



Native Fish Management and Recovery Strategy

Native fish Emergency Response Plan 2019-20

October 2019

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Murray–Darling Basin Authority pays respect to the Traditional Owners and their Nations of the Murray–Darling Basin. We acknowledge their deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

The guidance and support received from the Murray Lower Darling Rivers Indigenous Nations, the Northern Basin Aboriginal Nations and our many Traditional Owner friends and colleagues is very much valued and appreciated.

Aboriginal people should be aware that this publication may contain images, names or quotations of deceased persons.

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Background

Over the summer of 2018–19, three major fish death events occurred along a 40 kilometre section of the lower Darling River, near the town of Menindee, New South Wales. Occurring in rapid succession it is estimated that over a million fish died in the summer of 2018–19.

While fish death events are by no means unprecedented in the Murray–Darling Basin, by virtue of the scale of affected river and the rapid escalation of the events, these recent mass mortalities are widely considered to be some of the most serious on record. The fish mortality events serve as a visible warning of the significant pressure experienced by native fish across much of the Basin.

The fish death events also underscored the importance of native fish for Basin communities. Healthy and diverse populations of native fish in the Basin provide important ecosystem functions, cultural, social and economic services. Iconic fish species, such as the Murray cod, provide cultural keystones that link people with their culture and sense of place in the Basin. The fish death events of 2018–19 underscored that the community want to see action from governments to support fish populations in the Basin.

The Basin Plan requires that risks be managed within an adaptive management framework, including the publication of guidelines on the management of risks where required. Fish death events pose a significant risk to the achievement of Basin Plan environmental, social and economic objectives. The recovery of fish populations requires close cooperation among Basin governments for Basin-scale outcomes. Effective coordination and collaboration requires the identification of clear roles and responsibilities, but also the establishment of a common framework to guide actions when urgent responses are required.

What may cause mass fish death events during extended dry conditions?

Dry conditions mean that fish become reliant on shrinking refuges. As water holes constrict native fish face overcrowding, decreased water quality and increased competition for resources. These conditions lead to increasingly stressed fish, making them more susceptible to disease and fish deaths.

Reduced water quality in particular can trigger widespread fish deaths. For example in the Lower Darling in 2018-19 water temperatures increased and rivers became disconnected, causing waterways to separate into different layers (stratify). Under these conditions cooler, denser, water settles in the lower parts of the channel and doesn't mix with warmer oxygenated water sitting above. If the separation persists, the lower layer may lose all oxygen.

In these conditions fish congregate in the upper layer, where oxygen is still available. These conditions create a high-risk situation for fish. If the layers are disturbed and suddenly mix, the upper oxygenated water will be contaminated by the de-oxygenated water. Fish will no longer be able to survive in the deoxygenated environment.

Independent Panel Assessment findings

The Independent Panel Assessment of the 2018–19 Fish Deaths in the Lower Darling led by Professor Rob Vertessy¹, found that the main causes of the fish deaths were likely a combination of factors including low inflows due to drought, water extraction and river and water

¹ Littleproud, D. (2019), Media Release: Independent assessment of fish deaths, 22 January

management, and the prevailing weather conditions². The Independent Panel Assessment found there is a high chance that severe fish death events, such as those recently experienced in the Lower Darling, will reoccur in the future, and recommended significant interventions and coordination to manage future events including:³

- identifying which sites are likely to be at significant risk of fish deaths during the remainder of 2019–20
- establishing a Basin-scale “emergency response” group (cross jurisdiction and agency) for scoping, planning and implementing a risk assessment framework for fish across the Basin and associated site-specific responses
- identifying sites across the Basin that are key to the long-term maintenance of fish populations both locally, regionally and across the entire Basin
- prioritising, where possible, intervention actions for these sites
- identifying the range of technological interventions available to reduce the risk of fish deaths at key sites (e.g. de-stratification, oxygenation, fish removal)
- preventative and reactive monitoring at key sites to assess impact of any deployed interventions.

² Vertessy, R. et al (2019), Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling: Interim Report with Provisional Findings and Recommendations

³ Baldwin DS, (2019) *Stratification, mixing and fish deaths in the lower Darling River*.

Emergency Response Plan 2019–20

This Emergency Response Plan sets out how Basin governments will manage significant fish death events in 2019–20, including how the Australian Government will complement the actions of Basin governments and, where appropriate, take an active role in supporting actions to reduce the likelihood or consequences of fish deaths and enhance recovery. It draws on recommendations from the Independent Assessment of fish deaths in the Lower Darling⁴ and identifies:

1. roles and responsibilities
2. coordination
3. high-risk sites for 2019–20
4. investigation of options for managing fish death events
5. emergency response protocol
6. recovery
7. review

This document sets out a clear [Emergency Response Protocol](#), to guide a coordinated Basin-scale response to significant fish death events.

It is important to note that this document sits within a broader strategy to manage and recover native fish populations, which will be delivered as part of the long-term Native Fish Management and Recovery Strategy, to be finalised by end April 2020.

Principles for Emergency Management

Under emergency conditions Basin governments operate under the following high-level principles, which will guide actions and interventions to manage fish death events at the Basin scale.

- Protection of fish populations: The protection and preservation of fish populations across the Basin will be paramount to fish death response measures
- Comprehensive: The development of emergency arrangements will consider the phases of prevention, preparedness, response and recovery
- Coordinated: Organisations come together and share resources to support emergency management responses. Activities are complementary and integrated. Information is shared to achieve a common purpose
- Collaborative: Planning and systems of work reflect common goals and a unified effort
- Flexible: Emergency plans and responses are agile to change and can adapt to evolving circumstances
- Shared responsibility: Every party understands their own responsibility in an emergency, and the responsibility of others
- Communication: Information sharing is supported and managers are responsible for providing and sharing clear, targeted and tailored information to enable decision-making by all stakeholders
- Continual improvement: All sectors continuously learn and innovate to improve practices and share lessons, data and knowledge.

⁴ Vertessy, R. et al (2019), Independent Assessment of the 2018-19 Fish Deaths in the Lower Darling: Final Report

Roles and responsibilities

For any emergency response, particularly at large scales, it is important that there are clear roles and responsibilities to ensure efficient management of [Basin-significant fish death events](#). It is also important to recognise that these roles may need to adaptively evolve as the system enters a recovery phase.

Basin government roles

Basin governments are responsible for managing and investigating fish death events which take place within their jurisdiction and have already taken significant action to manage fish populations within their jurisdictions (Appendix 2). In recognition of the continued dry conditions experience in 2019–20, Basin governments may undertake the following actions as needed this year:

- identify high risk sites and priority refugia for fish
- provide information to the MDBA when the risk of a fish death event escalates or should be included on the Basin-wide 'water quality risk map'
- have response plans prepared for priority assets (which may include species) and/or catchments
- monitor sites which are at high-risk of fish deaths, to provide up to date information on the status of risks to communities
- identifying opportunities for collaboration and support between states on critical prevention or response actions e.g. staff resources, equipment and expertise
- ensure permits and access arrangements for interventions are in place at high risk/priority refugia
- monitor outcomes of any interventions to support recovery responses
- lead the communication of fish death risks, events and interventions with communities, and in collaboration with the Australian Government where it is of Basin-significance.

Australian Government role

The Australian Government has a key role in supporting Basin governments respond to fish death events of Basin-scale significance. This includes:

- supporting the collaboration and coordination of emergency response activities, and sharing of resources, through the organisation of annual Risk Management Planning and Review forums
- release of funds via the Native Fish management and Recovery Strategy Emergency Contingency Fund to support Basin governments in managing urgent and extreme fish deaths of Basin-scale significance
- provision of Commonwealth environmental water where available to assist in the management of fish deaths where water is available and their mitigation is a priority for water holders
- contributing to Joint Government water quality monitoring programs conducted across the Basin, which assist in identifying risks and managing interventions
- establishing a 'Fish death incident database' to record Basin-significant fish death events across the Basin. This database will to be updated each year at the Risk management review forums.

Actions for Community

Communities can help governments to mitigate and respond to fish deaths across the Basin, including in the preparatory, prevention, response and recovery phases. Key actions for community include:



Monitoring local waterways and notifying relevant local and state officers when they observe fish death events



Participation in citizen science programs with the State governments



Supporting State interventions, through providing land access where required, sharing local knowledge and observing fishing regulations implemented to protect native fish



Spreading the word to ensure communities are informed of where there have been fish death events, where interventions are taking place and what areas should be avoided on the river



Participating in community-led movements to protect remnant fish populations to support the recovery of stressed fish (e.g. community-driven fishing embargoes in regions where there has been recent fish deaths can allow fish to more rapidly build condition, breed and grow their populations)



Looking after drying rivers and pools through keeping stock away from river channels and leaving native vegetation and woody habitat where it is to improve water quality over the long-term, supporting native fish recovery.

Should a fish death event occur the community's first point of contact is their local or State government. State governments have access to the on-ground resources to initiate a response where needed and understand the appropriate pathways to escalate matters.

Where community members contact MDBA engagement officers, the MDBA will transfer them to the relevant State agency to ensure their concerns are adequately addressed. The MDBA will also keep a watching brief on risks across the Basin in conjunction with State governments through the water quality risk map. Where communities identify additional risks that do not appear on this map the MDBA will assess the risk and review the map to ensure it provides accurate and current information.

Members of the community should report mass fish deaths to their relevant local authority.

New South Wales: Fishers Watch – 1800 043 536

Victoria: Environment Protection Authority – 1300 EPA VIC (1300 372 842)

South Australia: Fishwatch Hotline – 1800 065 522

Queensland: Department of Environment and Science – 1300 130 372

Australian Capital Territory Access Canberra – 13 22 81

Coordination

Risk management forums

Reviews of the 2018–19 fish death events identified that there was a need for expertise-based planning to better coordinate Basin-scale responses to fish deaths in the future. To support Basin-scale planning and coordination, a Risk Management Planning Forum will be held at the start of the high-risk season and a Risk Management Review Forum at the end of the high-risk season.

The initial planning forum will be held in early October with risk management staff and technical specialists for the following purpose:

- confirm locations in the Basin where there is a high risk of fish deaths
- discuss the preparedness and intervention activities taking place within each jurisdiction, particularly at high-risk sites, and where there are other watch-points
- discuss coordination of response options between jurisdictions
- consider recovery arrangements to support fish populations and minimise downstream impacts following an event
- share the outcomes of recent research and technology trials to inform interventions.

At the end of the high-risk season a second Risk Management Review Forum will be held with the following objectives:

- Basin governments provide an overview of fish death events and management of extreme risks in their catchments, how they were managed, strengths and weaknesses of their approach—summarising key learnings for the year. This information will be incorporated into an MDBA-managed Fish Death Incident Database. Content for the database will be provided at the review forum and updated at each subsequent forum.
- joint governments review of the deployment of the Emergency Contingency Fund and whether the process could be made more effective or varied for the next water year
- identify recovery actions taking place, and where further action is required

- prioritise additional research and technology trials to improve Basin preparedness for Basin Officials Committee consideration the following year if required.

High risk sites for 2019–20

Using available monitoring and historical knowledge the MDBA has developed an early warning system in the form of the water quality risk map for fish (Figure 1). This map identifies the risk of the following water quality issues occurring under current conditions at monitored sites across the Basin:

- blackwater (associated low dissolved oxygen)
- acid sulphate soils
- algal blooms (associated low dissolved oxygen)
- elevated salinity
- stratification (associated low dissolved oxygen).

The likelihood of these events taking place is based on known risk factors including geomorphology (river reach and structures), likelihood of algal blooms (from monitoring alerts), climatic conditions (Appendix 1), and current operations. Monitoring and flow data are important inputs into this assessment of where risks are likely to occur. For example, State algal monitoring programs identify alert levels for blue-green algae. In addition some water quality data parameters (salinity of EC, temp, limited Dissolved Oxygen) are collected through the River Murray hydrometric network, and support the identification of water quality risks under dry conditions. Finally, flow data up to September 2019 provides a current understanding of where water availability is particularly restricted due to significant reductions in flow.

The consequence of these water quality risks on fish populations are defined at Table 1. These definitions are assigned through understanding the severity and extent of water quality risks for each region, based on flow history, our ability to manage risks (i.e. water availability) and expert opinion.

Table 1: Consequence ratings for water quality risks

Consequence (impact)	Ecological outcome
Minor	individuals may die (sensitive) (very localised) (sub lethal for the hardy species) (local area)
Major	lethal impacts (many sensitive species) some hardy species (larger individuals) die (local area)
Catastrophic	lethal impacts all species (mass fish deaths) (some individuals may survive) (wide spread)

Through combining the likelihood and consequence ratings of each risk across the Basin the following three categories of risks have been identified:

- **Extreme risks:** At these sites the likelihood of a serious water quality incident taking place is almost certain and would have a lethal impact on all species at that location (catastrophic impact).

- High risks: The likelihood of a serious water quality incident taking place is likely or almost certain and will have a lethal impact on many sensitive species and some hardy species locally (major impact).
- Watch list: All other risks which are likely to occur and will have an ecological impact.

It is important to recognise that these maps cannot be relied on to comprehensively identify water quality risks across the Basin. Should climatic conditions suddenly change or where there are monitoring gaps, unexpected events may still occur. It will be important for managers to use on-ground networks to supplement available data.

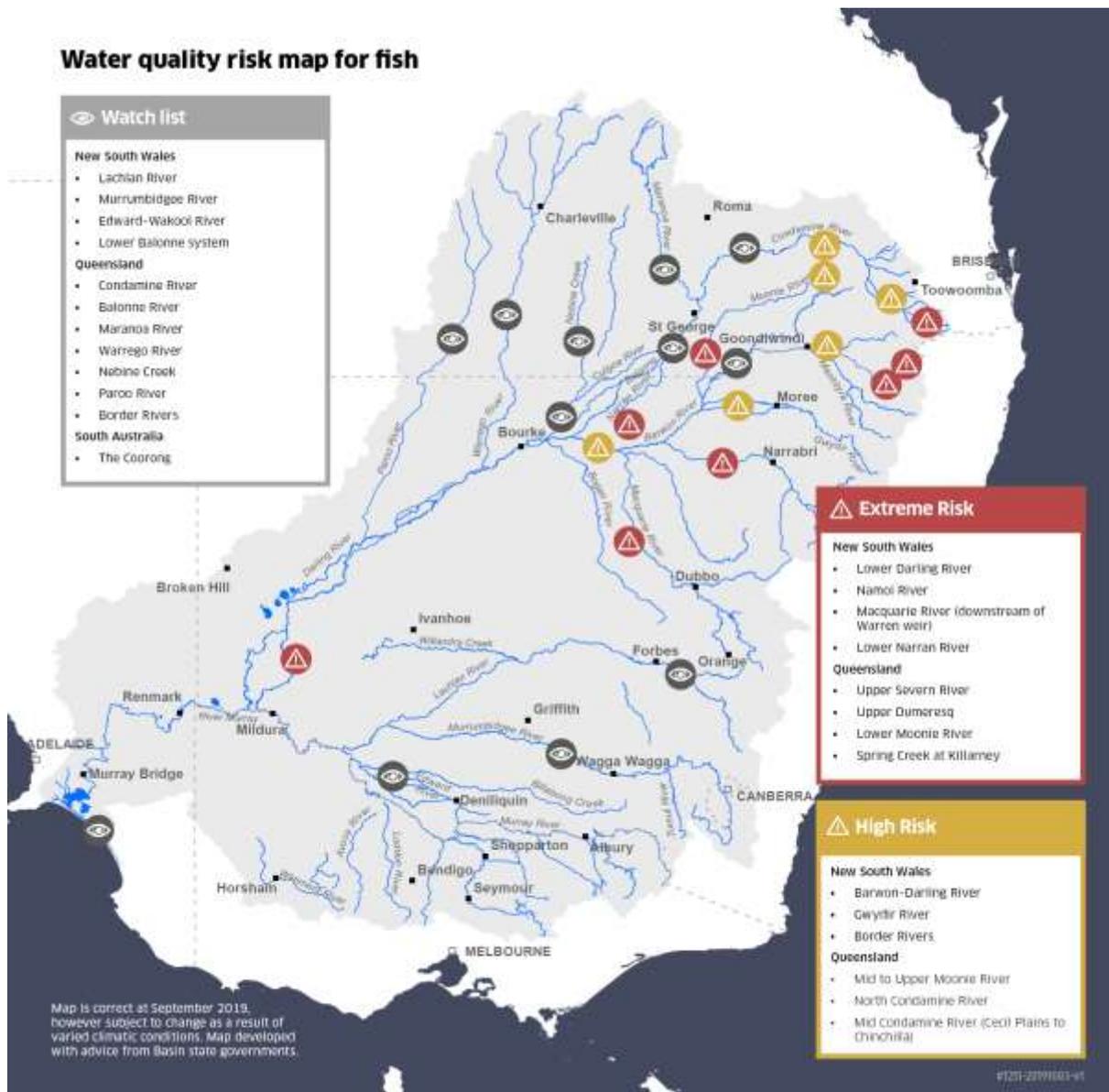


Figure 1: Murray-Darling Basin Water Quality Risk Map for fish

Investigation of options

As conditions dry options for mitigating serious water quality risks become limited and generally fall into the following categories:

- **Add water:** where water is available it can be applied to mitigate water quality risks and provide connectivity to other refuge sites. In some cases operational water can be released in a way that will manage water quality events without impacting water availability. Environmental water can also be applied to support ecological outcomes. This option is viable where it is a priority to support the local fish population (see Box 2) and where water is available. In much of the northern Basin, where risks are elevated, there are no environmental allocations available and other options must be considered.
- **De-stratify water:** options are available to de-stratify the water column prior to the development of significant temperature and oxygen differences between river layers. These de-stratification techniques generally should be used alongside aeration approaches, to enhance fish survival.
- **Aerate water:** aerating water increases oxygen levels in the river, and can create in-stream refuges for fish. Aerators may also be used to improve water quality at off-stream refugia for fish to be translocated to. In-stream options are preferred as they have a higher chance of success, particularly where they create in-stream refugia.
- **Translocate fish:** translocation of native fish is a valuable tool to protect and recover threatened species, ensure sufficient numbers of breeding adults remain in refuge pools to enhance recovery or remove endangered species from locations where they can no longer survive. However, the removal of individuals from a population at risk should only be actioned where the population cannot be reliably maintained within their native habitat. [National Policy Guidelines](#) to manage the impacts of fish translocations as well as jurisdictional requirements will need to be observed to ensure any translocations are done safely and minimise the risk of disease. Translocated fish may also be used to establish captive breeding populations in hatcheries. These fish will be used to stock our rivers to increase fish population numbers as conditions improve.

The MDBA is currently working with NSW DPI Fisheries to investigate other emerging technology options to reduce the risk of mass fish deaths in the Lower Darling in 2019–20 (Table 2). Technology, when deployed early could reduce the extent of stratification occurring at key refuges, preventing low oxygen conditions from arising. An assessment of potential options to provide fish refuges is underway with the assistance of a Project Advisory Group. In the short term, it is most likely that technologies which were proven to be successful in 2018–19 will be deployed such as venturi (bubble) aeration.

Options 4 and 5 will be considered as part of this project, yet may contain additional risks that could limit their potential viability.

Table 2: Technology options being investigated to reduce fish deaths in the Lower Darling in 2019:20.

Option	Type	Description
1	Bubble aeration	Aerator systems including venturi, diffusers and compressed air
2	Nano bubble aeration	Aeration through the use of micro diffusers
3	De-stratification	Mechanical systems which limit or break-up stratification through movement and mixing of the water column.

		This both aerates through movement, and prevents favourable conditions for algal bloom development
4	Chemical additives that release oxygen	Use of chemical products to introduce oxygen to the water body
5	Algal bloom inhibitors or dispersal agents	Use of chemical products to manage algal blooms through inhibition, dispersal or changes to water chemistry

Emergency Response Protocol 2019–20

This Emergency Response Protocol sets out the joint government process for managing Basin-significant emergency fish death events to guide the deployment of the Australian Government’s \$300,000 Native Fish Management and Recovery Strategy Emergency Contingency Fund. This fund will allow rapid responses to meet the biological needs of native fish, providing time for longer-term Basin government interventions to be enacted.

Objective

To manage [Basin-significant fish death events](#) within the Basin.

Emergency Response Roles

Community members: where community members observe a fish death event they should contact their relevant local authority on the contact numbers provided at [Section 1](#).

Local catchment managers: should local managers become aware of an emergency fish death event, they will alert the State representatives for the region.

Basin governments: Basin State and ACT governments will assess their capability to respond to emergency fish death events. Where further support is needed Basin governments will put forward a proposal to access the Australian Government’s Emergency Contingency Fund administered by the MDBA.

Australian Government Emergency Contingency Fund (ECF) Program Officer: using the principles established under this protocol the ECF Program Officer will work with the relevant proponent to provide evidence to support the immediate release of Emergency Contingency Funds for emergency fish death events.

Operational Advisory Groups (OAGs) and Technical Advisory Groups (TAGs): where it is possible to mitigate the fish death event using water, the coordination of environmental flows will be undertaken through the pre-existing OAGs/TAGs for the affected region.

Activation of the Emergency Response Protocol

The Emergency Response Protocol provides a five-step process to manage fish death events of Basin-scale significance (Figure 2).



Figure 2: Activation of the Emergency Response Protocol

Step 1: Trigger

The Emergency Response Protocol is triggered under two circumstances:

Trigger A: When the risk of a fish death event moves from high to extreme on the 'Murray-Darling Basin water quality risk map' and States identify the need for pro-active Commonwealth support.

Trigger B: When a Basin-scale significant [emergency fish death](#) event takes place, requiring an immediate response.

Step 2: Deploy the Emergency Contingency Fund where required

As risks escalate to extreme, or if there is an urgent fish death event of [Basin-scale significance](#) the Basin government will directly submit a proposal to the Native Fish Management and Recovery Strategy Emergency Contingency Fund (ECF) Program Officer to access a specified portion of the Emergency Contingency Fund. These funds will support short-term responses in 2019–20 until longer-term Basin government processes have an opportunity to take over. The proposal must be provided in the format provided at Attachment 1 and will detail:

1. Why intervention is required to protect an asset of Basin significance
 - a) Why Australian Government support is required beyond Basin government resources
 - b) What intervention is proposed including details on how Australian Government funds will be applied to a response action (which must be consistent with Figure 4)
2. How Basin government resources will support long-term recovery at the site
3. Are there are sufficient on-ground resources and coordination to deploy the proposed action, with the relevant approvals in place
4. Is there a need to coordinate the response across Basin governments

When an urgent proposal comes to the ECF Program Officer they must assess the situation (Figure 2), working bilaterally with the relevant Basin government to justify and deploy an immediate response. Based on this information the ECF Program Officer will make a recommendation to the MDBA Chief Executive to release funds.

Step 3: Notify Basin governments

When the Australian Government's Emergency Contingency Fund is deployed the MDBA will notify the Basin Officials Committee (BOC) of the event. Immediate notification will ensure the Basin Officials are prepared for any downstream impacts, are aware of remaining funds available under the Emergency Contingency Fund and can offer support to the Basin government where the risk occurs should they have resources available for deployment at nearby locations.

Step 4: Communicate emergency event

In the event of an emergency fish death event each agency will operate under their respective 'Emergency communication plans' and the joint emergency communications principles. States will take the lead role in communicating with key stakeholders leading up to, during, and after fish death events within their jurisdiction. Where required the MDBA will support the relevant Basin government by sharing their communications materials to Basin stakeholders.

Step 5: Report on the Emergency Contingency Fund

Basin governments will provide a summary report reviewing the application of the Emergency Contingency Fund within 3 months of their deployment. The summary report will describe the consequences of the intervention action, including monitoring outputs and interpretation of the action's strengths and effectiveness. They will also provide information on the long-term

approach which will be applied to recover local fish populations and mitigate future events. This reporting will improve knowledge and inform adaptive management, feeding into subsequent Risk Management Forums.

Decision-support

Box 1: What is an emergency fish death event of Basin-scale significance?

An emergency event under this plan is defined as fish deaths which:

- a) affect an asset of Basin-scale significance (see Box 2)
- b) will have a major or catastrophic impact on native fish at that location (decision tree 1).

Box 2: When is an asset of 'Basin-scale significance'?

Basin-significant assets include **priority sites**, **priority species** and **important populations** which are necessary for a species' long-term survival and recovery.

Priority sites for fish are set out in the Basin-wide environmental watering strategy (BWS) in *Table 9: Important Basin environmental assets for native fish (see Appendix 3 this document)*. The MDBA compiled this list to identify broad-scale locations that are important for breeding, growth and survival of native fish. This list was compiled using expert opinion and information provided for the assessment of key ecological assets in the development of the Basin Plan.

Priority species at the Basin-scale are those identified under the *Environmental Protection and Biodiversity Conservation (EPBC) Act* as threatened and includes Macquarie perch, Murray cod, Trout cod, Silver perch, Yarra pygmy perch, Murray hardyhead, Barred galaxias and Flathead galaxias.

Important populations of fish are identified as those which include:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity

These species (Appendix 4) become a priority of Basin-scale significance at an asset or regional scale if a fish death event will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population which cannot be re-established through natural migration
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population in at least eight of 10 years at 80% of key sites for moderate to long lived species or
- interfere substantially with the recovery of the species.

Decision tree 1 – Criteria for the release of emergency contingency funds

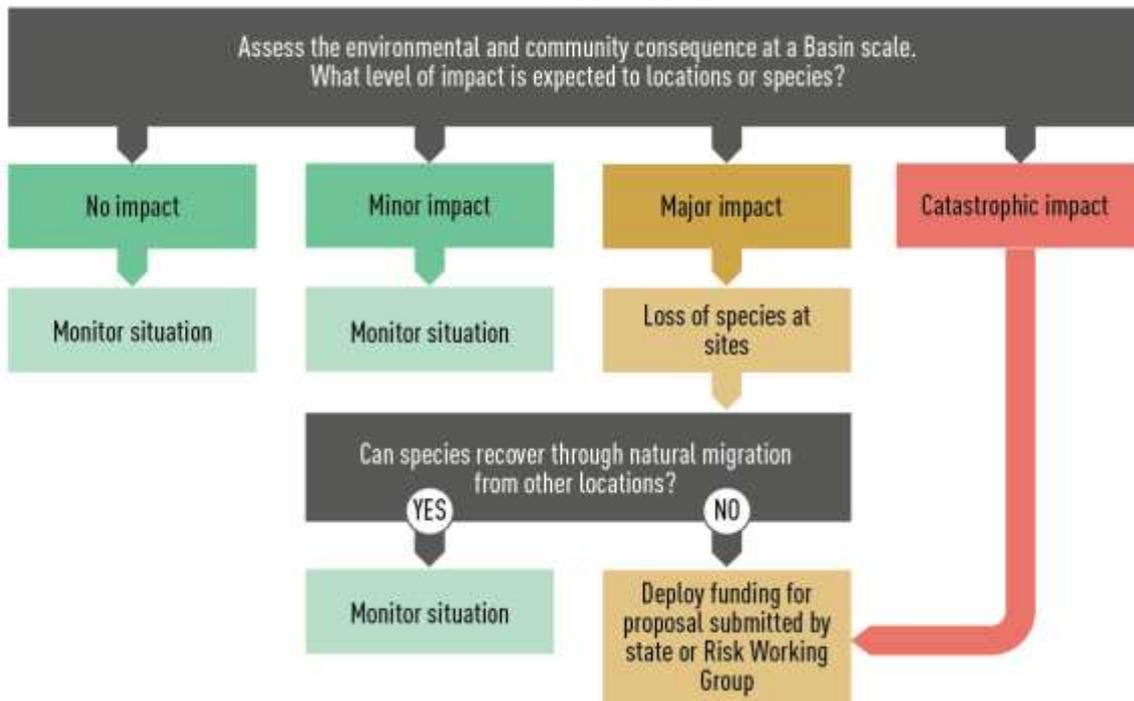


Figure 3: Decision tree to guide deployment of Emergency Contingency Fund.

Decision tree 2 – Criteria for urgent action to mitigate significant fish deaths in the Murray–Darling Basin

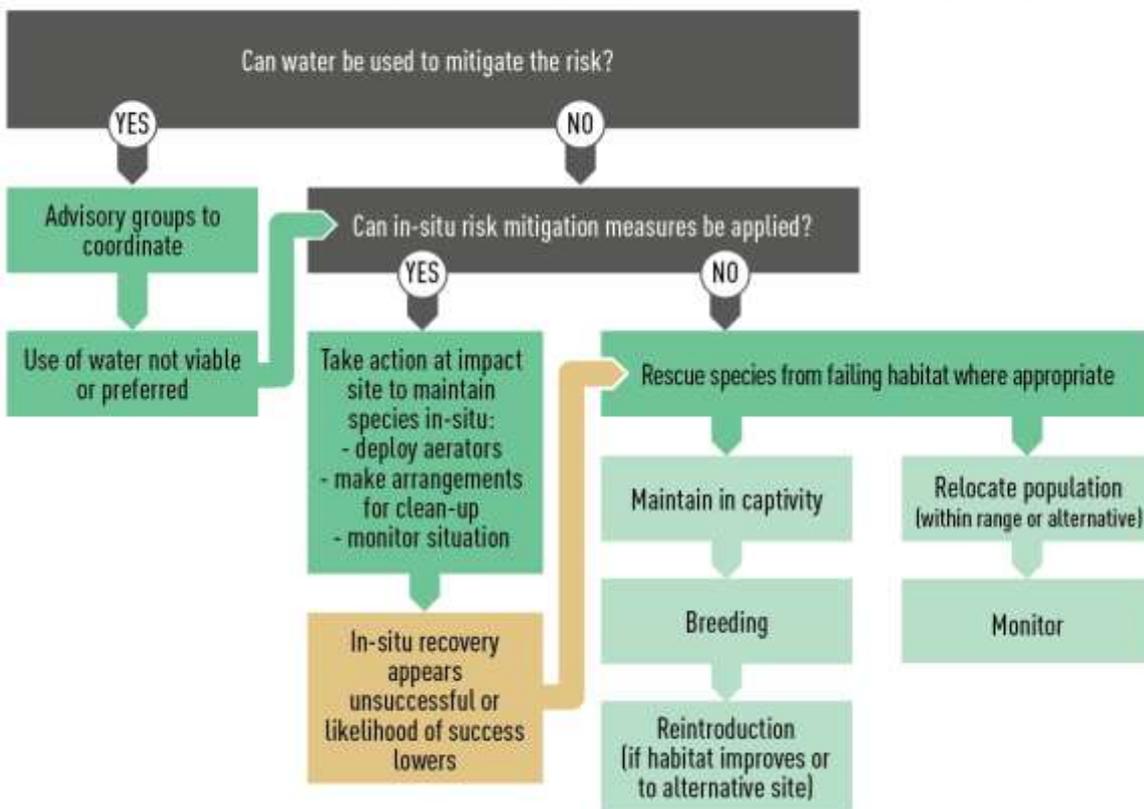


Figure 4: Decision tree to guide response to significant fish death events

Funding principles

The Australian Government have committed \$300,000 as part of the Native Fish Management and Recovery Strategy to respond to Basin-significant emergency fish death events in 2019-20. This funding amount is based on the amount of Australian Government funding required in previous years to respond to emergency fish death events.

All governments have acknowledged that conditions for 2019-20 have been particularly difficult, with drought predominating in the northern Basin and conditions unlikely to improve (Appendix 1). However, should Joint or Australian Government support be required above the \$300,000 available, the provision of additional funds will be subject to further discussion with the Basin governments.

Joint government emergency communications principles

The central aim of emergency communication is to provide timely, useful and actionable information to all stakeholders, clearly, consistently, openly and quickly. This may include explaining policies, laws, plans and practices when the Emergency Response Protocol is activated. Joint governments will operate according to the following key emergency communications principles during an event:

- have a clear lead agency for communications (State where fish death occurs)
- have one source of truth for information
- be honest, open and inclusive
- ensure facts are accurate
- correct mistakes as soon as possible
- provide up-to-date information in a timely manner
- provide as much local or regional detail as possible
- tailor information to the identified audiences
- communicate internally
- communicate with partner governments and relevant government agencies

When communicating information to stakeholders during an emergency, Basin governments have agreed to communicate:

- what you know
- what you don't know
- what you're doing
- what you want communities to do
- where to obtain appropriate information from (i.e. source of truth).

Recovery

Following an ecological impact on a fish community, recovery needs to be supported at both the short and longer term scales. A necessary part of the recovery process at the Basin scale will be a stocktake of the fish death events which took place and the management of extreme risks across catchments. This information will be incorporated into an MDBA-managed Fish Death Incident Database. Content for the database will be provided at the Risk management review forum and updated at each subsequent forum. The database will help to build knowledge and monitor the occurrence of fish deaths taking place in the Murray-Darling Basin. In addition it will identify priorities for recovery action.

Short-term recovery actions interact strongly with response options and should be implemented as soon as the impact of the emergency event begins by States, while long-term recovery may take place over a series of years.

Longer term recovery actions should improve the resilience of the system and allow fish populations to grow and breed. To support healthy and resilient fish populations Basin Governments are progressing the development of a Native Fish Management and Recovery Strategy (NFMRS) for the Basin. The proposed NFMRS aims to protect and restore native fish populations of the Basin over the long-term, and will be developed and implemented collaboratively with the Basin governments, First Nations and wider community. It will build on existing and past native fish programs, projects and initiatives across the Basin, incorporating new research and policy to prioritise fish recovery actions. Some of the actions which may be included under the Strategy to reduce the risk of significant fish death events include:

- maintaining streams and habitats (possible de-silting of refugia, riparian fencing) – including through the provision of appropriate flows
- habitat rehabilitation/modification to support fish
- improvements in fish passage including barrier removal and building of fishways
- conservation stocking and breeding programs to allow reintroduction as habitat becomes available
- fishing controls/embargoes
- population modelling to understand the status and requirements of a population
- improved monitoring and knowledge to prioritise activities to support fish recruitment.

Review

This Emergency Response Plan provides a clear protocol for managing fish death events of Basin-scale significance in 2019-20. The process pathways and principles under this Emergency Response Plan will ensure we are prepared to allocate resources and effectively engage with community, to manage Basin-significant fish deaths this season.

As risks to fish populations decrease, governments will come together to review the effectiveness of this plan, document emergency events each year and adjust our planning, to ensure the management of emergency fish death events continually evolves to meet government requirements and community expectations.

As just one component of the broader Native Fish Management and Recovery Strategy, this Emergency Response Plan will be complemented by longer-term actions which will build system resilience, with the aim to restore healthy fish populations to the Murray–Darling Basin.

Attachment 1

Application form for emergency response funding to facilitate fish rescues/interventions in response to a Basin scale significant fish death event or risk.

1. *Person completing this form*

NAME:.....POSITION:..... ORGANISATION:..... LOCATION:..... DATE REPORTED:..... TIME REPORTED:.....

2. *Information provided on extreme event*

TYPE OF WATERBODY (please circle): (A) Stream (B) anabranch (C) Lake (D) Dam CATCHMENT (specify e.g. Lower Darling, Lower Balonne): PRECISE LOCATION: (including GPS coordinates)..... DETAILS OF EXTREME EVENT: (please provide photos if possible)
--

CONDITIONS AT LOCATION OF EXTREME EVENT:

Sample No.	1	2	3	4	5
Name of sampling site (GPS coordinates)					
pH					
Temp (°C)					
Dissolved Oxygen					
Turbidity					
Other (specify)					

HAVE SAMPLES BEEN COLLECTED? (FISH OR OTHER): YES NO

(if yes give details of what was sampled, who took the samples, how they have been preserved and where they are presently located)

.....

.....

.....

.....

.....

1. *Details of Basin-scale significance*

NATIVE FISH SPECIES at

Risk.....

.....

CONSERVATION

STATUS:.....

.....

EST. POPULATION

SIZE.....

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Appendix 1: Climate context for 2019–20

Over the past three years much of the Basin has experienced dry and warm conditions, with record-breaking temperatures experienced for Australia in December 2018, January and March 2019, and for summer 2018–19 as an aggregate (Figure 1). The 2018 calendar year was the third warmest year on record since 1900 and is the sixth consecutive year that temperatures have been well above average across the Basin⁵. Since record-breaking rain fell over much of the Basin from May to September 2016, climate conditions have been much drier than average. Between 1 October 2016 and 31 July 2019 rainfall has been in the lowest 10% of years in the historical record since 1900, with many regions in the Basin experiencing severe drought (Figure 2).

Low flow and cease-to-flow conditions were experienced in many northern Basin catchments over the 2018–19 water year. Storage levels in the northern Basin are lower than during the millennium drought and observed inflows in the Macquarie and Namoi valleys were the lowest inflows on record extending back more than a century.

A brief respite to these dry conditions was associated with Ex-Tropical Cyclone Trevor in early 2019 which resulted in minor flooding in the Warrego and Maranoa as well as some small flows from the Namoi, into Walgett Weir, and from the Macquarie/Castlereagh River along the Barwon to refill the Brewarrina Weir pool. Subsequently, flows from the Warrego entered the Darling River and reached Wilcannia in mid-June 2019⁶. Rainfall in the Maranoa and Nebine systems also provided inflows into the Darling via the Culgoa River, giving some relief to refuge water pools through the lower Balonne River. For the Macquarie River, flows had reached Brewarrina Weir in April–May 2019, replenishing refuge pools along the way. The NSW government embargo on extraction in place at the time allowed the flows to travel long distances through these rivers.

Around this time, the NSW Office of Environment and Heritage and the Commonwealth Environmental Water Holder (CEWH) ordered releases of up to 36 GL of environmental water from the Border and Gwydir catchments as part of the collaborative and coordinated Northern Fish Flow event. The 'Northern Fish Flows' travelled around 1,500 km along the Dumaresq, Macintyre, Gwydir and Mehi and Barwon Rivers, and finished just downstream of the junction of the Culgoa and Barwon Rivers, exceeding expectations⁷.

According to the latest seasonal outlook from the Bureau of Meteorology, while the El Niño-Southern Oscillation (ENSO) is currently neutral, a positive Indian Ocean Dipole is likely to see the prevailing warm and dry conditions continuing across the Basin over spring 2019. These conditions mean it is likely that further fish deaths will occur in the summer of 2019-20.

⁵ MDBA (Murray-Darling Basin Authority). 2019. *River Murray system weekly report for the week ending Wednesday, 2 January 2019*. The weekly report provides updates on operations, river flows, storage inflows, gauge levels, rainfall and salinity data, Canberra. Available: <https://www.mdba.gov.au/sites/default/files/weeklyreports/River-Murray-Operations-Weekly-Report-2nd-January-2019.pdf>; <https://www.mdba.gov.au/river-information/weekly-reports>.

⁶ WaterNSW. 2019. *Water availability report (issued 8 July 2019)*. Available: https://www.watarnsw.com.au/data/assets/pdf_file/0019/145702/Water-Availability-Report-8-July-2019.pdf

⁷ CEWO (Commonwealth Environmental Water Office). 2019b. *The Northern Rivers - Northern fish flow Update 5*. Available: <https://www.environment.gov.au/water/cewo/publications/northern-fish-flow-update-5>; <https://www.environment.gov.au/water/cewo/catchment/northern-fish-flow-2019>;

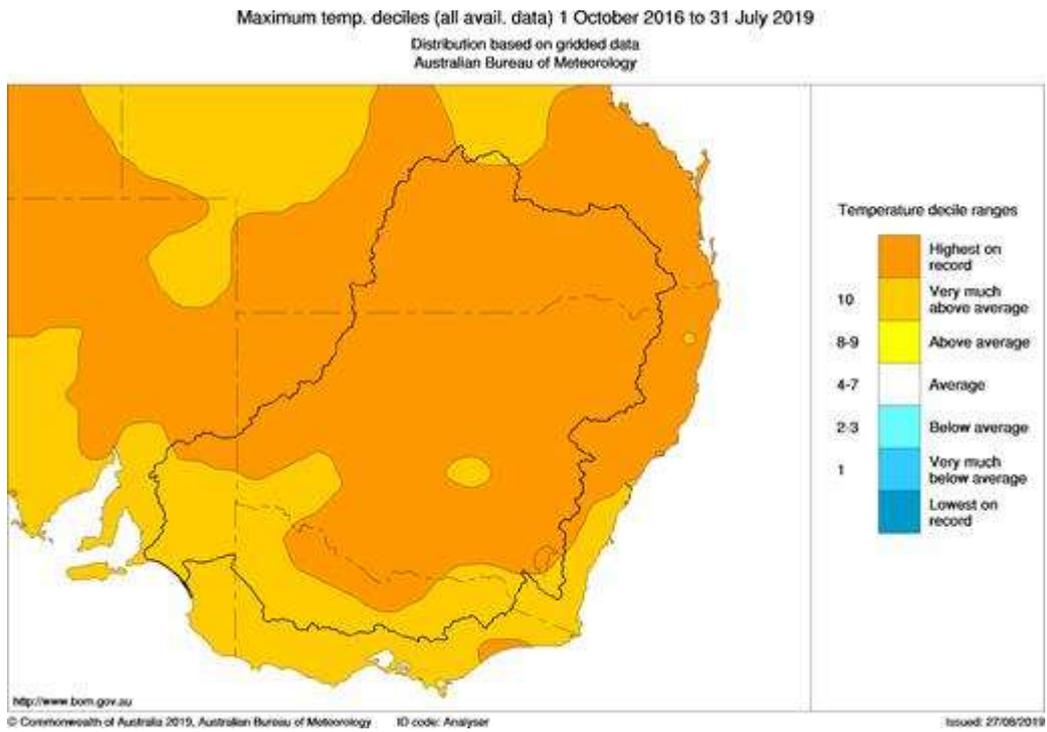


Figure 1: Temperature deciles for the Murray-Darling Basin, 1 October 2016 to 31 July 2019

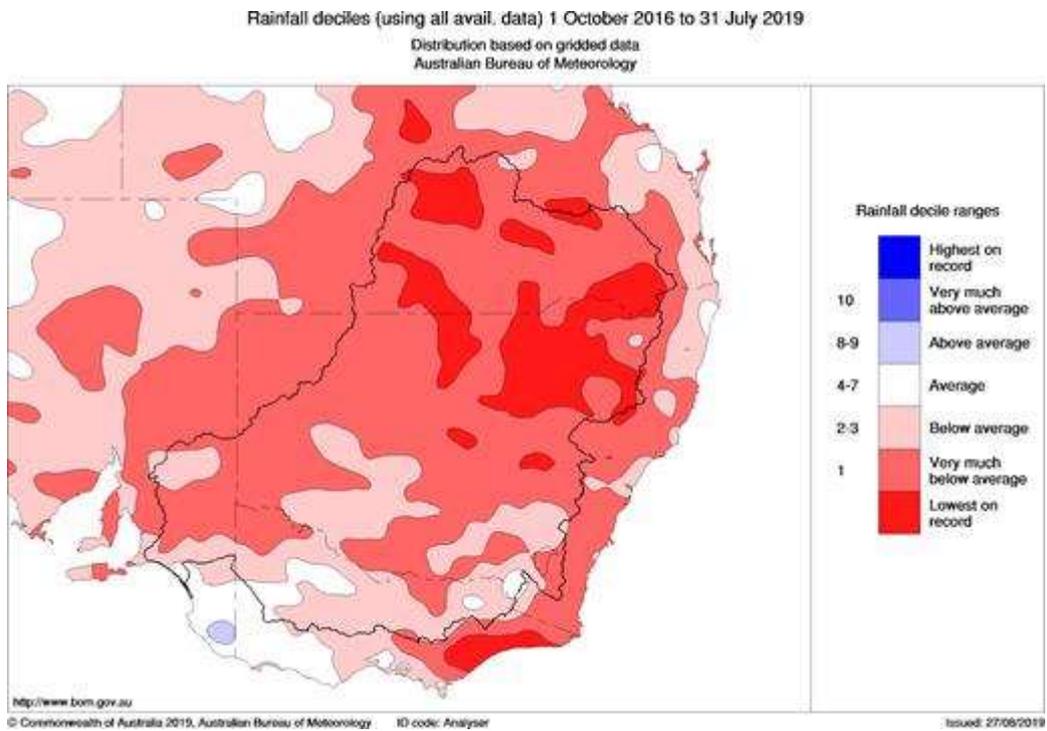


Figure 2: Rainfall deciles for the Murray-Darling Basin, 1 October 2016 to 31 July 2019

Appendix 2: Programs to protect native fishes and manage fish death events in the Murray–Darling Basin

Roles and Responsibilities	Fish death management arrangements
QLD	
<p>Responsibility for responding to fish deaths in Queensland varies depending on the circumstances, magnitude and location of the events.</p> <ul style="list-style-type: none"> • Department of Environment and Science (DES) is responsible for investigating major incidents (>50 fish dead), and local government for minor incidents (<50 fish dead), from suspected unlawful release of contaminants. • Department of Agriculture and Fisheries (DAF) is the responsible agency where the most likely cause of death is fishery related, (e.g. bycatch) or disease. • Department of Natural Resources, Mines and Energy (DNRME) is responsible for fish deaths related to water allocation and management under the <i>Queensland Water Act 2000</i>. • Storage operators (e.g. Sunwater) are responsible for ensuring water they manage is fit for purpose including for consumptive and recreational purposes, and that infrastructure is operated in a way that minimise fish deaths and water quality issues within storages and downstream. • Local government is responsible for the clean-up of dead fish that may cause public health issues. 	<ul style="list-style-type: none"> • There is no requirement to clean up fish deaths if there is no risk to public health, noting that removal of carbon and other nutrients may reduce overall productivity of aquatic ecosystems. • Limited flow regulation and callable held environmental water mean that there is limited opportunity to actively address risk of imminent fish deaths in the Queensland Murray-Darling Basin. • Queensland provides information as required to environmental water holders to support decisions about use of held environmental water, including to address risk of fish deaths. • Queensland’s focus is on building long-term regional resilience of native fish populations to local extinctions by protecting flows that support critical refugial waterholes and fish migration opportunities
NSW	

<p>NSW DPI is the lead agency for coordinating the response to fish kill incidents in NSW. The Department has fish kill response kits located at many regional Fisheries offices which include water quality testing and fish sampling equipment to allow a rapid response to fish kill events. NSW DPI has developed a protocol with EPA for investigating and reporting fish kills to increase our understanding of why they occur and to address their causes. Generally, DPI Fisheries Officers will investigate fish kills in non-metropolitan areas while EPA officers will investigate fish kills in Sydney, Newcastle and Wollongong metropolitan areas. In many cases a joint inspection will be appropriate. Regardless of the location, EPA Officers are responsible for detailed investigation of kills which appear to be related to pollution events, hazardous chemical incidents or discharges from commercial or industrial premises.</p> <p>When a report of a fish kill is received all information is to be recorded on the Fish Kill Notification & Investigation Report. Officers of the Department of Primary Industries (DPI) who receive this information must notify the Environmental Protection Agency (EPA) on 131 555 office and vice versa. Local offices of the Local Land Service and the relevant local council should also be notified.</p>	<p>To continue to manage the risks of fish deaths over the coming summer, DPI Fisheries will develop and implement a strategic response framework in line with the Vertessy Report recommendations, which will:</p> <ul style="list-style-type: none"> • identify sites across the NSW Murray-Darling Basin that are key to the long-term maintenance of fish populations across the entire Basin (particularly for threatened species, populations and communities), and their associated risks of fish deaths; • use valley based technical advisory groups to assess, monitor and prioritise, where possible, intervention actions for these sites; • identify, and where possible, implement the range of technological interventions available to improve water quality and reduce the risk of fish deaths at key sites (e.g. artificial aeration, oxygenation and chemical treatments); • assess options for targeted rescue and relocation of native fish where feasible, using coordinated groups where possible; • continue monitoring at key sites to assess the impact of any deployed intervention, and; • developing and adopting a communication strategy that informs and involves communities and agencies across the Basin.
<p>VIC</p>	
<p><i>Interim Response Guide – Fish Death Events</i> was released by the EPA Victoria in May 2019 and provides agencies with guidance and clarification on the arrangements and responsibilities for the response and management of fish death events (note final</p>	<p>The <i>Interim Response Guide – Fish Death Events</i> outlines the management arrangements including:</p> <ul style="list-style-type: none"> • Notification of Fish Death Event • Initial Assessment and Triage • Response and Field Investigation

<p>publication expected shortly). A State Response Plan for Fish Death Events is currently being prepared.</p>	<ul style="list-style-type: none"> • Collation and Analysis of Samples • Ongoing Management • Public Information / Media • Emergency Response <p>Victorian CMAs have developed response plans for some catchments e.g.</p> <ul style="list-style-type: none"> • Goulburn Broken CMA has a response plan for threats to native fish populations caused by low flows in the Hughes Creek and Sevens Creek. This is in response to fish rescues undertaken in recent years to protect threatened populations of Macquarie perch and trout cod. • North Central CMA is working to secure the future of small bodied native species, including Murray hardyhead, through the identification and protection of suitable refuge sites across their region.
<p>SA</p>	
<p>Primary Industries and Regions South Australia (PIRSA) is the lead agency for coordinating the response to fish kill incidents in South Australia. Biosecurity SA investigate environmental kills, whereas PIRSA Fisheries and Aquaculture take the lead on kills likely caused by disease.</p> <p>The Environment Protection Authority (EPA) will take the lead if a suspected pollutant has caused a fish kill incident.</p>	<ul style="list-style-type: none"> • Operating the Barrages to ensure connectivity and enable fish passage. • As part of the RRP, Department for Environment and Water (DEW) has commissioned the development of the <i>Translocation strategy for small-bodied freshwater fishes in the SA MBD Region</i> which provides the framework for the translocation of these species, including the rapid response to emerging threats. <p>Further information on reporting fish deaths in South Australia is available from: https://pir.sa.gov.au/_data/assets/pdf_file/0006/165390/FISH_KILLS_frequently_asked_questions_Jan2012.pdf</p>
<p>ACT</p>	

<p>ACT government manages fish death events</p>	<ul style="list-style-type: none"> • Fish Kill Protocol for the ACT (https://actgovernment.sharepoint.com/sites/Intranet-EPSSD/Shared%20Documents/ACT-Fish-Kill-Protocol.pdf#search=fish%20kill)
<p>Commonwealth</p>	
<p>The Department of Agriculture have implemented a number of programs using Commonwealth funding to support preparation for 2019-20 fish deaths</p> <p>The MDBA manages joint funded (JF) projects including monitoring, to support planning for 2019-20</p>	<ul style="list-style-type: none"> • \$388K Lower Darling Fish Monitoring and engagement program – Mapping the lower darling; understanding the impact of the 2018-19 fish death event on local populations, citizen science and community engagement • Emergency response plan with \$300K emergency contingency fund • Technology trials in the Lower Darling (JF)

Appendix 3: Important Basin environmental assets for native fish

The MDBA's purpose in compiling this list has been to identify broad-scale locations that are of Basin significance for native fish. Outcomes at these locations can be achieved through the use of environmental water in conjunction with natural events and consumptive water. Where active management is not possible, the primary purpose for listing as an environmental asset is to ensure no loss or degradation of their condition. Environmental water managers should use this list as an input into identifying those environmental assets that can be managed with environmental water (termed priority environmental assets by the Basin Plan). Further management of regional and local-scale assets (not explicitly identified in the below table) will also need to be considered in planning and management, particularly to achieve outcomes for threatened species.

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
Southern Basin						
1. Coorong, Lower Lakes and Murray Mouth	*	*	*		*	*
2. Swamps on the lower Murray channel, between Wellington and Mannum (swamp geomorphic region)		*			*	
3. Kerang Lakes					*	*
4. Katarapko anabranch	*			*		
5. Pike anabranch	*			*		
6. Lower River Murray main channel (from Darling junction downstream)	*	*	*		*	*

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
7. Murray main channel (from Hume dam to Darling junction)	*	*	*	*	*	*
8. Chowilla anabranch	*	*	*	*	*	*
9. Lindsay–Walpolla–Mularoo Creek	*	*	*	*	*	*
10. Lower Darling main channel	*	*	*	*	*	*
11. Darling anabranch			*			*
12. Hattah Lakes			*			*
13. Euston Lakes (including Washpen and Taila creeks)					*	
14. Lowbidgee Floodplain			*			
15. Murrumbidgee main channel (including upland reaches)	*		*		*	
16. Upland Murrumbidgee main channel	*		*		*	

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
17. Cotter River			*		*	
18. Koondrook–Perricoota	*	*	*	*	*	
19. Gunbower	*	*	*	*	*	
20. Barmah–Millewa	*	*	*	*	*	*
21. Edward–Wakool system	*		*	*		*
22. Werai Forest			*	*		
23. Billabong–Yanco–Columbo creeks		*	*	*	*	*
24. Lake Mulwala	*		*	*	*	*
25. Ovens River	*	*	*	*	*	*
26. Lower Goulburn River	*	*	*	*	*	*
27. Upper Mitta River			*		*	
28. King River		*		*	*	*
29. Broken River	*	*	*		*	*

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
30. Broken Creek					*	*
Northern Basin						
31. Warrego (Darling to Ward rivers)	*	*		*	*	*
32. Anabranches laterally connecting the Paroo and Warrego rivers (including Bow, Gumholes and Cuttaburra creeks)	*					
33. Barwon–Darling (Menindee to Mungindi)	*	*		*	*	*
34. Namoi (Gunnedah to Walgett)	*	*	*	*	*	*
35. Culgoa junction to St George (including lateral connectivity to the floodplain)	*	*			*	*
36. Macintyre River – floodplain lagoons between Goondiwindi and Boomi	*	*	*		*	*
37. Macquarie River – below Burrendong Dam to Warren	*	*			*	*

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
38. Macquarie Marshes to Barwon, including lateral connectivity at the marshes	*				*	*
39. Lower Bogan River to junction with the Darling River	*				*	*
40. Talyawalka anabranch	*			*		*
41. Lower Moonie River to Barwon River	*	*		*		*
42. Condamine River – Surat to Oakey Creek, including lower Oakey Creek	*	*		*	*	*
43. Floodplain lagoons between Condamine and Surat	*	*	*		*	*
44. Lachlan River – Condobolin to Booligal	*	*	*	*	*	*
45. Macintyre River – Mungindi to Severn in NSW	*	*		*	*	*

Environmental asset	Key movement corridors	High Biodiversity	Site of other Significance	Key site of hydrodynamic diversity	Threatened species	Dry period / drought refuge
46. Paroo River	*	*			*	*
47. Condamine headwaters and Spring Creek upstream of Killarney				*	*	*
48. Severn River within Sundown National Park		*		*	*	*
49. Peel River downstream of Chaffey Dam		*		*	*	*
50. Namoi River upstream of Keepit Dam		*		*	*	
51. Charley's Creek and tributaries (upstream from Chinchilla)		*	*	*	*	*

Notes: Sites of significance – includes areas that have high natural abundance of native species and/or are recruitment hotspots.

This table has been compiled using expert opinion and information provided for the assessment of key ecological assets for the development of the Basin Plan.

Appendix 4: Native Fish species targeted under the Basin-wide environmental watering strategy

- Murray hardyhead (*Craterocephalus fluviatilis*)
- Olive perchlet (*Ambassis agassizii*)
- Southern pygmy perch (*Nannoperca australis*)
- Yarra pygmy perch (*Nannoperca obscura*)
- Southern purple-spotted gudgeon (*Mogurnda adspersa*)
- Silver perch (*Bidyanus bidyanus*)
- Golden perch (*Macquaria ambigua*)
- Murray cod (*Maccullochella peelii peelii*)
- Trout cod (*Maccullochella macquariensis*)
- Macquarie perch (*Macquaria australasica*)
- Freshwater catfish (*Tandanus tandanus*)
- Hyrtl's tandan (*Neosilurus hyrtlii*)
- Rendahl's tandan (*Porochilus rendahli*)
- Northern river blackfish (Qld population) (*Gadopsis marmoratus*)
- River blackfish (*Gadopsis marmoratus*)
- Two-spined blackfish (*Gadopsis bispinosus*)
- Mulloway (*Argyrosomus japonicus*)
- Black bream (*Acanthopagrus butcheri*)
- Greenback flounder (*Rhombosolea tapirina*)
- Sandy sprat (*Hyperlophus vittatus*)
- Small-mouthed hardyhead (*Atherinosoma microstoma*)
- Congolli (*Pseudaphritis urvili*)
- Common galaxias (*Galaxias maculatus*)
- Short-headed lamprey (*Mordacia mordax*)
- Pouched lamprey (*Geotria australis*)