The economic cost of harmful algal blooms in China from 2008-2012

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1. Brief introduction
2. Monitoring system of HABs in China
3. Economic cost of HABs in recent 5 years

Part 1

Marine environment monitoring in China

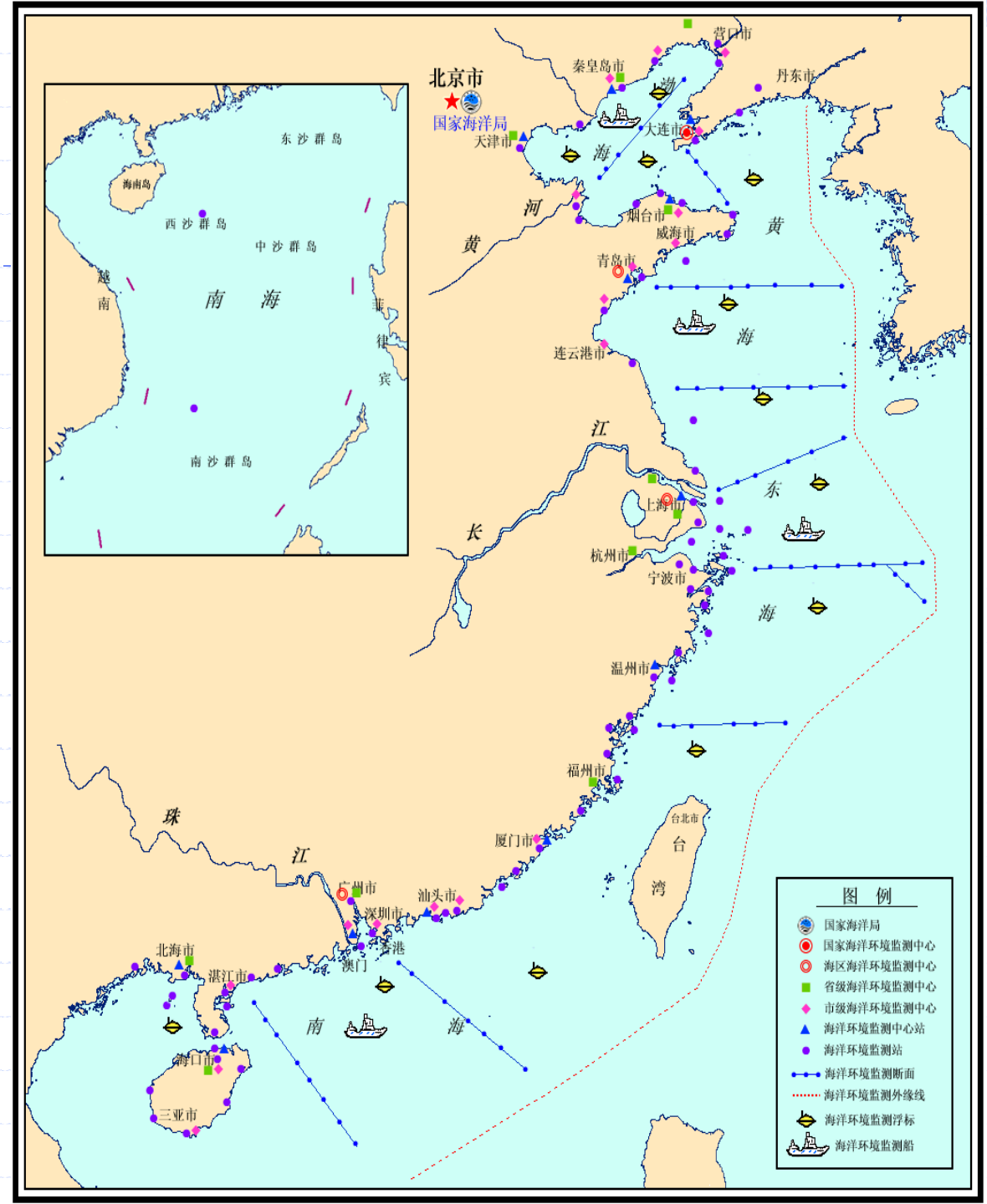
General information

- Located in the southeast of Asian landmass.
- The total coastline is 32,000km, of which, the continental coastline is 18,000 km. The total territorial waters claimed under China's jurisdiction is about 3 million km^2.
- Chinese coastal water is divided into four sea areas : the Bohai Sea , Yellow Sea, East China sea and South China Sea.
- More than 1,500 rivers flow into the sea through broad drainage areas.
- Own abundant marine biodiversity with 22,629 recorded species and various types of marine ecosystems such as mangroves, coral reefs, coastal wetlands, sea grass beds, islands, bays, estuaries and upwelling , etc..

Organization

State Oceanic Administration (SOA)

- **National Professional Centers**
  - National Marine Environmental Monitoring Center (NMEMC)
  - National Marine Data and Information Service (NMDIS)
  - National Marine Environmental Forecast Center (NMEFC)
  - National Satellite Ocean Application Service (NSOAS)
- **Regional centers**
  - North China Sea Branch of State Oceanic Administration (Qingdao)
  - East China Sea Branch of State Oceanic Administration (Shanghai)
  - South China Sea Branch of State Oceanic Administration (Guangzhou)
    - Coastal stations — 13
      - Coastal Laboratories — 66
- **Local Governments**
  - Provincial stations — 11
  - Municipal stations — 50
- **Others:** Institutes\Scientists\volunteers



Marine environmental monitoring agencies and monitoring areas in China

The total monitoring agencies in China is 144, of which, 83 belong to SOA, 61 belong to local governments.

State Oceanic Administration

- **National Center — 1**
- **Regional center — 3**
- **Coastal station — 13**
- **Coastal Lab. — 66**

Local Government

- **Provincial station— 11**
- **Municipal station — 50**

Review of the marine environment in China

The sketch map illustrates the distribution of polluted coastal waters.

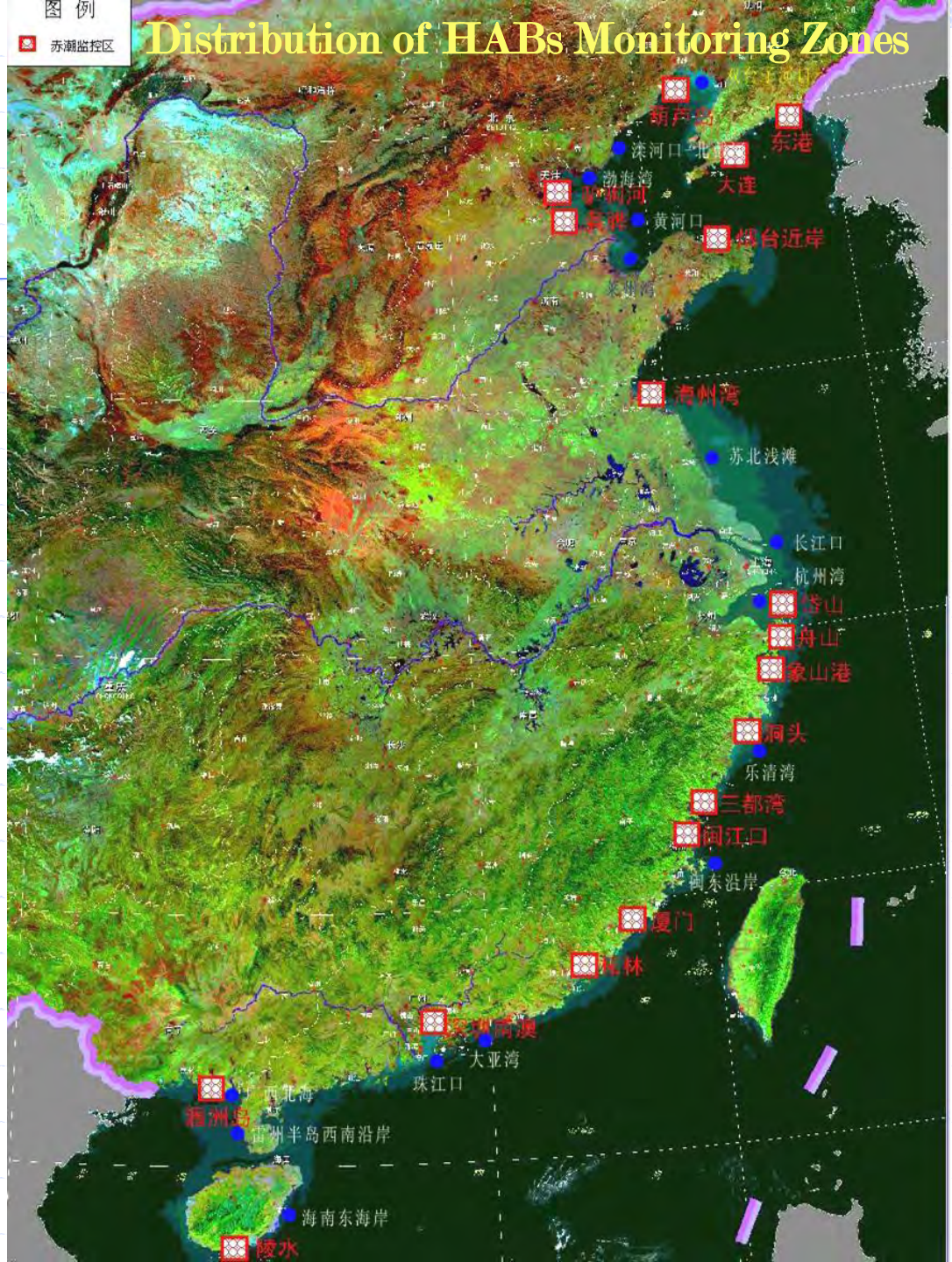
- In the past 5 years, the marine environmental quality of China was in good condition.
- Major pollutants are nutrients (Nitrogen, Phosphorus), hydrocarbon and some trace metals (lead).
- Some of the coastal areas are still suffering from land-based pollution, environmental disasters and habitat destruction.

Part 2

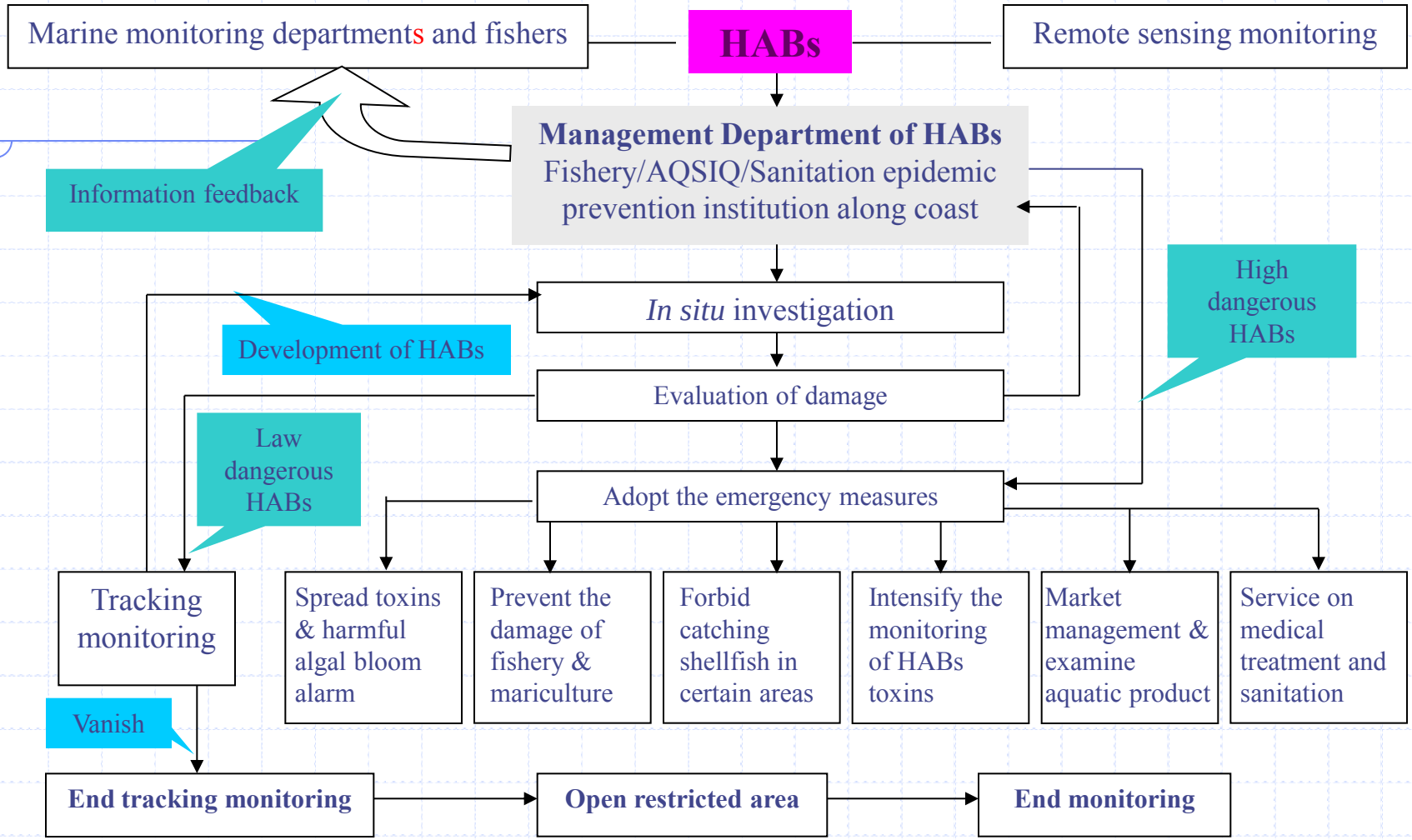
Monitoring system of HABs in China

Monitoring & control zones of HABs

- The national monitoring system of HABs was initiated in 2002, when 10 HABs monitoring zones were set up. By now, there have been 19 HABs monitoring and control zones and 16 ecological monitoring and control zones bestrewing the Chinese coastal areas and greatly enhance the harmful algal blooms—monitoring capacity.
- HABs monitoring and control zones are mainly situated in: aquaculture areas, ecological protection areas, recreation resorts and HABs frequently plagued areas, etc..



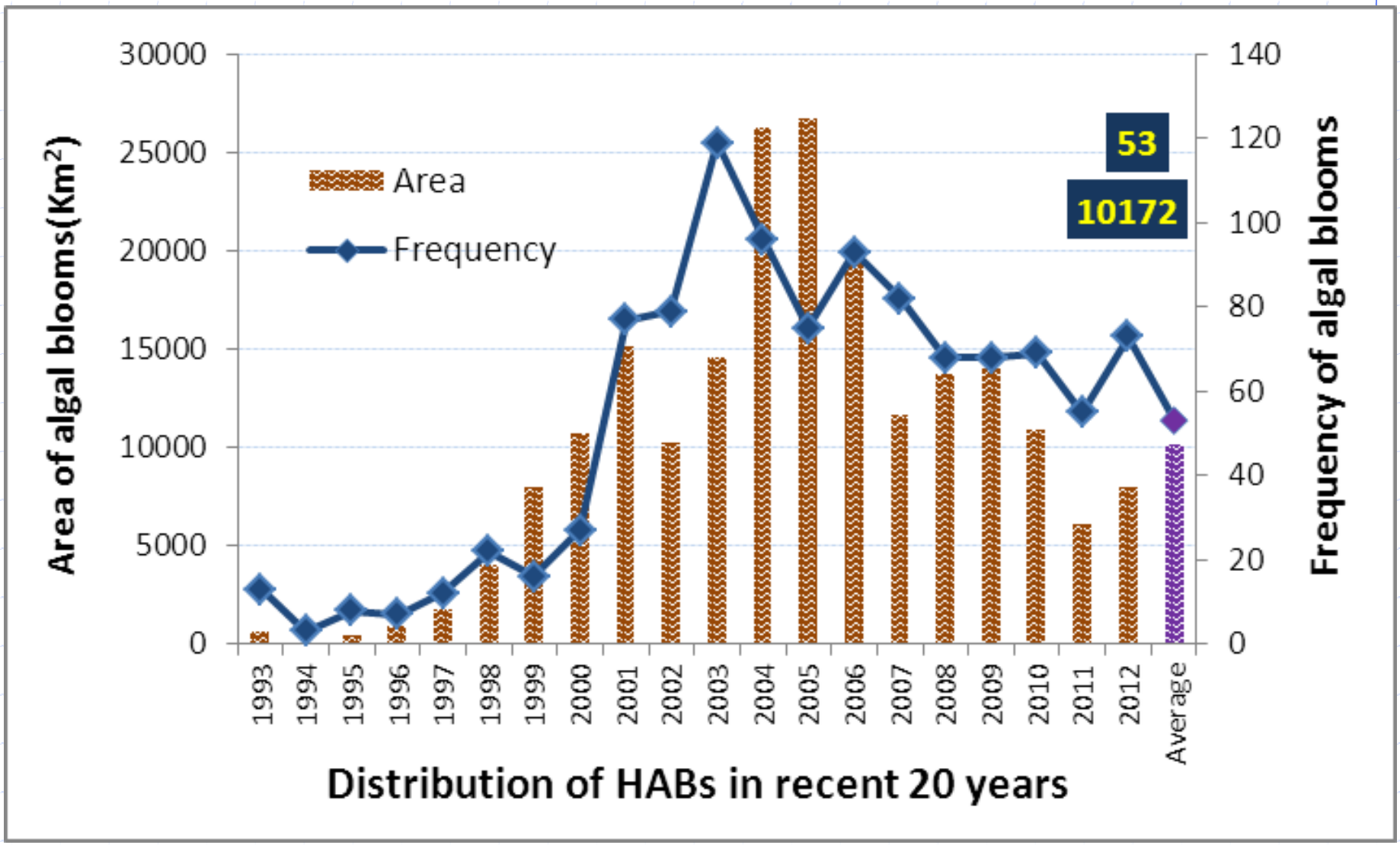
Harmful algal blooms mainly frequent the East China Sea and the Bohai Sea.



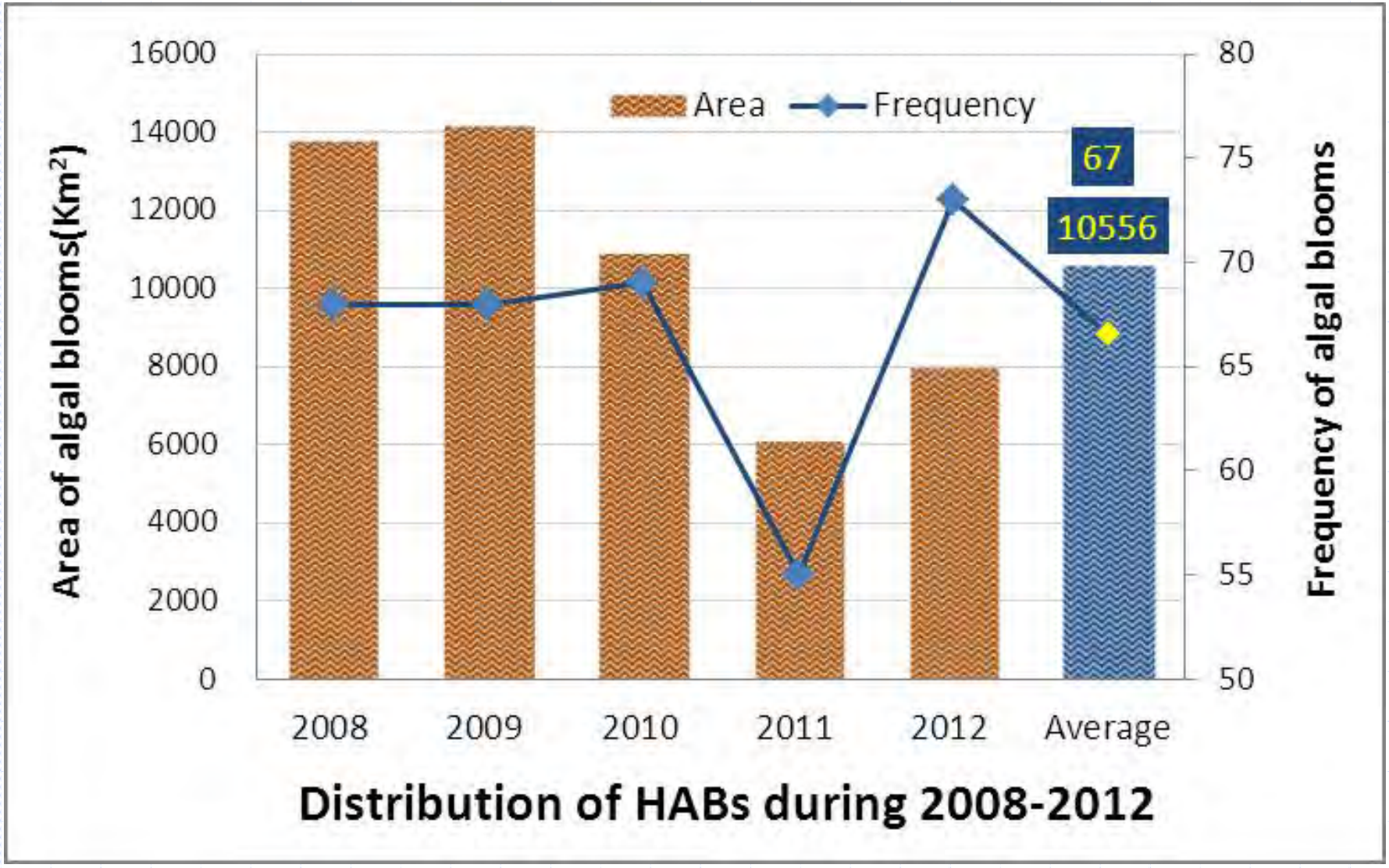
Monitoring System and Emergency Response of HABs

Part 3

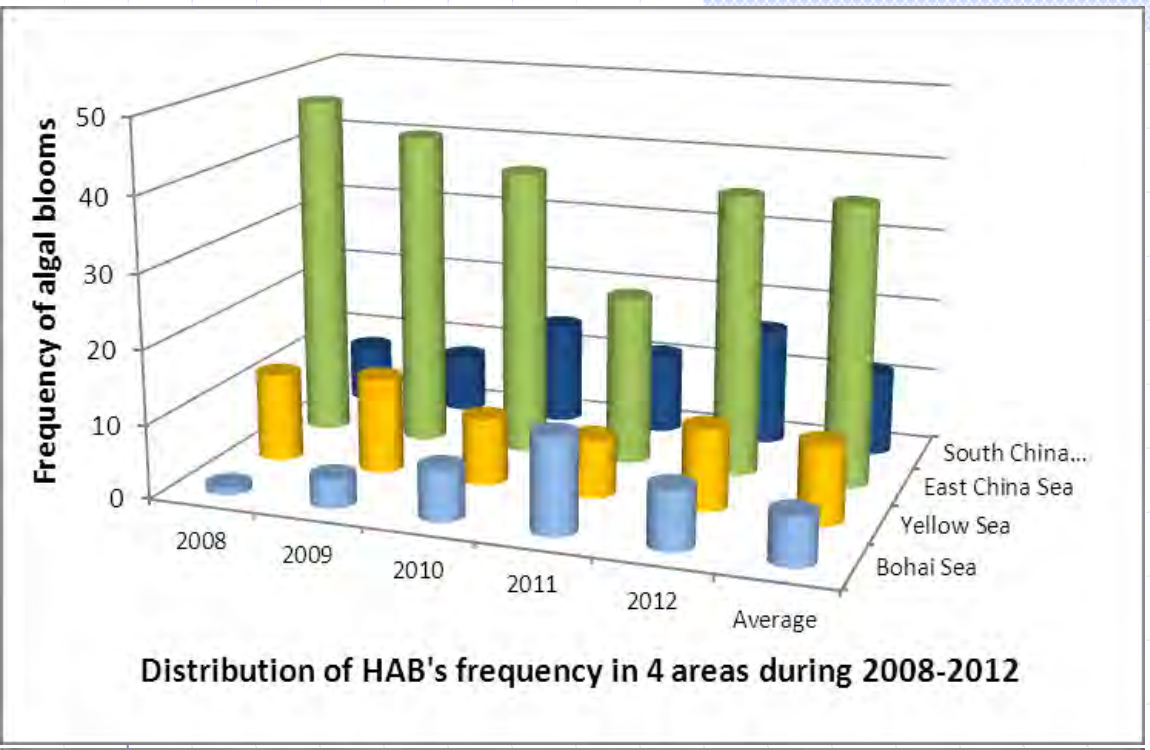
The financial loss caused by Harmful Algal Blooms in China from 2008 to 2012



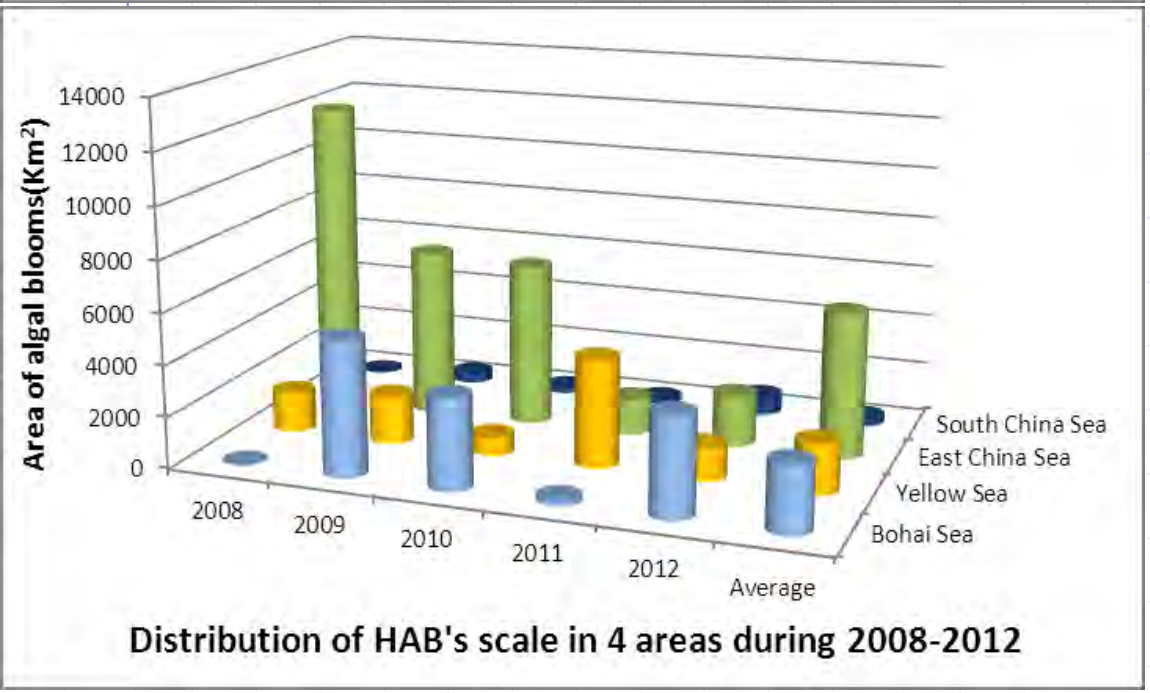
The frequency and scale of marine red tides reached a high level during 2003-2006.



The occurrences of marine red tides and affected areas are basically stable compared with that in recent 20 years.

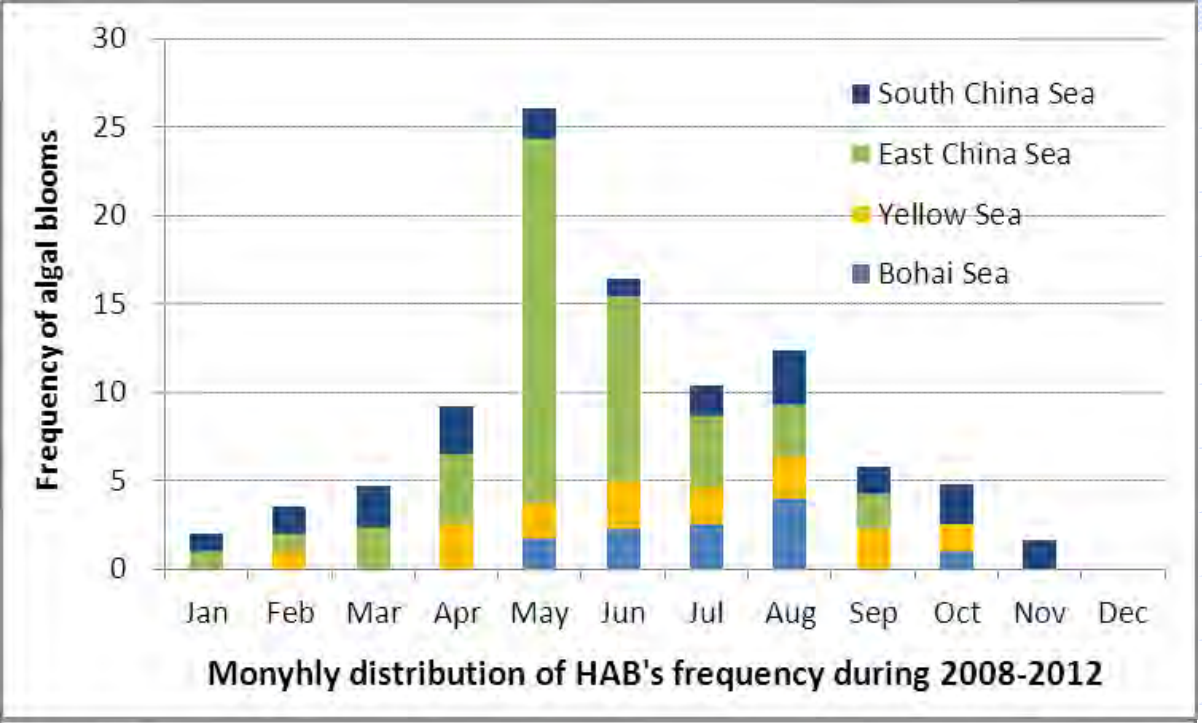


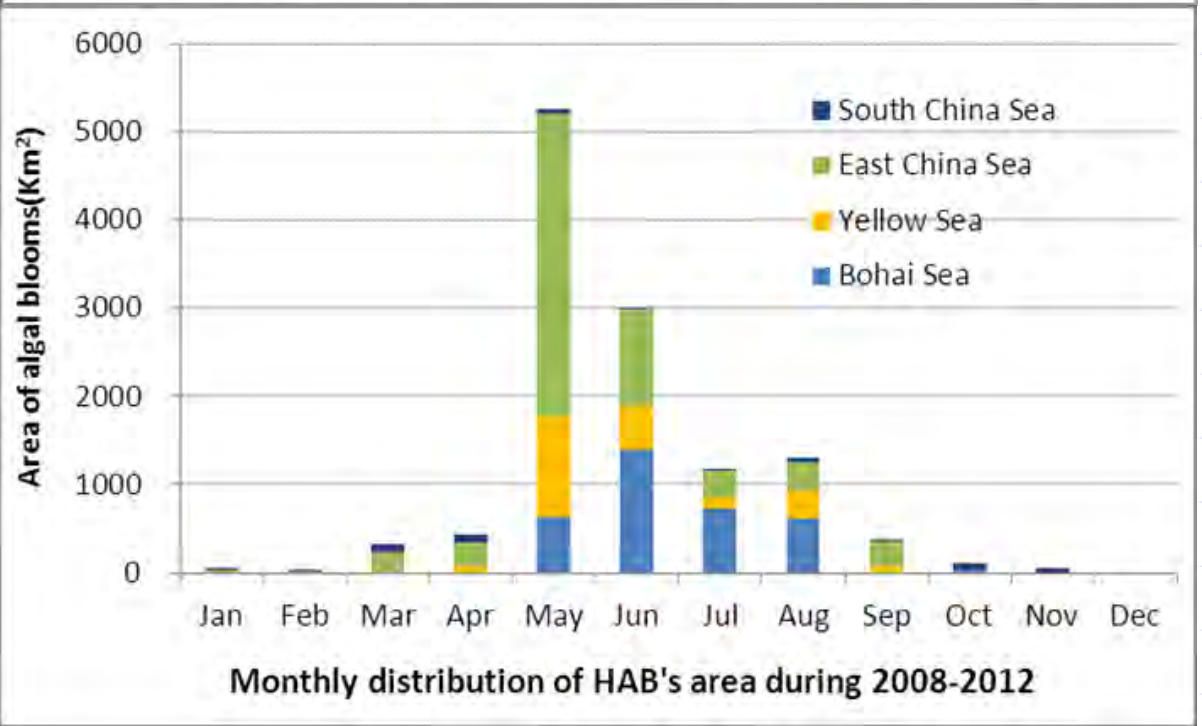
Distribution of HAB's frequency in 4 areas during 2008-2012



Distribution of HAB's scale in 4 areas during 2008-2012

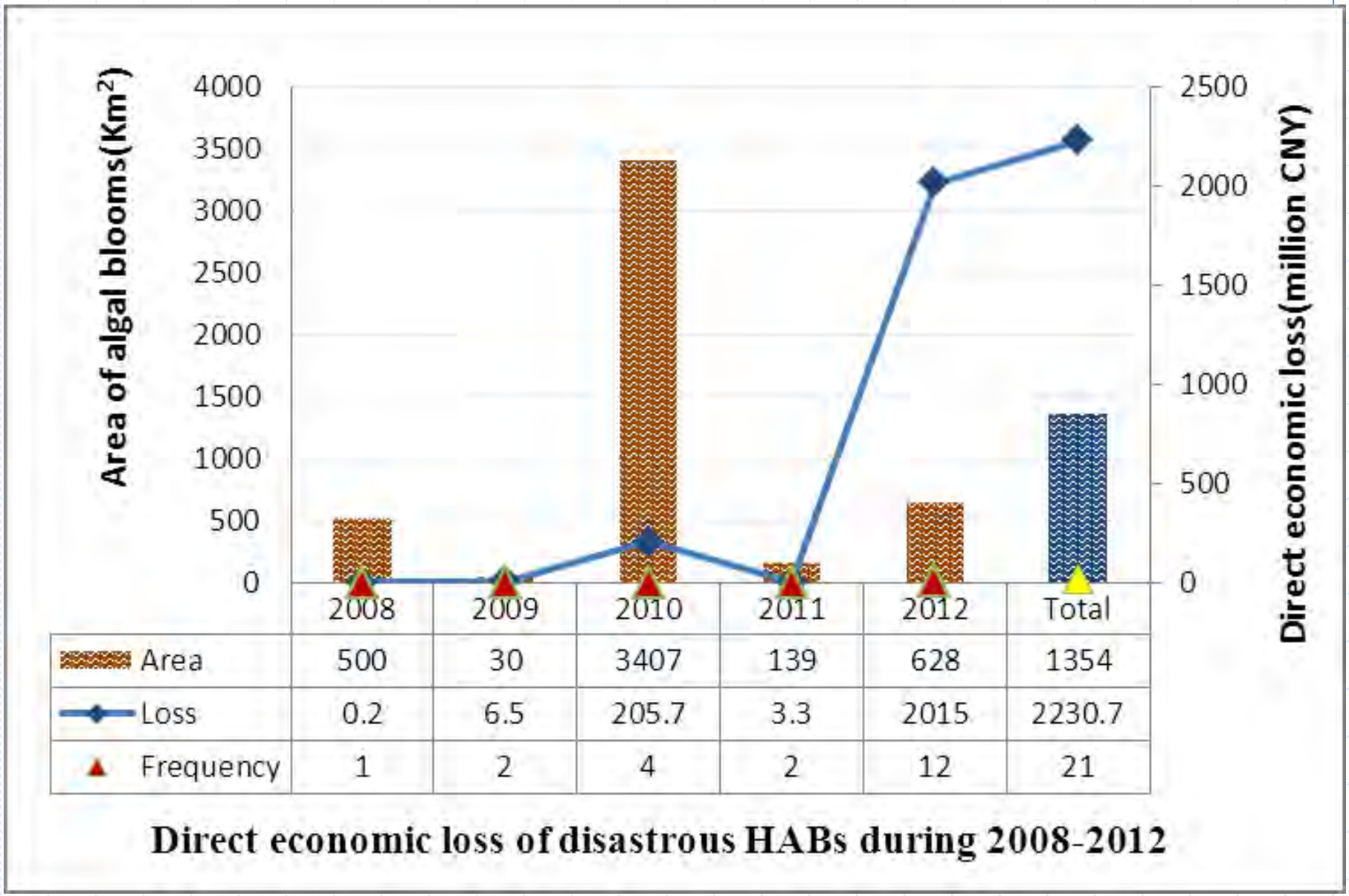
- Harmful algal blooms in Chinese coastal waters are mainly located in the East China Sea where the HABs happened more frequently and affected evidently much larger areas than the other three sea areas, accounting to 57% and 54% of the total HABs events separately over the past 5 years.
- Large scale harmful algal blooms mainly occur in the sea waters adjacent to the Yangtze River estuary and south-east coastal waters in China.





- HABS always happen in May and June annually .
- The frequency was much higher and the affected areas were much larger than the other months, accounting to 52% and 73% of the total HABs events over the past 5 years.

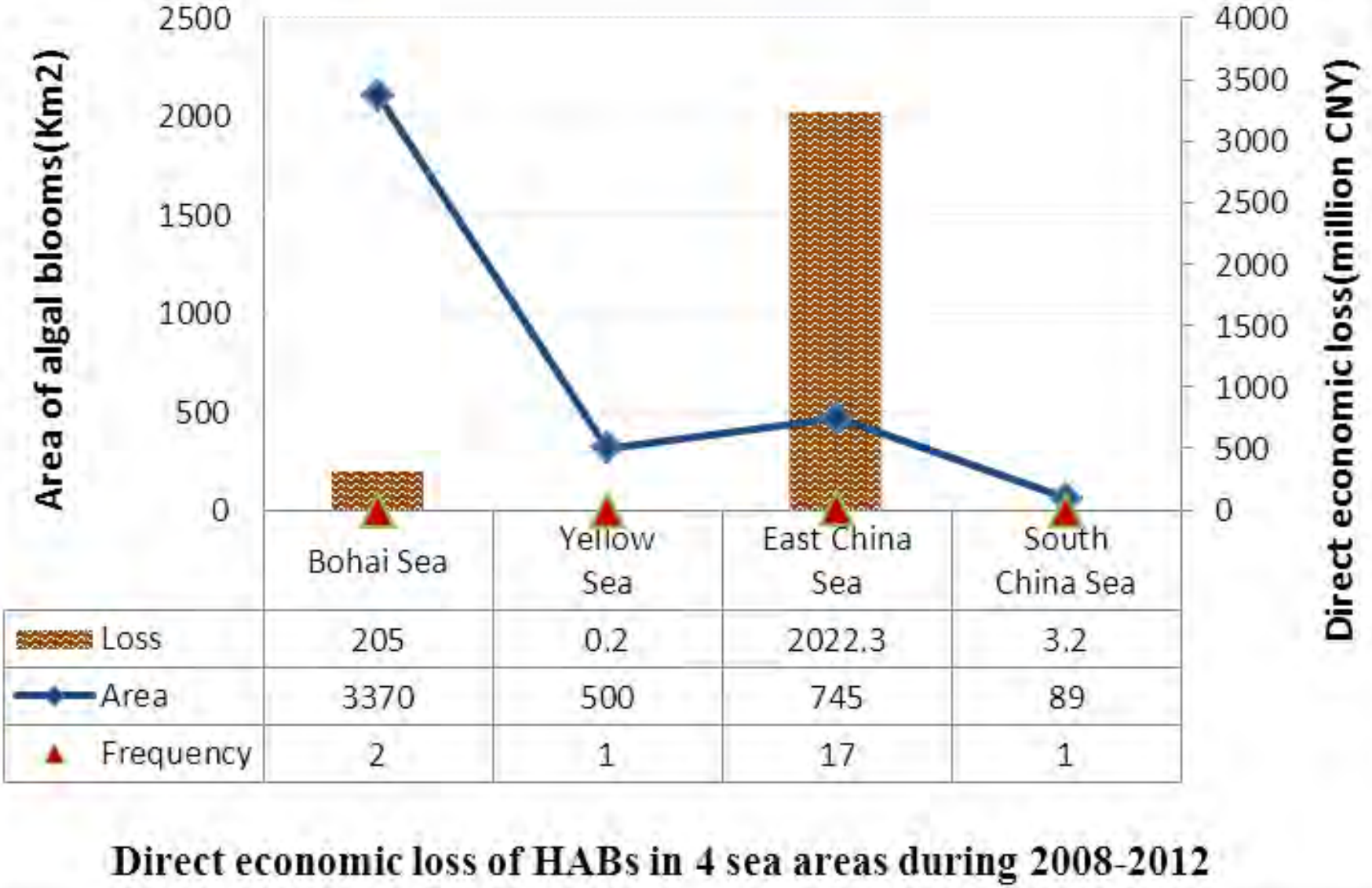
The distribution of disastrous harmful algal blooms during 2008~2012. They were concentrated in the Bohai sea and the south-east coastal areas.



	2008	2009	2010	2011	2012	Total
Area	500	30	3407	139	628	1354
Loss	0.2	6.5	205.7	3.3	2015	2230.7
Frequency	1	2	4	2	12	21

Direct economic loss of disastrous HABs during 2008-2012

The total economic cost is nearly 2.23 billion Yuan (364 million USD) in recent 5 years.

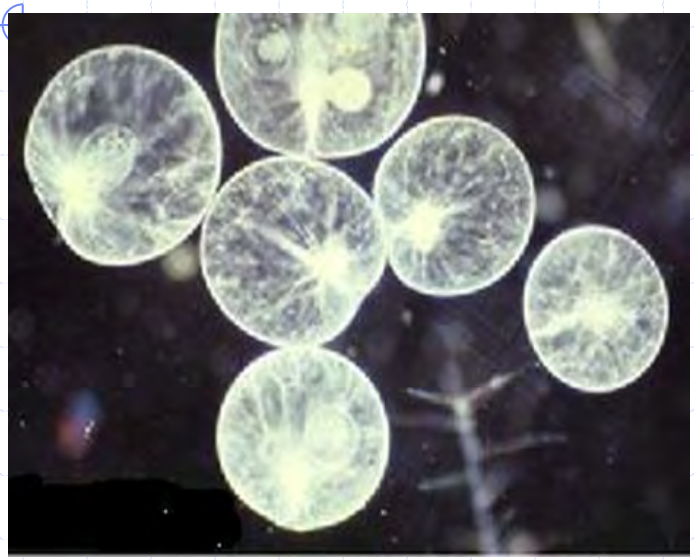


	Bohai Sea	Yellow Sea	East China Sea	South China Sea
Loss	205	0.2	2022.3	3.2
Area	3370	500	745	89
Frequency	2	1	17	1

Direct economic loss of HABs in 4 sea areas during 2008-2012

The East China Sea suffers the largest direct economic cost in recent 5 years, nearly 91%.

Disaster-causing species:
Noctiluca scintillans (Macartney) Kofoid & Swezy

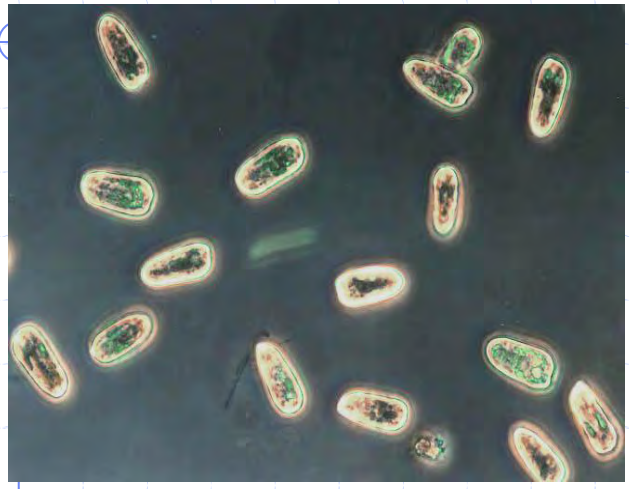


Empire : Eukaryota
Kingdom : Chromista
Phylum : Dinophyta
Class: Dinophyceae
Order: Noctilucales
Family : Noctilucaceae
Genus : Noctiluca

- Faust & Gulledge notes toxic blooms of this species have been linked to large fish and marine invertebrate kills.
- Although this species does not produce a toxin, it accumulates toxic levels of ammonia which is excreted into the surrounding waters.
- In 2008, this species caused mass mortality of cultivated shellfish in Liaoning Province.

April 10th, 2012, *Noctiluca scintillans* burst in Shenzhen, Guangdong Province

Prorocentrum donghaiense D.Lu



Empire: Eukaryota

Kingdom: Chromista

Phylum: Dinophyta

Class: Dinophyceae

Order: Prorocentrales

Family: Prorocentraceae

Genus: Prorocentrum

- Some experiments on this species show the damage to marine organisms.
- It is a common species along East China sea in recent years.
- Frequently break out with *Karenia mikimotoi* .

Table2-7 Effects of *Prorocentrum donghaiense* on organisms of different trophic levels (compare with control)

实验生物 organisms	指标 index	暴露时间 exposure time	生态毒理效应 effects	
			10^7 cells L^{-1}	10^8 cells L^{-1}
卤虫 (*Artemia salina*)	存活 survival	96h	90% （5×10^7）	100% （1×10^8）
轮虫 (*Brachionus plicatilus*)	种群繁殖 reproduction	9d	60% （5×10^7）	46% （1×10^8）
蒙古裸腹溞 (*Moina Mongolica*)	存活 survival	10d	30% （6×10^7）	90% （2×10^8）
	产幼数 reproduction	10d	43% （6×10^7）	35% （1×10^8）
鲈鱼（幼鱼） (*Lateolabrax japonicaus*)	存活 survival	96h	100% (5×10^7)	100% （2×10^8）
扇贝胚胎(*Argopecten irradiants* lamark)	孵化率 hatching rate	24h	97% （5×10^7）	98% （1×10^8）

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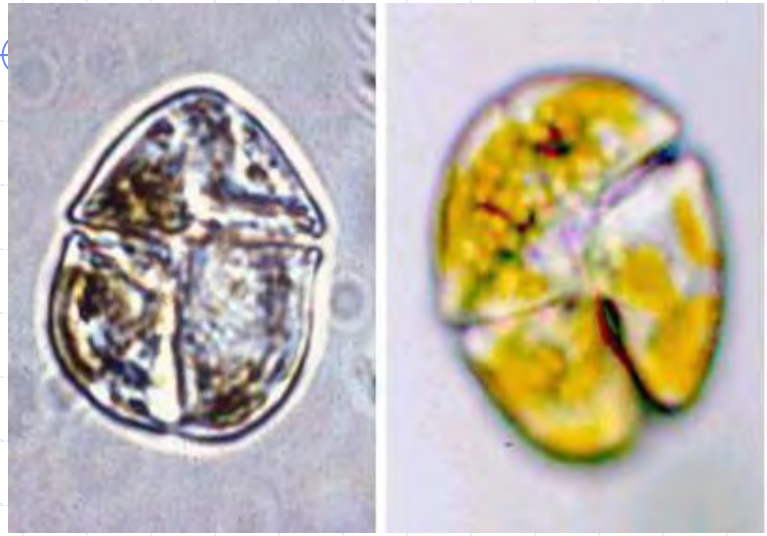
Karenia mikimotoi Gert Hansen & Ø.Moestrup



Empire: Eukaryota
Kingdom: Chromista
Phylum: Dinophyta
Class: Dinophyceae
Order: Brachidiniales
Family: Brachidiniaceae
Genus: Karenia

- A recurring blooms of this species previously emerge in the coastal waters of Japan and Korea; Red tides commonly occur in warmer months and are associated with the deaths of massive fish and shellfish.
- In 2012, this species caused huge damage to the mariculture industry of Zhejiang and Fujian provinces, especially to cultivated abalone. The direct economic loss was more than 2 billion Yuan (330 million USD)

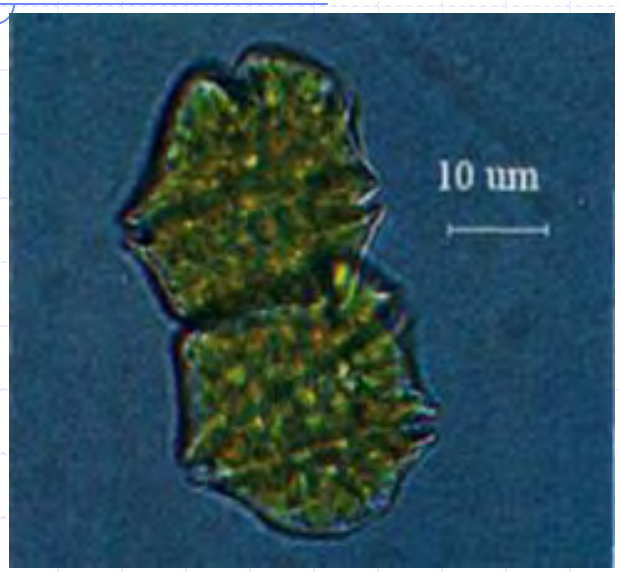
May 29th, 2012, *Karenia mikimotoi* burst in Fujian Province. A large number of abalone were dead. The mortality is more than 50%.

Mesodinium rubrum Leegaard

Empire: Eukaryota
Kingdom: Chromista
Phylum: Ciliophora
Class: Ciliatea
Order: Ciliatea
Family: Didiniidae
Genus: *Mesodinium*

- The damage of this species was rarely reported.
- There were several red tide events of *Mesodinium* that occurred in China.
- In 2010, this species spread nearly 20 Km^2 and led to 5 million Yuan loss in Hebei Province.

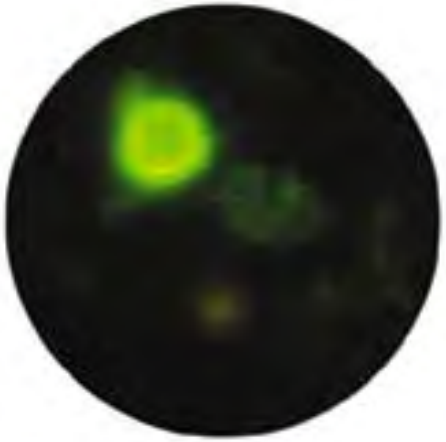
Cochlodinium geminatum (Schütt) Schütt



Empire: Eukaryota
Kingdom: Chromista
Phylum: Dinophyta
Class: Dinophyceae
Order: Gymnodiniales
Family: Gymnodiniaceae
Genus: Cochlodinium

- In 2006, the blooms of *Cochlodinium* occurred. This indicates that it has been increasing and expanding in Chinese coastal water.
- Ichthyotoxins produced by *Cochlodinium* have caused major losses in fishery and shellfishery production in many countries, especially in Korea.
- More than 3 million Yuan economic loss was caused by *Cochlodinium* in Aug., 2011, in Guangdong Province. The maximum area was 89 Km^2, and the most affected species were fish fry and juvenile fish.

Aureococcus anophagefferens Hargraves & Sieburth



Empire: Eukaryota
Kingdom: Chromista
Phylum: Heterokontophyta
Class: Pelagophyceae
Order: Pelagomonadales
Family: Pelagomonadaceae
Genus: Aureococcus

- From 2009-2012, the brown tide led to huge damage of scallop culture industry in Hebei Province.
- The phytoplankton community with the maximum cell density around 10^9 cell/L.
- Due to the cessation of feeding and the stagnant growth of scallops, the blooms of this species significantly damaged the mariculture industry in this region.

SUMMARY

- There are more than 330 cases of red tides in China from 2008 to 2012, encompassing a total area of 53,000 km^2 with an economic cost of nearly RMB 2.23 billion (364 million USD).
- The southeast coastal area of China is an important fishery area where red tides occur frequently and cause enormous economic losses.
- The main months of annual events are May and June.
- The main disaster-causing species are *Karenia mikimotoi*, *Noctiluca scintillans, Cochlodinium geminatum and Prorocentrum donghaiense.*
- The worst-hit species affected by harmful algae blooms are cultivated abalone and fish.


Thank you for your
kindly attention !