Ecological restoration of cold-water corals on the Mediterranean continental shelf

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Monografía

"Cold-water coral (CWC) habitats dwell on continental shelves, slopes, canyons, seamounts, and ridge systems around the world's oceans, from 50 m to depths up to 4000 m. CWC species provide heterogeneous habitats supporting a myriad of associated fauna and form highly diverse CWC reefs and CWC gardens. Main threats, currently impacting CWC ecosystems come from anthropogenic stressors, such as fishing activities, oil and gas exploitation and the incipient mining activity. Likewise, climate change, causing changes in the water column, is also affecting these ecosystems. Life-history traits of CWC species (long lifespans, slow growth and limited recruitment) make them very vulnerable to current and potential threats. Given their limited recovery capacity, interest to preserve and restore CWC ecosystem is steadily growing. The creation of Marine Protected Areas and active ecological restoration actions are nowadays the best management tools to conserve native ecosystems and represents an opportunity to revert the anthropogenic damage that has already taken place. Through passive (natural regeneration after the cessation of stressors) and active (human interacts with biotic and/or abiotic ecosystem features) approaches, restoration activities seek to accelerate the recovery of ecosystem structure and functioning relative to a reference model. Contrarily to terrestrial and shallow-water marine ecosystems, ecological restoration in intermediate (50 - 200 m) and deep marine (> 200 m) environments has received lesser attention. To date, only few restoration actions at local scales have been carried out at those depths, mainly due to technical and economic limitations which questions its wide application. Scaling-up restoration actions and make them affordable are the main present challenges for CWC restoration. In this sense, in order to move forward towards the conservation of intermediate and deep-sea ecosystems, the general aim of the present thesis is to assess the impact of fishing activity on CWC gardens as well as to explore the feasibility of novel active ecological restoration techniques.All the work performed during this thesis has been carried out at the Cap de Creus marine area (North-Western Mediterranean Sea), specifically at the continental shelf (60 - 130 m), where gorgonians, sponges, and sea pen species form CWC gardens supporting a variety of mobile associated fauna. The target species is the yellow gorgonian Eunicella cavolini (Koch, 1887) which dominate in the area forming density patches. In the first chapter, the impact of artisanal fishing was quantified to evaluate the threat of this activity on CWC gardens and to provide essential information to mitigate such impact. The rest of chapters (2, 3 and 4) evaluated, for the first time, the viability to actively restore degraded E. cavolini populations. Specifically, in the second chapter, gorgonians obtained from bycatch (accidentally caught of non-target species) of local artisanal fishers, were transplanted to artificial structures deployed on the continental shelf (805 m). This pilot study demonstrated, for the first time, the high

survival of E. cavolini transplants. Following, and going one step forward, in the third chapter, field experiments and modeling approaches were combined to develop and technically validate an innovative large-scale and cost- effective restoration method for CWC gardens. Successful results evidenced the feasibility of recovering bycatch E. cavolini and returning them to their natural habitat with this novel method so-called "badminton method". Finally, in the fourth and last chapter, a large- scale restoration action of E. cavolini populations was carried out in collaboration with local artisanal fishers during two consecutive fishing seasons by applying the technique previously developed. A large number of gorgonians (460 colonies) were successfully reintroduced and survived at the end of the action (2 years) at 80-100 m depth. The results suggested an initial establishment of a new gorgonian population, which will potentially evolve toward a comparable natural population in terms of size and spatial structure, if natural recruitment also occurs. Moreover, an economic evaluation was performed, also confirming the cost efficiency of this method aimed at enhancing the recovery of impacted CWC gardens.The lack of knowledge of some key ecological processes of CWC ecosystems as well as the technical limitations hinder a complete evaluation of restoration efforts performed. However, this thesis represents a promising improvement for the conservation and recovery of CWCs that could be extended to other areas and regions."-- TDX

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