Environmental Benefits Risk Analysis webinar: responses to questions

Responses to stakeholder questions asked at the environmental benefits and risks webinar on 23 September 2022.

Question: How many properties are affected by increased inundation in this Barmah-Millewa area?

The map shown in the presentation was for the Barmah Millewa Forest alone, to demonstrate the potential environmental benefits within the forest.

Barmah Millewa Forest is all public land. Whilst the proposed higher flow options would result in some inundation of private properties upstream and downstream of the forest, as well as in adjacent systems such as Bullatale Creek, the program will minimise these impacts as far as possible.

This will be achieved through the program's ongoing engagement process and discussions with private landholders to identify the most appropriate mitigation measures at various flow options.

Mapping of the flow options under consideration is publicly available on the program's virtual room, under 'interactive map' on the bottom left of the screen.

Question: Is there a timeline of event milestones available for the program? When is the landholder negotiations likely to occur and when is program implementation likely to occur?

A timeline of key program activities and stages is currently being developed and will be made publicly available on the program's information hub.

Landholder negotiations will occur after a detailed flow options analysis and an investment decision is made by the Australian Government.

The NSW Government is developing a state-wide Landholder Negotiation Scheme (formerly known as the Landholder Negotiation Framework) setting out the approach to negotiating agreements with landholders affected by water for the environment being delivered at higher flow levels than current operating practice.

Stakeholders are encouraged to have their say when consultation begins on the proposed scheme. Information on this state-wide consultation process will be made publicly available on the Department of Planning and Environment website.

Question: Referring to slide 16 on weed assessment, can you clarify if this modelling is all 'theoretical,' or are you presenting any practical in field research?

The weed assessment used Species Distribution Models (SDMs) to identify areas of suitable habitat for weed species and how these areas are likely to change under the flow option scenarios. SDMs are built using current weed distribution, sourced from the Atlas of Living Australia (ALA). ALA is Australia's national biodiversity database and the most comprehensive dataset of species occurrences, including field research from governments, universities, communities and public sector. Additional species occurrence data was also provided by the NSW Department of Primary Industry, which was collected during site surveys.

Question: What are the flow height restrictions for water orders?

Currently all water orders (environment and consumptive) are limited to 22,000 ML/d at Wagga in the Murrumbidgee, and 25,000 ML/d at Doctors Point and 15,000 ML/d downstream of Yarrawonga in the Murray. The program is investigating options to increase these limits for environmental water orders.

Question: Are any of these areas high use recreation areas for wake boarding and water skiing. If so which units? (Asked in reference to geomorphic risk sub-reach assessment)

Yes. The program's geomorphic assessment identified vessel wash as a contributing driver of bank erosion along multiple reaches within the program area. Impacts from vessel wash have been observed to a greater degree in the Murray River, especially upstream of Yarrawonga Weir (see MDBA, 2017). However, further monitoring in the Murrumbidgee and Edward-Wakool is required to evaluate the extent of vessel wash impact across the whole program area. In the geomorphic assessment, identified vessel wash impacts were incorporated into the 'baseline trajectory of change', against which the impact of raised flow limits was assessed.

Question: When you talk about environmental benefits to vegetation and fish etc, what is the baseline data used to quantify these increases?

The environmental benefits assessments evaluate the potential outcomes of the program over the long term, under a variety of climate conditions as represented by the historic climate record from approximately 1895 onwards.

The baseline for the environmental assessments is a ~120-year modelled scenario reflecting the historic climate record, current flow constraints, current system operations and water extractions, as well as the changing condition of current vegetation and fish communities over the time period. This base case is the best estimate of how current

vegetation and fish communities would vary over time, given the condition of these communities is not static but changes in response to climate and flows.

Question: How do you know the fish are stimulated to move? Have on ground studies been done to support the modelling? If so when, and where, were these studies done?

There has been long-term fish movement monitoring since the mid-1990s, including active tracking of fish with radio-tags, acoustic tags, Passive Integrated Transponders (PIT) tags, as well as fishway trapping. Most of this data is relevant to the Murray, Edward, Murrumbidgee and Darling systems.

More recently fish movement histories can be reconstructed with otolith microchemistry. The population modelling framework accessed this fish movement data and the relationship with flows. This included using the observed data to develop rules for fish movement in the fish population models. View an example of the long-term fish movement data.

Question: What is the trajectory for fish if nothing is done?

It varies by species and future flow scenarios. The population model used a base case (where managed environmental flows are limited to current operating limits) and then higher managed flows under relaxed constraints scenarios.

The population model predicts smaller golden perch populations under the base case (no action is taken) compared to the proposed raised flow limits while Murray cod populations remain relatively stable. This is because Murray cod can spawn and recruit during regulated flows where they have access to permanent flowing water and snags, and other parameters important to population persistence.

By contrast, golden perch recruitment is strongly influenced by higher river flows inundating wetlands and floodplains and allowing long range fish migrations. Golden perch populations in the Murray and Murrumbidgee program areas are strongly supported by emigration of juvenile fish from the key recruitment areas in the northern Basin and lower reaches of the Murray. Golden perch populations in the program areas are boosted following higher flows promoting this emigration and generally slowly decline until the next higher flow. Under the base case (no action) there are fewer opportunities for this emigration, so the model predicts smaller golden perch populations over the long-term compared to the raised flow limit option scenarios.

Further work is required to understand influences of climate change on fish populations.

Question: Of all the species of fish in the Murray, which fish has the highest reproduction statistics, and can you put a chart up comparing top 10 species in the Murray?

For large-bodied fish (adults >500 mm long) some species have very high fecundity (female egg carrying capacity), such as golden perch (500,000 eggs for a large female), while other species have relatively low fecundity, such as Murray cod (100,000 eggs for a large Murray cod).

Small-bodied native fish also have strong variation in egg carrying capacity, noting high fecundity does not always result in high egg survival rates as there is much complexity in successful larval survival.

View a recent knowledge compendium paper covering this topic.

Question: A lot of modelling has been done. How has this been supported by actual data? This includes weeds/erosion/fish, etc.

All models have been built based on current and historic field data, with models then predicting how changes in river flow and inundation will likely affect the environment.

For instance, the:

- weeds risk assessment uses weed distribution mapping from the Atlas of Living Australia with supplementary data from NSW Department of Primary Industries to build Species Distribution Models (see also response to question 3)
- geomorphic (erosion) risk assessment uses recent and historic satellite and aerial imagery and LiDAR, in combination with extensive field data collected in previous assessments to understand the geomorphic dynamics of reaches and evaluate the potential impact of altered flow regimes
- fish population modelling is based on extensive monitoring and research on fish lifecycles including factors such as the flow and temperature driving spawning and recruitment, growth and migration. The population modelling for golden perch and Murray cod has been validated with observed data
- native vegetation modelling uses current mapping of vegetation distribution together with knowledge on vegetation response to flow and drought gained by on ground monitoring across the Murray and Murrumbidgee valleys over approximately the last 20 years
- waterbird modelling uses data from ground and aerial surveys across the project areas to directly relate waterbird numbers to flow and inundation data
- ecosystem production modelling was quantified using established relationships between habitat type and inundation metrics, based on published field and laboratory studies

- water quality risk assessment uses empirical evidence from past adverse water quality events to assess the mechanistic relationship between higher flows and adverse water quality event likelihoods and consequences.

Question: Is there lots of fish movement data in the Murray system using radio and acoustic tags and data of fish moving through fishways?

Yes, as per the response to a previous question there is significant data concerning fish movement in the Murray-Darling Basin. Initially, this was via dart tagging, then radio/acoustic/PIT tags and fishway trapping, and more recently otolith microchemistry. Much of this data is published and scientific papers can be accessed via Google Scholar.

View a recent knowledge compendium paper covering this topic.

Question: What about increases in carp numbers due to program, which will decrease native fish numbers?

Carp are one of the major risks to any river restoration program. They are adaptable and can take advantage of almost any freshwater/brackish aquatic habitat. Floodplains are a key habitat carp exploit for feeding and breeding. Cohorts of carp are often associated with large floods, or more often with a series of large floods (i.e., 1970s flood series).

The program's carp population modelling is currently in the final stages and a report will be made available on the program's information hub. Carp population modelling did not predict a large increase in populations, partly as the flows being proposed are small compared to natural floods, and natural floods will continue to have the greatest impact on carp numbers. In any case, where there are strong predicted benefits to native fish these positive changes should be considered even if there are potential minor benefits to carp.

Find out more about modelled carp populations.

Question: Has the Murray River been managed to validate data, including the water modelling? What modelling has been done to support landholders and agriculturalists who own land that will be constantly inundated or regularly inundated and who will no longer have access to large portions of their land?

The Murray River is operated in accordance with the Murray-Darling Basin Agreement and the objectives and outcomes agreed by the Basin Officials Committee. For more information view the objectives and outcomes document for river operations in the Murray River system. The system has not been managed to validate data or modelling.

No land will be constantly inundated by the flows being considered by the program.

On average, over the long term, these higher environmental flow releases would occur about four to five years per decade, comprising of some smaller events and some larger

events up to the flow limit. Releases would be made for short periods of time during winter and/or spring. These higher environmental flow releases would not occur during extreme wet conditions when there is elevated flood risk.

The expected inundation extents under program flow options have been modelled and are publicly available on the program's virtual room by selecting the 'interactive map' icon on the bottom left of the screen.

Program staff will engage with all potentially affected landholders to better understand potential impacts of the flow options under consideration and how these impacts can be mitigated.

Question: In reference to slide 27, can you overlay the migration of foxes onto drier land during this flooding period and the cost of damage during this period? And the waterbird impact from these same foxes returning to their habitat once floods subside?

The current environmental risks assessment only addresses invasive weeds. Invasive fauna is not considered. The waterbird data is based on the relationship between observed waterbird numbers/diversity and water flows, which would include the impact of foxes on waterbirds under current conditions.

The potential costs associated with invasive species control will be considered as part of impact mitigation and compensation packages, consistent with the program's Impact Management Toolkit principles.

Question: Why is the focus on predicted benefits while ignoring the on-ground evidence?

The focus of the environmental benefit and risk assessments is understanding potential outcomes of the program across the Murray and Murrumbidgee River systems.

While this work identified substantial benefits at the river system scale, it has also identified some risks in local areas, for example in relation to erosion in some reaches (as identified in the geomorphic risk assessment). Risks such as erosion and weeds have also been highlighted by some landholders through the case study process.

Work undertaken to date is a first step and further work, including on-ground assessment and feedback from landholders, is required to understand the issues more comprehensively across the program area.

As part of this ongoing work, the program will continue to collaborate with stakeholders, gather feedback and data on:

- modelling and mapping inundation footprints, including potentially impacted assets
- various flow options and potential impacts and benefits

- assessing community benefits and impacts
- assessing environmental benefits and risks
- measuring outcomes for First Nations communities
- identifying opportunities and mitigation measures
- the proposed Landholder Negotiation Scheme
- impact management methodologies
- gauging and tracking stakeholder sentiment (through online surveys).

Question: What modelling has been done to support landholders and agriculturalists who own land constantly inundated or regularly inundated?

No land will be constantly inundated by flows being investigated by the program

On average, over the long term, higher environmental flow releases would occur about four to five years per decade comprising some smaller events and some larger events up to the flow limit. Releases would be made for short periods of time during winter and/or spring. These higher environmental flow releases would not occur during extreme wet conditions when there is elevated flood risk.

The expected inundation extents under program flow options have been modelled and are publicly available on the program's virtual room by selecting the 'interactive map' icon on the bottom left of the screen.

Work as part of the program has included risk assessments covering geomorphology (erosion), weeds, water quality and hypoxic blackwater. Some landholders have also identified risks relating to erosion and weeds. Work to date is a first step and further work is required to understand the issues identified by the assessments and landholders.

Question: Perhaps the program should get involved in some more real, on-ground studies to assess the risks and benefits of the program?

The environmental benefits and risk assessments have drawn on extensive on ground studies and have been undertaken by, or with, the input from those involved in this on-ground work. For example, in relation to fish population modelling the work is extensively informed by fish monitoring across the Murray and Murrumbidgee rivers, including the monitoring and research of spawning and recruitment and tracking of fish migration over the last two decades. In addition, the modelling has been checked against historic records of fish population numbers across the Murray and Murrumbidgee, for example from historic commercial fish catch data. The population modelling was undertaken by Arthur Rylah Institute, an organisation heavily involved in fish monitoring and research across the Murray-Darling Basin. The Department of Regional NSW's - Fisheries has also been extensively involved, contributing their knowledge from across the region. Similarly, with

the other themes (e.g., vegetation, geomorphology/erosion and weeds) information has been drawn from on-ground studies and on-ground monitoring.

In addition, the program will continue to collaborate with stakeholders on key program areas including:

- ground-truthing modelling and mapping, including potentially impacted assets
- various flow options and potential impacts and benefits
- the proposed Landholder Negotiation Scheme
- proposed impact management methodologies
- gauging and tracking stakeholder sentiment (through online surveys).

Question: Has South Australia agreed to having lower end flows as more water will be lost in the wetlands?

At present the NSW, Victorian and South Australian Governments are investigating the potential benefits and impacts associated with several flow limit options. No decision has been made on flow limits under the program, and this will ultimately be a decision for the Australian Government together with the Murray-Darling Basin Ministerial Council. Outcomes in terms of flows to South Australia will be a feature of the flow limits adopted upstream in the Murray, Goulburn and Murrumbidgee, together with hydrological processes such as attenuation and wetland storage.

Question: Following on from a previous question, how does the department plan to monitor environmental benefits into the future?

Monitoring of ecological outcomes from environmental water use is routinely carried out by State and Australian Government agencies, for example the Commonwealth Environmental Water Office and the Murray Darling Basin Authority (including under The Living Murray program).

Environmental outcomes from the relaxation of constraints will be reflected in the ongoing data collected under these existing programs. Through program delivery the need for additional monitoring programs may be identified and recommended to monitor environmental benefits across the program area.

Question: Have the benefits to private landholders in natural floods been evaluated?

The flow timeseries modelling is based on includes unregulated (natural) and regulated inundation events.

The analyses presented include results for public and private land. Native vegetation modelling is based on mapped vegetation communities and includes benefits on private

properties where native vegetation currently occurs. Waterbird analyses was conducted on a wetland-by-wetland basis, with some wetlands on private property. Similar instances can be found in all benefit and risk analyses.

The program is likely to deliver a range of other benefits to private landholders, such as improved access during small and medium size natural floods due to the upgrading of infrastructure as part of the program's impact mitigation measures. These broader potential benefits will be assessed as part of program delivery.

Question: When is the on-ground work going to start for affected landholders?

On-ground work has already commenced for the Sustainable Diversion Limit Adjustment Mechanism (SDLAM) Acceleration Program. Further information on the progress and works delivered under the SDLAM Acceleration Program can be accessed via the Department of Planning and Environment website.

For the broader Reconnecting River Country program area, on-ground work will start after an investment decision is made by the Australian Government to implement the program and negotiation agreements are reached with landholders, leaseholders and other third-parties.

Question: How many properties do you need to negotiate flood easements with to achieve the capacity for the modelled increase in inundation area?

The next phase of the program will include identifying potentially affected properties using modelling and stakeholder feedback. The program will engage with affected landholders, leaseholders and other relevant third parties to understand potential impacts and benefits. The exact number of landholders identified as potentially affected will be refined through this process.

After an investment decision is made by the Australian Government to implement the program affected landholders will be invited to negotiate mitigation measures. This may include paying the landholder to acquire an easement to occasionally inundate land.

Question: Does all this work come to a screaming halt after 30 September when the Australian Government funding runs out and the staff employed on this, and other SDLAM supply projects, lose their jobs?

No. The Australian Government recently approved transition funding to continue the program's key engagement activities and technical and policy work while the strategic business cases are being considered for investment.

Question: Are you addressing weeds in wetlands only or on private land as well? What timeframe are you looking at for flooding private land each year as we have had water over part, or all, of our property for over nine months in the last year?

The invasive weeds assessment considered weeds on public and private land, including wetlands, agricultural land and other land uses.

In relation to the timeframes of higher flows and inundation, the program proposes the following duration of flow deliveries:

- Murrumbidgee River at Wagga Wagga - up to five days at the peak flow rate, followed by a gradual reduction in flows back to background flow levels
- Murray River at Doctors Point and downstream of Yarrawonga Weir – seven to 21 days at the peak flow rate, followed by a gradual reduction in flows back to background flow levels
    - occasionally, and when conditions are appropriate, flows below 30,000 ML/d at Doctors Point and below 35,000 ML/d downstream of Yarrawonga Weir may be delivered for up to 30 days.

Event durations will likely be longer at downstream locations as the flows move downstream and naturally rise and fall at a slower rate. The duration of floodplain inundation will also vary depending on location and local landforms. Some land will only be inundated while the river is above the commence to inundate level, while wetlands and other natural depressions will likely hold water for longer, after the river level and flow have receded.

Over the long term, higher flow releases would occur about four to five years per decade comprising some smaller events and some larger events up to the flow limit. Releases would be made for short time periods during winter and/or spring. Higher environmental flow releases would not occur during extreme wet conditions when there is elevated flood risk.

Question: How has the Murray Strategic Business Case been completed with so many questions left unanswered and why are we not able to see it?

The Murray Strategic Business Case was developed in line with NSW Treasury Business Case Guidelines TPP18-06, using the best available knowledge to understand the benefits, costs, risks and opportunities the program may create, and how these would change based on different scenarios. The Murray Strategic Business Case seeks investment from the Australian Government to proceed to a Final Business Case that will include refined information built from extensive stakeholder engagement, including additional technical studies to inform a final investment decision.

The program is currently developing summary documents for the Murray and Murrumbidgee strategic business cases, which will be made available on the program's information hub.

Question: The perch modelling was from 1900 to the present day. How did the Arthur Rylah Institute overlay their theoretical modelling on the carp population between 1900 and 1964?

The fish population modelling was based on a long time-series of hydrological data from 1896-2019. The simulated hydrological (flow) data provided a basis for the carp modelling but carp did not spread throughout the Murray-Darling Basin until the 1970s.

The historic simulated flow data assumes current regulation and extraction rates throughout the period 1896-2019. This approach allowed assessment of fish responses to program flow options across a range of climatic conditions, including extended dry and wet periods and periods of average climate conditions. The population model uses the flow time series to predict carp population response to those flow regimes and then corroborates these predictions for some spatial areas and time periods with empirical field data. For example, the model predicting a decline in carp numbers during the Millennium drought was also seen in the field data.

Question: Why is this program being given priority over preventing the ongoing pollution of the river by unacceptable discharges?

The program outcomes do not take priority over the control and regulation of pollution in river systems. This remains the responsibility of the NSW Environment Protection Authority (NSW EPA). Water Infrastructure NSW has and will continue to report any identified pollution concerns to the NSW EPA as the responsible authority.

Question: In 2021, which flood areas along the Murray did you visit? The reason I ask this is I have never seen more carp swarming across the floodplains than in 2021. Not one native fish was observed during these periods in a practical setting.

Carp proliferate in wetland and floodplain habitats when conditions are favourable. Flows benefitting carp also benefit native fish, with species like golden and silver perch being dependent on higher flows for spawning, and Murray cod benefiting from extra productivity during high flows. The Commonwealth Environmental Water Office undertook monitoring of fish spawning and recruitment at 16 sites across the Wakool and Yallakool system in 2021 as part of their ongoing monitoring program. The monitoring identified good native fish recruitment outcomes, with the multiple flow pulses providing spawning opportunities and ongoing food resources for young fish. View the results of some of this work.

The carp population modelling for the program is currently in the final stages and a report should be made available for public access by the end of the year. The carp population modelling did not predict a large increase in carp populations, partly as the flows being proposed are small compared to natural floods, and natural floods will continue to have the biggest impact on carp numbers. In any case, where there are strong predicted benefits to native fish these positive changes should be considered even if there are potential minor benefits to carp.

Question: I didn't see cuscuta campestris in the weed observations. Is it not a threat?

Cuscuta campestris (golden dodder) is included in the current analysis as a weed of concern known to spread via water. Due to its life history, it is modelled in the 'terrestrial dry' functional group as, although it can travel on water, it does not require inundation to complete its lifecycle.

The modelling of individual weed species was conducted for priority species identified by the expert stakeholder panel involved in the project, and where there was sufficient data to construct models using recorded observations of the species. This was primarily for species with a direct requirement for inundation to complete its lifecycle.