RIVER LAKES COORONG ACTION GROUP

Discussion Paper No.3:
CONTROL OF HARMFUL ALGAL BLOOM (HAB) IN SOUTH AUSTRALIAN MARINE WATERS

(Prepared by: River Lakes & Coorong Action Group)

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EXECUTIVE SUMMARY

There is insufficient info to be definitive about the full cause of the HAB, but we believe the evidence is clear that the Murray River floods of 2022/23 were a contributing factor in sustaining the HAB which was first reported in late February to early March 2025 and that both short term and long term actions need to be taken to reduce the risks of future HAB in SA waters.

Global Warming is undoubtedly the prime cause for the unprecedented HAB in SA. This was responsible for the exceptionally warm Leeuwin Current in 2025 and the erratic behaviour of the Bonney Upwelling in recent years as well as more frequent extremes of droughts and major flood event in the Murray-Darling River Basin (MDRB) such as the 2022/23 floods.

Unprecedent quantities of nutrient rich sediments (30yrs worth of average discharge) along with herbicides, pesticides, PFAS, pharmaceuticals and other chemicals of concern were flushed out of the MDRB in the 2022/23 floods into the coastal waters between Cape Jaffa and Cape Jarvis as well as being carried through Backstairs Passage and deposited in Gulf St Vincent, the north coast of Kangaroo Island and around Cape York Peninsula. This is the same footprint of the HAB.

There is strong evidence to show that the nutrient rich Bonny Upwelling (still enriched by the 2022/23 floods) was trapped under the exceptionally strong and warm (2-3C above average) Leeuwin Current causing a stratification of the ocean water column at approximately 50m depth off Cape Jaffa for the first several months of 2025. These are ideal conditions for a HAB to be initiated rather than the phytoplankton bloom that normally occurs with this upwelling.

Once a HAB has been established, the HAB can create anoxic condition and release nutrients from benthic sediments to sustain the bloom. HAB toxins may also kill sea grasses which have been weekend by herbicides from the 2022/23 floods, releasing more nutrients to feed on.

A short-term measure to reduce future HAB is to have more regular minor floods in the MDRB, similar to a more natural rhythm, which would provide a moderate level of nutrients discharged through the Murray Mouth which would sustain the rich fishing waters without causing a HAB.

A longer-term solution is to implement an integrated land management system which optimises and controls the use of fertilisers and other farm chemicals as well as improves land use practices, and other ways to improve water quality in the MDRB.

1. WHERE IT BEGAN

The Harmful Algal Bloom (HAB) was first noticed around Robe and Cape Jaffa in February or March 2025 with initial density in the order of 27,000 - 74,000 cells per mL (27 million to 74 million cells per litre) and then spread through Backstairs Passage into Gulf St Vincent and eventually into parts of Spencer Gulf.

The HAB was first thought to be predominantly *Karenia Mikimotoi* but subsequently, the main component is now thought to be the close relative *Karenia Cristata*. It is common for HAB to be a mixture of several Karenia species especially in the declining period of the bloom (Zhang, et al, 2025). Most of these species look similar under a microscope and can only be reliably identified by gene sequencing as has been done by Prof. Shauna Murray of UTS in Sydney (ABC News, 6/11/25, Hayes, et al,).

Hence in this paper HAB will refer to Karenia as the general classification of the dinoflagellates in the bloom, as the characteristics and behaviours in the environment of the various Karenia species are similar (Brand, 2012). The toxins each species produces are quite different but all the chemicals each species produces are still not yet well understood (McGowan, 2023).

2. WHAT INITIATED THE HAB

A HAB may be compared to a bushfire in that it requires a triggering mechanism to start the bloom but then may be self-sustaining until it runs out of fuel/food.

The conditions favourable for Karenia to bloom are generally accepted as:

- Warm water temperatures i.e. mainly blooms start in late Summer and Autum.
- Extended calm oceanic conditions for bloom formation.
- Stratified water column due to either salinity or temperature.
- High nutrient and dissolved carbon rich water, usually from river discharges after floods, nutrient upwellings, etc

The first three of these required conditions have undoubtedly prevailed in South Australian marine waters in 2025 after the algal bloom was first detected around late February to early March 2025. However, there is uncertainty about the source of ‘High nutrient and dissolved carbon’ that has initiated the Karenia to bloom.

Many misconceptions about possible sources of dissolved nutrient and carbon such as Desalination Plant, Wastewater Treatment Plants, Chinese Warships, etc. can be quickly dismissed.

However, possible sources of nutrients to initiate the HAB that can not be so readily dismissed include:

- Murray River floodwaters in late 2022/early 2023.
- The Bonney Upwelling not reaching the surface.
- Leeuwin Current having exceptionally high water temperatures killing sea grass and other marine life.

Global Warming is undoubtedly the underlying cause for changes in climate including warming and changes to ocean currents, disruption of ocean upwellings, increased frequency of major flood and drought events.

2.1. **Murray River Floods of 2022/23**

The 2022-2023 River Murray flood event was the highest flood since the 1956 floods and the third highest on record.

Barrage flows began increasing from ~20 GL/day in July 2022 to 120 GL/day in January/February 2023. (see Fig.1. – Barrage Flows). On 13 December 2022, all operational barrages near the Murray Mouth were opened, creating 2,000 km of free-flowing river following the removal of the weirs up to Yarrawonga (Victoria).

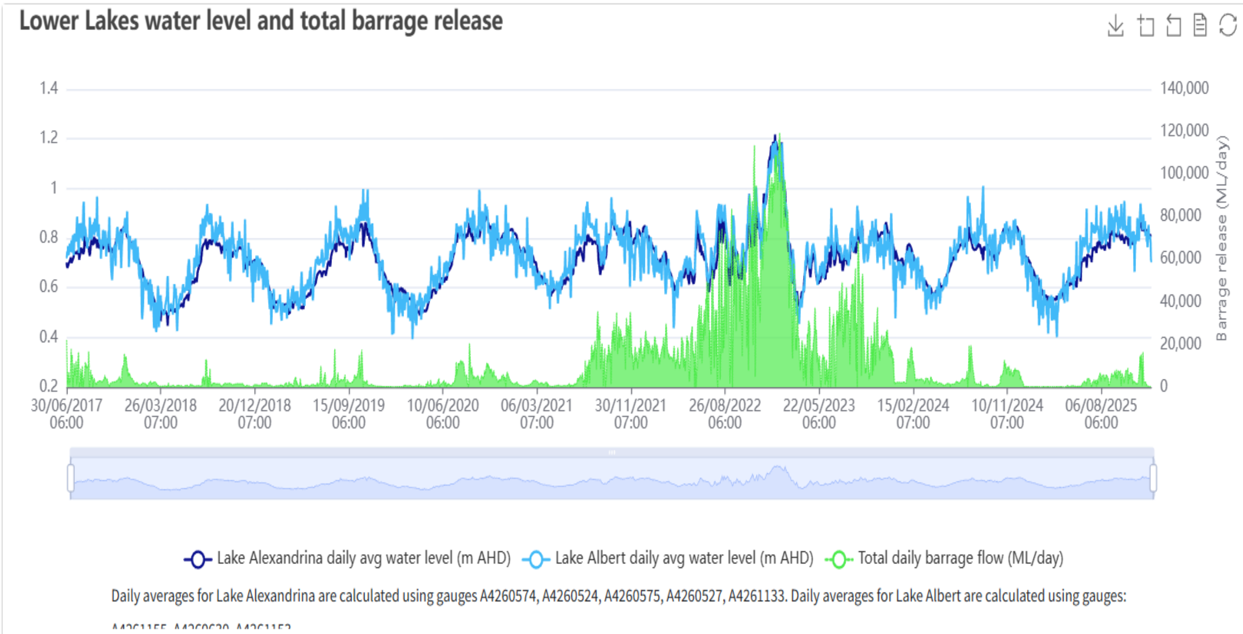


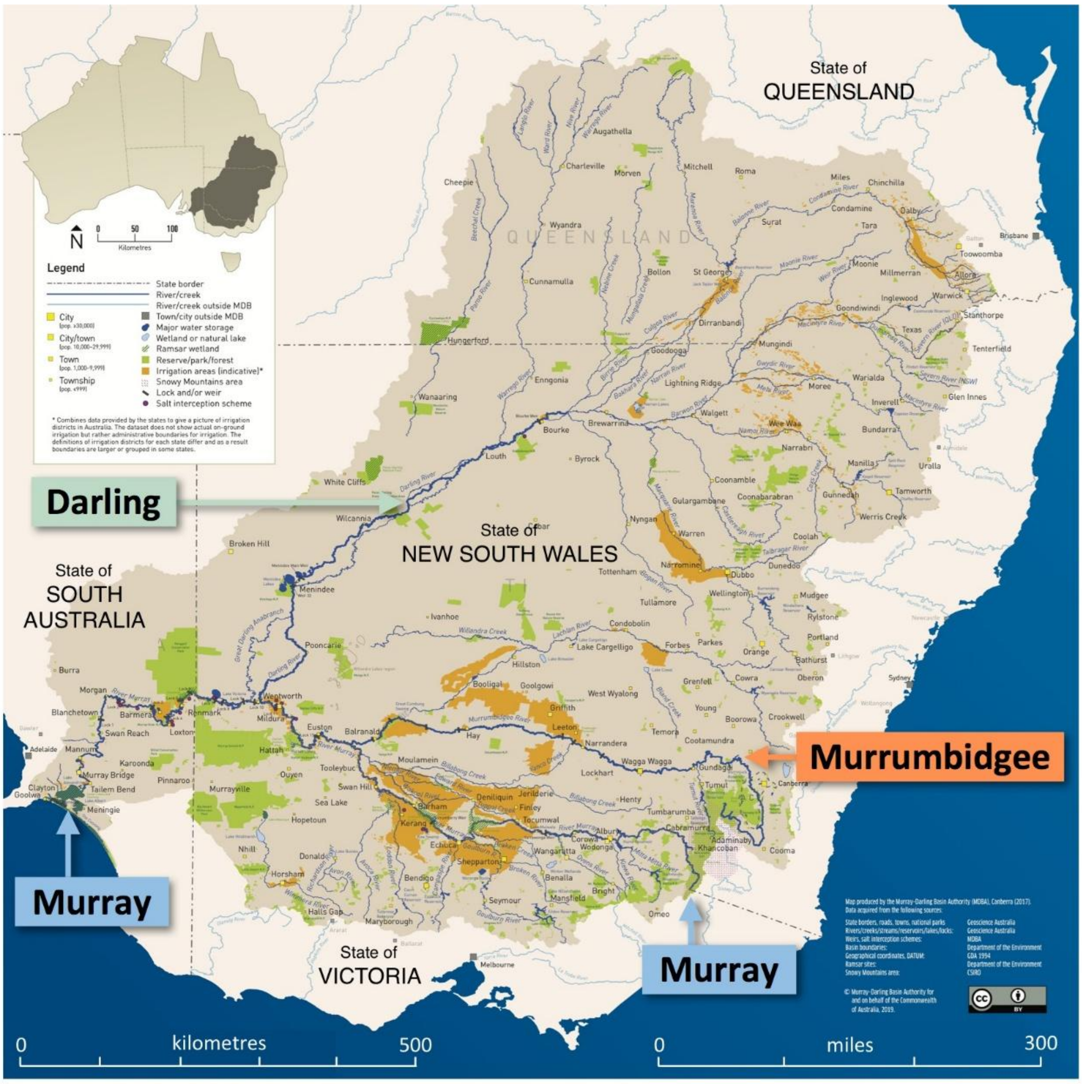
Figure.1. – Lower Lakes Water Level and Total Barrage Release

The 2022-23 Murray River floods discharged massive amounts of nutrients, primarily nitrogen and phosphorus, along with organic carbon, herbicides and other farm chemicals, from the Murray-Darling Basin floodplains into the Southern Ocean. Official estimates of the quantities of nutrients discharged in the 2022/23 floods are that 30 times the average quantities of nutrients discharged in an average year were discharged during this single flood event.

Satellite imagery has identified that much of this nutrient rich flood waters were carried by prevailing ocean currents through Backstairs passage and into Gulf St Vincents and possibly into Spencer Gulf (See Fig. 2. – Murry Mouth during the Murray River Floods of 2022/23).

The Murray-Darling Basin (MDB) is Australia's largest river system and is one of the world’s largest river basins. The Murray-Darling Basin, covering 14% of the Australian continent (over 1 million sq km), providing water for 2.4 million people, and supporting 40% of Australia's agricultural output, including significant portions of its fruits, cotton, and wine grapes and more recently almonds (See Fig.3. – The Murray-Darling River Basin).

Figure 2. – Murray Mouth during the Murray River Floods of 2022/23



Source: Murray–Darling Basin Authority (https://www.mdba.gov.au/sites/default/files/pubs/1269-Murray-Darling-Basin-Map-Poster-A1_0.pdf). Added: state and principal river names; scales.

Figure. 3. – The Murray-Darling River Basin

2.2. The Bonney Upwelling

Upwellings are a common worldwide phenomenon. They are usually associated with large river systems discharging nutrient rich sediments into bays or gulfs and then into deeper waters off the continental shelf. These nutrients are then returned to the bays or gulfs when cooler deep water returns when favourable winds drive the warmer water offshore.

When upwelled nutrients meet sunlight near the surface, minute phytoplankton (plant-like cells) ‘bloom’, turning the ocean green and providing a vital food source for a range of animals from krill (a type of zooplankton) to small schooling fish. These feed larger animals including rock lobsters, giant crabs, fish (including commercial species), squid, seabirds, seals, dolphins and whales.

Humans too are part of this complex food web, commercially fishing both krill and the larger predators that feed on it. Upwelling systems provide 50% of the worldwide fisheries catch despite occupying only 1% of the ocean surface. The Bonney Upwelling currently sustains economically important commercial fisheries including rock lobster, bottom trawl, and squid fisheries.

The phytoplankton community in the Bonney Upwelling region predominantly consists of **diatoms**, supplemented by **dinoflagellates** and other flagellates. These species are considered characteristic of upwelling systems globally.

The Bonney Upwelling normally occurs in Summer to Autum and according to the Blue Whale Study (ref: https://bluewhalestudy.org/the-bonney-upwelling/) the Bonney Upwelling was particularly strong in 2023/24, but has not been recorded is Sea Surface Temperature satellite imagery since July 2024. (see Fig.4 - BOM map of surface water temp).

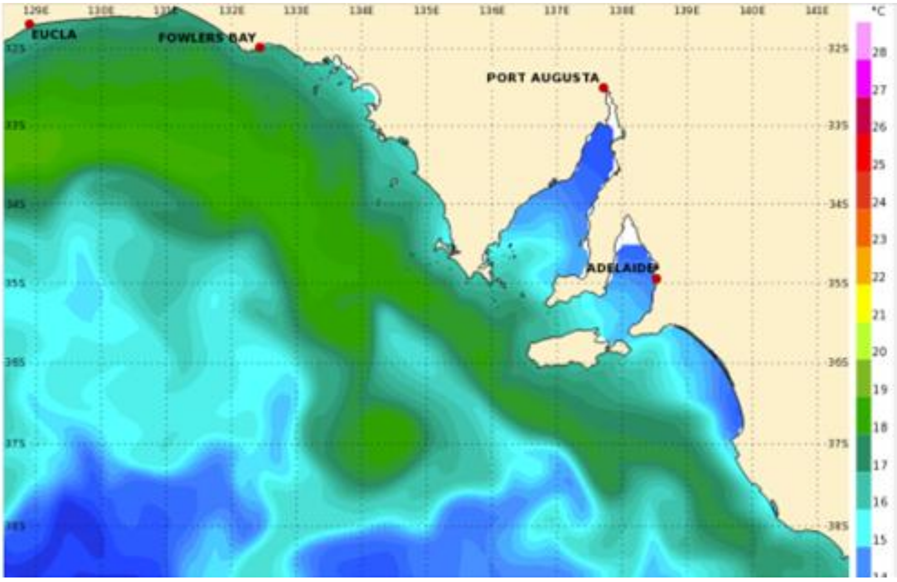


Figure.4. - Surface Water Temperatures from BOM in mid June 2025.

Upwelling extends right across much of the continental shelf (waters less than 200m deep) as shown in the map below (see Fig,5. – Typical Surface Water Temperatures), but only surfaces in certain areas, such as the Bonney Upwelling, where upwelled water is deflected by the coast. The narrower the shelf, the more intense the surface upwelling.

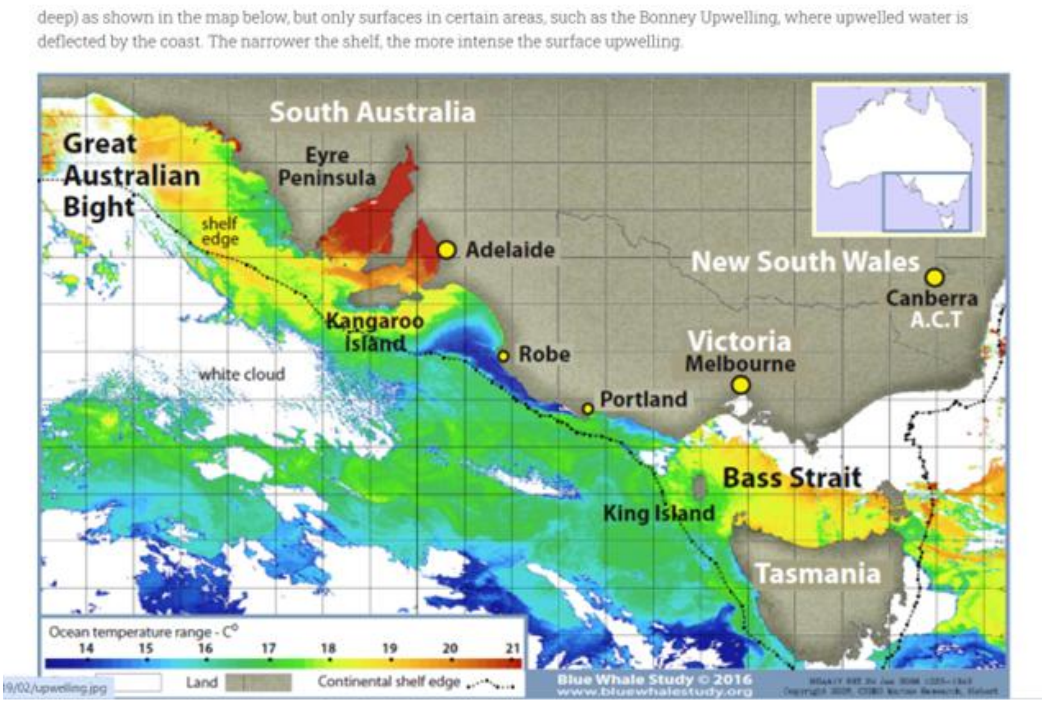


Figure.5. - Typical Surface Water Temperatures in Autum (ref. Blue Wale Study)

Upwelling events may last from hours to weeks and are followed by 'relaxation' periods as winds calm or blow from other directions. Their timing and intensity vary from year to year. The right balance between upwelling and relaxation events is crucial to primary (phytoplankton) production.

Hence the driving mechanism (dominant South-Easterly winds in Spring and Summer) must not have been strong enough in 2024/25 to break through the super warm Leeuwin currents occurring in the area in early 2025.

However, only surface water temperatures have generally been reported in local media which indicating that the Bonney Upwelling did not reach the surface in 2025, but reports have not mentioned how far beneath the surface the upwelling has risen or if it has not moved onto the continental shelf at all.

From information available from IMOS (Integrated Marine Observing System) available through the Australian Ocean Data Network (AODN) full depth observations of temperature and salinity are available for this area. These indicate that a distinct stratification occurred in early 2025 and continued to exist through to at least May 2025. This stratification showed a temperature difference of over 5C and a salinity difference of 0.5 g/L at a depth of approximately 50m. (see Fig. 6. – Ocean Column Profile via ARGO on 4/01/25, 21/02/25, 13/03/25, 11/04/25 and 30/05/26).

This stratification of the water column with the cold water not reaching the surface, as seen in 2025 is very different to previous years and is different to what has occurred in 2026 which is similar to the typical surface water temperatures shown in Fig.5.

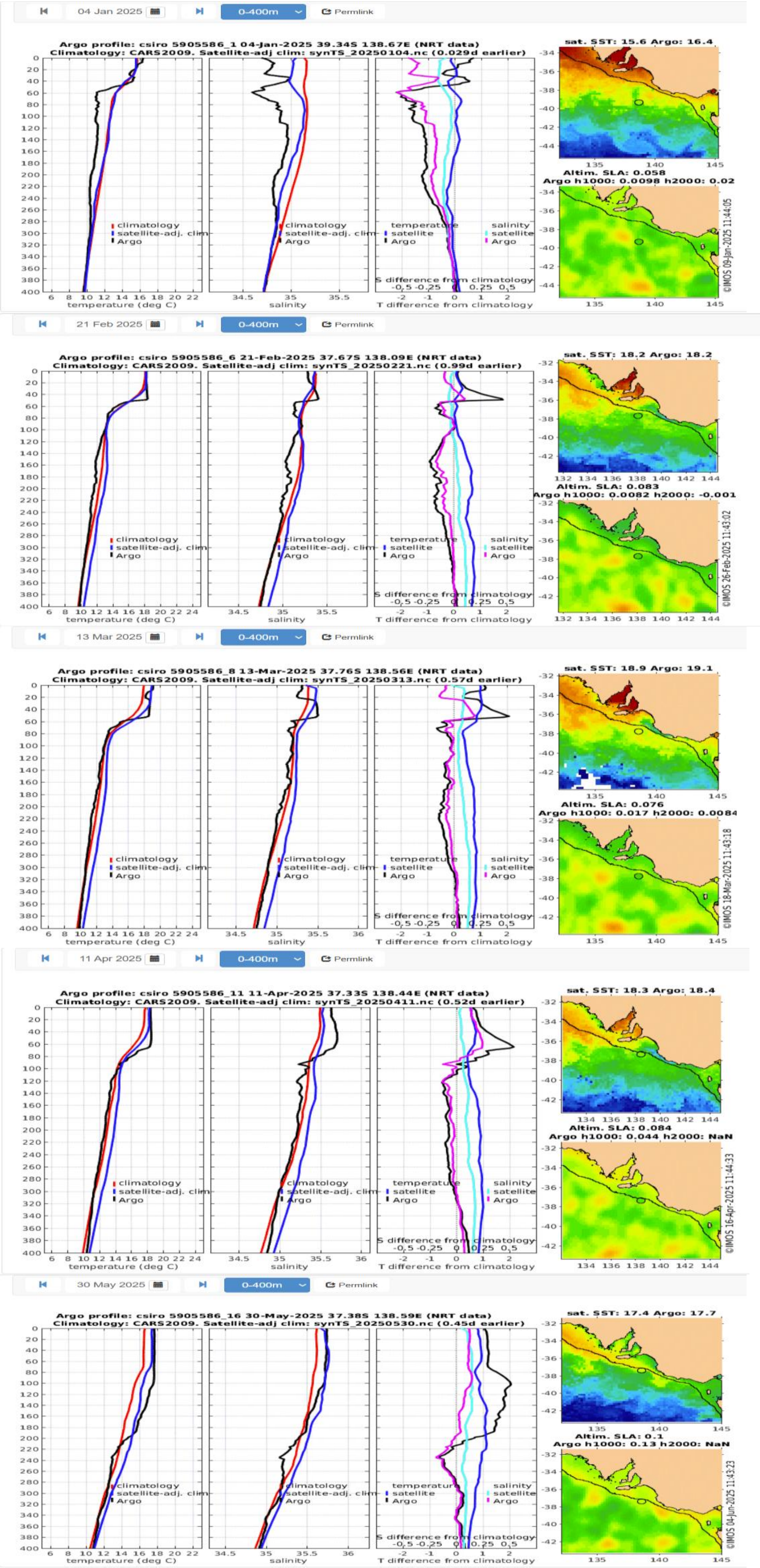


Figure.6. - Ocean Column Profile via ARGO on 4/01/25, 21/02/25, 13/03/25, 11/04/25 and 30/05/26)

2.3. Leeuwin Current

The Leeuwin Current was up to 2.5^{0}C warmer than average in Summer and Autum of 2025 and was particularly strong and persistent (See Fig.7. – Surface Seawater Temperature and SST Anomaly in March 2025 and See Fig.8. - Rip Charts, SST in early June 2025).

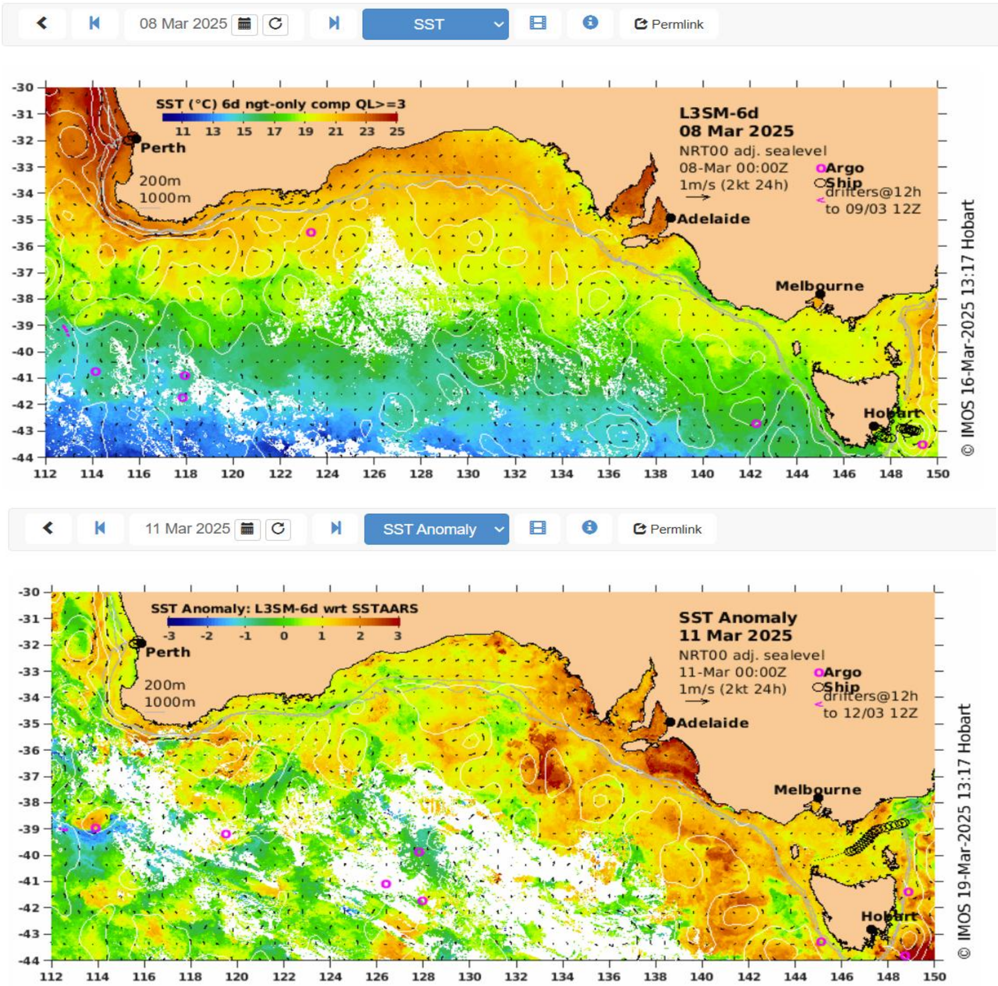


Figure.7. - Surface Seawater Temperature and SST Anomaly in March 2025

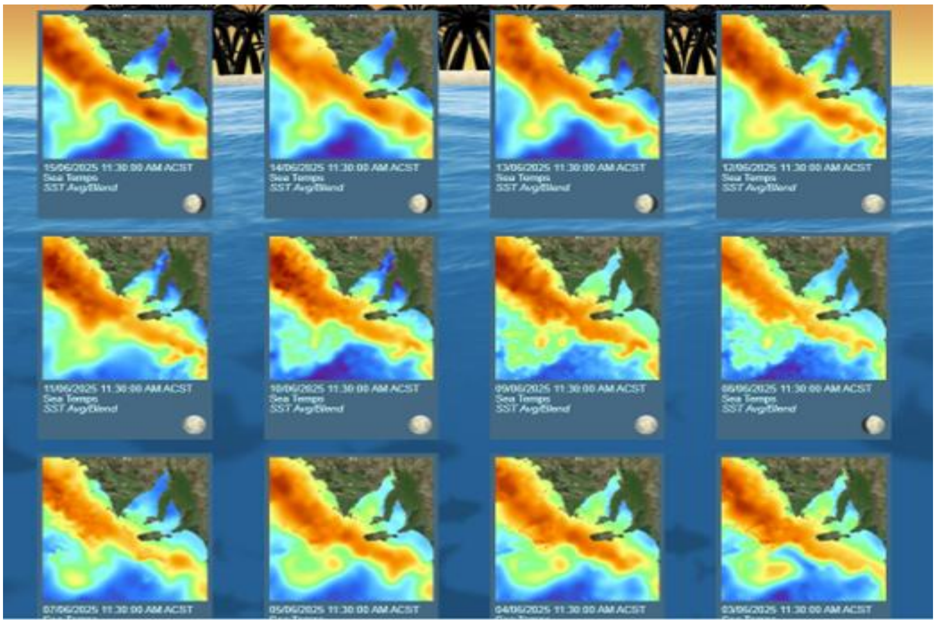


Figure.8. - Surface Water Temperatures in June 2025.

The Leeuwin Currents are typically weaker during El Nino events (see Wikipedia https://en.wikipedia.org/wiki/Leeuwin_Current) and as the 3 years prior to 2025 were dominated by La Nina, it is not surprising that the Leeuwin Currents were particularly strong in 2025.

The Leeuwin current is not only approximately 2.5^{0}C warmer than average but has also swept to the south of Kangaroo Island and onto the west coast of Tasmania in 2025, rather than enter Spence Gulf and Gulf St Vincent and not reach past KI as it did in 2023/24 and as shown in Figure.5. - Typical Surface Water Temperatures in Autum.

It has been suggested that these exceptionally warm waters may have reached to the seabed (20 to 200m depth on the continental shelf) and over-stressed sea grasses and other benthic organisms causing a die-off and release of nutrients.

For this to occur there would need to be no stratification of the water column, with warm water from the surface to the bottom. However as seen in Figure.6. – Ocean Colum Profile, there was a strong stratification of the water column at about 50m depth with a temperature difference of over 5C.

However, herbicides deposited during the 2022/23 floods could have weakened seagrasses and other benthic organisms to make them more susceptible to environmental stresses.

2.4. HAB Initiating Mechanism

Plankton live in a watery arms race for survival with other organisms, adapting to different conditions to provide an advantage over these other organisms for access to their food.

Karenia have developed several characteristics which can provide them with an advantage over other competing organisms. These include:

- They are **mixotrophic** being able to use a mix of nutritional strategies, combining **autotrophic** (making their own food, usually via photosynthesis) and **heterotrophic** (consuming organic matter) methods for energy and carbon, allowing them to adapt to different environmental conditions like light and nutrient availability.
- They can move purposefully through a water column (up to 20-25m/d) and will usually adopt a diurnal pattern to be near the surface in daylight hours and use photosynthesis to grow and then move to depth at night and operate heterotrophically to continue to grow.
- They can multiple rapidly to take advantage of plentiful food source, to outcompete other organisms.
- They can produce chemicals (including toxins) that inhibit the growth of other competing organisms.

What initiated the Karenia bloom in SA water in February/March 2025 is open to conjecture as there is little to no monitoring data available to even identify where the bloom was initiated, let alone determine the mechanism or conditions that facilitated the initiation (ABC News 22/09/2025, Horn). But as this is the first time that a HAB has been witnessed in this area, it would appear that some exceptional environmental circumstances must be responsible for initiating the HAB.

Based on the exceptional environmental conditions that are discussed above and the known advantage mechanisms of Karenia, a few possible scenarios are possible causes for the initiation of the HAB.

The Leeuwin Current killing sea grasses and other benthic organisms seems unlikely to have initiated the HAB as the warmer currents were further off-shore than normal and hence in deeper waters (>100m). In addition, the warmer waters stratified over the deeper colder waters which would have protected the benthic sea grasses and other organisms.

Similarly, there is no reason to believe that the nutrient from the nutrient rich sediments from the Murray River floods of 2022/23 should now become available and initiate the HAB after sitting inert for approximately two years.

However, if the nutrient rich Bonney Upwelling waters were trapped under the exceptionally warm Leeuwin Currents, as the data shows, then the upwelling would try to find a path of least resistance to the surface, as the Bonney Upwelling still has some driving force but not enough to overcome the exceptionally warm Leeuwin Current. This path of least resistance would be the shallower, cooler water near Cape Jaffa which is inshore of the Leeuwin Current.

These mixing zones of the upwelling off the coast from Cape Jaffa did not break through to the surface as confirmed by satellite imagery. These conditions would favour the exclusive development of Karenia rather than the normal mixture of plankton, which includes Karenia, but is usually dominated by diatoms which rely on sunlight to photosynthesise.

There would be a mixing zone at the interface, and as Karenia can purposefully move through a water body to find favourable conditions, they could live in the warmer surface water and feed in the nutrient rich cooler deeper waters.

These would be ideal conditions to initiate a HAB.

This is where the HAB first appeared in the region in late February or early March 2025 (see Fig.9. – First Signs of HAB at Cape Jaffa in early March 2025).

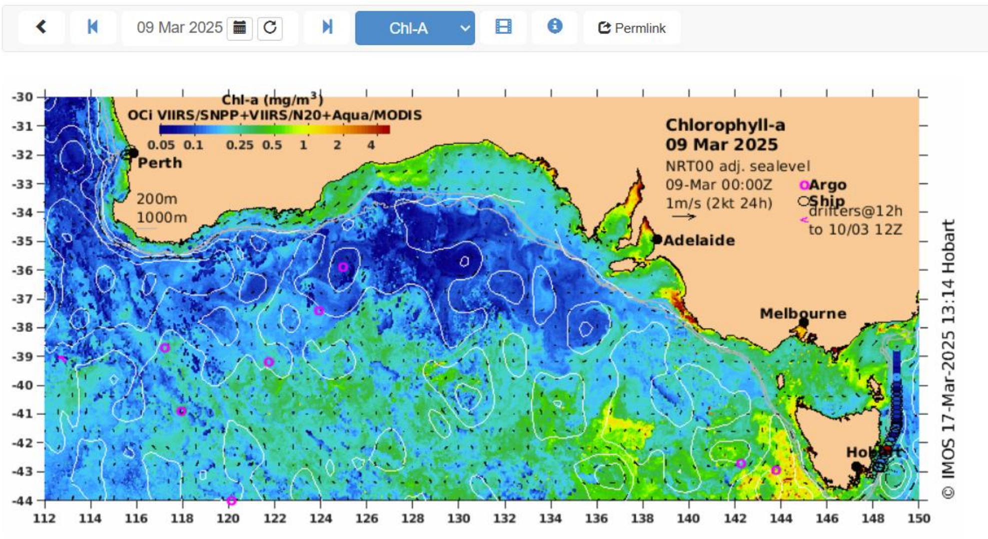


Fig.9. – First Signs of HAB at Cape Jaffa in early March 2025

This is only a theory (like many others) but the nutrient for the bloom must have come from somewhere to initiate the HAB and this is a credible possibility.

However this upwelling is unlikely to have sustained the HAB, as the upwelling is intermittent and is unlikely to have sustained the HAB as it moved into Gulf St Vincent. (See Fig.10. – HAB Movement in 2025).

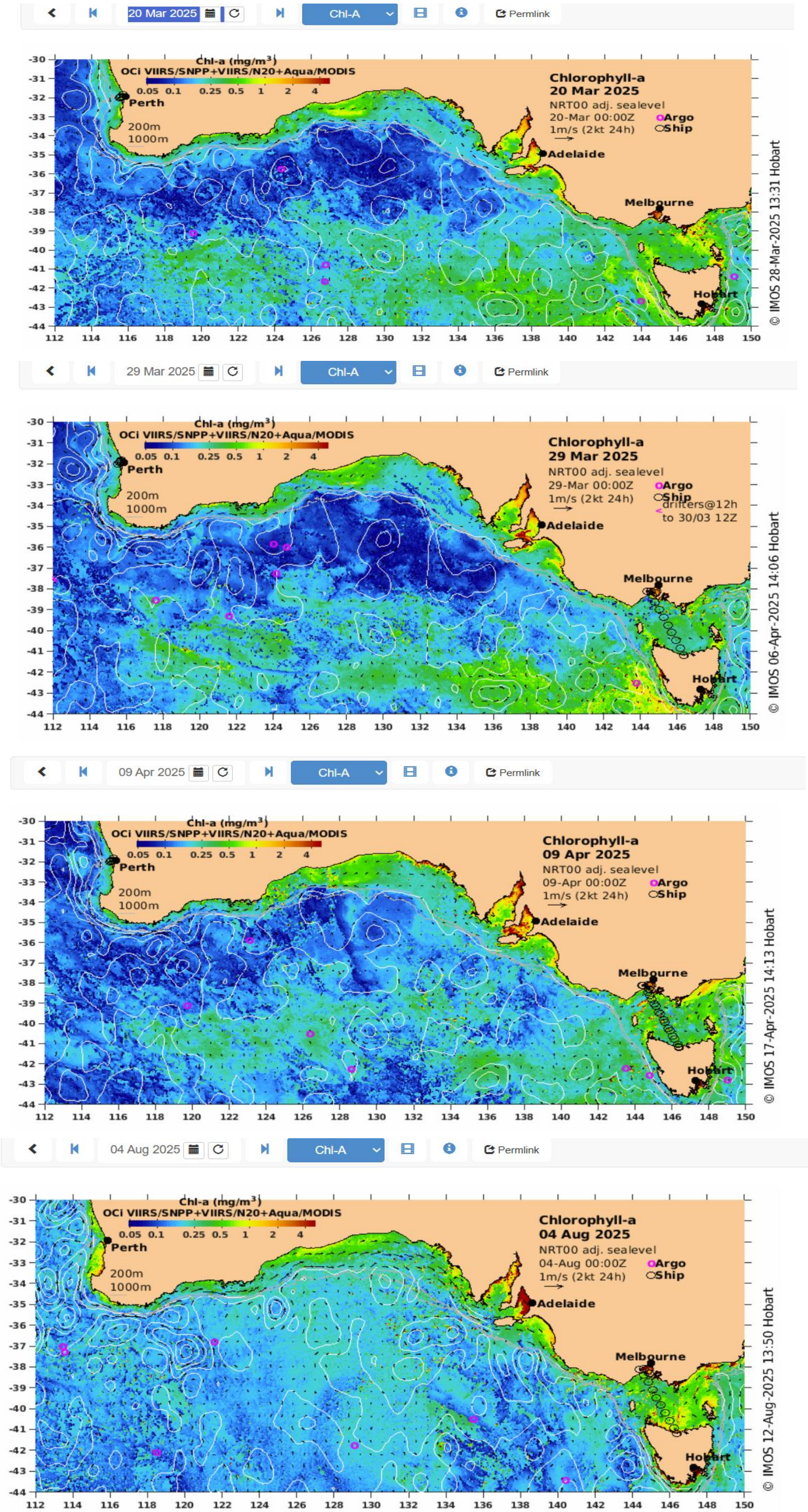


Fig.10. – HAB Movement in 2025

3. WHAT HAS SUSTAINED THE HAB

All plausible theories for the initiation of the HAB have been eliminated except a submerged Bonney Upwelling and this remaining theory for initiating the HAB is unlikely to be a viable cause to sustain the HAB when it tracked away from the Cape Jaffa area.

The nutrient concentrations in the marine waters around Adelaide are insufficient to support the Karenia concentrations recorded (>10^6cell/L). This phenomenon has been observed in other Karenia HABs (Dixon, et.al, 2014) and it has been found that a common source of nutrients, is nutrients released from sediments in the presence of anoxic conditions created by the HAB.

Hence, once the HAB had been initiated, this HAB was able to alter the environment in such a way to release nutrients for its ongoing needs.

Significant research has been increasingly focussed on "Iron bound Phosphorous in Sediments" (Tao, et al, 2025). It has been found (An, et.al., 2019) that up to 80% of the P requirement of a HAB may be supplied by benthic flux from sediments in a marine environment under anoxic conditions. (see Fig. 11. – P Release from Sediment under Anoxic Conditions)

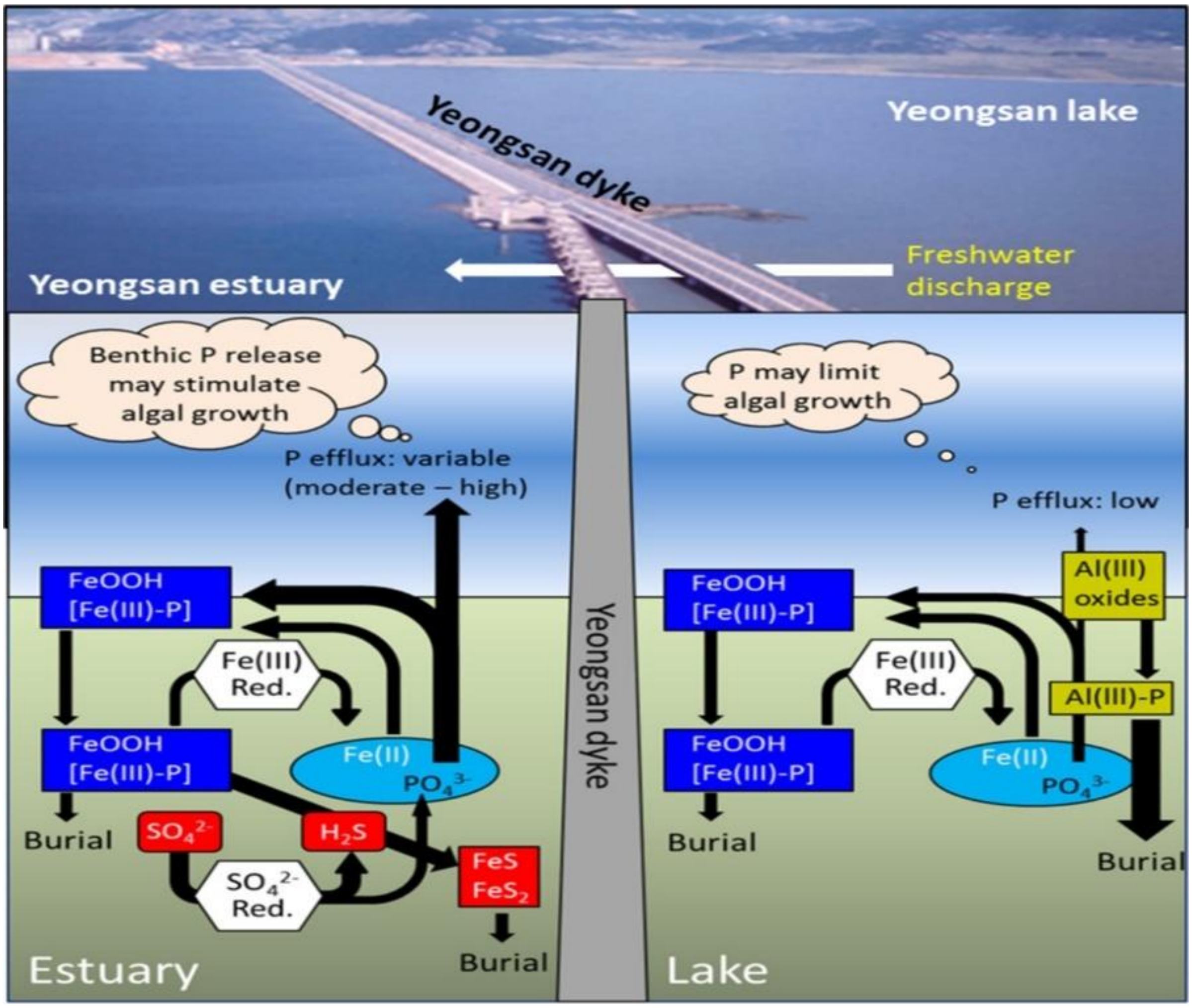


Figure. 11. – P Release from Sediment under Anoxic Conditions (An, et al, 2019)

Once the Karenia HAB was established it was able to operate as a mixotroph; sinking to the bottom at night and feeding as a heterotroph, consuming oxygen and turning the sediments anoxic, causing the release of P into the water column as well as killing slow moving fish (e.g. juveniles) and seagrasses and other benthic organisms which released more nutrients, then returning to the surface in the daylight to feed through photosynthesis and releasing oxygen into the surface waters.

As a result of Climate Change it has been found (Gilbert, 2020) that use of fertilisers is altering the chemical composition of aquatic environments to the disadvantage of diatoms and favouring growth of mixotrophs such as Karenia. (see Fig.12. – Use of Fertilisers favouring Growth of Mixotrophs).

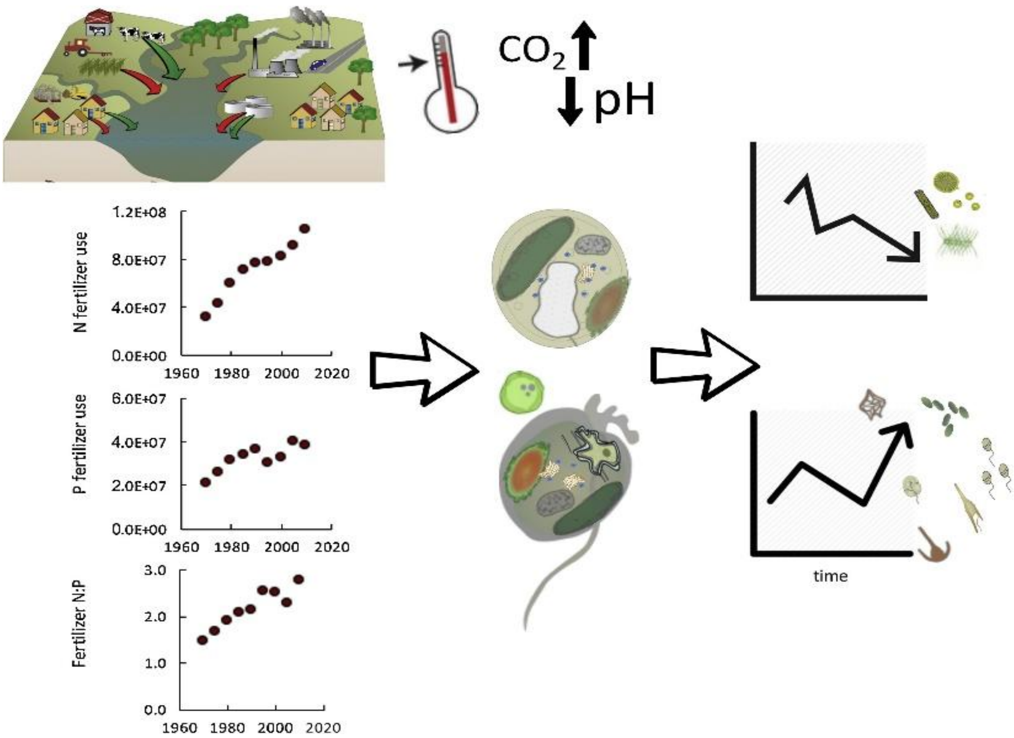


Figure.12. – Use of Fertilisers Favouring Growth of Mixotrophs

Once the HAB was established off the coast of Cape Jaffa, satellite imagery has shown that the Karenia moved with the same currents that drove the nutrient rich flood waters from the Murray River floods of 2022/23 through Backstairs Passage and into Gulf St Vincent and onto Spencer Gulf (see Fig.13. – Murray River 2022/23 Flood Water enter Gulf St Vincent and Fig.14. – HAB enters Gulf St Vincent).

In addition, the 2022/23 floods undoubtedly carried herbicides and other farm chemicals with the freshwater plume through Backstairs Passage and deposited these in Gulf St Vincent and Spencer Gulf. Common agricultural herbicides such as atrazine, diuron, hexazinone, and tebuthiuron show significant persistence (Mercurion, et al, 2016), allowing them to travel far from a river month and cause damage to marine life long after deposition in the marine sediments.

Half-lives of some of these herbicides can be over one year in a marine environment and may have caused the death of sea grasses and either killed or weaken other benthic organisms which would have added to the nutrient pool available to the HAB.

There is growing recognition of the potential impacts from a wide variety of chemicals of concern for both human and environmental health. Examples include herbicides, pesticides, PFAS and pharmaceuticals. Chronic impacts on complex aquatic ecosystems take a long time to become apparent and we have limited knowledge of the role of water quality (especially chemicals of concern) in these declines.

Figure.13. – Murray River 2022/23 Flood Waters enter Gulf St Vincent

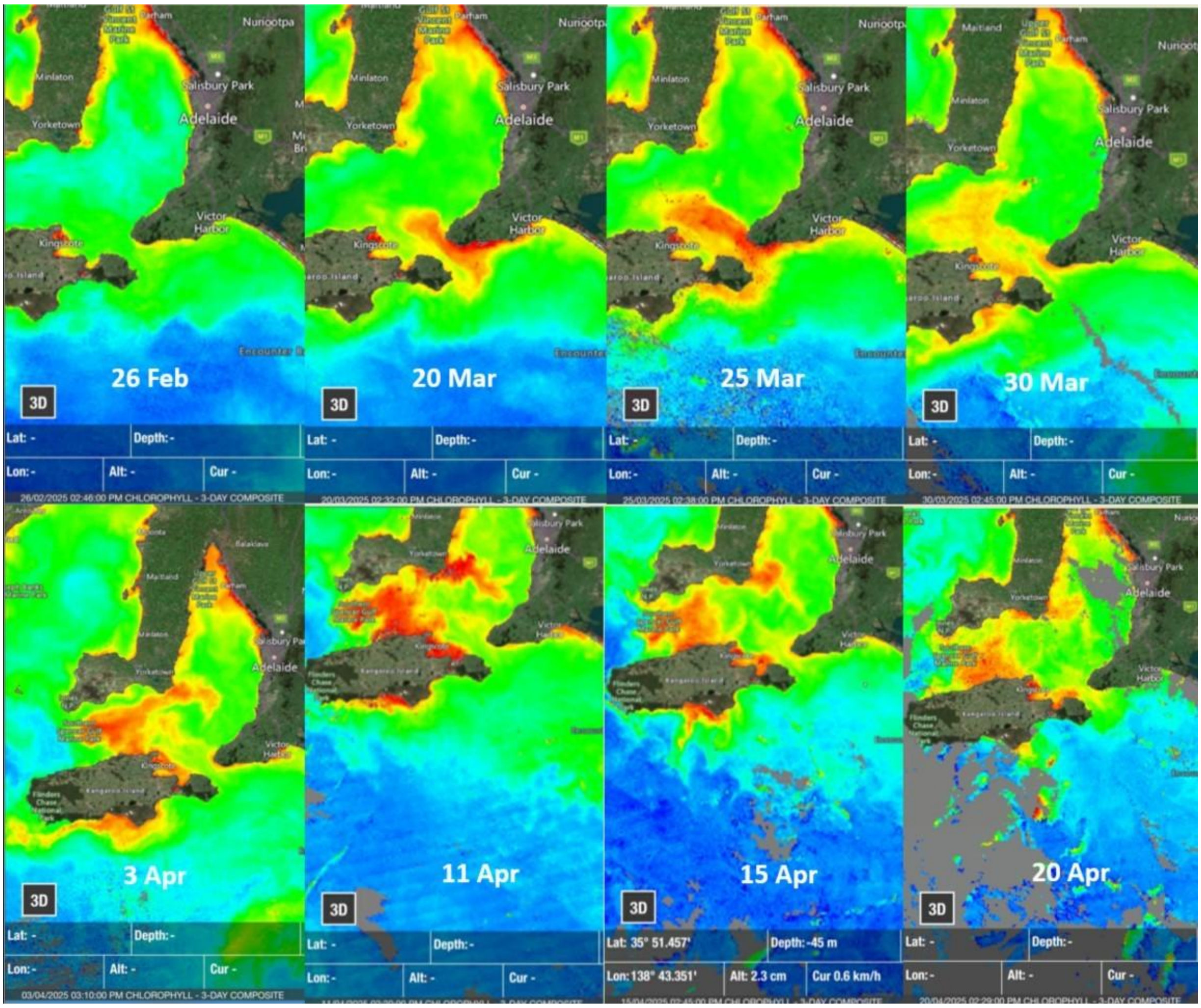


Fig.14. – HAB enters Gulf St Vincent (Chlor. A levels from Feb to Apr 2025.)

The Karenia was able to sustain itself by operating as a mixotroph in a diurnal sequence, releasing nutrients from the sediments at night by turning the seabed anoxic as it moved into new nutrient rich flood sediments, then moving towards the surface in daylight hours to feed via photosynthesis.

This then was the under-water bushfire which was initiated not by a lightning strike but by a nutrient rich upwelling, which then ignited/released the nutrient rich sediments in its path to fuel the on-going HAB fire.

4. WHAT CAN BE DONE TO AVOID FUTURE HABs IN SA

4.1. Need for Scientific Monitoring

There is a scarcity of good scientific monitoring in place where the HAB has been found and this must be one of the starting points for a multi-disciplined expert research team to put in place to be able to understand the mechanisms that are driving the HAB.

Due to the lack of any monitoring data to confirm this theory (or any other theory) it is difficult to rule out any possible causes (other than the obvious non-credible or conspiracy theories).

However, some facts are very compelling or even undeniable.

4.2. Global Issues

The unprecedented HAB in SA waters must be recognised as a direct consequence of the escalating climate crisis. A prolonged marine heatwave and altered rainfall patterns, along with unlimited food sources, have led to this catastrophic event of extraordinary scale and extent of impact.

Global Warming is undoubtedly the prime cause for the unprecedented HAB in SA. This is responsible for the exceptionally warm Leeuwin Current and the erratic behaviour of the Bonney Upwelling.

4.3. Source of Nutrients to Fuel the HAB

The source of the nutrients to initiate (or ignite) the HAB is most likely to have come from the Bonney Upwelling, but this could not have continued to fuel the on-going HAB as it entered Gulf St Vincent and beyond.

The only plausible source of the nutrients to fuel the ongoing HAB (fire) are the sediments deposited by Murray River 2022/23 Floods. It is quite compelling that this is the source of the nutrients (fuel) for the on-going HAB as:

- the HAB has followed the path of the flood waters,
- the HAB has been limited to the extent of sediments deposited by the flood waters, and
- the intensity of the HAB at any location would appear to be proportional to the volume of flood sediments deposited, diminishing in intensity and longevity the further from the Murray River mouth.

Reduced maritime productivity was documented in a report in 2018 (Auricht, et.al., 2018) due to significant periods of reduced nutrient export from the Murray River. The nutrient export volume was significantly lower due to the effects of the Millenium Drought, combined with reduced flows as a result of historic over-allocation of water to extractive uses.

At the time it was reported as a negative effect on productivity, particularly for the crayfish industry. It is also an indicator of the volume of nutrient being retained on floodplains instead of being exported in more regular outflows.

4.4. Control of Nutrients that have Fuelled the HAB in SA

Increasingly frequent regional droughts, combined with significantly reduced river flows, are intensifying nutrient loads and stagnant conditions in rivers of the Murray-Darling Basin, causing large outbreaks of freshwater algal blooms throughout the basin and it would appear that these conditions are now impacting the coastal waters of SA.

The 2022-23 flood caused unprecedented ‘black water’ through the river systems. Flows during that period were high in organic and nutrient loads that caused anoxic conditions throughout the Lower Murray River, Lake Alexandrina and Lake Albert, and the Coorong. This poor water quality caused massive fish kills and devastation to freshwater species in the Lower Lakes and marine life in off-shore zones adjacent to the Murray Mouth.

Following the 2022/23 floods there has been a toxic algal bloom in the Autum of 2024 and 2025 of blue-green algae (BGA) or cyanobacteria, *Cylindrospermopsis raciborskiis* in Lake Alexandrena and the Murray River channel between the lake and the Goolwa Barrage for the first time in living memory (SA Health, 2025). This has been a freshwater algal bloom different to the Karenia marine algal bloom but does indicate the high nutrient load left by the 2022/23 floods.

The 2022-23 flood itself was an exceptional natural event beyond any plausible intervention. However, that event followed many decades of reduced flows and particularly reduced floodplain inundation throughout the Basin. The historic regular natural overbank flows have become rare events under river operating rules and increased storage in upstream dams, with small floods now typically with greater than 10-year intervals, compared with natural two-three yearly events.

Floodplain detritus builds up very significant volumes without regular flushing by small flood events. When large to extreme flood events occur, the accumulated excess of nutrients will be discharged into the marine environment, compared to the pre-development natural regime.

The floodplains of the Lower Murray in South Australia had no overbank flows from 1996 to the end of the 10-year Millenium Drought in 2010. The floods of 2010-12 would have watered and flushed the dry floodplains. However, after those floods extensive floodplain areas returned to drought conditions, apart from a short flood peak in 2016 which receded rapidly.

This long period without any floodplain inundation contributed to the huge load of accumulated plant debris, nutrients and salt which was flushed out by the 2022-23 floods, creating the massive brown plume of freshwater and silt which washed into the ocean, causing so much marine death after the flood.

Serious impacts are now apparent in the connected marine ecosystems, indicating the importance of measures to ensure minimum flows in the rivers and to manage environmental water to sustain floodplain health and water quality, and to manage the volumes of nutrient exported to the marine environment.

While significant volumes of water have been recovered for environmental use, this water cannot be delivered effectively to floodplain sites due to landholder objections to minor controlled flooding on floodplains. At the same time, there has been little progress in extremely slow negotiations to change flow operating rules to allow controlled flows to key floodplain sites.

Until these constraints are resolved, the water recovered for the environment can only be used within river channels up to flow limits of 15,000 ML/day, far short of the 40,000 ML/day flows needed to begin to inundate floodplains.

The need to reduce the risk of further marine blooms should be referred to the Murray-Darling Basin Plan Review currently underway, with a recommendation to expedite resolution of constraints to allow more effective delivery of recovered environmental water as a matter of urgency, with the aim of providing more regular flushing of floodplains to deliver smaller nutrient outputs into the marine ecosystem.

The revised Basin Plan needs to include preventive measures to minimise these threats as a priority, to reduce the risk of future marine HAB.

In the longer-term, farm practices with fertilisers and herbicides needs to be improved to improve the efficiency in the use of the fertilisers so less finds its way into river waters and persistent herbicides do not damage downstream environments. Also land use and zoning of buffer zones along river banks will also improve river water quality (See Fig.15. – Integrated Catchment Management).

Figure. 15. – Integrated Catchment Management (Victorian Environ Water Holder, 2025)

A whole of Murray-Darling Basin approach is needed as proposed by the One Basin Cooperative Research Centre (One Basin CRC) in their “BASIN SCALE: A Collaborative Declaration Towards a Sustainable and Productive Murray-Darling Basin” (One Basin CRC, 2025).

A thorough review of land use practices has also been conducted by the Wentworth Group of Concerned Scientists and published under the title “A Blueprint for the Repair of Australia’s Landscape, July 2024” which describes a suite of practical actions and investments to repair Australia’s degraded landscapes, and in doing so, prepare for the unprecedented climatic pressures ahead.

The Blueprint identifies 24 practical actions which aim to:
(1) repair the productive base of agricultural soils,
(2) fix overallocated and fragmented river systems and rehabilitate degraded catchments,
(3) restore healthy native ecosystems to a minimum 30% of their pre-1750 extent,
(4) mitigate extinction risk and ensure survival of Commonwealth-listed threatened species,
(5) maintain and improve the health of estuaries.

5. Conclusion

The very large (third largest recorded) River Murray floods of 2022/23 carried with it large and unprecedented nutrient loads and herbicides which not only cause huge damage and environmental catastrophises at the time but had long lasting and recurring impacts including:

- A freshwater toxic BGA bloom of *Cylindrospermopsis raciborskiis* which had never been witnessed before in Lake Alexandrina and the Goolwa channel in each of the two Autumns following the 2022/23 floods,
- An extremely rich phytoplankton bloom dominated by photosynthesising diatoms in 2024 when the Bonney Upwelling, enriched by the nutrients of the 2022/23 floods, reached the surface off the coast of Cape Jaffa.
- A algal bloom of mixotrophic Karenia dinoflagellates off Cape Jaffa when the Bonney Upwelling, still rich with the nutrients of the 2022/23 floods, failed to reach the surface in early 2025 due to the very strong and exceptionally warm Leeuwin Current which swept south of Kangaroo Island and onto Tasmania.
- The HAB of Karenia initiated by the Bonney Upwelling in early 2025 produced anoxic condition in the benthic sediments deposited by the 2022/23 floods, causing the release of nutrients into the water column as well as killing seagrasses and other benthic organisms which releases more nutrients allowing the HAB to be sustained.
- Marine currents drove the HAB through Backstairs passage following the trail of nutrient rich sediments deposited by the 2022/23 floods into Gulf St Vincent and onto the Adelaide metropolitan beaches and then into Spencer Gulf.

An initial step to control HAB's in SA is to expedite the resolution of constraints to Murray River flows to allow more effective delivery of recovered environmental water as a matter of urgency. The aim is to provide more regular flushing of floodplains to deliver smaller and regular nutrient outputs into the marine ecosystem similar to the natural rhythm of the basin which feeds the rich marine waters and the fishing industries that depend on them. This needs to be an outcome of the Murray-Darling Basin Plan Review in 2026.

In addition, an integrated land management system needs to be developed which optimises and controls fertiliser and herbicide use and instigates land use practices to protect and control water quality in the Murry-Darling Basin.

To continue the bushfire analogy, controlled release of nutrients (regular burn-offs) is required to avoid a build up of nutrients (fuel or undergrowth) in the floodplains which can lead to a HAB (wild bushfire) when extreme events such as the 2022/23 floods occur.

Without urgent coordinated climate action, alongside strengthened monitoring, rehabilitation, and First Nations-led governance of sustainable water management, such events as the marine HAB in SA will escalate in frequency and severity in both river and marine systems.

This ecological crisis is also a cultural and psychological one – felt acutely by First Nations peoples and regional communities whose identity and wellbeing are tied to a healthy environment.

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