

MITIGATING THE IMPACTS OF COASTAL DEFENCE MEASURES

Laura Airoidi ^{1*} and Shimrit Perkol-Finkel ¹

¹ University of Bologna - laura.airoidi@unibo.it

Abstract

Defense measures have a strong impact on species composition, abundance and diversity of coastal marine environments. Understanding the factors controlling these impacts is crucial for proper management of coastal areas. We show results of field studies aiming at developing means for promoting the growth of desirable species and for controlling the spread of invasive species on coastal man-made structures

Keywords: Adriatic Sea, Coastal Management, Species Introduction, Biodiversity, Coastal Engineering

Evidence for severe loss of marine habitats is increasing worldwide, stirring concern because of their recognized ecological and economical values (1). Recent estimates suggest that > 60% of native habitats may have been lost throughout history in many coastal areas of the planet (2). Losses have resulted from natural and particularly from anthropogenic factors driving marine systems through thresholds of degradation (3). Losses are ongoing at accelerating rates and overall benefits of current protection measures are low. Urbanization is one of the leading causes for habitat and species loss in coastal waters. Today 22,000 km² of European coastlines are covered by urban marine structures and further development is expected (2). Such structures are often built on sandy bottom where they generate changes in species composition, abundance and diversity. Understanding the factors controlling such changes is crucial for proper management of coastal areas. The current research aims at outlining a new approach of sustainable management of urban marine structures, by incorporating ecological knowledge of their functioning and of the appropriate scales, spatial and temporal, of management. We show results of past and ongoing experimental field work which specifically dealt with: 1) analyzing the impact of coastal artificial structures on native assemblages, 2) monitoring the spread of nuisance or invasive species on coastal artificial structures, and 3) developing means for promoting the growth of desirable species. These studies have been done along the 190 km of coastal defence and other armoured urban infrastructures along the Italian North Adriatic Sea. Results show that the proliferation of coastal defense measures causes a disruption of native soft-bottom environments and unnatural changes to the composition, abundance and diversity of native assemblages. Proliferation of coastal defense structures can also have critical impacts on regional species diversity, removing isolating barriers, favoring the spread of non-native species and increasing habitat heterogeneity (4, 5, 6). In order to provide advice about how to mitigating the impact of these measures on the environment, we tested the feasibility of promoting the growth of desirable native species on urban marine structures, using the canopy-forming alga *Cystoseira barbata* as model species. We documented the ongoing loss of this species in native habitats in this region in relation to severe anthropogenic disturbances, and their replacement by opportunistic species of lesser habitats complexity. We estimated natural recovery potential by *in-situ* monitoring of subsequent recruitment, survival and growth patterns of *C. barbata* juveniles, and tested the potential for urban armoured structures to provide additional suitable substrata for this species. Transplantation experiments demonstrated that *Cystoseira* has the potential to grow on urban structures, but its success is influenced by several factors, including wave exposure and herbivorous pressure. Urban marine structures do not function as natural habitats. Advancing our understanding of the impact of urban structures on natural habitats, and increasing our ability to control their assemblages is of prime importance in light of the continuous proliferation of these artificial habitats. Management for these artificial habitats should be specifically adapted, aimed at increasing their ability to sustain various ecological and biological applications, for example, by managing their prevailing assemblages. Finally, we suggest that instead of relying on the construction of new artificial reefs for restoration and enhancement, ecologists, engineers and decision makers should consider maximizing the ecological functioning of existing man-made structures. Acknowledgements Work was supported by: the EU projects MarUrbe (FP7-PEOPLE-2007-2-1-IEF-219818), DELOS (EVK3-CT-2000-00041) and THESEUS (FP7 - ENV2009-1, grant 244104), the MIUR project BIORRES (Prin 2007) and the University of Bologna Strategic Project ADRIABIO.



Fig. 1. Google view of coastal defense and other armoured urban structures along the Italian coasts of the North Adriatic sea

References

- 1 - Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R. V., Paruelo J., Raskin R. G., Sutton P., and van den Belt M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253-260.
- 2 - Airoidi L., and Beck M. W., 2007. Loss, status and trends for coastal marine habitats of Europe. *Oceanogr. Mar. Biol. Ann. Rev.* 45, 345-405.
- 3 - Jackson J.B.C., Kirby M.X., Berger W.H., Bjorndal K.A., Botsford L.W., Bourque B.J., Bradbury R.H., Cooke R., Erlanson J., Estes J.A., Huges T.P., Kidwell S., Lange C.B., Lenihan H.S., Pandolfi J.M., Peterson C.H., Steneck R.S., Tegner M.J. and Warner R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293, 629-638.
- 4 - Airoidi L., Abbiati M., Beck M.W., Hawkins S.J., Jonsson P.R., Martin D., Moschella P.S., Sundelöf A., Thompson R.C. and Åberg P., 2005. An ecological perspective on the deployment and design of low-crested and other hard coastal defence structures. *Coast. Engineer.* 52, 1073-1087.
- 5 - Bulleri F. and Airoidi L., 2005. Artificial marine structures facilitate the spread of a non-indigenous green alga, *Codium fragile* ssp. *tomentosoides*, in the North Adriatic Sea. *J. Appl. Ecol.* 42, 1063-1072.
- 6 - Fauvelot C., Bertozzi F., Costantini F., Airoidi L. and Abbiati M., 2009. Lower genetic diversity of populations of the limpet *Patella caerulea* on urban coastal structures as compared to natural rocky habitats. *Mar. Biol.* 156: 2313-2323.