



Sedimentation impacts in Moreton Bay: a priority
knowledge synthesis

IMPACTS:

Epibenthic Bivalve Reefs



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**

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Epibenthic Bivalve Reefs: Sedimentation Impact Statement

Status and trend summary

Table 1 provides a qualitative assessment of the epibenthic bivalve reefs (or shellfish reefs) in Moreton Bay, highlighting key aspects of their current condition, future trajectory and the impact of sedimentation. The current condition of these bivalve reef populations is rated as 'Poor', with 'High'

confidence. This reflects the current and historical impacts of human activities such as coastal development and historical harvesting in the 1800s and early 1900s. Sedimentation, stemming from increased runoff, is a significant factor contributing to this condition, which is indicative of the influx of sediment and nutrients that have degraded habitat quality.

The condition trend is noted as 'Declining,' also with 'High' confidence. Despite prolific recruitment and recovery through the 1900s, high-quality shellfish reef habitats have continued to be impacted through a combination of flood events, poor water quality and diseases. The contribution of sedimentation to this trend is assessed as 'Major' (Table 1). Flood events brought high sedimentation rates and volumes into the Bay, impacting (i) settlement success through loss and covering of hard substrates, (ii) energy intake through increased suspended sediment and reduced phytoplankton activity, (iii) disease impacts through organic enrichment and eutrophication, and (iv) increased runoff of pollutants (especially trace metals). Addressing these challenges requires targeted sediment management strategies and restoration efforts to mitigate the impacts of sedimentation, as climate change is predicted to increase the intensity of flooding and coastal development continues nearby.



*Shellfish reef habitat, Moreton Bay
Photo credit: R. Porter*

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

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

Overview

Bivalves are part of the large mollusc grouping (or phylum), which comprises soft-bodied invertebrates that are wholly or partly enclosed in a calcium carbonate shell. Bivalves are characterised by a shell that is divided into two valves, connected via a hinge, and are largely sedentary with a deposit- or suspension-feeding lifestyle.

Bivalves include rock oysters, clams, mussels, scallops and more (Figure 1). Moreton Bay hosts a large and significant bivalve mollusc fauna, with a preliminary checklist recording 350 species belonging to 155 genera and 55 families (Healy and Potter, 2010). Usually only three or four species are able to successfully form biogenic reefs in subtropical Moreton Bay (B. Gilby, pers. comm.). This diversity is attributed to the Bay's unique position within the eastern Australian subtropical-to-temperate transition zone and its strong connections to both oceanic and estuarine influences.

The focus of this impact statement is on shallow (intertidal and shallow sub-tidal), epifaunal (living on the surface) bivalves due to their ecological, cultural and economic value. The predominant epifaunal bivalves in Moreton Bay include:

1. Cemented rock oysters (Ostreidae) ('rock oysters' or 'oysters' hereafter), typically the rock oysters, *Saccostrea cucullata* and *Saccostrea glomerata*, which have a strongly clumping lifestyle
2. Pearl oysters (Pteriidae) and Mangrove oysters (Isognomonidae), also with a strongly clumping lifestyle
3. Hairy mussels (*Trichomya hirsute*), which form extensive shallow subtidal and intertidal beds throughout the Bay and also have a strongly clumping lifestyle
4. Hammer oysters (*Malleus albus*), usually solitary or in patchy aggregations, and living on the surface of sandy-mud substrates in intertidal and shallow subtidal areas, often in seagrass (to 5-10 m) (B. Gilby, pers. comm.).
5. Other relatively abundant epifaunal bivalve taxa, including species within the true cockles (Cardiidae), Arcidae (ark shells, Sydney cockle), Chamidae (jewel box clams), Mactridae (duck clams) and Pinnidae (razor clams) (Healy and Potter, 2010).



(a) Cemented Rock Oysters (Ostreidae)



(b) Pearl Oysters / Quampies (Pteriidae)



(c) Cockles (Cardiidae)



(D) Hairy Mussels (Mytilidae)

Figure 1. Photos of four of the main epibenthic bivalves in Moreton Bay.

These bivalve communities are also well known for forming shellfish reefs (Figure 2) due to their clumping lifestyle and abundance (Healy and Potter, 2010; Gilby *et al.*, 2019c, 2021). They are well known for their roles as ecosystem engineers, habitat formers, water quality regulators and nutrient cyclers (Anderson *et al.*, 2019; Gilby *et al.*, 2021). Their value is described in more detail below.

Population status

The devastation of shellfish reefs in Moreton Bay has been ongoing for decades and centuries, with significant losses due to overharvesting, land-use changes, increased siltation, and diseases (Thurston *et al.*, 2020). The current status of shellfish reefs in Moreton Bay is poor, with widespread functional extinction (Beck *et al.*, 2011). An estimated 96% of the vertical zonation suitable for oyster habitation has been lost in areas like Pumicestone Passage within Moreton Bay over approximately 120 years (Wills *et al.*, 2024). Only isolated, patchy, and degraded remnant intertidal shellfish reefs persist, primarily dominated by the Sydney rock oyster (*Saccostrea glomerata*) (Wills *et al.*, 2024).

Current oyster production in the region is less than one-tenth of its historical peak (Thurston *et al.*, 2020), while the remaining oyster populations continue to experience recurring severe QX disease epizootics (Diggles, 2013).

Value

Ecological value

1. Formation of shellfish reef habitats

The clumping habit of epibenthic bivalves, particularly rock oysters, hairy mussels, pearl oysters and ark shells, can form extensive shellfish reefs in shallow subtidal and intertidal areas throughout the Bay (Healy and Potter, 2010) (Figure 2).

These shellfish reefs provide attachment surfaces and settlement opportunities for an extensive range of organisms (e.g. molluscs, sponges, hydroids, bryozoans, tubicolous polychaetes, barnacles and sea squirts) that live on the surface of other organisms (epibionts). The clumping habit also results in valuable refuges for many different invertebrates and some vertebrates (especially small fish) (Ellis *et al.*, 2004; Healy and Potter, 2010).

Shellfish reefs can structure entire ecosystems, providing hard subtidal and intertidal reef structures, food, and habitat for invertebrates and fish (Diggles, 2013). They can substantially contribute to the diversity, biomass, and abundance of fish in the area (Gilby *et al.*, 2018a).

2. Maintenance of water quality

Shellfish reefs can help maintain water quality and ecosystem health by providing a unique and critical service in water filtration (Healy and Potter, 2010; Anderson *et al.*, 2019). They can filter organic and inorganic particles suspended in the water column within their gill (ctenidial) complex (Healy and Potter, 2010).

Shellfish reefs regulate nutrients by three methods:

- (i) using them for growth,
- (ii) deposition into anoxic sediments via pseudofaeces, and
- (iii) providing beneficial environments for nitrifying and denitrifying bacteria to thrive, driving nitrogen removal to the atmosphere (B. Gilby, pers. comm.).

Shellfish reefs exert ‘top-down control’ on phytoplankton populations - a primary food source for oysters and other bivalves (Diggles, 2013); the absence of which can lead to a substantial increase in phytoplankton blooms (Jones *et al.*, 2011). The removal of suspended particulate matter by shellfish reefs also improves water clarity, which can have negative impacts on many benthic invertebrates (Diggles, 2013; Wills *et al.*, 2024).

3. Food source

Bivalves are a primary food source for many predators, including stingrays, gastropods, octopods, crabs, fish, rays, wading birds and gulls (Pierce, 2008; Healy and Potter, 2010).

4. Stabilisation of fine or moving sediments

The clumping habit of these bivalves is considered an important factor in the stabilisation of soft or moving sediments (Healy and Potter, 2010; Anderson *et al.*, 2019). This includes facilitating the persistence of proximal seagrass beds (B. Gilby, pers. comm.). This stabilising effect occurs even after the bivalves die (Ellis *et al.*, 2004; Healy and Potter, 2010). This means that some of the key functions of these habitats can be relatively easily mimicked or replaced or by artificial shellfish reefs (Duncan *et al.*, 2019; Gilby *et al.*, 2019c, 2021).

Cultural value

There is strong evidence of the long-standing use of epibenthic bivalves as a food source by the Quandamooka people based on their abundance in shellfish middens in Moreton Bay, including rock oysters, hairy mussels, Sydney cockles, and pearl oysters or Quampies (Healy and Potter, 2010; Ross *et al.*, 2019b; Thurston *et al.*, 2020). Quampies (*Pinctada albina*), for example, continue to be a culturally important food for the Quandamooka people including for ceremonial use (Thurston *et al.*, 2019).

However, the Quandamooka people of Moreton Bay have reported concern over the diminishing populations of Quampies (D. Burns, Quandamooka, pers. comm.). Like other important epibenthic bivalves, Quampies require a hard substrate on which to attach. Healy and Potter (2010) also suggest that the Pteriidae (including Quampies) may have a lower tolerance to sedimentation than other bivalves.

Economic value

Rock oysters continue to form the basis of an aquaculture industry in Moreton Bay, (Thurston *et al.*, 2019; West *et al.*, 2019). As of 2015–16, sixty-seven oyster businesses operated 97 approved areas covering 435 ha of the Bay, with an annual production valued at over \$500,000 (West *et al.*, 2019).

Natural shellfish reefs provide important structural habitats and support for food species, which in turn support many higher-level food web species (see Ecological value section above). These species are often targets for commercial and recreational fishing which have high commercial value in Moreton Bay (Thurstan *et al.*, 2019). It is also argued that shell reefs should be promoted as nature-based solutions that provide coastal protection and help in climate change mitigation and adaptation (Ysebaert *et al.*, 2019).

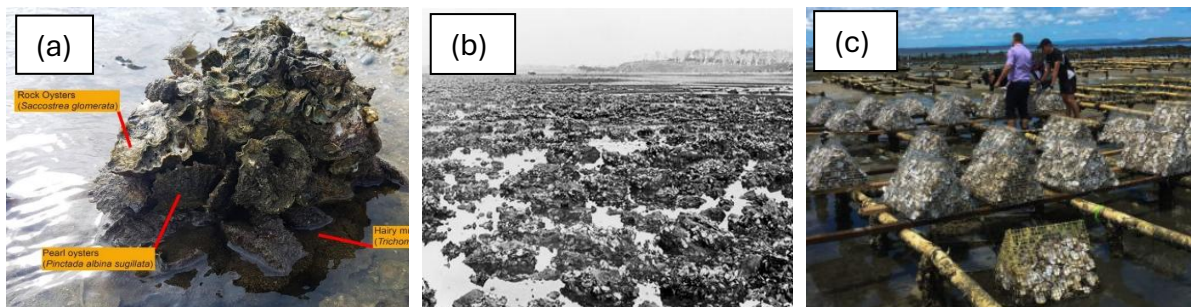


Figure 2. (a) An example of a small shellfish reef clump consisting of three bivalve species and demonstrating their attachment to the hard substrates of other shells. (b) Intertidal oyster bank (or shellfish reef) at Toorbul Point in 1906 (Photo from John Oxley Library). (c) Experimental oyster baskets, or artificial shellfish reefs in Moreton Bay (Photo courtesy of Robbie Porter).

History

Sydney rock oysters (*Saccostrea glomerata*) historically formed extensive oyster banks covering 2,036 ha of Moreton Bay by 1886 (Thurston *et al.*, 2019). These were mined for food and lime, with the production peaking in 1891 (Diggles, 2013), reaching nearly 21,000 sacks (approximately 1890 tonnes) from Moreton Bay.

The decline in oyster landings and presumably reefs began from the 1920s and continued throughout the 20th century (Thurston *et al.*, 2019). By 1920, oyster farmers shifted their focus almost exclusively to cultivation on intertidal banks (Diggles, 2013). Oyster farms still exist in Moreton Bay today, albeit on a significantly reduced scale, covering only 435 hectares in 2008. However, Diggles (2013) notes that while harvesting was significant, it is unlikely to have been the primary cause of the large-scale decline in shellfish reefs, as prolific recruitment was noted to replenish the beds.

The primary drivers for the decline and loss of shellfish reefs from the 1920s onwards have been identified as a combination of flood events, poor water quality and diseases (Diggles, 2013; Thurston *et al.*, 2019). All of these are related to the impacts of sedimentation on these organisms, as described below.

Impacts of sedimentation

The impacts of sedimentation on epibenthic bivalve reefs in Moreton Bay are broadly described in the conceptual model (Figure 3). Given the important ecological, cultural and economic role played by epibenthic bivalves in Moreton Bay, there is particular concern for the impacts of sedimentation on these taxa.

The primary processes by which sedimentation impacts epibenthic bivalves include:

1. Habitat changes

Sediment has transformed large areas of benthic habitat in the Bay from sandy to muddy, with muddy bottom habitats increasing significantly in extent over time (Jones *et al.*, 2011; Saeck *et al.*, 2019a; Grinham *et al.*, 2024). Significant areas of clean sand have been replaced by mud, with muddy sediment habitats increasing by more than 50% between 1970 and 2015, to over 860 km², making mud the dominant sediment type in the Bay (Kemp *et al.*, 2019; Grinham *et al.*, 2024). Clean sand habitats have declined by 20% (260 km²) over the 30-year period from 1970 to 2011.

Major floods starting in 1887 introduced large amounts of sediment and nutrients into the Bay. The impacts of these flood events were exacerbated by the increased movement of sediment through the landscape (sediment flux) due to European land-use practices, such as deforestation, which accelerated significantly by 1870. These changes are highly likely to have increased sedimentation in the Bay by a factor of ~10 from the late 1800s onwards (Coates-Marnane *et al.*, 2016b). Habitat changes from sandy towards more muddy substrates directly impact bivalve and other groups as follows:

- (i) Favours mud-dwelling, deposit feeding species: Muddy substrates favour populations of mud-dwelling, deposit feeding species such as cockles, polychaetes and gastropods (Jones *et al.*, 2011; Diggles, 2013; Richardson *et al.*, 2015; Ellis *et al.*, 2017; Pandolfi *et al.*, 2019). However, even deposit-feeding species can be smothered and buried, potentially causing major declines (e.g. 90%) in macrofauna within 10 days (Gibbs and Hewitt, 2004; Anderson *et al.*, 2019).
- (ii) Reduces populations of suspension-feeding species: A change from sandy to muddy substrates reduces populations of suspension-feeding species such as oysters and mussels, which prefer firmer and/or sandy substrates (Healy and Potter 2010; Ellis *et al.*, 2017).
- (iii) Reduces primary productivity: The incursion of muddy habitats directly reduces primary productivity through an increase in suspended sediments and hence, water clarity and light penetration (Jones *et al.*, 2011; Lockington *et al.*, 2017). Elevated suspended sediments also have significant implications for benthic-pelagic coupling (Jones *et al.*, 2011; Ellis *et al.*, 2017; Anderson *et al.*, 2019). In this altered state, sediment microbial nutrients become decoupled from benthic productivity and are instead released into the water column (Saeck *et al.*, 2019a). The resulting nutrient flux

boosts pelagic productivity, further reducing light availability and reinforcing the muddy conditions (Saeck *et al.*, 2019a).

(iv) Reduces the availability of hard substrates: The incursion of muddy habitats promotes algal turf growth, which traps sediment and reduces the availability of hard substrates on which many larger shellfish reef-forming bivalves can settle (as post larval stage) and grow into reproducing adults (Ellis *et al.*, 2004; Diggles 2013; Albert *et al.*, 2021). This has implications for future shellfish reef recovery or the placement of artificial shellfish reefs, in that areas that were once used by bivalves for settlement and growth may no longer be suitable, thereby reducing the potential for future shellfish reefs in the Bay (B. Gilby, pers. comm.).

2. Smothering and burial

Sediment deposition can directly smother and bury benthic animals, including epibenthic bivalves living on and in sediments (Lockington *et al.*, 2017). Smothering was identified as a significant cause of mortality for oysters in subtidal shellfish reefs following flood events in the late 1800s (Diggles, 2013), and it is also likely to impact the remaining shellfish reefs in future floods.

3. Poor water quality

Diggles (2013) suggests that declining water quality in Moreton Bay is considered the ‘overriding mechanism’ responsible for the decline of oyster reefs over the last 120 years. Historical epidemiology suggests that water quality decline, often associated with sedimentation and organic enrichment, contributes to the loss of shellfish reefs (Diggles, 2013). Sedimentation and sediment resuspension, combined with nutrient loading, can generate sediment-laden algal turfs over hard surfaces, which is sufficient to cause multi-generational recruitment failure for oyster spat in subtidal areas (Diggles, 2013). Ellis *et al.* (2004) also suggest that increases in suspended sediment reduce the energy intake of bivalves due to their ingestion in place of higher energy food sources.

4. Diseases

Increased sedimentation promotes organic enrichment and eutrophication, which can lead to increased abundance of spionid polychaete mudworms (Diggles, 2013). Historically, the decline of subtidal oyster reefs after flood events was associated with infestations by mudworms. Diggles (2013) also suggests that endemic mudworms increased in numbers due to siltation and organic enrichment caused by land clearing and increased water traffic.

The expansion of muddy areas due to increased sedimentation may have also increased the prevalence of the QX disease, caused by the paramyxean pathogen *Marteilia sydneyi*. The intermediate hosts for the pathogen include some of the mud-dwelling polychaetes, whose habitats have expanded due to sedimentation. This has potentially increased the impacts of infection on oysters (Diggles, 2013). These mortalities associated with QX disease emerged in the late 1960s and continue to this day. QX epizootics are particularly severe following flood events in disturbed catchments (Diggles, 2013).

Both of these disease issues are driven by declining water quality from anthropogenic catchment development (Diggles, 2013).

5. Recruitment failure

Diggles (2013) indicates a loss of approximately 96% of the vertical zonation suitable for oyster habitation. They suggest that dying oysters are not being replaced by new spat at lower tidal levels. This recruitment failure is likely caused by the lack of suitable hard surfaces for larvae to settle on, as resuspended sediments, stimulated by eutrophication, lodge in algal biofilms covering these surfaces (see 3. Poor water quality section above).

Recommendations

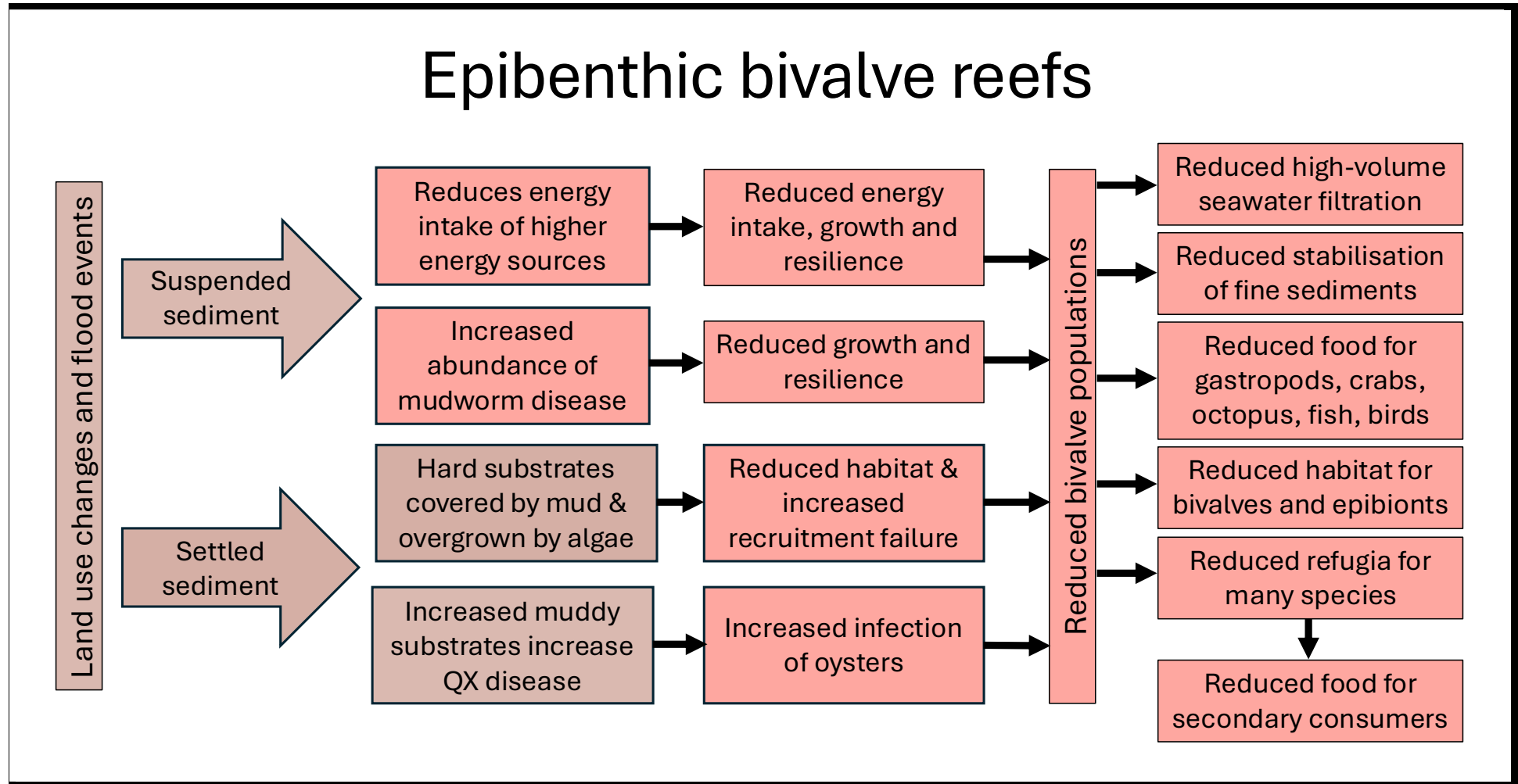
1. View oyster reefs as important habitats for fish and other species and as part of a more expansive, connected seascape (Gilby *et al.*, 2018b).
2. Substantially reduce terrestrial runoff to reduce the impacts of sedimentation, eutrophication and hypoxia on key benthic habitats (Gilby *et al.*, 2018b).
3. Restore shellfish reef habitats using clear, quantifiable goals and adaptive management based on robust, ongoing monitoring (Gilby *et al.*, 2018b).
4. Monitor the physicochemical environment and ecological processes (e.g., scavenging, predation, nutrient cycling) as indicators of ecosystem health (Gilby *et al.*, 2018b).

Expert reviews

Associate Professor Ben Gilby (Assoc Prof Animal Ecology, University of the Sunshine Coast) and Robbie Porter (Ozfish) kindly provided expert review of the Epibenthic bivalve reefs: Sedimentation Impact Statement.

Conceptual model - impacts of sedimentation on epibenthic bivalve reefs

Figure 3. Conceptual model that qualitatively describes the major impacts of sedimentation on epibenthic bivalve reefs in Moreton Bay. Brown boxes signify sedimentation-related processes; red boxes signify adverse impacts/outcomes.



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***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 5.9** 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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