Oyster reefs & mussel fields

- *Type: services delivered by organisms;*
- *Species: in salt water: common or flat oyster (Ostrea edulis; now occurring only sporadically), Pacific oyster (Crassostrea gigas; in the Netherlands since 1964) and the common mussel (Mytilus edulis). In fresh water: zebra mussel, painter's mussel, swan mussel, quagga mussel. It may be possible to use equivalent species.*
- *Application: in coastal waters and transitional waters starting at the 50% dry line down to depths of tens of meters. In moderately brackish and fresh waters, freshwater varieties can be used as an equivalent, particularly for water treatment.*
- *Contributes to:*
  - Natura 2000 habitats [7]: 'Sandbanks which are slightly covered by sea water all the time', 'Estuaries', 'Mudflats and sandflats not covered by seawater at low tide' including the associated vegetation, 'Large shallow inlets and bays', 'Hard oligo-mesotrophic waters with benthic vegetation of Chara spp', 'Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation', 'Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation';
  - Natura 2000 species [8]: birds, fish, and amphibians in particular;
  - Water Framework Directive (WFD) [9]: transitional waters, coastal waters, river waters and lakes.

Shellfish beds are natural elements in the Delta. They attenuate local currents and waves and therefore provide protection from, for example, the erosion of mud flats and shoals. In some cases, they can serve as alternatives for breakwaters made from rock or concrete blocks. They are not suitable for use as primary flood defences.

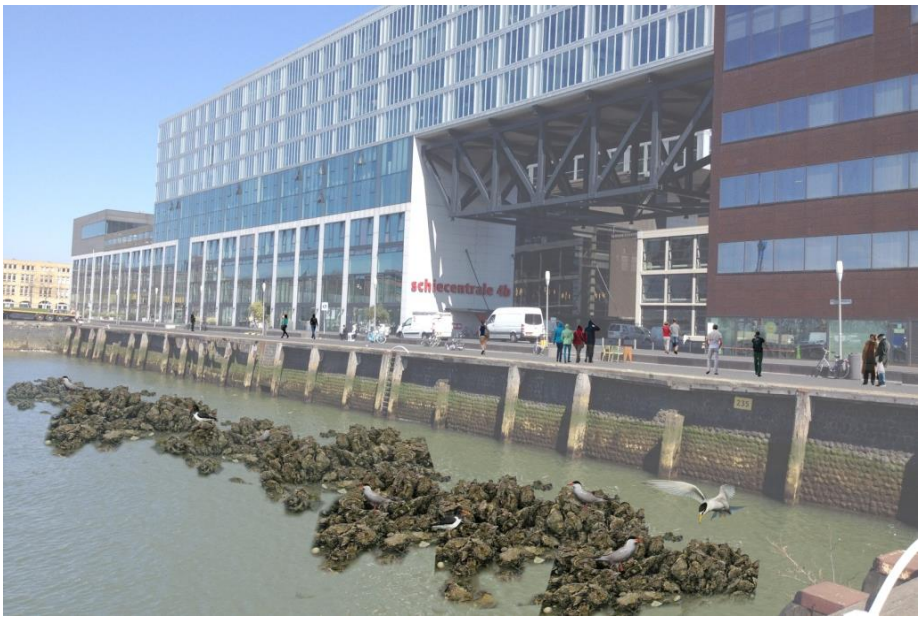
In addition, shellfish filter water. Algae are digested. What is left clumps together with sludge before being excreted and then serving as a substrate and food for benthos and other species. In combination with the sheltered environment they create, shellfish beds enhance biodiversity (through colonisation by other shellfish, sea lettuce, seaweed, sea squirts, anemones and polyps, and by acting as habitats or feeding grounds for lobsters, crabs, fish and starfish). In turn, this results in good feeding grounds for birds such as waders, ducks, and seagulls. This effect can extend to several tens of metres around the shellfish bed.

In addition, oysters and mussels can be harvested for human consumption.

All this applies primarily to salt or brackish waters. In fresh water, mussels can mainly be used for water treatment and as feeding grounds and habitats for flora and other fauna. Freshwater mussels can form mussel fields but they will not generally be located in areas where there is bank erosion. That means they cannot be used for bank protection.

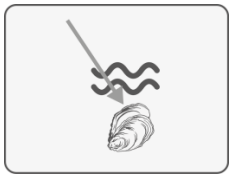
Specimen projects:

- Eastern Scheldt oyster reef (Viane and De Val)[1];
- Artificial reef near Oester Dam;
- Oyster reef in Bangladesh, Ecoshape;
- Oyster reef restoration, Florida [2].

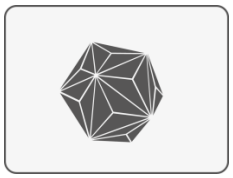


Spatial aspects

Areas that dry up



Light must be able to penetrate



Free form

Services

Ecosystem services generate benefits if people can exploit the services and capitalise them.

Erosion control[3,4]

Well-positioned shellfish beds can protect mud flats and shoals from wave impact and currents. Their structure allows them to capture sediment, resulting in the formation of new mud flats and shoals. This is particularly true of the salt and brackish varieties. This function is limited in fresh water.

Cleaning[3, 10]

Improvement in water quality as a result of filtration (sediment and algae). Efficacy depends on flow velocity, the water volume of the water body, and levels of algae and sediment.

Biodiversity [2,3, 4, 5,6, 11]

Wave attenuation, substrate (shellfish and faeces) and water treatment have a positive effect on flora and fauna populations. That contributes to the achievement of the WFD and Natura 2000 objectives and makes ecosystems more robust in terms of dealing with the adverse effects of climate change.

Water dynamic [2,3,4,7]

Indirect contribution to flood defences by protecting and extending mud flats and shoals by capturing sediment and attenuating waves. This service is delivered primarily in salt and brackish waters. However, oyster and mussel banks are not suitable for use as primary defences.

Benefits and cost savings [3,4,12]

The ecosystem services referred to above generate benefits if people can exploit the services and capitalise them.

Leisure value [2,6]

Providing leisure opportunities for water sports (diving, bathing and sailing), walkers and bird spotters by enhancing biodiversity and supplying clear and clean water.

Aquaculture [2,6]

Income from shellfish farming and fishing.

Maintenance costs

Cost savings can be made in the area of maintenance in particular because the shellfish banks limit the number of sand-nourishment operations by reducing the erosion of shoals. In addition, wave attenuation means that savings can be made in terms of raising dikes.

Natura 2000 and WFD measures

By protecting and creating mud flats and shoals, it will be possible to make cost savings on measures covered by Natura 2000 and WFD in the Delta.

Implementation of compensation

If the design is optimised, oyster reefs may be cheaper than stone embankments.

Both costs and benefits are location-specific and difficult to extrapolate. Cost-benefit analyses will therefore have to be conducted for each individual location.

Implementation costs

(Costs exclusive of design costs and monitoring)

Eastern Scheldt oyster reef - Viane and De Val *(EUR 48,000 = EUR 30/m²)* [6]

- Three oyster reefs measuring: 0.25x8x200m. Total surface area: ±1600 m².
- Transport distance: 2 – 7 km (depending on the reef; shellfish were taken from a mussel field in the vicinity that had been overgrown by oysters).
- Delivery and construction (including development of construction methods etc.): EUR 48,000 before VAT.

Artificial reef near Oyster Dam (EUR 188,000 = EUR 72/m ²)

- Four oyster reefs measuring: 0.3x8x25 m, 0.2x8x100 m, 0.4x8x100 m, 0.3x8x100 m;
- Total surface area: ±2600 m²;
- Transportation: > 25 km;
- Delivery and construction, not including overheads: EUR 188,000 before VAT.

Oyster reef or Oyster Dam

There is a considerable difference between the two applications in terms of the price per square metre. The difference can be explained by the following factors:

1. A larger transportation distance;
2. Purchasing oysters, as opposed to using freely available stocks;
3. Commercial party as opposed to implementation under own management;
4. Accessibility of location;
5. Size of the individual oyster reefs.

This emphasises the importance of drafting a location-specific cost estimate.

Management and maintenance

The idea is that the oyster reef will develop into a living reef that will be self-maintaining to a large degree and that will involve moderate maintenance costs.

Physical boundary conditions

The most important factors in a delta are:

Dynamics

In salt or brackish tidal waters, moderate currents, wave impact and limited dry periods (<50% of the time) are boundary conditions. Waves and currents generated by the wind and shipping can have a very negative effect. Storms can lead to the erosion and burial of shellfish beds. Long periods above the waterline can lead to the drying up or freezing of the beds. Shellfish in fresh water find it much more difficult to cope with periods above the waterline.

Salinity

Salinity determines the occurrence of different shellfish varieties and therefore the ecosystem services that can be delivered.

Substrate

Generally, a hard substrate will be needed for bonding (stones, shells, wood, and so on). Freshwater mussels can also thrive in soft substrates (which they dig into), but thick, soft layers of sludge are unsuitable (they smother the mussels). Artificial substrates such as rough ropes and nets have proven to be effective colonisation locations.

Silt levels and sedimentation speed

Excessively high silt levels and sedimentation smother shellfish. Flowing water is needed. Inadequate levels of silt and algae will result in the shellfish starving.

Oxygen level

If there is little or no oxygen for longer periods of time, shellfish will die. This is an issue in deep lakes (stratification) and a silt-rich bed (oxygen depletion by micro-organisms and the formation of toxic sulphides).

Miscellaneous

Diseases and predators can be a major threat to shellfish.

Potential sites

The most promising sites for:

Wave attenuation

Stony, sandy or silt-rich transitional zones from the water to the land in intertidal areas(creeks, mud flats, shoals) and in the shelter of breakwaters or harbour basins in the lower delta.

Biodiversity

Places with shallow to moderately deep water in all water types, with or without a hard substrate. An alternative is described in the 'Pile and pontoon hulas' fact sheet.

Cleaning

Water types with relatively low replenishment rates (lakes, stagnant secondary channels, harbour basins). In the rivers themselves, the replenishment rate is too high to result in a significant effect on water quality locally. On larger scales (in other words, catchments), there will be a significant effect.

Aquaculture

All suitable habitats that are easily accessible for purposes of management, maintenance and harvesting by oyster or mussel farmers (in other words, habitats that are not on shipping routes, where waves are moderate, and where the water is not too shallow).

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4. *Tangelder, M. Groot de, V. M. and Ysebaert, T.J.W. (2013) Biobouwers als optimalisatie van waterveiligheid in de Zuidwestelijke Delta. Ministry of Economic Affairs. IMARES report C198/13.*
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9. *Siebelink, B. (2005) Overzicht natuurlijke watertypen. Foundation for Applied Water Management Research (STOWA). STOWA report no: 2005-08.*
10. *De Hoog J.E.W., Ruster A.D. (1999) Potentiële effecten van zoetwatermosselen op het transport van verontreinigingen in het Hollandsch diep/ Haringvliet. Verspreiding van stoffen onder invloed van organismen in de Rijn/Maasmonding. Werkdocument 99.125X. RIZA.*
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12. *Coalitie Natuurlijke Klimaatbuffers (2014) Besparingspotentieel 'Bouwen met natuur'. Verkenning van het besparingspotentieel.*