Reconnecting River Country Program

Environmental benefit and risk analysis webinar

23 September 2022

Presenters:

Iwona Conlan, Environment and Heritage Group

James Maguire, Environment and Heritage Group

Ivor Stuart, Charles Sturt University

Panel members for questions (in addition to presenters):

Michelle Cavallaro, Water Infrastructure NSW

Paul Childs, Environment and Heritage Group

Produced by the NSW Department of Planning and Environment | Environment and Heritage on behalf of Water Infrastructure NSW

Sep 2022

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Outline

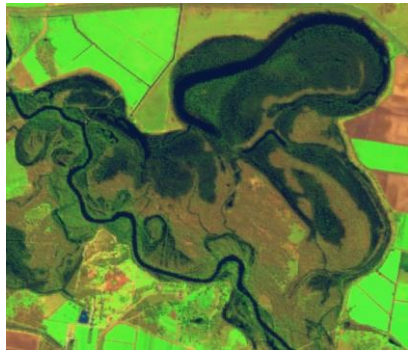
1. The current situation and why relax constraints?
2. Environmental benefit and risk analyses
   - Approach
   - Key findings
3. Questions with the panel.

Reconnecting River Country Program

- **Is about** improving flow connectivity to wetlands, riparian and floodplain vegetation communities through relaxing flow constraints in the Murray and Murrumbidgee catchments.

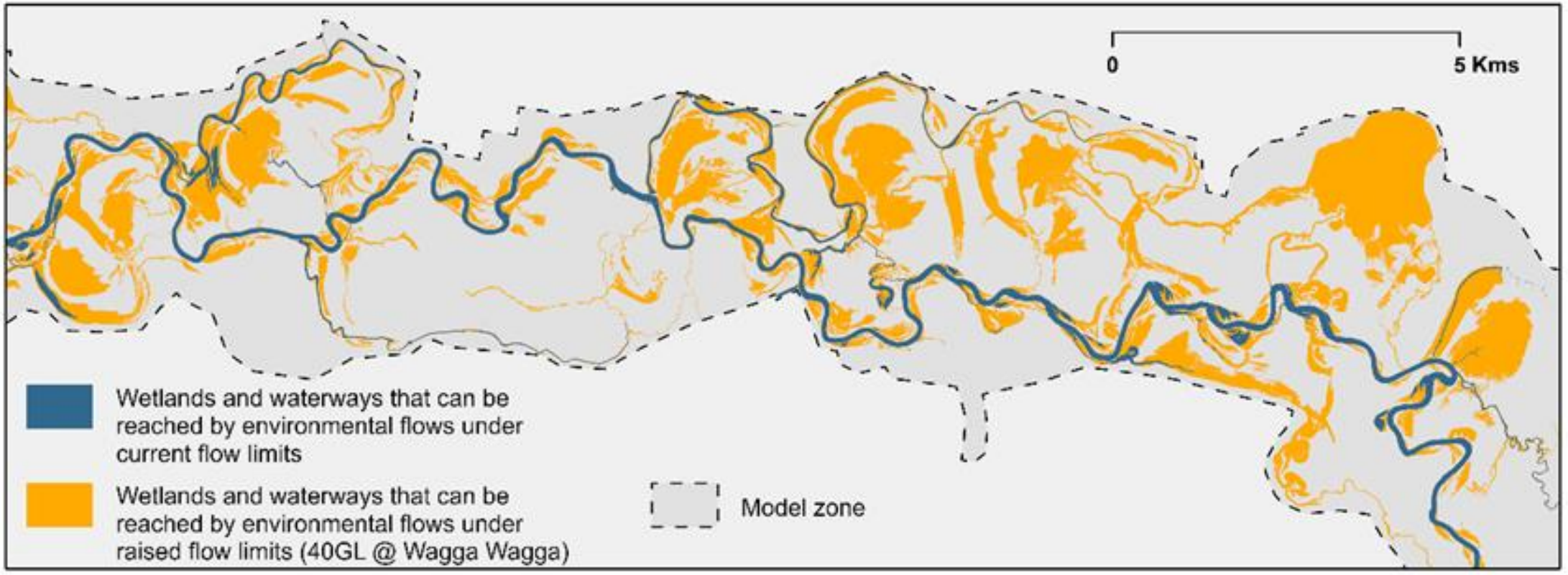
- **The goal** of the program is to achieve a balance of economic, social, cultural and environmental outcomes.

- **Environmental benefit and risk analysis:**
  - is part of a broader impact-benefit assessment of program options
  - a key input to strategic/final business cases
  - a key input to options assessment and refinement in next phase of the program
  - supports communication of program benefits.



Why relax constraints?

Rivers connect to their floodplains less often than is needed, which has led to a decline in the health of river, wetland and floodplain ecosystems.



Why relax constraints?
Mid-Murrumbidgee wetlands example

Mid-Murrumbidgee lagoon 1 in 2000 in healthy condition

Mid-Murrumbidgee lagoon 2 in 1998 in healthy condition

Photos: James Maguire, DPE
Lorraine Hardwick, DPE

Wetlands in poor condition after lack of connection

Mid-Murrumbidgee lagoon 1 in 2010 after extended dry

Mid-Murrumbidgee lagoon 2 in 2011 after extended dry

Photos: Carmen Amos, DPE
James Maguire, DPE

More frequent watering allows for quicker recovery/ better wetland health

Mid-Murrumbidgee lagoon 1 – less frequent inundation. Slower recovery and river red gum encroachment

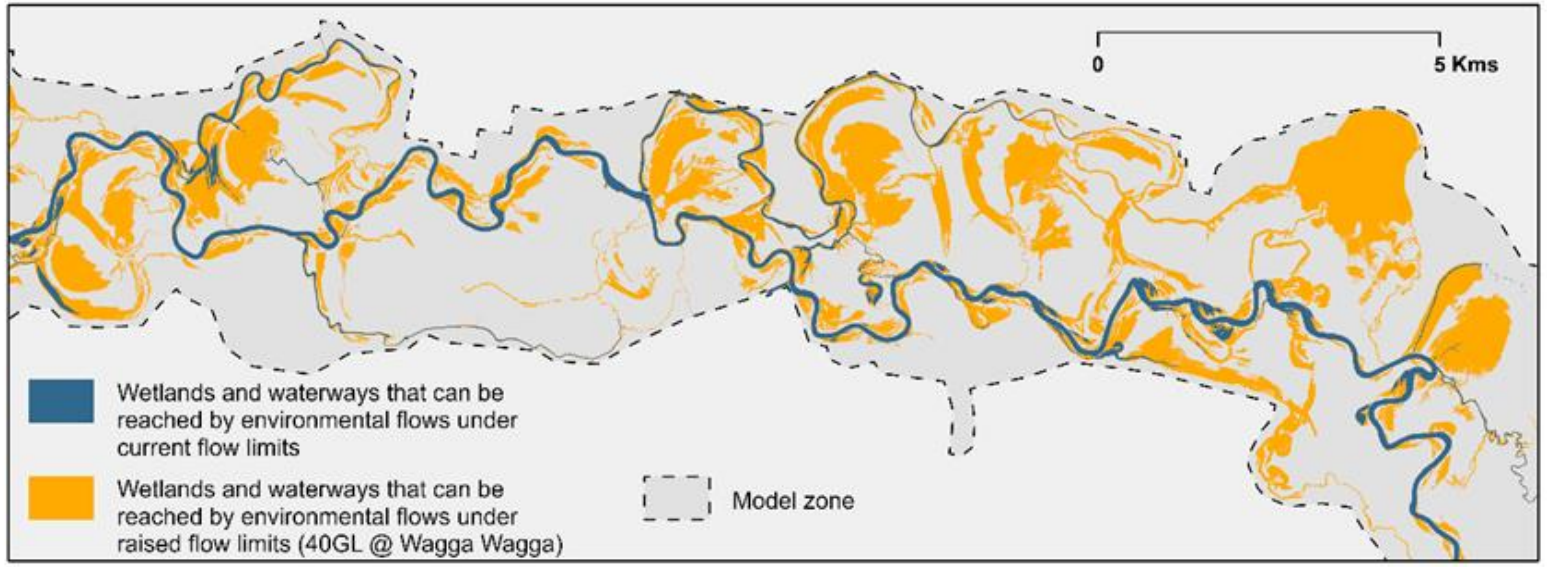
Mid-Murrumbidgee lagoon 2 in 2022 – frequent watering has allowed a faster recovery

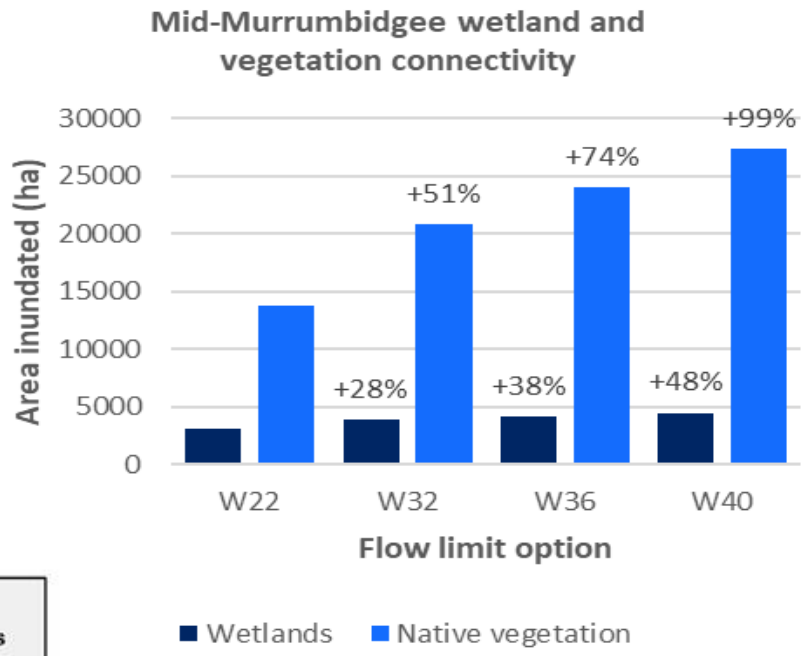
Photos: Amelia Walcott, DPE

Connectivity outcomes - Murrumbidgee

Water for the environment could reach:

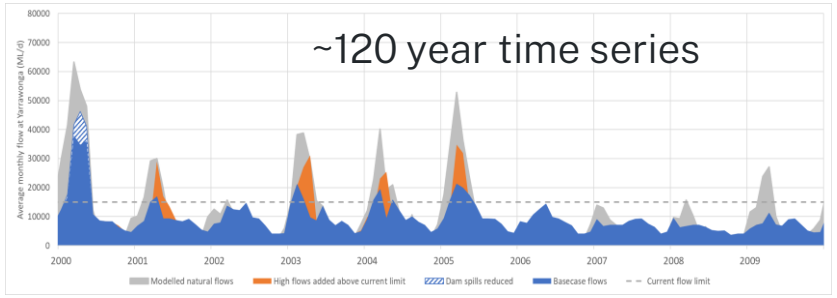
- up to 48% more wetland area
- up to 99% (2 times) more native vegetation area.



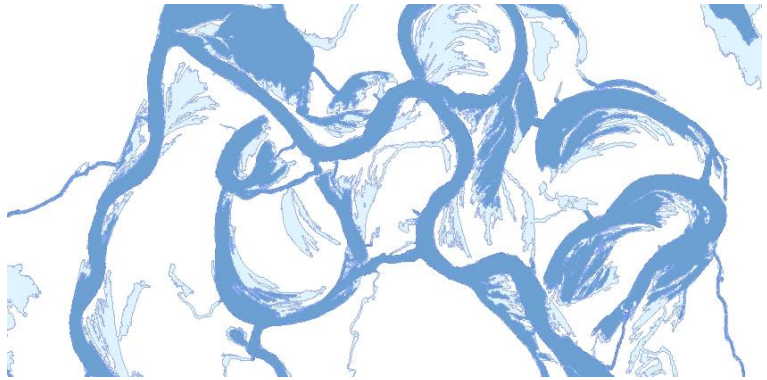


Flow Option	Flow at Wagga Wagga (ML/d)
Base case	22,000
Option 1	32,000
Option 2	36,000
Option 3	40,000

Environmental Benefit and Risk Analyses



Flow modelling



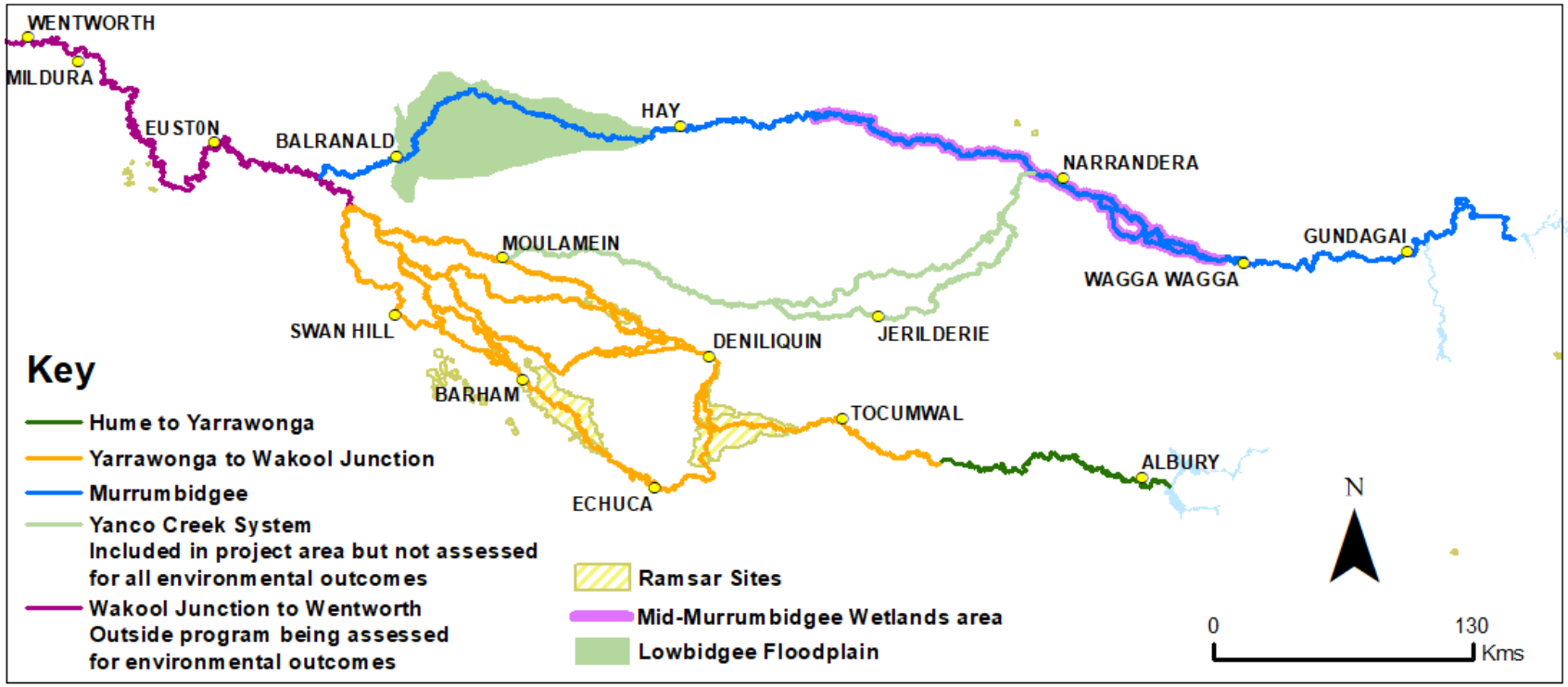
Inundation mapping

Benefits

- Native fish
- Lateral connectivity
- Waterbirds
- Ecosystem production
- Wetland and floodplain vegetation

Potential risks

- Water quality
- River form
- Invasive weeds



Flow limit options assessed

Murrumbidgee

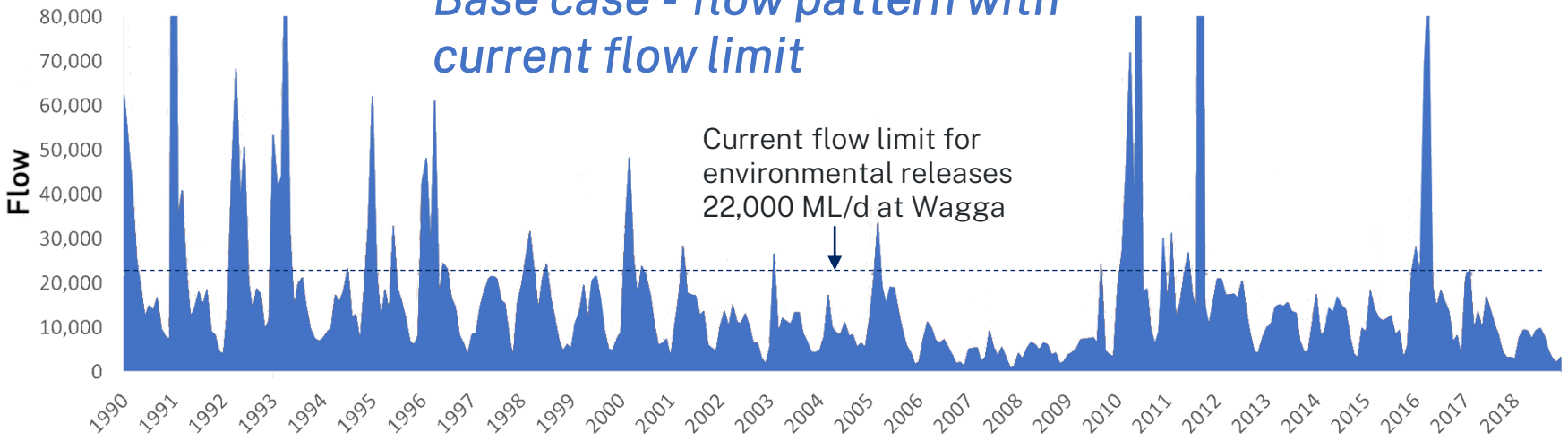
Flow limit option	Flow at Wagga Wagga (ML/d)
Base case	22,000
Option 1	32,000
Option 2	36,000
Option 3	40,000

Murray

Flow limit option	Flow at Doctors Point (ML/d)	Flow downstream of Yarrawonga Weir (ML/d)
Base case	25,000	15,000
Option 1	25,000	25,000
Option 2	30,000	30,000
Option 3	40,000	40,000
Option 4	40,000	45,000

What are we evaluating?

Base case - flow pattern with current flow limit

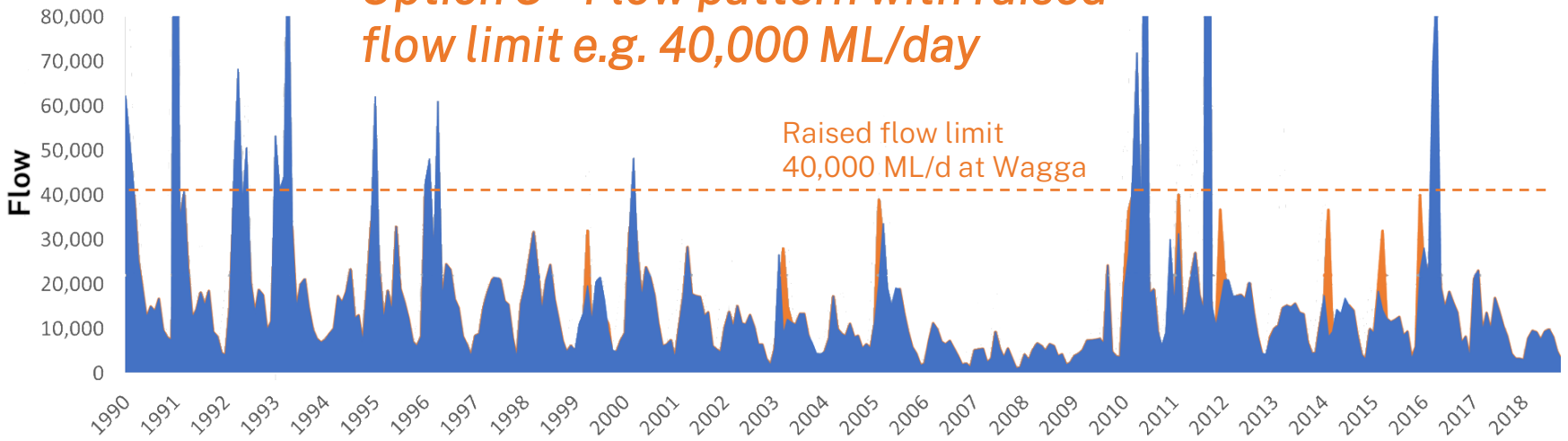


Base case flow time series includes:

- unregulated flows
- consumptive water deliveries
- other regulated system flows
- managed environmental water delivery up to current flow limit (e.g. 22,000 ML/d at Wagga)

versus

Option 3 - Flow pattern with raised flow limit e.g. 40,000 ML/day



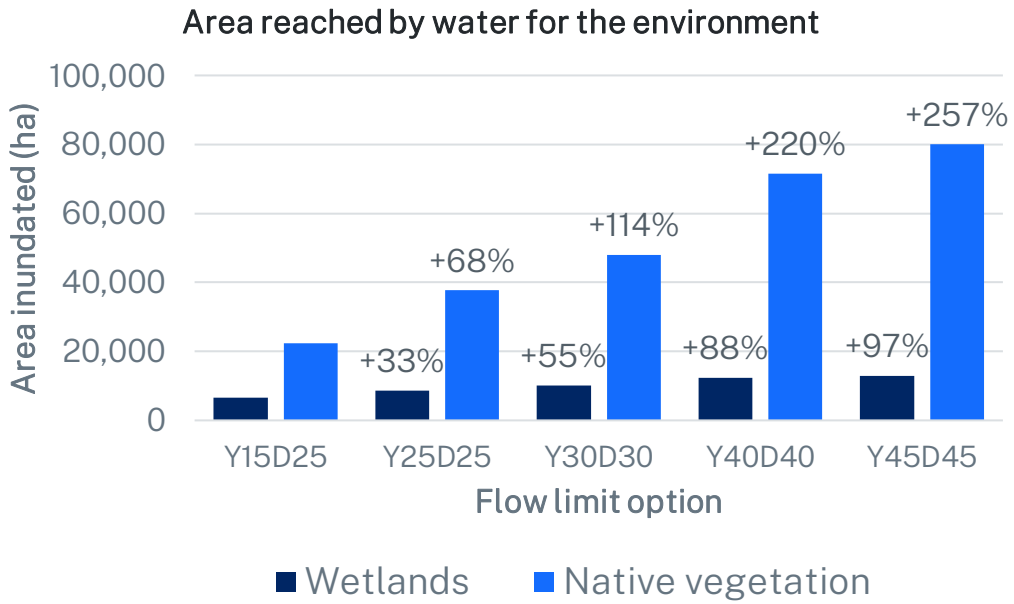
Raised flow limit time series include:

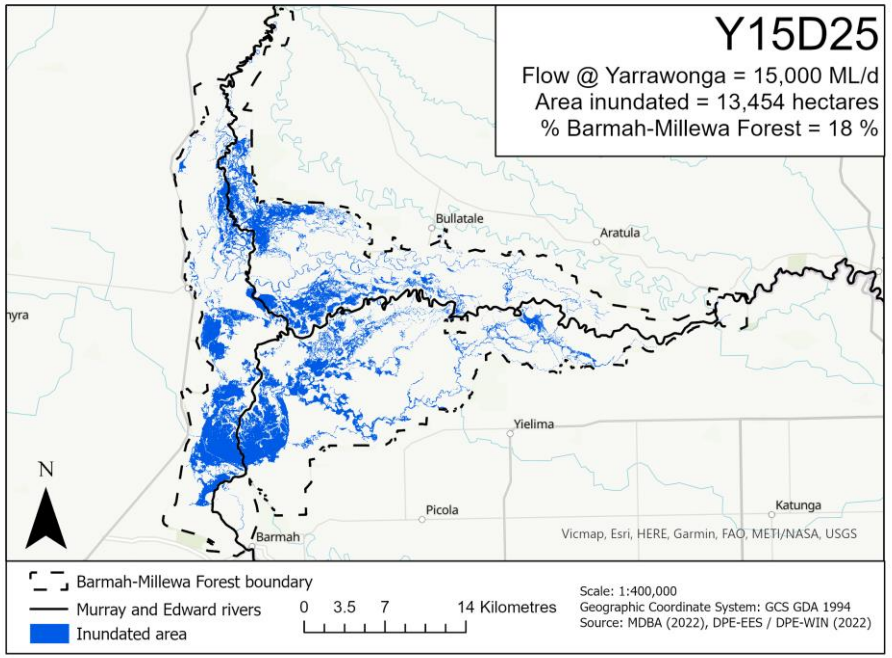
- unregulated flows
- consumptive water deliveries
- other regulated system flows
- managed environmental water delivery up to each raised flow limit option (e.g. 40,000 ML/d at Wagga)

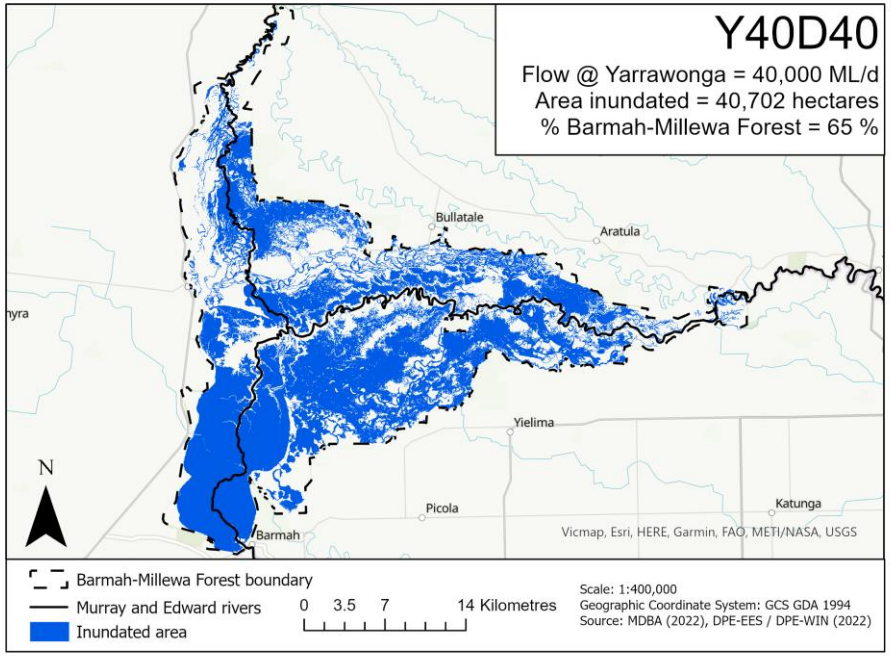
Connectivity outcomes: Murray

Water for the environment could reach (Hume to Wentworth):

- up to 2 times more wetland area (+97%)
- up to 3.5 times more native vegetation (+257%).

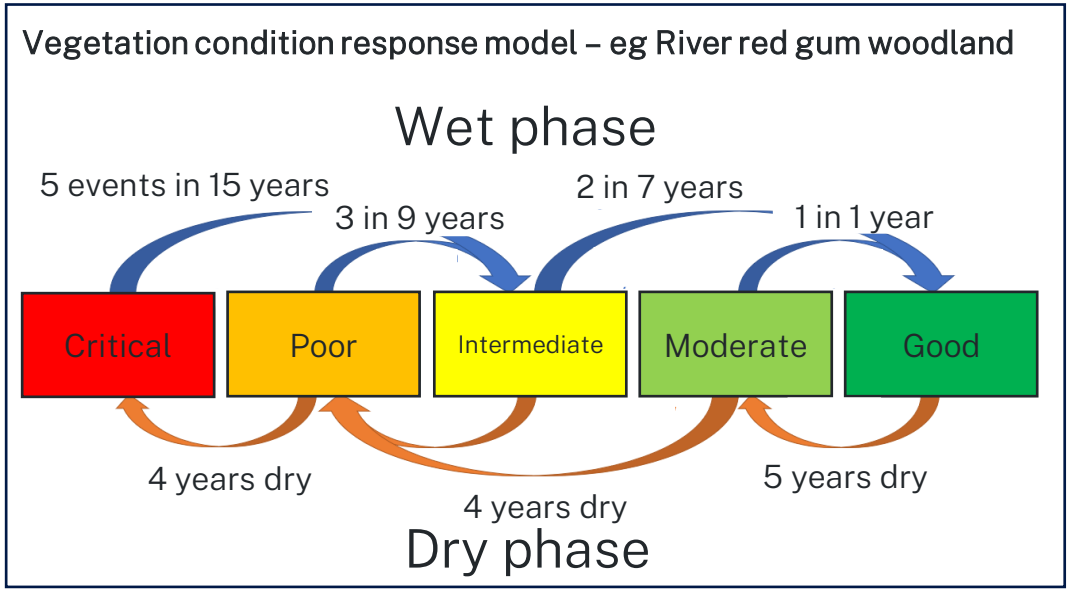






Wetland and floodplain vegetation – approach

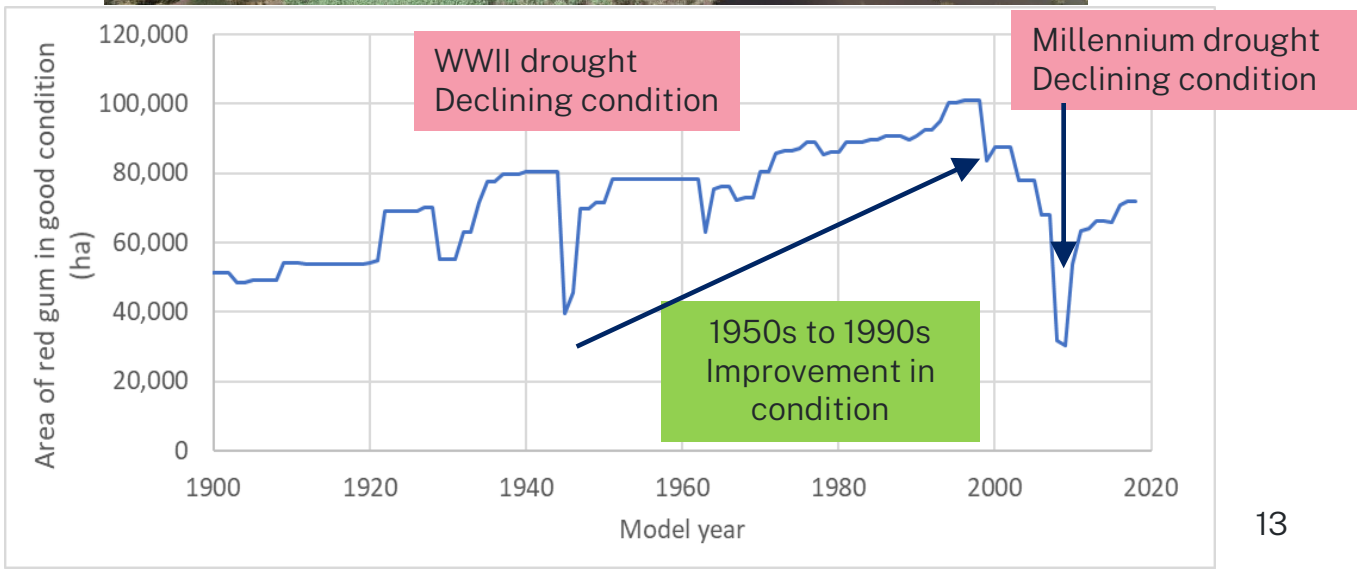
La Trobe University / Department of Planning and Environment



Vegetation condition modelling was undertaken for:

- river red gum forest and woodland
- black box woodland
- lignum shrubland
- wetland herblands - perennial wetland grass, sedge, and rush species.

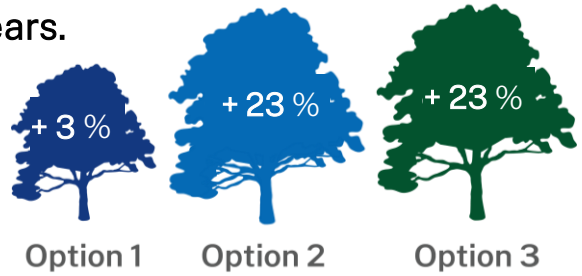
Reed Beds, Millewa Forest. Photo: Vince Bucello



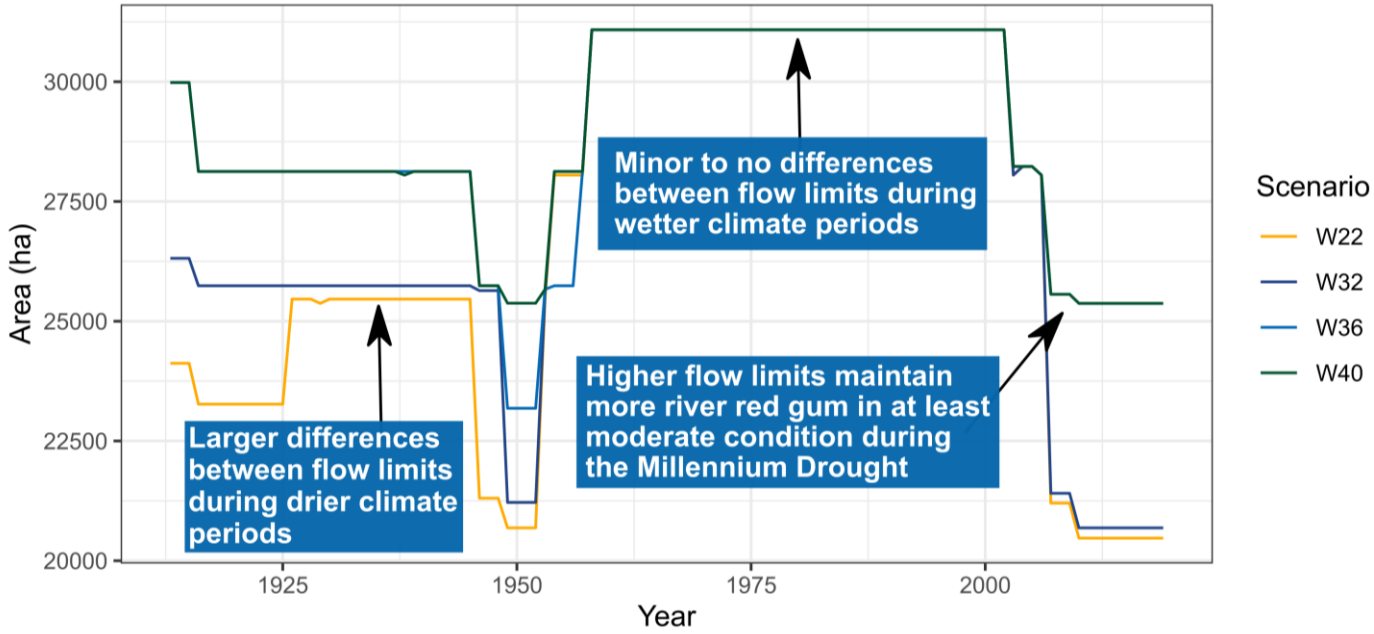
Wetland and floodplain vegetation – Murrumbidgee

- **Overall improvements for river red gum forest and woodlands** over the long term - **up to a 1,600 ha (6%) predicted increase** in average area of healthy river red gum

- **Dry times -** increased resilience of river red gum communities. **Up to a ~4,700 ha (23%) predicted increase** in river red gum forest and woodland **remaining healthy during drier years.**



Predicted area of river red gum in good or moderate condition over time



- Possible declines in black box condition due to predicted small reductions in the frequency/size of larger unregulated flood events.

Wetland and floodplain vegetation – Murray outcomes

- Over the long term - **up to 13,800 ha (+15%) predicted increase** in average area of healthy river red gum forest and woodlands.

- **Up to 50% predicted increase** in river red gum forest and woodland **remaining healthy during drier years.**

- Moderate predicted increases of healthy:
  - perennial wetland grass, sedge, and rush species (up to +10%)
  - lignum shrubland (up to +11%)
  - black box woodland (up to +5%).
- Possible condition decline for some higher-elevation vegetation.

Invasive weeds risk

Griffith University

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Weeds assessed

Aquatic weeds
- Sagittaria
- Lippia
- Salix (willows)

Terrestrial weeds
- African boxthorn
- Horehound
- Blackberries
- Bathurst Burr
- Terrestrial dry sp
- Terrestrial damp sp

Key findings:

- **Slight overall benefit (decrease in likely weed impact** under relaxed flow options)
- Exception: slight overall risk for Option 1 – Murrumbidgee)
- **Small changes in suitable habitat area for invasive weeds**
    - Decreases in suitable habitat for aquatic weeds
    - Increases in suitable habitat for terrestrial weeds
- **Decrease in weed hot spots**
- Weed management plans may be required to address potential increases in weed distribution and impact for certain species and locations.

Murray

Flow Scenario	*Standardised score (-100 - 100)*	Overall Risk
Option 1 25,000	-2.8	Slight overall benefit
Option 2 30,000	-3	Slight overall benefit
Option 3 40,000	-3.2	Slight overall benefit
Option 4 45,000	-2.8	Slight overall benefit

Murrumbidgee

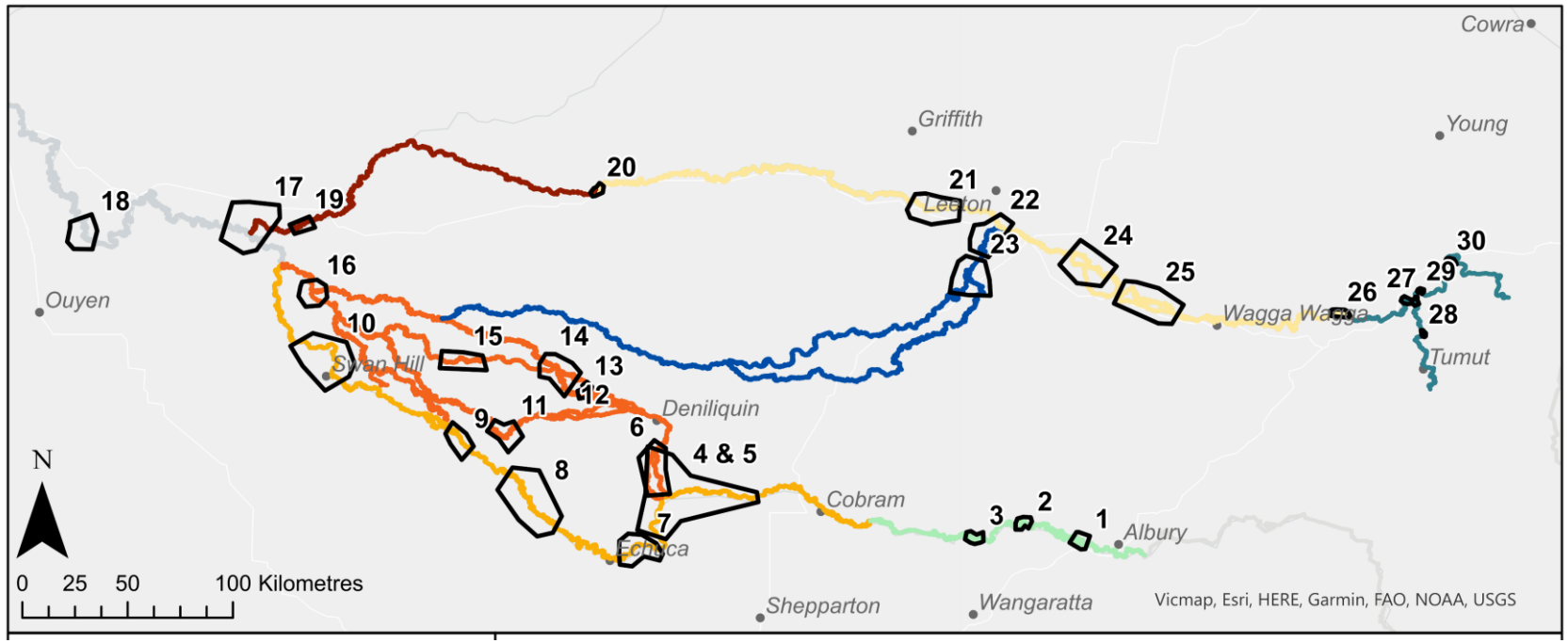
Flow Scenario	*Standardised score (-100 - 100)*	Overall Risk
Option 1 32,000	1.2	Slight overall risk
Option 2 36,000	-1.5	Slight overall benefit
Option 3 40,000	-2.3	Slight overall benefit

Erosion / Geomorphic risks - approach

Streamology

- The study evaluated the likelihood and consequences of geomorphic processes and outcomes under the program flow limit options.
- Assessment was applied to sub reaches that are representative of larger scale reaches.

Representative sub reaches assessed in study



Geomorphic features and processes

The geomorphic form of rivers is the product of multiple features and associated processes:

Existing geomorphic processes of concern

Bank Erosion

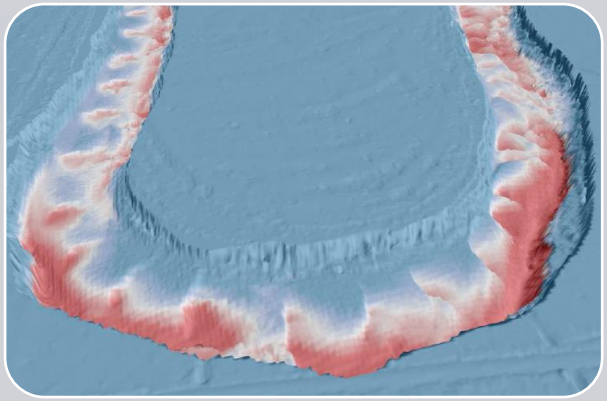
- Constant and prolonged sub-bankfull flows and vessel wash
- Influenced by soil type

Meander migration

- Erosion and deposition
- Bankfull/ overbank flows

Breakouts (Avulsion / Anabranching)

- Breech of natural levee (crest of river bank)
- Bankfull/overbank flows
- sub-bankfull flows



Reduced channel capacity (Barmah Choke)

Sand slug moving through reach

Erosion / geomorphic risks – key findings

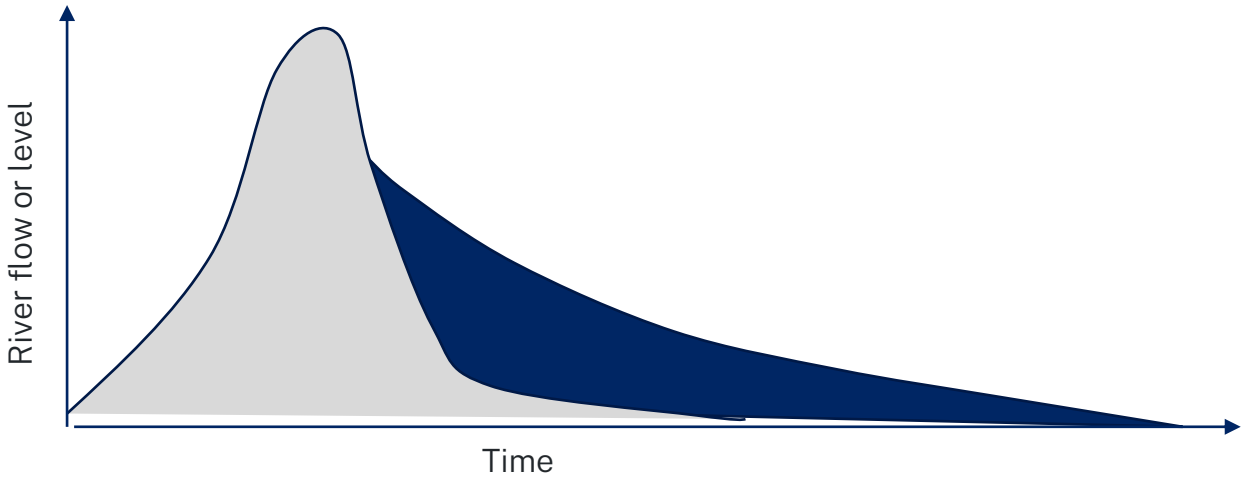
- *Low* to *medium* risk that geomorphic processes (e.g. bank erosion and anabranch development) would be accelerated.
    - The risk is reduced to ***Low*** in all Murrumbidgee and Murray River sub-reaches with potential mitigation measures.
- *Medium* risk remains after risk mitigation options are considered in:
    - 2 of 7 sub-reaches in Edward-Wakool
    - this *medium* risk is defined by *low* level consequence, but *possible* likelihood.
- *Low or Medium* level benefits are predicted
    - Benefits include increased nutrient and carbon transfer into the riparian zone and enhanced geomorphic diversity (creating and sustaining in-channel and riparian zone habitat structures).

Murray River near Corowa - Deposition of sediment on log revetment sites following ~40,000 ML/d flow in Sep 2021 Photo: Ben Berry, Soil Conservation Service

Opportunities to mitigate erosion risks

- Overbank flows can take the pressure off banks that experience long periods of constant sub-bankfull flows.

- Add a slow recession to higher flows to reduce risk of bank slumping.



- Active monitoring.
- Physical intervention (e.g. Hume to Torrumbarry River Works Program).


Rock or timber revetment


Pile fields


Fencing and revegetation

Photos from Soil Conservation Service

Native fish

Context

- Broadscale decline in native fish species and abundance across the Murray-Darling Basin.

- Declines caused by a range of reasons, including loss of baseflows, freshes, small-medium overbank events and loss of flowing river habitats.

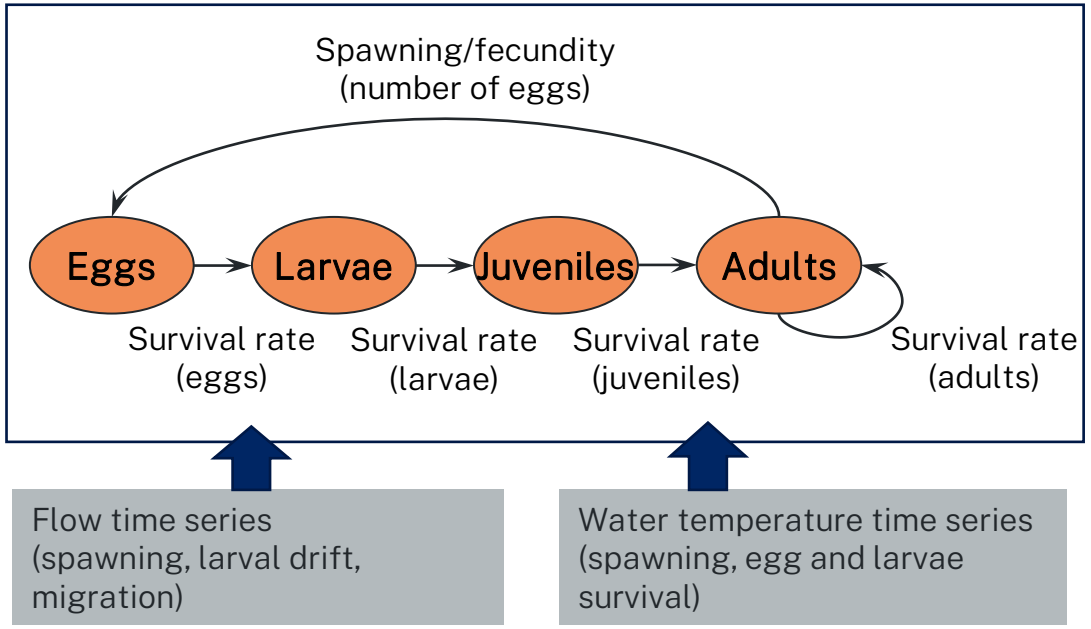
Native fish – approach

Arthur Rylah Institute (Charles Todd et al.)

Murray cod

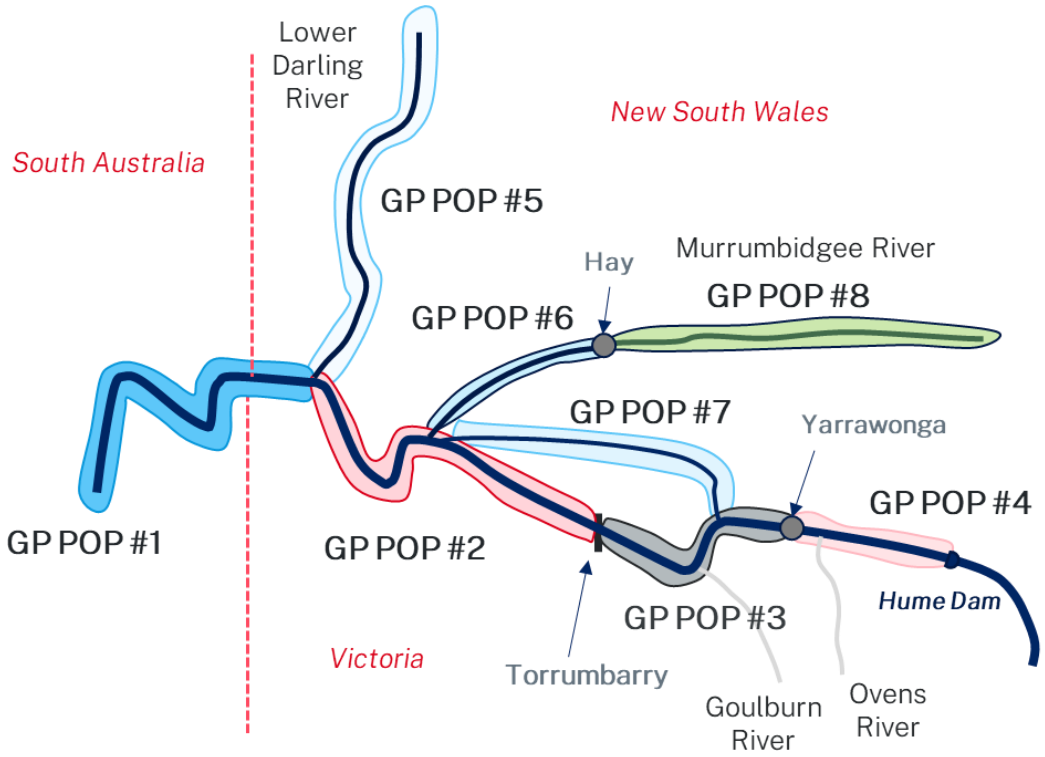
Golden perch

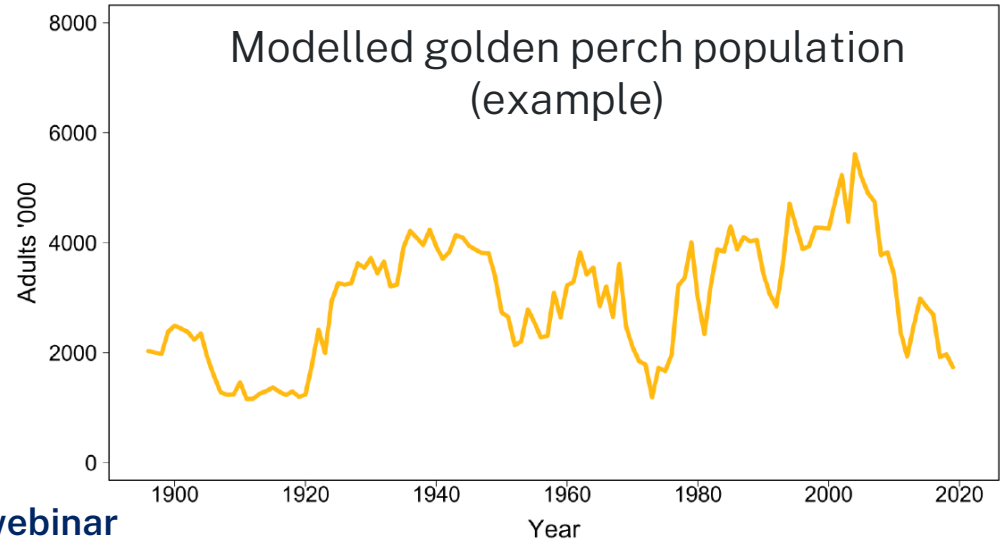
Stochastic fish population model



Flow time series (spawning, larval drift, migration)

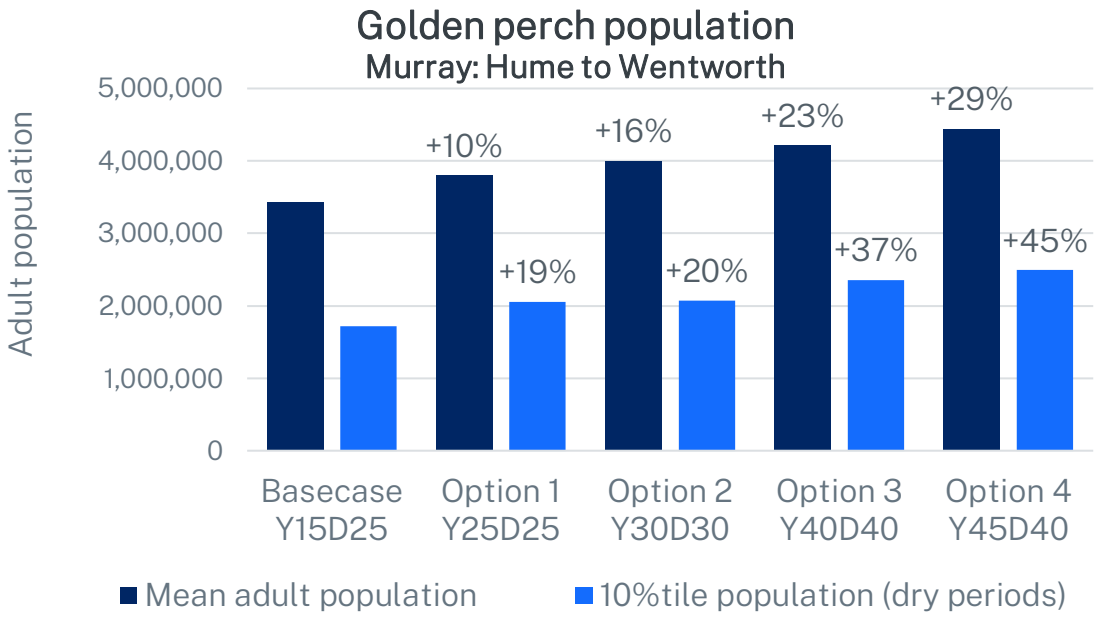
Water temperature time series (spawning, egg and larvae survival)



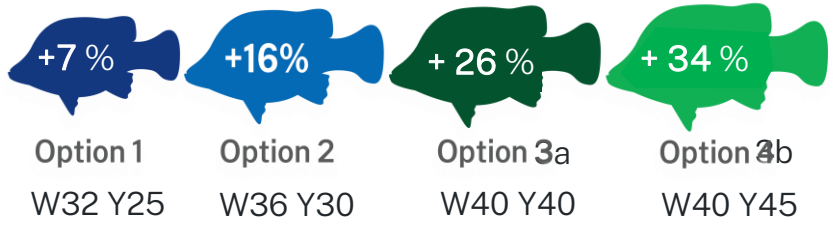


Native fish – Golden perch outcomes

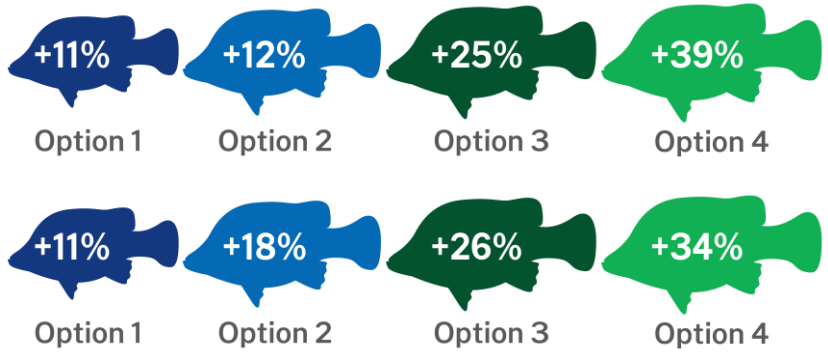
- **Predicted increased population of golden perch,** reflecting dependence on freshes and overbank flows for spawning, **recruitment and** movement.
- Greatest benefits predicted during **dry periods.**



Murrumbidgee



Murray



Hume to Yarrawonga

Yarrawonga to Wakool Junction

Native fish – Murray cod & wetland specialists

Neutral predicted outcome for Murray cod population, reflecting less dependence on freshes/overbank flows for spawning and recruitment, permanent flowing riverine flows are key (fish condition not included).

Expected benefits to wetland specialist fish species (e.g. flathead galaxias, southern pygmy perch) due to increased frequency of wetland connecting flows and improved condition of wetlands (not modelled).

Validation of golden perch model using independent field data showed good alignment, increasing confidence in predictions.

Flatheaded galaxias from Normans Lagoon in 2003.
Photo: DPI Fisheries

Productivity (food availability)

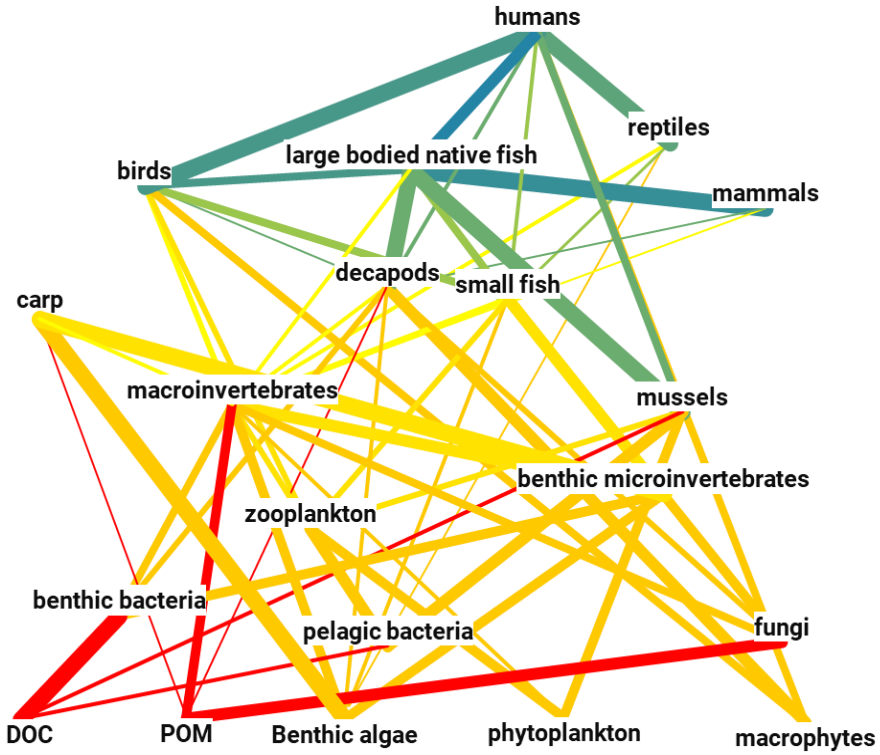
La Trobe University

Approach: Modelled total annual production over ~120 years for each flow limit option.

Key findings:

- **Murrumbidgee**
  - up to 11% increase in median total annual production compared to the basecase.
- **Murray**
  - up to 12% increase in median total annual production compared to the basecase.

This increased production would **provide increased food availability for native fish and other aquatic animals** during critical times, and has the potential to support increased breeding and recruitment.



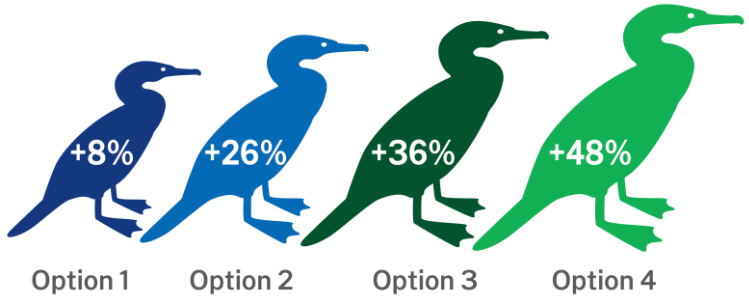
Modelled food web (Siebers et al. 2022)

Waterbirds – Murray outcomes

University of NSW and Department of Planning and Environment

Koondrook-Perricoota-Gunbower Forest

Predicted increase in long-term average waterbird numbers



Barmah-Millewa Forest

Predicted increase in waterbird numbers:

- up to 13% increase in long-term average
- up to 80% increase in drier years.

Increased probability of colonial waterbird breeding (up to +11%).

Waterbird nests. Photo: Vince Bucello

Waterbirds – Mid-Murrumbidgee outcomes

- Modelling predicted small / neutral outcomes for waterbirds over the long-term:
    - 2-3% increase in number of species
    - 1-2% increase in abundance.
- During 2000-2019:
    - 6-10% increase in waterbird species richness
    - 4-7% increase in waterbird density.
- Waterbird modelling was limited by the observational data (low numbers during/after drought).
- Despite the small predicted increases, relaxed constraints is expected to have significant benefits.

Egret. Photo: Vince Bucello

Water quality risks

Approach – study undertaken by CSIRO

- Eight water quality issues were considered:
  - hypoxic blackwater, blue-green algae blooms, salinity, turbidity, acid-sulphate soils, eutrophication, weir pool stratification, thermal pollution
  - detailed risk assessment for hypoxic blackwater, blue-green algae blooms and salinity due to mechanistic relationship with flow.

Key findings

- No increase to the risk of adverse water quality events.
- Benefits to water quality are likely, due to the potential to bring forward the timing of some high flow events from the warmer months (late spring/summer) to cooler months earlier in the season (winter/early spring).

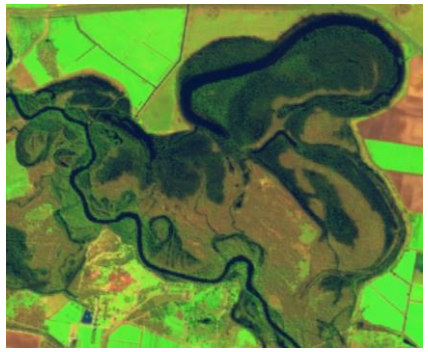
CONSTRAINT RELAXATION SCENARIO	CHANGE IN RISK RATING FROM CURRENT	RISK RATING	CHANGE IN BENEFIT RATING FROM CURRENT	BENEFIT RATING
Y25D25	No change	Moderate	Moderate -> High	High
Y30D30	No change	Moderate	Moderate -> High	High
Y40D40	No change	Moderate	Moderate -> High	High
Y45D40	No change	Moderate	Moderate -> High	High

In Summary

The analysis predicts:

- substantial potential ecological benefits across the Murray and Murrumbidgee river systems under relaxed constraints
- local ecological benefits in project areas
- increased resilience during dry periods
- higher flow limit options enable much greater wetland and floodplain connectivity and would provide the most substantial benefits
- environmental risks (weeds, poor water quality and erosion) are neutral, low - medium risk or slight benefit.





Acknowledgments

	**Fish Population Modelling for Native Fish Outcomes: Murray Cod and Golden Perch** Arthur Rylah Institute for Environmental (in collaboration with NSW Department of Primary Industries – Fisheries) Todd, C. Wootton, H., Koehn, J. Stuart, I., Hale, R. Fanson, B., Sharpe, C., and Thiem, J.
	**Waterbirds** University of New South Wales and NSW Department of Planning and Environment Bino, G., Spencer, J., Brandis, K. and Thomas, R.
	**Vegetation** La Trobe University (in collaboration with NSW Department of Planning and Environment) McPhan L.M., Capon S., Bond N.R.
	**Production Condition Predictive Modelling** La Trobe University (in collaboration with the NSW Department of Planning and Environment) Siebers, A., Crook, D., Silvester, E., Bond, N.

	**Water Quality Risk** 1. CSIRO: McInerney P, Rees G, Wahid S, Chen Y, Cuddy SM 2. NSW Department of Planning and Environment: Wolfenden; and Baldwin, D. Rivers and Wetlands: Hypoxic blackwater analysis (informed CSIRO Water Quality risk assessment and fish population modelling).
	**Invasive Species (weeds)** Griffith University Capon, S., Grieger, R., Chauvenet, A., Johnston-Bates, J., Franklin, H. and Burgoyne, H.
	**Geomorphology Risk** Streamology Lauchlan Arrowsmith, C.S. Vietz, G. Wakelin-King, G. Grove, J. Rutherfurd, I. Cheetham, M. Martin, J. Gower, T.G. Al Baky, A. Woods, K. Lam, D.

Questions & feedback ?

Panel for questions

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