NIWA
Taihoro Nukurangi

New Zealand seagrass

General Information Guide

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What is seagrass and where do you find it?

Seagrass is a marine flowering plant that inhabits the coastal zones of all continents except Antarctica. Seagrasses colonised the sea from terrestrial ancestors about 100 million years ago. New Zealand has only one species of seagrass, which is indigenous but also occurs naturally in southern parts of Australia. This species is *Zostera muelleri* (Māori: rimurēhia).

Historically, New Zealand specimens have also been referred to as *Z. novazelandica* and/or *Z. capricorni* but now all are classified as a single species[1,2]. Elsewhere in the world there are many other seagrass species; around 30 species in Australia and 50–60 species worldwide.

Zostera muelleri grows on silty or sandy tidal flats, channels and rivermouths in estuaries, on some coastal beaches and rocky reef platforms[3], and in shallow waters near offshore islands[4].

In New Zealand, seagrass is recorded as mostly intertidal (exposed at low tide and covered by shallow water at high tide) rather than subtidal (always underwater). This may be because of the relative ease with which intertidal meadows can be detected, and also the greater sensitivity of subtidal meadows to declining coastal water quality. Seagrass meadows have been recorded throughout New Zealand, from Parengarenga Harbour in Northland to Cooks Inlet on Stewart Island (the southern limit for seagrass worldwide) and a list of known records has been compiled[5]. Unfortunately, though, no systematic survey of seagrass distribution and abundance throughout New Zealand has been undertaken.

Diver sampling a subtidal seagrass meadow. Photo: Glen Carbines, NIWA

An extensive intertidal seagrass meadow in Whangapoua Harbour, Coromandel Peninsula. Photo: Fleur Matheson

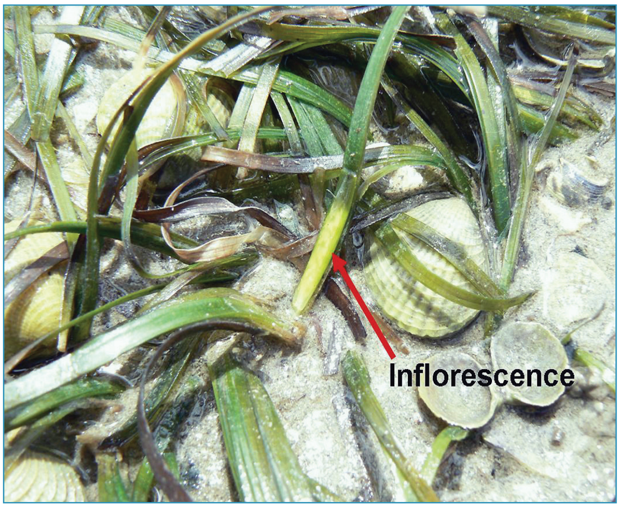
Seagrass growing on an intertidal, rocky reef, Gisborne. Photo: Jacquie Reed

Intertidal seagrass meadows in Tauranga Harbour. Photo: Virginie Dos Santos

What does it look like?

Zostera muelleri is a small plant compared to some of the larger-leaved specimens that grow elsewhere, particularly in tropical waters. It has thin, olive-green, ribbon-like leaves. The leaves range in size from approximately 5–30 cm in length (but usually around 10 cm) and 0.1–0.4 cm in width. When exposed at low tide, the leaves of intertidal plants lie flat on the sand and it can be difficult to recognise seagrass plants from a distance unless they are growing as a dense meadow. When submerged, the plant leaves float upright.

Seagrass leaves protruding from the sediment.
Photo: Fleur Matheson



Seagrass flowering shoot (inflorescence). Photo: Fleur Matheson

Seagrass plants have an underground root network and grow by creeping through the sand, continuously sending out new horizontal root runners (rhizomes) from which new stems, leaves and finer roots arise. Seagrass plants can also flower and produce seed but flowering has not often been reported for *Zostera muelleri* in New Zealand[6,7]. Seed production may be therefore rare or episodic[7,8].

Typical New Zealand specimen of Zostera muelleri.
Photo: Anne-Maree Schwarz, World Fish Center

Seagrass inflorescence showing female protruding stigma to catch male pollen for fertilisation.
Photo: Virginie Dos Santos

Seagrass leaf canopy.
Photo: Virginie Dos Santos

Why are seagrass meadows important?

Seagrass meadows are one of a number of valuable natural habitat types that occur in our coastal waters. Other examples include shellfish beds, mangrove and kelp forests, open sand flats and rocky reef platforms. They provide shelter and food for particular marine invertebrates and fishes, and foraging grounds for certain shorebirds.

Dense meadows of seagrass can stabilise the sea bed and reduce erosion. Seagrass leaves trap fine sediments and reduce particle loads in the water by slowing water movement and encouraging particle deposition[9,10] which improves the water clarity. Seagrass plants absorb nutrients from the water and seabed. They also release oxygen from their leaves and roots, which is beneficial for other biota and stimulates nutrient cycling.

Decaying seagrass is decomposed by bacteria and fed on by small marine animals (particularly snails but also worms, bivalves, and crabs), both within and adjacent to seagrass meadows[11], supporting the marine food web[11,12,13].

Crab in seagrass. Photo: Fleur Matheson

The small crustaceans and worms that live in seagrass meadows[14,15] are important sources of food for wading birds (such as the South Island oyster catcher, pied stilt, royal spoonbill, bar-tailed godwit) and fish (such as mullet, stargazers and juvenile flatfish)[5]. Snapper and leatherjacket juveniles, mullet, trevally, garfish, parore, spotties, pipefish and triplefins are often abundant in subtidal seagrass meadows in particular, but also reside in intertidal meadows when the tide is in[3].

Juvenile snapper found in seagrass in Rangaunu Harbour, Far North. Photo: Mark Morrison

*Seagrass with the seaweed Neptunes necklace (*Hormosira banksii*) and various marine shellfish (snails and bivalves).* Photo: Fleur Matheson

Seagrass meadow with dense cockle bed at the edge.
Photo: Fleur Matheson

Why are seagrass meadows important?
(continued)

Seagrass meadows in Kaipara Harbour are an important nursery ground for west coast snapper[16,17]. Shellfish (including cockles and the New Zealand scallop), especially juveniles, are also common in seagrass meadows[5]. They are often most abundant at the edges of seagrass beds probably because drifting juveniles are deposited there where water movement first begins to slow, or because the dense root mat of the seagrass bed interior hinders animal movement[14].

Seagrass plants may be grazed directly by larger animals. Worldwide there are a number of fish families with species known to consume living seagrass leaves (parrotfish, porgies, leatherjackets, and rabbitfish). Sea urchins, green turtles, dugongs, manatees (sea cows), and geese are also grazers of seagrass in other countries. In New Zealand, there appears to be fewer large seagrass grazers. Seagrass fragments are thought to be a food source for the garfish[5] but, in general, the importance of seagrass as a food source for New Zealand coastal fish is not well known.

The crab *Macrophthalamus hirtipes* grazes the rhizomes of seagrass growing on rocky intertidal platforms at Kaikoura[12]. The only New Zealand shorebird known to graze directly on seagrass is the black swan *(Cygnus atratus)*. Flocks of swans often gather in estuarine areas, particularly during the moulting season (summer–autumn), where they graze mostly on seagrass[18,19,20].

Seagrass detritus washed up on the shore. Photo: Fleur Matheson

Damage to seagrass caused by black swans grazing.
Photo: Virginie Dos Santos

Black swans grazing on seagrass submerged in shallow water in Tauranga Harbour.
Photo: Virginie Dos Santos

Seagrass decline

Seagrass meadows have been, and may still be, experiencing a worldwide decline. The global loss rate for seagrasses is estimated to be 2–5% per year, compared with 0.5% per year for tropical forests[21]. In New Zealand, significant declines in seagrass meadows took place mostly between the 1930s and 1970s in Whangarei, Waitemata, Manukau, Whangamata and Tauranga Harbours, as well as in the Avon-Heathcote estuary in Christchurch[4,5]. Other declines may not have been recorded. Detailed analysis of historical and recent aerial photographs shows that around one-third of the overall seagrass habitat was lost in Tauranga Harbour between the 1950s and 1990s, including a 90% loss of subtidal meadows[22].

Historical notes from the late 1800s and early 1900s suggest that seagrasses were once very abundant in certain New Zealand estuaries. Lush meadows in the Avon-Heathcote estuary harboured abundant eels and supported small shrimp and periwinkle fisheries. It was proposed at that time that seagrass be harvested and shipped to London as a stuffing for mattresses and upholstered furniture, but this apparently did not eventuate.

Seagrass may have been a useful resource for Māori; the starchy seagrass rhizome was used as a food source and the leaves were occasionally used to adorn clothing[5].

Possible causes of seagrass decline

Natural

Extreme climatic events
- Hurricanes
- Severe storms

Wasting disease
- Marine slime mould

Human

Pollution
- Sediments
  - Runoff from land
- Nutrients
  - Runoff from land
- Wastewater
- Herbicides
  - Runoff from land
  - Boat hull antifouling
- Heavy metals
  - Industrial discharges
  - Chemical spills and stormwater
- Petrochemicals
  - Fuel spills

Physical damage
- Harbour developments
  - Channel dredging
  - Shoreline reclamation
  - Construction of ports, marinas, canals
- Commercial fishing
  - Trawling
- Aquaculture
  - Marine farm construction
- Recreational activities
  - Propeller, anchor and mooring scars
  - Dragging boat hulls across foreshore
  - Trampling by horses, quadbikes and vehicles

Introduced species
- Overgrazing
  - Waterfowl
- Competition
  - Invasive marine plants

Global climate change
- Sea level rise
- Sea temperature rise
- Increased storm frequency

Causes of seagrass decline include:

• Wasting disease

Seagrass decline first became an issue of global concern when extensive areas of seagrass (*Zostera marina*) along the North Atlantic coasts of North America and Europe disappeared in the 1930s. The cause was generally thought to be a wasting disease (a fungal infection of the internal tissues) caused by the marine slime mould, *Labyrinthula zosterae,* although the losses also coincided with a period of extreme storms. There has been slow and incomplete recovery of seagrass meadows in these devastated areas overseas.

Labyrinthula was detected in New Zealand seagrass in the 1960s and may have contributed to the widespread 'browning-off' and decline of seagrass meadows reported at sites around Auckland City (Okahu Bay, Torpedo Bay, Mellons Bay, Howick Beach, Tamaki River estuary) and Christchurch (Purau) during this period[23].

However, it has subsequently been detected in healthy *Labyrinthula* seagrass beds, including on intertidal rocky platforms at Kaikoura[7]. This suggests that the organism is often present on the plant (particularly in old leaves). Blooms can occur (affecting young leaves) when seagrass plants are stressed and/or conditions favour the growth of *Labyrinthula* (such as low light, warm temperatures, and high salinity)[24].

Zostera marina *leaves with* Labyrinthula*, 'wasting disease' infection.*
Photo: Peter Ralph, Sydney University of Technology

• Threats from introduced species

In both the intertidal and subtidal zones, New Zealand seagrass is threatened with displacement by invasive, introduced species. In the upper intertidal zone, seagrass is threatened with competitive displacement by cordgrass (*Spartina anglica* and *S. alterniflora*). *Spartina* was introduced and planted in a number of New Zealand estuaries between 1913 and the 1950s to aid land reclamation for grazing and habitation. Its rapid spread and smothering of natural ecosystems means it is now a pest plant and is managed by the Department of Conservation. Eradication programmes have been undertaken in several regions including Auckland, Waikato, Bay of Plenty and Southland[25,26].

*Cordgrass (*Spartina *spp.).* Photo: New Zealand Plant Protection Society

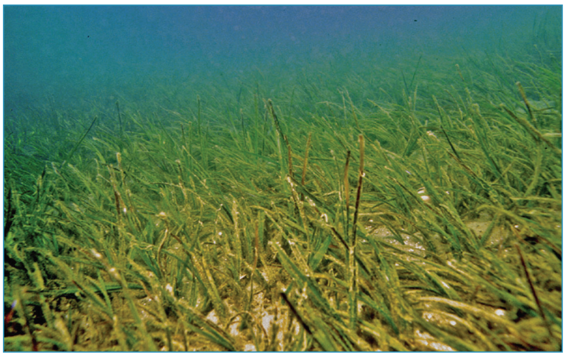
The marine aquarium weed *Caulerpa taxifolia* poses a serious threat to New Zealand's subtidal seagrass meadows. Although not yet detected in New Zealand coastal waters, a small amount of this plant was recently found in a saltwater aquarium in Auckland.

This invasive seaweed has had a devastating impact in the Mediterranean Sea, forming dense carpets which displace native seaweeds and seagrasses. *Caulerpa* is an unwanted and notifiable organism and if found must be reported to the Ministry of Fisheries or Biosecurity New Zealand[27].

*Marine aquarium weed (*Caulerpa taxifolia*).* Photo: Australian Institute of Marine Science (AIMS)

• Sedimentation and eutrophication

Pollution by human activities is considered to be the major contemporary contributor to seagrass decline worldwide and the reason for the slow and incomplete recovery of *Labyrinthula*-affected areas overseas. In New Zealand, sedimentation is regarded as the most widespread problem in our estuaries but nutrient enrichment (eutrophication) is also a concern[5,17,28]. Coastal marine areas downstream of urban areas discharging nutrient-rich wastewaters, or rural catchments with extensive fertiliser use, are particularly at risk from eutrophication.



Turbid water reduces the light penetration for seagrass photosynthesis. Photo: Malcolm Francis, NIWA

Pollution by fine sediments and nutrients results in poor water quality. Fine sediments, like silts and clays, are easily resuspended and make estuary waters turbid (cloudy), reducing light penetrating through the water needed by seagrass meadows for photosynthesis. Subtidal seagrass meadows are particularly vulnerable to pollution that affects water clarity. Sediments can also settle directly on the leaves of seagrass plants, burying or smothering them.

In estuaries in northern New Zealand where mangroves are present, deposition of fine sediments may encourage mangrove spread across the intertidal flats where they can compete with and displace intertidal seagrass meadows.

Intertidal seagrass smothered by sediment runoff in Whangapoua Harbour. Photo:Don Morrisey

Seagrass and mangroves cohabiting on the intertidal flats at Whangapoua Harbour. Photo: Anne-Maree Schwarz, World Fish Center

Nutrient pollution encourages the growth of nuisance microalgae and macroalgae (seaweeds). Microalgae include both phytoplankton (free-floating algae) and periphyton (algae that attach to surfaces including rocks, wood and seagrass leaves). Nuisance seaweeds found in New Zealand include the sea lettuce (*Ulva lactuca*) and gut weed (*Enteromorpha intestinalis*).

Seagrass with attached algae. Photo: Fleur Matheson

In the early stages of nutrient pollution the growth of seagrasses and algae may be enhanced, as both require nutrients for growth.

However, as nutrient pollution progresses, algae eventually outcompete seagrasses as they are typically better positioned (on seagrass leaves or floating in the water above) to intercept available light.

Seagrass meadow partially covered by the drifting seaweed, Neptunes necklace. Photo: Anne-Maree Schwarz, World Fish Center

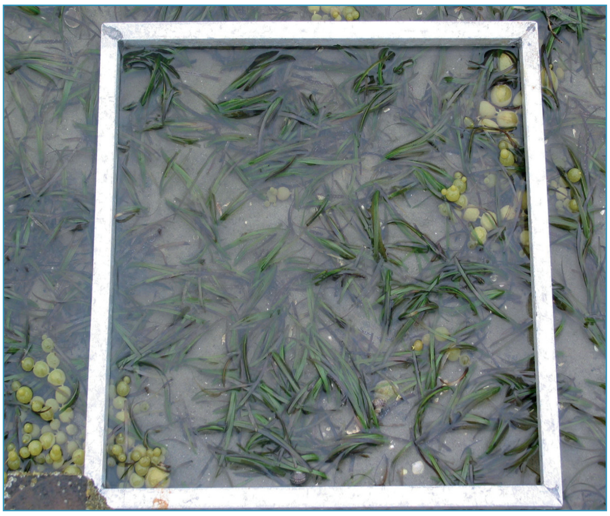
Seagrass near Tauranga smothered by drifting sea lettuce. Photo: Fleur Matheson

How do we know if it is declining in our area?

Seagrass meadows need to be monitored to determine whether their distribution, abundance and health are declining. Monitoring should be at least annually, for several years or more, to detect definitive trends. Monitoring of seagrass meadows in particular harbours or at specific sites may be carried out by coastal management agencies (e.g., the regional council) depending on monitoring priorities and available resources. Community groups can also become involved. SeagrassWatch is an international programme set up to help community groups monitor seagrass in their area[29].

In New Zealand, an Iwi Estuary Monitoring Toolkit is currently under development, which has a module dedicated to monitoring estuarine plant habitats, including seagrass[30]. Community groups may find both resources useful if they are concerned about the state of seagrass meadows in their local area and would like to assist coastal management agencies in monitoring and detecting changes in seagrass distribution and health.

Local kaitiaki roopu monitoring remnant seagrass in Whangarei Harbour. Photo: Fleur Matheson



A quadrat is a simple tool used to monitor seagrass cover. Photo: Fleur Matheson

A riparian buffer protecting a farm stream and trapping sediment and nutrient runoff from farmland. Photo: Paula Reeves,Wildlands Consultants

Dragging a kayak across seagrass beds can cause damage. Activities like this should be avoided. Photo: Virginie Dos Santos

How can we protect remaining seagrass?

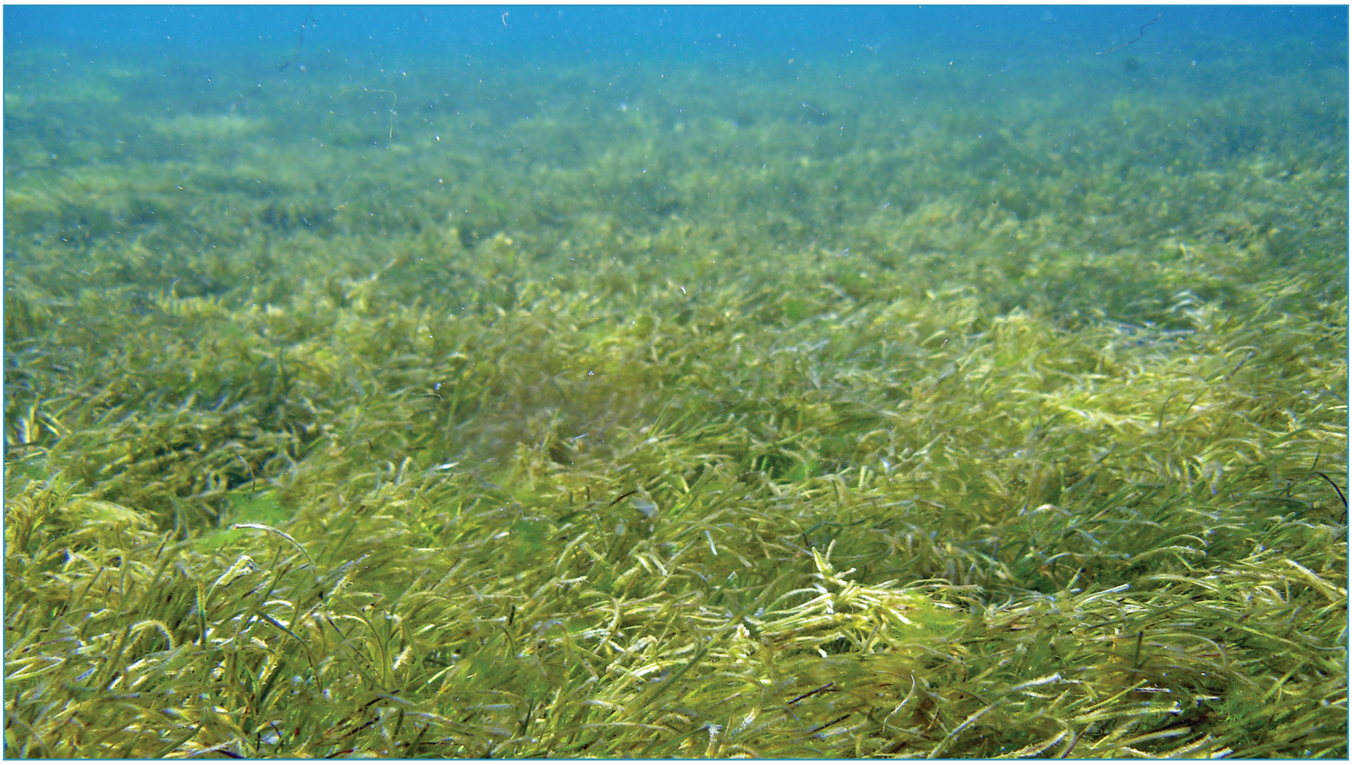
Human activities that increase sediment and nutrient runoff to waterways are directly contributing to seagrass decline. Other valuable marine habitats are also detrimentally affected[17].

Pollution can be reduced through the use of good land management practices (Table 1). Activities that physically damage seagrass meadows should also be avoided.

Research is currently underway to determine whether grazing by black swans can detrimentally affect seagrass meadows[18].

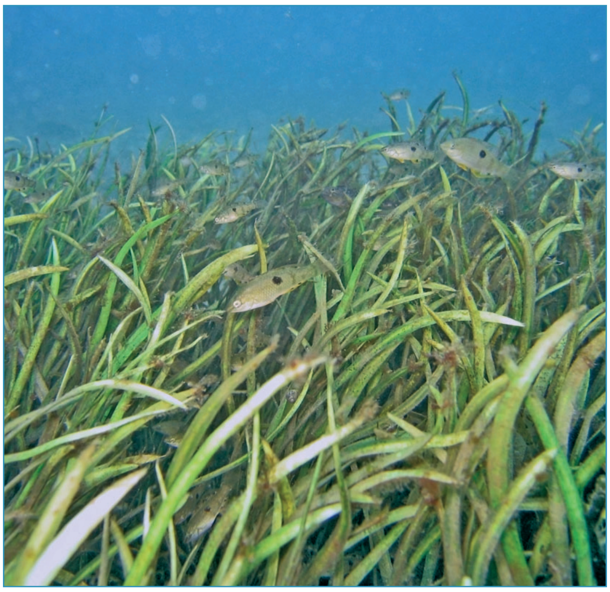
Table 1: Land management practices to reduce pollution of waterways.

Landuse type	Practice	Benefits
Farming	Adhere to fertiliser application guidelines	Reduces nutrient runoff from land
	Adhere to guidelines for treatment and disposal of effluent	Reduces pollutant levels in runoff and/or discharges to waterways
	Fence off streams from stock	Prevents erosion of stream banks and direct defecation into waterways
	Retire severely eroding land	Reduces sediment runoff
	Fence off and plant riparian (streamside) buffer strips	Traps and filters sediment and nutrient run-off
Forestry	Avoid bare ground exposure in wet weather	Reduces sediment runoff
	Use sediment traps in vulnerable areas (e.g., fords, road bridges)	Reduces sediment runoff
	Use riparian buffer strips	Traps and filters sediment and nutrient runoff
	Minimise any fertiliser use	Reduces nutrient runoff
Housing developments	As above for forestry	
	Adhere to septic tank installation and maintenance guidelines	Reduces nutrient leaching into local groundwaters
Urban	Use appropriate treatment facilities for town wastewaters	Reduces pollutant contamination of waterways
	Regulate and monitor industrial discharges	Reduces pollutant contamination of waterways
	Educate the public to reduce household pollutants being washed into drains	Reduces pollutant contamination of waterways



Seagrass needs clear water to thrive. Photo: Glen Carbines, NIWA

Seagrass does best on sandy to silty sediments in areas without strong currents or surf. Photo: Anne-Maree Schwarz, World Fish Center



Artificial seagrass mats can provide shelter for fish but are a poor subsitute for natural meadows. Photo: Crispin Middleton

Can we bring seagrass meadows back?

If seagrass meadows are to be restored to areas where they have been naturally present in the past, the original cause of decline must be eliminated. For example, if poor water quality was responsible for decline, then this must have improved to a satisfactory level to support seagrass growth once more.

In many cases the cause of decline may not always be clear. This can make it difficult to determine whether restoration is likely to be successful. In such cases a close examination of site suitability for seagrass growth (e.g., water quality, sediment characteristics, currents, wave and tidal exposure) will be required.

A second requirement for restoration is that there is a sufficient supply of viable seagrass seeds or vegetative fragments to reproduce from. Since seed production may be rare or episodic in New Zealand, a source of viable seagrass rhizome fragments and/or active transplantation of plants carefully sourced from nearest possible sites is likely to be required.

Artificial seagrass mats attract fish and can provide protection from predators but they are a poor substitute for natural meadows.

Patch of recently transplanted seagrass in Whangarei Harbour.
Photo: Fleur Matheson

Using artificial seagrass to protect natural seagrass (inserted in gaps) during establishment.
Photo: Fleur Matheson

Trials to restore it in the USA and New Zealand

Seagrass transplantation has been attempted in a number of places around the world in the last half-century. These trials have mostly taken place in the USA and it is estimated that less than half have been successful. This is probably because in many cases no attempt was made to restore suitable environmental conditions.

In New Zealand, recent work has assessed the feasibility of restoring seagrass meadows in Whangarei Harbour[31]. Water quality and seabed conditions in areas of the outer harbour where seagrass was once abundant are now considered adequate for seagrass growth and there are anecdotal reports of intertidal seagrass slowly expanding in some areas of remnant patches. A trial is currently underway, testing the feasibility of seagrass transplantation, including the success of different types of transplantation at a receiving site, and monitoring recovery of seagrass removed from a donor site[32].

This is only the second documented restoration trial to take place in New Zealand. The first trial was carried out in Manukau Harbour in the 1990s. Despite some initial success, the seagrass declined, probably because of sediment scouring during autumn storms[33]. This experience highlighted that physical disturbances, particularly during the early stages of plant establishment, are important and must be considered. In the Whangarei project, some seagrass plants have been placed within mats of artificial seagrass to test if this can function as a protective barrier against disturbance from strong waves and currents during early establishment.

Transplanting seagrass in Whangarei Harbour.
Photo: Jacquie Reed

Local kaitiaki monitoring the success of seagrass transplantation in Whangarei Harbour.
Photo: Fleur Matheson

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