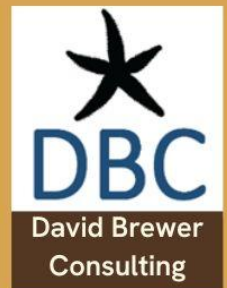




Sedimentation impacts in Moreton Bay: a priority
knowledge synthesis

IMPACTS:

Hard Corals



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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.

Hard Corals: Sedimentation Impact Statement

Status and trend summary

Table 1 provides a qualitative assessment of the coral communities in Moreton Bay, highlighting key aspects of their current condition, future trajectory and the impact of sedimentation. The current condition of these coral populations is rated as 'Fair,' with 'High' confidence. This reflects the current and historical impacts of human activities, including coastal development, historical dredging, and coral extraction, as well as the compounded effects of climate change. Sedimentation, stemming from increased runoff, is a significant factor contributing to this condition, indicative of the sediment and nutrient influx that has degraded habitat quality and altered species composition.

The condition trend is noted as 'Declining,' also with 'High' confidence. This downward trajectory underscores the ongoing pressures exacerbated by climate variability and the increasing frequency of disturbance events, such as floods and severe storms, which heighten sedimentation effects, and increased water temperatures that cause bleaching. However, there is also some evidence that corals can recover from impacts in the medium to long term.

Sedimentation's contribution to this trend is assessed as 'Moderate', with 'Medium' confidence, indicating its considerable role in hindering coral resilience and recovery. Such impacts lead to shifts from more diverse communities dominated by *Acropora* sp. to those dominated by sediment-resistant species like massive corals, which reduce overall biodiversity, habitat functioning and coral cover.

Addressing these challenges requires targeted sediment management strategies, restoration efforts and further research on coral communities to understand and mitigate sedimentation impacts, thereby stabilising and potentially reversing the declining trends observed in Moreton Bay's coral ecosystems (Table 1).

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

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



Fringing reef corals in Moreton Bay
Photo credit: C. Roelfsema

Overview

Corals are colonial marine invertebrates. They typically form colonies of many identical individual animals or polyps, often with hard skeletons made of calcium carbonate, which they secrete to build coral reefs.

Corals are vital to marine ecosystems, often referred to as the ‘rainforests of the sea,’ as they provide habitats for a diverse range of marine life and contribute to the biodiversity of ocean environments. Lybolt and Pandolfi (2019) define Moreton Bay’s reefal habitats as marginal reefs (Johnson and Neil, 1998a, b; Wallace *et al.*, 2009). These habitats are unique for their high-latitude location and are considered key ecological values in Moreton Bay (as described below). They are predominantly found in shallow water (above 3 m Lowest Astronomical Tide) (Roelfsema *et al.*, 2017), which could be a result of light limitation at greater depths due to turbidity, consistent with the general observations by Fabricius (2005).

Live coral cover varies across the Bay, showing an inshore to offshore gradient, with Myora Reef (near-oceanic site and furthest from the Brisbane River) still largely dominated by *Acropora* (34.9 ± 11.7% live coral cover) (Hammerman *et al.* 2022). However, near-river and intermediate sites like Wellington Point and Peel Island are dominated by stress-tolerant species, with lower live coral cover (1.8 ± 0.8% and 13.5 ± 8.3% respectively). These reefal communities include dead mainland fringing reefs (e.g. at Wellington Point and Cleveland Point) and live fringing reefs (e.g. around King, Green, St Helena, Mud, Peel, Goat, Coochiemudlo, and Macleay Islands) (Figure 1) which support coral assemblages historically dominated by *Acropora* and more recently by massive and sub-massive species, such as *Dipsastraea* (Lybolt and Pandolfi, 2019). *Porites* and *Montipora* species are generally absent from the Bay, but are present on reefs outside of the Bay, such as Flinders Reef, Flat Rock and Shag Rock (N. Hammerman, pers. comm.).

Over 60 species of Scleractinian hard corals from 21 genera have been recorded in Moreton Bay (Fellegara and Harrison, 2008). In 2015/2016, a total of 1,627.5 ha of area containing hard coral (and 192.5 ha of area containing soft coral) were mapped (Kovacs *et al.*, 2019). Mean live coral cover was highest at Myora Reef (in the eastern Bay) at 34.9% (in 2019) (Hammerman *et al.*, 2022), and this is the only site of modern coral assemblages within Moreton Bay that is dominated by *Acropora* corals (Hammerman *et al.*, 2022). Coral cover at most other sites is currently dominated by massive corals, particularly corals from the Families Faviidae and Dendrophylliidae (Fellegara and Harrison, 2008; N. Browne, pers. comm.) (Figure 2).

Population status

Corals in Moreton Bay recently experienced mass mortality due to the 2022 floods (Healthy Land & Water, 2023). The floods delivered a significant amount of sediment to the Bay, leading to an expansion of mud and associated nutrients that fueled algal growth, negatively impacting coral communities (see Impacts of sedimentation section below) (Healthy Land & Water, 2023). Furthermore, in 2024, corals in the Bay experienced relatively large temperature ranges from 14°C to 28°C, and although some bleaching occurred in summer it did not result in a mortality event (N. Browne, pers. comm.).



Figure 5: Inshore Moreton Bay reefal areas, derived through manual digitisation guided by 2014 ZY-3 satellite image (5 m x 5 m pixel) as a backdrop overlaid with spot-check field data collected in 2015 and 2016, for interpretation. Polygons are in this figure overlaid on a 2014 Landsat L8 (30 m x 30 m pixel) satellite imagery.

Figure 1. Map of the inshore Moreton Bay reefal areas. Figure presented with its original caption from Roelfsema et al., (2017).

As described in the History section below, there has been a long-term shift from branching *Acropora* corals to more stress-tolerant massive coral species in some areas of the Bay. For example, Goat Island had high coral cover of ~30%, dominated by plating *Acropora*'s prior to the 2022 floods (reduced to 10% coral cover) but show signs of recovery (Golding, 2022). Of four sites investigated (Peel Island, Goat Island, Myora reef and Flinders reef), only Goat Island was substantially impacted (Golding, 2022). The corals along the north-eastern edge of Peel Island had 15-20% coral cover, of which <25% was *Acropora* in 2024.

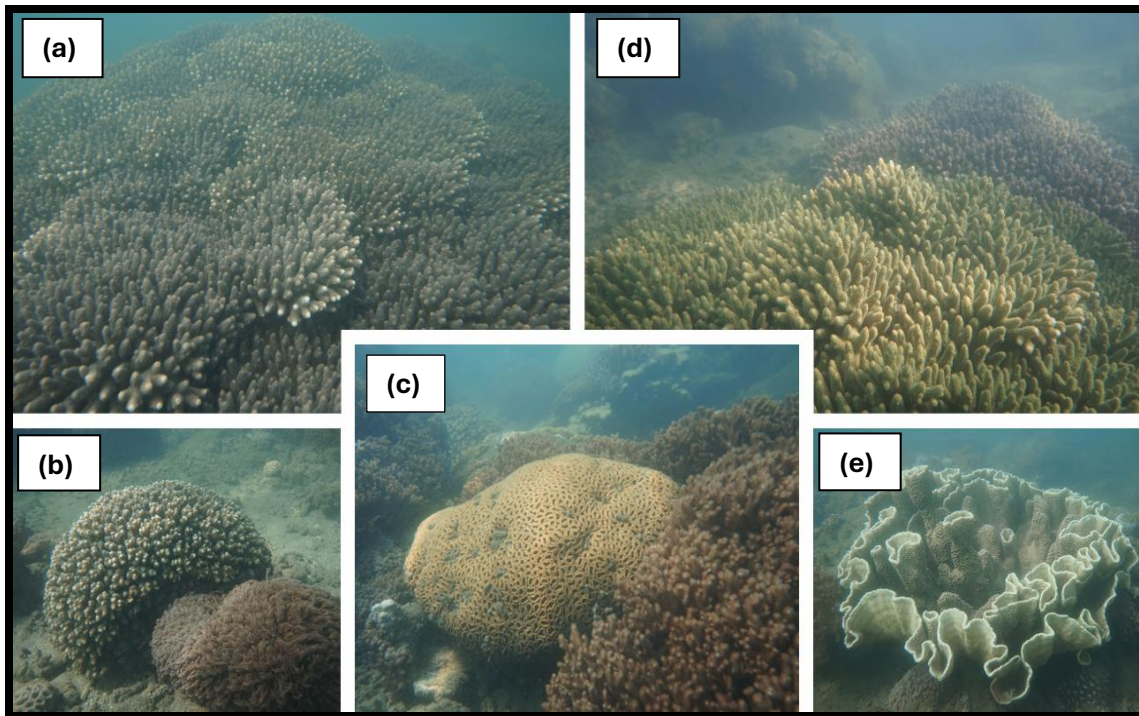


Figure 2. Recent photos showing examples of coral colonies from Moreton Bay: (a) - *Acropora* colonies from Myora Reef, lower left (b) - *Pocillopora* colony from Myora Reef, middle image (c) - mixed hard and soft coral community from Goat Island, upper right (d) - *Acropora* colonies from Peel Island, and lower right (e) - *Turbinaria* colony from Green Island. Photo credit: Nicholas M. Hammerman.

The partial recovery of some corals in the Bay following previous flood and bleaching events (summarised in the History section below) has led to the assertion that they are self-sustaining systems and may be relatively tolerant of environmental change (N. Hammerman, N. Browne, pers. comms.).

However, the increasing frequency of major flood events, strong storms (see main report † **Section 4**), and the associated diminishing water quality, along with increasing temperatures, will continue to reduce the opportunity for re-establishment of coral reef communities in Moreton Bay (Grothe *et al.*, 2019; IPCC, 2022; NOAA, 2023; Hammerman *et al.*, 2022). The dynamic between flood frequency and sediment clearing rates (described further in † **Section 4**), along with increasing frequency of elevated water temperatures, bleaching and coral recovery rates, suggests that corals in the Bay may be at substantial risk of an ongoing decline.

Value

Ecological value

1. Habitat and structural protection

While the building of significant reef structures is generally limited in this marginal environment, the region still hosts notable coral communities, including fringing reefs around islands in the inshore bay, such as Peel, Mud, Goat, Saint Helena, and Green Islands. As well as providing important habitats for many other species groups, these reef structures also shield adjacent shorelines from erosion.

2. Support for unique biodiversity

The coral communities of Moreton Bay support a highly diverse range of ecologically and economically important species. At least 64 species of scleractinian corals, including 59 reef-building species, have been recorded in the inner Bay (Veron 2000; Wallace *et al.*, 2009). The reefal habitats sustain a large array of species that find refuge and food within coral reef ecosystems. These include a wide variety of smaller fish species known for their colour and high diversity, such as angelfish (Pomacanthidae), butterflyfish (Chaetodontidae), clownfish (Pomacentridae), damselfish (Pomacentridae), eels (Muraenidae), gobies (Gobiidae), lionfish (Scorpaenidae), surgeonfish (Acanthuridae), and triggerfish (Balistidae). Economically valuable finfish species are discussed in the Economic value section below.

Cultural value

The Quandamooka have a deep connection that extends to all aspects of Sea Country, including coral reef habitats (Ross *et al.*, 2019b). Coral reefs are included within the scope of Traditional Knowledge and contemporary management efforts, with Quandamooka Rangers being actively involved in managing and monitoring Sea Country. This includes undertaking coral reef monitoring (Fischer *et al.*, 2019), demonstrating the practical application of their custodial responsibility and desire to enhance knowledge of marine ecosystems, including coral reefs, in order to care for them better (Fischer *et al.*, 2019).

Economic value

Coral reefs have historically provided economic value through resource extraction, which supplied calcium carbonate for a range of large concrete legacy constructions in South East Queensland (such as the *Sir Leo Hielscher Bridges* or ‘Gateway Bridge’) (Butcher, 2022). However, that dredging activity also had economic impacts on other users, such as the livelihood of commercial tunnel net fishermen who fished periodically for a range of species at Mud Island, before coral dredging (J. Page, pers. comm.; see † **Section 5.15**).

Ongoing economic value includes habitat support for highly diverse marine communities (see Ecological value section above), which attract tourists, students, etc, all are important contributors to many small businesses based within Moreton Bay. The coral reefs of Moreton Bay also support many species groups noted for their ‘immense cultural, social and economic value’ to a broad range of people, including Indigenous,

recreational and commercial fishers (Olds *et al.*, 2019). These species groups include Emperors (Lethrinidae), Rabbitfish (Siganidae), Groupers/Cod (Serranidae), Tropical Snappers (Lutjanidae), Sea breams/Snapper/Squire (Sparidae), Parrotfish (Scaridae), Tuskfish and Wrasses (Labridae). Recreational fishing in Moreton Bay, of which coral reefs are the major habitat, attracts a direct expenditure of about \$194 million per annum (Thurstan *et al.*, 2019) and brings significant economic benefits to the local area, with industries like boating, bait, and fishing tackle outlets benefiting from the ecological integrity of Moreton Bay coral habitats.

History

Moreton Bay's coral communities are considered marginal, heavily impacted by freshwater, sediment, nutrients, and turbidity from river discharge and human activities like land clearing, urbanisation and coral dredging (Fellegara and Harrison, 2008).

The dredging for coral/limestone to make cement saw the removal of a large biomass (>30 million tonnes) of hard coral around Mud and St Helena islands as well as off Wellington Point and Cleveland (Butcher, 2022). For example, by 1981, 48% of the Mud Island reef flat had been removed, and the surrounding islands' reefs are now almost entirely gone, replaced by a deep, muddy seabed (Butcher, 2022). This dredging ceased in November 1997, after approximately six decades of exploitation (Butcher, 2022). There is little prospect of corals re-establishing themselves in the dredged areas because they cannot attach themselves to the muddy bottom that remains, and because the combination of greater turbidity and water depth—a legacy of the dredging—also precludes effective coral establishment (Butcher, 2022).

There are several large river systems which feed into the Bay (i.e. Brisbane, Logan, Caboolture and Pine Rivers). These rivers discharge freshwater, sediment, nutrients, trace metals and turbidity into the Bay, but their levels of discharge have varied substantially between flood events. In recent history, Moreton Bay has experienced several notable flooding events, including those in 1974, 1996, 2011, and most recently in 2022 (N. Hammerman, pers. comm.). The 1974 floods killed many hard corals in the western bay (Butcher 2022; Fellegara and Harrison, 2008), while the eastern Bay sites experienced between 0-20% coral mortality (N. Hammerman, pers. comm.). The 1996 and 2011 floods caused lower and less widespread impacts on coral cover in the Bay (N. Hammerman, pers. comm.). The 2022 flood event delivered heavier rainfall and higher impacts in the Bay's lower catchment than in 2011 (N. Hammerman, pers. comm.). The impacts of 2022 on corals are yet to be fully investigated, but observations and some research results are described above in the Population status section.

Due to the types of historical impacts described above, modern coral assemblages are considerably different from historical fossil assemblages. The impact of increased sediment and nutrient input since European settlement is evident in the shift of the dominant coral community structure in Moreton Bay (Lybolt *et al.*, 2011; Hammerman *et al.*, 2022). The Bay was previously dominated by *Acropora* species, but now most coral communities in the Bay are dominated by massive corals (see Impacts of sedimentation section below) (Lybolt *et al.*, 2011; Hammerman *et al.*, 2022).

Impacts of sedimentation

Sedimentation is a major factor causing the severe degradation of coastal reefs globally (Fabricius, 2005). It adversely affects the structure and function of coral reef ecosystems by altering both physical and biological processes (Rogers, 1990). Sediment affects light availability, reef growth and ultimately coral community composition (Lybolt and Pandolfi, 2019).

Grinham *et al.*, (2024) describe the increase in sedimentation in the Bay in recent decades and note that:

- During major flood events, surface water nutrient and turbidity levels are elevated to 10 times above background.
- Fine sediment deposition has now impacted 98% of Moreton Bay.
- Porewater ammonium concentration can be elevated to 1000 times higher than surface waters.
- Annual sediment ammonium flux can be elevated to 180 times larger than the region's point source inputs.
- The 'clean sand' sediment class has been reduced in Moreton Bay from 442 km² to 30 km² in 50 years.

The impact of increased sediment and nutrient input since European settlement is evident in the shift of the dominant coral community structure in Moreton Bay (Lybolt *et al.*, 2011; Hammerman *et al.*, 2022). The whole Bay was previously dominated by *Acropora* species, but now most coral communities in the Bay are dominated by massive corals such as *Cyphastraea*, *Dipsastraea*, and *Goniopora* species (Lybolt *et al.*, 2011; Hammerman *et al.*, 2022). This aligns with the general understanding that massive corals are often more resistant to sedimentation compared to branching *Acropora* (see below) (Zweifler *et al.*, 2024).

Due to coastal modification and urbanisation, Moreton Bay generally follows a west-to-east gradient in coral condition and associated water quality. The western 'riverine' influenced side of the Bay typically has lower coral cover, a dominance of domed coral species and the near absence of branching *Acropora* species. The more 'oceanic' influenced eastern margin still supports branching corals and a comparatively higher coral cover (Lybolt *et al.*, 2011; Hammerman *et al.*, 2022). This gradient in coral cover and water quality is also evident in Hervey Bay, a similar embayment just north of Moreton Bay (Butler *et al.* 2013).

'In the past 200 years, reefs have changed significantly, and for the first time in 7,000 years reefs of Moreton Bay persist in a degraded state caused by increased sediment and nutrient runoff from anthropogenic land use changes. Reversal of this degraded state will require reduced sediment and nutrient loads onto the reefs' (Lybolt and Pandolfi, 2019).

The primary processes by which sedimentation impacts corals include:

1. Smothering

Sediment particles can smother reef organisms. Fabricius (2005) noted that high sedimentation rates (accumulating to $>100 \text{ mg cm}^{-2} \text{ d}^{-1}$ or suspended $>10 \text{ mg l}^{-1}$) can easily smother benthic communities. Even short exposure to sediments (a few days) can have long-term effects by removing young coral cohorts and delaying reef recovery (Fabricius, 2005).

Encrusting and massive corals can suffer sedimentation stress due to sediments settling on flatter coral surfaces and smothering/blocking corallites, the cup-like skeleton deposited by a coral polyp (Fabricius, 2005; Zweifler *et al.*, 2024).

Branching corals are less vulnerable to settling sediment due to their more vertical and complex structure (Rogers, 1990; Zweifler *et al.*, 2024).

Some corals have mechanisms to help cope with sediments, such as using tentacles, cilia, stomodeal distension, and entangling particles in their mucus, which may then be sloughed off (Rogers, 1990).

2. Reduced light penetration

Sediment particles, particularly resuspended sediments (turbidity), reduce the light available for photosynthesis for the symbiotic algae (zooxanthellae) within coral tissues (Rogers, 1990). This can lead to:

- reduced photosynthesis, which is critical for coral's energy budget and overall metabolism (Rogers, 1990)
- reduced calcification and slower growth rates (Browne *et al.*, 2021)
- a shallower, lower depth limit for reef growth (Rogers, 1990).

Turbid water corals may have a higher capacity for feeding, promoting their survival during turbidity and bleaching events (Fox *et al.*, 2018). Examples of these turbid water corals include *Turbinaria* species (Sofonia and Anthony 2008; Ross *et al.*, 2019a) as well as *Porites* and *Pavona* species (Zweifler *et al.*, 2024).

3. Altered benthic community structure

Sedimentation can lead to profound changes in coral population structures (Fabricius, 2005). Branching *Acropora* corals dominated Moreton Bay assemblages from 7,000 to 200 years ago. However, since that time, assemblages have transitioned to be dominated by massive corals such as *Dipsastraea* (Lybolt and Pandolfi, 2019).

Sedimentation can increase macroalgae, which compete with corals for space (Fabricius, 2005). Sediment settlement onto hard substrates can promote algal turf growth, which:

- inhibits coral larval settlement (Ellis *et al.*, 2017; Albert *et al.*, 2014, 2017)
- increases post-settlement mortality of corals (Fabricius, 2005)
- leads to reduced recruitment and juvenile density (Fabricius, 2005).

Hard corals also provide habitat for sedentary fishes (see examples in the Ecological value section above) and other reef-associated species (lobsters, crabs, shrimp and many other invertebrates) (Figure 3), which are forced to migrate, if possible, to less degraded habitats. Such changes are likely to result in reduced species richness, including a reduction in recreational fish populations.

4. Increased Bioerosion

Bioeroding communities are anticipated to undergo significant changes, which will increase in future years, potentially pushing reefs into net erosional states (N. Browne, pers. comm.). This is primarily due to the widespread loss of corals and increased nutrient pollution, which will elevate the importance of bioeroders in reef accretion (Browne *et al.*, 2021). These shifts are influenced by a complex combination of abiotic factors, such as ocean acidification, temperature, nutrients, light, and water flow, alongside biotic factors like recruitment and predation, as well as characteristics of the reef substrate itself. Such changes directly impact the density of the reef framework, sediment production, and the subsequent redistribution of carbonate material. However, accurately modelling these dynamics remains challenging due to the high diversity of bioeroding organisms, varied erosion mechanisms, and considerable spatial and temporal variability (Browne *et al.*, 2021).

The overall impacts of sedimentation on hard coral communities in Moreton Bay are broadly described in the conceptual model (Figure 4).



Figure 3. Coral reef-associated species in Moreton Bay, Queensland, including (a) the biscuit starfish, *Pentagonaster duebeni*, photo credit: C. Roelfsema; (b) Blood red featherstar, *Heterometra* sp., photo credit: C. van den Berg; and (c) the dorid nudibranch, *Chromodoris elisabethina*, Photo credit: C. van den Berg.

Recommendations

1. Mitigate sediment and nutrient runoff. It is crucial to reduce and mitigate sediment and nutrient runoff from anthropogenic land-use changes, including land clearing, agriculture, and urbanisation, to improve water quality and related conditions for coral reef growth (Kemp *et al.*, 2019; Lybolt and Pandolfi, 2019; Hammerman *et al.*, 2022).
2. Manage dredging impacts. Implement methods to reduce sediment plumes created during dredging operations. Specific suggestions include maintaining wider shallow margins to dissipate wave energy and opening more drainage points around Mud Island (Butcher, 2022).

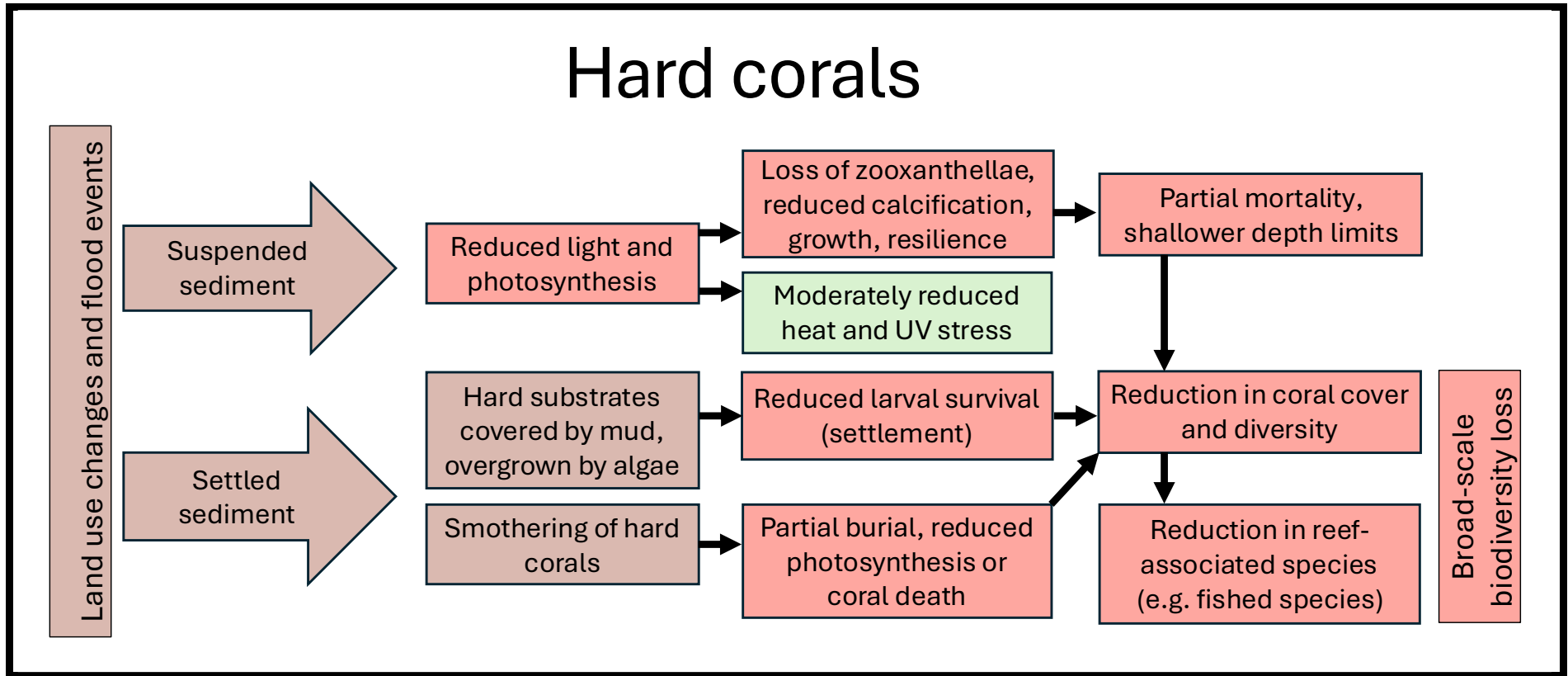
3. Use marine reserves. Well-designed and managed marine reserves, especially those that are well-connected and located in clearer waters, can enhance ecosystem resilience and support coral recovery from disturbances (Roelfsema *et al.*, 2017; Olds *et al.*, 2019; Ross *et al.*, 2019b).
4. Support ecological health. Foster healthy populations of herbivorous fish, which can protect reefs against overgrowth by sediment-trapping macroalgae (Fabricius, 2005).
5. Implement integrated management and monitoring. Adopt integrated land-to-sea management strategies through collaborative efforts (Ross *et al.*, 2019b). Regular monitoring and assessment of reef conditions are crucial for informing management decisions and raising community awareness (Roelfsema *et al.*, 2017; Haywood *et al.*, 2019). The presence of *Acropora* corals can serve as an indicator of successful management (Hammerman *et al.*, 2022).
6. Further research into the impacts of sedimentation on corals, including (i) disentangling the impacts on and responses of corals to sediments and nutrients, including different sediment types, (ii) evaluating the role of sediment shading during heatwaves, and (iii) investigating the impacts of microplastics on corals and benthic systems in the Bay.
7. Adopt localised and adaptive strategies. Conservation efforts should be tailored to the unique characteristics and specific stressors of individual reef systems, with management strategies addressing both short-term responses to disturbances and longer-term recovery dynamics (Zweifler *et al.*, 2024).

Expert reviews

Dr Nicholas M. Hammerman (University of Queensland) and Dr Nicole Browne kindly provided an expert review of the Hard corals: Sedimentation Impact Statement.

Conceptual model - impacts of sedimentation on hard corals

Figure 4. Conceptual model that qualitatively describes the major impacts of sedimentation on hard coral communities in Moreton Bay. Brown boxes signify sedimentation-related processes; red boxes signify adverse impacts/outcomes; green boxes indicate likely positive or neutral impacts/outcomes.



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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 corresponds to **Section 5.8** of the full report. A full list of external citations, data sources, and methods used in this document is included in the complete report, available at

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