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INSTITUTE FOR LAND, WATER AND SOCIETY

Improving the ecological condition of regulated rivers by altering the structure and operation of river regulating structures

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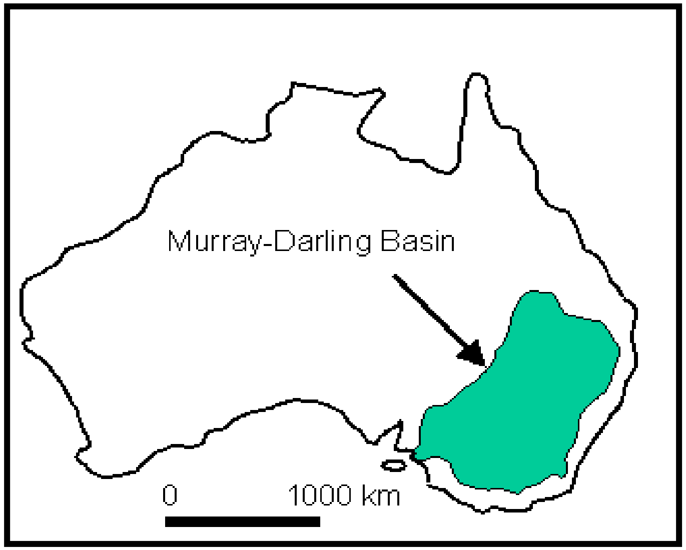
research FOR A SUSTAINABLE FUTURE

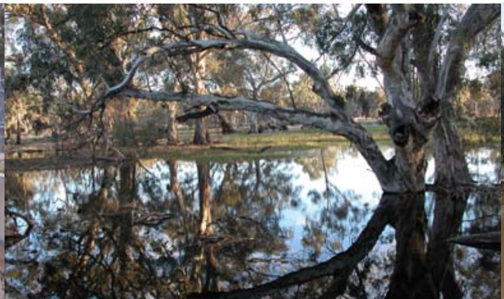



River regulation

- The flow regimes of most of the rivers in the Murray-Darling Basin (MDB) have been modified due to flow regulation and water extraction
- The majority of the licensed water in the MDB is used for irrigated agriculture








Impact of river regulation in MDB

- Cold water pollution downstream of large impoundments
- Shift in seasonality of flows and loss of variability
  - Most rivers previously had highly variable flow regime with winter/spring maximum flow
  - Under regulated conditions there is less variable flow regime with summer maximum flow
- Loss of small and medium floods
- Reduced flooding of wetlands




Impact on river ecology

- Lower species richness
- Dominance of tolerant species
- Disruption to breeding cues
- Reduced migration
- High abundance of alien species




Environmental water

- Environmental water available through several mechanisms

- Planned environmental water
  - Provided by legislation (eg. Water Management Act NSW)
  - Water allocated under rules of Water Sharing Plans

- Adaptive environmental water
  - Water committed to the environment under a water licence
  - Several organisations involved in purchase of water
    (eg. Living Murray, Water For Rivers, River Reach, Riverbank,
    Nature Conservation Water Trust)




Challenge

- To use environmental water to maintain and improve the ecological health of regulated rivers at the same time as sustaining productive irrigation industries

- Constraints
  - Diminishing water resources
  - Small environmental water allocation in regulated rivers
  - Constraints on water delivery

- It is imperative that we maximise environmental outcomes from the available environmental water




Can food production and environmental flows coexist?

- Better delivery of environmental flows can be achieved by altering the structure and operation of river infrastructure

- Examples
  - Reaches directly downstream of major dams
  - Mid-catchment riverine environments
  - Anabranches
  - Wetlands




Reaches downstream of major dams

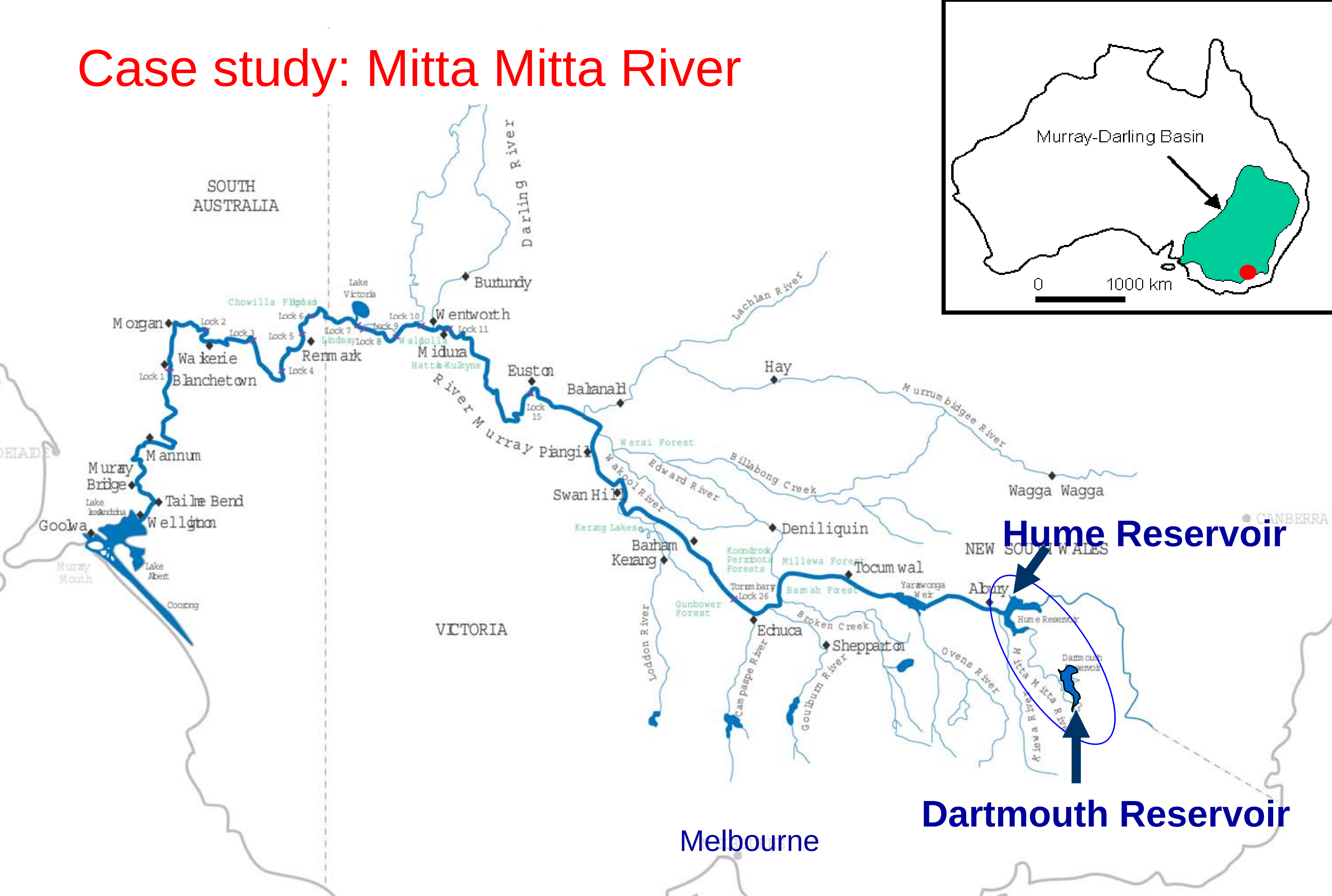
- Issues
  - Cold water pollution
  - Less variable flow regime
  - Shift in seasonality of flows

- Add infrastructure to dams to reduce cold water pollution (eg. multi-level offtake, impellers, submerged curtains)

- Alter operational plans of dams to introduce more variability into discharge patterns during periods of relatively constant discharge



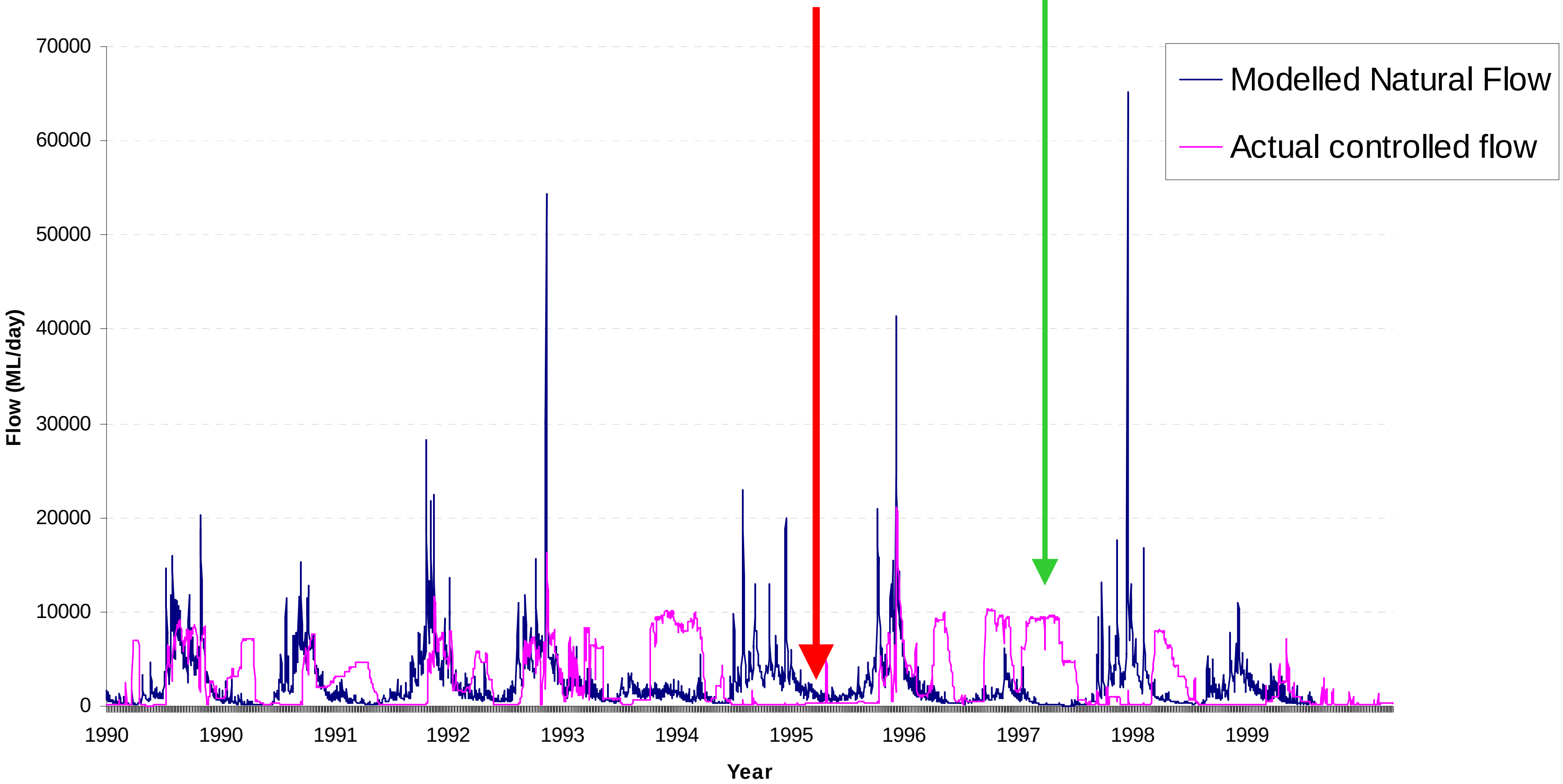

Case study: Mitta Mitta River



- Dartmouth Dam used as reserve storage
- Transfers are made from Dartmouth to Hume Reservoir in dry years

Dartmouth Dam releases

- Long periods of high flows (transfers from Dartmouth to Hume Reservoir)
- Long periods of low flows (filling phase)



Hydrograph for the Mitta Mitta River illustrating modelled natural flow conditions and actual controlled flow for the period 1990 to 2000 (Source MDBC)

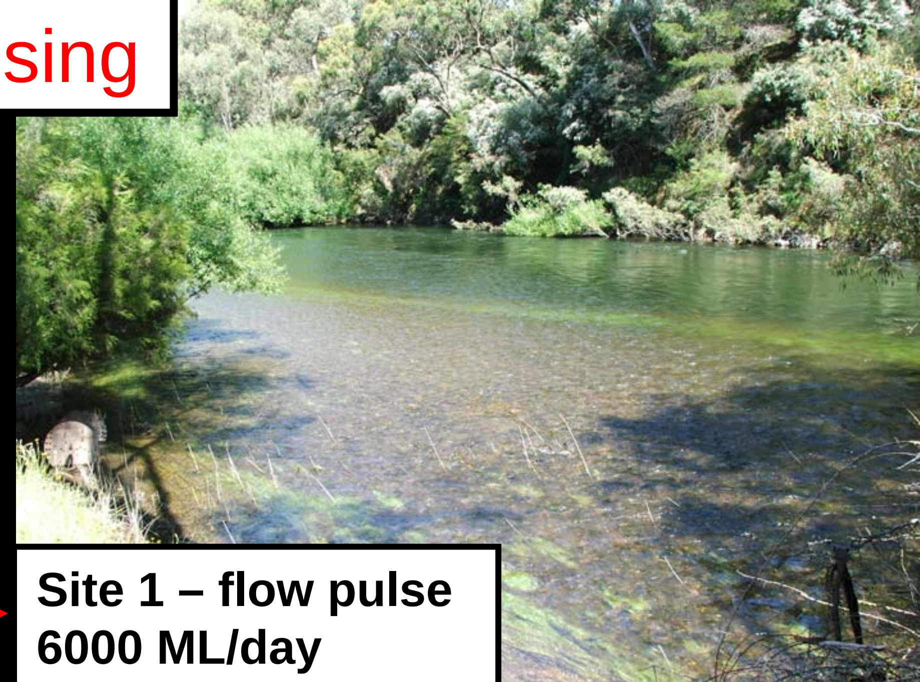
Issues

- Under constant flows biofilms build up to nuisance levels that are unacceptable to the public

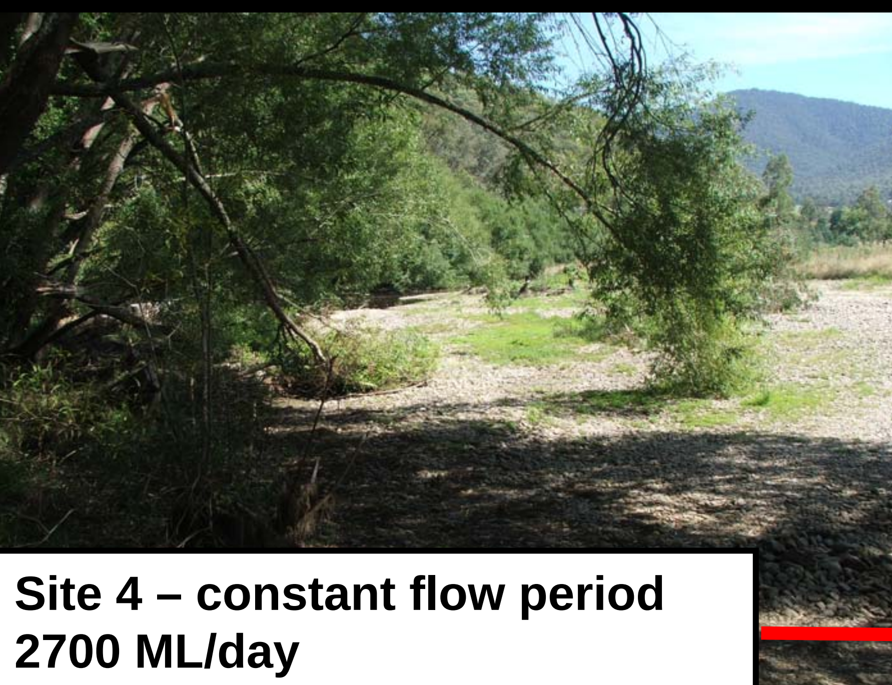
- There is lower biodiversity in the Mitta Mitta River compared to reference streams

Flow pulsing

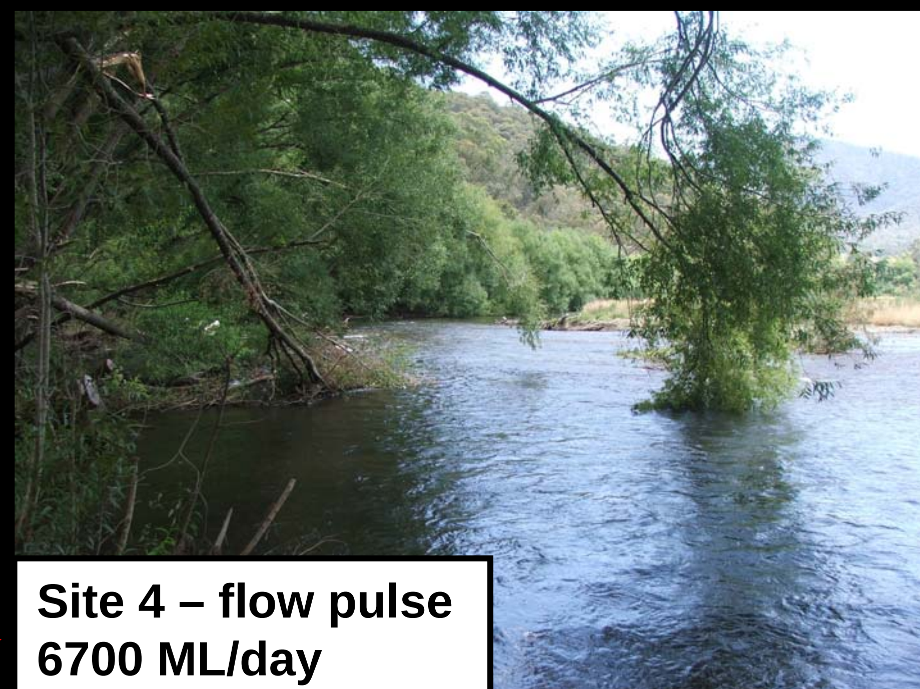
Site 1 – constant flow period
2000 ML/day



Site 1 – flow pulse
6000 ML/day



Site 4 – constant flow period
2700 ML/day



Site 4 – flow pulse
6700 ML/day

Summary of outcomes of flow pulse

- Increased dissolved organic matter and bacterial metabolism after pulse
- Algae
  - Scoured filamentous green algae from cobble during peak flow
  - Increase in algal diversity after pulse (community composition more similar to the reference site after flow pulse
  - These changes were not sustained 2 weeks after flow pulse
- Macroinvertebrates
  - Increased diversity directly downstream of dam after flow pulse
  - Community composition became more similar to the reference site
  - These changes were not observed at sites further downstream

Watts, R.J., Nye E.R., Thompson, L.A., Ryder, D.S., Burns, A. & Lightfoot, K. 2005. *Environmental monitoring of the Mitta Mitta River associated with the major transfer of water resources from Dartmouth Reservoir to Hume Reservoir 2004/2005*.. http://www.csu.edu.au/research/jcentre/reports/jcec_report97.pdf

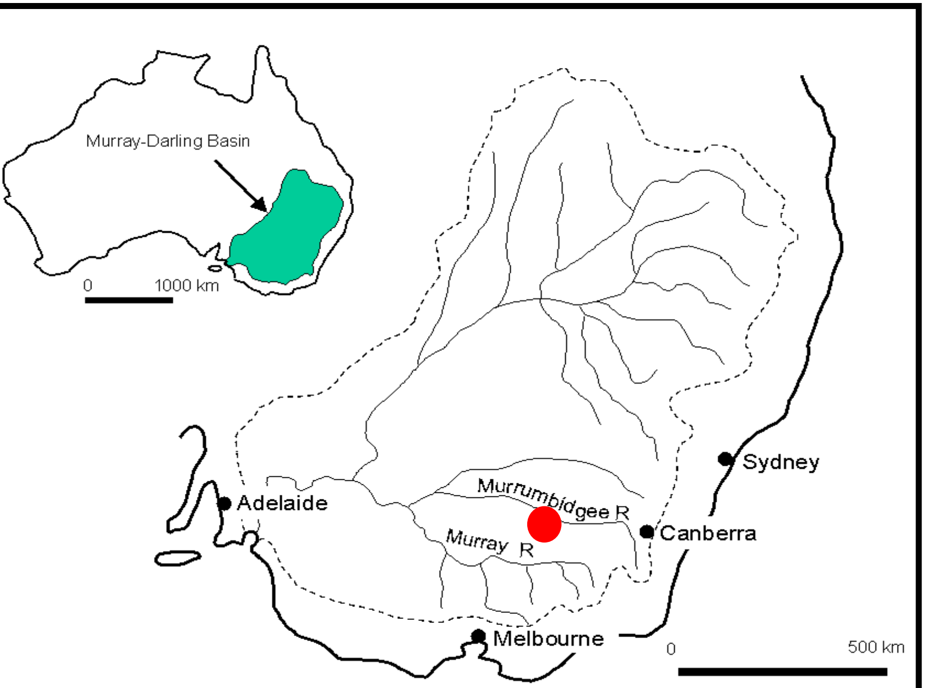
Watts R.J., Ryder D.S., Burns A., Wilson A.L., Nye E.R., Zander A. & Dehaan R. 2006. *Responses of biofilms to cyclic releases during a low flow period in the Mitta Mitta River, Victoria*, Australia. http://www.csu.edu.au/research/ilws/archive05/ILWSreports06.htm)

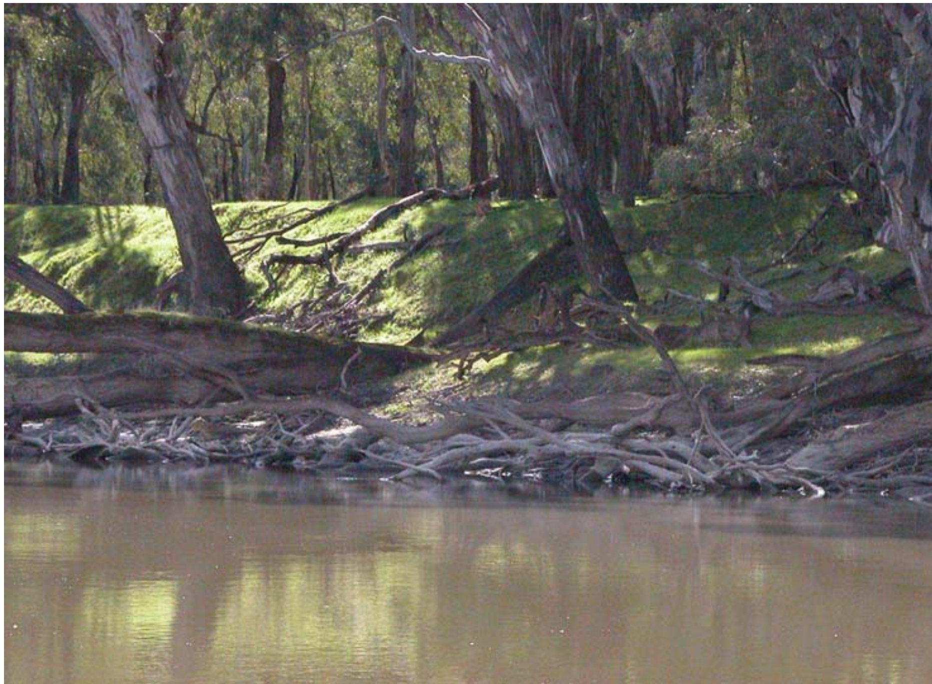
Mid-catchment riverine environments

- Issues
  - Loss of instream connectivity due to weirs
  - Loss of small and medium floods
  - Less variable flow regime
  - Shift in seasonality of flows
- Install fishways to improve fish passage
- Open gates on weirs to pass flows outside irrigation season
- Alter operation of weirs to achieve water level variation

Case study: flow variability in Mid-Murrumbidgee

- River red gum logs on river bank provide a surface for algae and habitat for fauna
- Water level changes cause wetting and drying of algae on logs





Simulated flow experiment

Blocks of wood exposed to periods of wetting and drying to simulate changes in water level that would be experienced under different flow regimes

Duration: 75 days

3 flow regime treatments:

- permanently inundated (ie. constant flow)
- 11 days wet/ 21 days dry (ie. 3 longer pulses)
- 5 days wet/ 9 days dry (ie. 6 shorter pulses)

Parameters examined:

algal diversity and productivity

Results – simulated flow experiment (75 days)

Permanently inundated	5d wet / 9d dry (6 wet cycles)	11d wet / 21d dry (3 wet cycles)
		
• low NPP • low diversity	• negative NPP • low diversity	• high NPP • high diversity

Ryder, D.S. 2004. Response of biofilm metabolism to water level variability in a regulated floodplain river. *Journal of the North American Benthological Society* 23(2), 214-223.

Ryder D.S., Watts R.J., Nye E., & Burns, A. 2006. Can flow velocity regulate epixylic biofilm structure in a regulated floodplain river? *Marine and Freshwater Research,* 57(1), 29-36.

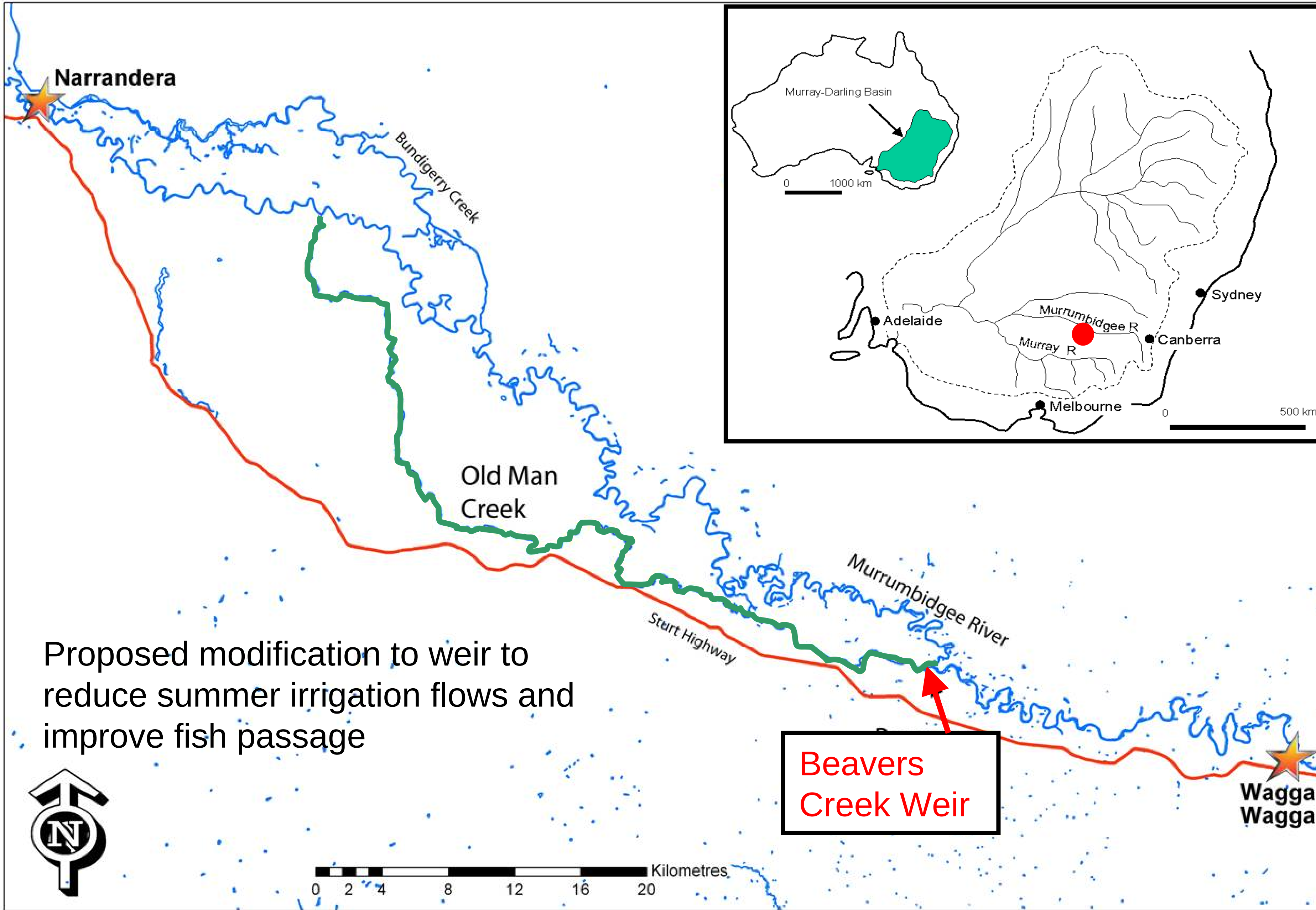
Anabranches

- Issues
  - Irrigation flows travel down anabranches in summer
  - Loss of irrigation water in anabranch
  - Loss of low flow refuge areas in anabranches

- Operate weirs on anabranches to reduce flows during summer and create low flow refuge environments

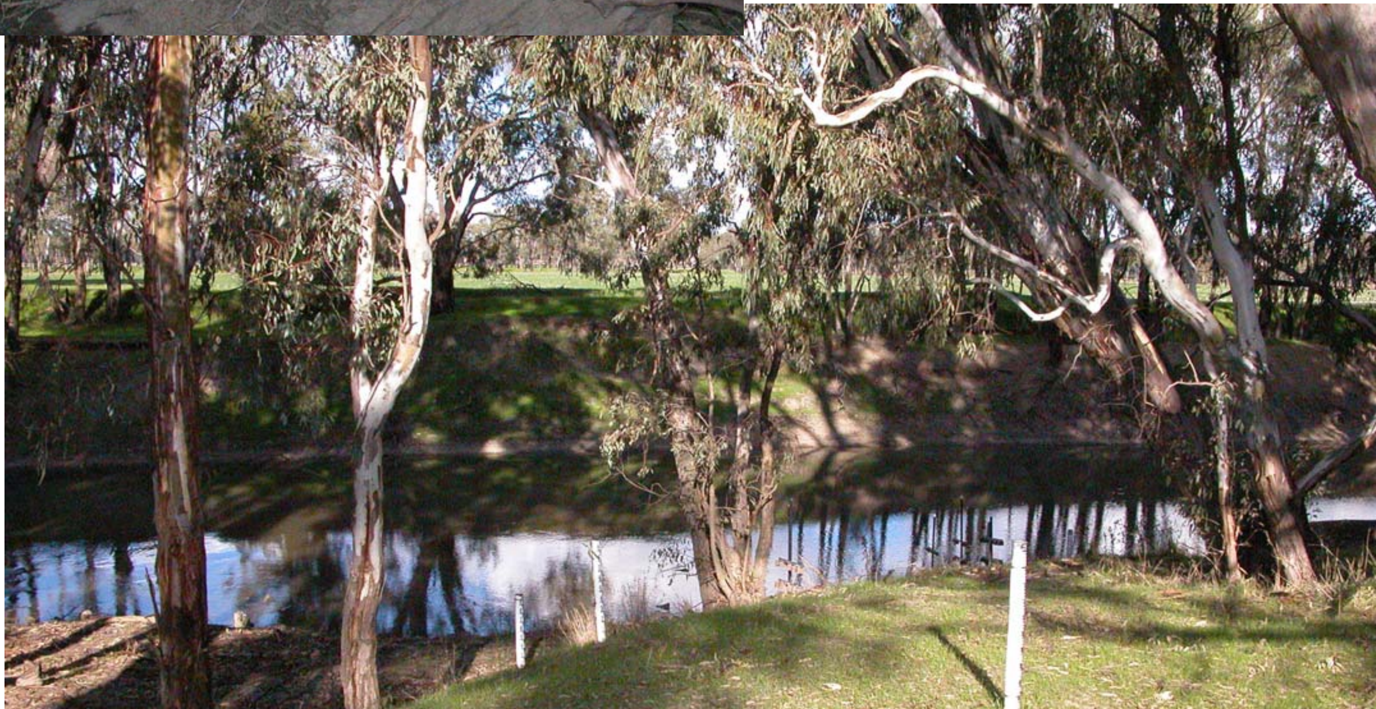



Case study: modification of weir on anabranch



Proposed modification to weir to reduce summer irrigation flows and improve fish passage

Beavers Creek



Infrastructure on wetlands

- Issues
  - Alteration of natural wetting and drying regimes
  - Reduced frequency of flooding of some wetlands
  - Long periods of inundation in wetlands influenced by weir pools
- Install regulators to protect wetlands from inundation
- Use mobile pumps to inundate wetlands
- Pulse flows from weirs to inundate wetlands
- Use irrigation canals to deliver water to wetlands




Wetland watering

Examples of ecological responses to wetland watering

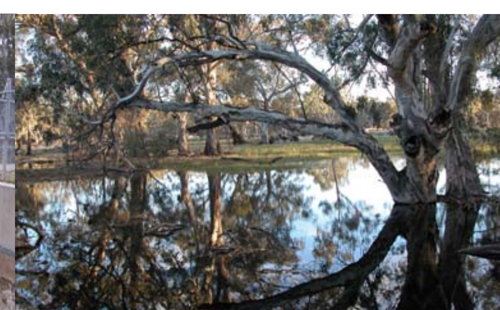
- increased wetland plant diversity
- bird breeding events
- pulse of microcrustaceans and fish larvae

Considerations

- Changing the structure and operation of river infrastructure is not a straightforward process and the social, economic and environmental impacts of proposed changes need to be considered

- Effective stakeholder engagement will be an essential component of any proposed change






Conclusions

- Currently not maximising the environmental outcomes from the available environmental water
- Achieve better delivery of environmental water by making operational and structural changes to existing infrastructure and in some cases installing new infrastructure
- Different strategies are required in different reaches
- Monitoring and adaptive management




Acknowledgements

Mitta Mitta River
Colleagues – D Ryder, A Burns, E Nye, A Wilson, R Dehaan
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Mid-Murrumbidgee flows (ARC project)
Colleagues - D Ryder, A Robertson
Industry partners – NSW DIPNR, NSW Department of Environment and Conservation

Beavers Creek anabranch
Colleagues – S Kopf, P Humphries
Industry partners – Water for Rivers

Wetland watering
Colleagues – O. Arnaiz, A Wilson, K Podnar, S. Wassens
Industry partners - Murrumbidgee CMA, Murray Wetlands Working Group

Review of structures and operation of flow regulating infrastructure
Industry partners – NSW Department of Commerce