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Marine ecological engineering: a sustainable solution for coastal and port infrastructures

Julie. R. PERSON [1], Manon. L. PEDRONI [1]

1. Pôle Mer Méditerranée, 229 chemin de la Farlède, Business Park des Playes, 83 500 La Seyne sur Mer, France.
person@polemermediterranee.com

Abstract:
Coastal areas are particularly attractive to men and conducive to their activities. Port developments lead to connectivity loss which plays an important part in the fish life cycle.
To anticipate the development of needs and services required to achieve the objectives of the European Marine Strategy Framework Directive in accordance with the Barcelona Convention, Pôle Mer Méditerranée with partners works on the structuring of an emerging sector with strong growth potential: the Mediterranean coastal ecological engineering.
Several innovative projects undertake research and development on this topic to experiment if the nursery functionality of ports could be enhanced in a Mediterranean context. Some of these projects are illustrated by first operational results which could lead to a very interesting economical development.
The next step will be to confirm economical sustainability, and to assess ecosystem provided services.
Keywords: Coastal ecological engineering, Port infrastructures, Marine ecosystems restoration, Emerging sector, Marina biodiversity.

1. Introduction

Coastal areas concentrate and support a very diverse range of human activities such as: fishing, aquaculture, transport, maritime industry, yachting, tourism, etc.
Coastal urbanization leads to the destruction and fragmentation of intertidal and shallow subtidal habitats and the loss of associated functionalities. Although primarily designed to achieve economic functions, port infrastructures also provide artificial environments for the establishment of benthic plants and animals, and attract juvenile and adult individuals of numerous coastal species. The lack of micro-habitats however, limits the potential for survival and growth of the earliest life stages of certain species (LAPINSKI *et al*., 2014), (Fig.1).
Three main international policies exist on the Mediterranean basin taking into account marine environment: the Barcelona Convention, the European Water Framework, and the European Marine Strategy Framework Directive (MSFD).

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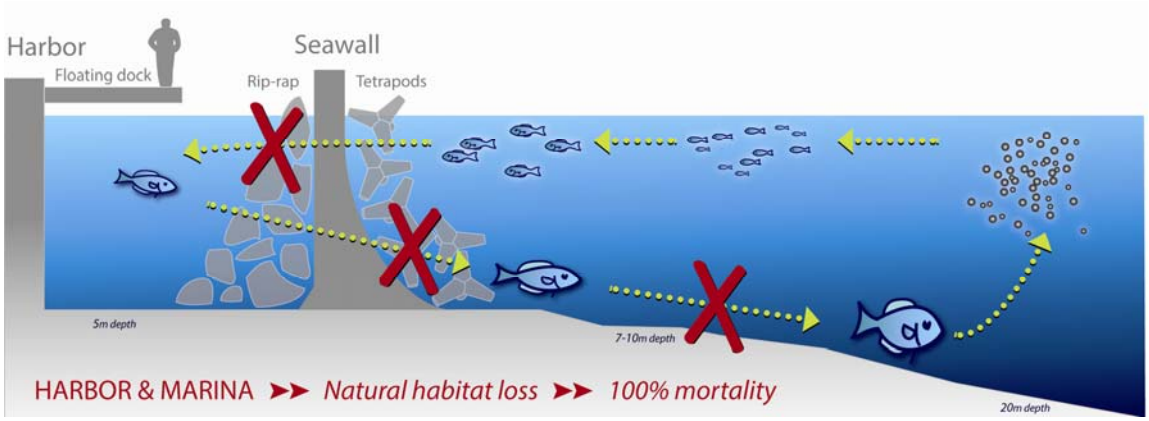

Figure 1. Consequences of port developement on fish life cycle (copyright: Ecocean).

During the last 5 years Pôle Mer Méditerranée (PMM) and Rhone-Mediterranean and Corsica Water Agency (RMC Water Agency), usually in association with regional or local authorities, have launched call for projects on ecological restoration of coastal and marine areas with the following goals: (i) a focus on in situ demonstrations or pilot operations; (ii) exemplary and transposable solutions in different areas of the Mediterranean coast; (iii) innovative concepts or tools; (iv) acceptable and economically feasible solutions in compliance with current regulations; (v) the ability to be appropriate by a manager of coastal and marine areas. (PERSON & HERROUIN, 2014)

2. Materials and methods

2.1 Coastal ecological engineering definition

We take the definition of coastal ecological engineering in the broad sense: the concept of sustainable coastal development and rehabilitation of degraded ecosystems, it seeks to combine engineering science and environment science to maximize the useful societal features. (HERROUIN, 2010)

2.2 Ecological functionalities

A prerequisite for ecological engineering interventions is the right management and the quality of marine waters. We found such areas in ports.

Among the experimental projects described here after, four ecological functionalities are mainly concerned (LENFANT *et al.*, 2015):

- Habitat for several coastal species at different life stages
- Natural fish-feeding possibility
- Protection against predation
- Connectivity and ecological corridors.

3. Results

The PMM supports several experimentation programs which are carried out on representative ports.

3.1 Commercial harbor: GIREL program

GIREL means "Infrastructure Management for Ecological Rehabilitation Littoral on the Site Grand Port Maritime de Marseille (GPMM)". It is the first French major pioneering restoration project. The marine port environment is rich and could play a part to enhance the marine biodiversity and contribute to a restoration of ecosystems. The aim is to integrate economic and ecological functions in the harbor infrastructures.

The issues underlying the GIREL project are:

- What are the ecological features offered by the port infrastructures?
- How to improve / extend these features?
- What is required information to define and implement an ecological restoration plan of marine harbor infrastructure?

GIREL includes three experimental pilots:

Habitats: Artificial habitat tests specifically aimed to provide a shelter for juvenile fish and to protect them against predators. Three habitat types are testing on breakwaters and quay walls: EGIS (Giant urchins & Reeds), ECOCEAN (BioHut®).

© *BioRestore*: this process increases the port ecological functions by working on the fish post-larvae stage which is the critical phase of the species life cycle. It's at this stage there is a high mortality rate due to the installation of these post-larvae on coastal habitat. The aim is to improve the survival rate at the transition from post-larvae to the juvenile stage. The pilot is based on a sustainable and innovative technology, PCC (Post-larval Capture and Culture)

Cystore-SUEZ: to develop algae transplantation methods of Cystoseira species, to provide to marine work managers an operational tool for recovery or ecological restoration.

To evaluate their efficiency all prototypes systems above mentioned have been tested and scientific monitoring conducted. The last 2014-2015 stage was to extend these systems to larger scale on infrastructures.

3.2 Marinas: NAPPEX program

The NAPPEX program belongs to the French National Biodiversity Strategy of the French Ministry in charge of Ecology. (www.nappex.fr)

NAPPEX overall objective is to test the transformation of marina areas into real shelters for fish larvae to increase the biodiversity of our coasts. For this, Biohut ® habitats will be installed in ports and more particularly on the docks and under the pontoons.

4. Conclusions

Port infrastructures attract fish post-larvae in their area in view of settlement, artificial micro-habitats on quays and breakwaters host a juvenile density significantly higher (4-5 times) than on reference sites.

These ecological restoration solutions are progressively integrated in maritime infrastructure eco-design. (Monaco, Reunion coastal road, Calais 2015…)

The next step is to confirm economical sustainability, and to assess ecosystem provided services.

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5. References

HERROUIN G. (2010). *New ecological engineering for the marine coastal areas*. Techno-Ocean Kobe.

LAPINSKI M., PERROT M., LE DIREACH L., ROUANET E., ASTRUCH P. (2014). *Support to nursery functionalities of the port of Marseilles-Fos given by artificial micro-habitats.* RECIF: Congrès sur les récifs artificiels: des matériaux à l'écosystème / Congress on artificial reefs: from materials to ecosystems, ESITC Caen, 27-28-29 Janvier/January 2014.

LENFANT P. *et al.* (2015). *Restauration écologique des nurseries des petits fonds côtiers de Méditerranée*. Projets SUBLIMO & DRIVER.

PERSON J., HERROUIN G. (2014). *Marine ecological engineering: a sustainable solution for coastal cities and areas*. Journal of Environmental Protection and Ecology, Vol. 15(4), pp 1619–1630.