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Pathways to reversing the hyper-eutrophic nutrient state of the Coorong

Restoring the nutrient cycle of the Southern Coorong and achieving a 'mesotrophic' (moderate nutrient) state requires an integrated management approach to improve its current hyper-eutrophic state. Detailed research investigation and a nutrient mass balance of the Coorong is being undertaken to identify where nutrients are and what processes influence them so that they can be targeted for removal. While immediate solutions to remove nutrients are needed, direct actions need to be carefully investigated, in consultation with the community and considering environmental, cultural and socio-economic factors. The following strategies are currently under consideration:

1. Strengthening flushing and connectivity to export excess nutrients and algae. This can be achieved by increasing:
   - inflows and/or outflows
   - channel depth to improve connectivity between and within lagoons.

   Under the climate change projections for 2050, the flows from the water recovered under the Basin Plan are expected to maintain flows across the barrages into the Coorong. Sea levels along the South Australian coast are also not expected to increase to the point where there is a greater connection between the Coorong lagoons (0.24 m AHD) until 2050.

2. Remediating sediments that are in poor condition is critical to restoring the Southern Coorong to health. Restoration of aquatic plants and the re-colonisation of sediments by macroinvertebrates can create oxygen-rich zones in the sediment. Oxygen-rich sediment will promote nitrifying and denitrifying bacteria and biologically-mediated nutrient removal. Most burrowing and filter feeding macroinvertebrates require salinities below 60 g/L (approx. 1.7 seawater salinity), which is often exceeded in the Southern Coorong under current conditions. Improving connectivity and flushing will remove salt and reduce salinity so that there are only short periods of time exceeding this threshold, enabling the ecosystem to help reduce nutrient levels.

3. Reducing external nutrient load to the Coorong could help, but would require whole of catchment nutrient reduction programs which would be costly and very difficult to implement, particularly for the Murray-Darling Basin catchment.

Image: Healthy sediment sample with aquatic plants (Photo: Luke Mosley)

4. Algal harvesting or removal/capping of hostile (hypersaline, sulfide-rich) sediments could also reduce nutrient enrichment at local scales, though both options involve significant practical issues to avoid disturbing aquatic plants and safe disposal of waste materials.

Addressing eutrophication and repairing the nutrient cycle will help improve the health of the Coorong and restore the needs of each component of the food web.

Further reading:

Mosley, L., S. Priestley, J. Brookes, S. Dittmann, J. Farkas, M. Farrell, A. J. P. Ferguson, M. Gibbs, M. Hipsey, J. Huang, O. Lam-Gordillo, S. Simpson, P. Teasdale, J. Tyler, M. Waycott, and D. Welsh. 2020. Coorong water quality synthesis with a focus on the drivers of eutrophication. Goyder Institute for Water Research, Adelaide.

Department for Environment and Water. 2021. State of the Southern Coorong – Discussion paper Building a shared understanding of current scientific knowledge | June 2021. Government of South Australia, Adelaide.

Acknowledgements

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Australian Government

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Department for Environment and Water

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 livings 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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