Review

Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review

Charles F. Boudouresque[1,*], Guillaume Bernard[2], Gérard Pergent[3], Abdessalem Shili[4] and Marc Verlaque[1]

[1] Center of Oceanology at Marseille, CNRS and University Campus of Luminy, 13288 Marseille Cedex 9, France, e-mail: charles.boudouresque@univmed.fr

[2] Groupement d'Intérêt Public pour la Réhabilitation de l'étang de Berre, Cours Mirabeau, 13130 Berre l'Étang, France

[3] Equipe Ecosystèmes Littoraux, Faculté des Sciences et Techniques, Université de Corse Pasquale Paoli, 20250 Corte, France

[4] Institut National Agronomique de Tunisie, 43 Avenue Charles Nicolle, 1082 Tunis Mahjajène, Tunisia

* Corresponding author

Abstract

Seagrass meadows are considered to be among the most important marine ecosystems, with regard to both ecology and biodiversity and for the services they provide. Seven species occur in the Mediterranean Sea: *Posidonia oceanica* (the most common in the open sea), *Cymodocea nodosa* (particularly common in the eastern basin), *Ruppia cirrhosa*, *R. maritima, Zostera marina* and *Zostera noltii* (mainly in estuaries and brackish lagoons), and *Halophila stipulacea* (introduced from the Red Sea). Seagrass regression may be due to natural processes and/or natural or anthropogenic disturbances and stress. It can also be due to long-term climate trends, e.g., the post-Last Glacial Maximum rise in sea-level, the Little Ice Age (LIA) cooling and the post-LIA warming, resulting in possible misinterpretation. Human-induced losses of *P. oceanica* have been mainly related to coastal development, pollution, trawling, fish farming, moorings, dredging, dumping and introduced species. All other seagrasses have also undergone more or less dramatic regression events. In fact, accurate data are generally of very local value and they are lacking for most of the Mediterranean Sea. In the absence of a reliable baseline, some widely cited cases of regression are questionable. Relatively healthy *P. oceanica* meadows, whose limits have changed little since the 1950s, may thrive in highly anthropized areas. In addition, the decline of one species can benefit another, so that the overall seagrass balance may remain unchanged (e.g., *Cymodocea* replacing *Posidonia*). However, to conclude that everything is for the best would be erroneous. First, the lack of data supporting the general regression hypothesis does not invalidate the hypothesis. Indisputably dramatic seagrass losses have been documented (e.g., *P. oceanica* and *Z. marina*). Second, the *Posidonia* regression is irreversible at human scales, while other seagrasses can rapidly recover, and the expansion of some seagrasses (e.g., *Cymodocea*) cannot counterbalance, in terms of ecosystem services, the decline of the *P. oceanica* meadows. Third, human pressure (demography, tourism, etc.) on Mediterranean seagrass ecosystems is destined to strongly increase in the coming decades. Finally, the rise in sea-level due to global climate change will automatically induce a withdrawal of the lower limit of seagrass meadows whenever the limit is beyond the compensation depth. So the regression trend observed in Mediterranean seagrasses, even if it proves to be currently weaker than postulated, will significantly increase and become a major concern in the future. There is therefore an urgent need for the adoption of a set of efficient indicators and the setting up of a robust comparative baseline in order to draw up an accurate assessment of the losses and, for seagrasses other than *Posidonia*, possible gains at Mediterranean scale. In addition, seagrasses and seagrass habitats should be granted legal protection and, where such protection already exists, it should be implemented.

Keywords: competition; disturbances; Mediterranean Sea; seagrass regression; stress.