

Tidal Flat Restoration in Fushino River basin by the cooperative works of various sectors

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River mouth area of Fushino River

写真： 第5次山口市総合計画



Upstream view of Fushino river just beneath Aratani dam reservoir

There are only 2, 3 dams. Those tributary areas are not large in the river basin, totally less than 5%.



Ichinosaka river near prefecture office, nationwide famous for fire-fly river construction



2006.8.15

Midstream view of Fushino river
Fushino river is relatively nature rich even in midstream.



Over view from Yamaguchi estuary to Fushino river basin

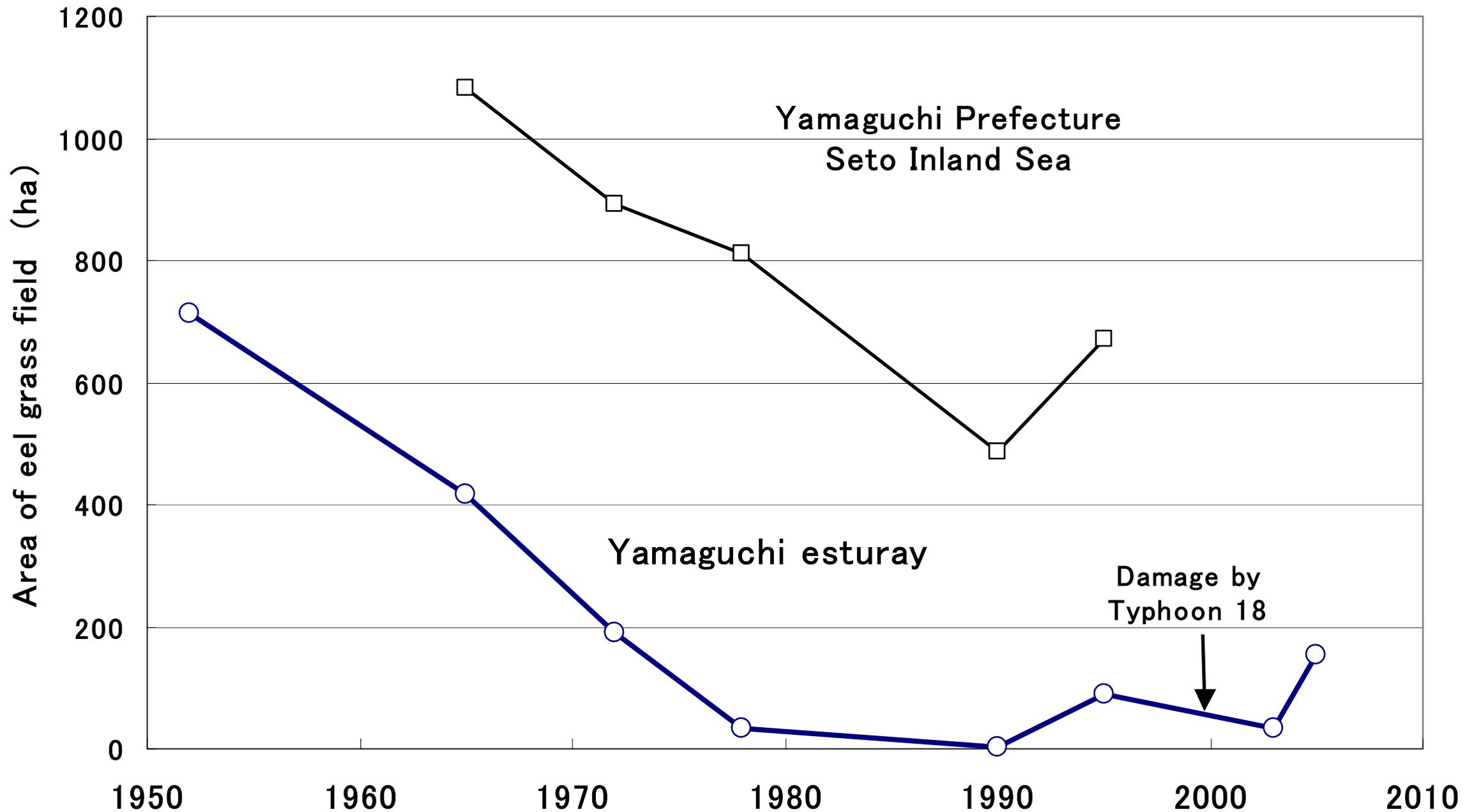
There are wide tidal flats Naka-gata, Shинchi-gata and Minami-gata etc, totally 350 ha. We can find many kinds of bird, and endangered species horseshoe crabs are still alive.

Recent state of Fushino river basin

- Fushino river is relatively familiar among people, and there are many activities for protecting and loving river environment.
- Water quality has become very clean accompanied by the sewage and similar system over 80%.
- Amenity evaluation is rather good too.

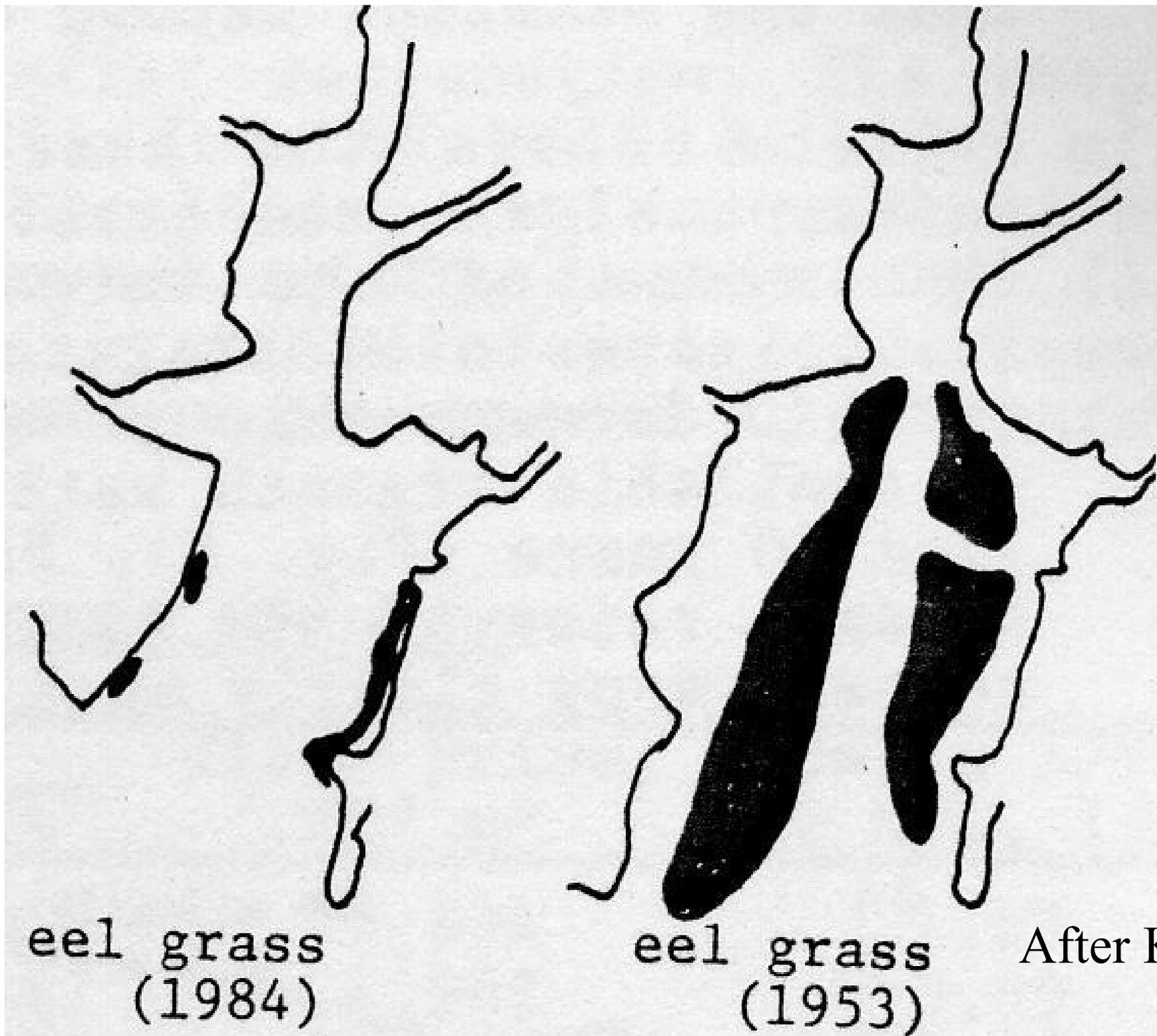
However,

- Fishery productivity of Yamaguchi estuary has become decreased remarkably for these 40 years.
- Sea grass field has decreased since 1950s.
- Consequently, fishery industry decayed remarkably.



Change of the area of eel grass field in Yamaguchi estuary

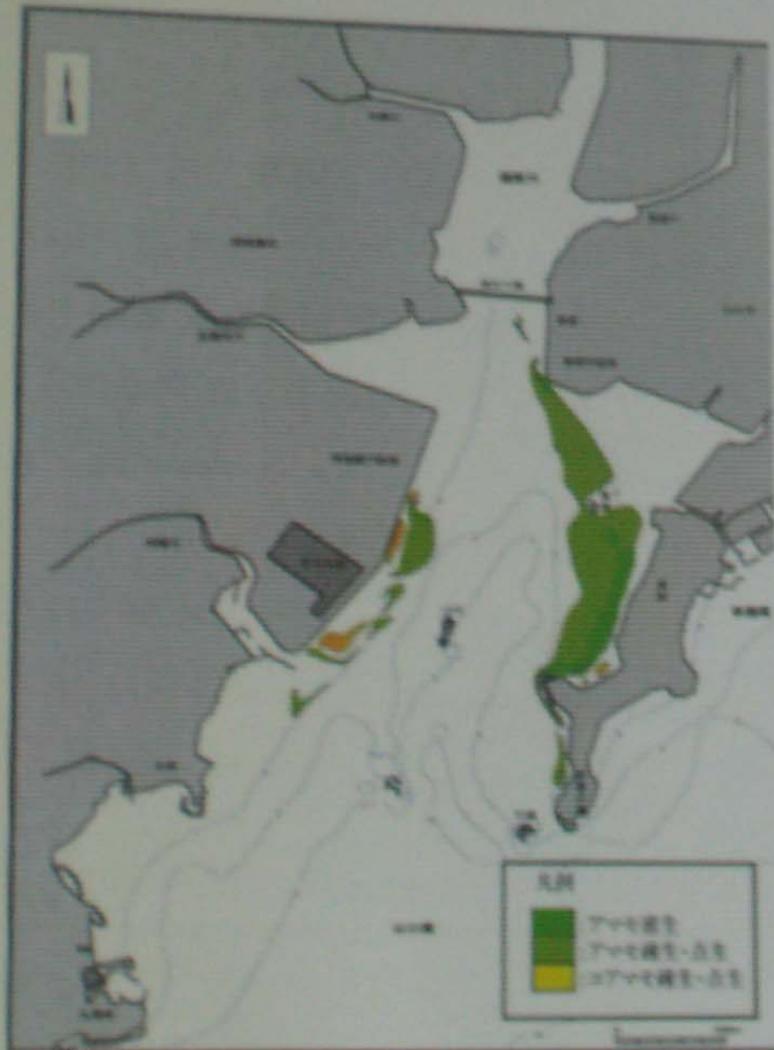
The area of sea grass field decreased from 700ha 1950s to almost zero 1990. Recently we can see the tendency of recovering.



Decay of eel grass field in Yamaguchi Estuary

山口湾アマモ場面積の変遷

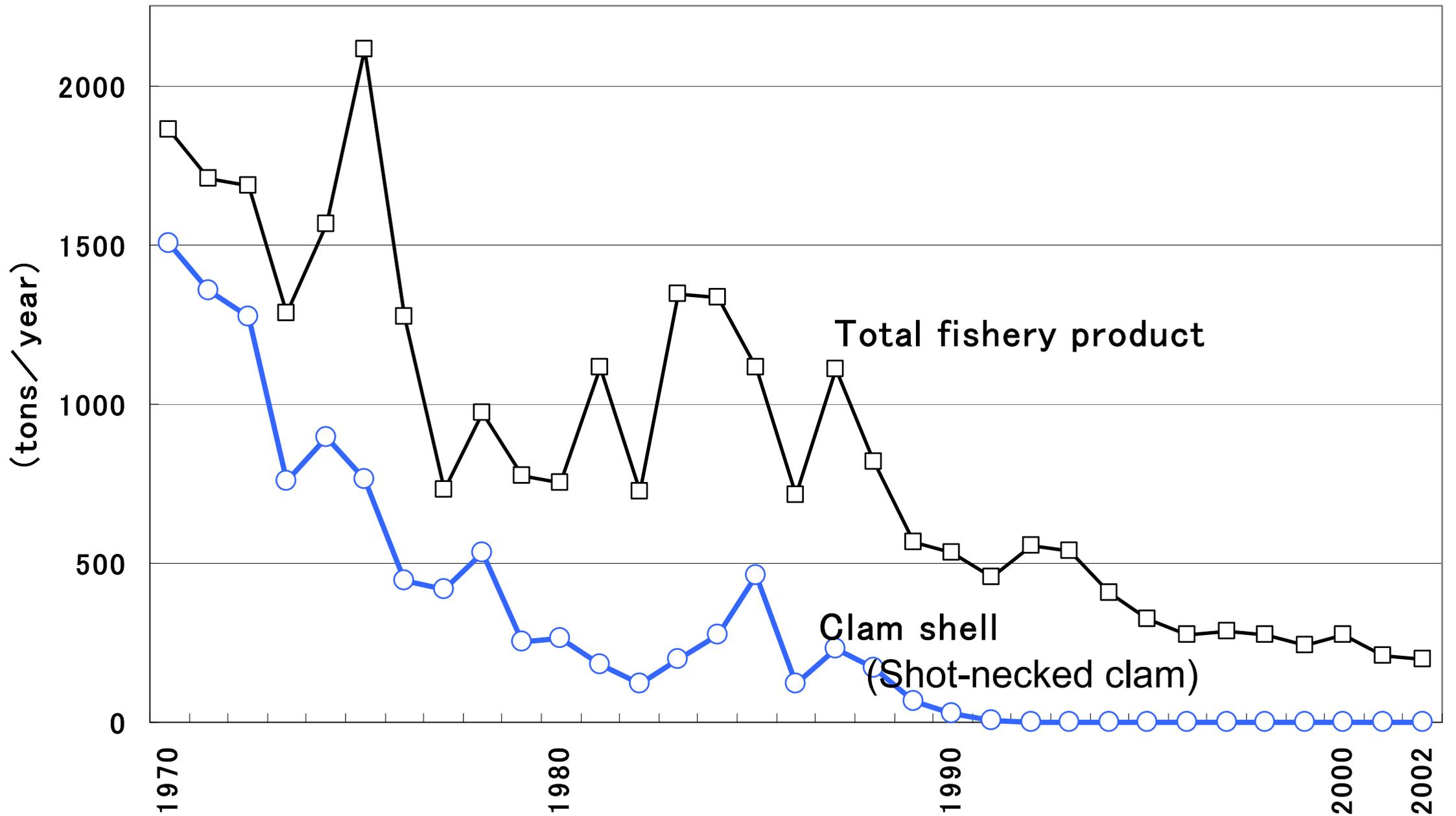
2005年(3年前)



2008年(今年)



Aerial distribution of eel glass field in 2005 and 2008



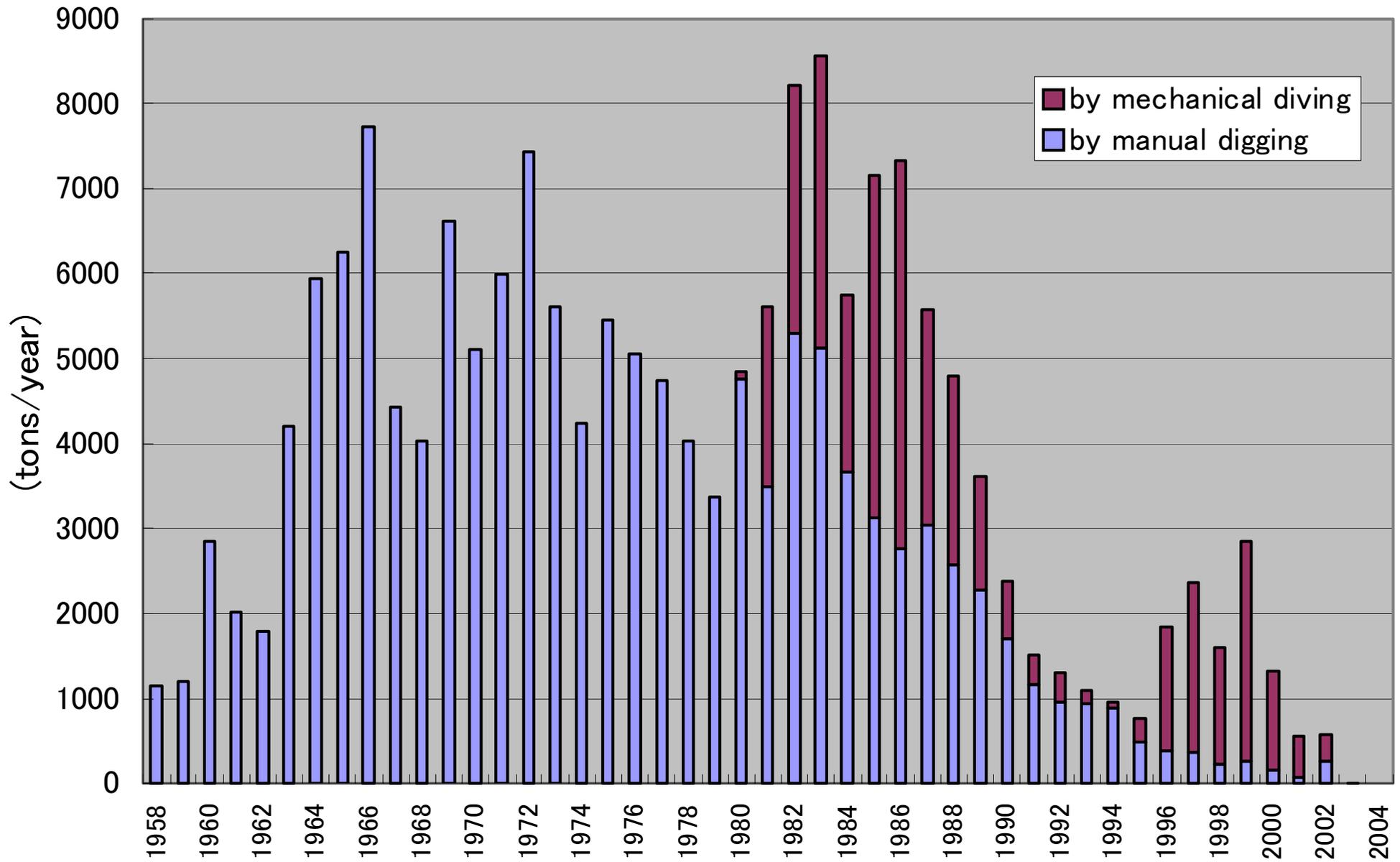
Change of fishery production in Yamaguchi estuary

Clam shell production decreased remarkably from 1500 t in 1970 to zero in 1991. Total fishery production decreased similarly near to 1/10.

Possible causes of clam shell decrease

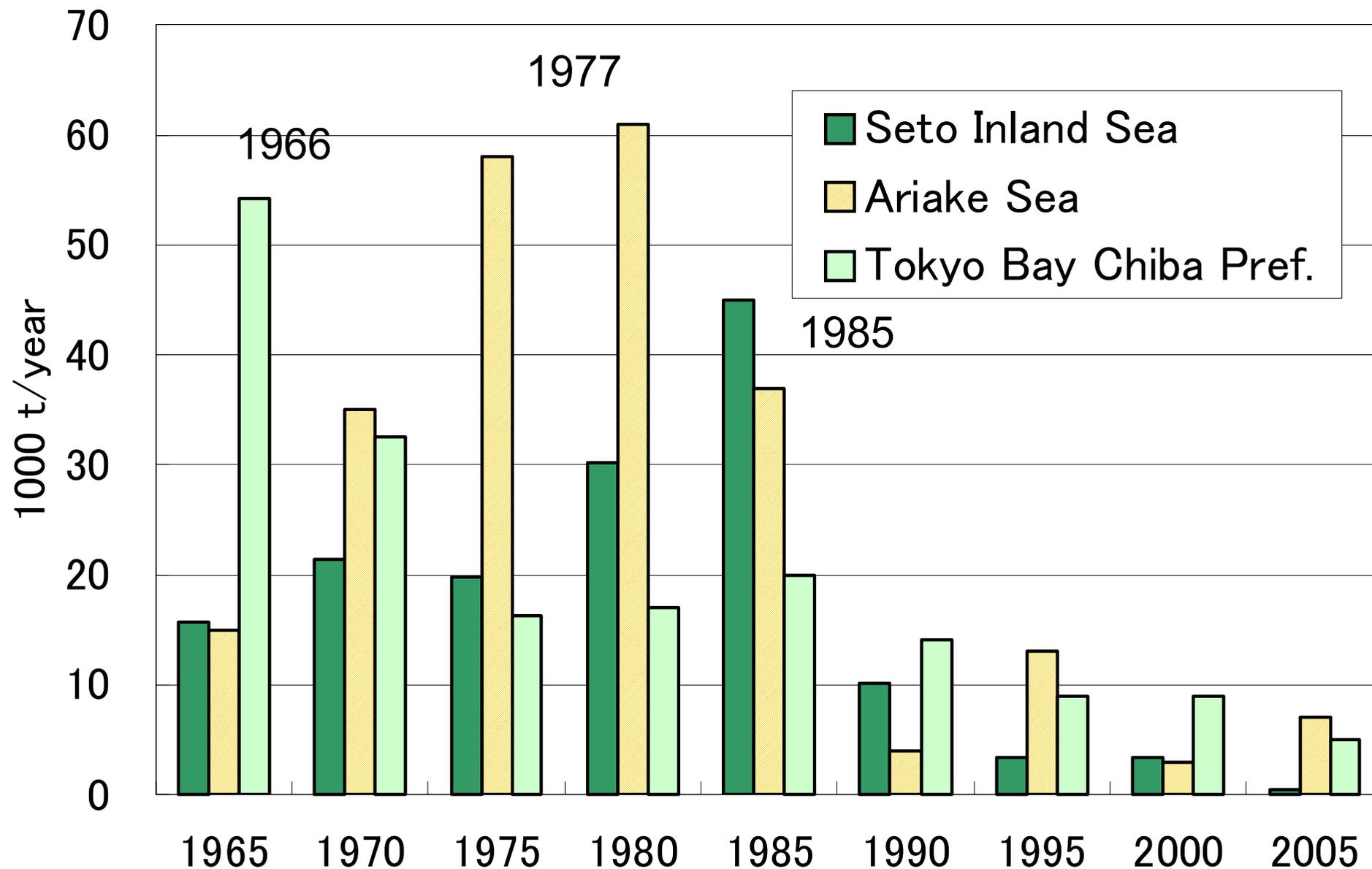
- Decrease of nutrient, N,P and other Fe etc.
- Sediment changed finer (Increase of fine particles supply, and decrease of sand supply)
- Influence of predators (Small eagle ray *Aetobatus flagellum* , Bladder moon shell *Glossaulax didyma*) relating to global warming
- Abused fishery of mother shells in Suo-nada





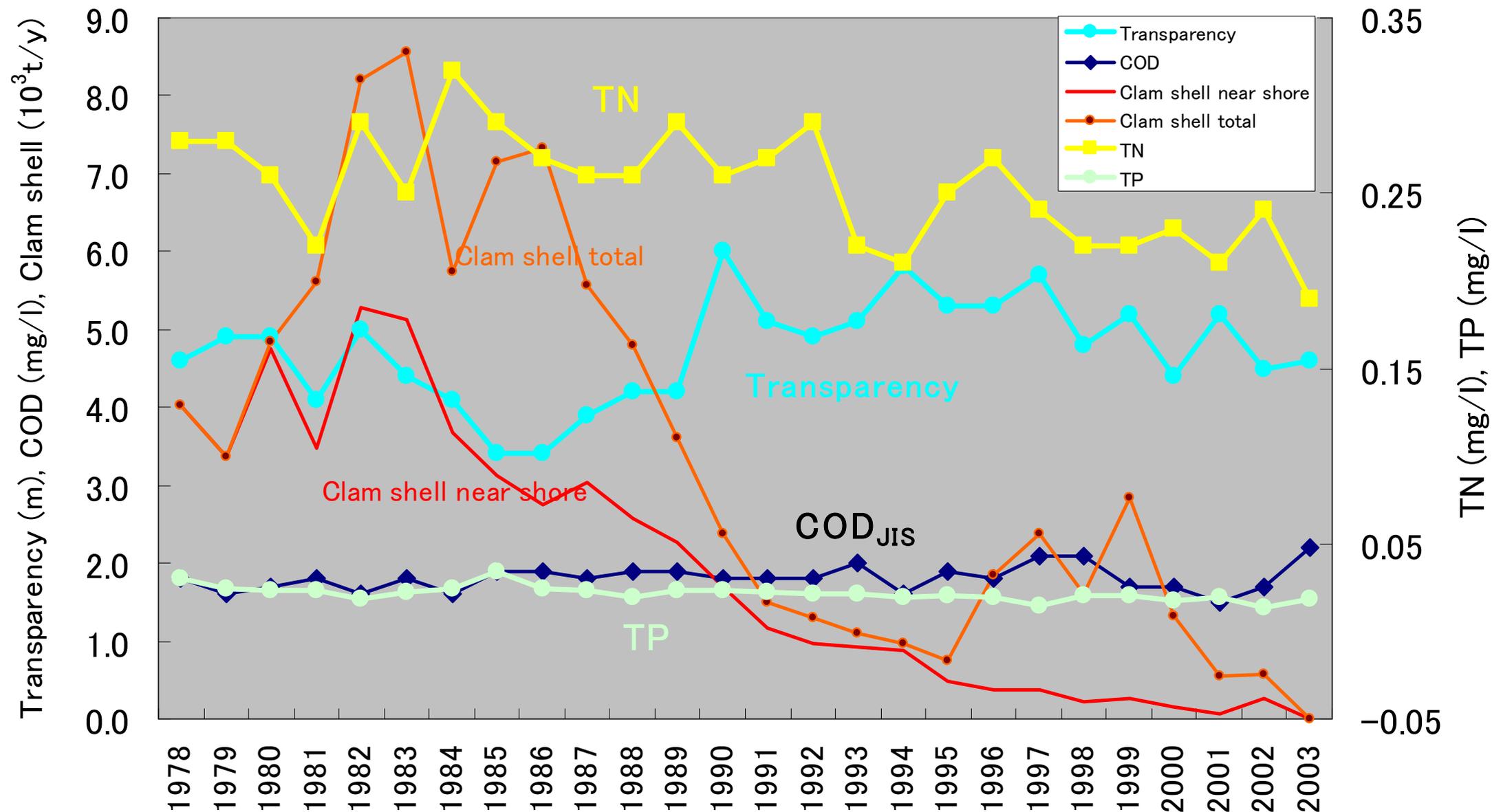
Change of clam shell production in Yamaguchi prefecture
Seto Inland Sea area

Latter purple peaks correspond to over-fishing of mother shells of short-necked clam from the off-shore area in Suo-nada. It might be due to TV broadcasting of the good quality of "Onoda Asari"



Change of the production of short-necked clam in 3 sea areas in Japan

The years of maximum production are 1966 Chiba, 1977 Kumamoto (Ariake Sea), and 1985 Seto Inland Sea



Change of the water quality and the production of short-necked clam in Western Part of Suo Nada

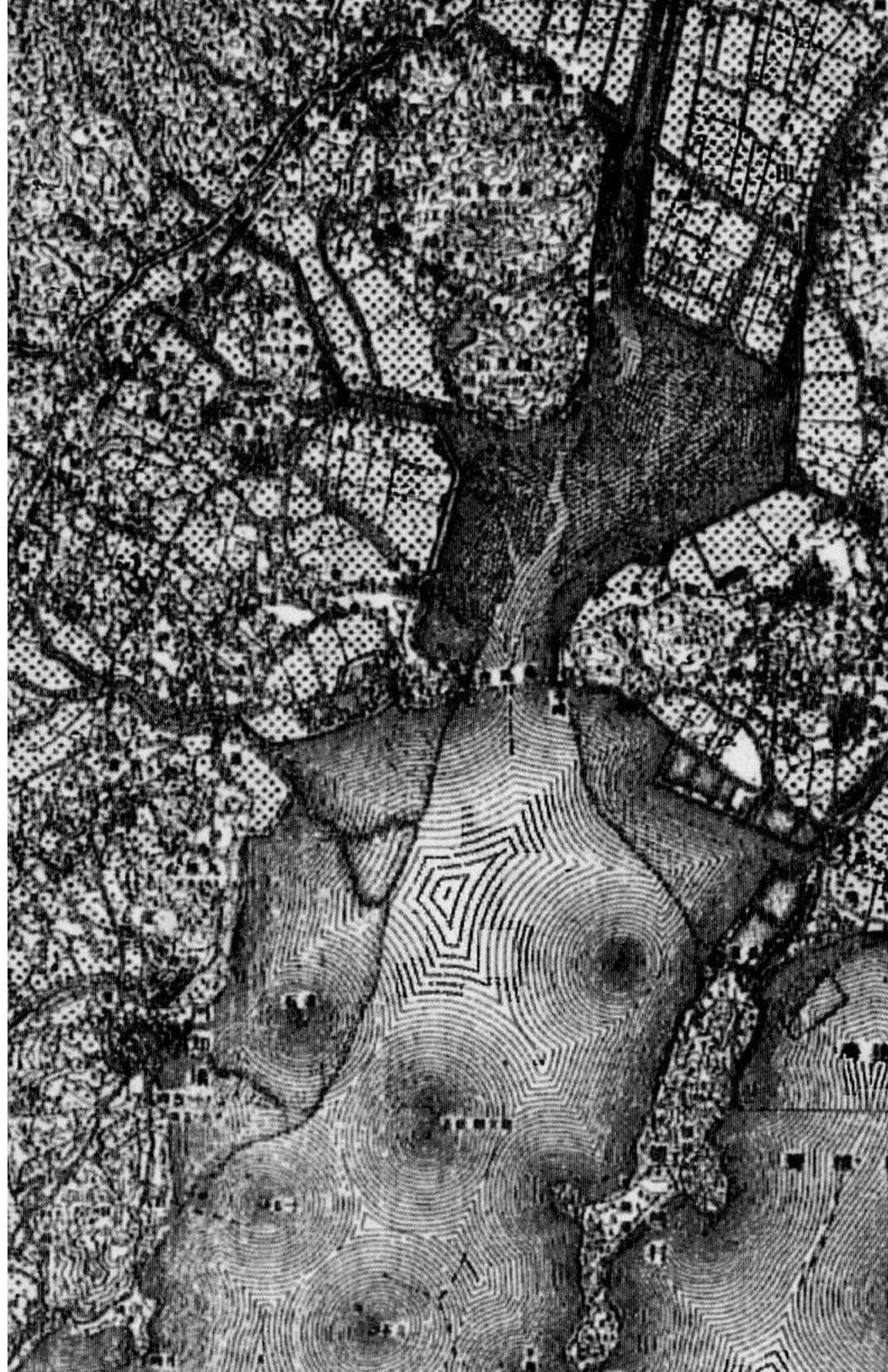
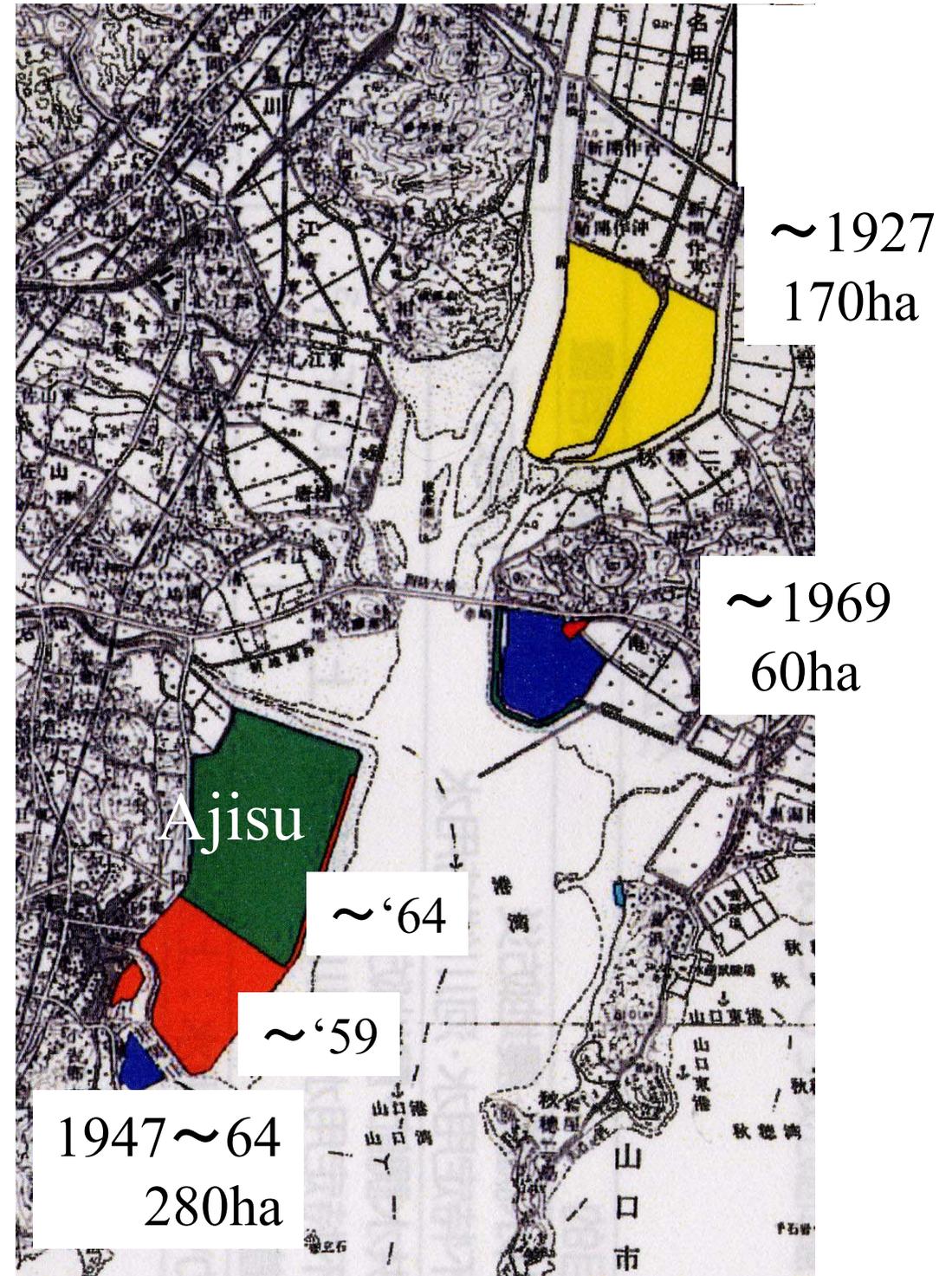
The concentration of total nitrogen has been decreasing clearly since early 1980's mainly due to the decrease of industrial load.

Besides, we should also think the following changes of human activities in the river basin for relatively long time scale of 40, 50 years.

Changes of the river basin

- Land use: Farmland decreased
paddy field 70 km² (1965) → 30 km² (2000)
Agriculture: modernized (irrigation, machinery)
- Sewage treatment: 18% (1985) → 67% (2001)
- Construction work: Shinkansen(-'75), Highway(-83)
- Gravel mining in mountain areas and previous sand mining in the river mouth area
- Land reclamation: 340 ha since 1947

Totally 340 ha was reclaimed since 1947.

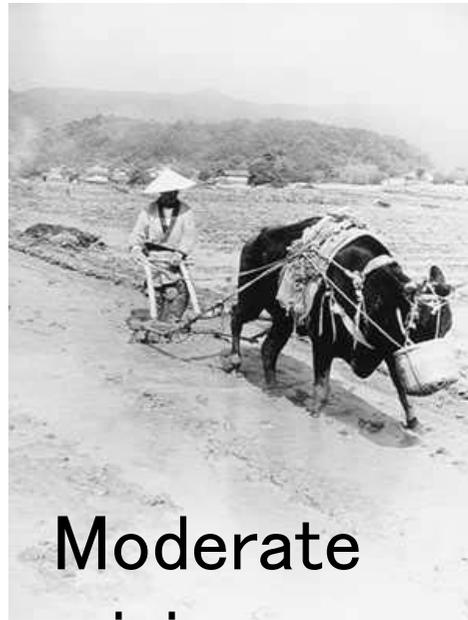
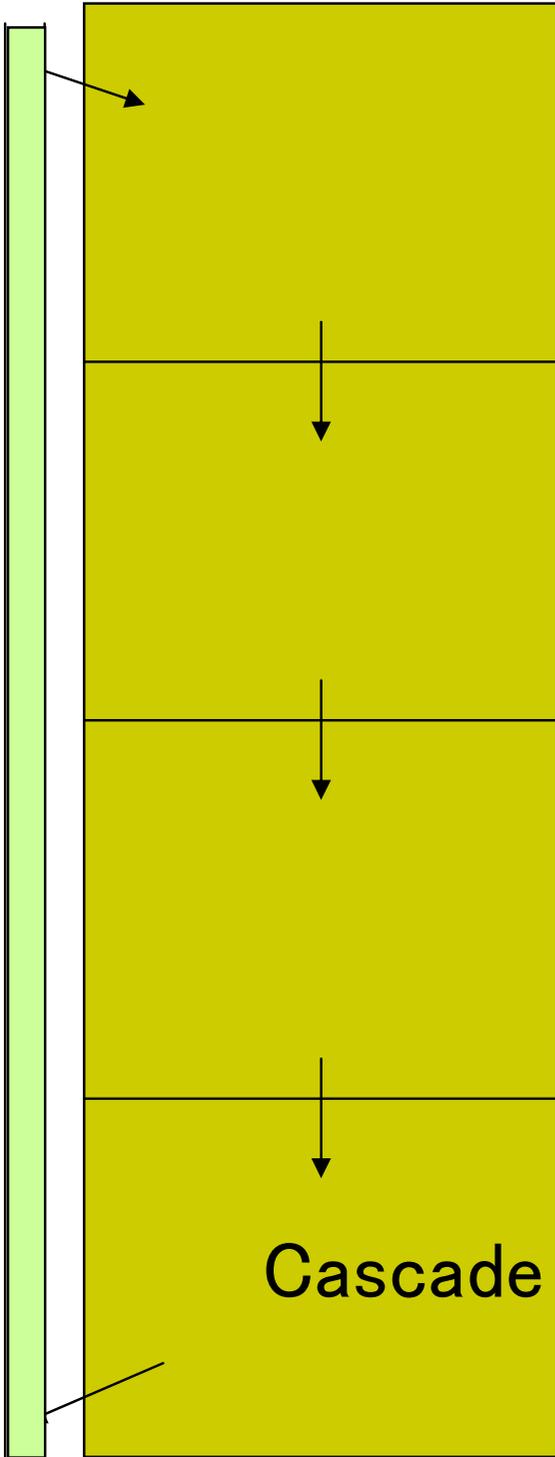


Topographic map in 1902

Land reclamation area and period

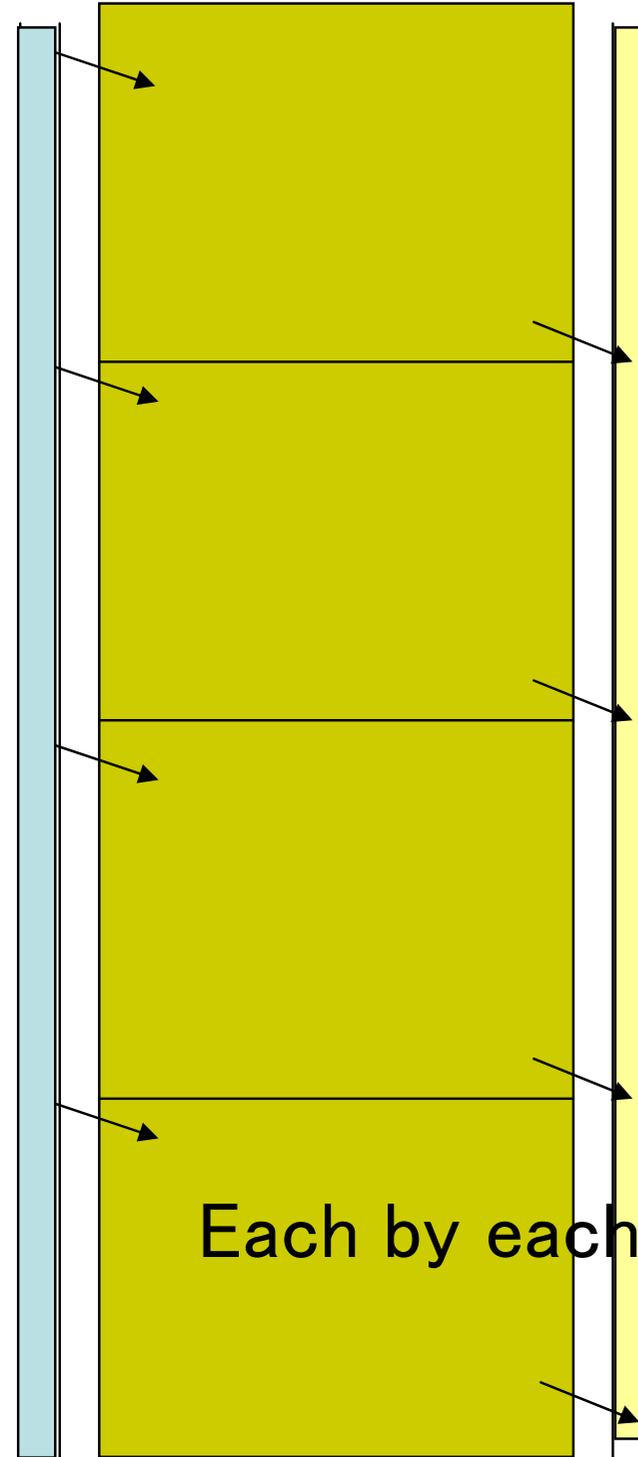
50 years ago

At present



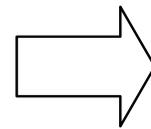
Moderate mixing

Organic fertilizer



Strong mixing

Inorganic fertilizer



Change of the style of paddy field increasing turbidity

Rice farming starts at the beginning of rainy season in the western part of Japan.



2004.5.13

水田代掻き時
の濁り



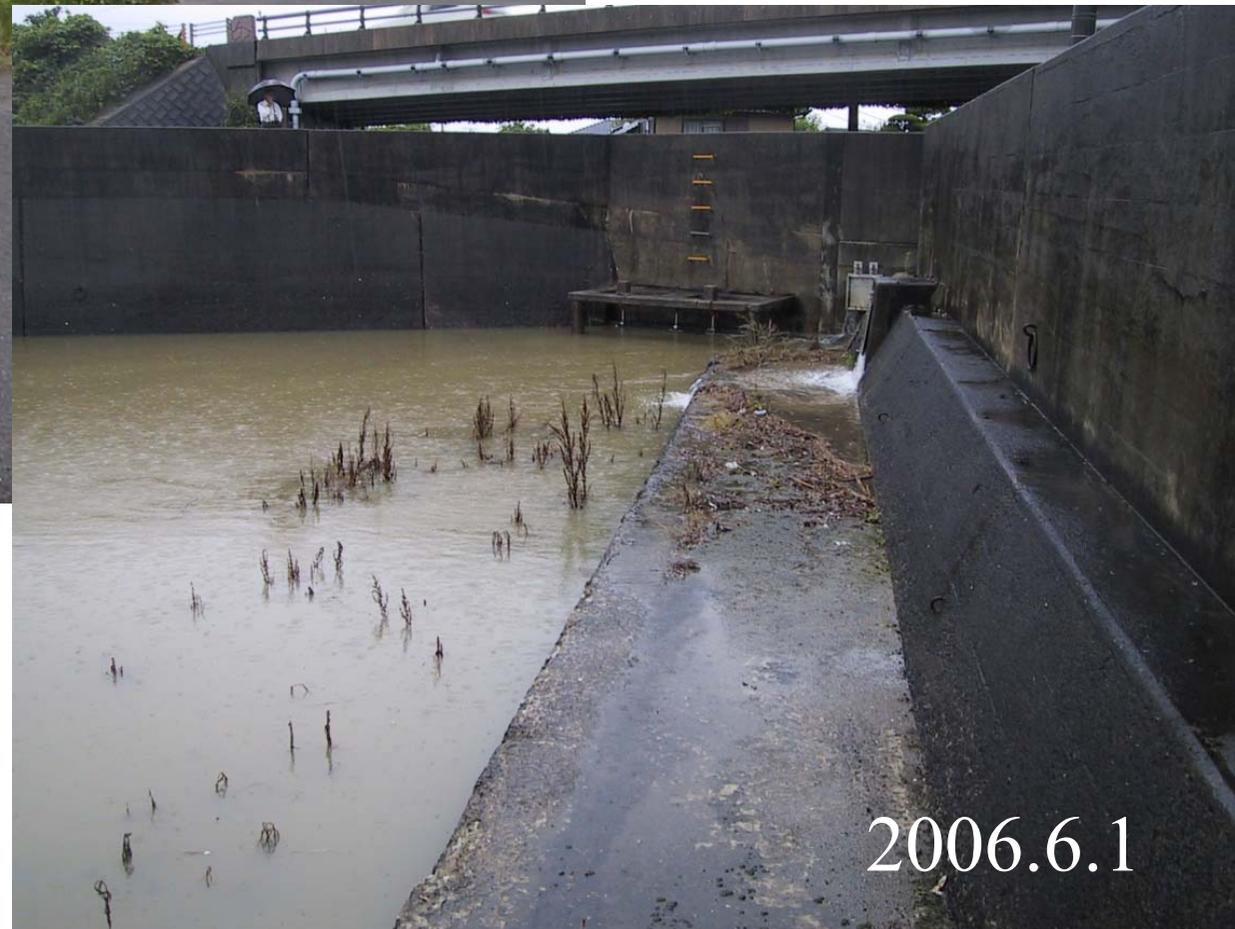
2003.5.31

Turbidity from paddy fields midstream

農地改良工事 の影響



Turbidity from
paddy field reconstruction
site

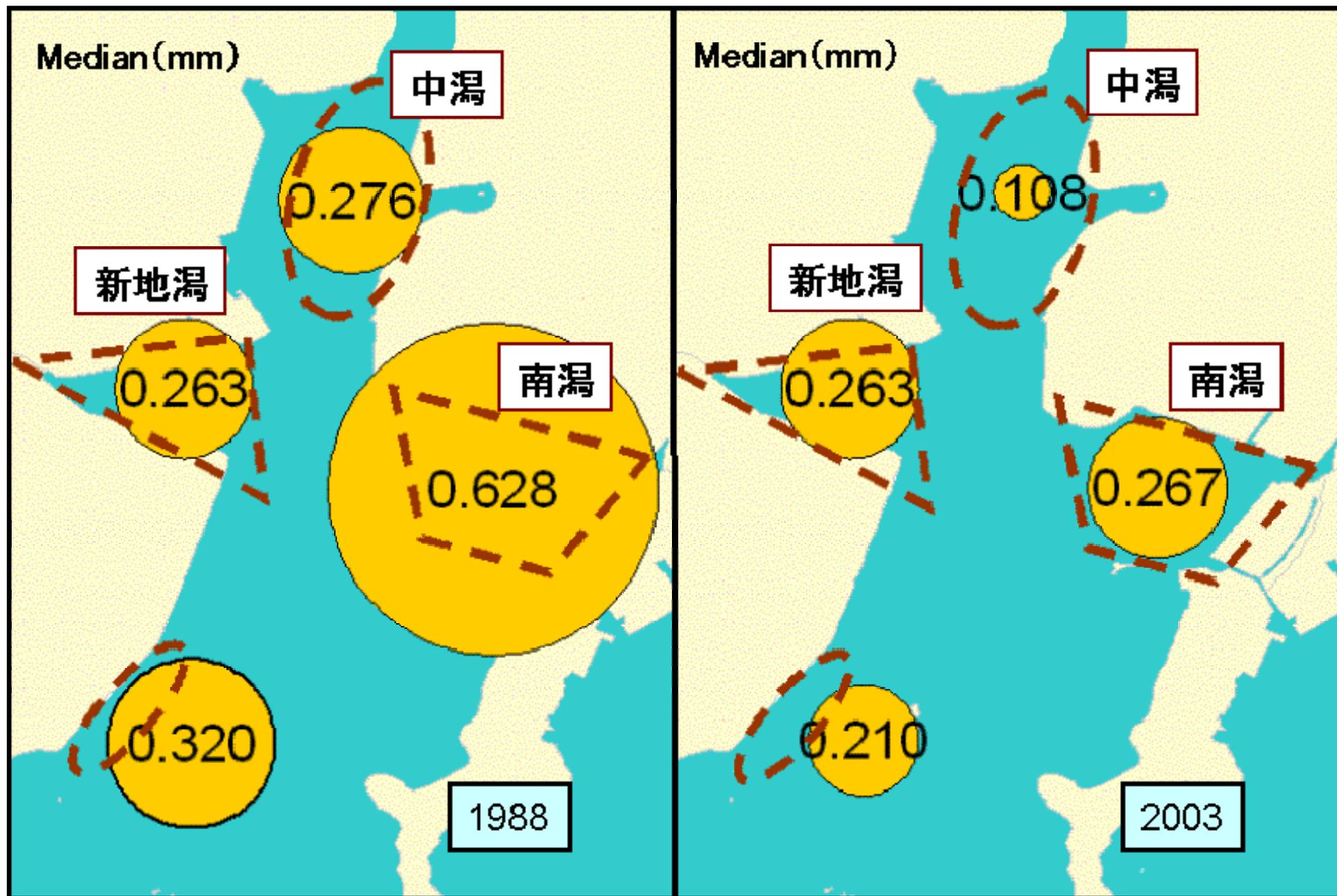


2006.6.1

Turbidity from road construction site

2005.7.3





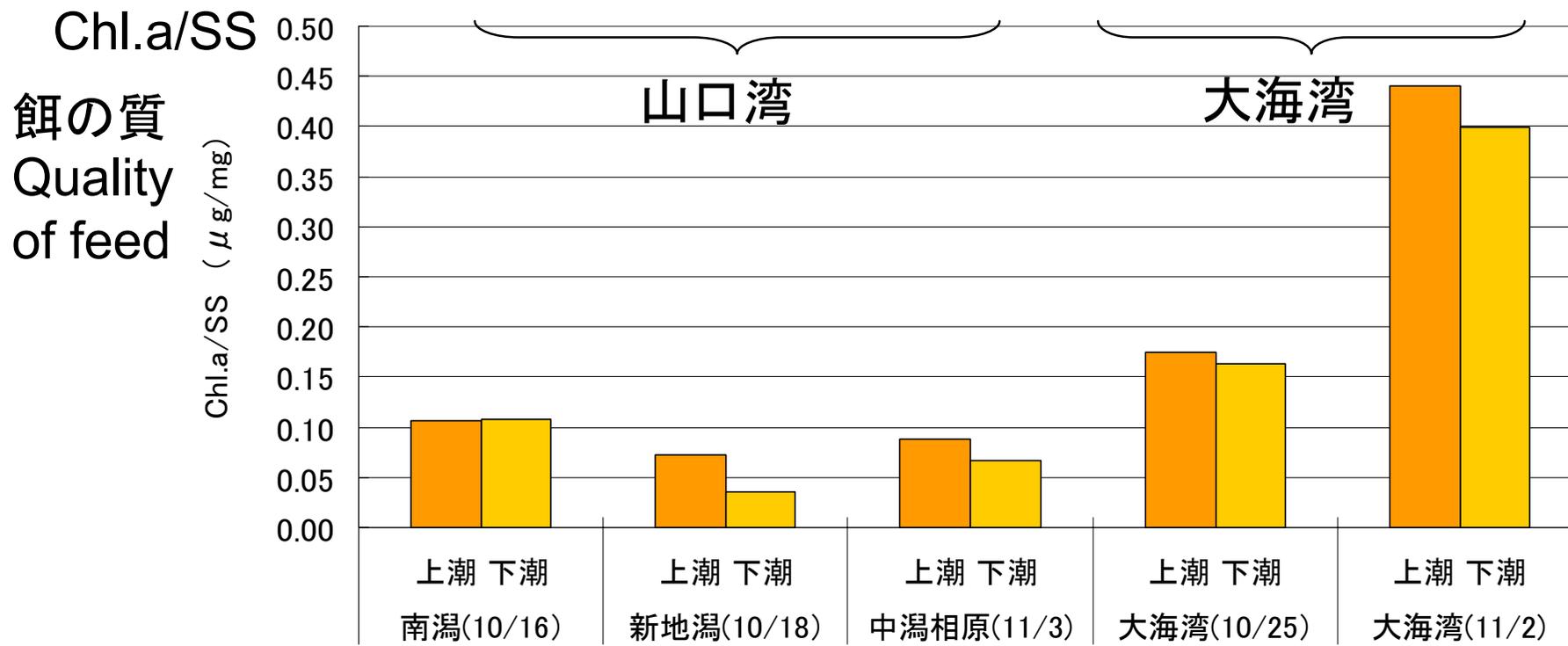
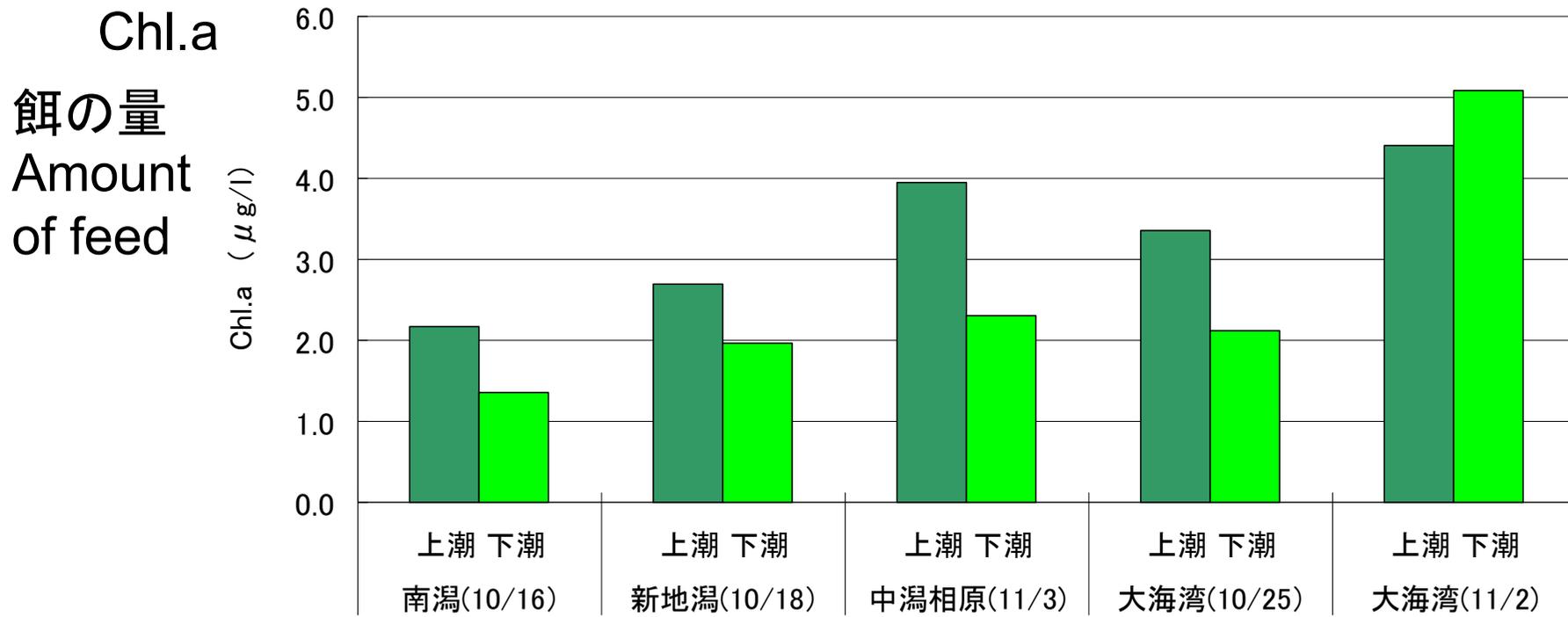
Change of the particle size of tidal flats in Yamaguchi Estuary

The median values of surface mud have decreased even during 15 years

Why fine particle size not good for short-necked clam ?



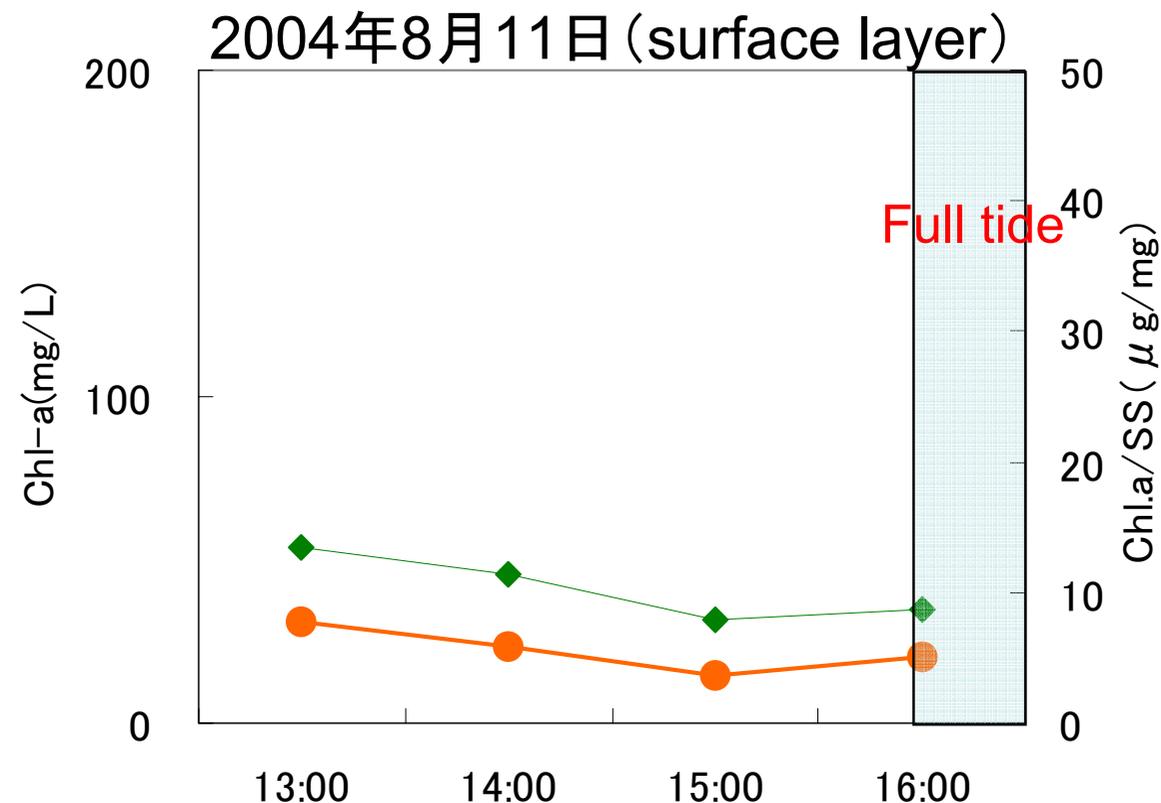
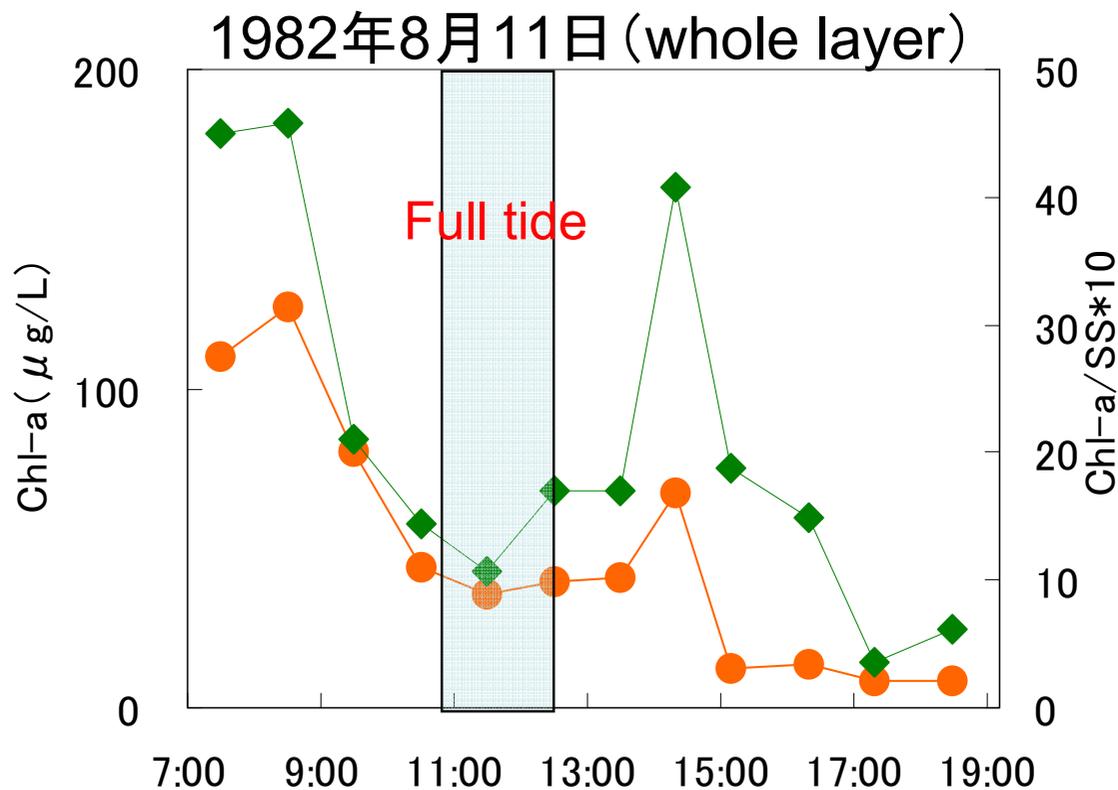
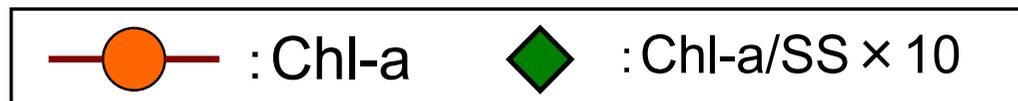
Sampling points of water quality near bottom (B+0.1m) for comparing Yamaguchi estuary and Ohmi estuary



左: 上げ潮時
Left Up-tide
右: 下げ潮時
Right Web-tide

The amount and quality of feed in Ohmi estuary was better than Yamaguchi estuary

Comparison of overlying water quality (2004)



Comparison of the quality of SS at the river mouth in the summer 1982 and 2004

Chl-a has decreased, and Chl-a/SS has become smaller from 4-5‰ to 1‰ even in surface layer.

The quality of feed particles becomes poorer than 20 years before.

Measures to Create a Lively River Basin

~ Fushino River Model ~

- Yamaguchi Prefecture started the committee to discuss unified environmental management of river basins. Plan was proposed for Fushino river basin as the model Mar 2003 after 1 year's discussion.

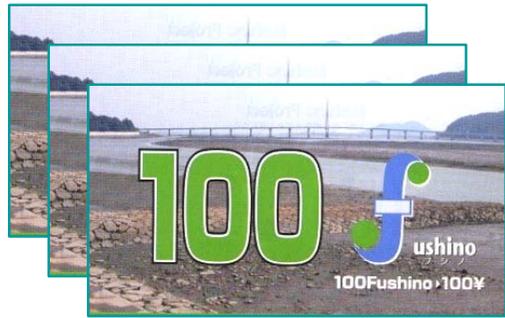
In the plan,

- Target : Cyclic-Symbiotic Society connected with river from forest to sea
- Key words :
 - ‘Local production and local consumption’
 - ‘Think of source when drink water’
 - ‘Co-operation between upper and lower basins and among various sectors’

Main Activities of River Basin Project

- Sound cycle of water
 - Safer river protecting against flood
 - Ample water and effective use
 - Water quality conservation
- Preserving ecosystems
 - Nature-rich river construction
 - Fire-flies living and Fish ascending & descending river
 - Restoring productive tidal flats and sea grass field
- Activation of local industry
 - Forestry, Agriculture, Fishery & Traditional industries
- Cooperation of upper and lower basins
 - Contact with river, culture and legends
 - Local money, Fushino River Forum, Environ.education

Local money 1 f (ushino) = 1 yen



1st year
620,000 f

n=33

Voluntary Work
implementing Group



N=2700

Citizens

voluntary work ↑ f

Local Money
managing Organization

↕ contract

13,000 f

service

f

Supporters
Shops, Restaurant, Tea rooms
etc. n=39



2003 ~ 2007,
Total participants 19000
Total issue, 5.3 million f

Structure of local money in Fushino River Basin

Focusing on the river mouth environment, we followed the Nature Restoration Program of the Ministry of Environment.



The first conference on the restoration of tidal flats in Fushino river mouth area, organized by Prefecture, Aug.2004

Conference member : 60

Academics : 9

Citizens : 18

Organizations : 18

Local governments: 11

National government: 4



蒲生干潟
(調査・1/2補助)



Gamoh
tidal marsh

サロベツ
(調査・直轄)



Sarobetsu
wetland

釧路湿原
(事業・直轄)



Kushiro
wetland

琵琶湖
(調査・1/2補助)



Lake Biwa

くぬぎ山
(事業・1/3補助)



Kunugiyama

小笠原
(調査・直轄)



Ogasawara
island

Ohdaigahara

大台ヶ原
(調査・直轄)



Kashibaru
wetland

桤原湿原
(調査・1/3補助)



三番瀬
(調査・1/2補助)



Sanbanse
tidal marsh

Fushino River
mouth tidal marsh

根
(調



石西礁湖
(調査・直轄)



Inishi
coral reef

11 Projects of Nature Restoration Program in Japan 2004

In 2007, the number Has increased to 24.

(National Park Areas 7
Quasi National Park &
Wild Animal Protection
areas 12, and Other than
natural park areas 5.

Our project is one of the
last category.)

Basic Concepts of Nature Restoration of Fushino River Mouth / Tidal Flats

- Following the guideline for nature restoration of Ministry of Environment Apr.2003,

① Cooperation of local stakeholders

Considering complexity of ecosystems

② Based on scientific knowledge

③ Adaptive implementation

Target: Restoration of 'Sato-Umi'

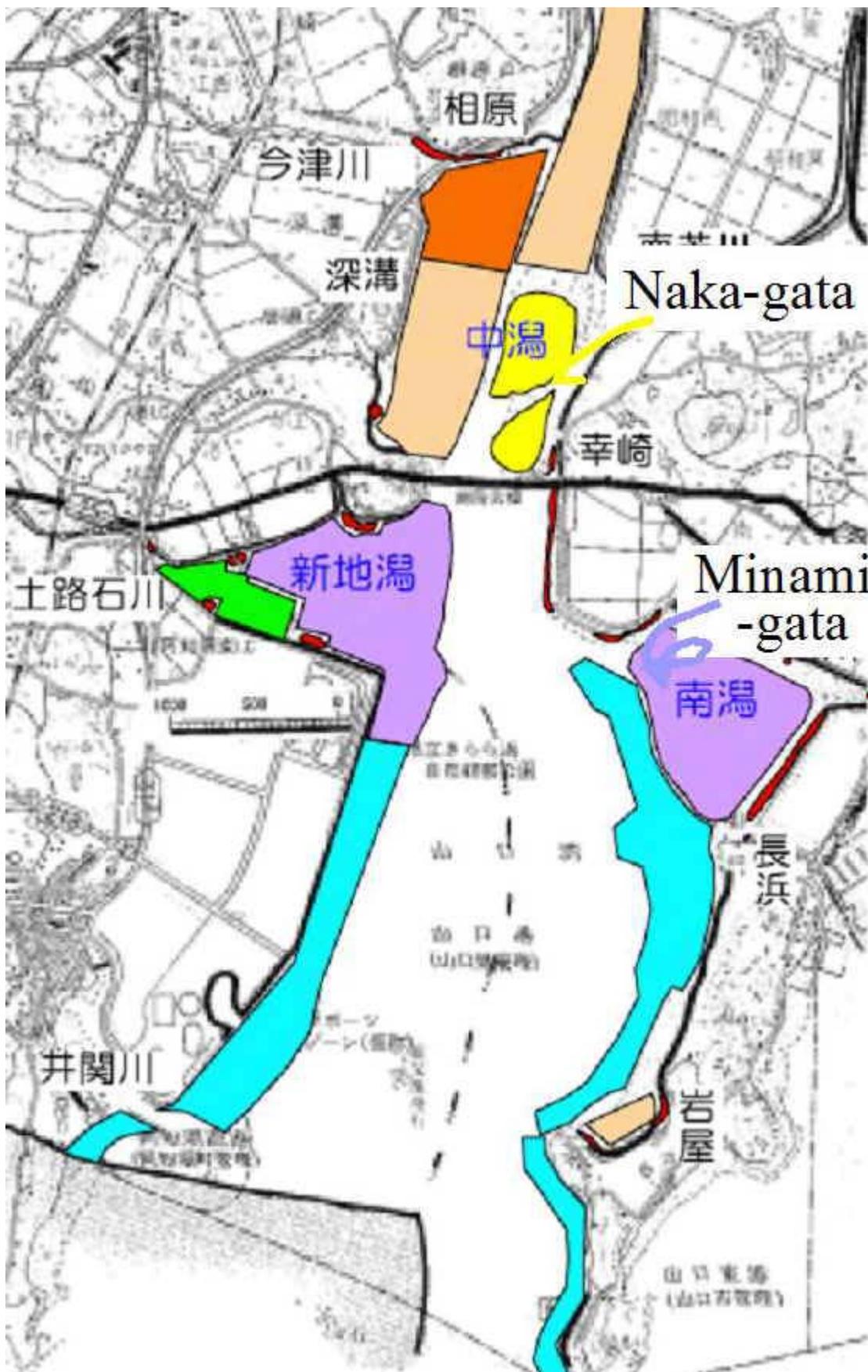
Sato-umi (里海)

The coastal sea with high productivity and high biodiversity under the mankind's interaction

By Prof. Yanagi

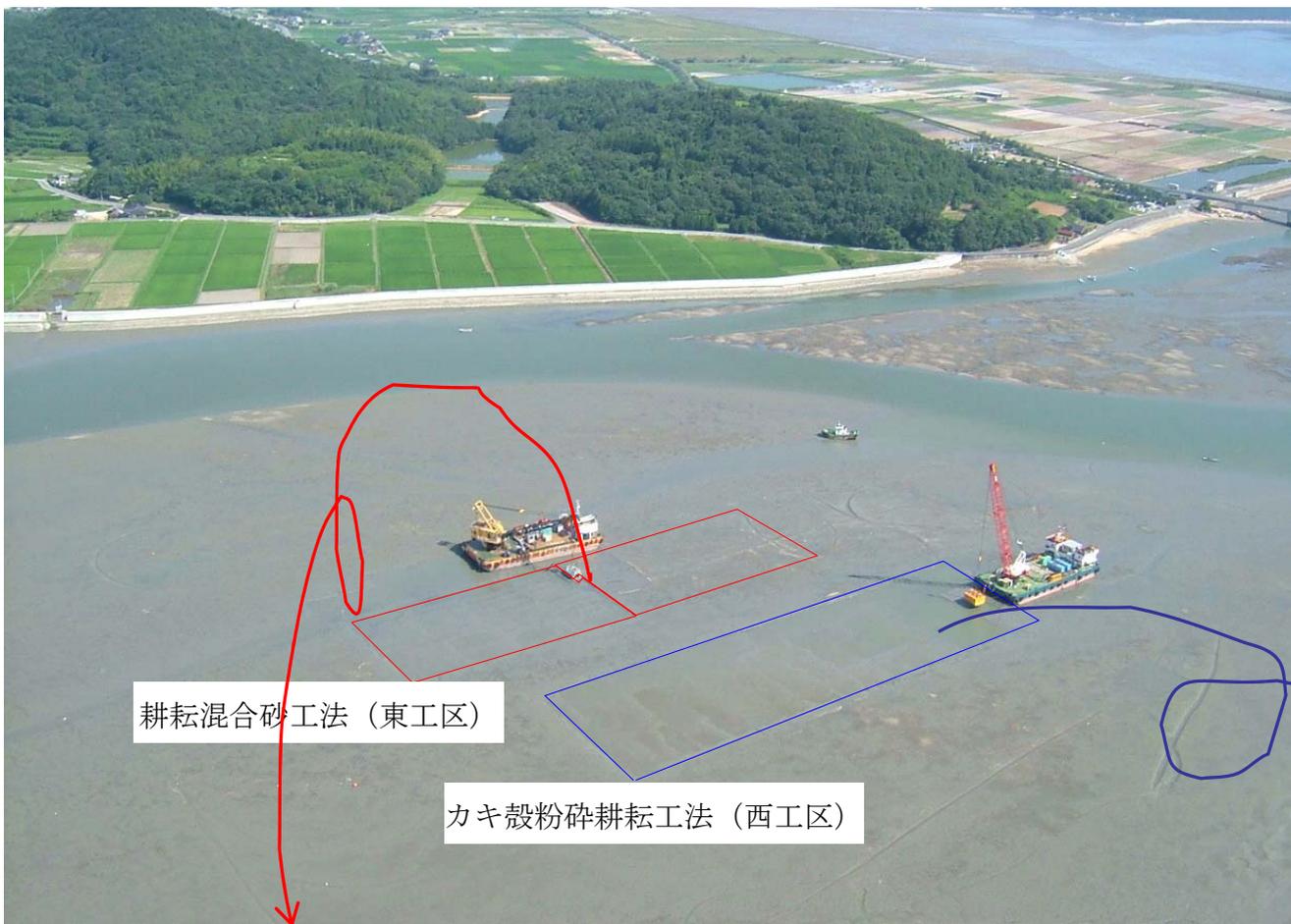
Better life through wise and sustainable use of coastal environments

By Prof. Matsuda

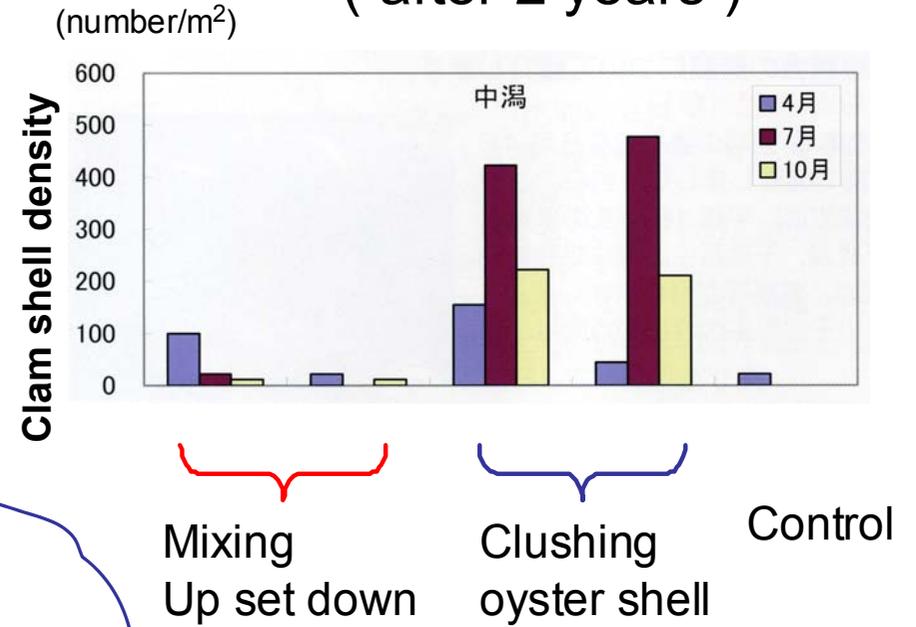


-  Ample muddy flat
-  Ample sandy flat
-  Horseshow crab spawning area
-  Ample eel grass field
-  Muddy recreational flat
-  Sandy observation flat
-  Preservation as it is

Goal allocation for tidal flat environment in Yamaguchi Estuary



Effect of improvement works (after 2 years)



Mixing up set down and with sand



Crushing oyster shell

Mechanical works for sediment improvement in Naka-gata



Making ridges



Making mound



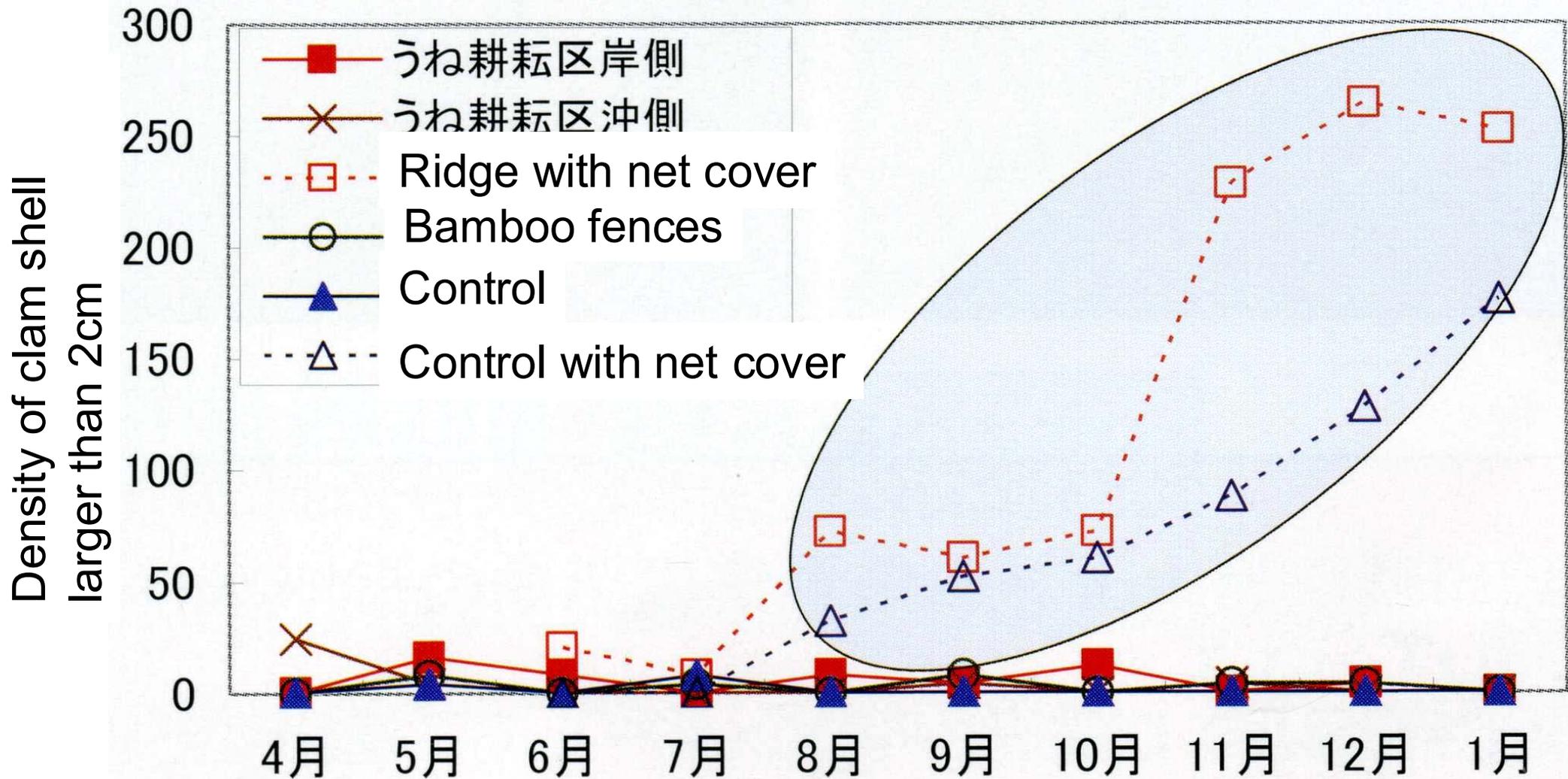
Bamboo fence



Planting eel grass

Manpower improvement of sediment and plantation in Minami-gata

(number/m²)



Effect of cultivation of Minami-gata tidal flat (2007)

Unfortunately the effect of plowing can not be clearly seen.
The effect of preventing eagle ray's damage was only clear.
The cover with fishing net on plowed mound was the best.

山口湾西岸に
鑄鉄の籠に間伐材を
入れた漁礁を設置し、
集魚効果と、鉄と腐植質
の効果もねらっている。



Voluntary work to set fish beds consist of cast iron cages and thinning wood to test the effect of iron and humic substance

Concluding remarks (1)

- Restoring project is going almost successfully during 5 years. The effect of the project can be gradually seen, though it is not clearly monitored except that eel grass field tends to increase.
- The cause of poor fishery production is complicated and not clearly elucidated. Therefore scientific study on ecosystem is needed to clarify the cause.
 - effect of global warming and predators
 - cause and effect of fine particle sediments
 - others e.g. over-fishing, nutrient condition etc.

Concluding remarks (2)

- Voluntary participants will keep enthusiasms to restore 'Sato-Umi'. However, wider layers of citizens are expected to join.
- Up to now, the leading effort by prefectural government plays very important role. But, it has been becoming difficult to get budget to support the project.
- Reconstruction of social system is necessary to restore 'Sato-umi'
 - Support of budget from public sector including investigation and improvement works of large scale.
 - **Environmental friendly fishery, forestry and agriculture**
 - **Slow life with more free time in people's mind**