The ocean we want: inclusive and transformative ocean science.
Pelegrí J.L., Gili J.M., Martínez de Albéniz M.V. (eds.). 2022. Institut de Ciències del Mar, CSIC, Barcelona.

3.7. The contribution of bivalves to coastal ecosystem services

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Ecosystem services are the benefits that societies obtain from ecosystems. This concept originated in the 1970s and gained importance when the United Nations launched the Millennium Ecosystem Assessment in 2005 (http://millenniumassessment.org). The objective of this assessment was to analyse the consequences of change in ecosystems for human well-being and to foster actions to improve their conservation and sustainable use.

The coastal strip provides numerous ecosystem services related to habitat availability, including environmental education, leisure, provision of food and mitigation of climate change. The bivalve molluscs that live there are involved in important ecological processes that help improve our quality of life (Smaal *et al.* 2019).

Regulating services

Bivalves act as ecosystem regulators contributing to nutrient cycling, creating and modifying habitat, preventing coastal erosion and promoting biodiversity (Figure 1). The discharge into coastal waters of nutrients, especially nitrogen and phosphorus from land-based activities, is an important factor in the development of eutrophication, a phenomenon that triggers an increase in primary production and the degradation of water quality. Marine bivalves filter suspended particles and transform them into their own tissue and biodeposits (faeces and pseudo-faeces) that are transferred to the benthos. Thanks to this filtering capacity, they reduce the appearance of microalgal blooms and increase

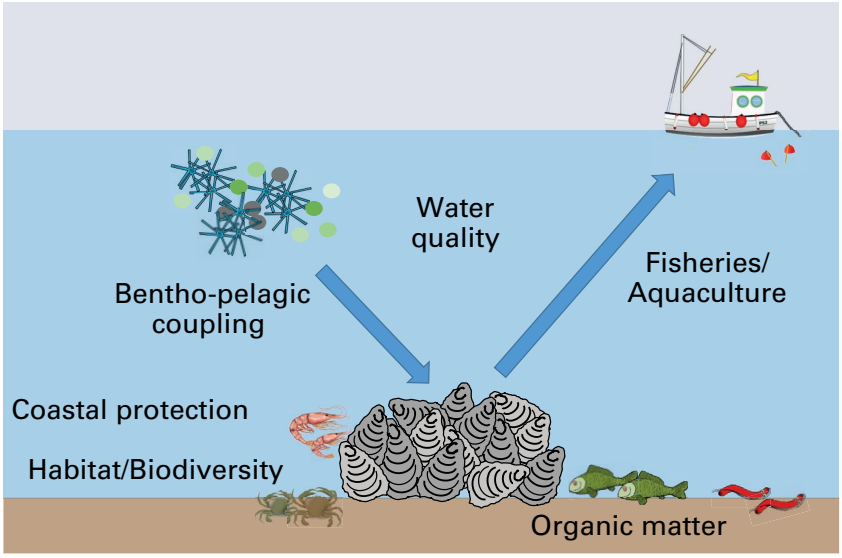

Figure 1. Diagram of the regulatory ecosystem services provided by bivalves.

Figure 2. Aggregations of mussels (*Mytilus edulis*) on the tidal flat of the Wadden Sea.

the transparency of the water, allowing greater penetration of light, which in turn favours the survival of phanerogam meadows. They also reduce the oxygen deficit caused by night-time respiration of phytoplankton and by sedimentation of phytoplankton blooms on the bottom. When the bivalve population is very dense, the transformation of phytoplankton and particulate organic matter into biodeposits can cause hypoxic or anoxic conditions on the bottom in areas with little water circulation. These wastes tend to have high concentrations of organic nitrogen which, once in the sediment, is used by denitrifying bacteria, thus promoting the mineralization and regeneration of the inorganic nutrients. The high capacity of natural and cultivated bivalve populations to extract organic particles from the environment is considered a nature-based solution (NbS) for mitigating excess organic matter in eutrophicated ecosystems and improving water quality in coastal areas (Galimany *et al.* 2017).

Furthermore, mussel aggregations and oyster reefs constitute complex three-dimensional structures that influence the morphodynamics of the bottom, the surrounding habitats and associated species (Figure 2). These biostructures help prevent coastal erosion and are biodiversity hotspots, harbouring high densities of invertebrates and providing shelter for juvenile fish.

Provisioning services

Bivalves also contribute to matter and energy outputs from ecosystems. Throughout history, molluscs have been present in the daily life of all civilizations. The first human groups that settled on the coast collected molluscs for food. Furthermore, shells used as tools, utensils and ornaments are often found at prehistoric sites. Molluscs provide a wide range of natural products based on both their meat and their shells. Their consumption is beneficial for health as they are low in fat and rich in protein, lipids and minerals (sodium, potassium, phosphorus, calcium, iodine, zinc and magnesium). Molluscs are one of the foods that contribute the most iron to our diet (4.5 grams per 100 of mussel meat) and are an excellent source of high-quality lipids because they concentrate omega-3 fatty acids. Fatty acid intake through consumption of bivalves is believed to have been critical for the development and evolution of the human brain (Crawford 2002). It should be noted that bivalves are at a low level in the human food chain, and their cultivation does not require the use of feed or medicine as they take advantage of the natural productivity of the environment in which they grow.

In addition to food, bivalves provide us with other direct benefits such as construction materi-

als (aggregates) and jewellery. Some species, such as mussels, anchor themselves to hard substrates, secreting filaments called byssus. These filaments are covered by a protein cuticle that gives them good mechanical properties and great strength and adherence. Research into byssus has stimulated the development of adhesive biomedical materials for the reconstruction of human tissues.

Cultural services

Services of a third type provided by bivalves are non-material values that we obtain through use and enjoyment such as entertainment and aesthetic pleasure. Shell collecting is a widespread habit among beachgoers and collectors. However, this practice causes environmental damage, to the point that in some countries it has been prohibited. Like terrestrial gardens, "bivalve gardens" are a recent activity in which mussels and oysters are cultivated by a community for personal consumption. On the east coast of the United States, this practice has evolved from programmes to restore degraded estuarine systems.

Society is losing the benefits it derives from bivalves as their populations disappear from our shores. The decline of bivalve beds in the Mediterranean is caused by a combination of factors such as disease, overexploitation, pollution and loss of habitat (Baeta *et al.* 2014). To mitigate this loss, various initiatives are being carried out. The Native Oyster Network and the Native Oyster Restoration Alliance are interconnected networks for promoting the restoration of oyster beds in Europe. Such projects should be extended through the rehabilitation of the habitat, the sowing of juveniles from cultivation and efficient stock management programmes to recover the bivalve populations and continue enjoying their services.

References

Baeta M., Ramón M., Galimany E. 2014. Decline of the *Callista chione* (Bivalvia: Veneridae) beds in the Maresme coast (northwestern Mediterranean Sea). Ocean Coast. Manag. 93: 15–25.

Crawford M.A. 2002. Cerebral evolution. J. Nutr. Health 16: 29–34.

Galimany E., Wikfors G.H., Dixon M.S., *et al.* 2017. Cultivation of the ribbed mussel (*Geukensia demissa*) for nutrient bioextraction in an urban estuary. Envir. Sci. Tech. 51: 13311–13318.

Smaal A.C., Ferreira, J.G., Grant J., *et al.* (eds.). 2019. Goods and services of marine bivalves. Springer Open. 598 pp.

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