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Submission to the Senate Environment and Communications References Committee Inquiry into Algal Blooms in South Australia

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Introduction

I submit this evidence to address the causes and impacts of algal blooms in South Australia's marine and coastal environments. My expertise includes over two decades of experience working as a scientist focussed on the water quality of the River Murray, Lower Lakes and Coorong, and its adjacent coastal waters. I have a PhD in aquatic biogeochemistry, am an Associate Professor at Adelaide University, former Principal Scientist (River Murray) at the Environment Protection Authority between 2004-2014, member of the Coorong, Lower Lakes and Murray Mouth Scientific Advisory Committee since 2011, and was appointed to the Darling-Baaka River Health Project Expert Panel in 2024. For this submission I draw on my specific research addressing drought, floods, and water quality in the Murray-Darling Basin.

This submission focuses on Terms of Reference (TOR) A (environmental, land management, and water quality factors contributing to blooms), B(iii) (impacts on marine biodiversity and ecosystem health), D (coordination of state and federal government responses, including scientific advice), E(iii) (support for research and monitoring), and F (adequacy of long-term strategies for monitoring, forecasting, and prevention). I highlight the River Murray's role in delivering essential nutrients to the coastal ocean, supporting productivity and food chains (including vulnerable species like Little Penguins). I also note impacts from upstream water extraction, diversion, river regulation, and land use changes that contribute to more irregular freshwater and nutrient delivery, altering coastal ecosystem health.

River Murray's Role in Driving Coastal Productivity (TOR A, B)

The River Murray is a vital source of nutrients (e.g., nitrogen and phosphorus) that enhance primary productivity in South Australia's coastal waters. Satellite data from 2002–2016 show strong correlations between river outflows and coastal phytoplankton biomass and productivity (Auricht et al. 2018).

Specifically, during high-flow periods nutrient plumes extend over 60 km from the Murray Mouth, which supports marine food webs. This effect can be observed in the chlorophyll (i.e. indicator of micro-algal productivity) and organic carbon concentrations in a 'high flow' period in 2011 compared to a 'low or no flow' period (2008, in Millennium Drought) shown in Figure 1.

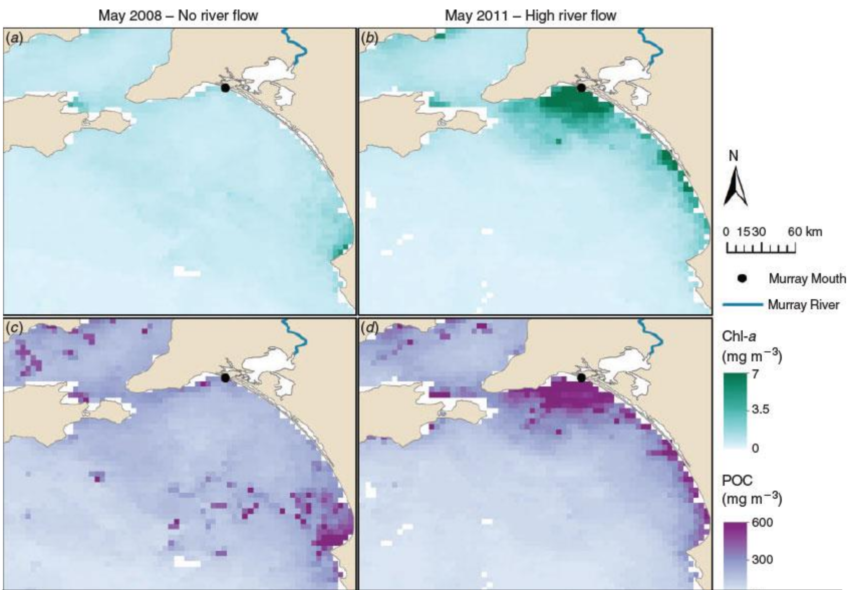

Figure 1: Satellite-imagery products showing chlorophyll-a (Chl-a) and particulate organic carbon (POC) concentrations in the no-flow period of May 2008, and a high-flow period in May 2011 (from Aurichte et al. 2018).

This nutrient input positively affects higher trophic levels, including fisheries and wildlife. In contrast, reduced River Murray outflows, as occurred during the Millennium Drought (2001–2010), correlated with declines in Little Penguin populations in Encounter Bay, linked to diminished food availability (e.g., anchovies and garfish) (Colombelli-Négrel et al. 2022). Penguin numbers were positively associated with fish abundance, an indicator of nutrient-driven productivity. Furthermore, hindcast models (pre-satellite data) using historical River Murray flows suggested that previous larger and more regular outflows sustained higher coastal productivity, benefiting biodiversity and ecosystem health (Auricht et al., 2018).

Disruptions to Nutrient Delivery and Links to Algal Blooms (TOR A, F)

Human activities in the Murray-Darling Basin have disrupted this natural nutrient delivery. Large-scale upstream water extraction (predominantly for irrigation) and river regulation (e.g., dams, weirs since the 1940s) have resulted in on average 54% less inflow to the Lower Lakes, but this can lower to <25% during drought conditions (Mosley et al. 2022). Furthermore, land use changes and practices associated with agricultural expansion (e.g. increased use of fertilisers), can exacerbate nutrient imbalances by increasing sediment and nutrient loads during irregular floods (Athukoralalage et al. 2024).

The 2022–2023 'mega-flood', the largest since 1956, contributed a large nutrient load to the coastal ocean; based on nutrient load assessment at upstream sites it delivered ~20% of the total nitrogen (TN) and total phosphorus (TP) loads from the River Murray in the entire 2011–2023 period, with hysteresis patterns indicating sustained nutrient release from floodplains (Athukoralalage et al. 2025).

In early-mid 2023, a team led by CSIRO that I was part of assessed impacts of the 2022-2023 flood on the coastal ocean, as part of a Goyder Institute project. This included sampling water quality, fish and invertebrates in and outside the flood plume zone. Data from this study is still being analysed and written up for the scientific literature. However high nutrient levels were present in the flood plume and that influence extended tens of km from the Murray Mouth (Figure 2).

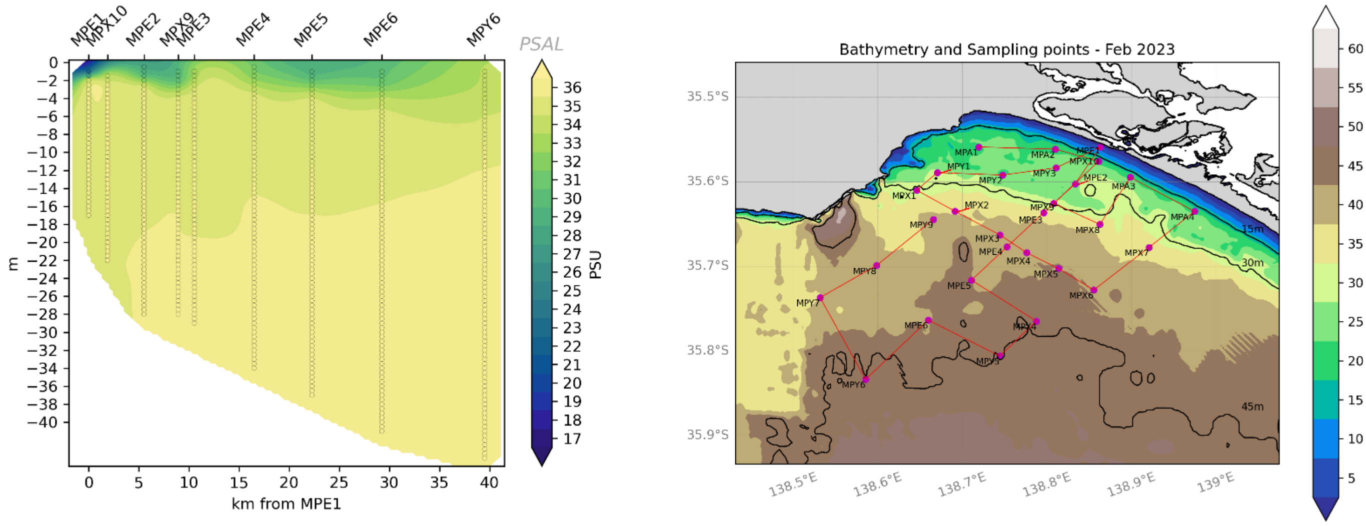

Figure 2: Selected water quality monitoring data on the River Murray flood plume in February 2023 (CSIRO, SARDI and University of Adelaide unpublished data). The figure on the left shows salinity with depth and distance along a transect from the Murray Mouth (note seawater is salinity 35, the lower salinity water from the River Murray plume, also containing high nutrient levels, can be observed in the upper 10-20m of the water column, extending >40 km from the Murray Mouth). Sites on the transect can be observed on the map to the right along with depth contours.

While floods can promote coastal ocean productivity, more irregular delivery of nutrients from the River Murray, amplified by changing drought-flood cycles due to water extraction and climate change, may potentially promote algal blooms due to larger but less frequent nutrient pulses (TOR B). However, in the case of the current 2025 algal bloom there was a long time period between the flood-related nutrient delivery in 2022-2023 and the bloom development, and there is high energy and mixing in that coastal region which would have dispersed nutrients once the River Murray flow receded. Unfortunately, as that coastal water study was only funded for a short time period, there is no direct evidence/data that nutrients persisted from the flood, in surface or deeper coastal water, to drive the current bloom development. Hence in my opinion it is highly uncertain what role the River Murray flood played

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in the 2025 algal bloom development. A large upwelling event and marine heatwave may have been sufficient to trigger this event in and of itself.

South Australia's strategies to monitor and predict such coastal algal blooms remain inadequate. Current monitoring focuses on riverine water quality or measurement of algae in the coastal water, with limited integration or funding for marine science infrastructure and data collection to forecast drivers of blooms now or into the future (TOR E, F). The majority of the above studies I highlight received little to no funding support, yet all clearly showed the importance of the River Murray to coastal ecosystems. The Basin Plan and Murray-Darling Basin Authority does not consider coastal water quality and ecological benefits or risks arising from River Murray outflows. Furthermore, catchment nutrient management in the Murray-Darling Basin has received inadequate focus, despite the Basin Plan requiring Basin States to develop water quality management plans as part of their water resource plans (TOR F).

Recommendations (TOR D, E, F)

1. Enhance inter-governmental coordination to recover water and prioritise environmental flows under the Murray-Darling Basin Plan, ensuring more consistent nutrient delivery to mitigate algal bloom risks and support coastal productivity.
2. Increase funding for integrated long-term monitoring (e.g., satellite and in-situ data collection) and research on interactions of river outflows, coastal water quality, and food web indicators like fish and Little Penguin populations.
3. Reduce nutrient runoff during floods via requiring basin states to incorporate appropriate nutrient management strategies, as part of their legislated requirements in the Basin Plan to prepare water quality management plans. Incentives to landholders to undertaken measures to reduce nutrient inputs and runoff could also be considered.

These measures will balance the River Murray's positive nutrient contributions while helping to minimise the risk of harmful algal blooms, safeguarding South Australia's coastal ecosystems.

References cited in above submission

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