Sedimentation impacts in Moreton Bay: a priority knowledge synthesis

IMPACTS: Seagrass

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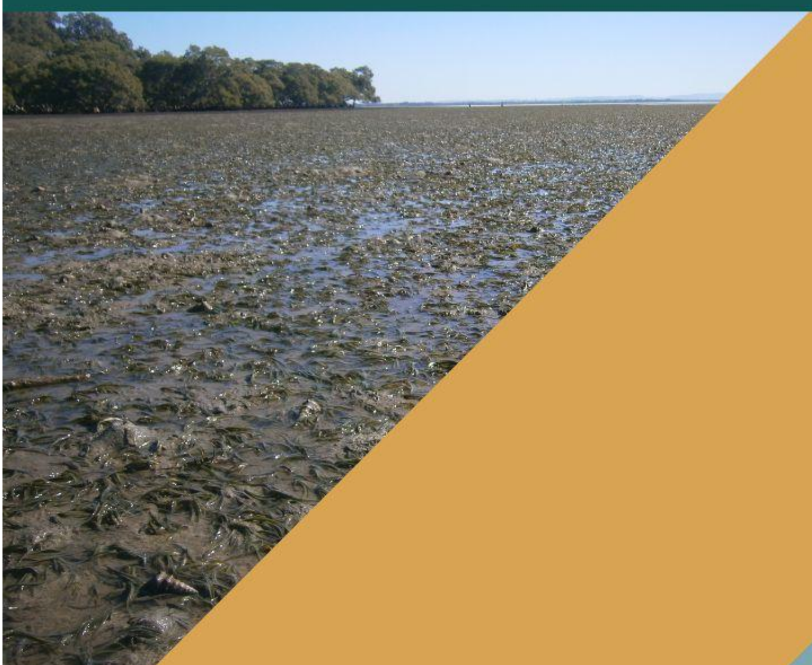

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This impact statement is drawn from

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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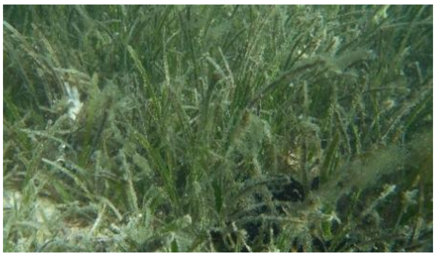
Seagrass: Sedimentation Impact Statement



Moreton Bay seagrass and epiphytes
Photo credit: T. Skewes

Status and trends summary

Table 1 provides a qualitative assessment of seagrass communities in Moreton Bay, highlighting their current condition, future trajectory and the impacts of sedimentation. Seagrasses are a prominent feature of the Moreton Bay ecosystem, providing important nursery, shelter and critical feeding habitat for many species. However, the steady increase in flood events since the 1990s has brought corresponding increases in sporadic terrigenous sediment influxes, reducing the light availability and healthy oxygenated sediments they rely on. Consequently, healthy seagrass beds have substantially reduced in area, mainly due to accretion and smothering, and low light penetration from resuspended sediments in turbulent conditions. Hence, their current condition has been assessed as 'Fair' with 'High' confidence (Table 1).

The condition trend is assessed as 'Declining', with 'High' confidence (Table 1). This mainly reflects the increasing trend in the frequency of large floods and associated sediment loads. It seems clear that without substantial reversals in sediment loads, seagrass communities will continue to experience unsustainable mortalities through high frequency of (i) light reduction via high ongoing loads of suspended sediments, (ii) smothering and burial and (iii) degradation of rhizosphere physico-chemistry and healthy oxygenated sediments. The consequent degradation of seagrass communities will flow on to corresponding declines in a wide range of species groups that rely on seagrass habitats.

Table 1. Qualitative assessment of the overall status and trend in condition, and of the likely severity and direction of sedimentation-specific impacts, for seagrass populations in Moreton Bay
[depends on region within the Bay (Healthy Land & Water, 2023)].*

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

Overview

Seagrasses are marine flowering plants that form meadows in intertidal and subtidal areas of Moreton Bay up to five meters in depth (Kovacs *et al*. 2019; Maxwell *et al*., 2019) (Figure 1), although some *Halophila* species in the northern Bay can be found below ten meters (Maxwell *et al*., 2019). They are a prominent feature of the Moreton Bay ecosystem, which includes seven species such as *Halophila ovalis* (a colonising species), *Zostera muelleri* (an opportunistic species), and *Cymodocea serrulata* (*a* persistent species) (Maxwell *et al*., 2019).

The largest continuous seagrass community is located on the Eastern Banks, situated between Moreton (Mulgumpin) and North Stradbroke (Minjerribah) Islands (Kovacs *et al*., 2019) (Figure 2), where at least six of the seven species are present, with varying degrees of species diversity and cover over time and space (Maxwell *et al*., 2019). Seagrass communities in the western and southern embayments are less diverse. *Z. muelleri* is the dominant species in these western and southern areas, with *H. ovalis* and *H. spinulosa* also occurring (Maxwell *et al*., 2019).

These meadows are an important habitat for numerous organisms and are recognised globally for their biodiversity and as critical nursery habitats for commercially important fish and invertebrate species (Leigh *et al.,* 2013; Maxwell *et al*., 2019). They also play important roles in coastal protection, and as carbon stocks.

However, the diversity of species within seagrass meadows decreases in areas with poorer water quality, particularly in the southern and western embayments of the Bay (Maxwell *et al*., 2019).

Population status

The Healthy Land and Water report card (Healthy Land & Water, 2023) describes the status of seagrass in Moreton Bay as ‘Fair’ for the central bay, western bay and southern bay, but ‘Excellent’ for the eastern bay. Depth ranges for seagrasses have declined for most regions and are described as ‘very poor’ for the southern bay (Healthy Land & Water, 2023). Overall, the extent of seagrass within Moreton Bay remains ‘Fair’ (Healthy Land & Water, 2023).

Sensitive seagrass species, such as *Halophila*, have been lost in some subtidal areas, although large areas of seagrass have persisted despite the 2022 floods (Healthy Land & Water, 2023). The 2022 floods led to seagrass meadows retreating to shallower areas in some Bay regions (Healthy Land & Water, 2023). Over the long term, substantial recovery of seagrass has been observed in Deception Bay and Bramble Bay (Healthy Land & Water, 2023).

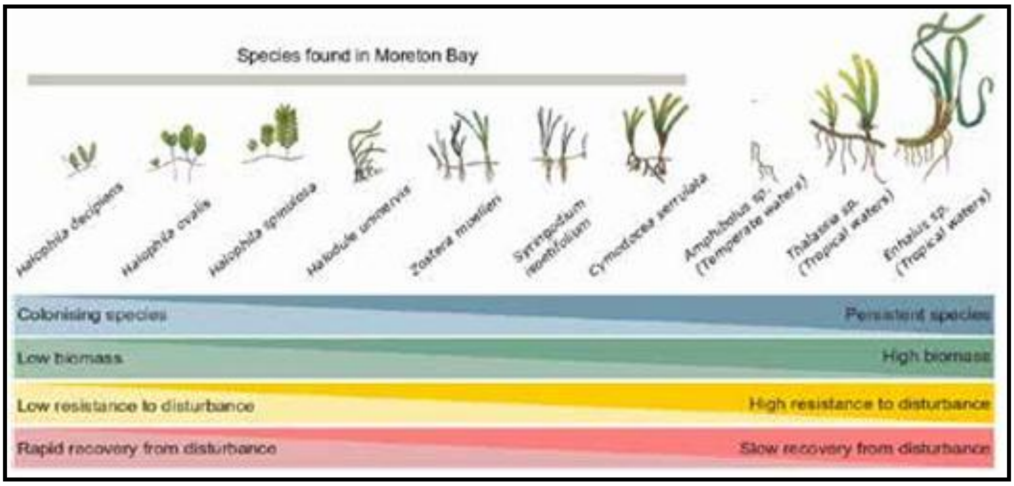


Figure 1. Seagrass species found in Moreton Bay. Extract from Maxwell et al. (2019).

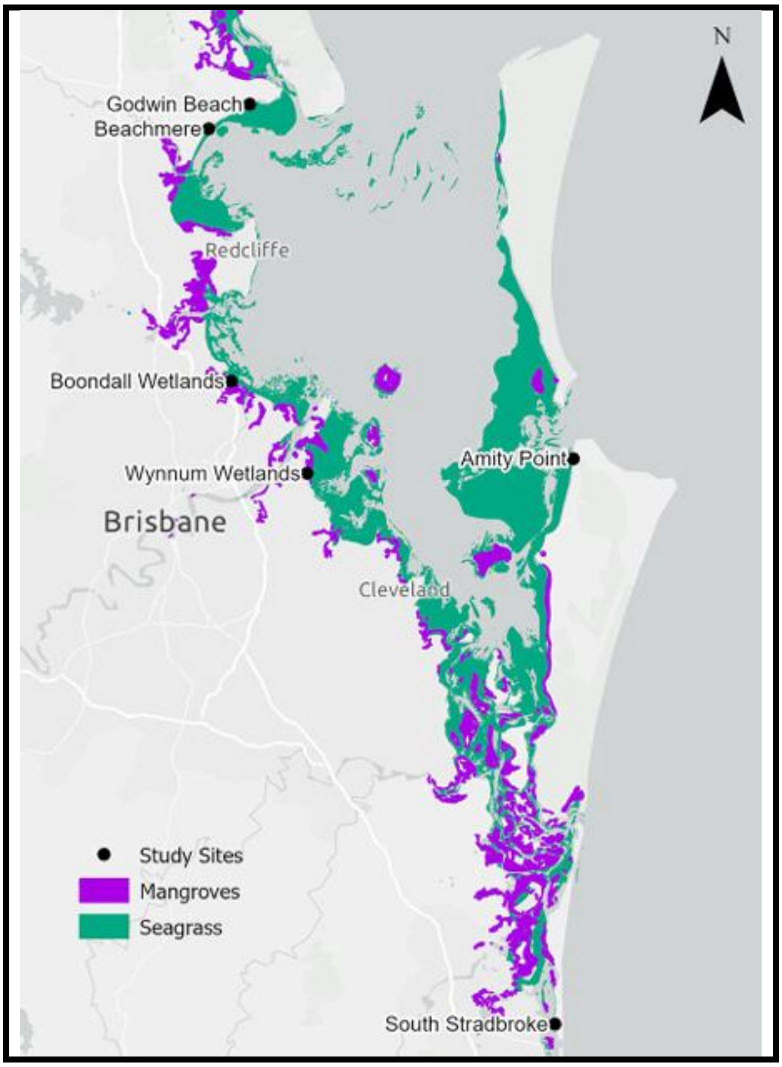


Figure 2. Distribution of Seagrass beds and Mangroves. Extract from Twomey et al. (2023).

Value

Ecological value

1. Habitat provision

Seagrass meadows serve as dominant habitat-forming components in shallow coastal zones globally (Zabarte-Maeztu *et al.*, 2021). They provide essential structure for prawn and fish communities, including commercially important fish and invertebrate species (Leigh *et al.,* 2013). They offer shelter, food, and structural habitat both above and below the substrate surface for numerous marine organisms (Zabarte-Maeztu *et al.,* 2021).

2. Food source

Seagrasses serve as a direct food source for a variety of herbivores, including charismatic megafauna such as green turtles (*Chelonia mydas*) and dugongs (*Dugong dugon*) (McKenzie *et al.,* 2021). In Moreton Bay, dugongs selectively feed on high-nutrient, low-fibre seagrass species like *H. ovalis*, and have been shown to prevent the spread of the more fibrous *Z. muelleri* by grazing, effectively cultivating areas for their preferred food (Maxwell *et al.*, 2019). Seagrasses also provide food for detrital and filter feeders (McKenzie *et al.,* 2021). Herbivorous fish, particularly rabbit fishes (*Siganidae*), consume seagrass in Moreton Bay, with juveniles preferring *Z. muelleri* (Maxwell *et al.*, 2019). Small gastropods like *Smaragia souverbiana* also target seagrass leaves, specifically preferring *Z. muelleri*, possibly due to lower phenol content (Maxwell *et al.*, 2019).

3. Biodiversity support

Seagrass ecosystems support high biodiversity (McKenzie *et al.,* 2021) and are globally recognised as hotspots for biodiversity (Maxwell *et al.*, 2019). The presence of seagrass significantly influences the abundance and types of species that use these areas (Maxwell *et al.*, 2019). The diversity effect also increases with the size of seagrass meadows and their proximity to other habitats (Maxwell *et al.*, 2019). Even during disturbances such as algal blooms, seagrass meadows continue to function as a nursery habitat for a diverse assemblage of fish and prawns (Maxwell *et al.*, 2019).

Connectivity between seagrass meadows and adjacent habitats, such as mangroves, is a vital factor influencing the abundance and types of species present, sometimes having a greater impact than the structural complexity of the meadow itself (Maxwell *et al.*, 2019). Sites in estuaries closer to seagrass patches consistently support a greater number of species and individuals than those further away (Maxwell *et al.*, 2019).

4. Ecosystem Engineering and Environmental Regulation

Seagrasses are described as 'ecosystem engineers' due to their ability to modify their environment (Zabarte-Maeztu *et al.*, 2021). For example:

- Seagrasses trap, accumulate and stabilise fine and suspended sediments - a major ecosystem service that supports coastal and marine systems (Maxwell *et al.*, 2019; Zabarte-Maeztu *et al.*, 2021).

- Seagrasses slow water movement and reduce near-bed currents, lessening physical stress on plants (Maxwell *et al*., 2019). This includes stabilising coastal areas by dampening waves, which reduces storm damage and promotes natural hazard regulation (Maxwell *et al*., 2019).
- Below-ground roots and rhizomes of seagrasses bind sediments, limiting resuspension and improving water clarity (Zabarte-Maeztu *et al*., 2021). This creates a positive feedback loop, enhances conditions for seagrass growth and extends their depth range (Maxwell *et al*., 2019). Following the 2011 flood in Moreton Bay, light quantity was significantly higher in areas with seagrass than in adjacent unvegetated sites (Maxwell *et al*., 2019).
- Seagrasses play a role in disease regulation by reducing harmful bacteria (McKenzie *et al*., 2021).
- Seagrass leaves provide grazing opportunities for other animals, helping to regulate broader ecosystem function and structure. Small fish and invertebrates graze on epiphytic growth on seagrass leaves, improving light conditions for photosynthesis and globally regulating ecosystem structure and function (Maxwell *et al*., 2019). In Moreton Bay, this grazing enhances seagrass persistence, particularly in areas with high nutrient loads (McKenzie *et al*., 2021).
- Seagrasses oxygenate the rhizosphere, the area surrounding their roots, modifying substrate chemistry and influencing the surrounding sediment environment (Zabarte-Maeztu *et al*., 2021).

5. Biogeochemical Cycling/Carbon Sequestration
Seagrasses contribute substantially to nutrient recycling (Maxwell *et al*., 2019). They are globally recognised as significant carbon stocks. Recent findings have highlighted high rates of carbon sequestration in sediments within seagrass meadows (Maxwell *et al*., 2019). They also play a role in regulating ocean acidification to increase calcification of reefs (McKenzie *et al.,* 2021).

Cultural value

Seagrasses in Moreton Bay provide substantial support for cultural values, including:

1. Support for traditional and contemporary fisheries and livelihoods
Seagrass meadows provide critical nursery habitats, food and shelter for marine communities that are the basis for valuable recreational and commercial fisheries for Aboriginal and non-Aboriginal residents (Ross *et al*., 2019a). Indigenous fishers have harvested seagrass-dependent seafood like finfish, crustaceans, shellfish, turtles, and dugongs for thousands of years, and these resources remain an important part of their culture today (Thurstan *et al.,* 2019). Some Quandamooka people continue to catch fish and shellfish, with mullet being culturally and economically significant (Thurstan *et al*., 2019).

2. Support for culturally significant species

Seagrass meadows serve as a food source for Green Turtles and Dugongs (Leigh *et al*., 2013), both of which are iconic coastal species in Moreton Bay and feature prominently in the Dreamtime stories of the Quandamooka people (Delaney, 2013). Traditional Custodians also link enhancing knowledge of local ecosystems to improving their care (Ross *et al*., 2019a).

3. Aesthetic appreciation

Aesthetic value is placed on waterways, and for Traditional Custodians, this appreciation is shaped by their ancestral connections, dreaming stories and a rich social memory (Ross *et al*., 2019a). They associate the aesthetic qualities of seagrass and their saltwater habitats with ecosystem health (Pinner *et al*., 2019) and feel despondent about the beauty that has been lost over time due to degradation (Ross *et al*., 2019a).

Economic value

Moreton Bay provides crucial ecosystem services to over two million people, including recreational and commercial fisheries, tourism, and aquaculture operations (Pascoe *et al*., 2025; Lockington *et al*., 2017). Seagrasses in Moreton Bay contribute significantly to various economic values, primarily through their role in supporting commercial and recreationally important species and activities (see † **Section 5.15**).

1. Support for commercial fisheries

Moreton Bay supports a significant commercial fishing fleet that provides fresh seafood, including prawns, crabs, and fish, many of which depend on seagrass for their survival (Pascoe *et al*., 2025). Maintaining the linkages between estuarine seagrass habitats and the larger meadows in the Bay is essential for supporting these commercial fisheries (Maxwell *et al*., 2019).

2. Support for recreational fisheries

Seagrass meadows are also the basis for valuable recreational fisheries in Moreton Bay (Leigh *et al.,* 2013). The region attracts large numbers of recreational anglers each year, many of whom prize fish species found in habitats supported by seagrasses (Pascoe *et al*., 2025). The importance of seagrass connections to other habitats is also noted for supporting recreational fisheries (Maxwell *et al.,* 2019).

3. Broader Economic Activities

The role of seagrasses in maintaining overall ecosystem health and supporting key species contributes to the appeal and functionality of the Bay. Seagrasses are also included in areas declared as RAMSAR sites and no-take zones within the Moreton Bay Marine Park, highlighting their recognised importance for protecting iconic coastal species and managing fisheries (Lockington *et al.,* 2017). High rates of carbon sequestration within seagrass sediments are also noted, emphasising the valuable ecosystem services these habitats deliver.

History

Historically, seagrass has been absent or sparse in some western embayments (Kovacs *et al*., 2019). An undocumented total loss in Bramble Bay is believed to have happened before the 1980s (Kovacs *et al*., 2019). Following flood events between 1987 and 1998, a loss of 2,000 hectares was calculated for southern Deception Bay, and an estimated loss of 800 hectares occurred around the southern Bay islands (Kovacs *et al*., 2019). However, since these historical losses, there have been no recorded large-area seagrass losses in the western Bay, even after major flood events in 2011 and 2013 (Kovacs *et al*., 2019).

The overall cover of intertidal seagrass in the western Bay has been reported as stable since 2001, and stable in Pumicestone Passage since the early 1970s (Kovacs *et al*., 2019). Encouraging recovery of meadows has been observed in some degraded areas, such as southern Deception Bay and parts of Bramble Bay (Maxwell *et al*., 2019). Near the Fisherman Islands port development, there has been a trend of slight seagrass expansion into deeper waters. At the same time, areas subject to bait worming have experienced a decrease in seagrass cover (45-54%) (Kovacs *et al*., 2019). Despite monitoring efforts, the exact current extent of seagrasses and how they vary temporally is difficult to quantify (Maxwell *et al*., 2019).

Impacts of sedimentation

The impacts of sedimentation on seagrass communities in Moreton Bay are broadly described in the conceptual model (Figure 3). Seagrasses in Moreton Bay are subject to threats that have been steadily increasing since the 1990s (Maxwell *et al*., 2019). The major drivers of seagrass decline include increased sediment and nutrient inputs from rainfall events via their catchment sources (Leigh *et al*., 2013). For example, in areas like Deception Bay, Bramble Bay and around Mud Island, fine sediments from the Brisbane River are regularly resuspended and contribute to poor water clarity (Adams *et al*., 2016). Port development and maintenance are another significant contributor to sediment loads that are introduced into the coastal benthic systems of Moreton Bay.

Such inputs of fine sediments from rivers, combined with wave action, contributes to significant sediment deposition and resuspension and makes seagrass survival and recolonization difficult. Consequently, these rainfall events have led to sediment accretion in the central basin increasing three to nine times over the past 100 years and have historically caused substantial seagrass loss (Maxwell *et al*., 2019).

The increased sedimentation into the Bay stems from both anthropogenic activities and natural processes (Kovacs *et al*., 2019), with climate change and land-use change considered to be major threats (Maxwell *et al*., 2019). Modelling indicates that increasing sediment loads, as predicted under future climate and management scenarios, are expected to cause a non-linear decrease in habitat suitable for seagrass (Maxwell *et al*., 2019; Saunders *et al*., 2019). With the population of South-East Queensland projected to increase significantly, pressures on seagrass ecosystems are expected to rise (Maxwell *et al*., 2019).

Declining water quality, associated with increased sediment, as well as toxins and nutrients, also contributes to the decline of seagrass and estuarine ecosystems and can manifest as increased phytoplankton blooms (Leigh *et al*., 2013; Kemp *et al*., 2019). Other impacting factors include changes in salinity, epiphyte cover, disease, pollution, large-scale blooms of the toxic filamentous cyanobacteria *Lyngbya majuscula* and other human impacts such as port development and bait worming (Kovacs *et al*., 2019; Maxwell *et al*., 2019).

The primary processes by which sedimentation impacts seagrasses include:

1. Reduction in light availability

Increased suspended sediment loads in coastal waters cause reduced light penetration to the seabed (Adams *et al*., 2016; Zabarte-Maeztu *et al*., 2020). Seagrasses, being primary producers, require sufficient sunlight for photosynthesis and growth. This reduction in light reduces seagrass productivity and growth (Saeck *et al.,* 2019b) and is considered a major cause of seagrass loss globally (Adams *et al*., 2016; O'Brien *et* al., 2018; Zabarte-Maeztu *et al*., 2020, 2021).

Light availability is the single most important driver of seagrass distribution in the Bay and is primarily controlled by water clarity, which is influenced by catchment-derived sediment (Maxwell *et al*. 2019). Settled fine sediment can also continue to shade seagrasses after deposition (Zabarte-Maeztu *et al*., 2020). Wave action can then resuspend sediment, which reduces light availability, lowers the depth limit of seagrass, and reduces sediment nutrient processing (O'Brien *et al.,* 2011; Adams *et al*., 2016). These impacts can lead to a regime shift from a clear to a turbid environment (O'Brien *et al.,* 2011). While studies frequently investigate light reduction as a single impact mode, it often occurs alongside other sediment effects (Zabarte-Maeztu *et al*., 2021),

2. Smothering and burial

Fine sediment can settle on seagrass leaves, leading to smothering, which inhibits photosynthesis by shading, increases oxygen demand, and restricts the exchange of metabolites (Zabarte-Maeztu *et al*., 2021). While excessive burial is detrimental, some degree of fine sediment accumulation and stabilisation is a natural process that can be advantageous for ecosystem functions, such as carbon sequestration (Zabarte-Maeztu *et al*., 2021).

In more severe cases, complete burial of the plant can occur, initiating these damaging mechanisms (Zabarte-Maeztu *et al*., 2021). The tolerance of seagrasses to burial varies by species (Cabaco *et al*., 2008), with smaller seagrass species generally being more vulnerable to the effects of fine sedimentation, such as burial (Zabarte-Maeztu *et al*., 2021). Burial thresholds (levels causing 50% or 100% shoot mortality) have been estimated for different species, ranging from 2 cm for *H. ovalis* to 19.5 cm for *Posidonia australis* in experimental settings (Cabaco *et al.,* 2008). *Posidonia sinuosa* is a large, slow-growing persistent species and was unaffected by burial depths of 1 and 4 cm for up to eight weeks, however, burial depths of 8 cm and 16 cm led to significant negative impacts on ramet photophysiology and growth (Webster *et al.*, 2025).

High concentrations of fine sediments or high sediment mud concentrations can also hinder the presence of seagrass. The estimated threshold for seagrass presence is a sediment mud concentration less than 50% (Adams *et al.*, 2016).

3. Degradation of rhizosphere physico-chemistry

When fine sediments and associated organic matter settle, they can intrude into the substrate pore space (Zabarte-Maeztu *et al.*, 2021). This intrusion reduces substrate porosity and permeability, which can exacerbate hypoxia (Zabarte-Maeztu *et al.*, 2020). Mud with high organic content is considered particularly problematic in this regard and can hinder seagrass growth and prevent recovery (Zabarte-Maeztu *et al.*, 2020). Webster *et al.*, (2025) noted that at burial depths of 8 cm and 16 cm, sediment redox damaged seagrass health, reflecting conditions consistent with impaired plant physiology and anoxic sediment in the root zone. Furthermore, sulphide intrusion was identified as a key driver of negative impacts on seagrass from burial, especially at depths where plants were still photosynthesising, but growth declined (e.g. 8 cm) (Webster *et al.*, 2025).

These three processes by which sedimentation impacts seagrasses (see above) often operate simultaneously and can also interact, potentially accelerating seagrass loss (Zabarte-Maeztu *et al.*, 2021). Fine sediment frequently interacts with nutrient enrichment, which can lead to increased organic matter. This interaction can cause additional shading by phytoplankton and epiphytes and impose extra oxygen demand, further complicating the seagrass response (Zabarte-Maeztu *et al.*, 2020).

Recommendations

1. Tailor management efforts to specific regions within Moreton Bay, as the environmental factors limiting seagrass presence can differ significantly between adjacent areas (Adams *et al.*, 2016). Species distribution models (SDMs) can be used to identify these local limiting factors and assess management options.
2. Prioritise water quality improvement:
    - Reduce the delivery of sediments and nutrients through catchment management (Adams *et al.*, 2016).
    - Improve the implementation of silt curtains to manage sediment (Saeck *et al.*, 2019b).
    - Continue efforts to reduce point-source nutrient loads, such as upgrades to sewage treatment plants (Maxwell *et al.*, 2019).
3. Mitigate direct physical effects:
    - Address high wave action, which can physically remove seagrass and resuspend sediment, through methods like break walls or gabions (Adams *et al.*, 2016). These actions should be prioritised in regions where wave action is the primary hindrance.

- Stabilise sediment in areas prone to resuspension. This can be achieved through the deployment of hessian bags or shell armour (Adams *et al.*, 2016). These methods can protect seagrass due to wave action and temporarily create a positive feedback loop for sediment stabilisation until meadows establish naturally (Adams *et al.*, 2016).

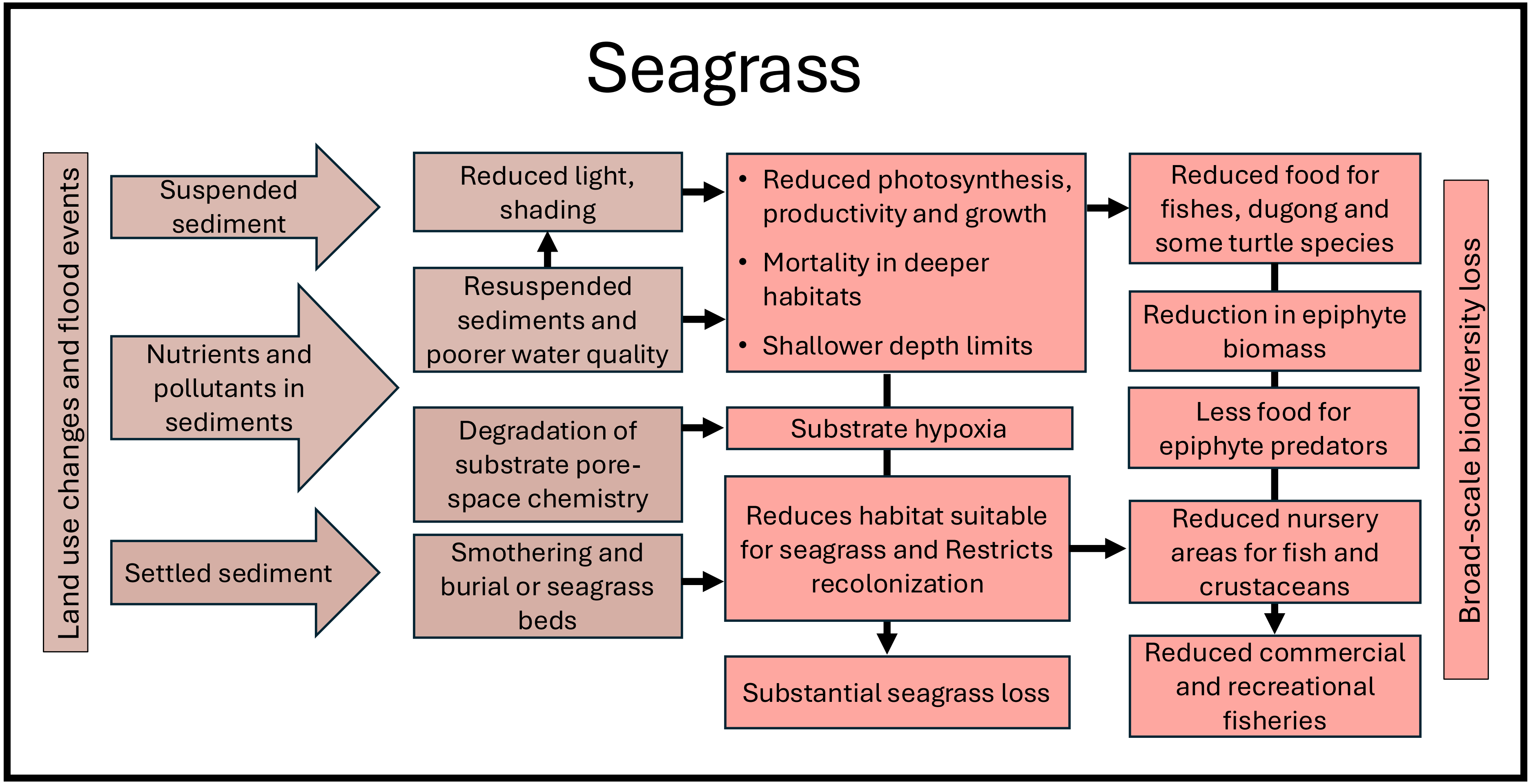
4. Enhance ecological feedback processes and resilience:
   - Focus on enhancing the biomass of existing seagrass meadows, especially in bistable areas (Maxwell *et al.*, 2015).
   - Implement actions that enhance natural feedback processes that promote resistance to impact and break down feedback processes that prevent recovery (Maxwell *et al.*, 2015, 2019). For example, managing to enhance grazing rates (e.g. through protecting herbivores or designating no-take fishing areas) can limit algal loads and improve seagrass growth and abundance (Maxwell *et al.*, 2015).
5. Support ongoing research and monitoring:
   - Develop and validate models (like SDMs and Bayesian Networks) to identify areas at risk of seagrass loss and to prioritise conservation and restoration efforts (Maxwell *et al.*, 2015; O'Brien *et al.*, 2011). These models can integrate disparate data types and provide high-spatial-resolution risk maps (Maxwell *et al.*, 2015).
   - Maintain long-term water quality monitoring programs that couple water quality indicators with ecosystem indicators (e.g. phytoplankton and benthic microalgae community composition and nutrient response) to track and respond to eutrophication pressures (Saeck *et al.*, 2019b).
   - Further investigate the complex relationships between multiple stressors (e.g. light, sediment, nutrients, wave action) and their impacts on seagrass, particularly how they affect light thresholds and the mechanisms of mud damage (Maxwell *et al.*, 2019; Zabarte-Maeztu *et al.*, 2021).
   - Address knowledge gaps, such as the full extent of seagrasses, their temporal variation, and their economic, social, and ecological value (Maxwell *et al.*, 2019).
   - Support socio-economic and cultural valuation of seagrass ecosystems (McKenzie *et al.*, 2021).
   - Build scientific literacy and awareness to foster local stewardship for seagrass conservation (McKenzie *et al.*, 2021).

Expert review

Dr Paul Maxwell (General Manager, EcoFutures Consulting) kindly provided an expert review of the Seagrass: Sedimentation Impact Statement.

Conceptual model - impacts of sedimentation on seagrass

Figure 3. Conceptual model that qualitatively describes the major impacts of sedimentation on seagrass communities 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 5.2** 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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