Application number: MCEF20113

Ecological restoration with oyster shell reefs at Sham Wan Restricted Area

"I hereby irrevocably declare to the Management Committee and the Steering Committee of the Fund, that all the dataset and information included in this Progress Report have been properly referenced, and all necessary authorizations have been obtained in respect of the use of information owned by third parties in the Funded Project."

"Any opinions, findings, conclusions or recommendations expressed in this Progress Report have been given or expressed without consultation with or reference to the Grantors and the Fund, and do not necessarily represent the views of the Grantors or the Fund."

Signature: _____
(Project leader, Professor Kenneth M.Y. Leung)

Date: ___13 December 2023_____

Completion Report

December 2023

Executive Summary

The overarching objective of this project was to design, implement and evaluate nature-based ecologically engineered solutions by deploying oyster shell reefs in Sham Wan Bay, Lamma Island to enhance biodiversity and ecosystem functions. For this purpose, locally grown native *Magallana hongkongensis* (Hong Kong oyster) shells were sourced from oyster fishermen at Lau Fau Shan, Hong Kong. Two types of oyster shell reef units were assembled: oyster shells were bagged either in biodegradable hemp or stainless-steel wire mesh. In total, 40 artificial reef units were made. Five hemp-bag and five steel-bag oyster shell reef units were deployed in four trial sites within the inner, sheltered coves of Sham Wan Bay.

Due to the south-facing opening of Sham Wan, there was substantial exposure to tropical storms that came within range of Hong Kong. This exposure led to a higher-than-expected level of impact on the oyster shell reefs as the Tropical Storm Ma-on (21 - 26 August 2022) and Tropical Storm Nalgae (26 October - 3 November 2022) caused structural damage to the two outermost, southern sites, warranting a revised monitoring plan that saw the reduction of four trial sites and four reference sites to two of each, respectively. Oyster shell reefs located at the innermost northeastern and northwestern side of the bay remained largely intact and monitoring for the two trial sites continued. In addition to natural disturbances, anthropogenic activities also played a role in the structural deterioration of the reefs. During the non-restriction period, lines from fishing boats and pleasure vessels tangled with the buoy lines of the reef units, damaging the attached reefs below as entangled lines were pulled. The setting and retrieval of boat anchors also inevitably caused structural damage to the reef units.

Despite these challenges, an increasing number of marine species was recorded in every subsequent monitoring period for both reef types. At the end of the 12-month trial period, 104 mobile species and 45 sessile species were recorded on oyster shell reefs, of which 96 species were filter feeders (64.4%) and 53 species were non-filter feeders (35.6%). Within the filter-feeding community, bivalves were the largest group with a record of 17 species, demonstrating that oyster shell reefs can recruit and support communities of filter-feeders capable of water filtration which has the potential to improve water quality *en masse*.

Out of the various taxonomic groups recorded, crustaceans were the biggest group with 43 species, followed by fish with 22 species, and gastropods with 17 species. Many species within these taxonomic groups were of commercial importance. Commercial fish species such as *Diagramma pictum* (painted sweetlip), *Epinephelus coioides* (orange-spotted grouper), and *Sebastiscus marmoratus* (marbled rockfish) were commonly observed. Invertebrates such as *Charybdis lucifera* (yellowish-brown crab) and *Sepia pharoanis* (Pharaoh's cuttlefish) were also recorded.

A highlight of the project was the encounter of multiple individuals of yellow seahorse *Hippocampus kuda* during the 6-month, 9-month, and 12-month monitoring periods. Three individuals were recorded at oyster shell reefs during the 9-month monitoring period. This species is considered vulnerable under the IUCN Red List of Threaten Species and is a species of conservation importance.

Other notable observations include a pair of *Trachyrhamphus* sp. (pipefish), an endemic bivalve *Limaria hongkongensis* (Hong Kong file clam) and a non-photosynthetic coral species *Balanophyllia* sp. (ahermatypic cup coral). The discovery of these species suggests that oyster shell reefs have the potential to recruit and provide important habitats for species of conservation importance as well as contributing to habitat complexity and biodiversity in degraded areas or homogenous environments with a low habitat complexity (e.g., a seabed with soft sediment mainly in Sham Wan Bay).

In Hong Kong, the Agriculture, Fisheries and Conservation Department (AFCD) has been implementing the Artificial Reef Project since 1996, deploying 600 units of artificial reefs with a total volume about 180,000 cubic meters, with an exclusive use of artificial substrate such as retired vessels, concrete blocks, and scrap tires. To date, about 200 species have been recorded on these artificial reefs, whereas on the artificial reefs made of recycled oyster shells of this study 149 species have been recorded in one year. This suggests that oyster shell reefs could be an effective nature-based solution with potential to be implemented on a large scale to promote local fisheries resources and enhance biodiversity.

Further investigation should be conducted to construct a more durable and resilient oyster shell reef, such as incorporating cementitious or reinforcement materials into the reef design. Using a combination of oyster shells and other eco-friendly materials (e.g., cementitious material or bamboo frames) can increase the stability, durability, and ecological performance of oyster shell based artificial reefs.

The research team had also sought to disseminate the findings of this project to stakeholders and the public in various settings and venues such as: a 30-minute presentation at the research sharing session at the Hong Kong Metropolitan University attended by academics and research staff; a 15-minute presentation at the fund sharing session jointly organized by Castle Peak Power Company Limited (CAPCO), The Hongkong Electric Co., Ltd. (HK Electric) and Hong Kong LNG Terminal Limited (HKLTL) attended by academics, green groups and fisheries sector representatives; an in-person poster presentation at the International Conference on Conservation and Sustainable Development of Coastal Wetland at the Hong Kong Metropolitan University; a radio interview by Dr. Merrin Pearse on the Sham Wan Project on The Brew on RTHK Radio 3; and a workshop at MakerBay Foundation (Tsuen Wan) titled: Shells to Hotels: Building micro-habitats with oyster shells for the rehabilitation of marine biodiversity attended by undergraduate students. A webpage dedicated to the project can also be found at https://www.ecoshoreline.org/projects.

The project has successfully demonstrated the ecological advantages of employing nature-based solutions by deploying oyster shell reefs in Sham Wan Bay, Lamma Island. Despite challenges posed by tropical storms, the oyster shell reefs present high potential to be implemented to enhance biodiversity and ecosystem functions throughout Hong Kong. Overall, this study represents a significant step towards sustainable coastal management and offers valuable lessons for future projects aiming to enhance marine biodiversity.