



Attachment 1 – overview of findings from projects undertaken by the Goyder Institute for Water Research

Below is an overview of the projects undertaken by the Goyder Institute for Water Research that relate directly or indirectly to the Murray-Darling Basin Plan, the Murray-Darling Royal Commission Terms of Reference or Issues Paper of the Commission. The projects are grouped by projects that assessed the Guide to the Proposed Basin Plan; projects that assessed the draft Basin Plan; projects that provided information relevant to the management of environmental flows for contributing to the environmental outcomes of the Basin Plan; projects that provided information relevant to the management of infrastructure for contributing to the environmental outcomes of the Basin Plan; and other projects relevant to Implementation of the Basin Plan

All cited references can be found in full at <http://www.goyderinstitute.org/publications/technical-reports/>.

Projects assessing the Guide to the Proposed Basin Plan

A compilation of reports informing a socioeconomic assessment of the Guide to the proposed Basin Plan

Key findings

- This compilation found that reports informing a socioeconomic assessment of the Guide to the Proposed Basin Plan had limited consideration for the potential benefits of sustainable diversion limits. A deeper treatment of the benefits of SDLs and their quantification and inclusion in a benefit cost framework was recommended.

Reference

Connor J. (ed.) (2011) *A compilation of reports informing a socioeconomic assessment of the Guide to the proposed Basin Plan*. Goyder Institute for Water Research Technical Report Series No. 11/4, Adelaide, South Australia. ISSN: 1839-2725.

A science review of the implications for South Australia of the Guide to the proposed Basin Plan

Key findings

- This work assessed the impacts of three environmental water recovery scenarios (3000, 3500 and 4000 GL/year) on likely environmental, water quality and socioeconomic outcomes.

Environmental water requirements and delivery:

- There was potentially sufficient average annual volume to meet the environmental water requirements (EWRs) of the Coorong, Lower Lakes and Murray Mouth (CLLMM) for each water recovery scenarios but the EWRs were unlikely to always be met due to how and when flows are delivered to the CLLMM.
- More CLLMM EWRs were met under the 4000 GL/year scenario than under the 3500 GL/year scenario, and more were met under the 3500 GL/year scenario than under the 3000 GL/year scenario.
- For the Riverland-Chowilla site, there was also potentially sufficient average annual volume to meet the EWRs, except for the 3000 GL/year scenario. However, as the EWRs specified timing, magnitude and duration of flows, these EWRs were not met under any of the scenarios because of constraints on the storage and release of water.



Salinity and water quality:

- There was a slight reduction of the risk of cyanobacterial blooms in the River Murray and maintenance of water levels in the Lower Lakes (to lower the risk of acidification) under the water recovery scenarios.
- Under the water recovery scenarios, salinity targets for Morgan were met and the risk of exceeding the salinity thresholds was reduced.
- Targets for salt export through the barrages was not met under any of the water recovery scenarios.

Socioeconomic impacts:

- Overall the socioeconomic impacts for major water users in South Australia were similar under the water recovery scenarios, with potential for mitigation and adaptation expenditures and damage costs associated with extreme droughts to be avoided in the future.

References:

Connor J.D., Banerjee O., Kandulu J., Bark R.H. and King D. (2011) *Socioeconomic implications of the Guide to the proposed Basin Plan – methods and results overview*. Goyder Institute for Water Research Technical Report Series No. 11/3, Adelaide, South Australia. ISSN: 1839-2725.

CSIRO (2011). *A science review of the implications for South Australia of the Guide to the proposed Basin Plan: synthesis*. Goyder Institute for Water Research Technical Report Series No. 11/1, Adelaide, South Australia. ISSN: 1839-2725.

Pollino C.A., Lester R.E., Podger G.M., Black D. and Overton I.C. (2011) *Analysis of South Australia's environmental water and water quality requirements and their delivery under the Guide to the proposed Basin*. Goyder Institute for Water Research Technical Report Series No. 11/2, Adelaide, South Australia. ISSN: 1839-2725.

Projects assessing the draft Basin Plan

Expert panel assessment of the likely ecological consequences in South Australia of the proposed Murray-Darling Basin Plan

Key findings

- This work provided an expert review of the impacts of the proposed environmental water recovery scenario of 2800 GL/year on the ecology of the South Australian Murray-Darling Basin. It was informed by work undertaken by the Murray-Darling Basin Authority and the South Australian Government.
- A limitation of the work used to establish water recovery targets of the Basin Plan was that only one possible scenario for the proposed water recovery volume (2800 GL/year) had been explored. This represented only one of many flow regimes for that water recovery volume that could occur.
- Benefits the proposed Basin Plan compared to a 'do nothing' scenario included improvement in native fish habitat; potential improvement in condition for floodplain vegetation communities at lower floodplain elevations; a reduction in the number of events with low water levels and elevated salinities in the Lower Lakes; improved connectivity between the Lower Lakes and Coorong; and increased opportunity for fish migration between the Southern Ocean and Coorong.



- Risks of the proposed Basin Plan included declining vegetation condition on the mid- and high- elevation areas of floodplains and associated loss of habitat provision for floodplain fauna; ongoing degradation of mid- and high-elevation floodplain wetlands and associated loss of habitat for floodplain wetland biota; an accumulation of salt in the Lower Murray region; the occurrence of extreme low-water levels and elevated salinities in the Lower Lakes and Coorong that would reduce the habitat available for fish and migratory waterbirds; continued requirement for dredging to be kept open during extended droughts; and loss of the ecological character of the Riverland-Chowilla and CLLMM Ramsar sites.
- More environmental benefits could potentially be achieved under the proposed Basin Plan if upstream delivery constraints were relaxed, providing more flexibility in managing environmental flows in the 40,000– 80,000 ML/day range. Lesser environmental benefits could eventuate as a result of other stressors, such as climate change and floodplain salinity that were not considered in work used to establish water recovery targets of the Basin Plan.
- Only limited environmental benefits could potentially be gained by additional local infrastructure in South Australia. Better environmental outcomes would be achieved by investing in opportunities upstream to improve flow diversity in the 40,000–80,000 ML/day flow band in South Australia. Active rehabilitation, such as species re-introduction, could also be considered once suitable conditions in a given asset are reinstated.

Reference

Lamontagne S., Aldridge K.T., Holland K.L., Jolly I.D., Nicol J., Oliver R.L., Paton D.C., Walker K.F., Wallace T.A., Ye Q. (2012) *Expert panel assessment of the likely ecological consequences in South Australia of the proposed Murray-Darling Basin Plan*. Goyder Institute for Water Research Technical Report Series No. 12/2. Adelaide, South Australia. ISSN: 1839-2725.

Assessing the impact of volumes proposed under the Draft Basin Plan on the Coorong and Murray Mouth region

Key findings

- This work assessed the impacts of the proposed environmental water recovery scenarios of 2400 GL/year, 2800 GL/year and 3200 GL/year on CLLMM region.
- The environmental water recovery scenarios improved ecological conditions in the CLLMM when compared to baseline conditions.
- Higher volumes of additional environmental water resulted in lower maximum salinities and higher minimum water levels within the Coorong, but there were few differences in the mix of ecosystem 'states' across the three water recovery scenarios.
- Only one additional EWR of the CLLMM was met for the 2800 GL/year compared to the 2400 GL/year scenario. An additional 4 EWRs were met for the 3200 GL/year scenario compared to the 2800 GL/year scenario.
- Additional environmental water recovery reduced the frequency and severity of failure to meet the EWRs.



- Results highlighted the importance of the pattern of flow delivery for meeting the EWRs specified for the Coorong.

Reference

Lester R.E., Fairweather P.G., Hamilton B.M. (2013) *Assessing the impact of volumes proposed under the Draft Basin Plan on the Coorong and Murray Mouth region*. Goyder Institute for Water Research Technical Report Series No. 13/2. Adelaide, South Australia. ISSN: 1839-2725.

Projects providing information relevant to the management of environmental flows for contributing to the environmental outcomes of the Basin Plan

Ecological Responses to Flooding in the Lower River Murray Following an Extended Drought

Key findings

- An extreme low flow period led to elevated salinities within the River Murray below Lock 1 and the accumulation of carbon on the floodplain, resulting in hypoxic conditions (low oxygen) in the Lower River Murray upon inundation of the floodplain during the flood.
- Flooding mobilised organic matter from the floodplain and the basin that stimulates the productivity of the River Murray ecosystem. Two large floodplain areas (Chowilla and Barmera) were identified as major sources of organic matter.
- The floodplain understorey plant community retained its capacity to respond to flooding despite an extended period without overbank flooding or managed watering.
- Managed watering and groundwater management of high priority areas during the low-flow period helped maintain long-lived tree and shrub water sources and maintain local propagule banks. The increase in tree water availability after flooding was greater than after managed watering and groundwater management.
- Emergent plants in wetlands in the River Murray below Lock 1 and Lower Lakes survived an extended low flow period (albeit in lower numbers). Submergent plants were extirpated in wetlands the River Murray below Lock 1 and Lower Lakes during the drought. Whilst they reestablished (albeit with a much small distribution and lower diversity) in the Lower Lakes during the flood, they had not reestablished in wetlands in the River Murray below Lock 1 by autumn 2011.
- Extended drought and low flow periods can have a significant negative effect on populations of large-bodied native species. Minimum entitlement flows to SA were not sufficient to induce spawning of those fish species whose spawning is flow dependent (e.g. golden perch and silver perch).
- Within wetlands Common carp displayed the greatest positive response to the flood with significant increases in relative abundance.
- Maintaining connectivity between the River Murray main channel and off-channel habitats such as the Chowilla anabranch system is important for the transfer of 'food' sources for aquatic ecosystems and the movement of biota (e.g. Murray cod).
- Maintaining the integrity of upstream flow events (e.g. from the Darling or Murray River's) is important to facilitate the dispersal and recruitment of fish within the Lower Murray.



References

- Aldridge K., Lorenz Z., Oliver R., Brookes J. (2012) *Changes in water quality and phytoplankton communities in the Lower River Murray in response to a low flow-high flow sequence*. Goyder Institute for Water Research Technical Report Series No. 12/5, Adelaide, South Australia. ISSN: 1839-2725.
- Cheshire K., Ye Q., Wilson P., Bucater L. (2012) *From Drought to Flood: Annual variation in larval fish assemblages in a heavily regulated lowland river*. Goyder Institute for Water Research Technical Report Series No. 12/6. Adelaide, South Australia. ISSN: 1839-2725.
- Holland K.L., Turnadge C.J., Nicol J.M., Gehrig S.L. and Strawbridge A.D. (2013) *Floodplain response and recovery: comparison between natural and artificial floods*. Goyder Institute for Water Research Technical Report Series No. 13/4, Adelaide, South Australia. ISSN: 1839-2725.
- Nicol J.M., Gehrig S.L., Frahn K.A. and Strawbridge A.D. (2013) *Resilience and resistance of aquatic plant communities downstream of Lock 1 in the Murray River*. Goyder Institute for Water Research Technical Report Series No. 13/5, Adelaide, South Australia. ISSN: 1839-2725.
- Oliver R. and Lorenz Z. (2013) *Floodplain influences on metabolic activity in the South Australian section of the Murray River during the 2010/11 flood*. Goyder Institute for Water Research Technical Report Series No. 13/1. Adelaide, South Australia. ISSN: 1839-2725.
- Thwaites L., Fredberg J. (2014) *The Response Patterns of Wetland Fish Communities Following Prolonged Drought and Widespread Flooding*. Goyder Institute for Water Research Technical Report Series No. 14/9, Adelaide, South Australia. ISSN: 1839-2725.
- Ye Q., Giatas G.C., Aldridge K.T., Bengler S.N., Bice C.M., Brookes J.D., Bucater L.B., Cheshire K.J.M., Cummings C.R., Doody T.M., Fairweather P.G., Frahn K.A., Fredberg J.F., Gehrig S.L., Holland K.L., Leigh S.J., Lester R.E., Lorenz Z., Marsland K.B., Nicol J.M., Oliver R.L., Overton I.C., Pritchard J.L., Strawbridge A.D., Thwaites L.A., Turnadge C.J., Wilson P.K., Zampatti B.P. (2014) *Ecological Responses to Flooding in the Lower River Murray Following an Extended Drought: Synthesis Report of the Murray Flood Ecology Project*. Goyder Institute for Water Research Technical Report Series No. 14/6, Adelaide, South Australia. ISSN: 1839-2725.

Projects providing information relevant to the management of infrastructure for contributing to the environmental outcomes of the Basin Plan

The influence of freshwater discharge on productivity, microbiota community structure and trophic dynamics in the Murray estuary

Key findings

- Organic matter and biota exported to the Murray estuary with freshwater discharge through the Murray Barrages contributes to the productivity of the estuarine ecosystem. Even low-volume discharge can have measurable benefits for estuarine productivity, whilst conspicuous flow pulses (~20,000 ML.day⁻¹) may provide productivity benefits that last for periods of months following flow recession.

Reference



Bice, C.M., Furst, D., Lamontagne, S., Oliver, R.L., Zampatti, B.P. and Reville, A. (2015) *The influence of freshwater discharge on productivity, microbiota community structure and trophic dynamics in the Murray estuary: evidence of freshwater derived trophic subsidy in the sandy sprat*. Goyder Institute for Water Research Technical Report Series No. 15/40, Adelaide, South Australia. ISSN: 1839-2725.

Science to inform operational decisions of major environmental infrastructure on floodplains in the SA River Murray

Key findings

- A carefully managed delivery of environmental water using constructed infrastructure achieved extensive floodplain inundation without exceeding guideline and statutory limits for water quality.
- There was evidence of an increased risk of problematic declines in dissolved oxygen levels associated with management of constructed infrastructure for delivering environmental water.
- Return flows from the Chowilla Anabranch to the River Murray during a managed inundation increased the abundance of resources that may stimulate the productivity of the River Murray ecosystem.

Reference

Wallace T.A., Furst D., Upadhyay S. and Daly R. (2015) *Science to inform operational decisions of major environmental infrastructure on the Chowilla Floodplain and other regulated floodplains in the SA River Murray*. Goyder Institute for Water Research Technical Report Series No. 15/18, Adelaide, South Australia. ISSN: 1839-2725.

Other projects relevant to Implementation of the Basin Plan

Statistically Downscaled Climate Change Projections for South Australia

Key findings

- Downscaled climate projections for the South Australian Murray-Darling Basin indicate future:
 - decreases in annual precipitation and precipitation in all seasons, with large relative decreases in spring;
 - increases in daily temperatures (maximum and minimum) in all seasons, with larger increases in maximum temperature in spring;
 - increases in solar radiation in all seasons, with larger relative increases in winter and spring; and
 - increases in areal potential evapotranspiration in all seasons, with relative increases greater in winter and spring.

Reference

Charles, S.P. and Fu, G. (2015) *Statistically Downscaled Climate Change Projections for South Australia*. Goyder Institute for Water Research Technical Report Series No. 15/1, Adelaide, South Australia. ISSN: 1839-2725.

Indigenous engagement in environmental water planning, research and management: Innovations in South Australia's Murray-Darling Basin Region

Key findings



- New approaches to Indigenous engagement in the South Australian Murray-Darling Basin region are comparatively unique, locally and regionally relevant, address relevant UN treaties and hold useful ideas for 'environmental management' in Australia and overseas.
- South Australia has developed a form of what can be described as partial Indigenous 'co-management'. This approach to Indigenous engagement is generating regional solutions to the broader challenge of incorporating Indigenous interests in environmental water management.

Reference

Hemming S., and Rigney D. (2014) *Indigenous engagement in environmental water planning, research and management: Innovations in South Australia's Murray-Darling Basin Region*. Goyder Institute for Water Research Technical Report Series No. 14/21, Adelaide, South Australia. ISSN: 1839-2725.

Restoring Murray Futures: Incorporating Indigenous knowledge, values and interests into environmental water planning in the Coorong and Lakes Alexandrina and Albert Ramsar Wetland

Key findings

- In southern South Australia, natural resource management has been transformed through a sustained Indigenous-led strategy focused on Indigenous nation building. The Ngarrindjeri Kungun Ngarrindjeri Yunnan Agreement process has produced a unique working relationship between an Indigenous nation and non-Indigenous interests represented by the government at all levels, universities and other groups. Key to this has been good governance, increased research, policy and planning capacity and strong local, regional and international partnerships. The success has inspired a radical and unique policy shift in Indigenous affairs in South Australia.

Reference

Hemming S., and Rigney D. (2016) *Restoring Murray Futures: Incorporating Indigenous knowledge, values and interests into environmental water planning in the Coorong and Lakes Alexandrina and Albert Ramsar Wetland*. Goyder Institute for Water Research Technical Report Series No. 16/8, Adelaide, South Australia. ISSN: 1839-2725.

River Murray Channel Environmental Water Requirements: Ecological Objectives and Targets

Key findings

- Conceptual models were developed for the River Murray Channel (a priority Environmental Asset as defined by the Long-term Watering Plan for the South Australian Murray-Darling Basin) as a basis for establishing ecological objectives, targets and EWRs for the Channel.
- Ecological objectives and targets were developed for a range of biota and process. Where practical, the targets are structured within a SMART (Specific, Measurable, Achievable, Realistic, Time-bound) framework.
- Seven EWRs for the River Murray Channel were also developed, with each EWR is expected to contribute towards achieving the ecological objectives and targets for the Channel.



- A preliminary assessment suggested that weir manipulation could contribute to achieving the objectives and targets of the Channel by partially reinstating seasonal patterns of water level, lateral connectivity and hydraulic diversity within the weir pools of the River Murray.

Reference

Wallace T.A., Daly R., Aldridge K.T., Cox J., Gibbs M.S., Nicol J.M., Oliver R.L., Walker K.F., Ye Q., Zampatti B.P. (2014) *River Murray Channel Environmental Water Requirements: Ecological Objectives and Targets*. Goyder Institute for Water Research Technical Report Series No. 14/4, Adelaide, South Australia. ISSN: 1839-2725.

In addition to the completed projects described above, the Institute has two current projects that are also relevant to the Basin Plan. They are:

- *Ecological connectivity of the River Murray: managing ecological outcomes and water quality risks through integrated river management* (<http://www.goyderinstitute.org/projects/view-project/70>)
- *Translating Ngarrindjeri Yannerumi into water resource risk assessments* (<http://www.goyderinstitute.org/projects/view-project/71>)