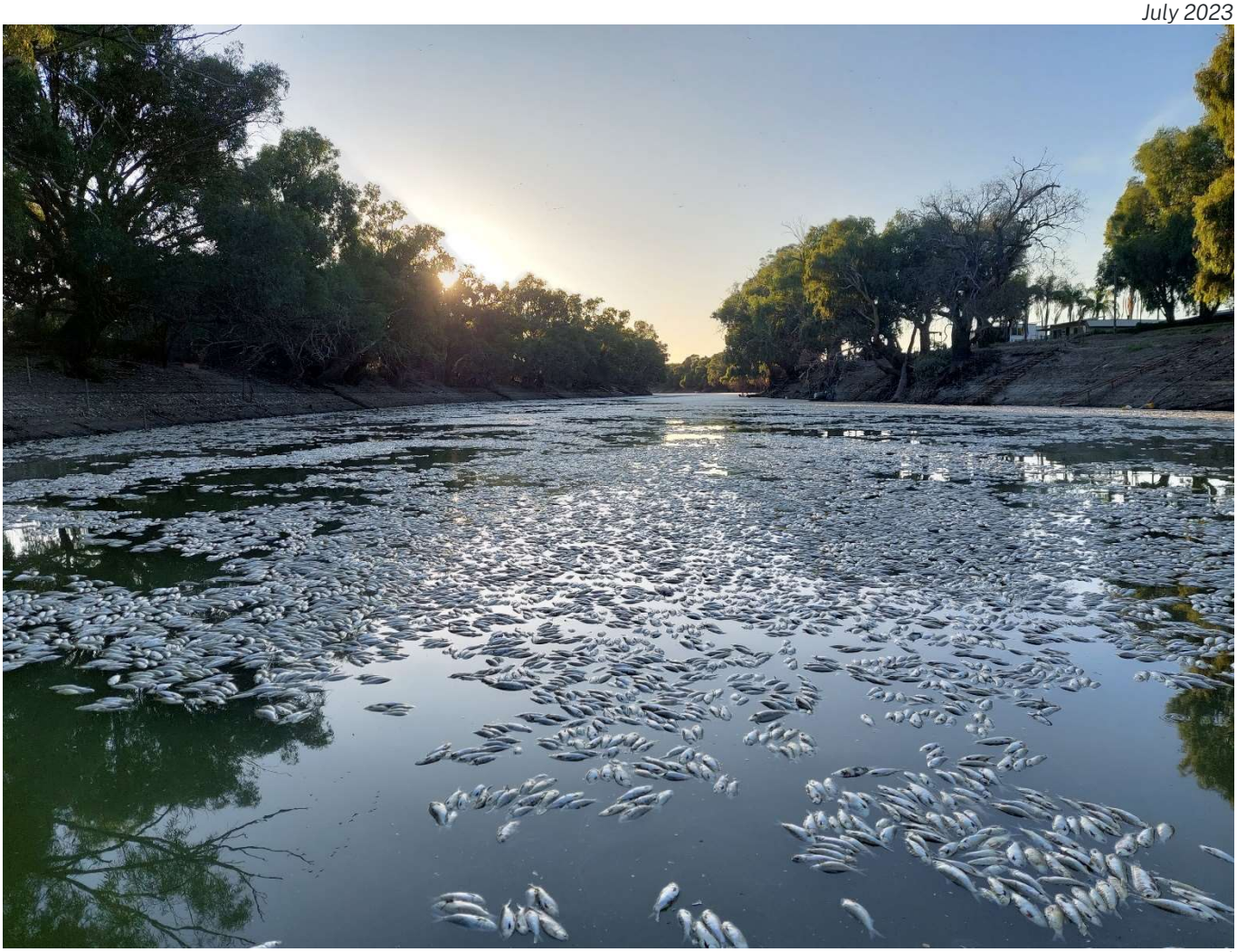
Department of Primary Industries
Department of Regional NSW

Independent Review into the February-March 2023 fish deaths in the Darling-Baaka River, Menindee

DPI Fisheries submission

July 2023



Lower Darling-Baaka River near Menindee, 17 March 2023)

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Background

Consistent with the *Fisheries Management Act 1994* (the Act), DPI Fisheries is responsible for ensuring that the fisheries resources of the State are conserved, developed and shared for the benefit of present and future generations. In particular, DPI Fisheries is required by the Act to:

a) conserve fish stocks and key fish habitats, and
b) conserve threatened species, populations and ecological communities of fish and marine vegetation, and
c) promote ecologically sustainable development, including the conservation of biological diversity

Consistent with the objects of the *Fisheries Management Act 1994*, DPI Fisheries seeks to make protection and rehabilitation of fish and fish habitats an essential part of natural resource management policy, on-ground implementation, and fisheries management decision making. This is achieved in the water policy and planning space through the provision of expert fisheries advice on the requirements of native fish to support informed decisions in the development of Water Sharing Plans and river operations.

In early 2023, mass fish deaths occurred in the Menindee Town Weir Pool of the Lower Darling-Baaka River (LDBR). NSW DPI Fisheries estimated tens of millions of Bony Herring, thousands of Golden Perch and (at least) dozens of Murray Cod and Silver Perch perished. Thousands of pest Carp were also affected. These events were larger in scale than the drought related fish deaths recorded during 2018 – 2020.

Given the scale of the fish death event and the significant ecological and cultural value of the LDBR and Menindee Lakes Systems, DPI Fisheries welcomes the independent review into the February-March 2023 fish deaths in the Darling-Baaka River, Menindee and thanks the NSW Chief Scientist & Engineer (CSE) for the opportunity to provide a submission. The response below addresses the three (3) main areas of investigation as outlined in the OCSE Terms of Reference.

1. Likely cause/s of the fish death event

In late February (24 – 28) DPI Fisheries received reports of tens of thousands of dead fish in the Darling-Baaka River (LDBR) from Menindee Main Weir to Menindee Town. Reports indicated the deaths were dominated by Bony Herring but also impacted Golden Perch, Murray Cod and Carp.

From 16-18 March, a large-scale fish death occurred in the 40km between Menindee Main Weir and the confluence of Menindee Creek with the main stem of the Lower Darling-Baaka, adjacent to the Menindee township**. It is estimated that tens of millions of fish were affected during the March event**, predominantly Bony Herring, with relatively low numbers of Golden Perch and Murray Cod, as well as Carp also impacted. The fish death area overlaps the area impacted during the 2018/19 Menindee fish deaths.

Noting that access was limited, DPI Fisheries also received reports and attended to fish death events in the LDBR river channel and in wetlands downstream of the Menindee Lakes in the weeks preceding the main fish death event on the 17 March 2023 as floodwaters receded and releases from the upstream lakes were reduced.

Based on historical experience, water quality data and expert opinion, **DPI Fisheries is of the opinion these fish deaths were a result of low oxygen (or hypoxic) conditions**. There are several potential contributors to these hypoxic conditions, many of which may have been acting concurrently, including:

- Flood waters from the Northern Basin systems had receded back into the main channel off floodplains. The scale of the 2022/23 flood event inundated floodplain habitat that had not been wet in decades, bringing large volumes of organic matter back to the main channel on the recession. Flooding during warmer months presents significant risks in terms of exacerbating microbial reactions that can strip the water of oxygen creating what is referred to as 'hypoxic blackwater' conditions. Hypoxic blackwater events are naturally occurring, however their frequency and severity has been increased due to the regulation of our rivers. NSW Government agencies had been tracking a large volume of poor quality water making its way down the Barwon-Darling in the months leading up to the Menindee fish death events. This plume of water had caused localised mortalities as it made its way through the system.
- Significant algal growth created large diurnal fluctuations in dissolved oxygen levels within the river. Algal respiration generates oxygen during photosynthetic phases in the presence of sunlight, however algae becomes a net consumer of oxygen at night. The largest reported fish death events were observed at first light, which is consistent with algal concentrations contributing to reduced oxygen availability overnight.
- A significant biomass of fish, primarily Carp and Bony Herring had accumulated in a relatively short section of the LDBR. Menindee Main Weir was opened for the first time in a decade in early 2023, with huge numbers of fish attracted to this area to undertake migrations as part of their life histories. When the weir was closed, fish began accumulating downstream, with no ability to move upstream as there is currently no fishway on the upper lake's structures (Lake Wetherall/Pamamaroo). The sheer numbers of fish accumulating in this reach may have magnified the impact of the event and potentially contributed to the mortality by exhausting the already limited oxygen resources entering the system from the upper lakes.
- Nutrients and organic matter from the floodplain were concentrated back into the river channel as the last of the flood waters receded. A spike in ambient temperature in the days leading up to the fish kill is likely to have exacerbated hypoxia, as warmer water holds less oxygen than cold water, and fish have higher oxygen needs at warmer temperatures.

The potential drivers of hypoxic conditions are not mutually exclusive, and it is feasible that some or all of the factors listed above contributed to a deterioration in oxygen availability and the subsequent mass fish death events. There is no credible evidence to suggest the fish death event had its causes in a specific pollution event, with water quality samples collected by the EPA immediately following the event indicating no abnormalities.

2. Response to the fish death event

DPI maintains a state-wide database of reported fish deaths in NSW containing more than 1,600 records dating back to the early 1970s and is involved in the assessment and reporting of fish death events in NSW outside of metropolitan areas. Fish death investigations are vital to ensure public health risks are identified and addressed by the appropriate authorities, environmental causes or disease are identified and where possible rectified or alleviated and where pollution is the cause, referral to the Environment Protection Authority (EPA) for investigation, with potential legal or remediation action possible. DPI has a long-standing cooperative protocol for fish death investigations and reporting with the EPA. The Department investigates fish deaths occurring in non-metropolitan areas while the EPA investigates fish death in the Sydney, Newcastle and Wollongong metropolitan areas. Other agencies may be involved, such as NSW Health or the NSW Food Authority where human health or food safety issues arise.

Multiple agencies across NSW and Commonwealth worked together during the March 2023 fish death response. DPI was supportive of the collaborative/multi-agency response given the complexity of the incident and the number of agencies and stakeholders involved.

Specific actions included:

- The incident was declared a formal state emergency and the associated Emergency Management protocols were put in place following NSW emergency arrangements.
- An Emergency Operations Centre was established in Menindee (and subsequently in Wentworth) to coordinate multi-agency operations as part of the response. Given the impact of the event on public amenity, communities, water security and the environment, there was no clear combat agency.
- The response was managed by the NSW Police as Incident Controller, as per the NSW Emergency Management Plan. NSW DPI was an active and willing participant in the response and contributed significantly to the implementation and outcomes during the event.
- DPI provided support before, during and after the fish death event primarily through undertaking site inspections and water quality monitoring, addressing community meetings and assessing conditions downstream to explore potential impacts and management options. DPI Fisheries mobilised field staff across multiple weeks to undertake fish rescue and relocation activities as required

Ongoing efforts to monitor and mitigate water quality risks through river operations were (and continue to be) pursued through the Hypoxic Blackwater Working Group, led by DPE Water. DPI provided advice to DPE Water regarding native fish considerations and implications of water management activities, including operational aspects and water quality information. The support for this group is ongoing.

Additionally, DPI Fisheries staff have completed fish sampling activities along the Lower Darling-Baaka during May/June 2023. DPI researchers completed a rapid assessment of available data to provide the community with information on the likely status of native fish communities after the event. Early observations indicate the abundance of key native fish, including Murray Cod and Golden Perch has declined in comparison to previous data collected since 2019. Carp were the most abundant species caught during the recent sampling.

3. Recommendations/considerations

Address immediate needs and ongoing threats within the LBDR

Water quality and native fish populations in the LDBR near Menindee are still at risk over the coming spring/summer without intervention. Ongoing data collection suggests there remains a significant oxygen demand within the reach of river adjacent to the Menindee township. The associated oxygen gradient between the upper lakes and the confluence of Menindee Creek remains an active management requirement for government agencies. To help mitigate these risks it is suggested that:

- Agencies continue to review and track the water quality in the LDBR, including examining and implementing options to address the short-term risks and options to minimise potential impacts in 2023/24 on native fish and water quality as per recommendations in Baldwin et. al 2022 and Boys et. al 2022.
- Identify appropriate mechanisms to ensure appropriate inflows into Menindee Lakes System (MLS), and related protection and delivery of operational and environmental flows to the LDBR for 2023/24 to support native fish and water quality.
- Actively manage releases from the MLS to support water quality and maintain appropriate refugia for native fish in the reach between the upper lakes and the confluence of Menindee Creek.

Continue fish monitoring

DPI Fisheries has a range of fish research and monitoring surveys in the LDBR region. Through funding provided by the MDBA, an ecological assessment of the impacts of the fish deaths in the Lower Darling over the 2018/19 and 2019/20 has been completed by NSW DPI Freshwater Research team. The results have been released as part of the Lower Darling-Baaka Drought Response report and in peer reviewed literature (Stocks et al. 2022).

Fish community monitoring in the LDBR continues as part of the LDBR Recovery Reach project, as well as other NSW and Basin-wide programs, including Basin Plan Environmental Outcomes Monitoring (BPEOM) – Fish project and the MDB Fish Survey project, which will provide the opportunity for longer term assessment of native fish conditions (as per Crook et al 2023).

The May 2023 surveys in the LDBR have documented some changes in the fish population in comparison to similar surveys in 2019, 2020 and 2021. The 5 most abundant species detected were (from most abundant to least abundant): Carp, Bony Herring, Goldfish, Golden Perch and Spangled Perch. Early observations from the data indicate that the abundance of key native fish, including Murray Cod and Golden Perch has declined in comparison to previous data collected since 2019. Additional detailed analysis will continue as part of project specific work and shared when possible.

Continued monitoring, evaluation, and reporting (MER) at appropriate spatial and temporal scales will allow examination of multi-decadal trends in relative abundance, biomass, and size structure of native and introduced fish communities (e.g. Crook et. al 2023), helping to assess progress against ecological objectives and changes as a function of environmental conditions, including droughts and floods.

Water management to support critical native fish requirements

The abundance of some native fish species in the LDBR has declined (in comparison to data collected since 2019) following the fish deaths events of early 2023. This is despite earlier demonstrated recovery of native fish from 2020-2022, driven by natural flows and deliveries of water for the environment to the LDBR.

Large-scale, extreme changes in flow conditions – from zero flow to major flooding in the space of 4 years – poses significant and ongoing risks and challenges to native fish. Such extreme changes represent a departure from the natural flow regime in the LDBR, which were typified by within-channel flow variability throughout the majority of years, punctuated by larger floods and occasional short cease-to-flow events (Mallen-Cooper and Zampatti 2020).

The risks to native fish that result from these broad changes in the LDBR flow regime include:

- Fewer within-channel flow pulses – these events are important for river productivity, spawning by some species, supporting recruitment of young fish, and providing opportunities for movement, including downstream dispersal of young.
- Protracted periods during drought where the river contracts to a series of disconnected pools, prone to algal blooms and thermal stratification/de-stratification, which can result in mass fish deaths (as experienced during 2018 - 2020 at Menindee and along the LDBR).
- Long periods between flood events that cycle floodplain carbon and nutrients through riverine systems. Regulation of our rivers has reduced flood frequency, so when major flooding does occur it mobilises unnaturally large volumes of carbon and other nutrients which contribute to poor water quality (e.g. hypoxic blackwater) and algal blooms.
- Ecosystem bottlenecks, where rapid increases in abundance of food and fish during floods (particularly pest species Carp) are followed by rapid reductions in habitat and resource. This can be compounded by large aggregations of fish downstream of barriers to fish movement.

- Depletion of populations of key species throughout long stretches of the river system. Population recovery in these stretches can be compromised by existing barriers to movement from upstream and downstream waterways, as well as availability and access to preferred habitat.

It is crucial we adaptively manage and conserve native fish and their habitats by using the best available knowledge from management, research, First Nations people and the wider community. The long-term sustainability of native fish populations in the LDBR is dependent on a variable but perennial flow regime that supports the life history needs (spawning, breeding habitat, growth and dispersal) of different species. To achieve this, we must continue to consider system-scale connectivity in water management and planning so that appropriate flows support the ecological, social, cultural and economic values of the LDBR.

The appropriate management of inflows into Menindee Lakes System, and related protection and delivery of operational and environmental flows to the LDBR to support breeding, recruitment and dispersal of native fish will be a crucial part of future planning. We note that carefully planned and optimised delivery of water for the environment in the LDBR in 2016/17, and again in 2020/21, contributed to positive outcomes relating to Murray Cod breeding and recruitment, and dispersal of Golden Perch (Stuart and Sharpe 2022).

Enhance fish passage outcomes in the LDBR

NSW has finalised the development of the NSW Fish Passage Strategy (the Strategy), which seeks to address the 165+ highest priority barriers to fish passage in NSW over a 20-year period. Phase 1 of the Strategy seeks to address over 50 high priority barriers in the first 5 years of the Strategy. Funding from the NSW Government, Basin Plan Implementation and the Commonwealth Department of Climate Change, Energy, the Environment and Water is being used to commence Phase 1 implementation, including in the Lower Darling.

Fish passage at Menindee has been identified as high priority as part of the Strategy, with DPE Water developing proposals to progress fish passage work at Menindee as part of the Menindee Lakes SDLAM water savings project. The project has since been rescoped into the *Better Baaka* Program by DPE Water, however there is no confirmed funding pathway for this proposal.

DPI Fisheries recommendation to improve fish passage and connectivity at Menindee is for consideration be given to passage through the system as a whole. This would require fishway construction at 3 outlet works (Lake Wetherell, Lake Pamamaroo and Lake Menindee Outlet Regulators) as well as the associated inlet regulators to facilitate passage between individual lakes. This recommendation is based on ecological considerations, given flows are discharged from a variety of points within the system depending on resource availability, management controls and associated demand.

Following the previous mass fish death events in the LDBR in 2018/19 and subsequent recommendations from the Vertessy et al (2019) report, the Lower Darling Fish Passage Program was developed and committed $6M from the Commonwealth to restore fish passage connectivity along the LDBR by refurbishing existing fishways at Weir 32, Pooncarie Weir and Burtundy Weir. The program was intended to be delivered over phases, with Phase 1 ($1.1M) focusing on pre-construction activities and Phase 2 focusing on construction work.

Phase 1 activities are nearing completion following delays related to persistent high flows over 12+ months that limited necessary site surveys. Investigations to date have determined that Phase 2 works should focus on rebuilding Burtundy Weir fishway, with further design activities at Pooncarie Weir and Weir 32 being paused due to project outcome overlaps with the SDLAM/*Better Baaka* program. Continued Commonwealth support for the Lower Darling Fish Passage program will be central to both mitigating future risks of fish death events and promoting broader native fish

recovery. Commitments were also made by the previous Commonwealth government to fast-track the development of fish passage at Menindee.

Establish an extreme event management program

Extreme disturbance events (e.g. floods, droughts, fires) exacerbate impacts on already stressed native fish populations. Recent experience during the 2019-2021 fish death events across NSW and the 2023 fish death events at Menindee highlight the significant impacts extreme events can have on native fish, communities and staff resources, as well as the reaction this engenders in local, regional, and international communities. A proactive and coordinated multi-agency program that provides for preparedness, response and recovery actions would acknowledge the ongoing challenges facing native fish populations and their importance to the social and cultural values of regional communities.

Such a program would establish native fish recovery initiatives and preparedness actions in partnership with landholders, industries and Aboriginal communities and lead to a coordinated multiagency approach.

The Program would involve specific activities that focus on:

- Broadening native species husbandry (including threatened species), using genetic/genomic interventions to build resilience into populations to withstand extreme events
- Identification of viable technologies to minimise impacts of extreme events (see recommendations in Baldwin et. al 2022 and Boys et. al 2022) on native fish and water quality, including research and development projects related to dissolved oxygen impacts
- Explore integration with early-warning systems for water quality (either already available or under-development) to ensure timely and effective pre-emptive deployment
- Undertake studies in high-risk/priority areas to evaluate the effectiveness of in-situ placement of viable technologies in minimising the impacts of extreme events on native fish and water quality
- Utilise advancements in remote sensing/sensor technology and connectivity for real-time monitoring and control of aeration systems. Implement remote monitoring to assess dissolved oxygen levels, water quality parameters, and system performance.
- Establish a pre-emptive deployment strategy based on the data collected from the early-warning systems, ensuring timely and effective intervention to mitigate potential impacts.
- Fish community monitoring in priority areas to assess condition and response to intervention activities.

Investing in a Native Fish Extreme Events Response Program allows better preparation for future extreme events that are likely to occur more frequently, minimising impacts whilst also engaging and empowering local communities with direct on-ground response and recovery actions.

Continuation of LDBR Recovery Reach investment

NSW has established the Lower Darling-Baaka River Recovery Reach (LDBR RR) through funding made available from the MDBA as part of the Native Fish Recovery Strategy (NFRS). The appointment of a Lower Darling-Baaka Recovery Reach Coordinator has allowed the continuation of community engagement, on ground outcomes and fish community monitoring. The program has been running since 2019-2020, with over $1 million invested in native fish related works, research and engagement.

In response to the Menindee Fish Deaths of 2019-20, funding to fast-track recovery activities in the Lower Darling was prioritised during the drafting stage for the NFRS to assist with immediate responses to the mass fish deaths that occurred near Menindee and subsequently in the LDBR downstream.

Broad objectives include:

1. Monitor the status of the fish community in the LDBR post the 2018-19 fish deaths to track recovery.
2. Support Golden Perch population recovery through enhanced understanding of the spawning locations and required hydrological conditions that contribute to the dispersal and recruitment of the species in the broader Barwon-Darling River, including dispersal into the LDBR.
3. Develop and implement on-ground works that assist in the protection and enhancement of native fish habitat, whilst creating a greater awareness and participation from local communities.
4. Assist with planning of flow events (environmental or operational deliveries) that support key life history outcomes for native fish in the LDBR RR.
5. Provide on-ground coordination across activities and groups to engage with the community, build capacity, and share results.

Given the continued impacts to river health and native fish in LDBR, and importance of the Menindee Lakes to recovery and connectivity of fish populations in the Murray-Darling Basin, it is critical that investment in efforts of the LDBR RR are maintained and expanded into the future.

As part of this work there is an opportunity to enhance cultural outcomes through a co-designed river health program with the Barkandji traditional custodians that reflects their aspirations for the Baaka and community outcomes. Such a program would support the Barkandji community to inform and educate the Lower Darling-Baaka and NSW communities on the cultural values and uses of the river, and ensure such knowledge is embedded in river management decision making (including water management, native fish recovery, emergency response, fisheries management, biosecurity management etc) building capacity in planning, training and natural resource management.

Implement an Integrated Pest Management Program for Carp

With the latest surge in Carp populations following the recent floods, there is an increased need to take action to mitigate the negative consequences of Carp. Monitoring by DPI research staff has clearly indicated a significant increase in carp numbers and there is strong evidence to suggest this increase is a key threat to native fish populations.

The Commonwealth is still considering the information provided in the National Carp Control Plan (NCCP) and the potential use of a Carp virus as a biological control agent. There is a need to expedite any additional research identified in the NCCP and establish a clear position on the role of the virus in future management actions.

Prevention, control or eradication of any invasive species, including Carp, is likely to be most effective when undertaken using an Integrated Pest Management approach (IPM). Research undertaken during the development of the NCCP indicates reduction of Carp impacts may benefit from an integrated approach in which virus deployment is preceded by targeted harvesting, particularly in high-density Carp populations. IPM is an ecosystem-based strategy focused on using a combination of techniques to manage pests. Holistic carp management actions will be crucial to recovering native fish stocks and reducing future risks.

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