

Connectivity and flushing

The Coorong is a unique and complex estuary with features that have made it prone to reaching its current degraded state.

Flow of water into and through the Coorong (ie. connectivity) is generally low because:

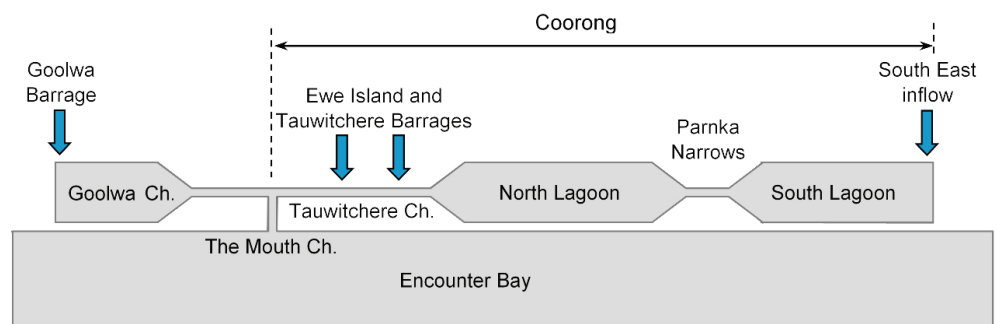
- it is in a semi-arid region with low rainfall
- there is a regulated supply of freshwater through barrages from the River Murray and to a lesser extent, from the South East Drainage Network. Both of these sources have been impacted by anthropogenic water extractions and diversions over the last century
- tidal flushing from the sea through the River Murray mouth is more restricted now due to reduced River Murray flow and reliance on dredging to maintain an open system
- the Coorong has very shallow areas and a narrow channel at Parnka Point that restrict how well the Southern Coorong is connected to the northern Coorong and the sea.

Water stays in the Southern Coorong for long periods of time, so that water evaporates but salt does not, meaning that during periods of low flow the water becomes saltier over time. This process of evapo-concentration occurs every year in spring and summer as the weather becomes hotter and drier. During a drought, there is less freshwater entering the Coorong to exchange the saltier water, so the Southern Coorong becomes more hyper-saline. The Southern Coorong was persistently extremely hyper-saline during the Millennium Drought, which was catastrophic for the plants and animals that live there.

Like salt, nutrients are affected by evapo-concentration. Several other processes have led to the Southern Coorong becoming hyper-eutrophic. For example, nitrogen can be locked away in aquatic plants or released as gas by biological processes, however, the high salt levels stop these natural pathways. Therefore, low connectivity and hyper-salinity has increased the process of eutrophication.

When the Southern Coorong is well connected, animals and plankton can move freely. Zooplankton, which enters the Coorong in freshwater from the

*Schematic view of the Coorong
(from Gibbs et al., 2018).*



River Murray and South East Flows, forms the base of food webs. There is a low supply of these as food for fish and birds during periods of low flow and connectivity.

Fish can freely move into and out of the Southern Lagoon when it is well connected and the salinity is not too high. Sandy sprat and Congolli are medium and large-sized fish that are an important part of the diet of Mulloway. In years that water levels have been high, both prey fish are found in the Southern Coorong, but they are absent in drier, and hence higher salinity, years.

The Coorong is a naturally variable system, but the desired state for the Southern Coorong includes only short periods of low connectivity and high salinity. During periods when connectivity is improved, salt and nutrients can be flushed out and animals can move freely. Options to improve connectivity are being investigated through Project Coorong.

Further reading

Asanopoulos, C. and Waycott, M. (2020) The growth of aquatic macrophytes (*Ruppia tuberosa* spp. and *Althenia cylindrocarpa*) and the filamentous algal community in the southern Coorong. Goyder Institute for Water Research Technical Report Series No. 20/13, Adelaide, South Australia. ISSN: 1839-2725

Gibbs M, Joehnk K, Webster I, and Heneker T (2018). Hydrology and Hydrodynamics of the Lower Lakes, Coorong 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. Royal Society of South Australia, Adelaide.

Ye, Q., G. Giatu, S. Dittmann, R. Baring, L. Bucater, D. Deane, D. Furst, J. Brookes, D. J. Rogers, and S. Goldsworthy. 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, Adelaide.

Acknowledgement

The Healthy Coorong, Healthy Basin Action Plan is part of the South Australian Government's overarching Project Coorong initiative.

This project is part of the South Australian Government's Healthy Coorong, Healthy Basin Program, which is jointly funded by the Australian and South Australian governments.

The Goyder Institute for Water Research is the delivery partner for research components of Healthy Coorong, Healthy Basin, providing independent research to inform future management decisions for the region.

Glossary

Ammonium — A dissolved form of nitrogen readily taken up by algae and aquatic plants.

Anoxic — Lacking oxygen.

Aquatic plants — A phrase used to describe the mixed submerged aquatic plant community that includes *Ruppia tuberosa*, *Ruppia megacarpa* and *Althenia cylindrocarpa*. Where otherwise stated, the phrasing will be referring to either species independently or the genus.

Bacteria — A unicellular microorganism with simple internal structures.

Bioturbation — The reworking of sediments by animal activities including burrowing, ingestion, and defecation of sediment grains. It has a profound effect on sediment condition and the environment.

Connectivity — A mechanism that allows for the movement of water, materials and animals between areas, including between the north and south lagoons of the Coorong, between the sea and the Coorong through the Murray Mouth, and from the River Murray or south east flows to the Coorong (but not typically vice versa). It is an important element of hydrodynamics, has a strong influence on water quality (through exchange of salt and nutrients) and is essential for some ecological processes, such as migration of fish at different times of year and for the transport of zooplankton from freshwater inflows to support food webs of the Coorong.

Detritivore — An animal that feeds on dead material, especially plant parts.

Denitrification — The process by which nitrate is converted to nitrogen gas bubbles, which are released to the atmosphere. If the sediment is anoxic, then nitrification-denitrification cannot occur and the nitrogen remains in the nutrient cycle.

Eutrophication — The process of nutrient enrichment and the increase in the supply of organic matter. Eutrophic systems typically have excessive plant and algal growth, which become internally produced organic matter loads as they decay. They grow excessively in response to nutrient enrichment such as nitrogen and phosphorus inputs. Eutrophication has cascading effects for the entire ecosystem. The hyper-eutrophic state in the Southern Coorong is characterised by high concentrations of chlorophyll-a (>50 mg/L), total nitrogen (>4 mg/L) and total phosphorus (>0.2 mg/L) in the water.

Evapo-concentration — The concentration of solutes such as salt and contaminants as water evaporates. The effects of evapo-concentration increase with increasing water residence time, and at higher temperatures in summer.

Filamentous algae — The green filamentous algal community which occurs in the Coorong, consisting of *Ulva paradoxa*, *Rhizoclonium sp.* and *Cladophora sp.*

Herbivore — An animal that eats plants.

Hyper-eutrophic — An extremely high-nutrient state due to eutrophication.

Hyper-saline — Salinities that are greater than that of normal seawater.

Macroinvertebrate — Invertebrate fauna that are greater than 0.5 mm.

Mesotrophic — Intermediate levels of nutrients, common in healthy estuaries. A mesotrophic Coorong would be fairly productive (with plant and animal life), but could be at risk of having water quality problems.

Millennium Drought — An Australian drought which impacted the Murray-Darling Basin over the period 1996–2010, and substantially impacted the Coorong over the period 2001–2010. The period from 2007–2010 was particularly extreme with extended periods of no flow through the barrages to the Coorong.

Monosulfidic black oozes — Monosulfidic black oozes (MBOs) form when there is an excess of organic matter, and sediments become anoxic as the bacteria consume all the oxygen to decompose the organic matter. Iron (III) and sulfate are converted by bacteria to iron (II) and hydrogen sulfide, because there is no oxygen. The iron typically comes from iron oxide minerals in the sediment that are reduced, whereas sulfate comes from water (it is plentiful in seawater and saline groundwaters)

Nitrogen — A nutrient that is essential to plants and animals and forms compounds such as amino acids and proteins. Nitrogen can be found in aquatic environments in dissolved, particulate, inorganic, organic and gaseous forms. Too much nitrogen can be associated with eutrophication.

Nitrate — A dissolved form of nitrogen.

Glossary

Nitrification — Nitrification is the process by which ammonium is converted to nitrite and then nitrate. It can also take place in the sediment and requires oxygen. Denitrification is the process by which nitrate is converted to nitrogen gas bubbles, which are released to the atmosphere. If the sediment is anoxic, then nitrification-denitrification cannot occur and the nitrogen remains in the nutrient cycle.

Nutrient cycle — The movement or exchange of nutrients, such as nitrogen, from inorganic and organic forms into organic matter, including plants and animals, and back again.

Oxygenate — Supply or enrich with oxygen. Sediments in aquatic systems need to be oxygenated in order for healthy nutrient cycling and nutrient exchange from sediment to water and to the atmosphere to occur. Oxygenation of sediments can occur through biological processes (e.g. animal movement, pumping through plant roots), or physical processes such as water turbulence and currents moving sediments around.

Phosphorus — A nutrient essential to life and strongly influencing water and sediment quality in the Coorong. Phosphate is the dissolved form of phosphorus, which is uptaken by plants and algae.

Photosynthesis(e) — The conversion of light energy to organic compounds, can be referred to as carbon fixation.

Phytoplankton — Small plankton algae that is essential to aquatic food webs.

Respiration — Respiration is a chemical reaction which takes place in all living cells and releases energy from glucose. Anaerobic respiration occurs without oxygen and releases less energy but more quickly than aerobic respiration.

Ruppia — A genus of aquatic plant, referring to the species *Ruppia tuberosa* in the Southern Coorong.

Salinity — Salinity can be defined as the concentration of dissolved mineral salts present in waters and soils on a unit volume or weight basis.

Southern Coorong - The Southern Coorong is defined here as the area ranging from Parnka Point in the north and south to 42 Mile Crossing, approximately 65 to 105 km from the Murray Mouth that connects the estuary to the sea.

Turion — Reproductive structure of *Ruppia tuberosa* (Type I and Type II) and *R. polycarpa* (Type I) produced underground that is capable of forming into a new plant

Water quality — The condition of water or some water-related resource as measured by biological surveys, habitat-quality assessments, chemical-specific analyses of pollutants in water bodies, and toxicity tests.

Zooplankton — Animals (often microscopic) that either move by water currents or are weak swimmers in the water column.

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