



For 2007' Symposium and Workshop in Korea  
Sustainable Mariculture in the Yellow Sea

# TECHNIQUES AND DEVELOPMENT FOR SUSTAINABLE CAGE MARICULTURE IN CHINA

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**Research on**

**Mariculture Engineering , Facilities and Equipment**


**At present, mainly on R&D of offshore cage and artificial  
fish reef technology**

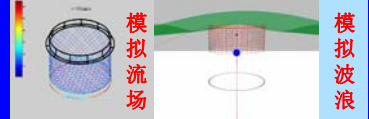


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- General description**
  - Traditional Cages**
  - Offshore Deep Sea Cages**
  - Cage mariculture in the Yellow Sea**
  - Sustainable Cage Mariculture Practices**
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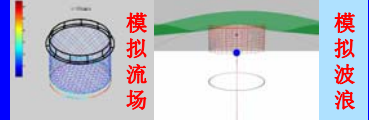


## 1. Introduction

- ♠ Cage mariculture in China started in early 1970s and developed rapidly during the 1980s and 1990s.
- ♠ By the year of 2006, there are more than 1 million cages in all. Over 30 species of fish are farmed in cages  
Annual fish production from cage mariculture: about 30 t  
Sea cage farming has become a mainstay in the whole industry of mariculture in China.

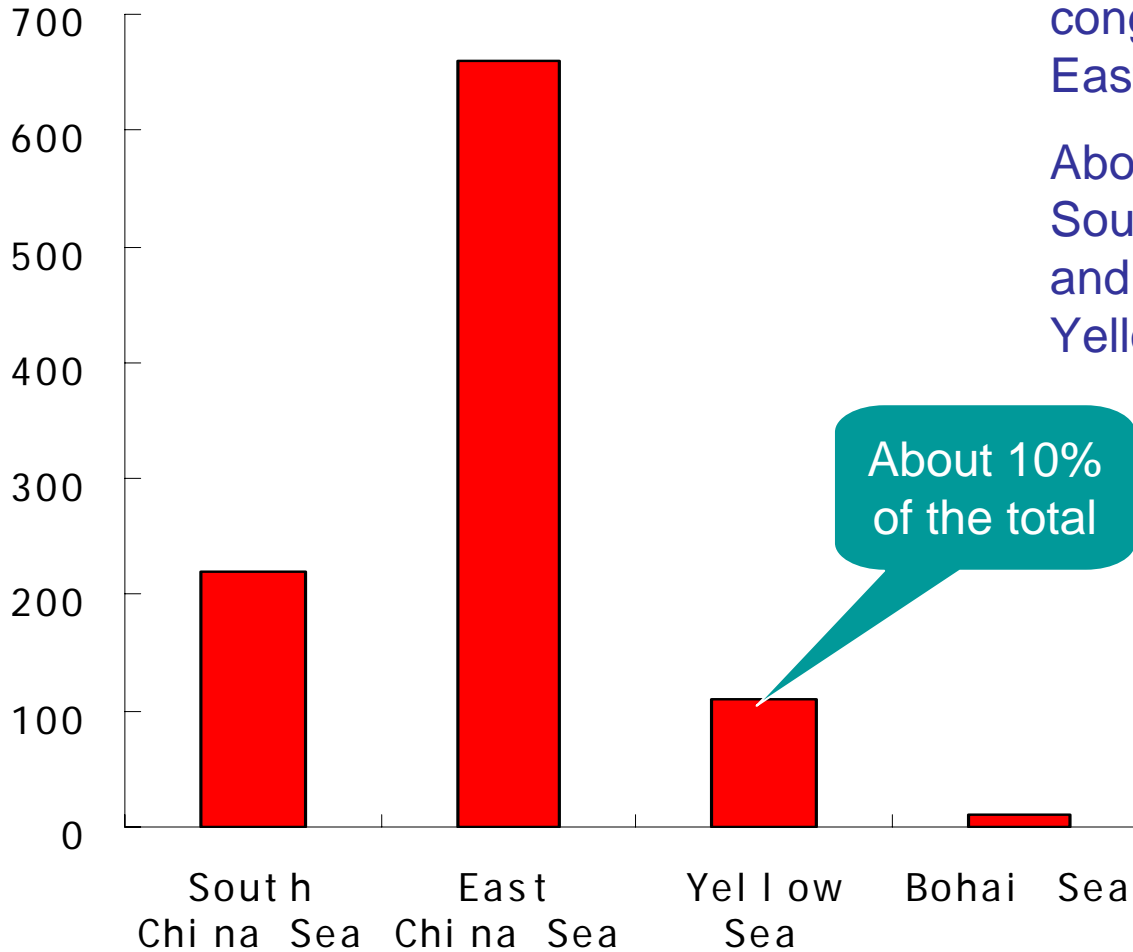
## 2. Classification

- ♠ The small cages of traditional designs are defined as traditional cages. While cages characterized by larger in carrying capacity, resistance to waves and currents and being sited in offshore and deeper water areas are defined as Offshore Deep Sea Cages.  
Traditional cages: about 1 million  
Offshore deep sea cages: over 3800



## 3. Distribution

Cages (000')

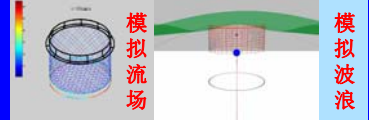


Cages are mostly congregated in the East China Sea

About 20% in the South China Sea and 10% in the Yellow Sea

About 10% of the total

Distribution of sea cages in China



## 4. Major species farmed

Species	The north	The south
Sea bass ( <i>Lateolabrax japonicus</i> )*	✓	✓
Red drum ( <i>Sciaenops ocellatus</i> )		✓
Large yellow croaker ( <i>Pseudoscisena crocea</i> )		✓
Red sea bream ( <i>Pagrosomus major</i> )	✓	✓
Black sea bream ( <i>Sparus macrocephalus</i> )	✓	✓
Groupers ( <i>Epinephelus awoara</i> , <i>E. akaara</i> )		✓
Greenling ( <i>Hexagrammos otakii</i> )*	✓	
Black rock fish ( <i>Sebastes fuscescens</i> )*	✓	
Cobia ( <i>Rachycentron canadum</i> )		✓
Swallowtail ( <i>Trachinotus ovatus</i> )		✓
Puffer ( <i>Fugu rubripes</i> )	✓	
Flounder ( <i>Paralichthys olivaceus</i> )**	✓	
Turbot ( <i>Scophthalmus maximus</i> )**	✓	

\* Over wintering species ; \*\*Species in testing



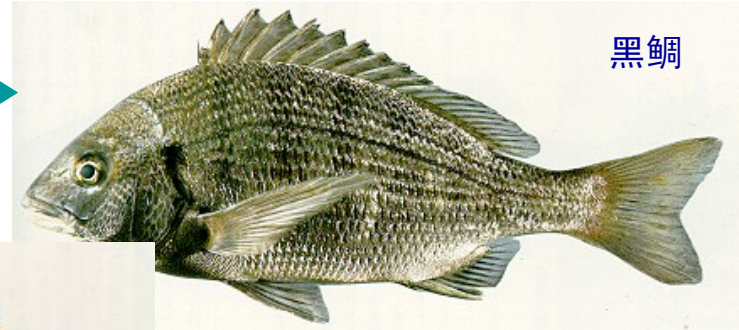
Flounders

Turbot

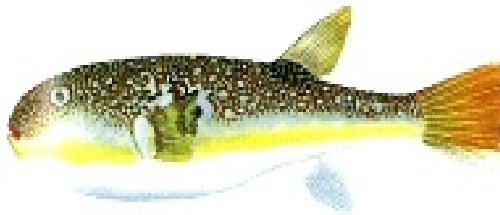
Swallowtail



Black Seabream



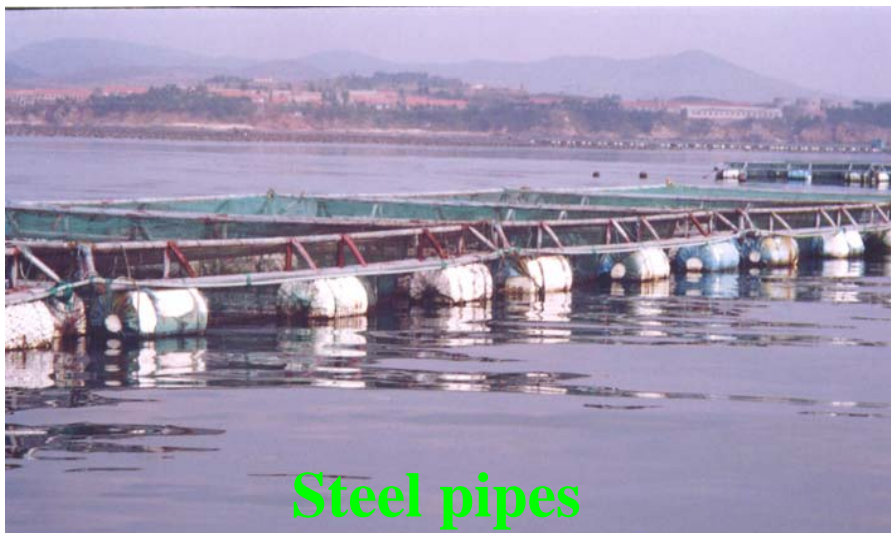
Red Seabream



Greenling

Large yellow croaker

### 1. Structures, Sizes and Materials



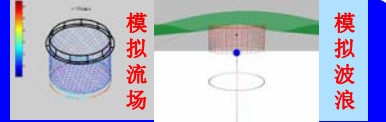
### Typical structures and sizes

**Structure: 3 types (photos)**

**Size:  $3 \times 3$  to  $5 \times 5$  m in square with net depth of 3~5m.**

**With hundreds or thousands of cages connected together**





## 2. Problems of traditional cages

- These cages cannot withstand the strong wind and big waves in heavy sea, more and more cages have to be crowded in the near shore, shallow and sheltered areas, which brings in many problems. For instance, the stocking density is beyond the carrying capacity of environment and the lack of effective method to prevent net bag from fouling makes the exchange of water difficult.
- The accumulation of waste metabolite and the waste feeds polluted the farming environment and problems of self-pollution are serious. Moreover, most of the near shore waters are polluted by waste from on-land industries. All resulted in fish disease to break out and fish quality and economic efficiency to decrease, which have restricted the development of cage mariculture in China.

➤ **Damaged traditional farming cages by typhoon**



Total losses  
142 million  
USD

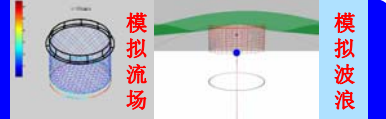
➤ **Losses from pollution and fish diseases**



To realize sustainable development, a new model of cage mariculture have to be developed.

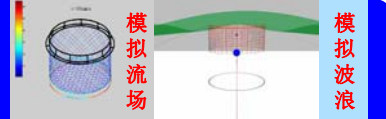
That is **Offshore Deep sea Cage Farming**





## 1. Advantages of offshore cage farming

- ✓ **High tech and automation**
- ✓ **Long life span and fouling resistant**
- ✓ **More resistant to wind and wave thus can be sited in more exposed waters.**
- ✓ **Large carrying capacity and better economic benefits**
- ✓ **Friendly culture model with the environment**
- ✓ **Little risk of loss and lower cost**
- ✓ **Better fish quality and higher prices ( Although the farming species are almost the same as those of traditional cages, the environment improved)**



## 2. Major structures and properties

- ① HDPE circular floating cage
- ② Submersible cage
- ③ Flexible cage made from ropes and floats
- ④ Two-cones-shaped net cage
- ⑤ Installed steel structure cage
- ⑥ Strengthening plate cage

The first 4 types are mostly used

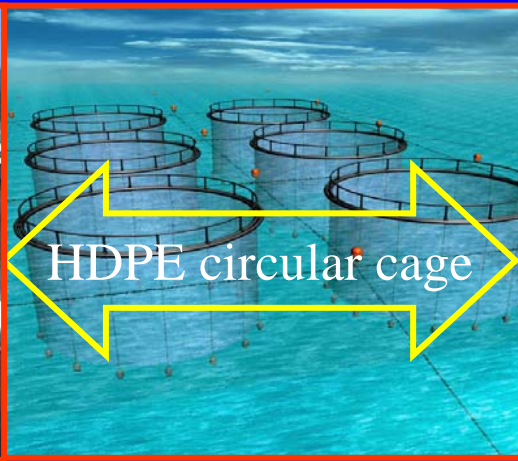
① floating cage



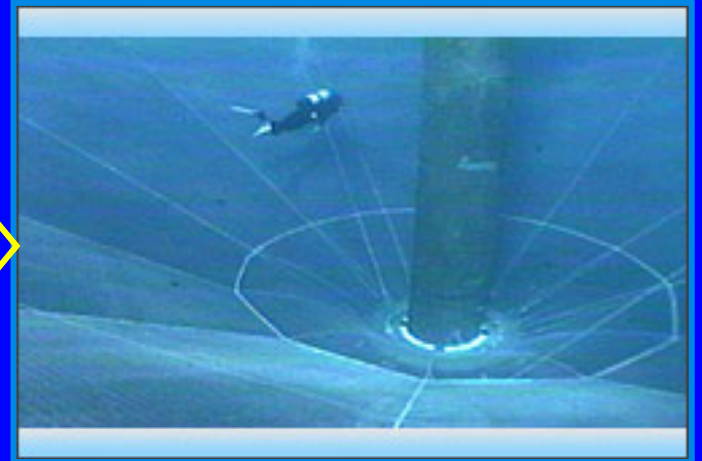
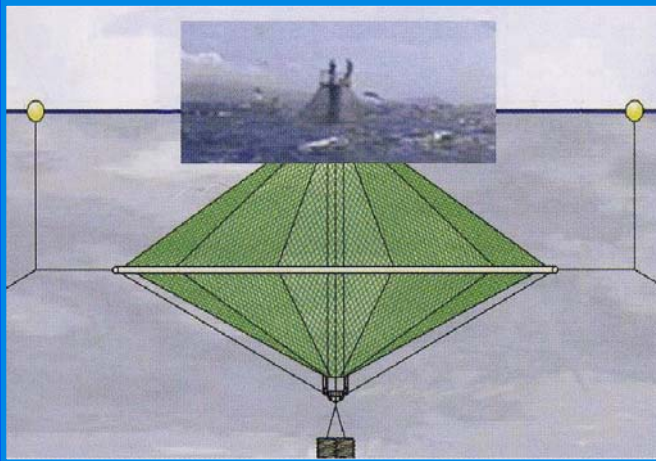
② submersible cage



HDPE circular cage



③ Two-cones-shaped net cage



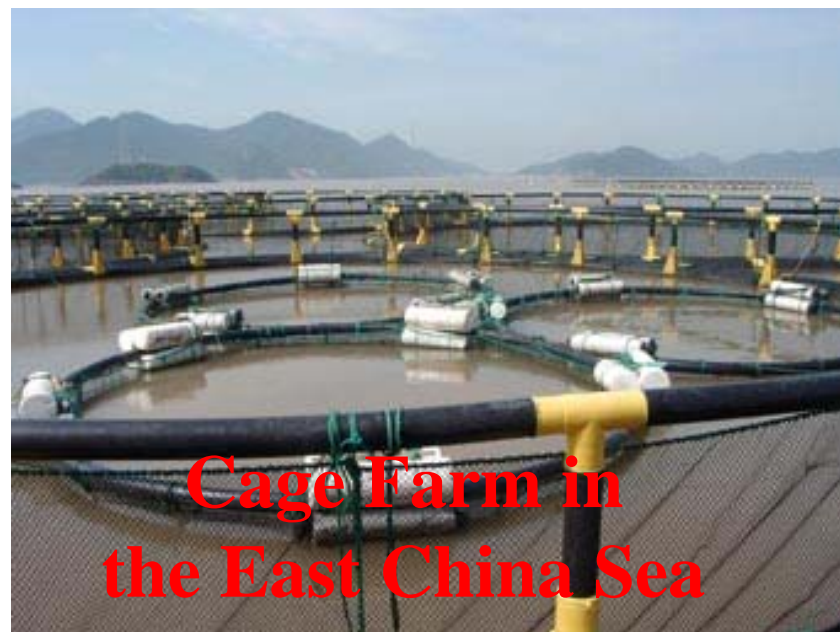
④ Cage made from ropes and floats



# Typical Offshore Cage Farm in China



**Cage Farm in  
the Yellow Sea**



**Cage Farm in  
the East China Sea**

**Circumference: 40~60m**  
**Water volume: 800~3000m<sup>3</sup>**  
**(for different net depth)**

**Anti-wind force: 10-12**  
**Wave action: 5~7m**  
**Current: 1m/s**



## 3. Progress of Research and Technology

### ● Other Types of Net Cage Developed Newly



# ● Cage Manufacturing Equipment and Products



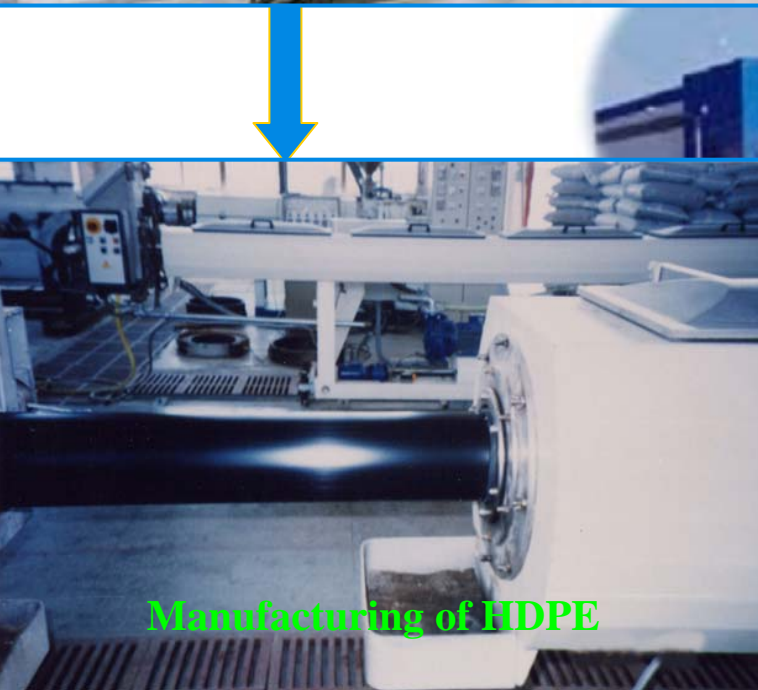
Production line of HDPE pipes



Making of Cage connection fittings

网箱生产基地

Qingdao Shenbo  
Sea-cage Co.,Ltd.



Manufacturing of HDPE



HDPE pipes & connection fittings

# ● Related facilities and equipment for cage farming

—— Fish size grading system, live fish harvesting and net cleaning machine



Small fish swim out of the panel  
While the large fish remained



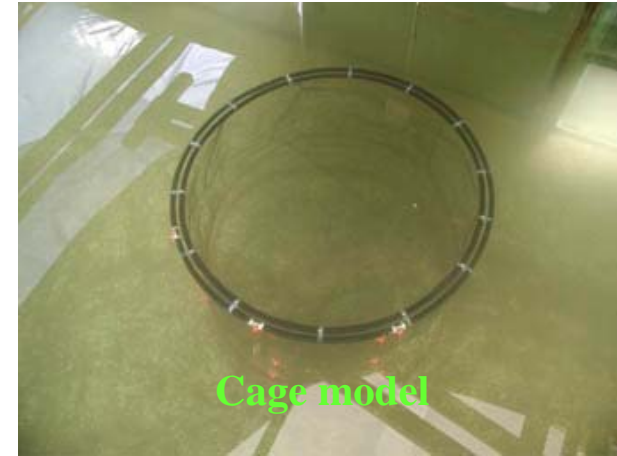
# ● Related facilities and equipment for cage farming

## — Feeding machine and monitoring system



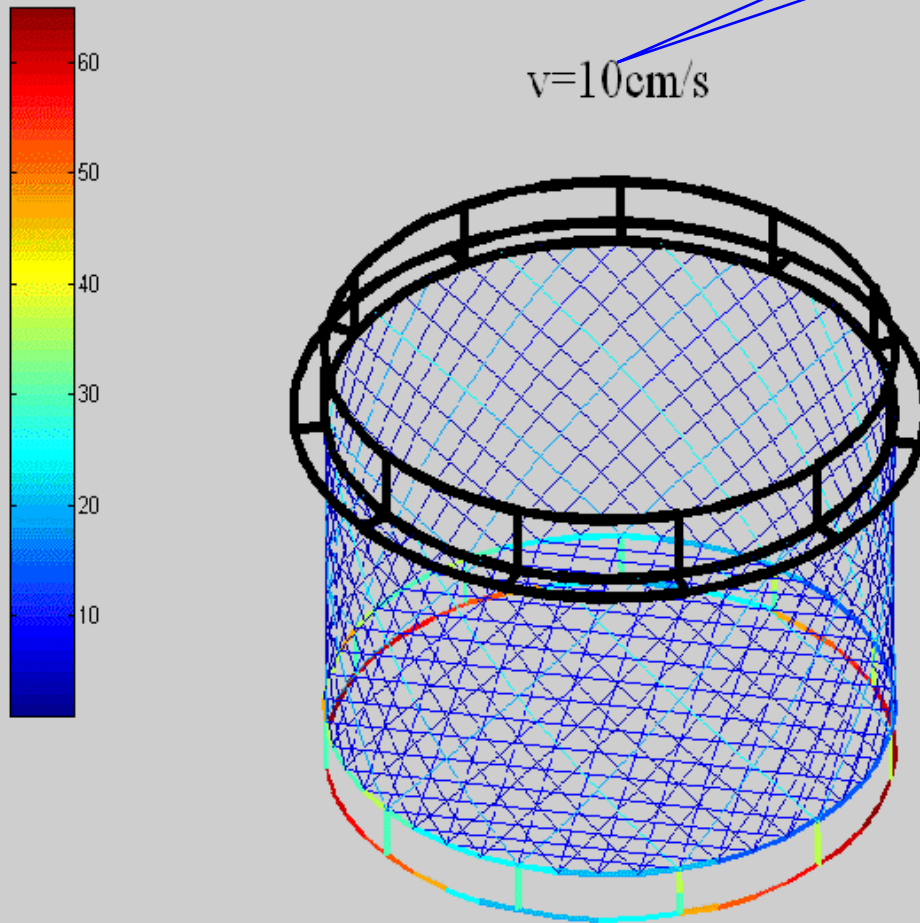
# ● Physical and Numerical Modeling

## ❖ Physical Modeling Test



## ❖ Numerical Modeling

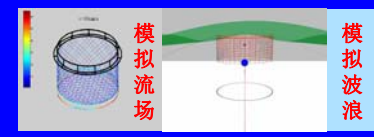
In current



With the changing of the current speed, the shape and motion of the cage are showing.



# IV CAGE MARICULTURE IN YELLOW SEA OF CHINA



- Generally, cage mariculture of China in the Yellow Sea takes the same steps with the development of the industry of the country
- Cages in the Yellow Sea are not as crowded as those in the East China Sea and the South China Sea. Now there are about 100,000 cages in Shandong, Liaoning and Jiangsu provinces located along the Chinese coast of the Yellow Sea



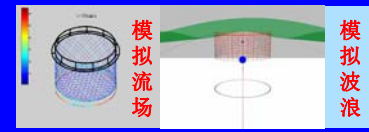
Cages in Lingshan Island, Qingdao the Yellow Sea



Cages in Xiapu, Fujian the East China Sea



## IV CAGE MARICULTURE IN YELLOW SEA OF CHINA



- The factors which restrict the scale of cage mariculture of China in the Yellow Sea are:
  - Firstly, the Yellow Sea is comprised of shallow areas of continental shelf and there are few sheltered bays with enough water depth along the coast for cage farming.
  - Secondly, the water temperature in the Yellow Sea is relatively low during the winter, which allows only a few species of fish (now mainly *Sebastes schlegeli*, sea bass and *Hexagrammos otakii*) to live through the winter time inside the cages.



**Black rock fish**  
*Sebastes schlegeli*



**Sea bass**  
*Lateolabrax japonicus*

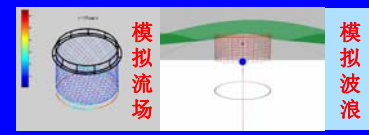


**Greenling**  
*Hexagrammos otakii*





# V SUSTAINABLE CAGE MARICULTURE PRACTICE



- Firstly, to develop the new and advanced offshore deep sea cages with characteristics of good performance and lower cost to substitute the traditional cages and move the cages to more exposed and deeper water areas.
- Secondly, to strengthen the research and development on healthy and sustainable cage farming technology, including:
  1. Effective compounded feeds (Substitute the trash fishes used)
  2. Efficient and non-toxic anti-foulants (Anti-fouling more the 10 months)
  3. Seed supply, stocking and hatcheries (Species selection)
  4. Carrying capacity and remediation technology (Just at the beginning)
  5. Supplementary equipment, such as automatic feeder, sensing and monitoring systems, centre control platform and multi-purpose speedboats, etc.
- Thirdly, Scientific management on cage culture is being established and perfected to make the industry healthy and sustainable, for example, to establish the system of rotation culture or qualification approval and qualification certificate.
- Fourthly, Compliance with the Good Agricultural Practice in cage culture  
The national standard of [Cage Culture Base Controls Points and Compliance Criteria](#) has been made and is in the process of authorization for enforcement.



**We believe that**

**Best management and technological progress will make cage mariculture in the Yellow Sea healthy and sustainable!**

**THANK YOU !**