European Commission

Science for Environment Policy

Mussels used to map habitat connectivity of Natura 2000 marine sites in Portugal

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A species of mussel has been used to investigate the connectivity of two marine protected areas (MPAs) along the central Portuguese west coast in a new study. The chemistry of mussel shells was used to trace the dispersal routes for larval mussels, demonstrating that the Arrábida MPA is an important source population in the area.

Source: Gomes, I., Peteiro, L.G., Albuquerque, R., Nolasco, R., Dubert, J., Swearer, S.E. & Queiroga, H. (2016) Wandering mussels: using natural tags to identify connectivity patterns among Marine Protected Areas. *Marine Ecology Progress Series*. DOI: 10.3354/meps11753

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Understanding connectivity within habitats is important for the effective management of marine ecosystems, including networks of protected areas, such as MPAs. The dispersal of larval species in marine ecosystems influences the extent to which different populations of a species are connected, which is necessary to ensure population survival.

In Europe, the OSPAR Commission and Marine Strategy Framework Directive (MSFD) advocate the establishment of connected MPA networks. Population connectivity is one of the widely accepted criteria used to assess the ecological coherence of MPA networks in Europe. Natural tags — such as the geochemical composition of the shells of marine organisms — are increasingly used in marine research to understand these connections. This approach requires information on location-specific chemical signatures, which are influenced by the physical and biological characteristics of the local marine environment and are incorporated into the shells of marine organisms.

This study used the mussel *Mytilus galloprovincialis* to investigate connectivity between the Berlengas and Arrábida MPAs in Portugal, both of which are part of the Natura 2000 network of protected sites in Europe. In this region, upwelling — the wind-driven movement of bodies of oceanic water — is an important process in the dispersal of larval organisms, including free-swimming larval mussels.

To trace the movement of mussel larvae around the MPAs, the researchers analysed the microchemistry of the larval shells using 'laser ablation inductively coupled plasma mass spectrometry' (an analytical technology that enables highly sensitive elemental and isotopic analysis to be performed directly on solid samples). Eleven different sites in the region were selected to rear larval mussels in order to expose them to the local chemical and environmental conditions.

Environmental data was also integrated and compared at the sites, including sea temperature (from the data provided by the Hybrid Coordinate Ocean Model or HYCOM) and ocean upwelling data from the Spanish Institute of Oceanography. Shells of reared larvae were then analysed in the laboratory to determine the trace element microchemistry and enable the researchers to produce a reference map of natal origins based on the chemical make-up within the shells (chemical signatures). This map was used to determine the larval origin of more than 200 newly settled mussels within the region. Tracing natal origins is possible as mussels preserve their larval-shell chemical signatures after settling in rocky habitats.

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The researchers were able to determine the origin and dispersal of almost 60% of the collected mussels along 120 km of coastline. They found three distinct chemical signatures of the larval shells corresponding to three regions (Estremadura, Cascais and Arrábida).

Zinc, lead and uranium concentrations were the most useful elements in indicating regional signatures of mussels and are likely related to high levels of metal concentrations in coastal water in the region from urban and industrial waste and agricultural run-off. For example, larvae reared in Cascais Bay had higher concentrations of zinc in their shells, likely related to high concentrations of zinc in the Tagus estuary due to its release from chemical, steelwork and shipbuilding industries.

The Arrábida MPA was an important source population for the other two regions (70% of mussels collected from Cascais and 27% from Estremadura) and showed high rates of self-recruitment (58%) (i.e. 58% of juvenile mussels were identified as offspring of adults from the same location), but limited connectivity to the Berlengas MPA. The importance of Arrábida as a source population supports measures in the 2005 management plan for the MPA, which prohibited trawling, dredging and bivalve harvesting to preserve its role as a nursery for many marine species.

The researchers say that these direct measures of habitat connectivity can be a powerful tool to inform policymakers on the conservation and management of networks of protected areas in coastal marine ecosystems. Despite the fact that the study focuses on a single species, the researchers say that *M. galloprovincialis* can act as a model species to give an idea of optimal spacing of reserves due to its dispersal abilities, broad distribution and its role as an 'ecosystem engineer', maintaining and modifying rocky shore communities.