



Effects of NIS on Mediterranean marine ecosystems: the case study of Egadi Island MPA (Sicily, Tyrrhenian Sea)

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Habitat modification and loss, climate change and the introduction of Non-Indigenous Species (NIS, i.e. organisms introduced outside of their natural, past or present, range and outside of their natural dispersal potential) are considered to be the main threats to Mediterranean marine biodiversity and natural ecosystem functioning. NIS may become invasive (IAS = Invasive Alien Species) and may have significant environmental, socio-economic and human health impacts.

The Mediterranean Sea is one of the major hotspots for NIS introductions, with the total for these species having almost reached the 1,000 figure (equivalent to ca. 6% of the total flora and fauna). NIS are entering the Mediterranean Sea passively or through human-mediated pathways. The Suez Canal is considered to be the main vector for marine introductions into the Mediterranean Sea. The Suez Canal in fact has been responsible to date for 53% of all exotic marine species entering the Mediterranean. The widening of the existing Suez Canal in 2015, so as to cater for increased volumes of shipping, is expected to have a further strong impact on the Mediterranean marine ecosystems. Ship-borne transportation infrastructure is expanding along with volumes of ballast waters, ballast tanks, anchoring and fouling, and collectively they are considered as the second vector of introduction in terms of importance.

For instance, *Sargassum muticum* and *Caulerpa taxifolia* have been spread in the Mediterranean through shipping and recreational vessels. The jellyfish *Rhopilema nomadica* has been reported to negatively affect coastal power-generation installations, whilst impacting fisheries, human health and tourism. *Lagocephalus sceleratus* and *Pterois volitans*, both Lessepsian migrants, are examples of a toxic and a venomous fish species, respectively. Yet another Lessepsian fish migrant, the bluespotted cornetfish (*Fistularia commersonii*), is an extremely voracious predator which is aggressive when occurring in schools, whilst the two rabbitfish species *Siganus luridus* and *Siganus rivulatus* have largely displaced the native *Sarpa salpa* in the Levantine swathes of the Mediterranean Basin.

The intense maritime traffic within the Strait of Sicily, which witnesses 90% of all the oil traffic traversing the Mediterranean Basin, has made Sicily and its surrounding islands, including MPAs, highly vulnerable and susceptible to biological invasions. Indeed, MPAs seem to be ineffective in protecting native biodiversity from biological invasions. We hereby report on the case study of the Egadi Islands MPA (western Sicily, Tyrrhenian Sea) where 14 NIS and 3 cryptogenic species (*Aplysia dactylomela*, *Asparagopsis taxiformis* and *Percnon gibbesi*, species that cannot be classified with confidence among native nor among introduced ones) have been recorded till now, and where maritime traffic has certainly spearheaded their introduction and spread. Detrimental ecological effects, direct or indirect, on native benthic assemblages have already been exerted by some of the newcomers.

Even though the need to control IAS and to mitigate their impacts (on native species, on the structure and function of ecosystems, and on human health) is widely recognized by scientists, policy-makers and environmental managers, comprehensive and effective strategies to manage NIS have not yet been formulated at a pan-European level.