



Sedimentation impacts in Moreton Bay: a priority
knowledge synthesis

IMPACTS:

Phytoplankton



This impact statement is drawn from

Sedimentation Impacts in Moreton Bay, a priority knowledge-synthesis

The report was commissioned by The Moreton Bay Foundation in 2025 to summarise key evidence on how sedimentation affects Moreton Bay's coastal and marine ecosystems, and the ecological and cultural values they support. The report brings together published and grey literature, conceptual models, and expert review to provide a clear, high-level understanding of sedimentation pressures, their impacts, and remaining knowledge gaps.

This standalone document can be found in the full report. Where references are made to other sections, these are indicated by this symbol: †. A full list of external citations, data sources, and methods used in this document is included in the complete report, available at **moretonbayfoundation.org**

David Brewer Consulting (DBC) has prepared this report for The Moreton Bay Foundation under the contract titled 'TMBF Priority Knowledge Synthesis: Sedimentation Impacts in Moreton Bay'. Information about the Moreton Bay Foundation can be found at: <https://moretonbayfoundation.org/>

Authors: David Brewer, Alex Milward

Approved: David Brewer (Director, Upwelling Pty Ltd trading as David Brewer Consulting)

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Phytoplankton: Sedimentation Impact Statement

Status and trend summary

The Bay's phytoplankton community appears resilient, reflecting a system that has improved due to management interventions aimed at reducing nutrient inputs. However, nutrient loads, particularly nitrogen, have remained unchanged in the Bay since approximately 2000. Table 1 provides a qualitative assessment of the phytoplankton communities in Moreton Bay, highlighting their current condition, future trajectory and the impacts of sedimentation.

Persistent, chronic pressure from catchment-derived sediment and nutrients has posed an ongoing threat, including recent increases in the relative abundance of bloom-forming marine diatoms, cyanobacteria and dinoflagellates. The current condition of the Bay's phytoplankton is rated as 'Fair' with 'Moderate' confidence.

The trend in phytoplankton condition in the Bay is assessed as 'Stable', with 'Medium' confidence, despite some observed resilience of the phytoplankton community to past nutrient management interventions. The rating is based on the lack of recent progress in nutrient load management, a similar lack of progress in land clearing and catchment erosion, the ongoing expansion of muddy sediments, and continued human population growth in the Moreton Bay catchment.

The impact of sedimentation on both the current condition and trend of phytoplankton in Moreton Bay is considered 'Moderate' with 'Medium' confidence.



*Phytoplankton species
Skeletonema costatum
Photo credit: E. Saeck*

Table 1. Qualitative assessment of the overall status and trend in condition, and of the likely severity and direction of sedimentation-specific impacts, for phytoplankton populations in Moreton Bay.

Value condition assessment	Assessment	Confidence
Current condition	Fair	Medium
Contribution of sedimentation to the current condition	Moderate	Medium
Condition trend	Stable	Medium
Contribution of sedimentation to trend	Moderate	Medium

Overview

Phytoplankton are critical for primary productivity, water quality, habitat condition and biodiversity in Moreton Bay (Saeck *et al.*, 2019a), contributing an estimated 74% of the Bay's total primary productivity (Saeck *et al.*, 2019b).

The Moreton Bay phytoplankton community is generally typical of a temperate shallow coastal water (neritic) assemblage, dominated by chain-forming diatoms. It also contains a low proportion of nano- and picoplankton (Saeck *et al.*, 2019b). Spatial variation exists in the Bay phytoplankton, with a relatively higher abundance of oceanic and dinoflagellate species in the northern regions compared to the south (Saeck *et al.*, 2019b).

Moreton Bay has overall low areal phytoplankton productivity due to light and nitrogen limitation during summer and temperature limitation during winter (O'Mara *et al.*, 2019). The Bay is oligotrophic (low nutrients, low productivity) for most of the year with acute nutrient pulses delivered by high rainfall events that stimulate productivity peaks (Saeck *et al.*, 2019b). These nutrient pulses drive phytoplankton growth and shifts in species composition (Saeck *et al.*, 2019b).

A west to east gradient of phytoplankton standing stocks across the Bay reflects the influence of river discharges (Saeck *et al.*, 2019b), with higher chlorophyll *a* concentrations found in the western and southern regions of the Bay ($2.20 \pm 0.7 \mu\text{g L}^{-1}$ and $2.36 \pm 0.8 \mu\text{g L}^{-1}$, respectively), where riverine influence is significant (Saeck *et al.*, 2019b). The eastern Bay exhibits lower chlorophyll *a* levels ($0.87 \pm 0.28 \mu\text{g L}^{-1}$) due to minimal river discharge influence and stronger oceanic flushing (Saeck *et al.*, 2019b).

Population status

Overall, the Bay's phytoplankton community appears resilient and reflects a relatively healthy system that has improved due to management interventions (Saeck *et al.*, 2019b). However, persistent, chronic pressure from catchment-derived sediment and nutrients poses an ongoing threat, continuing to fuel algal growth, as observed following the 2022 floods (Saeck *et al.*, 2019b). Such conditions cause unnaturally high productivity of phytoplankton which can often manifest as algal blooms and shifts in community composition (Lockington *et al.*, 2017; Huang *et al.*, 2024).

While some areas show improved water quality and algae indicators, others have experienced declines (Healthy Land & Water, 2023). Between 2022 and 2023 chlorophyll *a* declined from 'Excellent' to 'Very good' condition in the Bay overall (Healthy Land & Water, 2023). However, in the eastern Bay, the decline was more severe, from 'Excellent' to 'Poor' condition (Healthy Land & Water, 2023).

The increased delivery of nitrogen, fine sediments, and pollutants from land-use changes continues to occur in the bay. This has impacted the photosynthetic community, leading to persistent phytoplankton blooms and shifts in phytoplankton community composition (Coates-Marnane *et al.*, 2020). In extreme cases, this leads to an increase in bloom-forming marine diatoms (including harmful algal blooms), hypoxic

dead zones and a decline in dominant benthic diatoms (Saeck *et al.*, 2019b; Coates-Marnane *et al.*, 2020).

Value

Ecological value

Phytoplankton are critical to Moreton Bay's ecosystem productivity, and as primary producers, they form the base of the Bay's food web, converting available nutrients into the fundamental energy source for the entire aquatic community, supporting most higher trophic levels (Saeck *et al.*, 2019b; Huang *et al.*, 2024). This process is also vital for maintaining good water quality for Bay ecosystems (Saeck *et al.*, 2019b).

Phytoplankton produce around 50% of the world's oxygen through photosynthesis and hence play a vital role in regulating climate by influencing oceanic and atmospheric processes; a process which also contributes significantly to carbon cycling by absorbing carbon dioxide (Saeck *et al.*, 2019b). The dissolved oxygen produced by phytoplankton is also critical for other trophic levels in the Bay ecosystems (J. Lu, pers. comm.)

Cultural value

The Quandamooka people do not have the same overt cultural connections with phytoplankton as they do for many marine species which are often named, for example, in the context of Aboriginal place names and symbolic associations (Pinner *et al.*, 2019). The cultural significance of phytoplankton should be viewed with an emphasis on a holistic view of culture and the indivisibility of people and country, and encompassing interests in ecosystem health, biodiversity, resources, and ancestral connections (Pinner *et al.*, 2019).

This value can be seen, for example, through phytoplankton's role as the base of the marine food web (Huang *et al.*, 2024), supporting larger consumers such as fish, marine mammals, jellyfish, and sea turtles; many of which do have highly significant cultural connection with the Quandamooka people. Phytoplankton are also fundamental to the Bay's water quality and habitat condition, contributing to the overall health that sustains life and traditional resources like fish and oysters. This same importance can be inferred for the other critical roles that phytoplankton play in supporting the marine ecosystem, including in nutrient cycling, supporting secondary production and in transferring energy and nutrients between the seafloor and the water column.

Economic value

Phytoplankton in Moreton Bay are crucial to the region's economy due to their foundational role in the marine food web (Saeck *et al.*, 2019b). They provide the essential food source for higher trophic levels, including fish, crabs, and oysters, which are used for both commercial purposes and recreational enjoyment (Jones *et al.*, 2011). Moreton Bay's commercial fisheries are valued at approximately \$24 million per annum, while the recreational fishing sector generates around \$194 million per (Thurstan *et al.*, 2019), most of which are also underpinned by phytoplankton.

The overall health and productivity of the Moreton Bay ecosystem, which is critically supported by phytoplankton, also underpins other crucial economic activities like tourism and aquaculture operations (Lockington *et al.*, 2017).

History

Historically, sewage discharges were a significant driver of phytoplankton growth, leading to elevated nitrogen and chlorophyll *a* in western Moreton Bay, particularly Bramble Bay, before 2000 (Saeck *et al.*, 2019b). Investment in sewage treatment plant upgrades successfully reduced chronic nitrogen loads and subsequently lowered mean monthly chlorophyll *a* concentrations (Saeck *et al.*, 2019b).

In the late 20th century (prior to 2000) the western region of Moreton Bay, particularly Bramble Bay, experienced elevated nitrogen concentrations and high phytoplankton biomass due to sewage discharge, indicating symptoms of eutrophication (Coates-Marnane *et al.*, 2020). Major investments in the early 2000s to reduce nitrogen loads from sewage treatment plants by approximately 70% led to observed declines in annual mean phytoplankton biomass (Saeck *et al.*, 2019b; Coates-Marnane *et al.*, 2020). This reduction in chronic nutrient loads appears to have improved the Bay's resilience to large, episodic nutrient loading events from floods, with phytoplankton blooms following the 2011 floods being much shorter-lived than those in 1996 (Saeck *et al.*, 2019b).

Despite these improvements, nitrogen concentrations have not decreased substantially across the Bay since the early 2000s, and may even be increasing in some areas, potentially due to substantial nitrogen recycling processes within the Bay and nutrients released from previously-deposited catchment sediments (Saeck *et al.*, 2019a).

Moreton Bay's phytoplankton community appears resilient to both long-term and short-term changes in nutrient inputs, with no evidence of permanent state shifts observed to date (Saeck *et al.*, 2019b). Shifts in community composition in response to acute nutrient inputs from large episodic rainfall events are typically temporary, with communities returning to baseline conditions within approximately two weeks (Saeck *et al.*, 2019b).

Impacts of sedimentation

The impacts of sedimentation on phytoplankton communities in Moreton Bay are broadly described in the conceptual model (see Figure 1). Sedimentation acts as a double-edged sword for phytoplankton. While sedimentation can reduce access to sunlight for photosynthesis and energy production, it also provides nutrients for consumption and a rich diet. This leads to a complex and often problematic overabundance of these microscopic organisms that can impact the broader ecosystem health of Moreton Bay (Leigh *et al.*, 2013; Lockington *et al.*, 2017; Coates-Marnane *et al.*, 2020; Saeck *et al.*, 2019b). These phytoplankton blooms can occur almost immediately (within days or weeks) of a flood event (O'Mara *et al.*, 2019; Saeck *et al.*, 2019b; Huang *et al.*, 2024).

Fine sediments and mud entering the Bay significantly increase water turbidity and reduce water clarity (Coates-Marnane *et al.*, 2020). The resuspension of these sediments directly affects light availability, which can limit phytoplankton productivity (Lockington *et al.*, 2017; Saeck *et al.*, 2019b; Grinham *et al.*, 2024).

Despite the turbidity, deposited sediments (particularly those from floods) also act as a significant source of bioavailable nutrients, especially nitrogen and ammonium (Huang *et al.*, 2024). Organic compounds from soil erosion are particularly bioavailable to microbes, which then release more nutrients. In marine waters, salinity can rapidly enhance the release of adsorbed nutrients, further fueling algal growth (Huang *et al.*, 2024; Lu *et al.*, 2025). These nutrients have also led to an increase in bloom-forming marine diatoms and a decline in the dominance of other diatoms since the mid-20th century (Coates-Marnane *et al.*, 2020). In some cases, the enhanced nutrient availability from resuspension can lead to increased phytoplankton biomass despite the elevated turbidity (Jin *et al.*, 2022).

The decomposition by microbes of the increased organic matter from the sediment and stimulated algal growth consumes dissolved oxygen, leading to deoxygenation, which harms the broader aquatic ecosystem (Lu *et al.*, 2025).

The combined effect of reduced light and smothering of the benthos by fine sediments can also cause a shift from benthic to pelagic (water column/phytoplankton) dominance in primary production, with increased water column nutrient flux perpetuating these conditions (Lockington *et al.*, 2017; Saeck *et al.*, 2019b).

The impacts of sedimentation on phytoplankton in Moreton Bay appear to be increasing and posing a greater threat to the ecosystem's health, despite some observed resilience of the phytoplankton community to past nutrient management interventions (Saeck *et al.*, 2019b). This is based on:

- the dramatic increase in sediment export from its catchments since European settlement, with current rates estimated to be approximately 100 times greater than pre-settlement levels due to land clearing and erosion (Saeck *et al.*, 2019a)
- muddy sediments more than doubled their coverage since 1970 (Lockington *et al.*, 2017) and have continued to expand since 1998 (Healthy Land & Water, 2023)
- nitrogen concentrations have not decreased substantially across the Bay since the early 2000s, and may even be increasing in some areas (Saeck *et al.*, 2019a)
- the limited success in reducing the sediment load entering Moreton Bay (Saeck *et al.*, 2019a).

Continued population growth and urban expansion are predicted to place Moreton Bay under more pressure from sediment and nutrient additions (Saeck *et al.*, 2019a). As catchments remain degraded, nutrient loads and sediment infilling will continue to increase, which will progressively impact biogeochemical processes and primary producers in the Bay (Saeck *et al.*, 2019b).

Recommendations

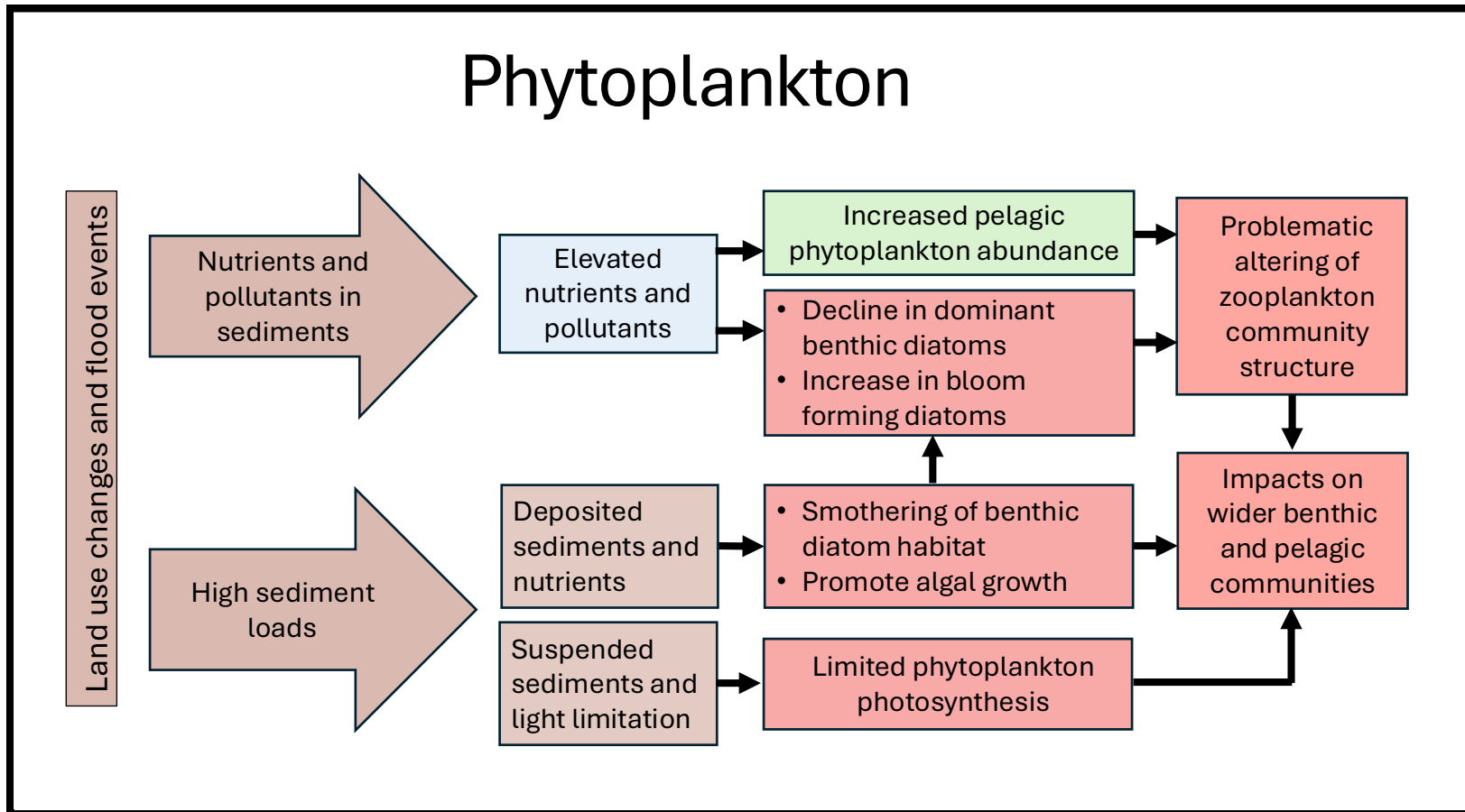
1. Urgently reduce the overall diffuse sediment loads entering Moreton Bay from its catchments (Leigh *et al.*, 2013; Saeck *et al.*, 2019a,b).
2. Invest in catchment conservation and restoration, including:
 - Rehabilitate degraded stream networks and upper catchments (Leigh *et al.*, 2013; Saeck *et al.*, 2019a,b; Grinham *et al.*, 2024; Lu *et al.*, 2024)
 - Protect and enhance streambank (riparian) vegetation (Leigh *et al.*, 2013; Saeck *et al.*, 2019a; Lu *et al.*, 2024)
 - Address channel and gully erosion, which are major sediment loading pathways (Leigh *et al.*, 2013; Lockington *et al.*, 2017)
 - Support sustainable and regenerative agricultural practices to improve soil health and reduce pollutant runoff (Healthy Land & Water, 2023)
 - Protect and enhance wetlands and floodplain ecosystems, as they provide vital services such as sediment and nutrient retention (Healthy Land & Water, 2023).
3. Implement improved erosion and sediment controls, particularly for land development activities. This includes focusing on engagement and compliance within industries with high soil disturbance, such as agriculture and development (Healthy Land & Water, 2023).
4. Implement innovative stormwater management practices in new developments to reduce sediment and nutrient runoff (Healthy Land & Water, 2023; Saeck *et al.*, 2019a).
5. Enhance nitrogen management. While sedimentation is often a physical process affecting light, the sediment itself carries and releases nutrients, particularly nitrogen, that fuel phytoplankton growth in Moreton Bay (Grinham *et al.*, 2024; Saeck *et al.*, 2019a; Huang *et al.*, 2024).
6. Improve monitoring for a broader suite of parameters, including organic forms of nutrients and carbon, to understand their impact on algal growth responses and refine water quality models (Lu *et al.*, 2024).

Expert review

Dr Jing Lu (Research Fellow, Australian Rivers Institute, Griffith University) kindly provided an expert review of the Phytoplankton: Sedimentation Impact Statement.

Conceptual model - impacts of sedimentation on phytoplankton

Figure 1. Conceptual model that qualitatively describes the impacts of sedimentation on phytoplankton communities in Moreton Bay. Brown boxes signify sedimentation-related processes; blue boxes signify other relevant and interacting consequential inputs or impacts; red boxes signify adverse impacts/outcomes; green boxes indicate likely positive or neutral impacts/outcomes.



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Cover Images:

(Top) *Phytoplankton species Skeletonema costatum*. Photo credit: E. Saeck

(Bottom) Photo credit: K. Walters



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DBC
David Brewer
Consulting