golden perch) and *pangula* (black bream or silver perch) are favourite eating fishes, culinary treasures and health-giving food of the Baakandji people. Both were once common in the *Baaka*, but today *kunpali* are becoming rare and *pangula* are extremely rare.
- *Yamaka* (eel-tailed catfish) were kept as a food reserve because they do not migrate, meaning people knew where

they could be found in times of food shortage. *Yamaka* are also extremely rare today in the *Baaka*.

- *Nhaampa* (bony bream or bony herring) is a small but important fish that, although sometimes eaten, is recognised as an important part of the food chain, supporting larger native fish species and many water birds.

Effects of the 2018–19 fish kills on communities

Baakandji traditional community

Through 2018 and 2019, barely any water flowed to the lower DBR. Less than 15 000 ML flowed past Wilcannia during the whole of the 2018 and 2019 calendar years. For most of this 2-year period, communities along the length of the DBR were left with poor-quality water to wash in, cook with and drink. In many places, bottled drinking water, water purifiers and rainwater tanks were supplied by volunteer organisations from far and wide. To many people, this addressed an issue that government failed to grasp.

The fish kills of Murray cod, golden perch, bony bream and silver perch through 2018 and 2019 had profound implications for the Baakandji. The death of hundreds of Murray cod represented killing events such that the Baakandji had not seen since massacres at the hands of early European settlers (Hercus 1969). Bony bream (*nhaampa*) is the totem of many Baakandji families, including a large family living at Menindee today. Witnessing the deaths of millions of bony bream was, to them, like witnessing the death of family members.

Along with fish kills, the protracted drying of the *Baaka* affected many other foods that Baakandji people rely on, including freshwater mussels, yabbies, shrimp, turtles, waterbirds, goannas, kangaroos and emus. In those predominantly Aboriginal communities that were affected, echoes of colonial destruction and neglect were triggered, leading to several blockades and protests along the river. Again, Baakandji people felt their culture, history, health and mental and physical well-being were under threat.

In February 2019, several Baakandji cried and jumped into the water to help staff from NSW DPI Fisheries rescue stranded Murray cod, which were then taken away to breeding and hatchery facilities. The Baakandji stated to Fisheries staff that ‘these are our cod, they are part of us, they belong here, and must be brought back here to us’.

Non-traditional river communities

Native fish and recreational fishing activities are vital to tourism in the MDB. The annual economic contribution from recreational fishing in the MDB has been estimated to be in the order of A\$1.3 billion (direct expenditure) and an additional value-added expenditure in the order of A\$375 million (Ernst and Young 2011). In the small Lower Darling towns of Menindee and Pooncarie (populations of 551 and 166 residents respectively), fishing-based tourism is seen as vital in supporting local businesses such as hotels, cafes, petrol stations and shops.

When there was no water in the Darling River through 2019, the tourists didn’t come. Fishing stopped. We really struggled to stay open. As soon as the water returned, so did the

tourists, and eventually the fishing tourists and things picked back up. If this happens again, we probably won’t survive [Josh Sheard, Pooncarie publican, 2020].

For local communities, the 2018–19 fish kills at Menindee and along the lower DBR were heart breaking and will have an enduring impact on tourism, local businesses and social amenity. Millions of dead fish lined Menindee town’s riverbanks from December 2018 to February 2019, and the threat of more fish kills persisted even longer as extended drought conditions and poor water quality continued. Local recreational anglers volunteered time and equipment through the hot summer months to rescue and relocate thousands of native fish, and to maintain aerated refuges powered by expensive diesel pumps fitted with venturi oxygenators (I. Ellis, unpubl. obs.). Many of these volunteer anglers have not been fishing since, despite the return of river flows in early 2020, such was the mental anguish they experienced through the fish kills and rescue efforts.

As well as the effect on fish stocks, water quality was affected during and after the fish kills. Even after treatment, town water supplies retained foul odours, and complaints of skin conditions related to water quality were common. For months, fresh drinking water was trucked to Pooncarie and Menindee at the expense of local councils or volunteer organisations.

A small positive outcome from the death of so many fish is that non-Indigenous community members in the Lower Darling have developed an appreciation of the emotional and spiritual connections shared between the Baakandji and the *Baaka* for many thousands of years.

Graeme McCrabb, a grape grower and keen angler in Menindee, attended and reported the mass fish kills to NSW DPI Fisheries staff. The first reports of dead golden perch in the river just upstream from Menindee started coming in on 15 December 2018, after which large Murray cod started floating to the surface. Dead cod were collected for DPI Fisheries so ear stones could be removed to age the fish. The biggest fish were over 1.2 m long, and the oldest turned out to be almost 30 years old. Approximately 100 000 native fish died that time over a 15-km stretch. Another fish kill occurred a few weeks later, c. 6 January 2019, but over a 30-km stretch, including the stretch in which the first kill had occurred. There were a million dead fish at least, nearly all native species, with just a few hundred non-native carp. Then, on the morning of 28 January 2019, there was a third fish kill in the same stretch. The maximum temperature that day was only ~30°C, the better part of a 20°C drop from the high 40°C days in the prior week. Again, there were millions of dead fish over a 30-km area of devastation. Although the earlier two kills were extremely disturbing, the third one was absolutely devastating for the community.

The stress on the community during each fish kill was immense. There were thousands of golden perch and threatened silver perch lying in the shallow water on the edge of the river. By disturbing them by hand or using the wake from boats, locals could get them going again briefly. People also ran pumps directly back into the river trying to create a refuge zone of aerated water. It was of little use. The sad fact was that most fish had died by the next day. There was a profound sense of failure.

Many in town battled with mental strain through that summer and the next, with tears coming in response to the simplest things:

My mate Paul Grosse and I went out to assist one large cod, only to see it die while we tried. It's still a haunting memory [Graeme McCrabb, December 2020].

Yet, people did a huge amount of work throughout the disaster, running donated aerators, helping rescue fish and collecting dead fish for research purposes.

There were two independent reports produced on the kills (Australian Academy of Science 2019; Vertessy *et al.* 2019), highlighting terrible drought but also overextraction of water as a key NSW Water policy failing. Policy change and reform are, and have been, difficult, and the current policy will likely leave the Menindee Lakes and the Lower Darling in a similar position again in the future. The community is asking how this can happen. No one has provided them with answers or solutions, and there does not seem to be any vision of how to prevent the same thing happening again.

It rained earlier in 2020 and some water arrived at Menindee. The grape grower in me is happy, but the fisherman in me has grave concerns for the future of native fish in the Murray Darling Basin [Graeme McCrabb, December 2020].

What comes next?

The authors of this document have endeavoured to highlight the inherent interconnections between environmental, social and cultural outcomes. Given the interconnections, these outcomes should not be considered separately in the planning and delivery of environmental programs. There are some recent examples of where this has occurred. During 2019, NSW DPI Fisheries staff collected stressed native fish from at-risk pools near Menindee following consultation with local Baakandji representatives and recreational fishers. Some of these rescued fish were transported to the Narrandera Fisheries Centre hatchery facility where, following health checks and quarantine, their release to holding ponds at the hatchery facility was attended by Baakandji representatives. Some of these fish have since bred successfully.

In early, 2020 rains in the northern MDB resulted in flow returning to the DBR and partially filling the Menindee Lakes. The inflows carried millions of juvenile golden perch, spawned far upstream by parents responding to the recommencement of flow. The recommencement of flow into the lower DBR provided an opportunity in December 2020 to restock the lower DBR with offspring of Murray cod rescued from Menindee in 2019. The first release of these Murray cod fingerlings was attended by representatives from the Menindee community, including the Baakandji Native Title Prescribed Body Corporate, anglers who voluntarily assisted NSW DPI Fisheries to rescue thousands of native fish, the Baakandji River Rangers and students from Menindee Central School:

I felt happy to witness this, but sad at the same time because I am worried that they might die before reaching maturity due to a lack of water flowing down the Baaka [Badger Bates, December 2020].

More releases of Murray cod, golden perch and silver perch fingerlings back to the lower DBR are planned over the next few years.

State and federal agencies have also collaborated in the planning and delivery of 'environmental flows' to the lower DBR, targeting native fish breeding outcomes through late 2020–21. Monitoring during delivery of the Lower *Baaka* flows in 2020–21 identified strong breeding by Murray cod that had survived the earlier fish kills, and dispersal of juvenile golden perch from the Menindee lakes downstream to the Lower *Baaka* (and potentially the Murray River). The planning of this environmental water by participating agencies included considerable community engagement, but there is recognition of the potential for wider engagement and stronger collaboration in future flow planning activities.

Currently, the volumes of water available for environmental flows throughout the large northern MDB are not sufficient to ensure perennial flow throughout the whole connected river system in the absence of operational deliveries and unregulated flood events. This raises questions regarding the adequacy of water policy and the allocations and delivery of water to meet environmental objectives (Walker 2019; Chen *et al.* 2021), and hence the inherently connected social and cultural outcomes that this paper highlights.

In November 2020, the DBR above Menindee stopped flowing again. Without substantial inflows to the Menindee Lakes, the lower DBR is forecast to again cease flowing in early 2022.

Conclusion

Like communities across the MDB, and indeed Australia more widely, the people of the lower DBR feel a responsibility to care for their river. For decades the Baakandji people have held serious concerns regarding water management in the *Baaka*, its wetlands and its catchments. They are concerned that water extractions from rivers (including upstream catchments) and pumping from aquifers will dry the deepest waterholes that provide refuge for fish and other creatures during droughts. Such concerns are also reflected by many in the non-traditional and scientific communities (see Walker 2019; Mallen-Cooper and Zampatti 2020; Chen *et al.* 2021).

In the summer of 2018–19, the deaths of millions of fish near Menindee highlighted these concerns, bringing the health of the river system to national and international attention. Local communities were central to the immediate actions undertaken in response to the fish death events, relaying critical information from the field, helping struggling fish survive, assisting with research data collection and supporting the delivery of on-ground efforts aimed at reducing further fish deaths. This tragic series of massive fish kill events was viewed as catastrophic for these small, remote regional communities. It highlighted not only the strong current and traditional connections of the Baakandji to the *Baaka* and its fish, but also the emotional connection of the whole community to the river system. In this sense, the events brought the community together through common actions and grieving.

After the fish kills, the community worked hard to develop economic and social recovery by securing government support

for several local projects, including funding for tourism, the sealing of local roads and upgrades to mobile phone coverage, although the latter two are yet to be delivered. Together, the community continues to advocate for meaningful change in water management and policy at the state and federal levels. The community wants native fish to survive, birds to breed, tourists to visit and local business and families to prosper. It hopes the death of millions of native fish in recent years contributes to meaningful and enduring change in water management at the state and federal levels. The community wants to be part of recovery processes moving forward that care for their lifeblood, their river. The involvement of Indigenous and non-Indigenous communities in the recovery of native fishes is now advocated through a Native Fish Recovery Strategy (Murray–Darling Basin Authority 2019, 2020), and now is the time to commit to put this strategy into action.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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