Project Coorong World Wetlands Day Science Forum 2021 – Abstracts

Table of Contents

Theme 1: First Nations Knowledge

Ngarrindjeri Knowledge

Author: Tim Hartman Senior, Ngarrindjeri Aboriginal Corporation

Caring for Ruwe and the Kurangk

Our vision for our Yarluwar-Ruwe is based on the relationship between our people and our Yarluwar-Ruwe which goes back to Creation.

The river, lakes, wetlands/nurseries, Coorong estuary and sea have sustained us culturally and economically for tens of thousands of years.

Ngurunderi taught us how to sustain our lives and our culture from what were our healthy lands and waters.

Our lands and waters must be managed according to our Laws to make them healthy once again.

As the Ngarrindjeri Nation we must maintain our inherent sovereign rights to our Yarluwar-Ruwe.

Ngarrindjeri people have a sovereign right to make our living from the lands and waters in a respectful and sustainable way.

Lartara-Wirkeri Cultural Governance in Program Delivery (Limestone Coast Region)

Authors: Robyn Campbell, Burrandies Aboriginal Corporation, Doug Nicholls, South East Aboriginal Focus Group, and David New, Limestone Coast Landscape Board

Walking together

In 2008 the South East Aboriginal Focus Group (SEAFG) began the journey to revive cultural governance framework as a way of securing ownership of culture in a highly modified landscape.

Lartara-Wirkeri translates to sticks-three and is a contemporary application of ancient forms of communication and organisation. The Three sticks represent different stages of engagement to process. Song & Dance (We will celebrate when…), Ceremony & Talk (Plan together…) and Hunt & Gather (Do Together…). The framework respects ancestors and uses cultural symbology to promote First Nation autonomy.

Supporting a cultural economy

In 2015 the Lartara-Wirkeri Cultural Governance framework developed into a Cultural Governance agreement between the SEAFG and Burrandies Aboriginal Corporation. This agreement maps out a working relationship where the SEAFG provide the cultural knowledge in decision making and Burrandies provide the business delivery mechanism to undertake fee for service works and program delivery. Burrandies is delivering the South East First Nations engagement component of Project Coorong.

Further reading

Cultural Awareness Message, Burrandies Aboriginal Corporation https://youtu.be/NY34utGS59M

Burrandies Cultural Connections https://www.facebook.com/burrandies/

Theme 2: Coorong Water Quality, Aquatic Plants and Modelling

Coorong Water Quality

Author: Associate Professor Luke Mosley, University of Adelaide

Nutrients, in particular nitrogen and phosphorus, are elements that are essential for aquatic plant and algal growth. However, too much nutrient input or lack of flushing can lead to excessive algal growth and build-up of organic matter in the water and sediment (known as eutrophication). The Coorong has experienced declining ecological health that has been linked to flow declines, persistent extremely high salinity, and excessive algal growth (Figure 1).

The Healthy Coorong, Healthy Basin Nutrient Dynamics project aims to greatly improve understanding of nutrient sources and processes to inform how to shift the Coorong back to a healthier state. Based on previous monitoring of water salinity, chlorophyll *a* (a measurement of total green micro-algae in water), total nitrogen and phosphorus concentrations, the southern parts of the Coorong are highly eutrophic. This was exacerbated during the extreme Millennium Drought period when no river inflows occurred, and salinity peaked at approximately 5 times seawater salinity.

The Coorong sediment is in poor health with high nutrients and anoxic black oozes present throughout the South Lagoon and southern region of the North Lagoon (Figure 2). The sediment organic nitrogen isotope "signature" values are consistent with an algal derived source to the sediment. Sediment and groundwater input investigations are in progress to better understand dissolved nutrient fluxes (nutrient transfers, for example between sediment and water, or vice versa) and processes. Early results show high nutrient concentrations in the sediment pore water that are fluxing back to the surface water, creating a "vicious cycle" for maintaining high algal productivity.

Our current understanding is that high salinity and sulfide in the sediment appears to reinforce the eutrophication process by negatively impacting benthic microbial, fauna and flora communities, which promote nutrient retention and elimination processes. We have observed that *Ruppia* and macroinvertebrates (where present) are oxygenating the sediment and reducing black ooze build-up. At a system level, water quality needs to be greatly improved however to enable effective restoration of ecosystems. Decreasing nutrient loads and increasing lagoonal flushing (via enhanced freshwater and/or seawater inflows and/or lagoon connectivity) would be beneficial to reduce eutrophication in the Coorong.

Figure 1: Algal and organic rich water and green filamentous algae near Parnka Point in the central Coorong

Figure 2: A typical sediment core in the South Lagoon showing anoxic black oozes with a lack of benthic macroinvertebrates present

Further reading

Aldridge, K., Mosley, L.M., Oliver, R. (2018). Water quality of the Coorong, Lower Lakes and Murray Mouth. In Natural History of the Coorong, Lower Lakes, and Murray Mouth (Yarluwar-Ruwe). Eds: L. Mosley, S. Shepherd, Q. He, S. Hemming and R. Fitzpatrick. https://www.adelaide.edu.au/press/system/files/media/documents/2020-07/uap-natural-history-cllmm-ebook.pdf

Mosley, L.M., Priestley, S., Brookes, J., Dittmann, S., Farkaš, J., Farrell, M., Ferguson, A.J., Gibbs, M., Hipsey, M., Huang, J., Lam-Gordillo, O., Simpson, S.L., Teasdale, P.R., Tyler, J.J., Waycott, M., Welsh, D.T. (2020). Coorong water quality synthesis with a focus on the drivers of eutrophication. Goyder Institute for Water Research Technical Report Series No. 20/10. http://www.goyderinstitute.org/publications/technical-reports/

Coorong Aquatic Plants

Authors: Professor Michelle Waycott, University of Adelaide, Dr Jason Nicol, South Australian Research and Development Institute (SARDI) Aquatic Sciences, Associate Professor Sophie Leterme, Flinders University

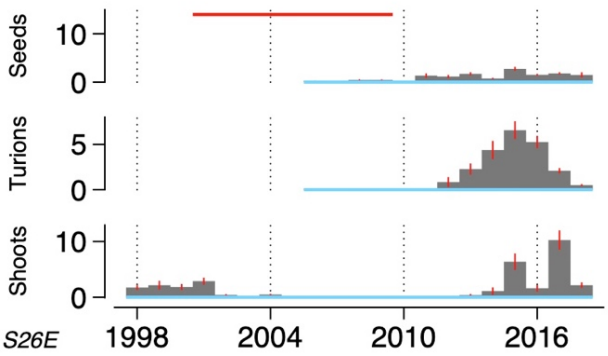
There has been a well-documented long-term decline to many of the highly valued plants and animals that make the Coorong their home. Even when viewed on a global scale, the Coorong is an ecosystem prone to extremes of variability—within and between years. The aquatic plants and algae have a range of adaptations to how, and if, they grow. These thresholds allow survival under the variability they are adapted to. The unique range of their tolerances to extremes of environmental conditions provide us with the ability to understand the suitability of habitat, including the highly desirable conditions for growth and production.

The last 20 years has seen the ecosystem forming excessive primary production biomass, in more recent years in the form of algae associated with eutrophication (nutrient enrichment). Subsequent impacts on the highly desirable species of aquatic plants (the *Ruppia tuberosa* dominated plant community), invertebrates, fish and waterbirds have occurred. Following the 2020 growing season the extent of the *Ruppia* dominated aquatic plant community has returned to the pre-Millennium Drought extent. However these shallow water areas are still significantly impacted by filamentous algal blooms leading to declines in seed production and turion formation.

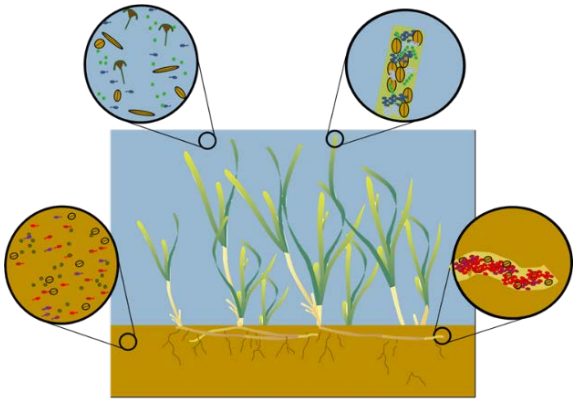
Researchers from the University of Adelaide assessing filamentous algal removal options,

Summer 2019. The dense filamentous algal mats formed in the warm, covering up to 50% of the area in the nutrient rich shallow waters of the central section of the Coorong between The Narrows and Parnka Point

Research underway has sought to determine possibilities to physically remove algae from *Ruppia* meadows before seed set is inhibited. However, the conditions leading to flowering and the development of the physically disruptive algal mats are coincident, preventing this option. We have demonstrated the upper thresholds for filamentous algal survival for different temperatures and salinities at higher nutrient regimes to assist in modelling management options. Ongoing work to characterise the current baseline of all primary producers in the southern Coorong is underway including their diversity, distribution and contribution to productivity.



Data from the long-term monitoring site (Paton et al. 2017) for Ruppia tuberosa, site S26E, Policeman's Point. Red bar across top, period of the Millennium Drought, blue line, period when sampling has been undertaken (winter sampling for shoots, the following summer for turions and seeds). The shaded bars represent the number of each category per 7.5 cm diameter core



Conceptual diagram depicting the different microbial communities being investigated for their community composition and nutrient contribution to the southern Coorong

Further reading

Asanopoulos, C. and Waycott, M. (2020). The growth of aquatic macrophytes (*R. tuberosa* spp. and *Althenia*) and the filamentous algal community in the southern Coorong. Goyder Institute for Water Research Technical Report Series No. 20/13. http://www.goyderinstitute.org/publications/technical-reports/

Auricht, H., Clarke, K. and Waycott, M. (2019) Investigation of the application of remote sensing to estimate coverage of surface exposed (floating) filamentous algae in the Coorong, South Australia. Goyder Institute for Water Research Technical Report Series No. 19/34, Adelaide, South Australia. ISSN: 1839-2725. http://www.goyderinstitute.org/_r2885/media/system/attrib/file/662/Goyder_TRS_19-34%20Coorong_Floating%20algae-FINAL_2019-12-19.pdf

Brookes, J., Dalby, P., Dittmann, S., O'Connor, J., Paton, D., Quin, R., Rogers, D., Waycott, M. and Ye, Q. (2018). Recommended actions for restoring the ecological character of the South Lagoon of the Coorong. Goyder Institute for Water Research Technical Report Series No. 18/04, Adelaide, South Australia. ISSN: 1839-2725. http://www.goyderinstitute.org/_r1568/media/system/attrib/file/546/Goyder_TRS_18-04_Coorong-Science-Advice_Sep%202018_FINAL.pdf

Collier, C., van Dijk, K., Erftemeijer, P., Foster, N., Hipsey, M., O'Laughlin, E., Ticli, K. and Waycott, M. (2017). Optimising Coorong *Ruppia* habitat. Strategies to improve habitat conditions for Ruppia tuberosa in the Coorong (South Australia) based on literature review, manipulative experiments and predictive modelling. pp. 1–169, University of Adelaide, Department of Environment Water and Natural Resources, University of Western Australia and DAMCO Consulting., University of Adelaide, Adelaide, South Australia. http://data.environment.sa.gov.au/Water/Data-Systems/CLLMM/Shared%20Documents/Optimising%20Coorong%20Ruppia%20Habitat%20Research%20Project%20Report%202018.pdf

Hipsey, M.R., Busch, B.D., Huang, P., Gibbs, M. (2020) Coorong Dynamics Model sensitivity tests and gap identification. Goyder Institute for Water Research Technical Report Series No. 19/35, Adelaide, South Australia. ISSN: 1839-2725. http://www.goyderinstitute.org/_r2886/media/system/attrib/file/663/Goyder_TRS_19-35%20Coorong%20Phase%200_WQ%20modelling%20Final.pdf

Paton, DC, Paton, FL and Bailey, CP 2017. Monitoring of *Ruppia tuberosa* in the southern Coorong, summer 2016-17. (University of Adelaide, Adelaide). https://data.gov.au/dataset/ds-dga-9c0f3a2a-c9b9-43a3-9edf-9d198c87e6e0/details?q=coorong Data set: Ruppia monitoring southern Coorong. https://data.gov.au/data/dataset/9c0f3a2a-c9b9-43a3-9edf-9d198c87e6e0/gmd

Waycott, M., McDougall, A., and O'Loughlin, E. (2019) Experimental testing of Coorong filamentous algal growth with increasing temperature and salinity. Goyder Institute for Water Research Technical Report Series No. 19/36, Adelaide, South Australia. ISSN: 1839-2725. http://www.goyderinstitute.org/_r2887/media/system/attrib/file/664/Goyder_TRS_2019-36%20Filamentous%20algal%20growth%20experiments_FINAL.pdf

Water Monitoring and Modelling

Author: Dr Matt Gibbs, Department for Environment and Water

Models provide a useful summary of our knowledge of a system and are the fundamental tool to enable "if-then" scenarios to be undertaken and inform future management. Prior model development of the Coorong Lagoon has focused on water level and salinity. Nutrient dynamics have been captured in the model recently, but many uncertainties remain due to the previous lack of data for modelling and limited understanding of the significance of several processes. How the data collected across the Healthy Coorong, Healthy Basin program is being used to improve the models available was presented, along with results on processes that flush the Coorong South Lagoon.

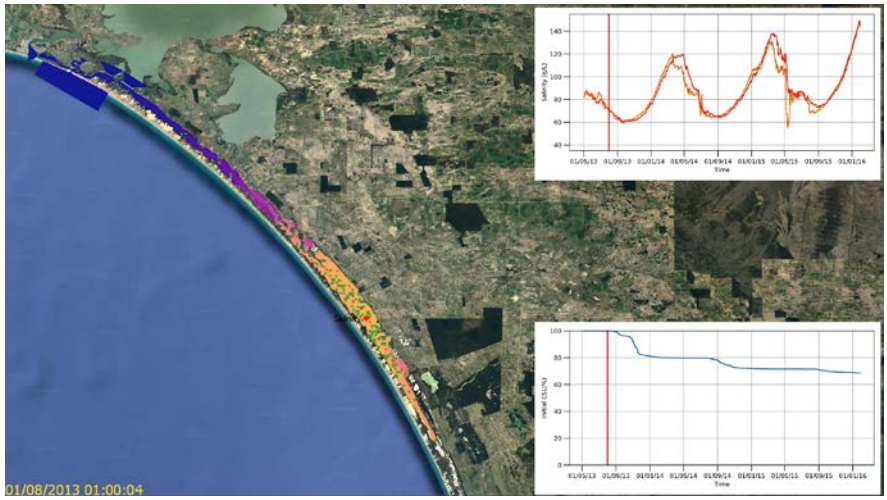
One of the major inputs to the models is data from the water monitoring program. The monitoring program has been extended substantially over the past year, to include:

- More frequent sampling and additional parameters added to grab samples of water quality and depth profiles
- Continuous monitoring of water quality parameters at existing stations
- Two additional meteorological stations at Long Point and Parnka Point, to add to the recently installed station inland from Policeman Point
- Continuous velocity sensor as well as velocity and flow measurements at multiple points in time.

The presentation included how these data sources are used and made availableto the public.

.

Depth profile monitoring



Model simulation of flushing of the Coorong South Lagoon

Theme 3: Coorong Fish

Fish Ecology in the Coorong: The Importance of Freshwater Inflows

Authors: Associate Professor Qifeng Ye, Luciana Bucater, George Giatas and David Short, SARDI Aquatic Sciences

The Coorong is a dynamic estuary that supports a diverse range of fish species of significant commercial, ecological, conservation and cultural values. Freshwater inflow (particularly from the Murray River) is a critical driver influencing fish ecology and habitats in the Coorong, primarily by affecting: (1) connectivity within, and between, marine, estuarine and freshwater environments; (2) salinity; and (3) productivity by transporting carbon, nutrients and microbiota from upstream.

Our long-term research and monitoring since the Millennium Drought, covering a period of hydrological extremes and varying conditions, has improved our understanding of how flow regime and river discharge influences fish ecology, population dynamics and the assemblage structure in the Coorong. During the drought, there was a substantial reduction in fish abundance, distribution and species richness in this region. Even smallmouth hardyhead, the most salt-tolerant species, was excluded from the entire South Lagoon. The recruitment of many estuarine species declined due to reduced suitable nursery ground. Since late 2010, the resumption of barrage flows including environmental water releases has restored estuarine-freshwater connectivity, reduced salinity and improved fish habitat in the Coorong. Fish species richness, abundance and distribution generally increased throughout the system, particularly during high flow years. The recruitment of estuarine species increased with extended nursery ground from the Murray Estuary to the North Lagoon. The abundance of smallmouth hardyhead increased significantly in the South Lagoon, with the salinity reduced to less than 100 parts per thousand. Furthermore, increased inflows improved pelagic productivity and the complexity/resilience of the Coorong food web. In more recent years, barrage flows have been managed under suitable hydrological/climatic conditions, supported by environmental water, to generate favourable salt wedge conditions to promote the recruitment of black bream, an iconic estuarine species.

The learnings from these studies in the Coorong highlight: the importance of science, particularly long-term data, to underpin adaptive management; and the concerted effort by multiple stakeholders and the long-term commitment required to achieve ecological improvement and recovery of the Coorong.

SARDI research team sampling Coorong fish (Photo credit: Anthony Moore, CEWO)

Further reading

Bice, C.M., Wedderburn, S.D., Hammer, M.P., Ye, Q. and Zampatti, B.P. (2018). Fishes of the Lower Lakes and Coorong: A summary of life-history, population dynamics and management. In: Natural History of the Coorong, Lower Lakes and Murray Mouth (eds L. Mosley, Q. Ye, S. Shepherd, S. Hemming, R. Fitzpatrick), pp. 371-399, Royal Society of South Australia, Adelaide. https://www.researchgate.net/publication/343252177_Fishes_of_the_Lower_Lakes_and_Coorong_A_Summary_of_Life_History_Population_Dynamics_and_Management

Giatas, G., Lamontagne, S., Bice, C., Ye, Q. and Paton, D. (2018). Food webs of the Coorong. In: Natural History of the Coorong, Lower Lakes, and Murray Mouth Region (Yarluwar-Ruwe) (eds L. Mosley, Q. Ye, S. Shepherd , S. Hemming , R. Fitzpatrick), pp. 422-441, Royal Society of South Australia, Adelaide. https://www.researchgate.net/publication/331110462_Chapter_39_Food_webs_of_the_Coorong#fullTextFileContent

Ye, Q., Bice, C. M., Bucater, L., Ferguson, G. J., Giatas, G. C., Wedderburn S. D. and Zampatti, B. P. (2016). Fish monitoring synthesis: Understanding responses to drought and high flows in the Coorong, Lower Lakes and Murray Mouth. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2016/000348-1. SARDI Research Report Series No. 909. www.researchgate.net/publication/307633754_Fish_monitoring_synthesis_Understanding_responses_to_drought_and_high_flows_in_the_Coorong_Lower_Lakes_and_Murray_Mouth

Ye, Q., Bucater, L., Short, D. A. and Giatas, G. C. (2020). Coorong fish condition monitoring 2008–2019: Black bream (*Acanthopagrus butcheri*), greenback flounder (*Rhombosolea tapirina*) and smallmouth hardyhead (*Atherinosoma microstoma*) populations. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000471-7. SARDI Research Report Series No. 1066. 97pp. https://www.mdba.gov.au/sites/default/files/pubs/coorong-fish-condition-monitoring-2018-2019.pdf

Ye, Q., Dittmann, S., Giatas, G., Baring, R., Nitschke, J., Bucater, L. and Furst, D. (2019). The current state of food resources supporting waterbird and fish populations in the Coorong. Goyder Institute for Water Research Technical Report Series No. 19/33, Adelaide, South

Australia. ISSN: 1839-2725 http://www.goyderinstitute.org/_r2884/media/system/attrib/file/661/Goyder_TRS_19-33%20Coorong%20Phase%200_Food%20resources%20%28Nov%202019%29_Final.pdf

Ye, Q., Giatas, G., Dittmann, S., Baring, R., Bucater, L., Deane, D., Furst, D., Brookes, J., Rogers, D. and Goldsworthy, S. (2020). A synthesis of current knowledge of the food web and food resources for waterbird and fish populations in the Coorong. Goyder Institute for Water Research Technical Report Series No. 20/11. http://www.goyderinstitute.org/publications/technical-reports/

Diadromous Fishes and Managing for Connectivity at the Murray Barrages

Authors: Chris Bice, SARDI Aquatic Sciences and Dr Brenton Zampatti, Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land and Water

Diadromous fishes – those that must migrate between freshwater and marine environments to complete their lifecycle – are a unique component of the Murray-Darling Basin (MDB) fish fauna. Six species were once common in the MDB, but following river regulation, all have declined due to the obstruction of migration and alteration of flow regimes. The Coorong, Lower Lakes and Murray Mouth (CLLMM) region, comprises both critical habitat and a migratory pathway for these species. Since 2004, research on the population dynamics and movement of diadromous fishes – specifically common galaxias, congolli, pouched lamprey and short-headed lamprey – has informed barrage operation, fishway construction and environmental water delivery to support migrations and rehabilitate populations.

Since the early 2000s, substantial changes have been made to barrage infrastructure, particularly the construction of fishways. At the same time, environmental water holdings have increased substantially. The first fishways were constructed on the Murray Barrages in 2003. Subsequent assessment of their effectiveness and long-term monitoring of migration through these fishways then informed construction of further fishways. There are now 11 fishways across the barrage network, representing one of the most ambitious tidal barrier fish passage programs in the world. The operation of these fishways is reliant on freshwater discharge. During the Millennium Drought, the barrages and fishways were shut from 2007–2010 with associated declines in diadromous fishes. Since the breaking of the drought in 2010, freshwater has been continuously discharged from the barrage fishways, largely supported by the delivery of environmental water.

Since 2010, abundances of diadromous fish have increased substantially. Environmental water has been a key to this outcome, particularly the targeted seasonal delivery of water to support attraction and passage through the fishway network. In conjunction, fishways and environmental water supports the migration of millions of diadromous fish on an annual basis. This includes species like congolli whose life histories operate at the spatial-scale of the CLLMM, but also pouched lamprey and short-headed lamprey that, following passage through the barrages, migrate hundreds of kilometres upstream. The story of diadromous fishes in the CLLMM highlights the importance of long-term datasets (monitoring), targeted investigations (research) and collaboration among multiple stakeholders to achieve positive ecological outcomes.

Adult female congolli

Pouched lamprey in a fishway trap

Further reading

Bice, C. M., Hammer, M. P., Wedderburn, S. D., Ye, Q. and Zampatti, B. P. (2018). Fishes of the Lower Lakes and Coorong: an Inventory and Summary of Life History, Population Dynamics and Management. Natural History of the Coorong, Lower Lakes and Murray Mouth region (Yarluwar-Ruwe). L. Mosely, Q. Ye, S. A. Shepard, S. Hemming and R. Fitzpatrick, Royal Society of South Australia, Adelaide: 371-399. https://www.researchgate.net/publication/343252177_Fishes_of_the_Lower_Lakes_and_Coorong_A_Summary_of_Life_History_Population_Dynamics_and_Management

Bice, C. M., Zampatti, B. P. and Fredberg, J. (2019). Fish assemblage structure, movement and recruitment in the Coorong and Lower Lakes in 2018/19. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000186-9. SARDI Research Report Series No. 1043. 67 pp. https://www.pir.sa.gov.au/__data/assets/pdf_file/0008/355589/Fish_assemblage_structure,_movement_and_recruitment_in_the_Coorong_and_Lower_Lakes_in_201819.pdf

Bice, C. M., Zampatti, B. P. and Morrongiello, J. R. (2018). Connectivity, migration and recruitment in a catadromous fish. *Marine and Freshwater Research* 69: 1733-1745. https://www.researchgate.net/publication/326652618_Connectivity_migration_and_recruitment_in_a_catadromous_fish

Theme 4: Coorong Invertebrates and Macroinvertebrates

Coorong Macroinvertebrates

Authors: Professor Sabine Dittmann, Orlando Lam Gordillo, Josh Nitschke, Dr Ryan Baring, Flinders University

The Lower Lakes, Coorong and Murray Mouth is a Ramsar listed wetland of international significance and provides important habitat for migratory shorebirds. Macroinvertebrates are an important food source for shorebirds, however, the density and distribution of macroinvertebrates is fluctuating throughout the Coorong and Murray Mouth, subject to the water flow from the River Murray. Long-term monitoring of macroinvertebrates revealed substantial decline during the Millennium Drought, and an ongoing recovery in the decade since flows resumed in late 2010. Higher flow volume and continuity of flow are beneficial for macroinvertebrate communities.

As the availability, accessibility and energy derived from macroinvertebrates are crucial for shorebird populations, our current investigations are filling these knowledge gaps. As macroinvertebrates are also prey for many species of fish, our studies are also assessing the prey availability for fish through sampling macroinvertebrates in submerged sediments. Recent findings include discovery of a species of worm not found in the Coorong before, which could be important for processes in the sediment and as an additional prey item.

The findings from ongoing monitoring and targeted investigations for the food web and nutrient dynamic components of the Healthy Coorong, Healthy basin program are informing environmental water management and the further management and improvement options for the recovery of the Coorong.

Sampling for macroinvertebrates in deeper sediments of the channel at Hells Gate in the central Coorong

Sampling for macroinvertebrates in mudflats of the South Lagoon

Further reading

Dittmann, S., Baring, R., Baggalley, S., Cantin, A., Earl, J., Gannon, R., Keuning, J., Mayo, A., Navong, N., Nelson, M., Noble, W. and Ramsdale, T. (2015). Drought and flood effects on macrobenthic communities in the estuary of Australia's largest river system. Estuarine, Coastal and Shelf Science 165: 36-51. http://dx.doi.org/10.1016/j.ecss.2015.08.023

Dittmann, S., Lam Gordillo, O. and Baring R. (2019). Benthic macroinvertebrate survey 2018-2019 report. Coorong, Lower Lakes and Murray Mouth Icon Site. Report for the Department for Environment and Water and the Murray-Darling Basin Authority. Flinders University, Adelaide.
https://www.mdba.gov.au/sites/default/files/pubs/coorong-lower-lakes-murray-mouth-benthic-macroinvertebrate-survey-2018-2019.pdf

Ye, Q., Dittmann, S., Giatas, G., Baring, R., Nitschke, J., Bucater, L. and Furst, D. (2019). The current state of food resources supporting waterbird and fish populations in the Coorong. Goyder Institute for Water Research, Technical Report Series No. 19/33, Adelaide, South Australia.
http://www.goyderinstitute.org/_r2884/media/system/attrib/file/661/Goyder_TRS_19-33%20Coorong%20Phase%200_Food%20resources%20%28Nov%202019%29_Final.pdf

Ye, Q., Giatas, G., Dittmann, S., Baring, R., Bucater, L., Deane, D., Furst, D., Brookes, J., Rogers, D. and Goldsworthy, S. (2020). A synthesis of current knowledge of the food web and food resources for waterbird and fish populations in the Coorong. Goyder Institute for Water Research Technical Report Series No. 20/11.
http://www.goyderinstitute.org/publications/technical-reports/

Maintaining viable waterbird populations

Author: Dr Thomas A. A. Prowse, University of Adelaide

The diverse and abundant waterbird community of the Coorong, and Lakes Alexandrina and Albert Wetland has played a central role in its listing as a Wetland of International Importance under the Ramsar Convention. The Coorong is an important site for migratory shorebird species of the East Asian-Australasian flyway, many species of which are suffering population declines. The Coorong also provides important foraging and breeding habitat for non-migratory and summer/drought refuging waterbirds, including piscivorous (fish-eating) species, waterfowl and large waders. The need for appropriate management of the physical and biological aspects of the Coorong, to enable it to support a diverse assemblage of waterbirds into the future, presents a substantial challenge. The majority of waterbird species use the shallow edges of the lakes and Coorong lagoons for foraging and roosting, so their abundance is very sensitive to water level and shoreline habitat conditions. Analysis of 20 years of time-series data from the annual waterbird census (Paton et al. 2020) has shown that the Millennium Drought (2001-2010) produced more losers than winners in the Coorong South Lagoon, with significant declines documented in 16 waterbird species. The abundance of some species has since recovered; however, the low abundance of many shorebird species remains a significant concern.

The Healthy Coorong, Healthy Basin waterbird project is seeking to improve our capacity to maintain viable waterbird populations by: (1) developing models to understand and predict the population response of key waterbird species to environmental and management scenarios; (2) quantifying and modelling the fine-scale suitability of waterbird habitats as a function of abiotic and biotic drivers; and (3) using GPS tracking and landscape-scale waterbird datasets to understand the role of the Coorong within the broader network of lakes and wetlands. By improving our understanding of the conditions favouring different waterbirds and the importance of the broader network of wetlands to these species, the project will inform the future management of the Coorong and on-ground works in wetlands throughout the region.

Chestnut teal

Sharp-tailed sandpiper

Further reading

Paton, D.C., Paton, F.L. and Bailey, C.P. (2020). Condition Monitoring of the Lower Lakes, Coorong and Murray Mouth Icon Site: Waterbirds in the Coorong and Lower Lakes 2019. The University of Adelaide, Adelaide.

Prowse, T.A.A. (2020). Review of the ecology, status and modelling of waterbird populations of the Coorong South Lagoon. Goyder Institute for Water Research Technical Report Series No. 20/12. http://www.goyderinstitute.org/publications/technical-reports/

Rogers, D. J. and Paton, D. C. (2009). Spatiotemporal variation in the waterbird communities of the Coorong. CSIRO: Water for a Healthy Country National Research Flagship, Canberra. http://www.clw.csiro.au/publications/waterforahealthycountry/cllamm/CLLAMM-Spatiotemporal-variation-waterbirds.pdf

Theme 5: Lower Lakes Ecology

The Living Murray Vegetation Condition Monitoring

Author: Dr Jason Nicol, SARDI Aquatic Sciences

The Living Murray (TLM) vegetation condition monitoring has provided a 10+ year data set that has documented the decline and recovery of vegetation in lakes Alexandrina and Albert from spring 2008 to the present day. The aim of the monitoring program was to evaluate TLM target V3: Maintain or improve aquatic and littoral vegetation in the Lower Lakes. Sites were established at 25 sites on lakeshores and in 12 wetlands with vegetation surveys conducted in spring (high lake levels) and autumn (low lake levels) most years. A total of 154 species, including 70 exotics and one species listed as rare in South Australia, have been recorded over the condition monitoring program.

Prior to the Millennium Drought and fall in water levels, limited historical data showed there was a diverse assemblage of aquatic and littoral species inhabiting the shorelines and wetlands of lakes Alexandrina and Albert. The unprecedented low water levels from 2007 to 2010 resulted in local extinction of submergent species and disconnection of shoreline reed beds, which did not recruit at lower elevations. When water levels were reinstated in spring 2010 plant communities improved but the limited evidence suggests that recovery to pre-drought communities has not occurred, in particular for submergent vegetation. Nevertheless, the change in plant communities has been small in recent years compared to the period between 2010 and 2014 indicating the community may be approaching equilibrium. The monitoring program has also shown that the vegetation is resilient but restricted to a narrow band around the edge of the lakes. Results from the monitoring program have informed lake level management, in particular introduction of lake level cycling to improve littoral vegetation diversity.

Left: Monitoring shoreline vegetation at the Bremer River Mouth, Lake Alexandrina

Right: Diverse shoreline vegetation at Raukkan, Lake Alexandrina

Government of South Australia

Lake Water Levels Determine the Rise and Fall of Threatened Fishes

Authors: Dr Scotte Wedderburn and Dr Thomas Barnes, University of Adelaide

Wetland fishes in the Lower Lakes were relatively unknown by non-indigenous people prior to comprehensive surveys conducted in 2002–03 when three threatened small-bodied (<8 cm long) fish species were discovered. These fish are ecological specialists requiring specific habitat, food and water quality, and therefore inhabit some of the most diverse wetlands in the Murray–Darling Basin. As indicators of ecosystem health in the Lower Lakes, the threatened fish populations are assessed annually in the Murray–Darling Basin Authority's The Living Murray condition monitoring program.

Murray Hardyhead is a schooling fish able to move within and between wetlands. Southern Pygmy Perch and Yarra Pygmy Perch are mostly solitary and sedentary, and require well-vegetated sites for feeding, spawning and cover from predators. Monitoring in the latter stages of the Millennium Drought identified loss of critical habitat and decline of the threatened fish populations. Murray Hardyhead has re-established in Lake Alexandrina following the drought but has not been detected in Lake Albert. A reintroduction program for pygmy perches was undertaken from 2011 to 2013. Wild Yarra Pygmy Perch had not been recorded since 2008 and a targeted survey in 2018 failed to detect the species, likely signalling the first freshwater fish species lost from the Murray–Darling Basin.

In contrast, the first wild generation of Southern Pygmy Perch following drought was recorded in March 2014. It appears the biological productivity generated with spring flow pulses and the corresponding increases in wetland water levels, using water for the environment, benefit young Southern Pygmy Perch by increasing growth rates. This benefit may be lost, however, if conditions deteriorate over summer. Modelling revealed a significant relationship between lake water levels and the abundance of Southern Pygmy Perch, where high mortality of young fish occurs if water levels recede below a critical minimum over summer–autumn. The likely causes are a reduction in habitat volume and availability of aquatic plants (and associated food sources) coupled with increased pressures from introduced fishes. These findings are used to guide lake level management with support of water for the environment at critical times and in combination with other requirements in the region.

Southern Pygmy Perch

Sampling threatened fish habitat on Hindmarsh Island

Southern Bell Frog Monitoring in Wetlands of the Lower Lakes

Authors: Kate Mason, Sam Hardy and Casey O'Brien, Landscape SA

Southern bell frog (*Litoria raniformis*) is considered to be the largest of the 12 frog species known to occur in the Murray Valley of South Australia. The species has been heavily affected by river regulation and reduced flows, leading to further habitat degradation, loss of connectivity between wetlands which exacerbates disease, and predation by introduced species. Its distribution and abundance in the Coorong, Lower Lakes and Murray Mouth (CLLMM) region has greatly diminished over recent decades, resulting in the species being listed as Endangered in South Australia. The known habitat preference of Southern bell frog within the CLLMM generally consists of lignum (*Duma florulenta*) shrublands, low sedgelands, inundated grasses (both terrestrial and non-monotypic common reed, *Phragmites australis*), and dense floating vegetative structure such as filamentous algae.

The Murraylands and Riverland Landscape Board works with wetland managers and community groups to monitor Southern bell frog populations around the Lower Lakes, aiming to track the health of known populations and detect the species at other wetlands with suitable habitat and hydrological regimes. This targeted monitoring consists of a combination of automated sound recording units and manual nocturnal surveys. No Southern bell frog were recorded during the 2020–21 manual nocturnal surveys, but the automated sound recording units are yet to be analysed.

Wetland habitat is assessed at monitoring sites where changes in habitat structure are recorded in response to water level management. Seasonal variability of water levels in the Lower Lakes is recommended to cue Southern bell frog breeding events and to increase the breadth of the littoral zone to increase opportunities for successful breeding and recruitment. A lack of calling Southern bell frogs in recent years could suggest the current water level management envelope may not be providing a breeding cue of sufficient magnitude when compared to the scale of water level changes during earlier years when there were higher abundances. Importantly, the community have participated in conservation of the Southern bell frog through the Foundation for Australia's Most Endangered teaming with Aquasave–Nature Glenelg Trust to establish a captive breeding program facility in Clayton.

Southern bell frog

Automated sound recorder set in a wetland on Hindmarsh Island

Further reading

Hammer, M., Wedderburn, S. and van Weenan, J. (2009). Action Plan for South Australian Freshwater Fishes, Native Fish Australia (SA) Inc. https://www.environment.sa.gov.au/topics/plants-and-animals/Threatened_species_ecological_communities/Conservation_status_of_threatened_species

Wedderburn, S., Whiterod, N. and Gwinn, D.C. (2019). Determining the status of the Yarra Pygmy Perch in the Murray–Darling Basin. Report to the Murray–Darling Basin Authority and the Commonwealth Environmental Water Office. https://www.mdba.gov.au/publications/mdba-reports/yarra-pygmy-perch-murray-darling-basin

The Lower Lakes, Coorong and Murray Mouth monitoring reports https://www.mdba.gov.au/publications/independent-reports/lower-lakes-coorong-murray-mouth-monitoring-reports

Theme 6: Climate Adaptation, Integration and Infrastructure Investigations

Climate Adaptation

Authors: Dr Michael Dunlop, Maryam Ahmad, Dr Gavin Rees, Dr Nicky Grigg, CSIRO

The Ever-changing Coorong

The dynamics of marine and river in flows have shaped the physical nature of the Coorong, Lower Lakes and Murray Mouth (CLLMM) for thousands of years. River regulation and extractions, the barrages and drainage have accelerated changes in flows, leading to salinisation and nutrient accumulation in the Coorong. The dynamics of fresh and salt water are responsible for the diversity of fish, birds and habitat types in the region, as well as shaping First Nation and European livelihoods. Changes to the dynamics have affected many species, but the system as a whole continues to host a great diversity of wetland habitats and species.

Human history includes settlement by First Nations (possibly before the Coorong formed), European colonisation (1830s), droving and grazing, commercial navigation of the Murray Mouth and river, development of irrigation and dryland farming, fisheries and various settlements. Tourism is now a major industry. A long conservation ethic is present in First Nation stories. European conservation efforts started relatively early, including protection of pelican breeding grounds (1890s) and management of duck hunting. They now include regulation of up-stream water extractions and environmental flows and Ramsar listing. In 2017 Native Title rights were granted over most of the CLLMM.

Since First Nations' settlement, the CLLMM has continuously supported multiple but evolving values. The history of the region illustrates the complex interplay between physical and social changes, with physical changes affecting things people value and changing social values driving other physical changes. However, deep cultural connections and multiple economic and recreational values have persisted through periods of significant change.

The Coorong region is an interlinked physical and social system that is continuously evolving on multiple timeframes. It will be impossible to prevent climate change from having continuing significant impacts in the Coorong; understanding past changes provides important context for exploring how the values people hold for it might be affected by future change.

The impacts of climate change

Increases in atmospheric carbon dioxide concentration, temperature, evaporation and sea level and changes in rainfall across the Murray Darling Basin will drive a series of hydrological

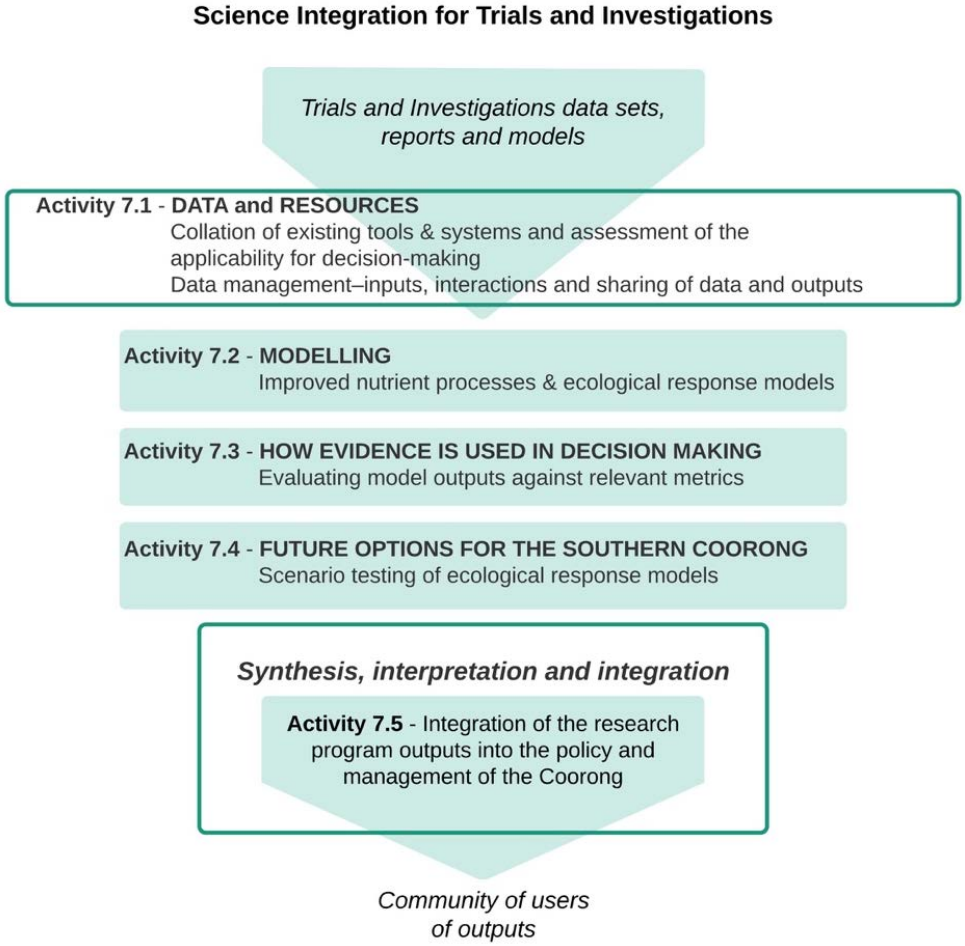
and other physical changes to the environment of the Coorong and Lower Lakes. In turn these will directly affect different biota, as well as affecting how biota interact with each other. The effects will cross all biotic groups, from the base levels of food webs (bacteria/algae and their processes), through to higher-level consumers such as fish and birds.

Coorong Science Integration

Authors: Professor Michelle Waycott, Dr Bec Quin, Dr Matt Gibbs, Dr Jody O'Connor, Matt Miles, Sarah Imgraben, Gareth Oerman, Claire Sims, and Eleanor Crichton, Department for Environment and Water, and Associate Professor Matt Hipsey, University of Western Australia

Science Integration from Trials and Investigations

The Healthy Coorong, Healthy Basin (HCHB) Trials and Investigations project includes a dedicated 'Science Integration' team to support the translation and application of science to ensure evidence-based decision-making in the Coorong. This team will ensure the integration of new and existing scientific knowledge and tools to underpin the design and implementation of short, medium and long-term management interventions in the Coorong.



Trials and Investigations Integration activities and the key summary outcomes to be developed

Key activities include the development of integrated, ecosystem-scale models, which incorporate the interactive effects of water flows and biogeochemical processes on habitat conditions for aquatic plants, fish and waterbirds in the Coorong. These models will incorporate new HCHB science regarding Coorong water flows, connectivity, water quality, sediment quality and nutrient cycling. Integrated system-scale modelling tools will enable exploration of the expected responses of the system's critical features and forecast impacts on habitat conditions for the Coorong food web.

HCHB Science Integration also includes comprehensive syntheses of the existing and emerging scientific knowledge of the Coorong. This work is critical to building a clear understanding of the current state of the Coorong, and identifying the key ecological processes and drivers that can be managed to help achieve a more desired ecological state.

Collectively, this work will provide direct support for evidence based decision-making in the Coorong based on an improved ability to simulate and evaluate hydrodynamic, water quality and ecological changes under different management scenarios.

Further reading

Department for Environment and Water (2020). The desired state of the Southern Coorong – discussion paper.
https://www.environment.sa.gov.au/files/sharedassets/public/coorong/ciip/southern-coorong-desired-state-discussion-paper-gen.pdf

Coorong Infrastructure Investigations Project

Project background

The objective of the Healthy Coorong, Healthy Basin (HCHB) Coorong Infrastructure Investigations Project (CIIP) is to investigate the feasibility of multiple long-term operational infrastructure and management options to improve the ecological health of the Coorong. The Department for Environment and Water is committed to involving the community in every step of the process and will be consulting with the community throughout the project.

During the first stage for CIIP options identification and shortlisting, a survey was circulated to the community to measure what they thought was important in evaluating options for the Coorong. They were also given an opportunity to offer any new ideas that they thought should be considered.

From this survey, a group of interested community members came together on behalf of the broader South Australian community, to decide on a list of things that they felt were important in determining the best option.

The community members determined that the most important, essential outcome, is finding:

"the option/s that best contribute to improving the ecology of the South Lagoon as determined by scientific evidence, given water availability and constraints."

In June 2020, we then asked the community to evaluate and prioritise the options, with the community determined values in mind.

Shortlisted infrastructure options

Following analysis of all the feedback gathered, and combined with a technical Multi-Criteria Analysis, the following five infrastructure options have been shortlisted and will now undergo a detailed feasibility assessment investigations

- A connection between the Coorong South Lagoon and Southern Ocean
- Coorong Lagoon dredging to improve connectivity
- Lake Albert to Coorong Connector
- Further augmentation of South East Flows to the Coorong
- Additional automated barrage gates.

This is an investigation into feasibility at this stage, not a decision to proceed any of these concepts.

Further community consultation will be required on any options deemed to be feasible before such a decision would be made.

Feasibility investigations

Feasibility investigations will now be conducted for the shortlisted options to develop a complete analysis, including combinations of the options. These investigations include but are not limited to:

- hydrodynamic, biochemical and ecological modelling
- ecological assessments and analysis
- engineering technical feasibility assessments
- concept designs
- social/economical assessments
- risk assessments
- cost/benefit analysis.

Feasibility investigations will help us determine the options that are likely to have the best benefit for the Coorong. For those options deemed feasible and desirable, business case(s) will be developed for consideration by the Commonwealth for further investment, including implementation. Further reading Department for Environment and Water (2021). Coorong Infrastructure Investigations Project webpage. www.environment.sa.gov.au/topics/coorong/coorong-infrastructure-investigations-project