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Long-term change and ecological restoration of the Yangtze River estuarine ecosystem in past decades

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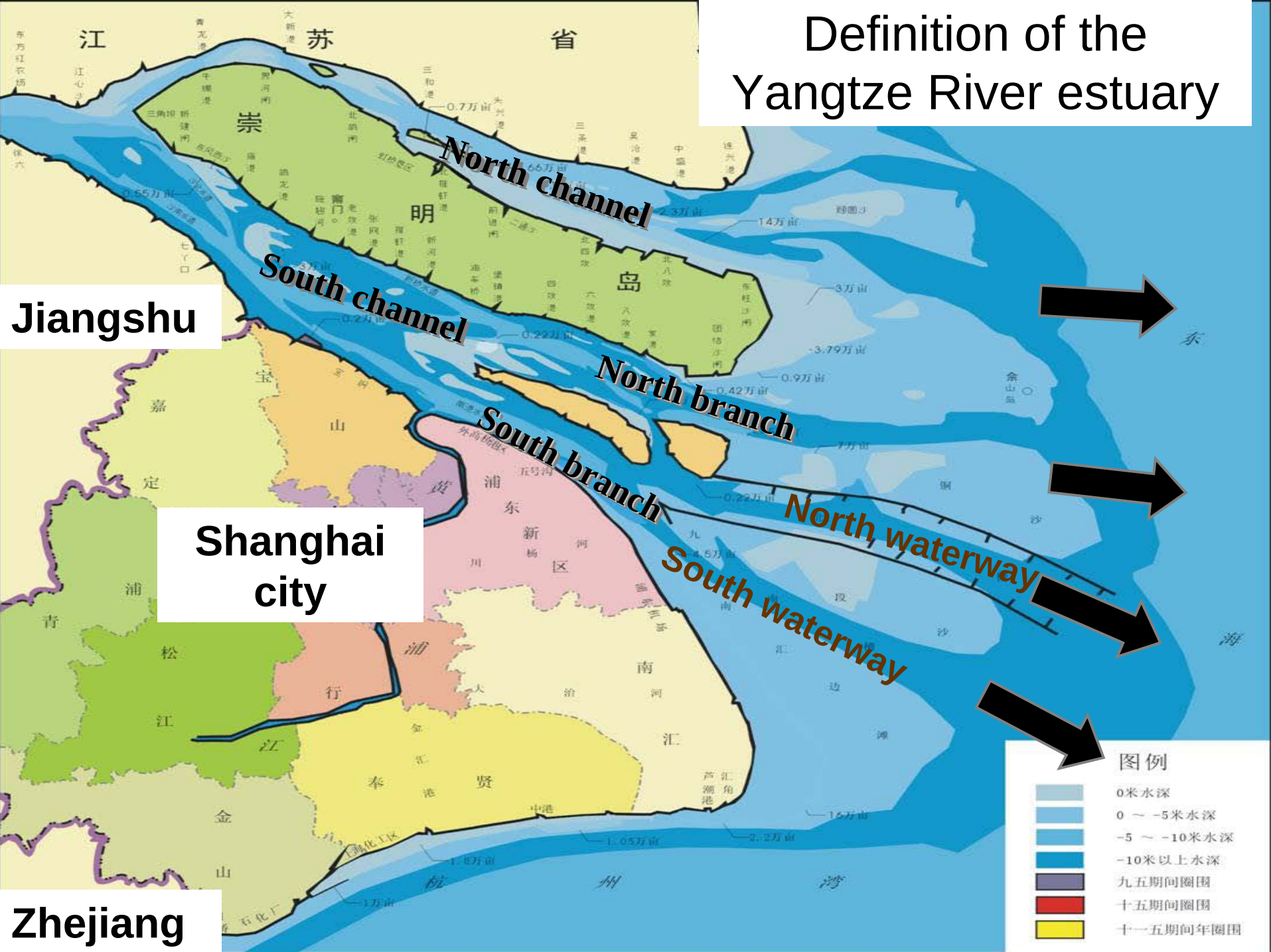
Introduction

Yangtze River is the longest river in China, Yangtze River Estuary is from Xuliujing to east China sea.

Width: 90km

distance: 223km

Covering Squire: 3000km^2

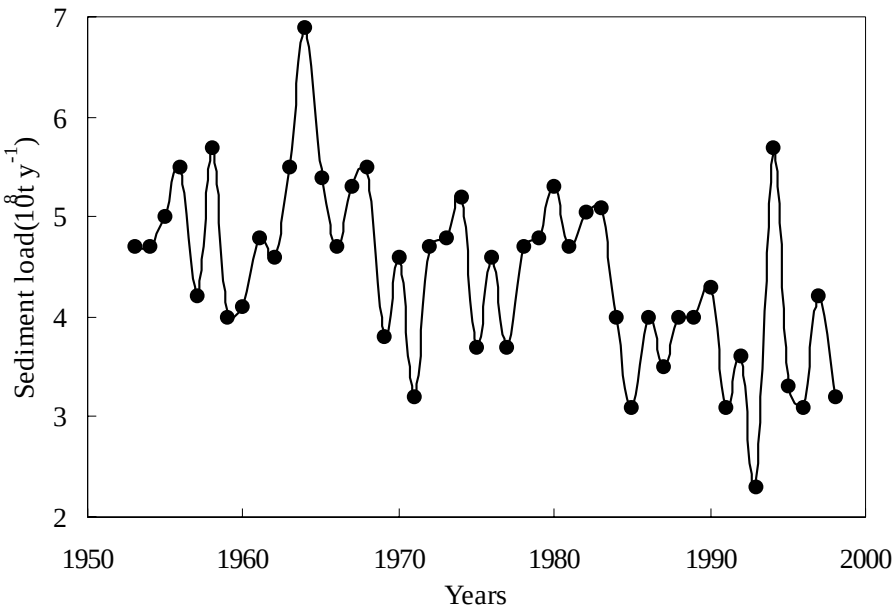

Definition of the Yangtze River estuary
North channel
South channel
North branch
South branch
North waterway
South waterway
Jiangshu
Shanghai city
Zhejiang
图例
0米水深
0 ～ -5米水深
-5 ～ -10米水深
-10米以上水深
九五期间圈围
十五期间圈围
十一五期间年圈围

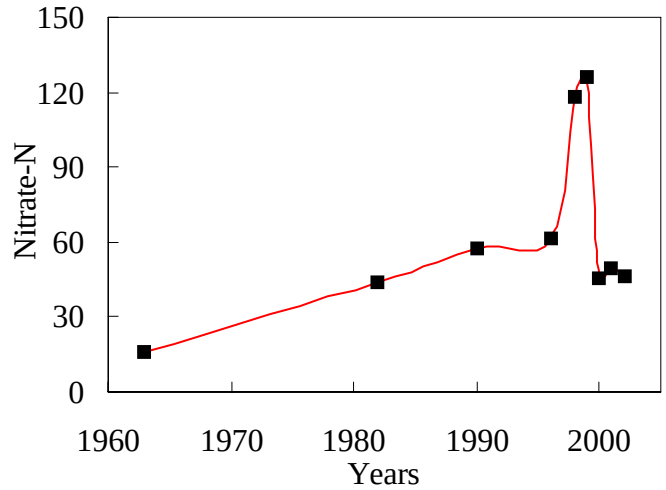
With economic development in estuarine area of Yangtze River, its environment and ecosystem have been damaged. It has also threaten to both ecosystem and public health of human being.

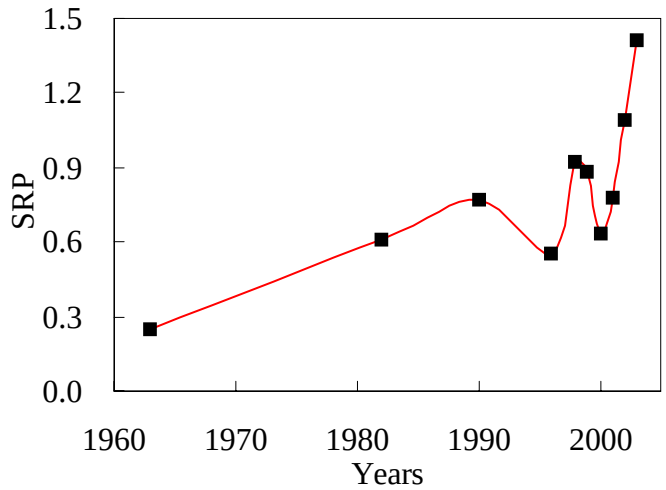
Present situation of aquatic ecosystem

- serious pollution in part water
- Communities structure of aquatic organisms is changed
- Biomass decreased sharply
- Diversity Index and species of aquatic organisms decreased
- Fish catch land reduced seriously
- Endanger rare and protected species disappeared in great number

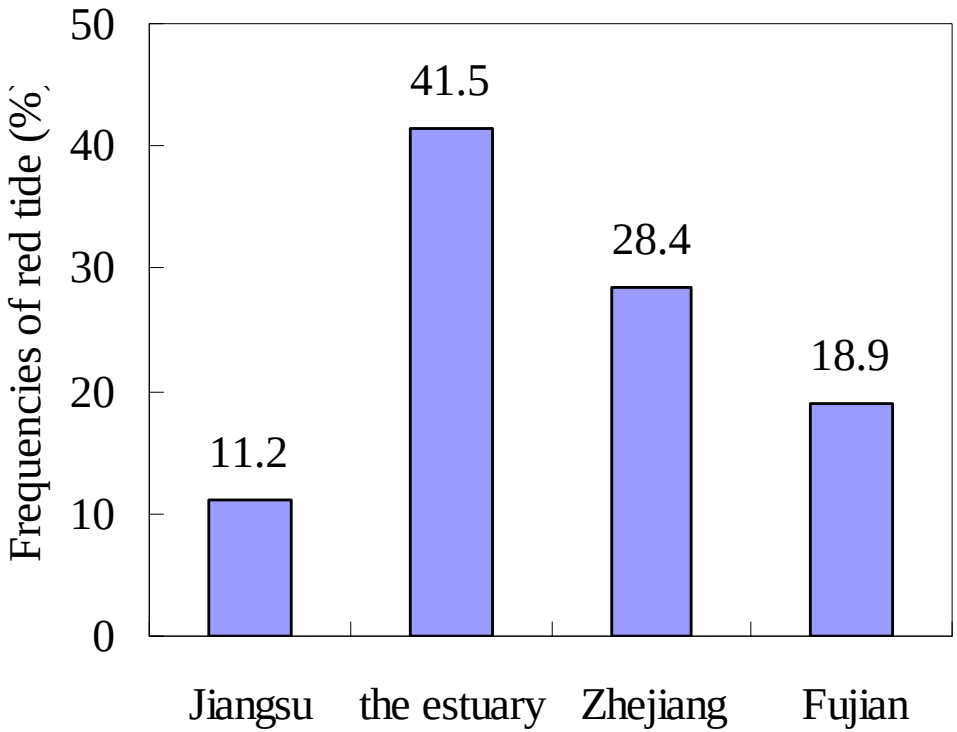
Long-term variation of sediment loads and nutrients concentration





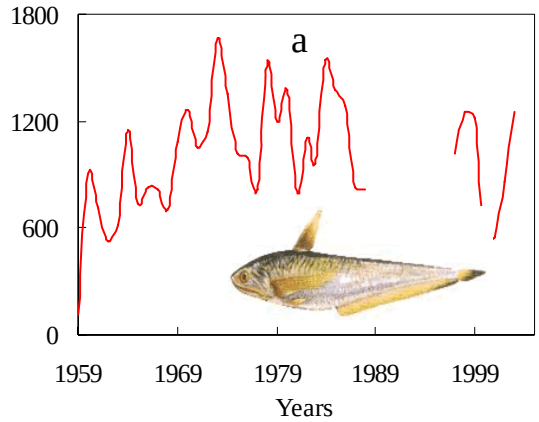


Eutrophication and red tide

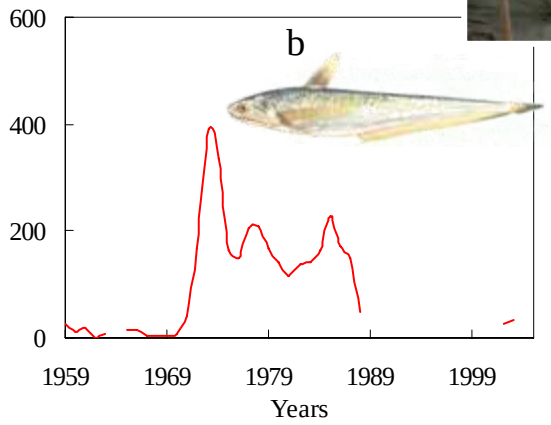


Over-fishing

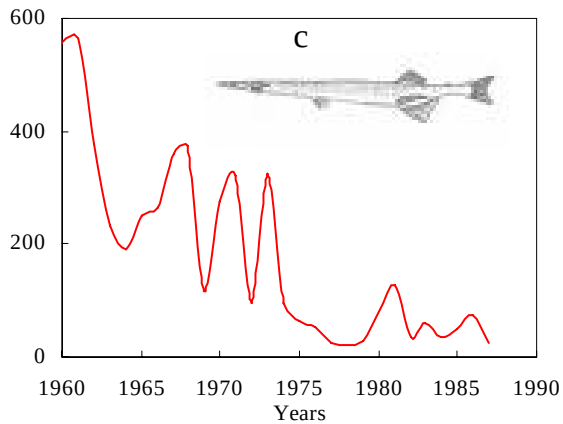
Osbeck's grenadier anchovy (*Coilia mystus*)



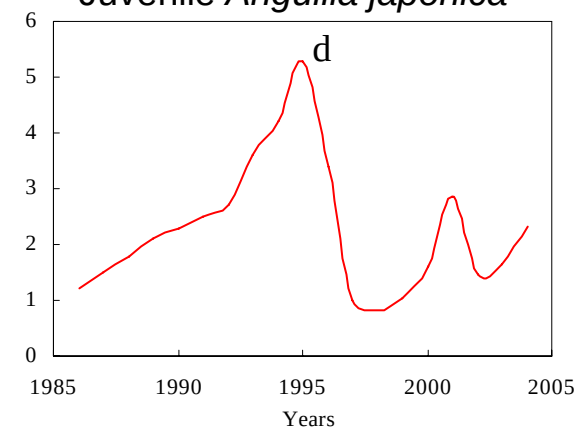
Japanese grenadier anchov



Hemisalanx prognathus

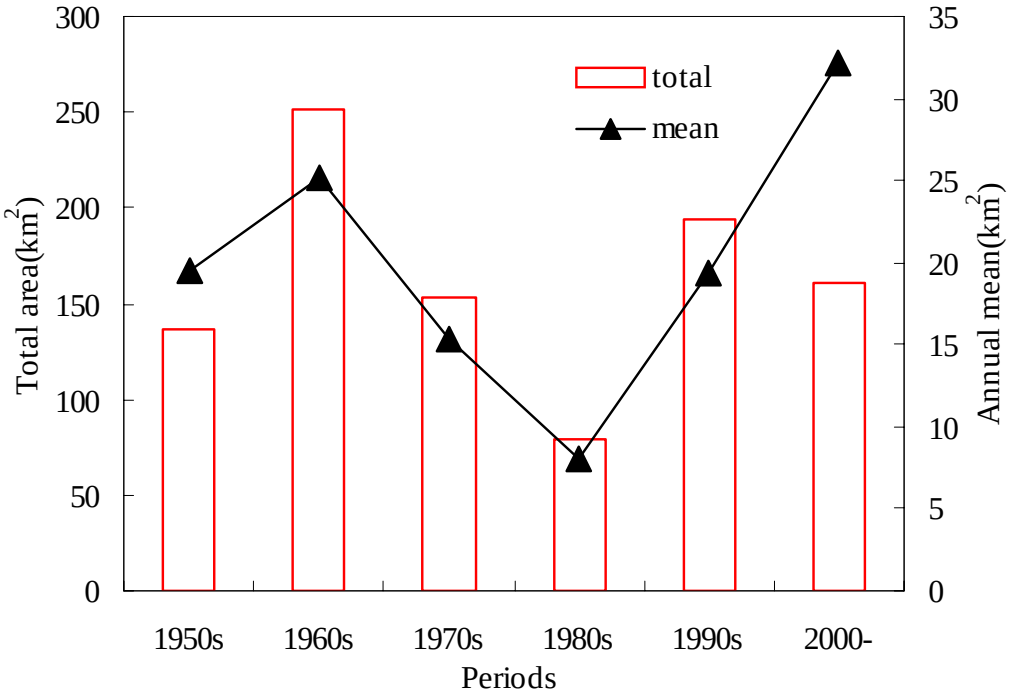


Juvenile *Anguilla japonica*

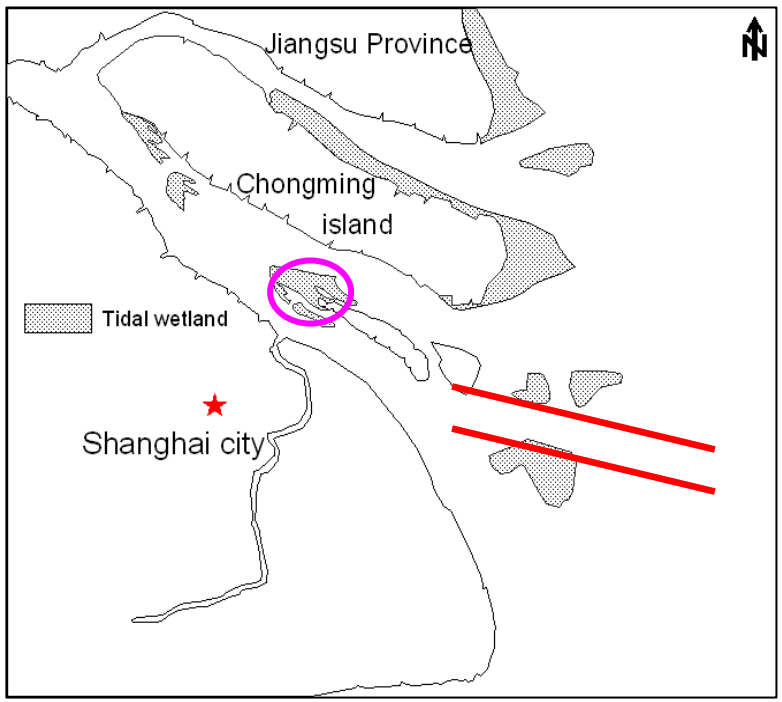


Habitat destruction

Land-reclamation



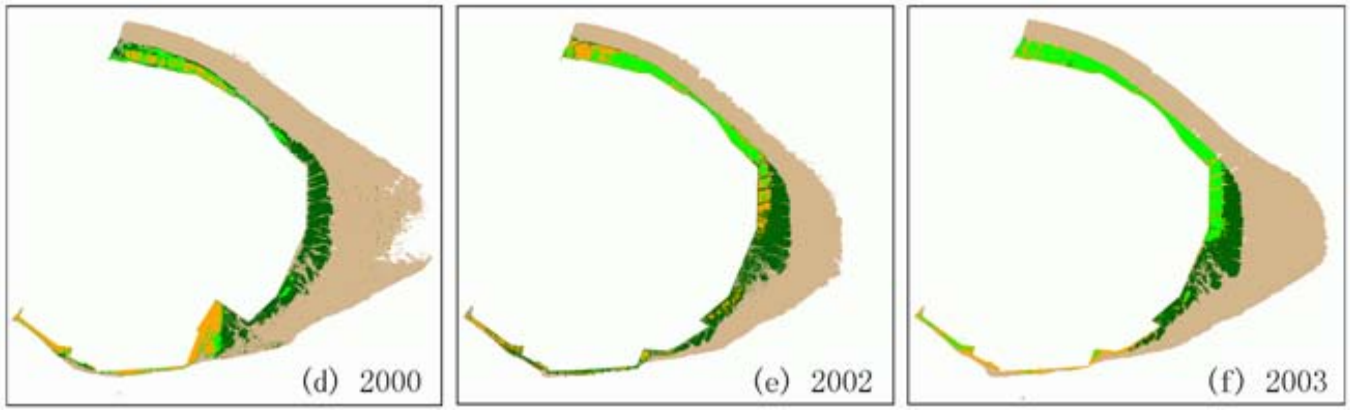
Impact of Large Engineer on the Estuary Ecosystem



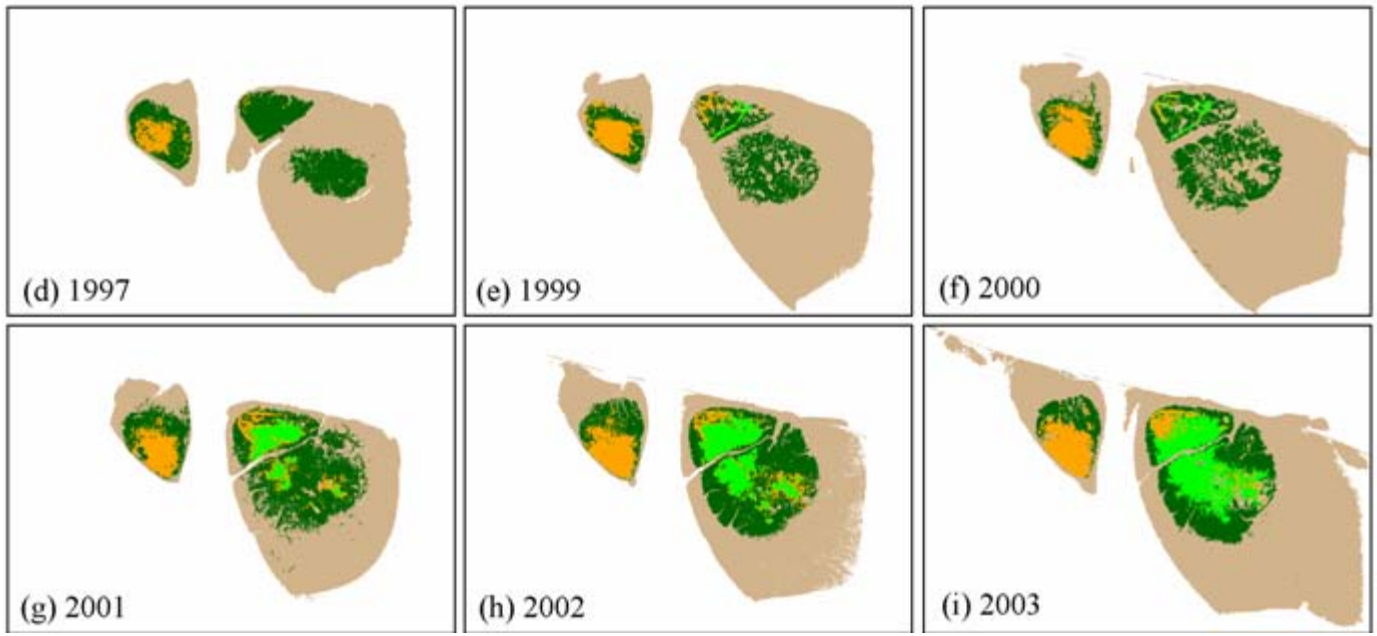
- Fragment and loss of habitat
- Migrating pathway of fish was changable
- Wetland loss
- Biodiversity declined
- Fishing ground change

Spread of invasive plant *Spartina alterniflora*

Dongtan wetland



Jiuduansha wetland



Tidal flat

Phragmites

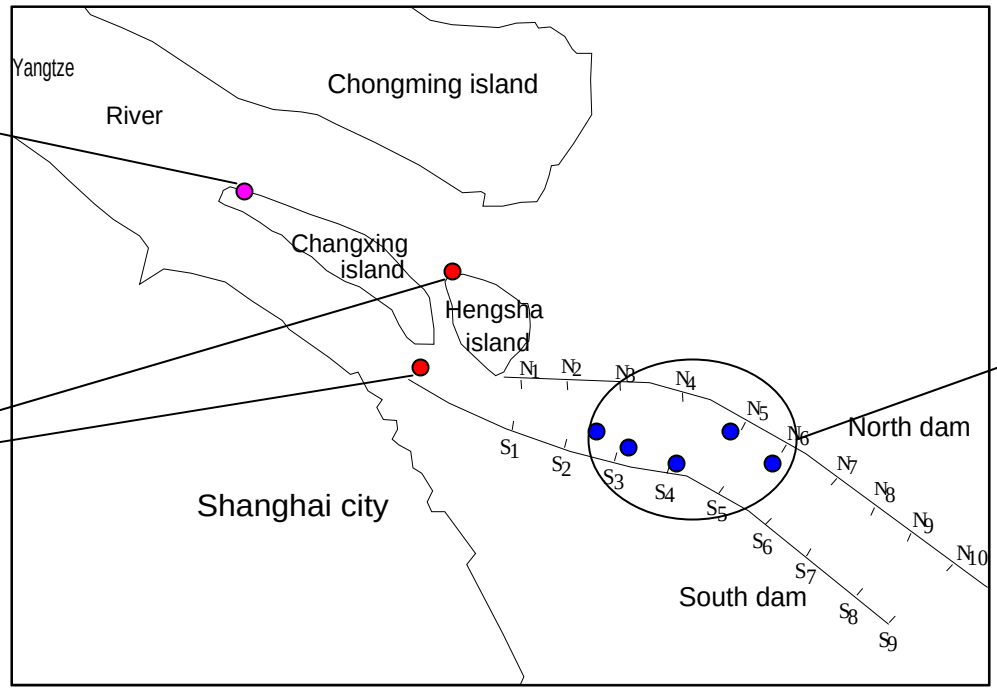
Scirpus mariqueter

Spartina alterniflora

Restoration of Yangtze River estuarine ecosystem

In 2002, 3080 individuals of Chinese sturgeon are released

In 2004, About 25000 adult individuals of Chinese mitten-hand crabs are released



In 2002 and 2004, total 30t benthos (mainly oyster *Crassostrea plicatula*)are released

Restoration I

Rebuilding the population of endangered aquatic species

About 3080 individuals of Chinese sturgeon (*Acipenser sinensis* Gray) have been released in the Yangtze River estuary in 2002.

Restoration II

Releasing Chinese mitten-hand crab

30000 individual Chinese mitten-hand crab had been released into the Yangtze River estuary in December 2004.

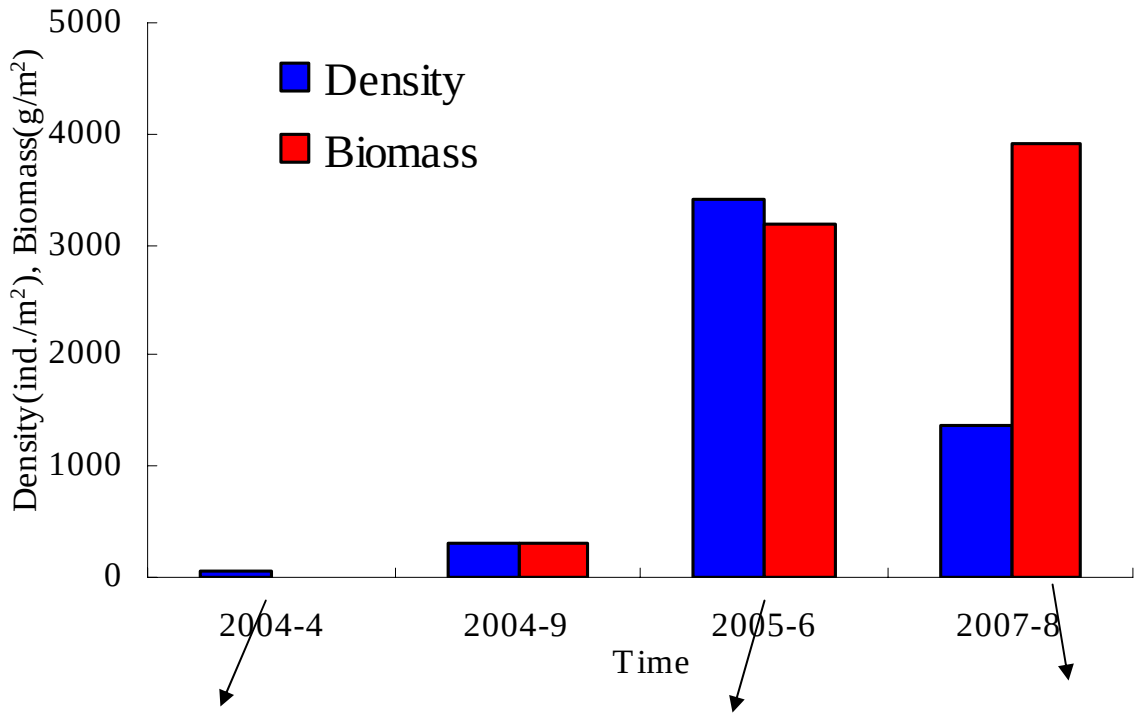
Restoration III

Creating artificial oyster reef

About 30t benthos (mainly oyster *Crassostrea* sp.) were released to concrete dam of Navigation Channel, which became 74 km^2 artificial oyster reef.

Results

Increase of oyster population



restoration

After one year

After three year

Macrobenthos in artificial created oyster reef

Species	2004-4	2005-6	2007-8
Crustaceans	2	20	25
Alpheus japonicus Miers		+	+
Balanus albicostatus Pilsbry	+	+	+
Exopalaemon annandalei			+
Exopalaemon carinicauda			+
Geograpsus crinipes		+	+
Hemigrapsus sanguineus		+	+
Metopograpsus latifrons		+	+
Macrobrachium nipponensis			+
Palaemon gravieri			+
Pilumuns seabriusculus		+	+
Pseudidotheidae sp.		+	+
Scylla serrata		+	+
Sesarma haematocheir		+	+
Sesarma tripectinis Shen		+	+
Synidotea laevidorsalis Miers		+	+
Mollusks			
Barbatia bistrigata	+	+	+
Littorinopsis intermedia		+	+
Mitrella bella		+	+
Mytilus edulis Linne		+	+
Nassarius variciferus			+
Nerita striata Burrow		+	+
Trapezium liratum		+	+
Annelids			
Neanthes japonica		+	+
Serpula vermicularis		+	+
Actiniaria			
Sagartiidae sp.		+	+

Habitat value of artificial created oyster reef for Nekton

Species	S_2	N_2	S_5	N_6	S_8	N_9
Coilia ectenes		+				
Coilia mystus	+	+	+	+		+
Protosalanx hyalocranius			+			
Harpodon nethereus				+	+	+
Anguilla japonica	+		+			
Saurogobio dumerili		+				
Cultrichthys erythropterus		+				
Arius sinensis	+	+	+	+		+
Liza haematocheila	+	+	+	+	+	+
Liza carinatus		+				
Eleutheronema tetradactylum	+		+	+		+
Lateolabrax japonicus	+	+	+	+	+	+
Coillichthys lucida	+		+	+	+	+
Johnius belengeri					+	
Nibea albiflora			+		+	
Synechogobius ommarutus	+	+	+			
Tridentiger trogonocephalus	+	+	+	+	+	+
Odontamblyopus rubicundus						+
Takifugu bimaculatus				+		
Takifugu niphobles				+		
Takifugu xanthopterus						+

Anguilla japonica ***Eriocheir sinensis***

Cynoglossus gracilis ***Lateolabrax japonicus***

Coilia ectenes ***Arius sinensis***

Scylla serrata ***Eleutheronema tetradactylum***

Ecological function- purified water

Bio-concentration factors of the oyster *Crassostrea* sp. for heavy metals

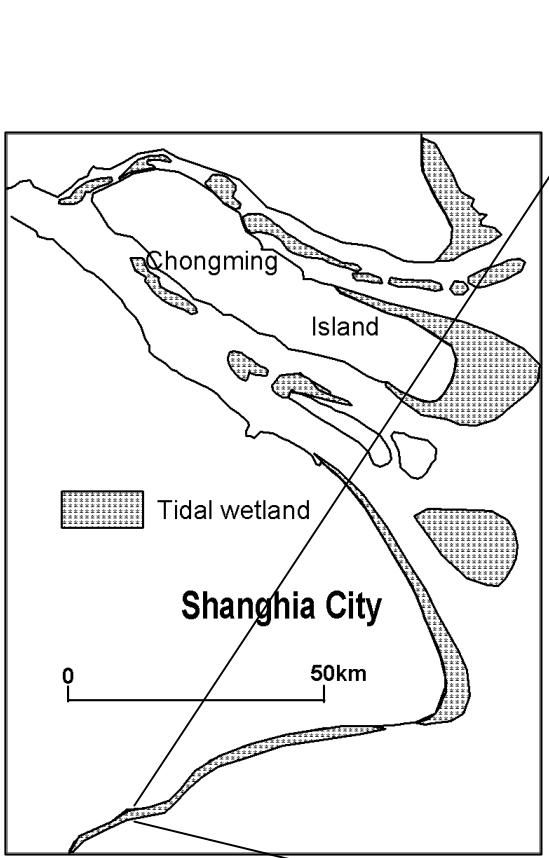
	Cu	Zn	Pb	Cd	Hg	As
BCFs ($\times 10^3$)	14.28±2.41	12.75±2.02	0.56±0.79	14.51±3.71	0.09±.04	0.59±0.20
BSAFs	26.78±4.5	23.24±3.69	1.04±1.47	16.62±4.25	0.41±0.17	11.91±4.11

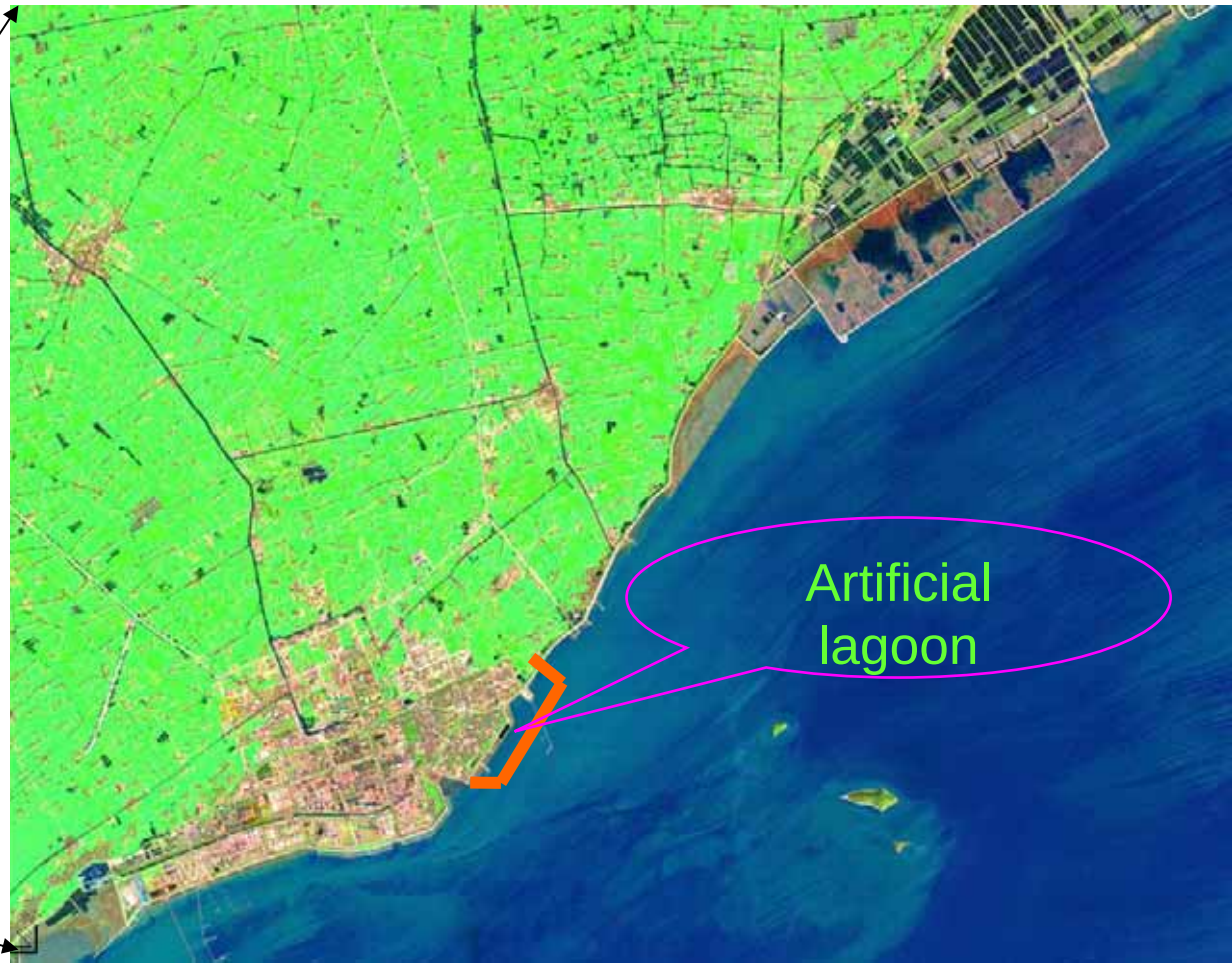
Standing stocks of nutrients and heavy metals accumulated by the oyster *Crassostrea sp*.

Items	Average concentration ($mg \cdot kg^{-1}$ fresh weight)	Standing stock (kg)
N	8.36×10^3	1462×10^3
P	0.57×10^3	100×10^3
Cu	141.4	24745
Zn	332.9	58257
Pb	3.48	609
Cd	1.45	254
As	1.88	329
Hg	0.001	0.18

Restoration IV

Restoration of artificial lagoon





We rebuild the aquatic ecosystem

We culture macroalgae to prevent and control eutrophication and red tide in artificial lagoon Hangzhou Bay.

Gracilaria tenuistipitata

Acanthopagrus schlegel

Metapenaeus monoceros

Nephtys californiensis

Pseudosiciaena crocea

Tegillarca granosa

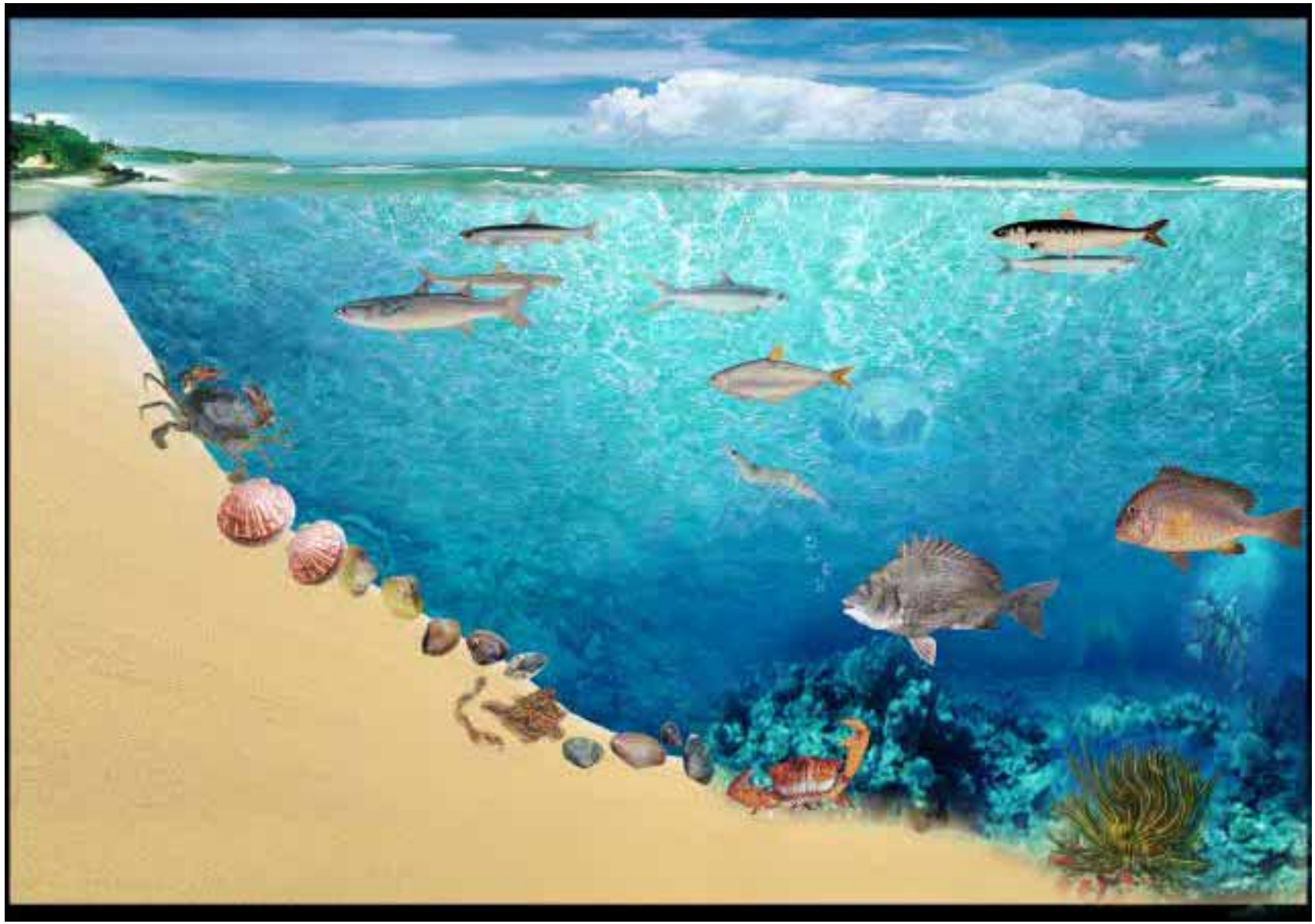
Mactra quadrangularis

Ruditapes philippinarum

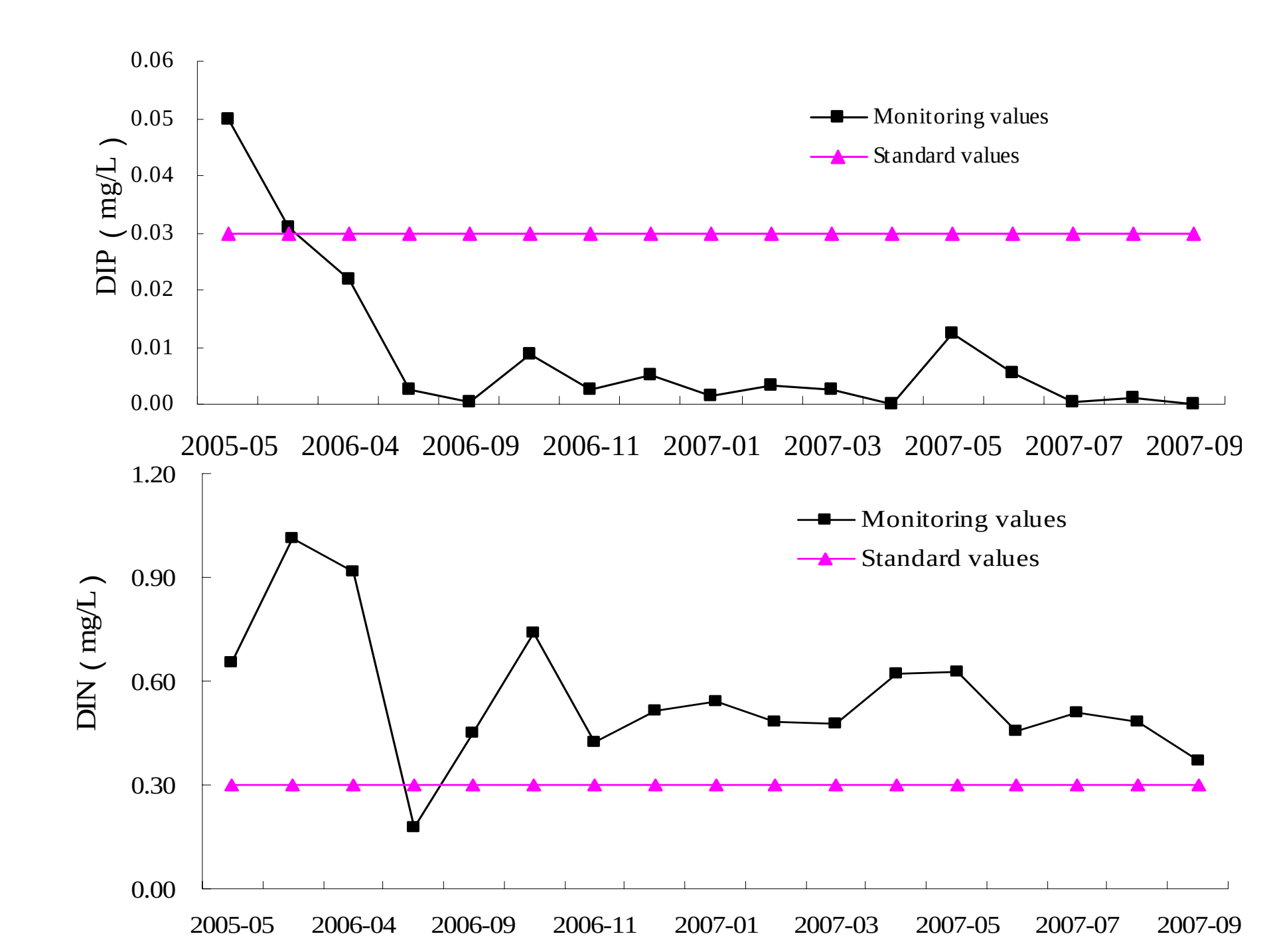
Exopalaemon carinicauda

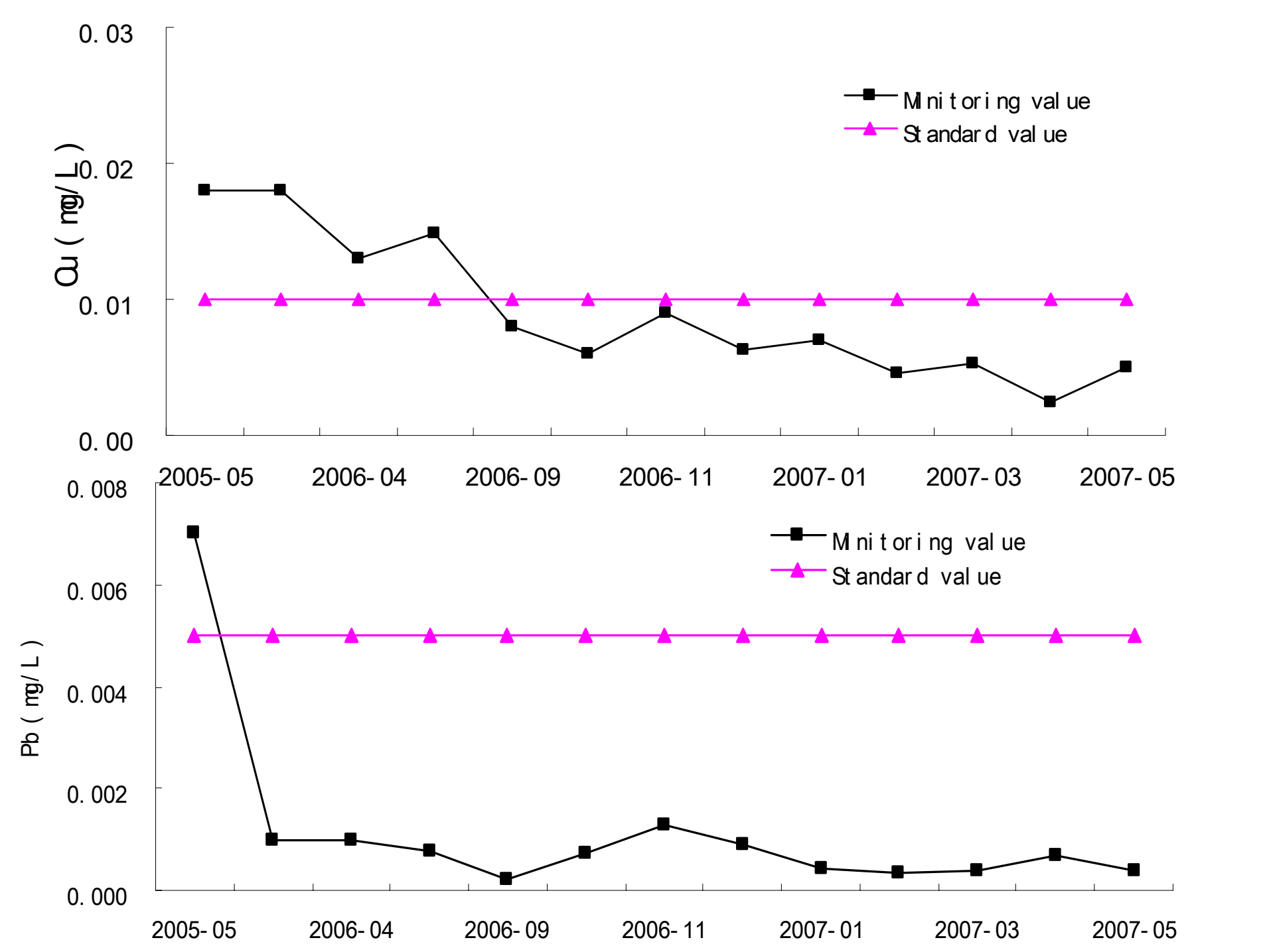
Thais clavigera Kuster

Rebuilding aquatic ecosystem of artificial lagoon



After-restoration


0.06
0.05
0.04
0.03
0.02
0.01
0.00
DIP (mg/L)
Monitoring values
Standard values
2005-05
2006-04
2006-09
2006-11
2007-01
2007-03
2007-05
2007-07
2007-09
1.20
0.90
0.60
0.30
0.00
DIN (mg/L)
Monitoring values
Standard values
2005-05
2006-04
2006-09
2006-11
2007-01
2007-03
2007-05
2007-07
2007-09


0. 03
0. 02
0. 01
0. 00
Cu (mg/ L)
Mi ni t ori ng val ue
St andar d val ue
2005- 05
2006- 04
2006- 09
2006- 11
2007- 01
2007- 03
2007- 05
0. 008
0. 006
0. 004
0. 002
0. 000
Pb (mg/ L)
Mi ni t ori ng val ue
St andar d val ue
2005- 05
2006- 04
2006- 09
2006- 11
2007- 01
2007- 03
2007- 05

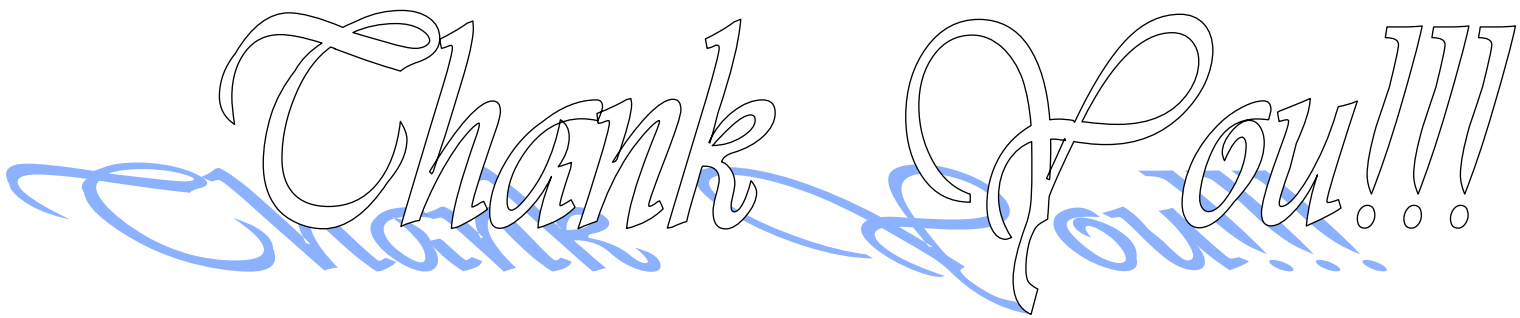
Conclusion

In past decade, many ecological restoration projects have been carried out successfully in the Yangtze River estuary and adjacent water.

•Chinese Sturgeon and Chinese mitten-hand crab were released successfully, It got environmental and ecologic effects.

•An artificial oyster reef has been built on the concrete dams of deep water navigation channel. The oyster reef played an important role in improving water quality, sustaining biodiversity, and providing breeding and nursery habitant for many economical aquatic organisms in Yangtze River estuary.

- Although we have succeed to set up an artificial oyster reef and restore the artificial lagoon, restoration of the whole Yangtze estuarine ecosystem is a very hard and long-term task. More aspects including ecology, economy and society should be considered in future restoring project.


Thank You!!!