

Development of Integrated Multi-trophic Mariculture in Open Sea

Jianguang FANG

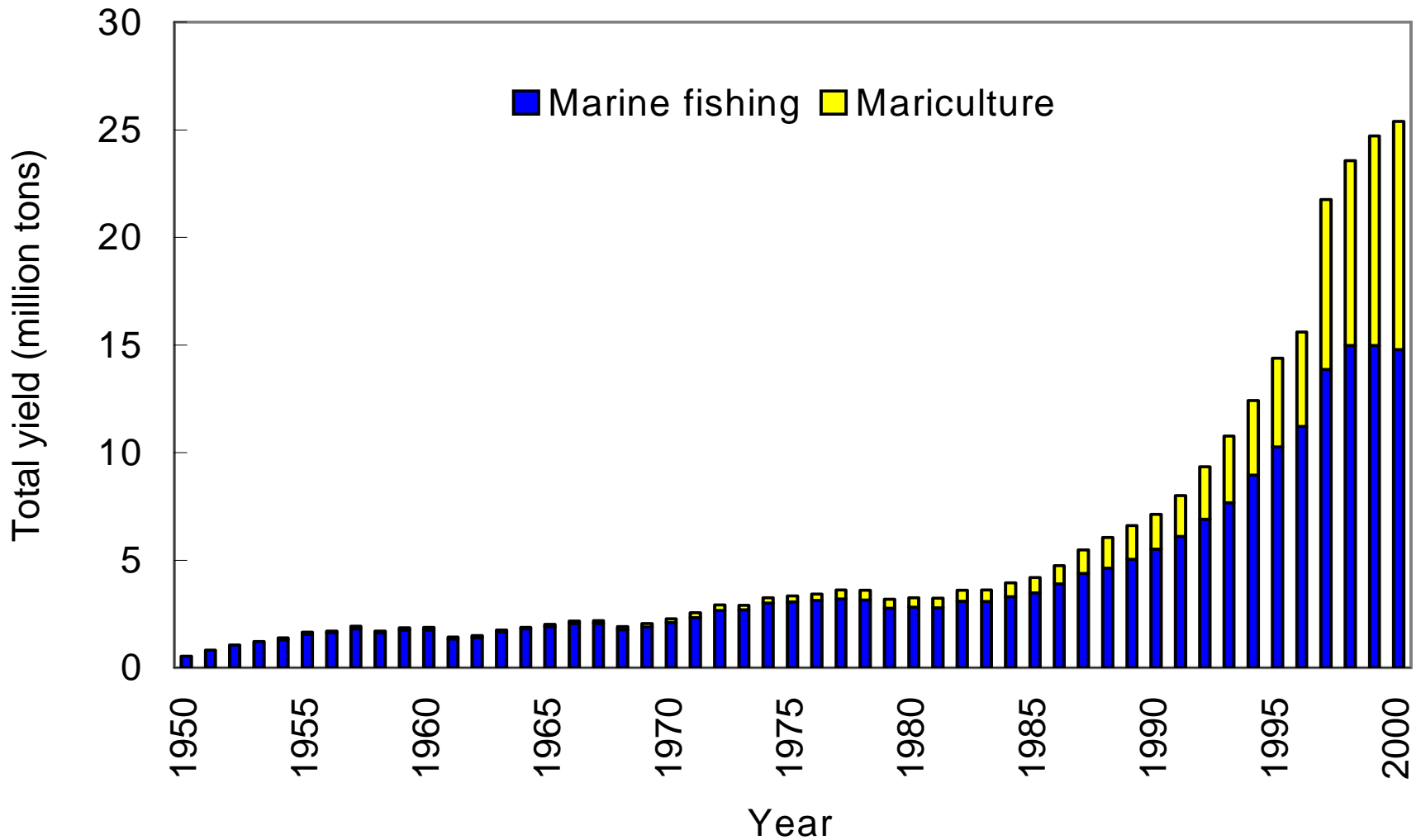
Mariculture Ecology Division

Yellow Sea Fisheries Research Institute (YSFRI), CAFS

Qingdao, 266071 P. R. China

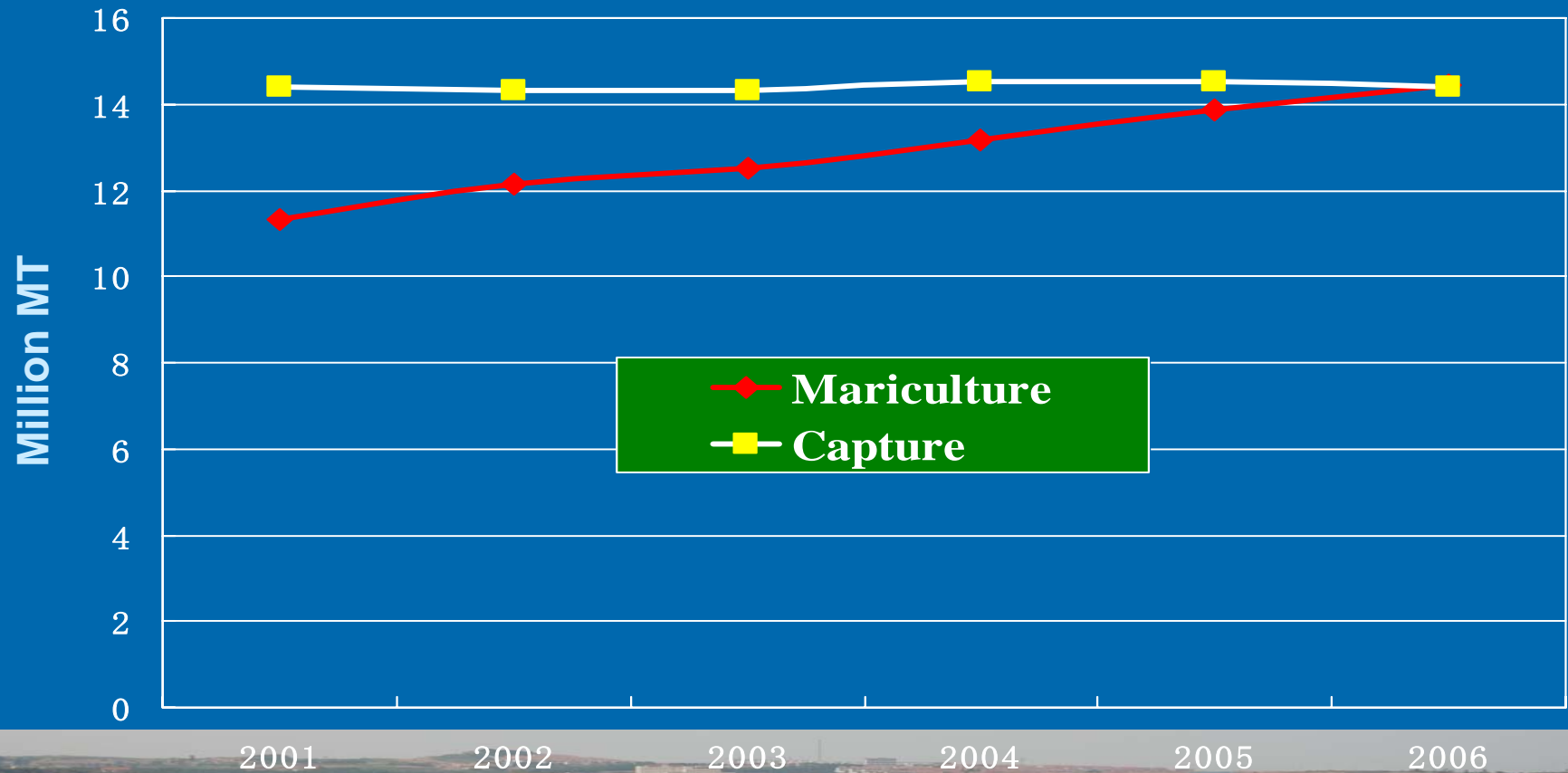
E-mail: fangjg@ysfri.ac.cn

2002. 6. 2



Development of Mariculture of China

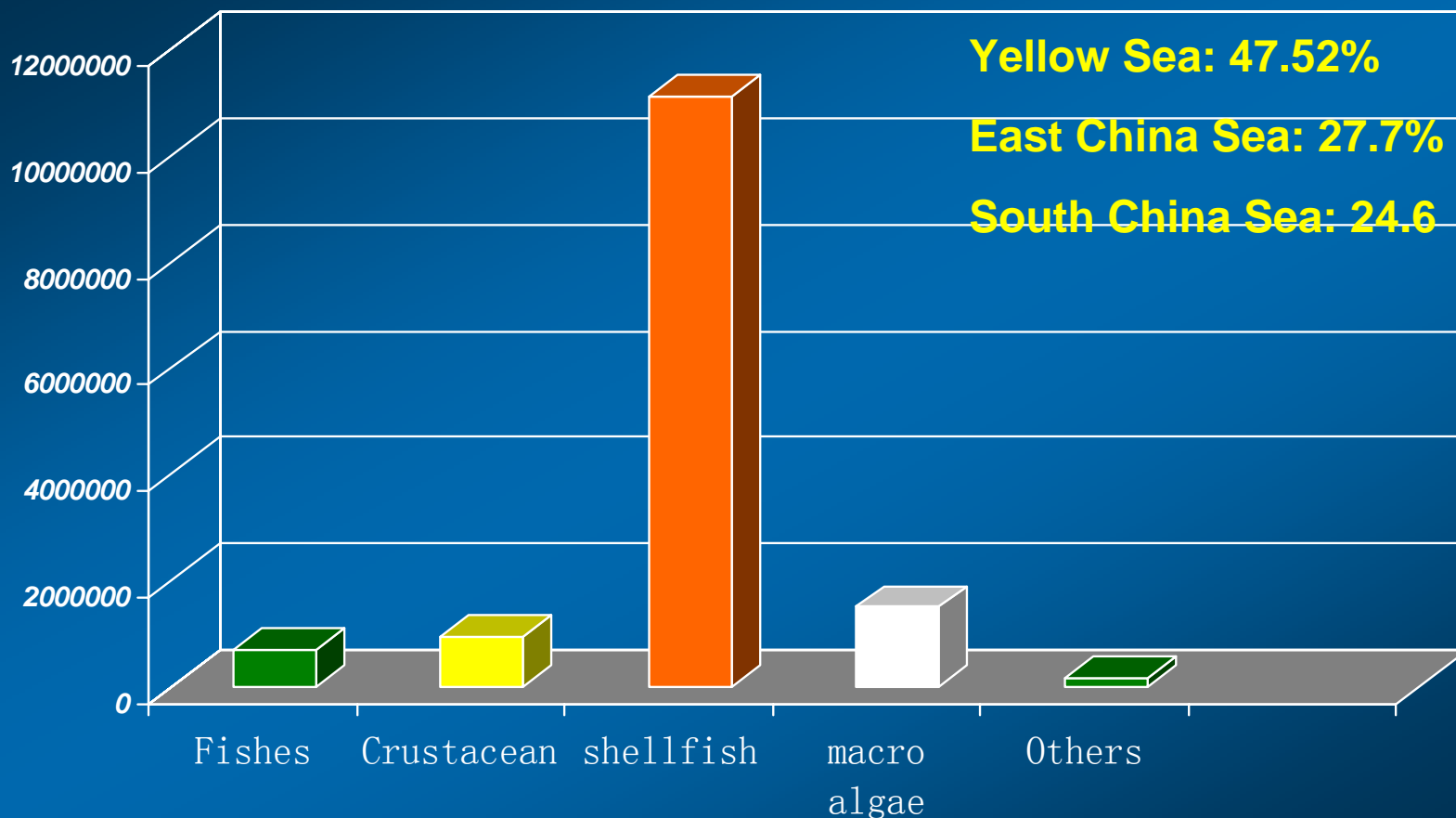
Development of Mariculture of China



2005: Mariculture 13,847,847 MT
Capture 14,532,984 MT

2006: Mariculture 14,456,399 MT
Capture 14,420,359 MT

Mariculture Yields of China in 2006 (Million MT)



Groups	Total	Bivalves	Macroalgae	Fishes	Crustacean	Others
Yield (M MT)	14.456	11.356	1.503	0.715	0.938	0.165

Major species of shellfish cultivated in Northern China



Pactinopecten yessoensis-



mussel *Mytilus edulis*



Scallop *Chlamys farreri*



Haliotis discus hannai



Oyster *Crassostrea gigas*

Major species of seaweeds cultivated in low temperature seasons in Northern China - *Laminaria japonica*



Sargassum sp



Gracilaria lemaneiformis

Major challenges

- **Increase the profit from Mariculture for farmers or companies, and**
- **Reduce pressure upon environment**

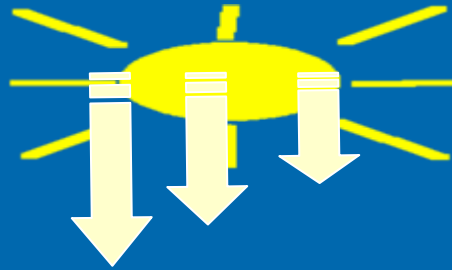
Integrated Multi-trophic Aquaculture is a ideal model to meet above challenges

Diet



Hydrodynamic

Nutrients (N, P)



Phytoplankton



Bivalves



Longline culture of
macro seaweeds

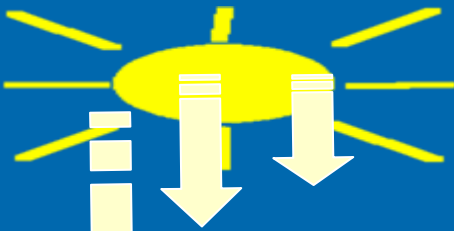


Abalone

The Models of IMTA Practiced for Suspending Mariculture

Hydrodynamics

Nutrients



Phytoplankton



Bivalves



Benthos
Seaweeds



Abalone, Sea urchin,
Sea Cucumber, clams

Models of IMTA for Sea Ranching

Species combination of Integrated multi-trophic mariculture in open sea for suspending culture

- **Depend on situation...**
 - **Bivalves (Scallop, oyster, mussel...) +seaweeds (Kelp, Gracilaria, Laver...)**
 - **Bivalves + Seaweeds + Fishes**
 - **Bivalves +Seaweeds + Abalone**

**The best combination is filtering feeders
+Seaweeds + Abalone+fish**

Advantage: higher economic benefit and environment friendly.

Species combination of Integrated multi-trophic in open sea for searanching

- Abalone + Sea cucumber +Seaweeds
- Seaweeds + Abalone + Sea urchin + sea cucumber+ scallop

The best combination is: Seaweeds + Abalone + Sea urchin + sea cucumber+ scallop

Consideration:

- Releasing healthy seedlings is the key measures
 - How to grow the seaweed in natural seabed
 - How to control the predators
-



Integrated Multi-trophic Aquaculture
based on carrying capacity practiced in
Sungo Bay, China



Yatou

Longline culture areas

Integrated multi-trophic mariculture in Sungo Bay

Searanching areas

Image © 2007 TerraMetrics
© 2007 Europa Technologies

© 2007 Google

Integrated culture of fish, seaweed, shellfish and sea urchin in Sungo Bay



Integrated culture of abalone (Sea urchin) and Kelp *Laminaria japonica*)







Daily management on
Integrated culture of abalone
and kelp on the sea

IMTA for Sea ranching or sea bottom culture in Sungo Bay



IMTA in offshore (Fish+Kelp+Scallop+Abalone)



The New designed experiment of IMTA of Kelp/sea cucumber/abalone



In this system, Abalone feeding kelp, while sea cucumber feeding the faeces of abalone, silt inside the cage, detritus of kelp. There is no food competition among the animals in the system. Farmers can get higher economic benefit than monoculture.

Sea ranching in ZZD

(Zhangzi Islands, Dalian, Liaoning Province)



62 Km away
from mainland

© 2008 ZENRIN
© 2008 NFGIS
© 2008 Europa Technologies
Image NASA

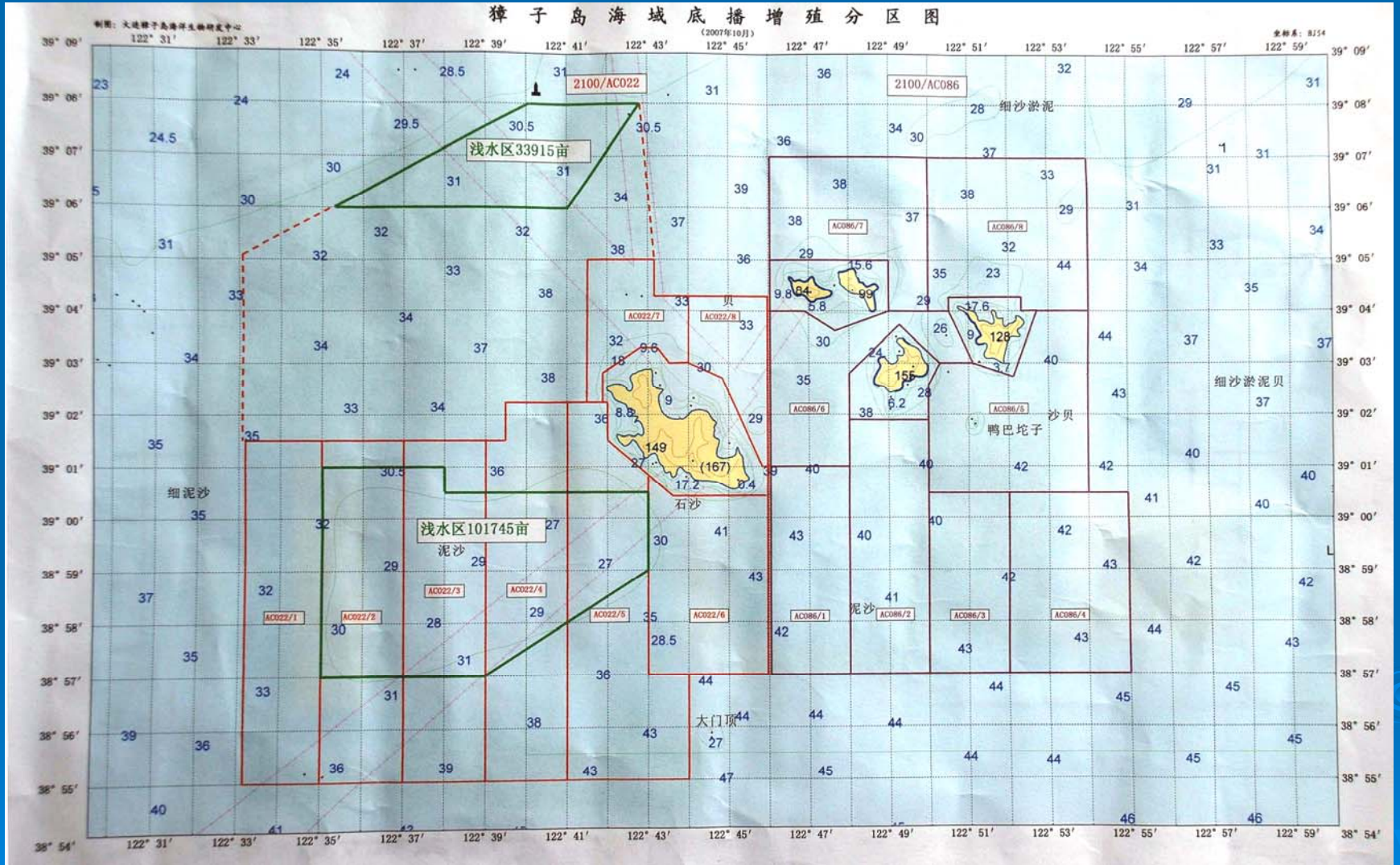
©2008 Google™

Eye alt 579.03 km

38°50'34.73" N 122°04'06.34" E

elev 0 m

Distribution of Sea ranching in ZZD



IMTA for Sea ranching or sea bottom culture in subtidal zone in Zhangzi Island, Dalian, Liaoning Province







Status of sea ranching in ZZD

Species	Sea ranching area (ha)	Annual yield (ton)
Scallop <i>Patinopecten yessoensis</i>	40,000	20,000
Abalone <i>Haliotis discus hannai</i>	1,000	100
Sea Cucumber <i>Apostichopus japonicus</i>	1,000	400
Sea urchin <i>Strongylocentrotus mudus</i>	1,000	300
Ark shell <i>Scapharca broughtonii</i>	3,000	500

Experiment of co-culture of scallop and shrimp in lantern nets in open sea



In this system, The fouling of *Caprella scaura* on nets can be controlled by the feeding of shrimp. Farmers can harvest both scallop and shrimp

Ecological Benefit from IMTA for both suspending and Enhancement in Sungo Bay

- Economic Benefit of IMTA of scallop, abalone, seaweeds and fish based on aquaculture carrying capacity is more than 40000RMB/1600m²**

Economic Benefit of Ecological Benefit Enhancement of scallop, abalone, seaweeds, clams, sea cucumber based on carrying capacity is about 10000RMB/667m²

- Economic Benefit of Monoculture of kelp and bivalves is 3000RMB/1600m² and 5000-8000RMB/1600m² respectively**

IMTA Model is an Environmental friendly and high economic benefit technologies

What we should think about Integrated multi-trophic mariculture?

- **Carrying capacity for each species**
- **Economic benefit**
- **Environment friendly**
- **Scio- Economic**
- **Fouling Control**
- ◆ **Predator remove**
- ◆ **Extending mariculture from inshore to offshore**

AIMS-- now and future :

- **Improve product quality seafood safety**
- **Reduce the stress on marine ecosystem**
- **Make more efficient use of resources**
- **Help farmers to get high economic benefit from IMTA**
- **Use IMTA as the bioremediation to control the eutrophication in Bohai Sea and Yellow Sea collaborated with other countries**



Is it possible to control the eutrophication in Bohai Sea by IMTA?



A sunset over a body of water, likely a bay or harbor. The sky is filled with large, dark clouds illuminated from below by the setting sun, creating a warm orange and yellow glow. The water is calm with gentle ripples. In the foreground and middle ground, there are numerous dark, dome-shaped buoys arranged in a grid pattern. A few small boats are visible on the water, and a dark landmass is visible on the right side of the horizon.

THANK YOU FOR
YOUR ATTENTION

21.11.2004



Culture Method and Economic Analysis

- The abalones are cultivated in the net cages from longlines with the kelp, and fed with fresh kelp.
- Culture density: 100 ind./net cages, 40000ind./400 cage/1600m².
- Profit: 50,000Yuan/ 1600m² (equal to US\$7000/ 1600m²)