

Marine ranching in China: a case study of Fuhan

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The global fisheries are continuously in decline because of overfishing, pollution, and climate changes and so on, as well as in the Yellow Sea fisheries. Many fishery species in YS have been co-exploited. In order to realize the sustainable fisheries in YS, PR China and ROK both have conducted the fishery implementations, including stock enhancement, sea ranching and artificial reef. In order to better conserve fishery resources, YSLME implemented a monitoring program to assess the progress of implementation of SAP in demo sites. The mission is to establish regional stock enhancement, sea ranching and artificial reef monitoring guideline, and network. Yantai University undertook the task of monitoring of implementation results in Fuhan Marine Ranching in China, which is one of three demo sites. After two years' work, this regular monitoring report was finally finished in accordance with the project M&E framework.

1. Background

Marine ranching was first raised by Japan during the Okinawa International Marine EXPO in 1973. But in China, as early as 1963, Chinese scientist Shuping Zhu presented the issue that "oceans and lakes are pastures where fish, shrimp and other aquatic animals live. Fishing is not a mining industry, but an animal husbandry". Afterwards, sea farming and ranching was brought up by Chengkui Zeng in 1978. He thought that agricultural and pastoral marine aquatic products production should include two production methods, agricultural production and animal husbandry production. Agricultural production can be called shallow sea agriculture, some are called cultivation aquaculture. It means plants and animals are artificially cultivated in a limited water space in the offshore sea. The production range is roughly in the coastal area. The isobath within about 20 to 30 meters, including the intertidal zone of the beach swamp. The cultivating objects are fish, shrimp,

shellfish, algae and sea cucumber and crab. Animal husbandry production means artificially bred plants and animals are released in natural waters, and harvest at appropriate times. During this period, they grow in nature on their own. But human beings can take some measures to regulate the ecology, such as changing the composition of fauna to increase the proportion of economically valuable species. Therefore, Hongsheng Yang thought that marine ranching is the advanced form of marine animal husbandry production. Proliferation and releasing are a link of marine ranching activities, which is a process of releasing artificially incubated larvae into the sea. Artificial reefs are artificial facilities providing habitat for marine organisms. So, it's a technical means of marine ranching construction. They're all parts of the marine ranching, which are also very basic and important. The proliferation and release of aquatic animals began in the 1970s and became large-scale in the late 1980s in China. Construction of artificial reefs began in 1979 and stagnated for some reason for twenty years. It was revived until the 21st century. Due to these, marine ranching in the true sense appeared in China. It covers the whole process of seed breeding, seedling raising, proliferation and recapture, which attaches importance to the restoration of habitats and conservation of resources. At the same time, the key technologies of marine ranching construction, such as fine seed selection and breeding, seedling breeding technology, algae habitat construction technology, breeding facilities and engineering equipment technology, intensive processing technology, are gradually maturing. Benefit from the maturity of all these conditions, marine ranching has developed rapidly in China in the past decade. Among them, the marine ranching construction of Shandong Province is very characteristic and fruitful. It may benefit by the new construction organization form that the enterprises implement construction and management, and the government provides appropriate policies and financial supports. Take Shandong Province for example, during 2005 to 2009, more than 20 kinds of marine animals were proliferated and released in the coastal waters of Shandong, and 226.6 million cubic meters of artificial reefs were dropped. At final the fishing catch reached to 180,000 tons, the total output value is 4.92 billion yuan, the fisherman received an additional 10,000 yuan per capita.

In 2006, the state council of China promulgated the *Program of Action for the Conservation of Aquatic Biological Resources in China*, which clearly put forward

“actively promote regional and comprehensive development in the main form of marine ranching and establish demonstration areas of marine ranching”. The central government finance began to provide special support to the marine ranching construction. The local departments of fishery responded positively, and the people from all walks of life took part in it extensively. Since then, the construction of marine ranching in China has formed a certain scale, and the economic, ecological and social benefits have become increasingly prominent. In 2013, *Several Opinions of the State Council on Promoting the Sustainable and Healthy Development of Marine Fisheries* clearly required "develop marine ranching and enhance construction of artificial reefs". Therefore, Ministry of Agriculture of China (now called Ministry of Agriculture and Rural affairs of China) decided to construct National Marine Ranching Demonstration Areas in 2015. There were 20 in the first batch, distributed in various coastal areas of China (Fig 1). According to *the Construction Plan of National Marine Ranching Demonstration Area (2017-2025)* issued by Ministry of Agriculture and Rural affairs of China, 178 National Demonstration Marine Ranching will be built until 2025.

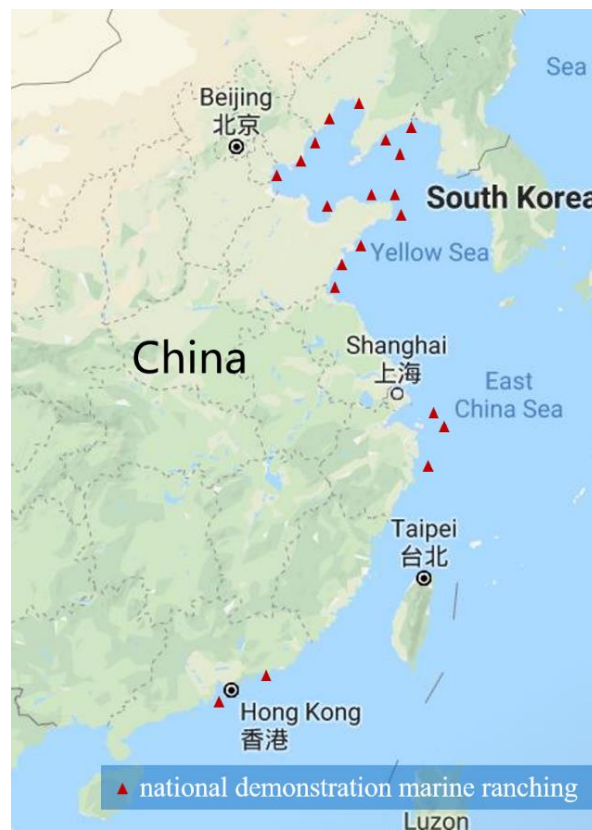


Fig 1 The first-round national demonstration marine ranching in China.

In China, Shandong is a province with strong fishery industry and abundant marine resources. Fishery economy occupies an important position in the social and economic development of Shandong. In recent years, under the supportive guidance of the department, bureau of fishery affair, Shandong has been vigorously promoting the construction of marine ranching by speeding up the transformation and upgrading of traditional fishery and by carrying out the transformation of marine fishery from “hunting” to “farming and ranching”, and has received 22 National demonstration marine ranching. Benefited from the normalized construction, marketized operation, and industrialized management of marine ranching, Shandong actively carries forward the establishment of long-term investment mechanism, encouraging the capital participation of enterprises and society. More than 130 enterprises have participated in the construction of marine ranching which develops diversified forms of management to promote the large-scale industrialized development of marine ranching. Fuhan marine ranching is one of them, which became national demonstration marine ranching in 2017.

2. General introduction of Fuhan marine ranching

Fuhan Marine Ranching is located in the east coast of China, facing the yellow sea (Fig 2). The construction began in 2013. The current building area is about 8 km². A total of 200,000 m³ artificial reefs (AR) were built and dropped into the sea. The types of AR include stone reefs, concrete reefs, steel frame reefs, algae reefs, oyster reefs and old fishing boats (Fig 3). Among them, eco-type reefs account for 25%. After the construction of the reefs, the main fishery resources released and enhanced are sea cucumbers, shellfish, cephalopods, fish and algae (Fig 4).



Fig 2 Location of Fuhan Marine Ranching



Fig 3 AR types



Fig 4 The enhanced species of fishery resources which were released or transplanted.

3. Construction process of Fuhan marine ranching

The Marine ranching mainly consists of nursery factory, artificial reef area, stereoscopic cultivation area, bottom seeding area, sightseeing tour area and aquatic product processing factory. Based on the design of Fuhan Marine Ranching, the whole construction process can be divided into five stages (Fig 5).

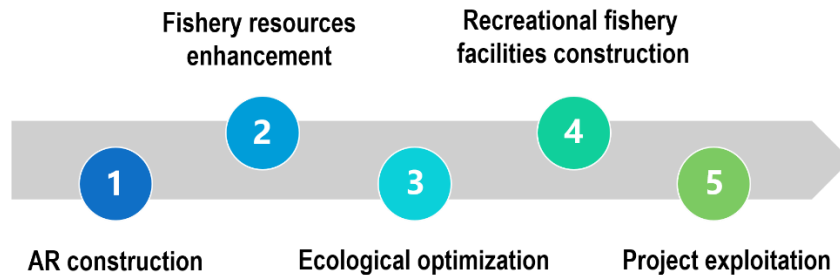


Fig 5 Construction process of Fuhan Marine Ranching

The first stage is artificial reef (AR) construction and launching, which was carried out in two steps (Fig 6). In the first step, stone reefs, concrete reefs and steel frame reefs

were built and launched, which took a total of 3 years. The main function of AR is fishery stock enhancement in this phase. In the second step, ecotype AR were built and launched, including the abandoned fishing boats, concrete AR with multiple structures, oyster shell reefs.

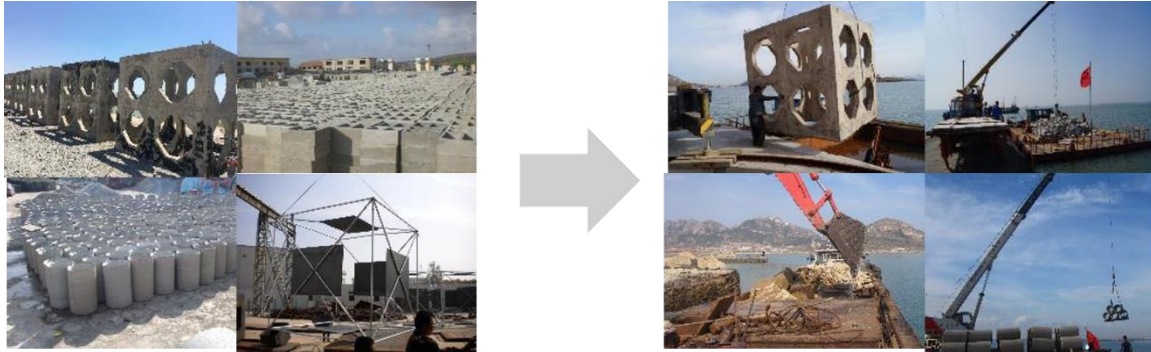


Fig 6 AR construction and launching.

The second stage is fishery resources enhancement. The Fuhan ocean technology co. LTD cooperating with universities and research institutes, carried out breeding research on jellyfish, golden cuttlefish, black sea bream, Korean rockfish and common Chinese cuttlefish. They also started the study on algae forest construction, including algae reef design, algae body transplantation and algae reef delivery technology.

Based on the above work, the ecological optimization of the marine ranching has been started. A multi-variety, efficient and stereoscopic ecological aquaculture test field was explored to launch featured green products. Among that, algae farming is in the upper layer, blue mussel, scallop and oyster farming is in the middle layer, fish farming is in the under layer, shellfish farming is in the bottom (Fig 7).

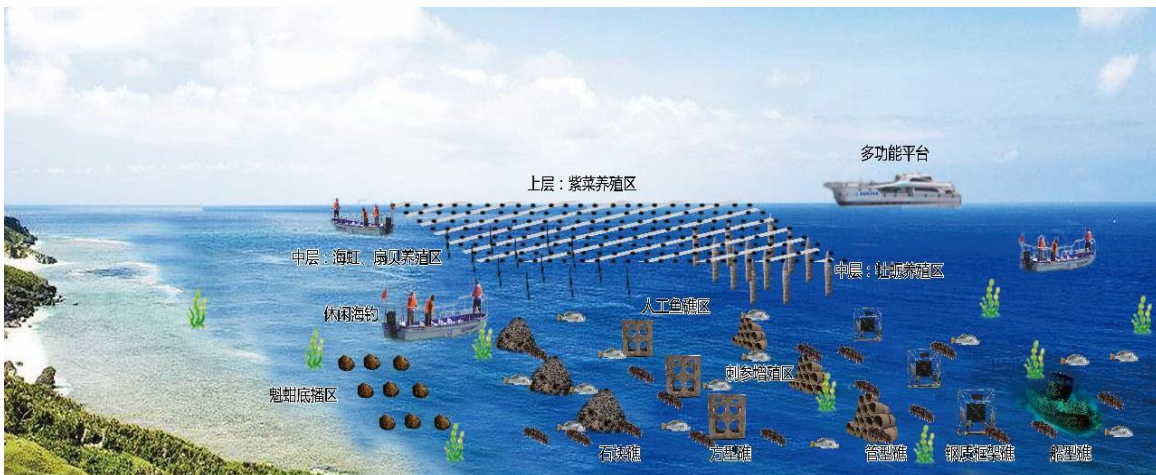


Fig 7 The design of Fuhan Marine Ranching.

The fourth stage is recreational fishery facilities construction, including marine ranching offshore multi-functional platform construction, Yacht Marina construction, marine ranching showroom construction and marine ranching institute construction (Fig 8).

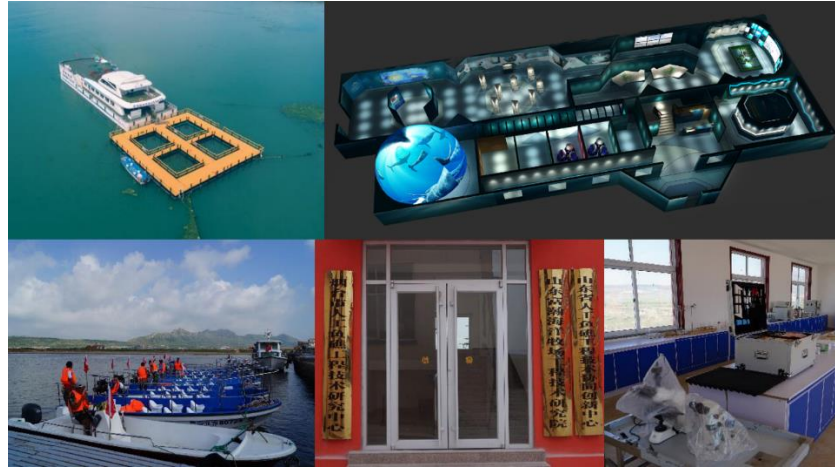


Fig 8 The recreational fishery facilities construction.

In the final stage, a variety of projects and tourism routes have been developed. At present, the development projects mainly include: leisure sea fishing, yacht sea sightseeing, fishing experiencing, sea wedding photography, island fishermen experiencing, fish releasing public service activities (Fig 9).



Fig 9 The project exploitation.

4. Construction effect

After one-year construction, AR began to attach with local algae and shellfish. At present, the total coverage of the AR reached more than 50 percent covered by algae and oyster. The economic fishery species in AR area increased (Fig 10), and the resource quantity was over 3 times of that before AR construction. At present, the annual output of

sea cucumbers is 60,000 kg, shrimp, crab and fish are 22,000 kg, and shellfish such as oyster, blue mussel is close to 1 million kg. Fishermen's catch and their income increased. Tourism revenue increased. A total of 50,000 tourists were received in 2017.



Fig 10 Productions from Fuhan Marine Ranching.

5. Future plan

Fuhan company next plant to carry out four aspects construction in Fuhan Marine Ranching. One is developing ecological aquaculture and deep-water anti-wave cage agriculture. The second is to construct marine algal bed to optimize the ecological environment of artificial reefs. The third is to continue to improve recreational fishing facilities of tourist service centers, marine ranching exhibition halls, and sea fishing port to develop leisure tourism. The fourth is to develop aquatic products deep processing. The aim is to establish a comprehensive and sustainable fishery demonstration base, with a complete process of recreational sea fishing industry, from seedling breeding in marine ranching to aquatic products deep processing.

Therefore, our future plan is to continue to track the construction of Fuhan Marine ranching. We will actively participate in the development and construction of tridimensional ecological aquaculture, artificial reefs and algal bed restoration, in order to deeply understand the conservation mechanism of fish stocks in the YS ecosystem. Finally, establish a regional monitoring network for sea ranching.