Sedimentation impacts in Moreton Bay: a priority knowledge synthesis

IMPACTS: Zooplankton

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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/

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Version:	Final Report
Date issued:	2026
Issued to:	The Moreton Bay Foundation
Citation:	Brewer, D. T. and Milward, A. S. E. (2026) 'Sedimentation Impacts in Moreton Bay: a Priority Knowledge Synthesis for The Moreton Bay Foundation'. TMBF, Brisbane, Australia. 244 pp.

Zooplankton: Sedimentation Impact Statement

Moreton Bay zooplankton
Photo credit: J. Uribe-Palomino

Status and trend summary

Table 1 provides a qualitative assessment of the zooplankton communities in Moreton Bay, highlighting their current condition, future trajectory and the impacts of sedimentation. The overall current condition of zooplankton in the Bay is rated as ‘Variable’, with ‘Low’ confidence. This reflects a lack of information for the status of zooplankton populations, combined with the more variable nature of their population dynamics. In the Bay, observations of lower copepod biomass despite higher abundances are typical of high nutrient (eutrophic) conditions.

Increased suspended sediment loads into the Bay bring chronic light limitation for photosynthetic phytoplankton (a major food source for many zooplankton) and carry highly available nutrients from catchment soils. Nutrient loads, particularly nitrogen, have not improved in the Bay since about 2000. Zooplankton are impacted indirectly by suspended sediment and nutrient loads due to their complex impacts on phytoplankton populations.

The increase in mud content in the Bay also has important ramifications for zooplankton. Mud deposition on the sea floor can smother habitats, affecting the emergence of some species of zooplankton from substrates, particularly demersal zooplankton that associate with the seafloor during the day. This smothering can also adversely impact primary producers, including benthic microalgae, which serve as another food source for zooplankton.

The trend in zooplankton condition in the Bay is assessed as ‘Declining’, with ‘Medium’ confidence. The impact of sedimentation on both the current condition and trend of zooplankton in Moreton Bay is considered ‘Moderate’ with ‘Medium’ confidence.

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

Value condition assessment	Assessment	Confidence
Current condition	Variable	Low
Contribution of sedimentation to the current condition	Moderate	Medium
Condition trend	Declining	Medium
Contribution of sedimentation to trend	Moderate	Medium

Overview

Zooplankton are floating, or weakly swimming, aquatic animals that drift with water currents and range from microscopic organisms to large species, such as jellyfish. They are mainly heterotrophic and usually consume phytoplankton and/or other zooplankton. Zooplankton are important nutrient cyclers and a critical link between primary producers and higher trophic levels in marine and coastal ecosystems (Pausina *et al.,* 2019). Arguably, the most important role of zooplankton is as the major grazer in food webs, providing the principal pathway for energy from primary producers (the phytoplankton) to larger consumers such as fish, marine mammals, jellyfish and sea turtles (Jacoby and Greenwood, 1989; Pausina *et al.,* 2019).

Copepods, a group of small crustaceans generally around 1 to 2 mm in length, dominate the zooplankton fauna in Moreton Bay, accounting for 74% of the permanent members (Pausina *et al.,* 2019). The copepod community is consistently dominated by calanoids, averaging 76% of total copepods (Greenwood, 1980; Pausina *et al.,* 2019). Other numerous holoplanktonic groups (or organisms that spend their entire life cycle in the water column) include appendicularians (larvaceans), cladocerans, chaetognaths (arrow worms), and cnidarians (Greenwood, 1980; Pausina *et al.,* 2019). The dominant large zooplankton species is the jellyfish, *Catostylus mosaicus,* that swarms periodically, and its large biomass at times contributes significantly to nutrient cycling (Gershwin *et al*., 2010; Pausina *et al*., 2019). This species is one of numerous other species of Scyphozoa (jellyfish) recorded in the Bay (*Gershwin et al*., 2010).

Population status

Moreton Bay is a shallow, subtropical embayment, and its zooplankton populations exhibit specific characteristics and dynamics influenced by both natural processes and anthropogenic impacts (Jacoby and Greenwood, 1989; Pausina *et al*., 2019).

Assessing the population status of zooplankton is not straightforward due to their high variability in space and time and the lack of direct monitoring compared to larger species groups and species of higher interest to stakeholder groups. One exception is the Blue blubber jellyfish, *C. mosaicus,* which has been shown to have seasonal and long-term cycles of abundance (Pitt *et al*., in prep.). These include blooms of abundance that have been recorded for at least 150 years. Impacts have included disrupting shipping in the 1800s and clogging power station water intakes in the 1930s (K. Pitt, pers. comm.).

Copepods are typical of a range of smaller zooplankton in the Bay and are generally smaller than copepods found in oceanic waters, which contributes to a lower biomass despite higher abundances in the Bay (Pausina *et al*., 2019). This is typical for zooplankton in coastal waters at lower latitudes (Pausina *et al*., 2019). However, high-nutrient (eutrophic) bays also commonly feature smaller zooplankton (Uye, 1994; Park and Marshal, 2000), suggesting that their populations may be impacted by human development and land-use changes (Saeck *et al*., 2019b).

The broader zooplankton community, which represents a wide range of species, is likely to have been impacted in different ways by a range of conditions. However, there is a recognised lack of reliable zooplankton population and biomass estimates and minimal validation for zooplankton components in water quality models, both generally and in the Bay (Pausina *et al*., 2019).

In summary, it appears as though zooplankton populations are impacted by factors such as high nutrient and sediment loads. However, their current status is difficult to ascertain without targeted monitoring programs.

Value

Ecological value

Zooplankton in Moreton Bay are critical to the ecosystem functioning of estuarine and coastal food webs (see Overview section above) (Pausina *et al*., 2019). Many larger consumers, such as fish, marine mammals, jellyfish, and sea turtles, are highly dependent on healthy zooplankton populations (Jacoby and Greenwood, 1989; Pausina *et al.,* 2019).

Zooplankton are also major grazers within the aquatic ecosystem, exerting selective pressure on phytoplankton community dynamics and influencing the fate of algal blooms (Stone and Steinberg, 2018; Pausina *et al*., 2019).

Zooplankton feeding, secretions, and excretions play a crucial role in nutrient cycling, supporting the production of microbes and phytoplankton (Condon *et al*., 2010; Pausina *et al*., 2019). This includes the assimilation of carbon and nutrients, and the release of nitrogenous wastes and dissolved organic carbon (Condon *et al*., 2010; Pausina *et al*., 2019). Demersal zooplankton, which dwell on or near the seafloor during the day and emerge into the water column at night, are important in transferring energy and nutrients between the seafloor and water column (Bishop and Greenwood 1994; Pausina *et al*. 2019).

Jellyfish, a significant component of Moreton Bay's zooplankton, host various organisms, including fish and copepods, thereby supporting pelagic biodiversity within the Bay (Carr and Pitt, 2008; Pausina *et al*., 2019). Periodic jellyfish swarms can play a major role in nutrient recycling through high predation levels on other zooplankton (Gershwin *et al*., 2010; Pausina *et al*., 2019).

Zooplankton can also serve as indicators of environmental changes such as sediment deposition, turbidity and nutrient enrichment (Pausina *et al*., 2019).

Cultural value

The Quandamooka people have cultural connections with zooplankton as demonstrated by their naming of jellyfish, for example, Birin (Yugumbeh), or Birihn (Bunjulung) (K. Pitt, pers. comm.). The cultural significance of zooplankton should also be viewed with an emphasis on a holistic view of culture and the indivisibility of people and country, encompassing interests in ecosystem health, biodiversity, resources, and ancestral connections (Pinner *et al.,* 2019).

This value can be seen, for example, through zooplankton's role as a critical link in marine food webs supporting larger consumers (see Ecological value section above) - many of which do have highly significant cultural connection with the Quandamooka people. This same importance can be inferred for the other critical roles that zooplankton play in supporting the marine ecosystem, including nutrient cycling, supporting microbial and phytoplankton production, and transferring energy and nutrients between the seafloor and the water column.

Economic value

Zooplankton in Moreton Bay are crucial to the region's economy due to their foundational role in the marine food web (see Ecological value section above) (Pausina *et al*., 2019). These food webs also support Moreton Bay's commercial fisheries, valued at approximately $24 million per annum and targeting species such as prawns, crabs, and various finfish, which rely on the food web underpinned by zooplankton (Thurstan *et al*., 2019). Similarly, the recreational fishing sector in Moreton Bay is generates around $194 million per annum in direct expenditure, with anglers targeting species like mud crabs, sand whiting, snapper, tailor, and bream (Thurstan *et al*., 2019); most of which are also underpinned by zooplankton.

Large zooplankton, such as the Blue blubber jellyfish (*Catostylus mosaicus*), can also have direct socio-economic effects, for instance, by causing disruptions to shipping activities when they form dense swarms (Pausina *et al*., 2019).

Ultimately, safeguarding zooplankton dynamics is crucial for protecting the broader ecological and economic resources of coastal areas, such as Moreton Bay (Pausina *et al*., 2019).

History

In the late 20th century (before 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). The repercussions for zooplankton included altering their community structure, abundance, and food quality, with cascading effects throughout the ecosystem (Pausina *et al*., 2019). 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). This change impacted zooplankton populations, primarily by altering their food environment and community structure (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). This reduction in overall phytoplankton biomass and the improved resilience to prolonged blooms likely led to an improvement in food quality for zooplankton and would likely create a shift in zooplankton community structure (Duggan *et al*., 2002; Özkundakci *et al*., 2020). However, the water quality model for Moreton Bay which predicts biomass changes in plankton has also had limited zooplankton validation (Herzfeld *et al.*, 2014; Pausina *et al.*, 2019).

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

Impacts of sedimentation

The impacts of sedimentation on zooplankton in Moreton Bay are broadly described in the conceptual model (see Figure 1). Land-use changes and floods in the catchment have dramatically increased sediment export into Moreton Bay (Coates-Marnane *et al.*, 2020; Grinham *et al.*, 2024). The increase in mud content has important, direct ramifications for zooplankton, particularly demersal zooplankton that associate with the seafloor during the day (Jacoby and Greenwood, 1989; Pausina *et al.*, 2019). Their emergence patterns are significantly influenced by the type of substratum, with higher emergence observed from structurally complex habitats, such as seagrass beds and coral reefs, compared to muddy habitats (Jacoby and Greenwood, 1989; Pausina *et al.*, 2019), which are increasing in the Bay (Grinham *et al.*, 2024).

However, the indirect impacts of high sediment loads also have major consequences for Moreton Bay ecosystems. Floods bring increased suspended sediment loads which lead to chronic light limitation, impacting phytoplankton photosynthesis. The sediments also act as a significant source of bioavailable nutrients, especially nitrogen and ammonium (Huang *et al.*, 2024; Lu *et al.*, 2025), which provides phytoplankton with a nutrient-rich diet. The combination of light limitation and high nutrients leads to a complex and often problematic alteration of the photosynthetic community, including a selective over-abundance of phytoplankton that can impact zooplankton and hence, broader ecosystem health (Leigh *et al.*, 2013; Lockington *et al.*, 2017; Saeck *et al.*, 2019b; Coates-Marnane *et al.*, 2020).

Increased sediment loads impact benthic microalgae, which are also a food source for zooplankton (Saeck *et al.*, 2019b). This has led to an increase in bloom-forming marine diatoms (a type of phytoplankton) and a decline in dominant benthic diatoms since the mid-20th century (Coates-Marnane *et al.*, 2020). These changes in phytoplankton community structure are likely to impact zooplankton populations that have evolved to depend on specific suites of phytoplankton for survival.

In addition to chronic catchment-based sedimentation, dredging operations in the Brisbane River estuary have also been found to lead to a significant decline in zooplankton abundances, although these may not have a substantial impact on their community composition or distribution (Greenwood *et al.*, 2002; Pausina *et al.*, 2019).

Recommendations

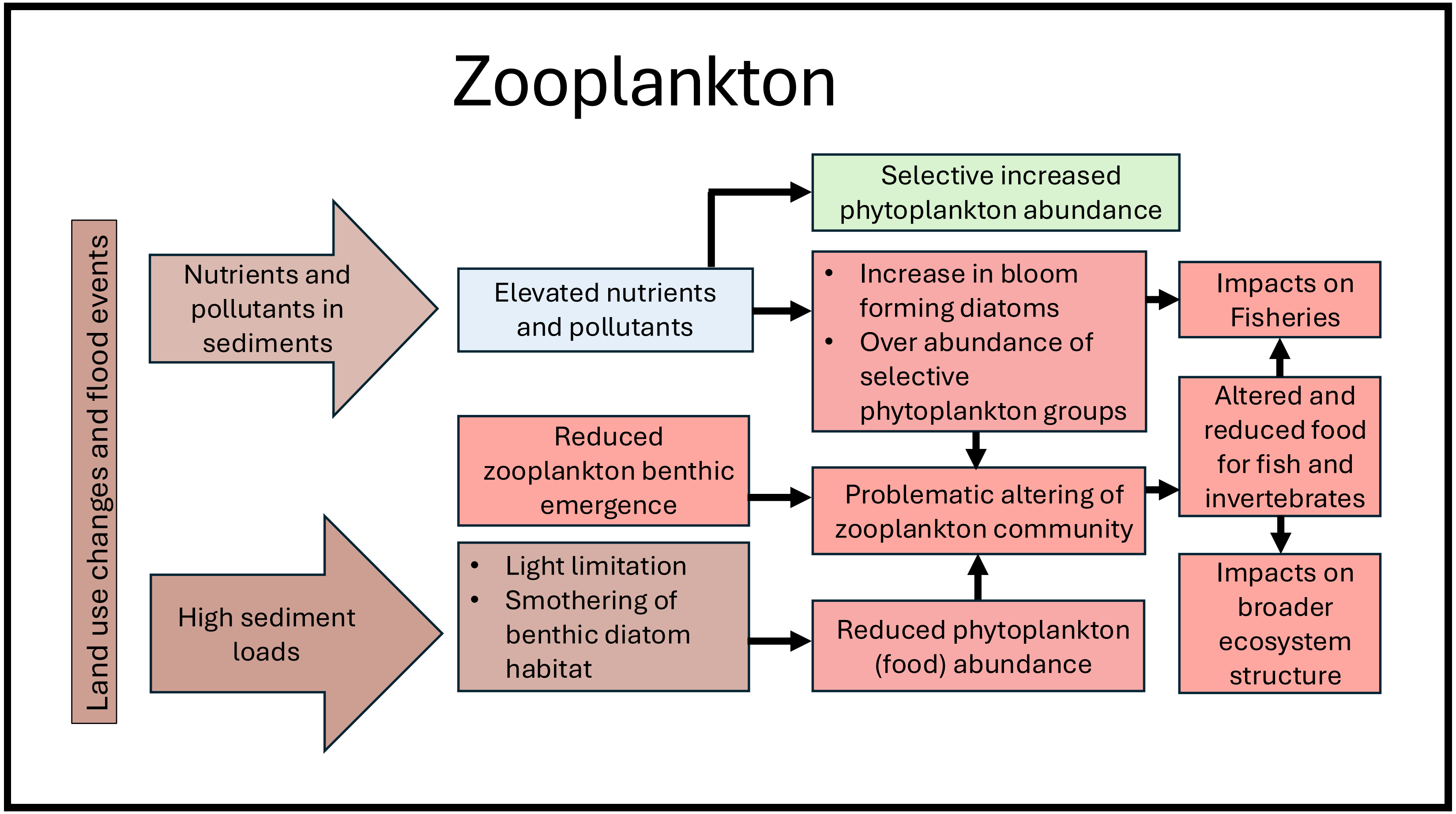
1. Increase research on the seasonality of zooplankton in relation to wet season freshwater inputs and nutrient loads, as current models suggest higher biomass during spring/summer, but this hasn't been field-tested after flood events (Pausina *et al*., 2019).
2. Sample smaller zooplankton, particularly microzooplankton, more thoroughly, as historical studies have likely underestimated their abundance and impact on phytoplankton (Pausina *et al*., 2019).
3. Consider using zooplankton as ideal ecosystem indicators for environmental change, eutrophication, pollution, and climate change. They are not currently included in monitoring programs, which tend to focus on physico-chemical parameters and phytoplankton biomass (Pausina *et al*., 2019).
4. Validate the zooplankton components in water quality models, like the Receiving Water Quality Model (RWQM). This is crucial to better understand Bay-wide zooplankton dynamics (Pausina *et al*., 2019).

Expert review

Professor Kylie Pitt (School of Environment and Science, Coastal and Marine Research Centre, Griffith University) kindly provided an expert review of the Zooplankton: Sedimentation Impact Statement.

Conceptual model - impacts of sedimentation on zooplankton

Figure 1. Conceptual model that qualitatively describes the major impacts of sedimentation on zooplankton 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) Moreton Bay (Quandamooka) zooplankton. Photo credit: J. Uribe-Palomino
(Bottom) Seagrass. Photo credit: K. Walters

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