The Occurrences of HAB in Chinese coastal waters in recent years

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1. HAB Events in coastal water of China

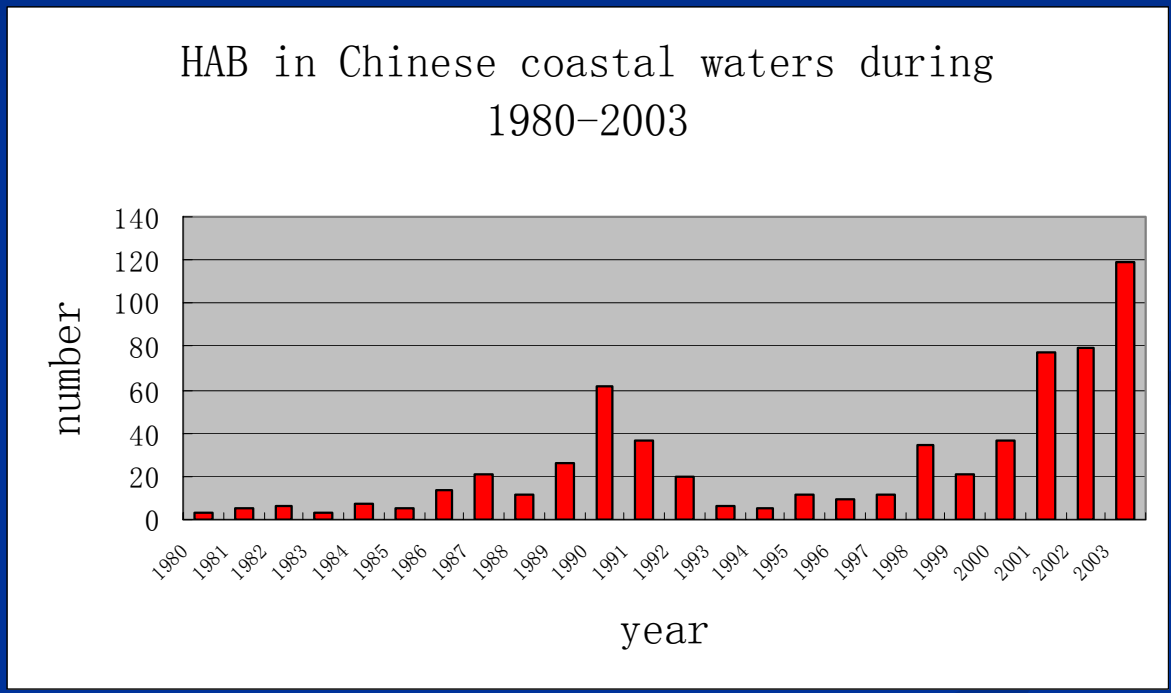
- 1930's: 1
- 1950's: 1
- 1960's: 2
- 1970's: 6
- 1980's: 30
- 1990's: 229
- 2000—2003： 303

There are 3 areas with frequent HAB occurrences

- Bohai Sea
- Yangtze River Estuary and coastal water of Zhejiang
- Coastal water of Guangdong

Increase of HAB in coastal water of China

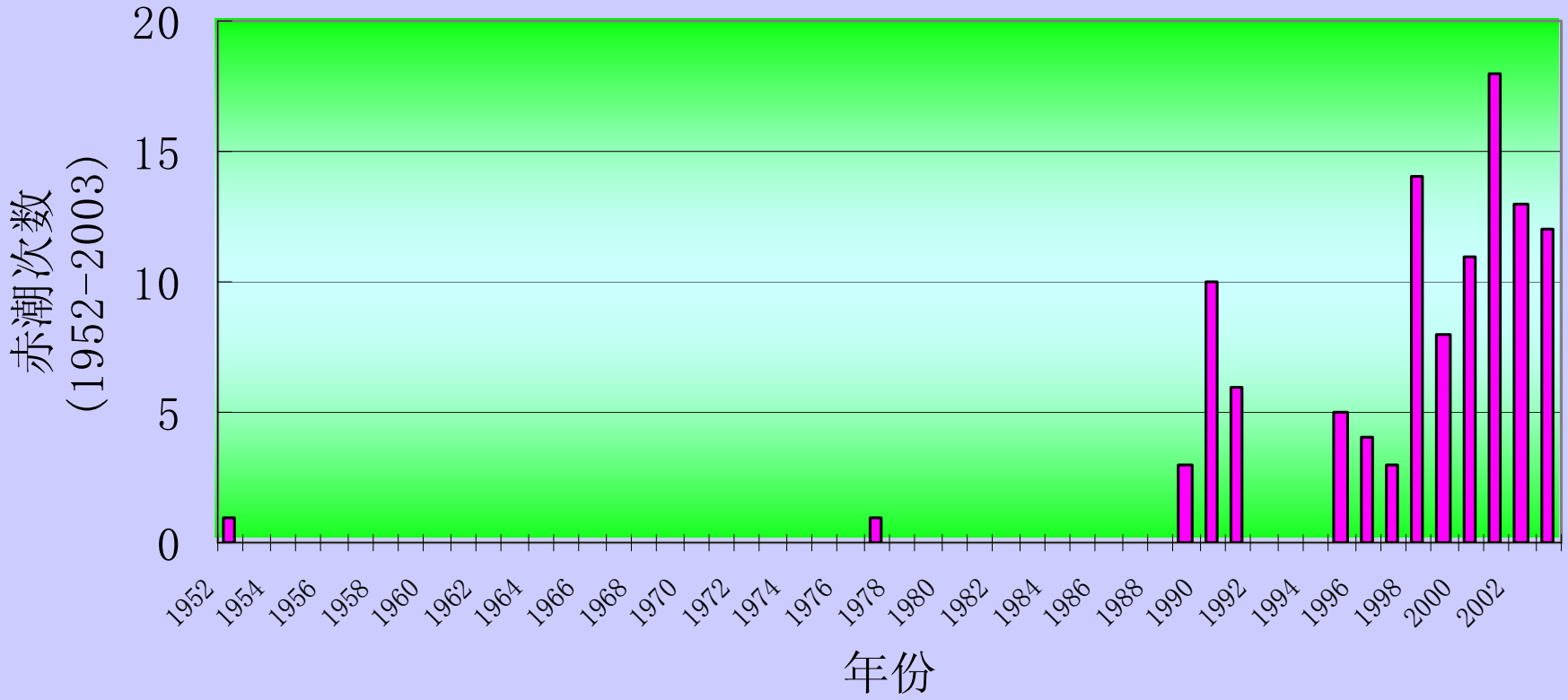
In new century, the occurrences of HAB has been increasing continuously, it is the second peak of HAB in China.



Till 2003, there were 647 HAB recorded, during 2001 to 2003, number of HAB was 275, accounting for 40% of total events recorded。

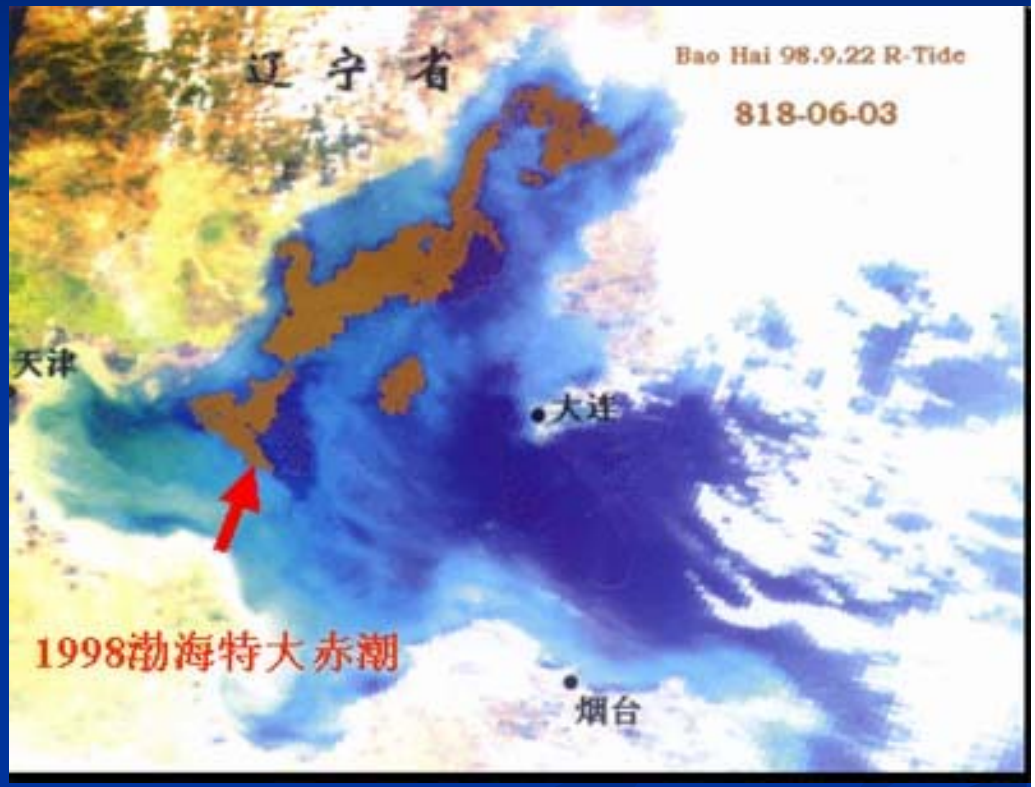
2. Some character of HAB in China Sea

HAB in Bohai Sea

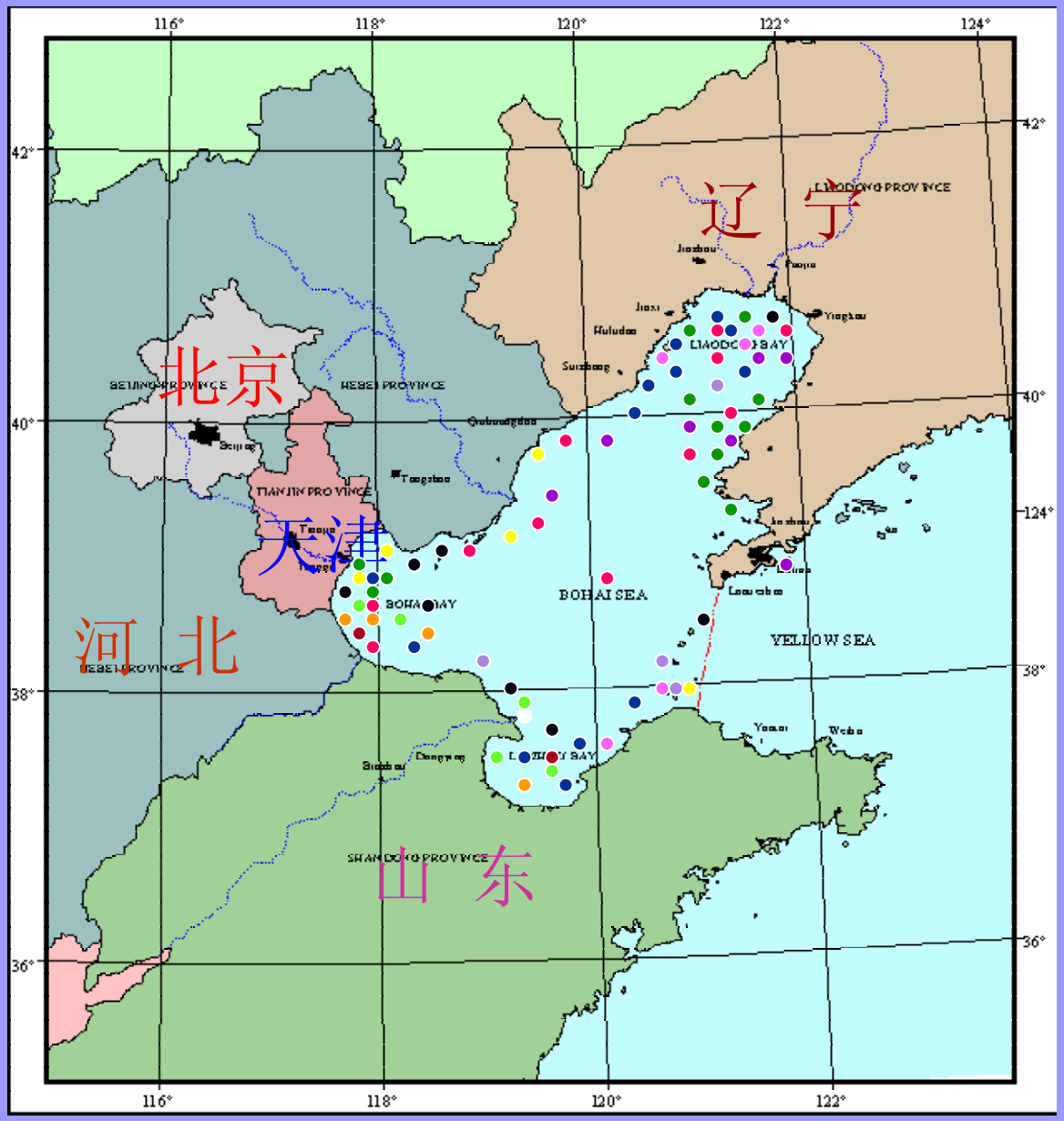


There were 109 HAB from 1952 to 2003

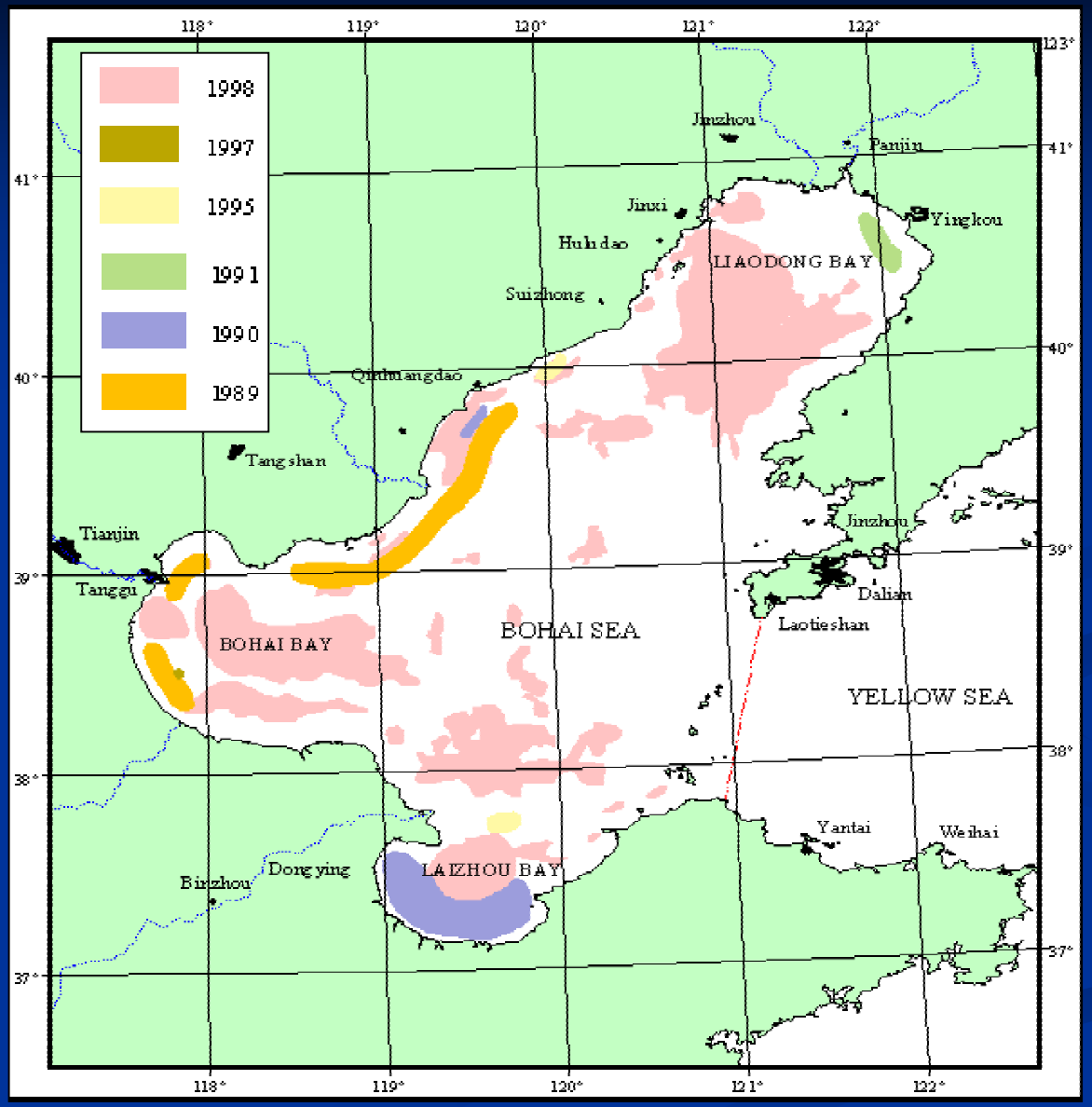
- Large in scale
  - —In 1952, thare was a HAB of *Noctiluca* with area of 1,460 km^2 in Estuary of Yellow River
  - —In 1998, a HAB of *Ceretium furca* in Liaodong Bay with a area of 5,000km^2
  - —In 1999, a HAB of *Noctiluca* in Liaodong Bay with an area of 6,300 km^2



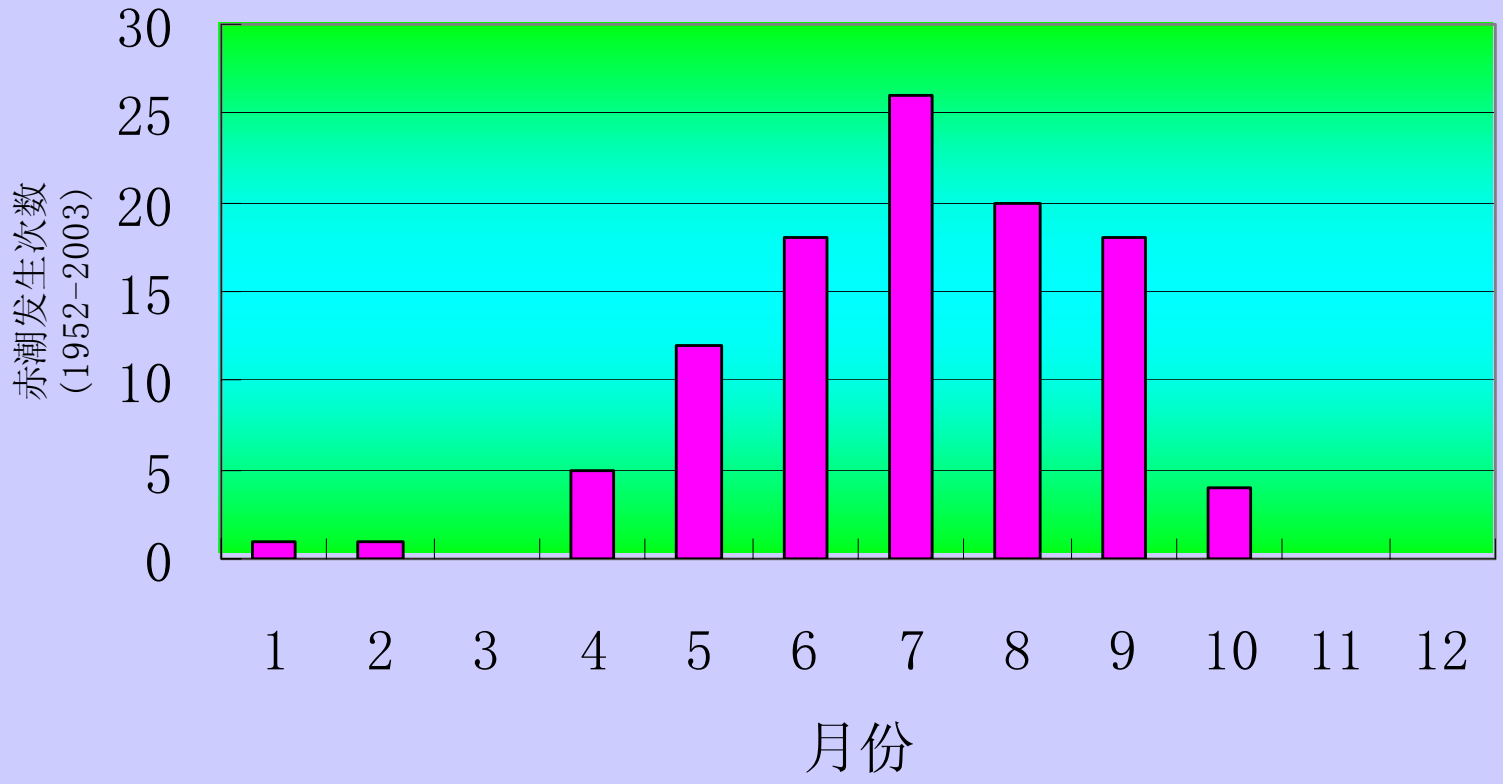
Most HAB located along the coast



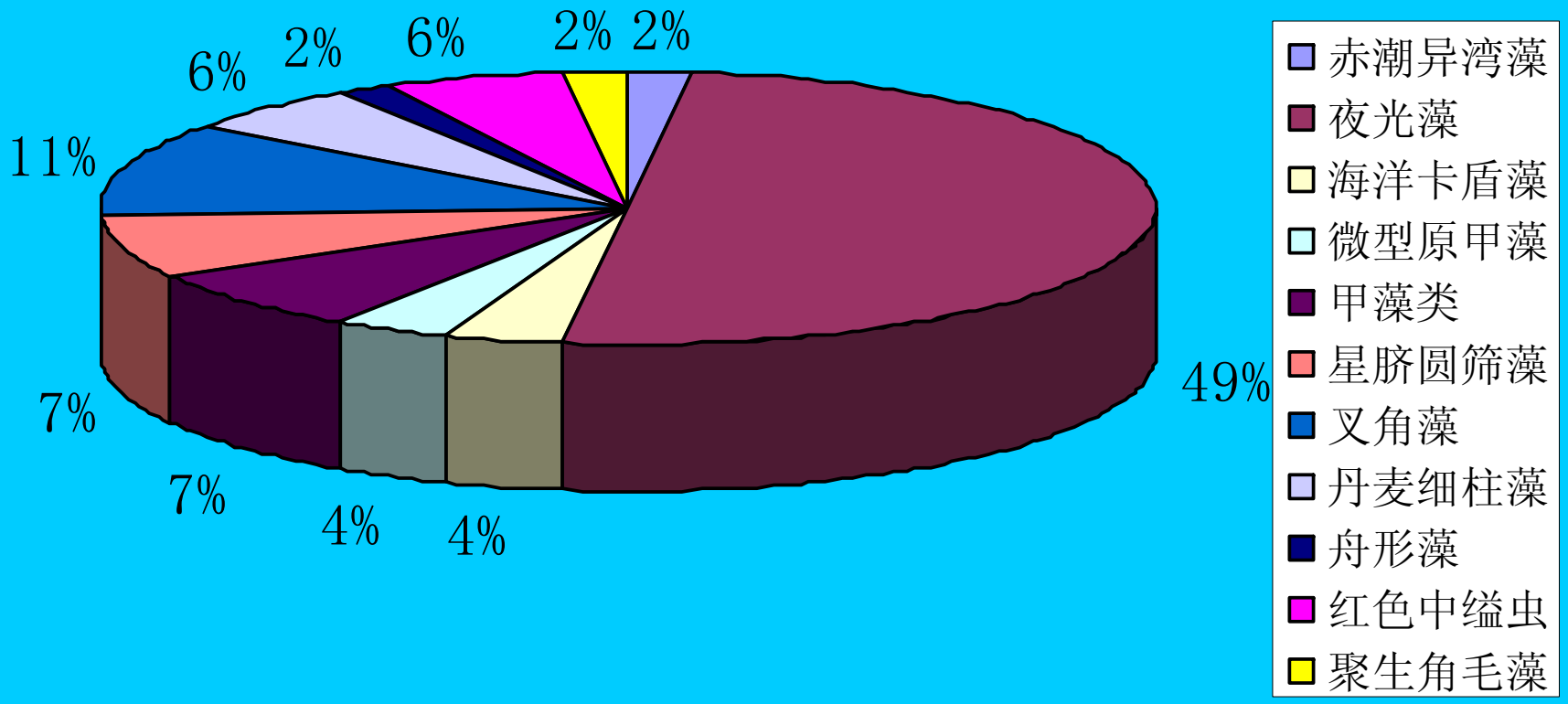
- 1952
- 1977
- 1989
- 1990
- 1991
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001


1998
1997
1995
1991
1990
1989
118°
119°
120°
121°
122°
123°
41°
40°
39°
38°
37°
Jinzhou
Panjin
Jinxi
Yingkou
Huludao
LIAODONG BAY
Suizhong
Qinhuangdao
Tangshan
Tianjin
Tanggu
Jinzhou
Dalian
Laotieshan
BOHAI BAY
BOHAI SEA
YELLOW SEA
Yantai
Weihai
Binzhou
Dongying
LAIZHOU BAY

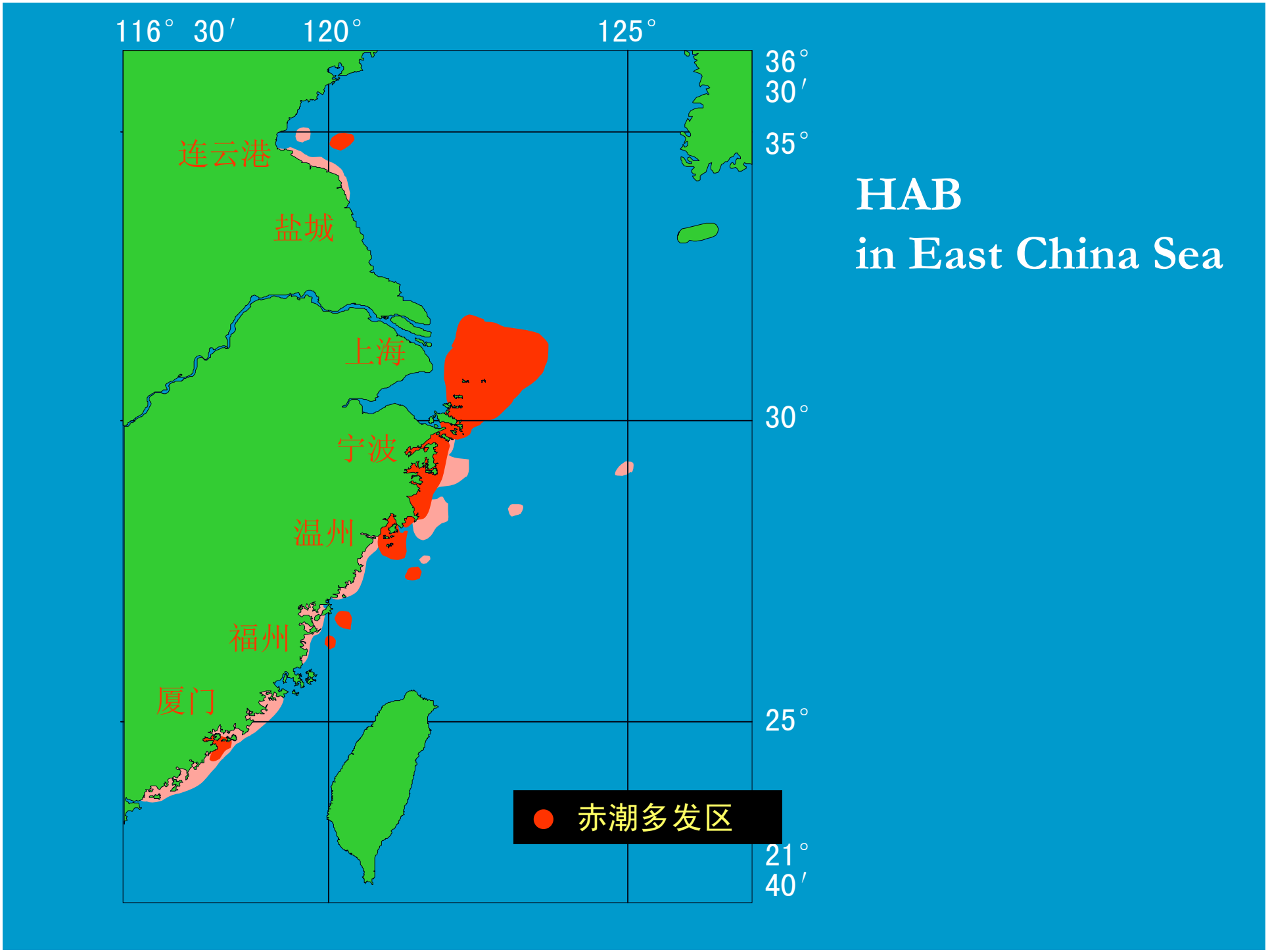
- **Time of HAB occurrence was June to Sept with peak in July**



- **Most causative species was nontoxic.**
- Main species include *Noctilluca scintillans* , *Ceretium farca* , *Mesodinium rublum* , ***Skeletonema costatum*** , *Chaetoceros socialis* , *Eucampia zodiacus*, *Leptocylindrus danicus* , *Chattonella marina*
- **Some are toxic** *Dinophysis fortii* , *Gymnodinium* sp



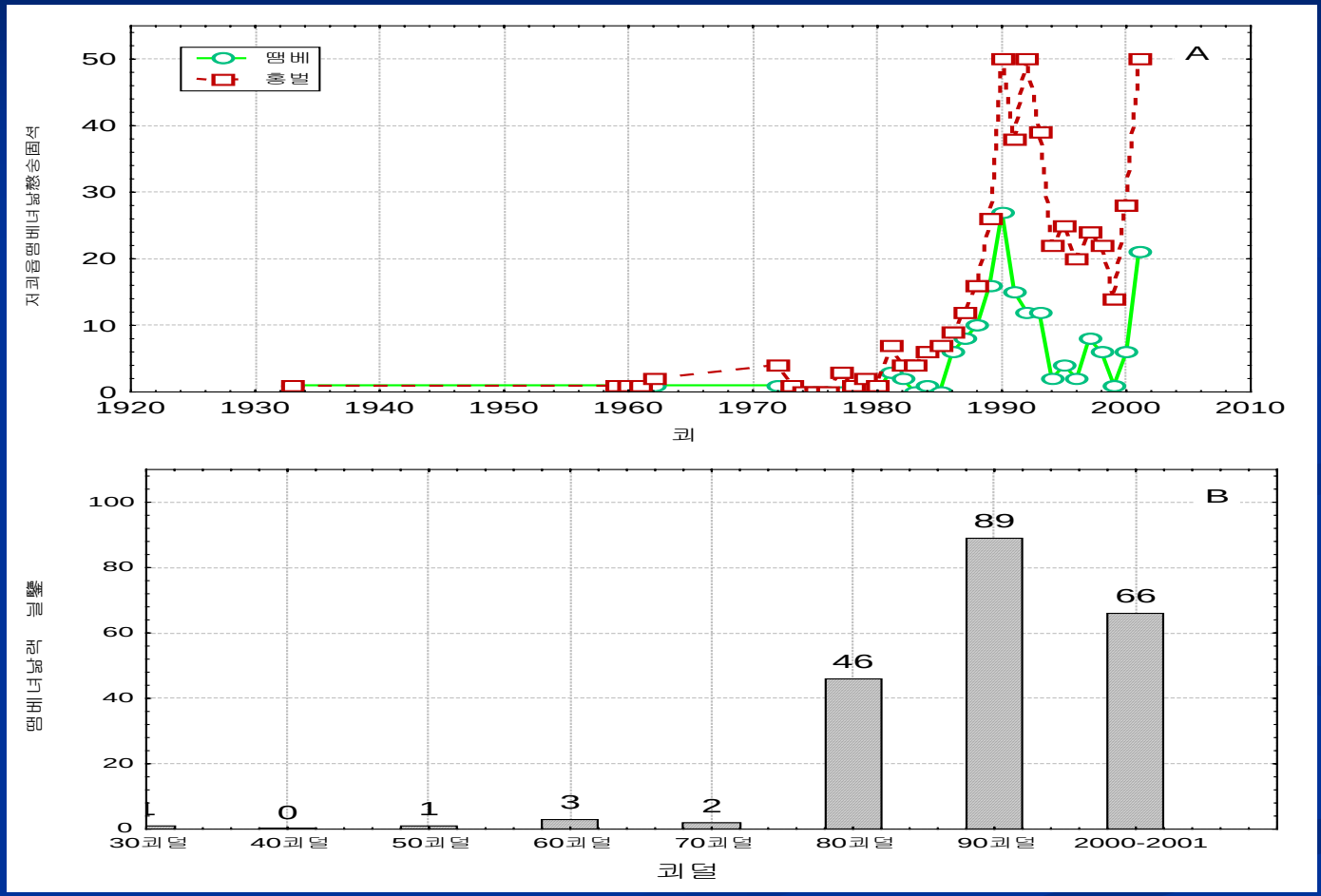
HAB of *Noctilluca scintillans* accounted for **50%**



HAB in East China Sea

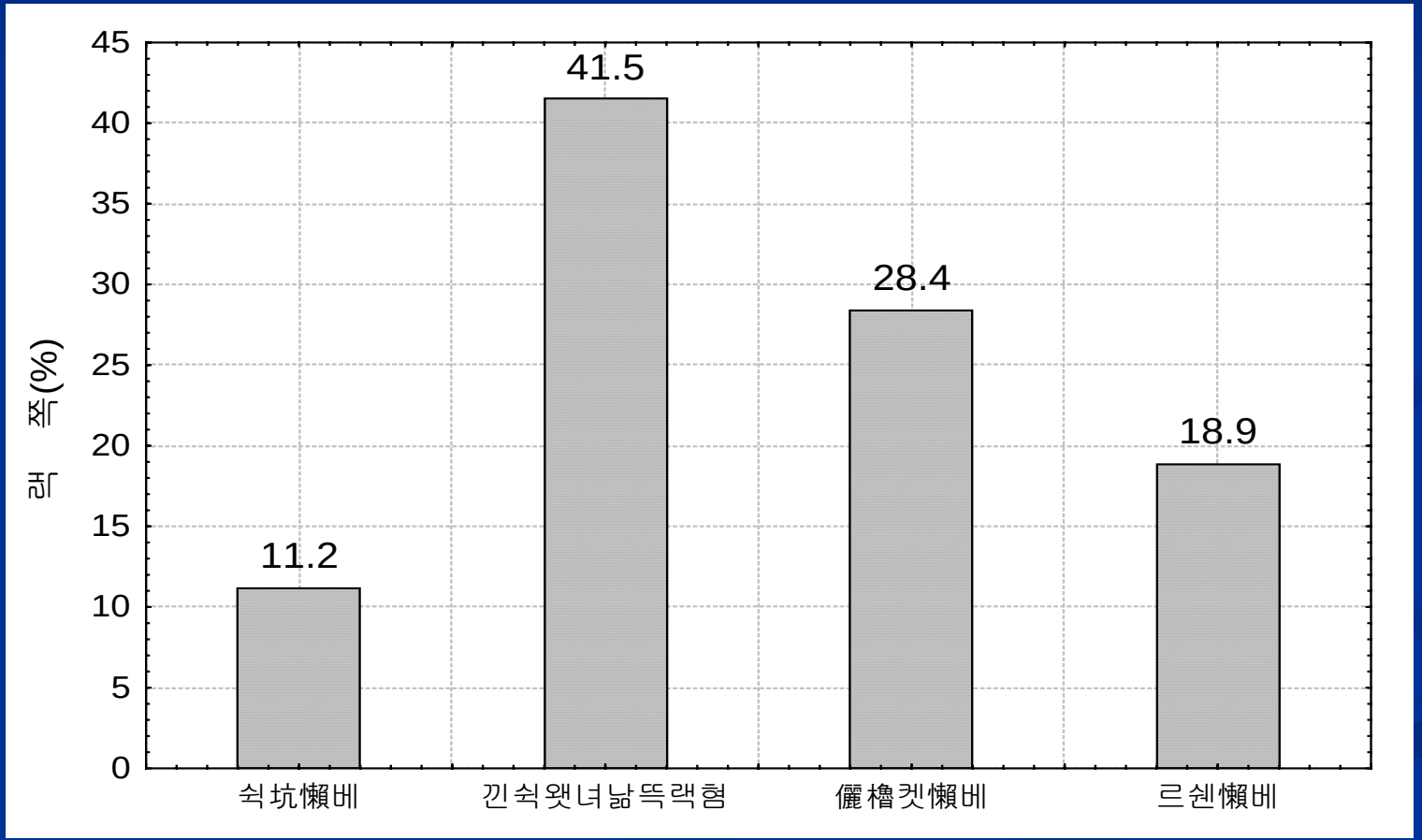
HAB in East China Sea

- Rapid increase

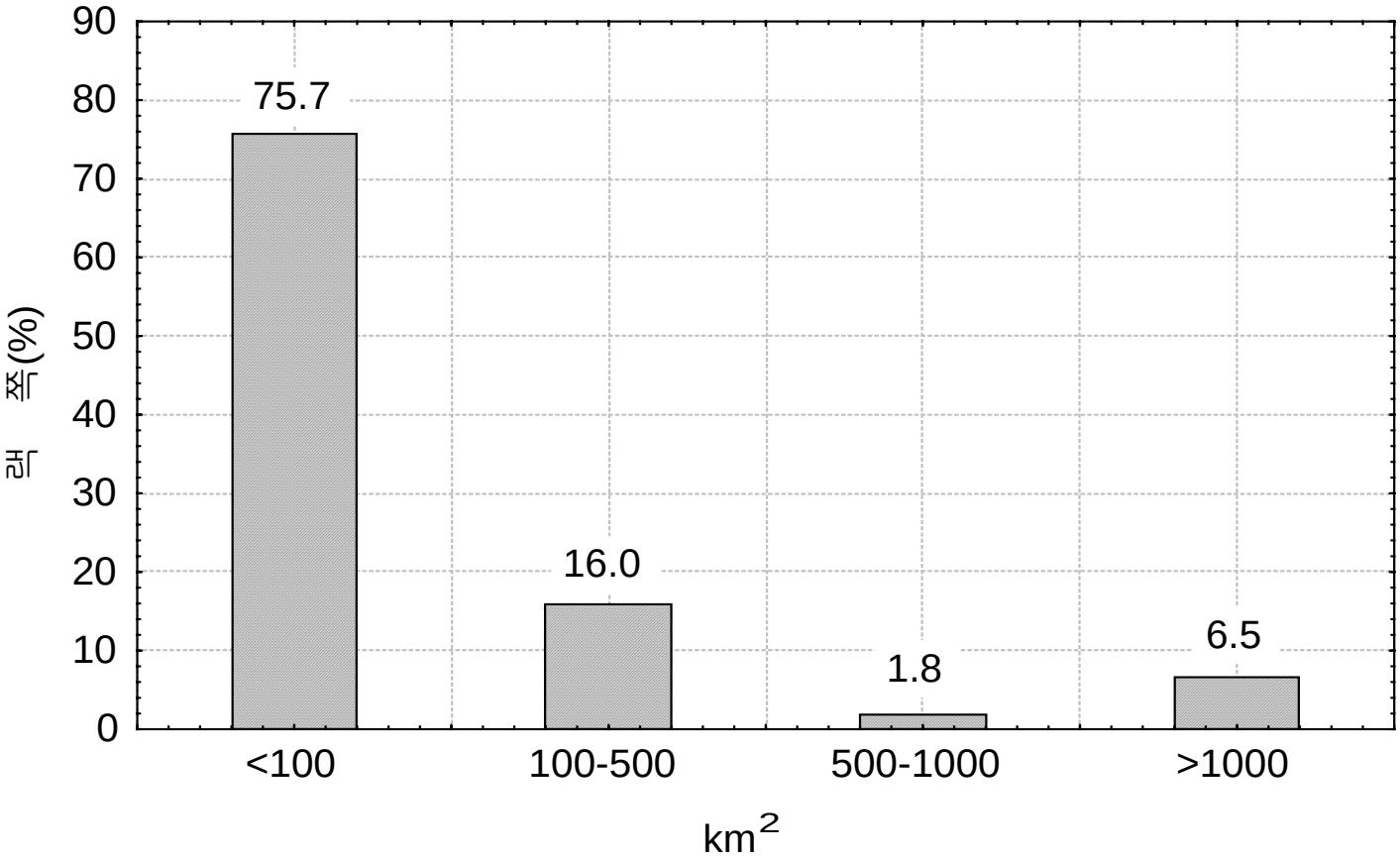


In 2002, there were 51 cases of HAB， in 2003 ， 86

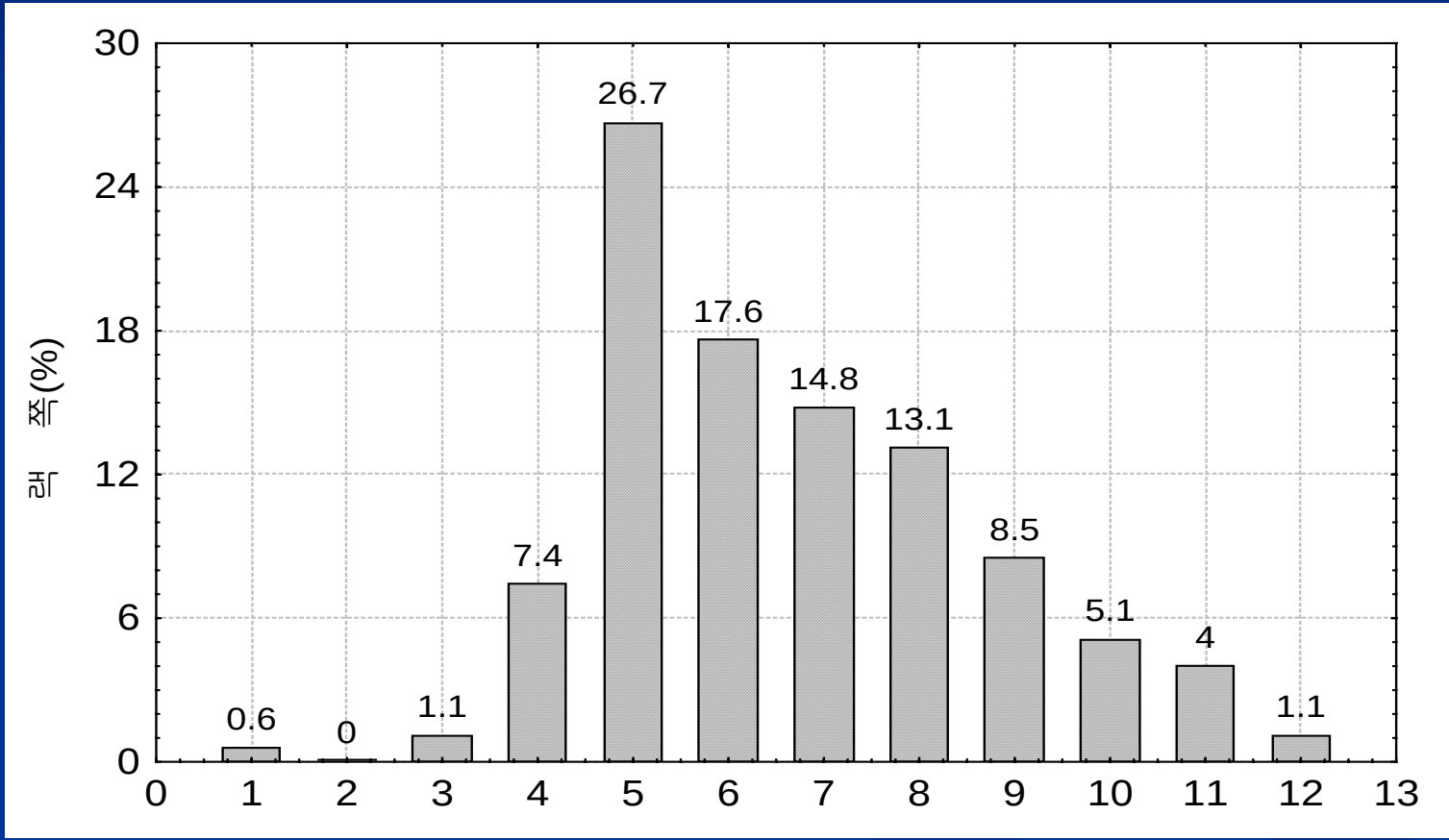
area mainly in Estuary of Yangtze And coastal water of Zhejiang



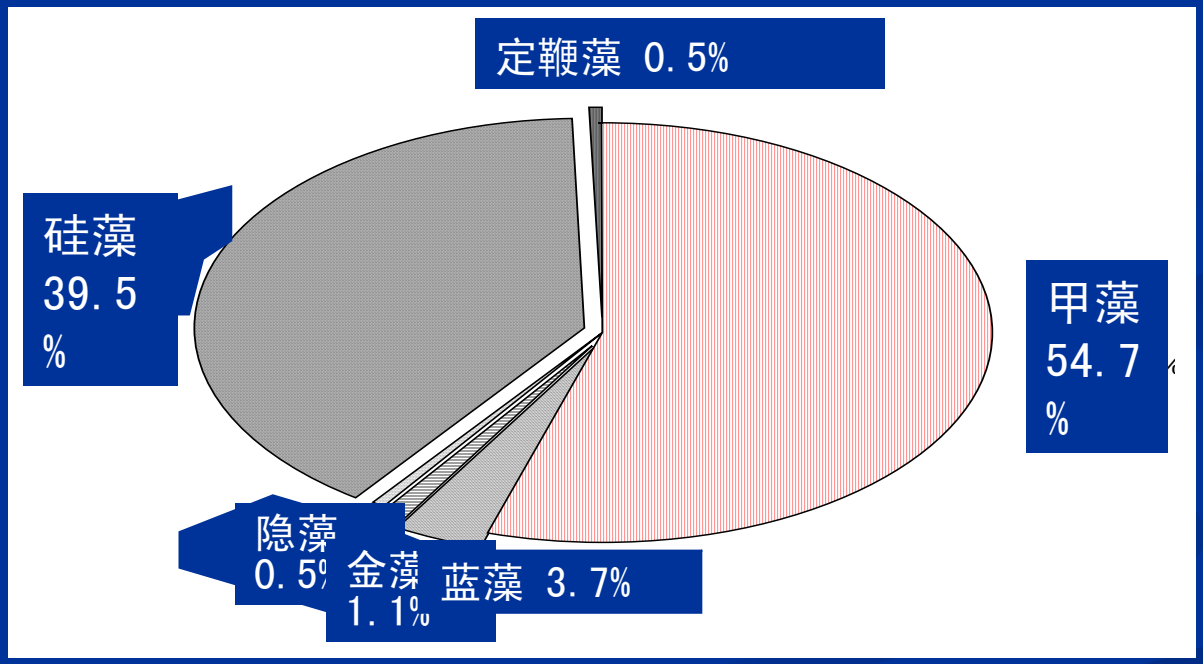
- scale is increasing



Peak in May


30
24
18
12
6
0
퍼센트(%)
26.7
17.6
14.8
13.1
8.5
7.4
5.1
4
1.1
0.6
0
1.1
0 1 2 3 4 5 6 7 8 9 10 11 12 13

There were 23 HAB organism formed HAB , accounding for 41.9% of total。

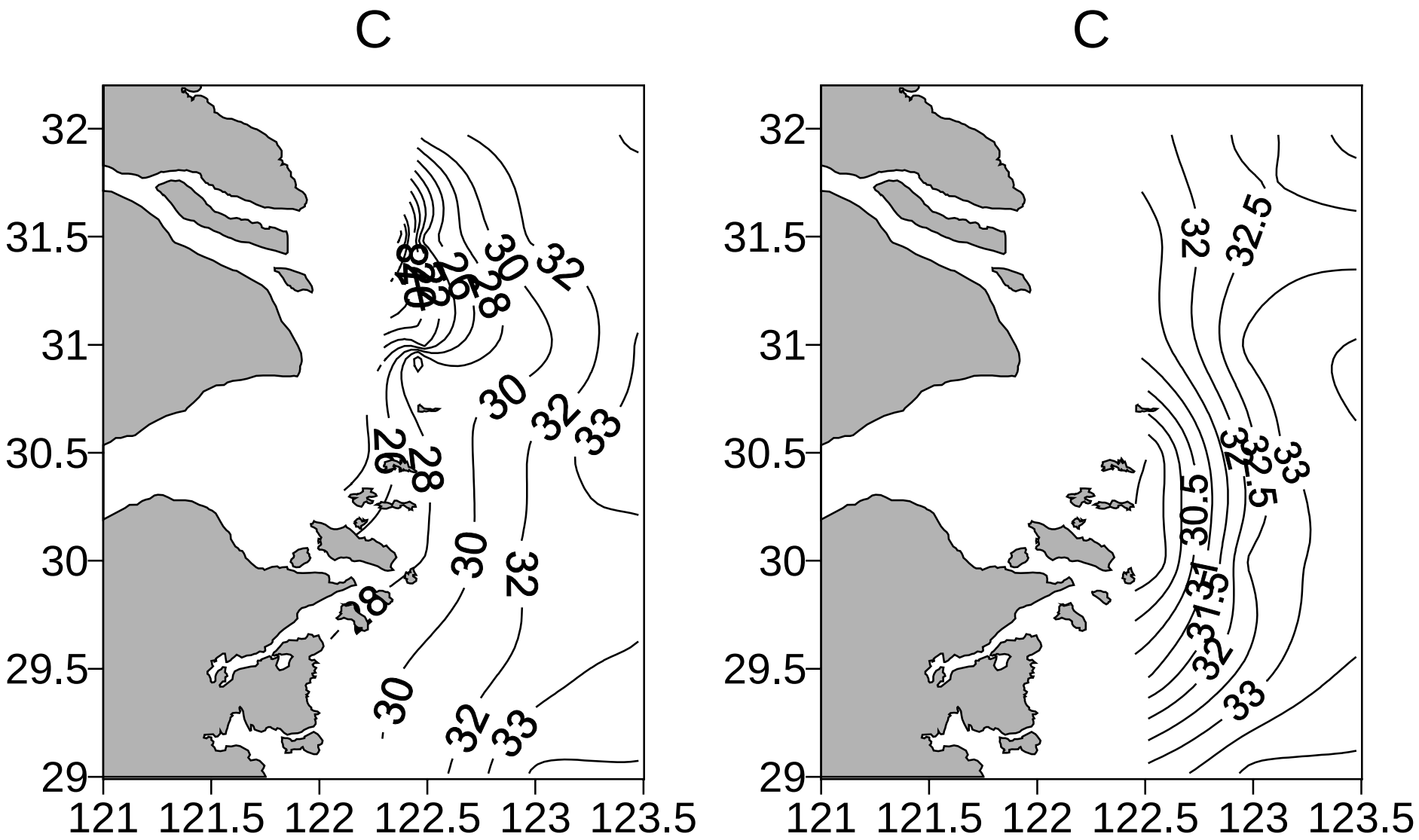


Since 2000， HAB of *Prorocentrum dentatum (donghaiense)* happened every year in May with area *over* 1,000 km^2 . In 2004, it reached 10,000 km^2， very rare in the world, worth study

time	location	area	Causative species
2000年05月03~24日	舟山中街列岛海域	7000	东海原甲藻/亚历山大藻
2001年05月10~17日	长江口外花鸟山邻近海域	1000	东海原甲藻
2001年05月10~13日	舟山群岛中街山列岛海域	3000	东海原甲藻/亚历山大藻
2002年05月3~11日	舟山中街山列岛海域	800	东海原甲藻/亚历山大藻
2002年05月17~19日	嵊山海域	900	东海原甲藻/中肋骨条藻/红色中缢虫
2003年5月4~11日	中街山列岛附近海域	3000	东海原甲藻
2003年6月25~30日	长江口外海域	1000	东海原甲藻/中肋骨条藻
2004年5月3-22日	浙江中部南部海域	10000	东海原甲藻/亚历山大藻

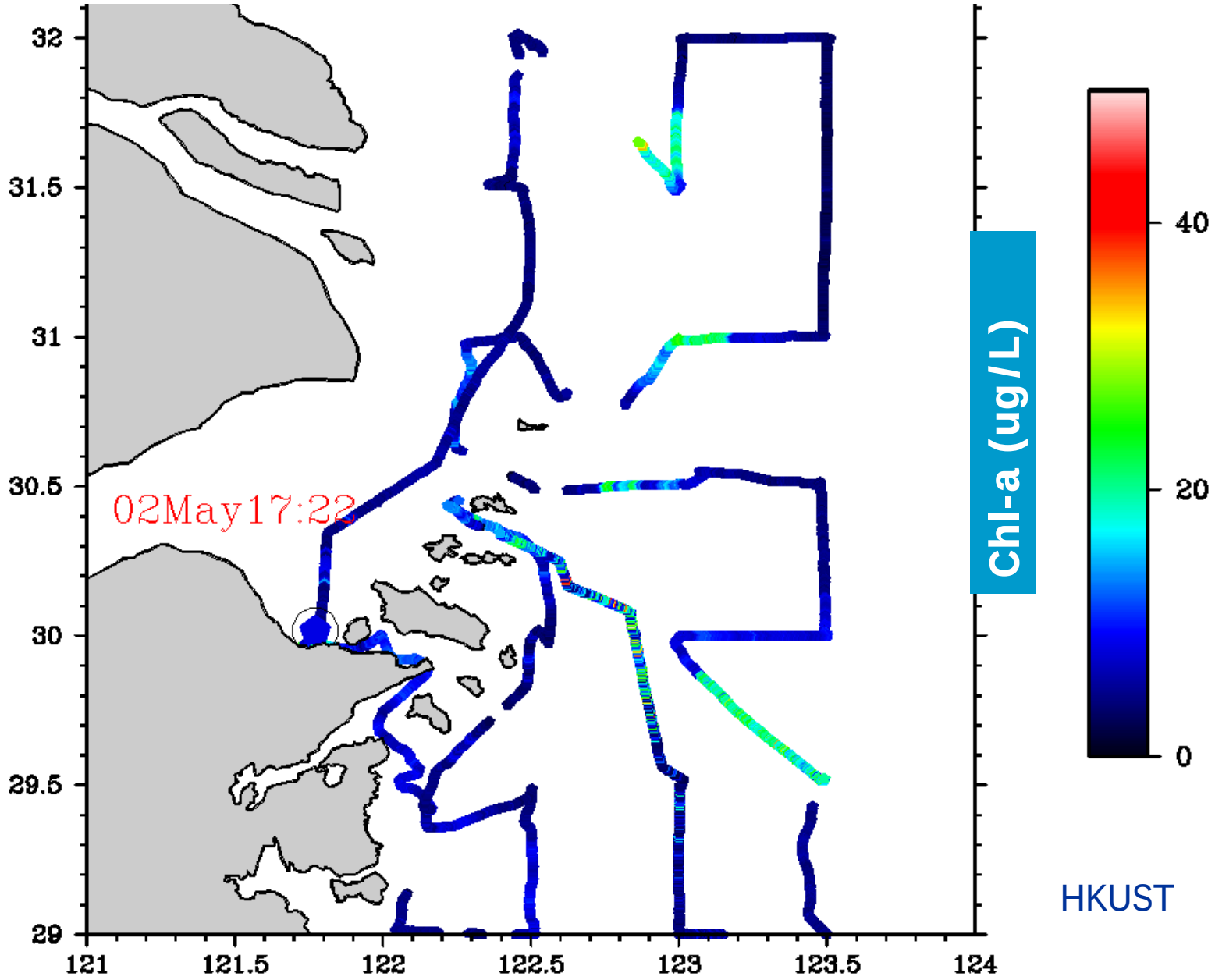

Group Photo with the crew

Photo after a safety exercise

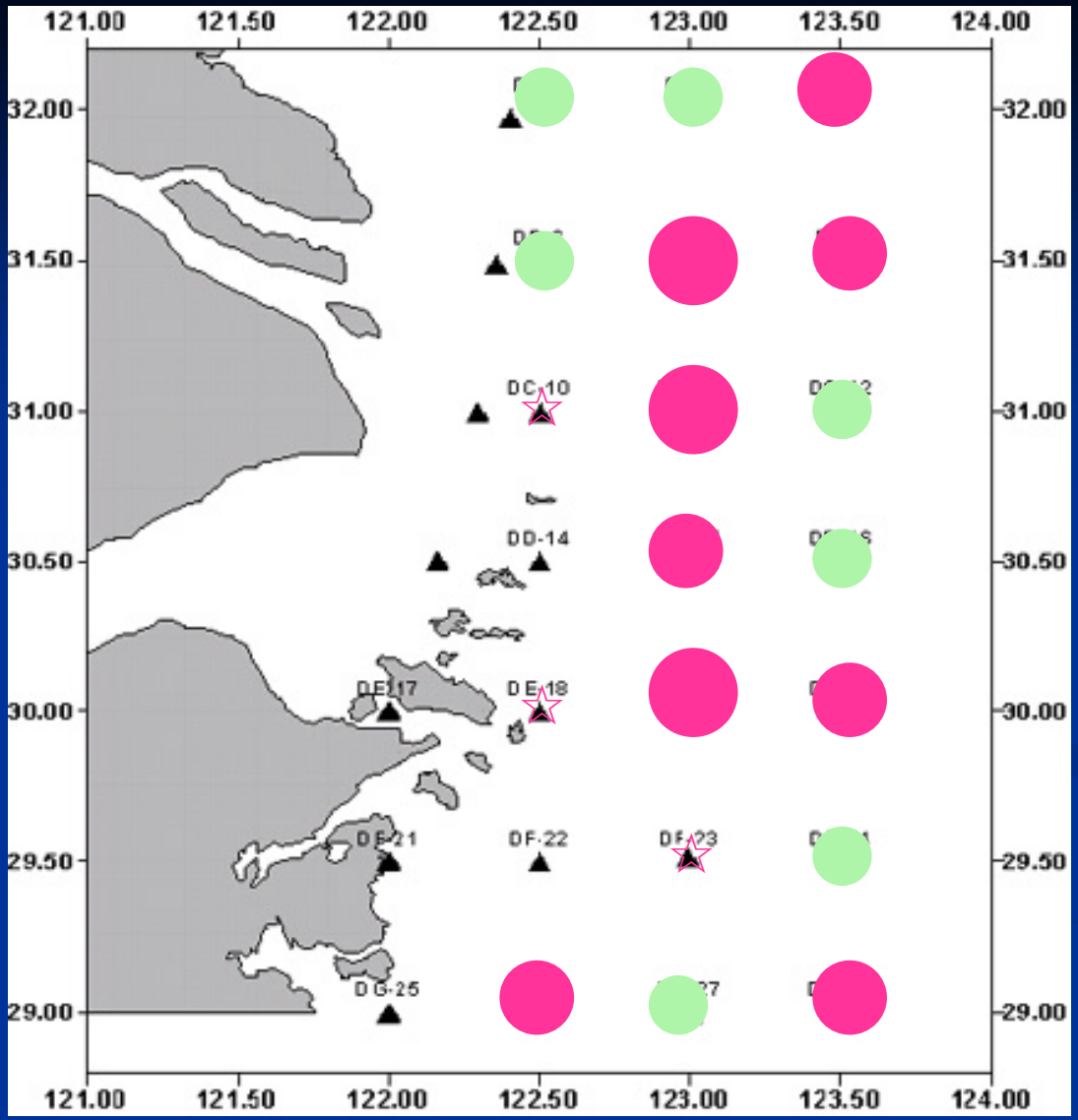


Salinity in May 2002

大面调查轨迹和表层叶绿素分布



HKUST



Present

〈10^3

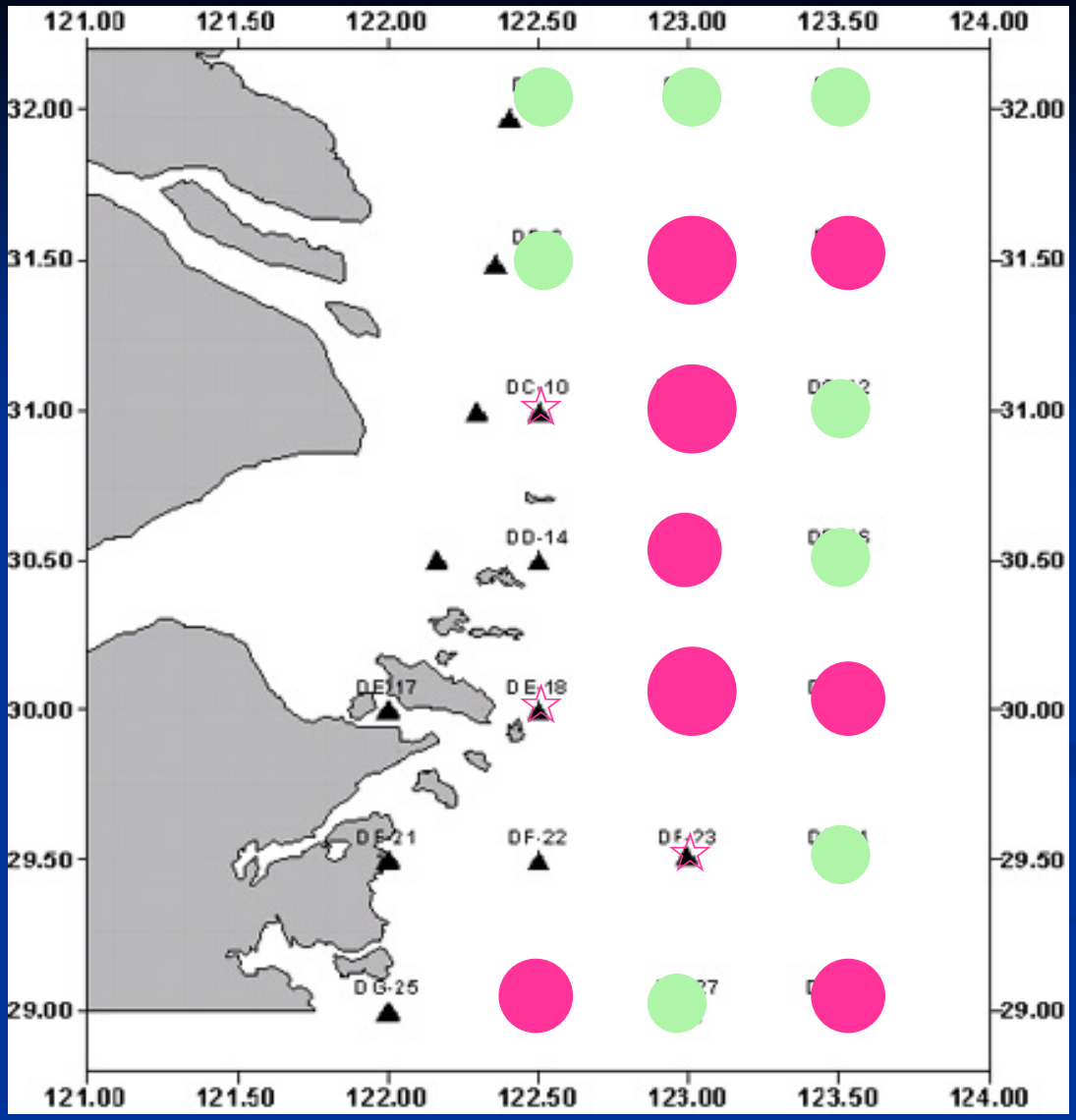
10^3～10^4

10^4～10^5

10^5 ～10^6

10^6 ～10^7

Distribution of total dinos in April 2002



Present

〈10^3

10^3～10^4

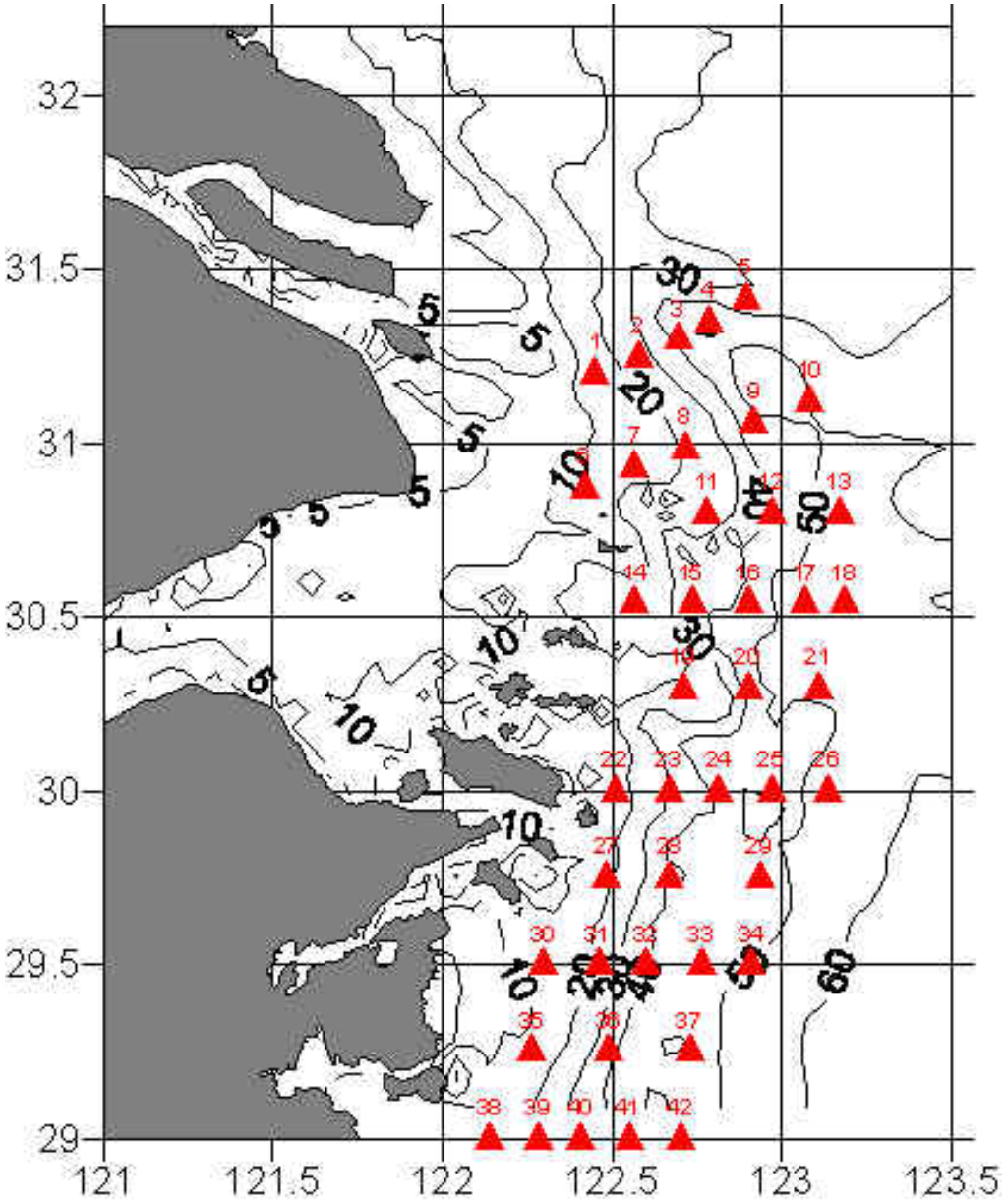
10^4～10^5

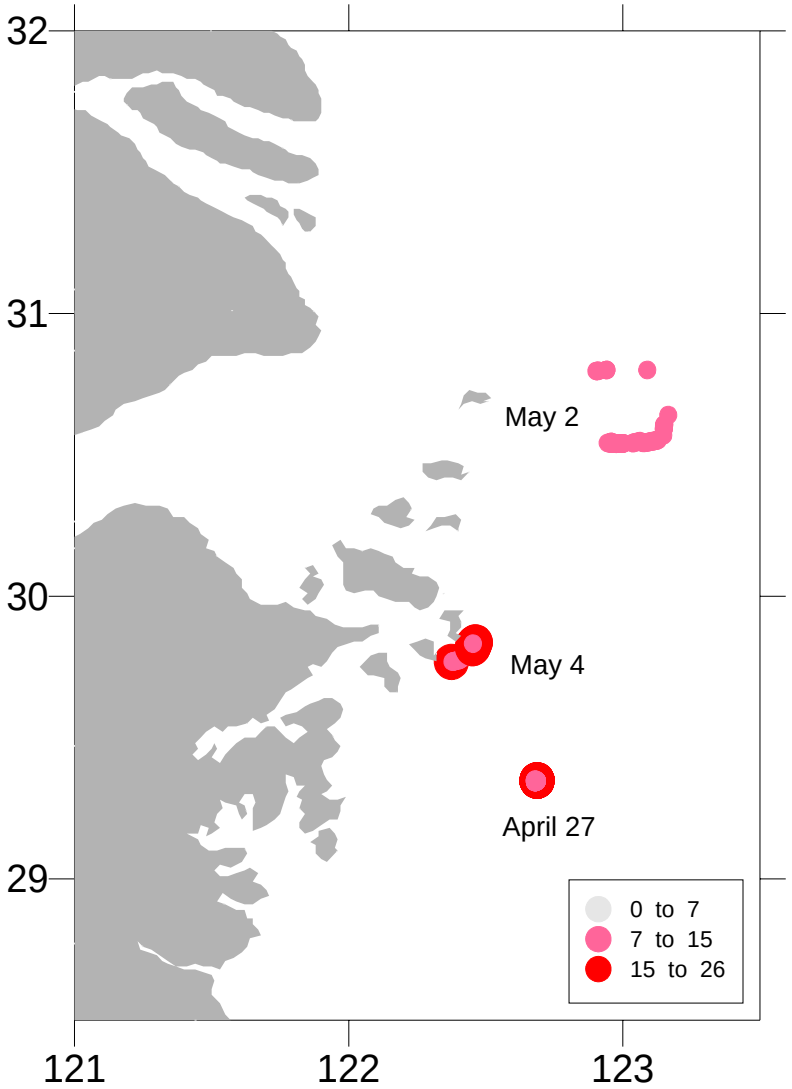
10^5～10^6

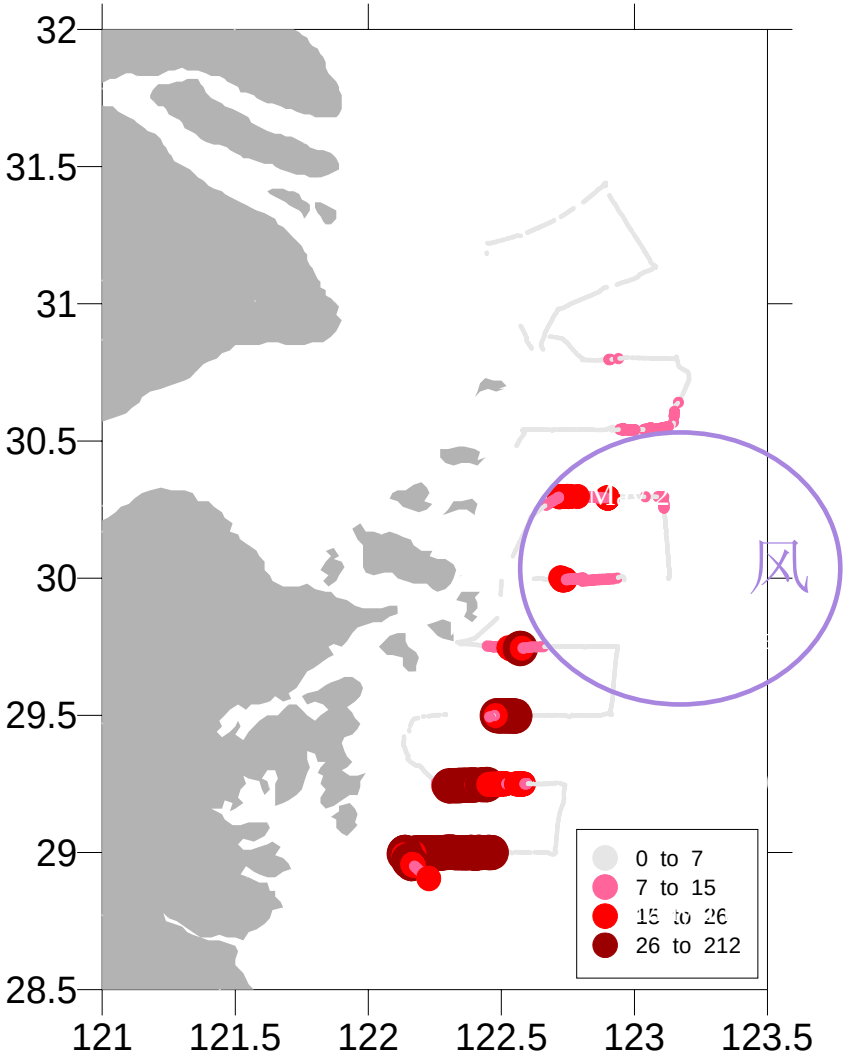
10^6～10^7

〉10^7

Distribution of *Prorocentrum donghaiense* in April 2002


32
31.5
31
30.5
30
29.5
29
121
121.5
122
122.5
123
123.5
Survey station
in May 2003





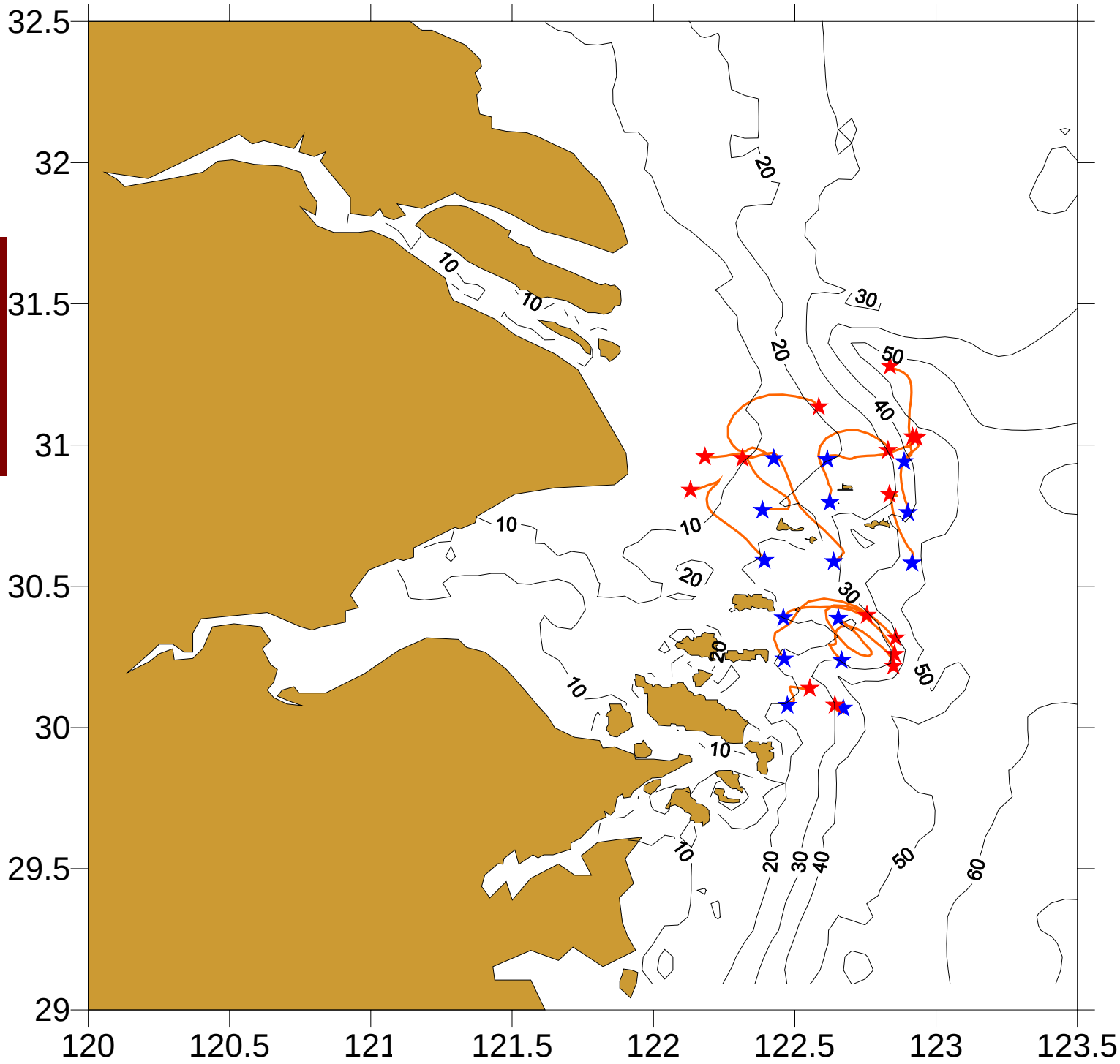
April

May

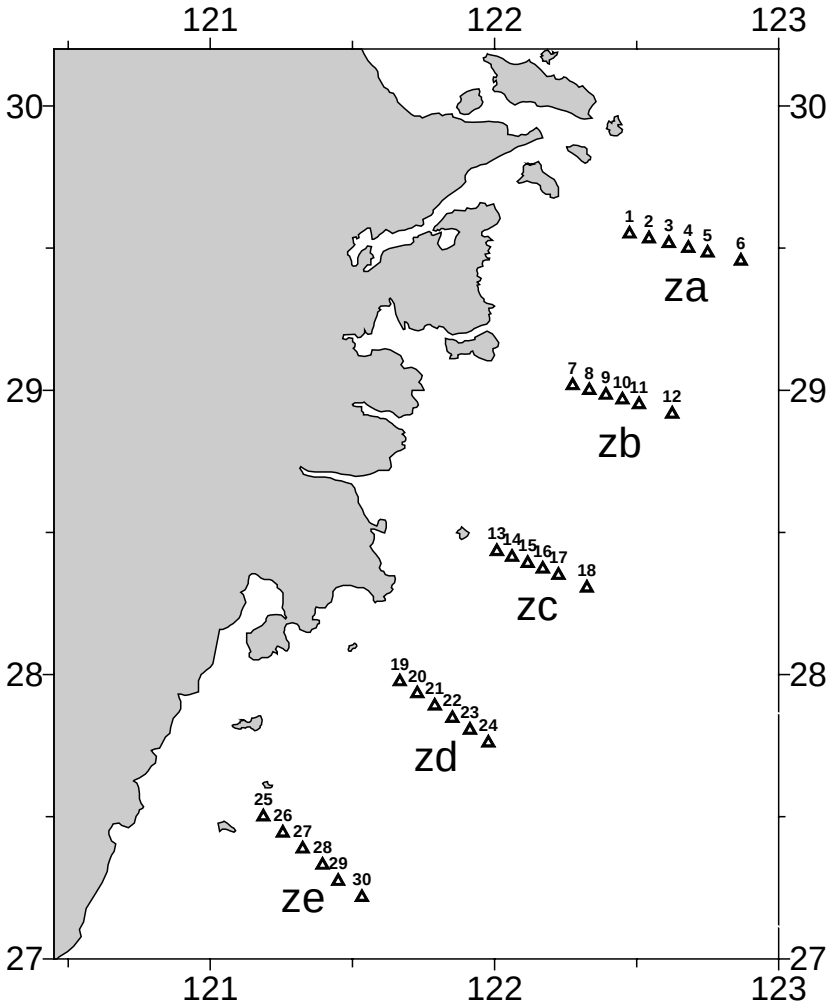
Chl-a in April and May, 2003

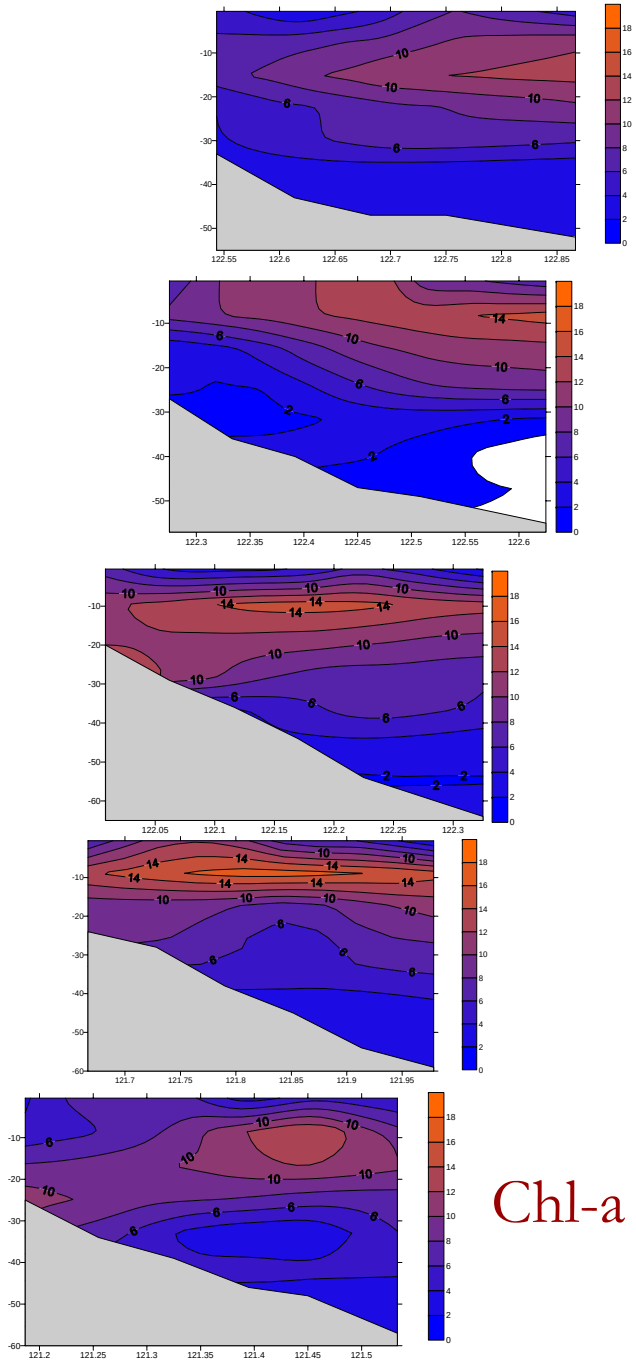
Barotropic
Tides only

True Bathy.



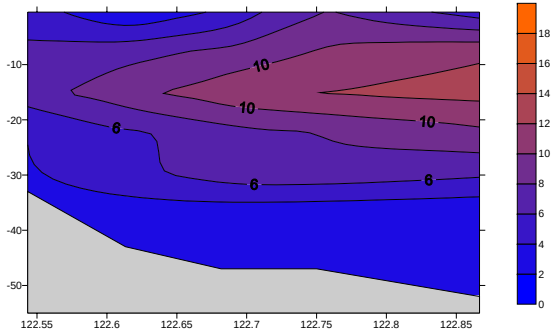
Cruise in April, 2004

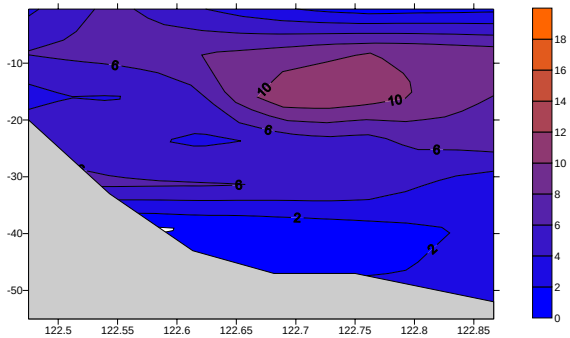


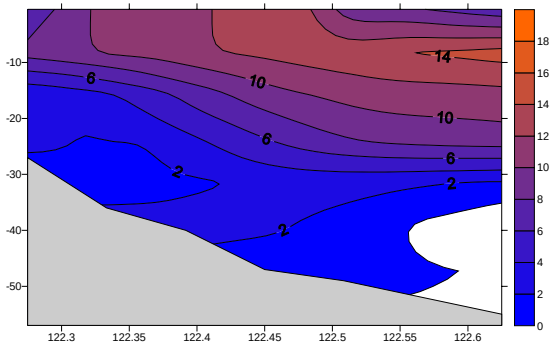


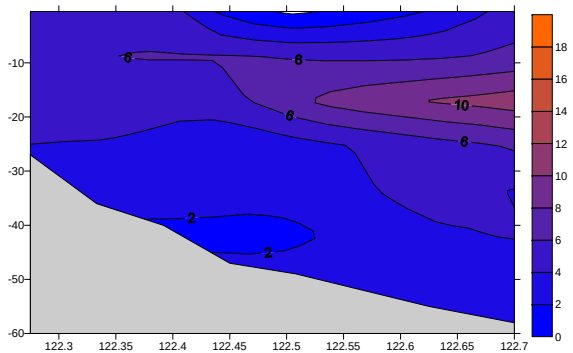
Chl-a

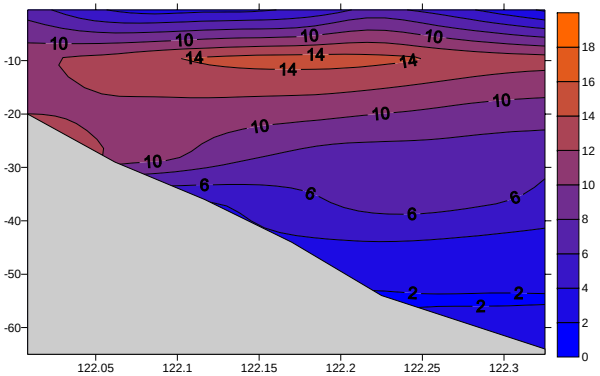
Chl-a in April in East China Sea

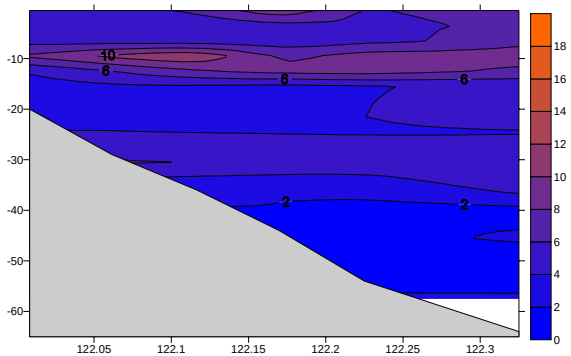




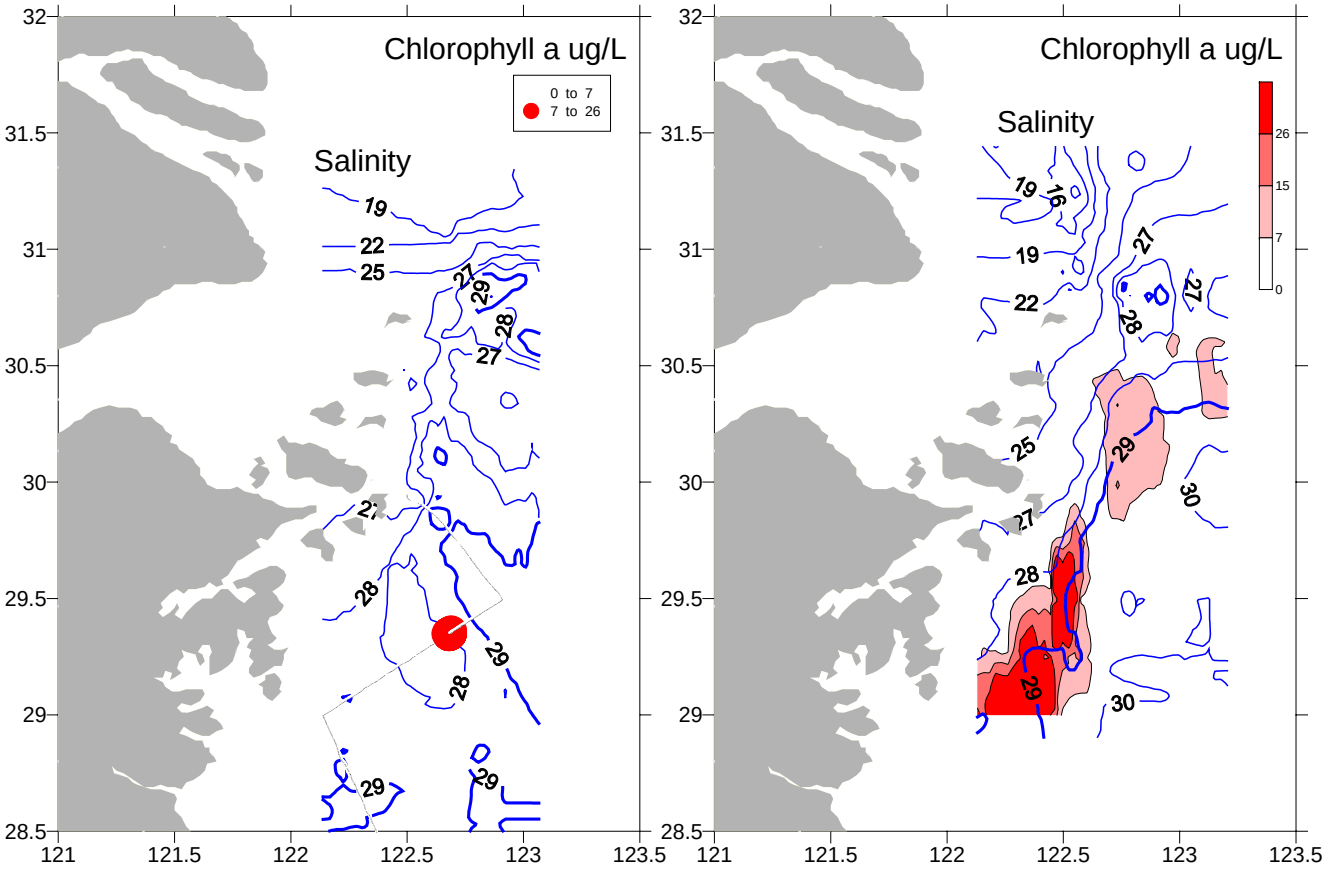






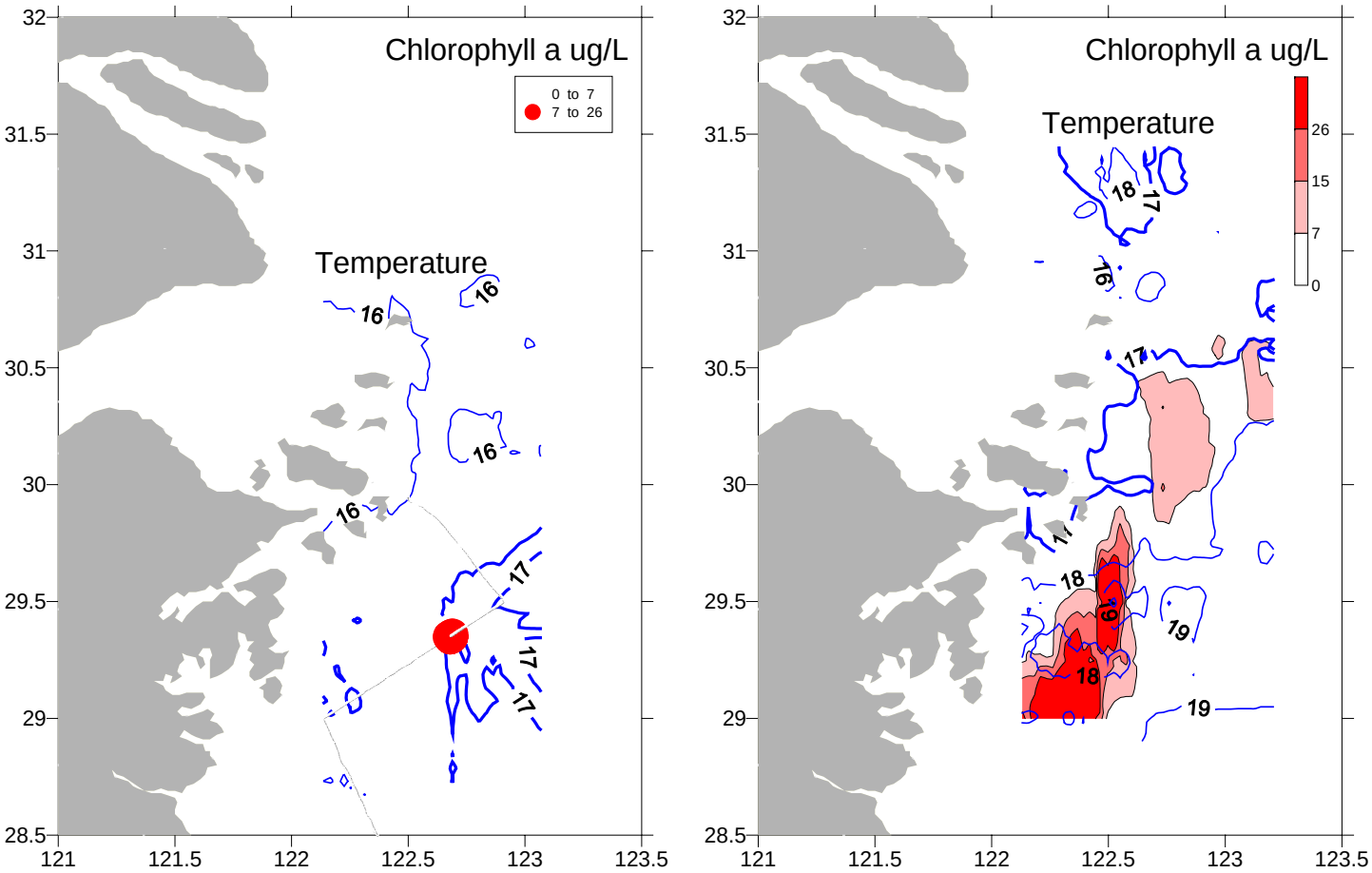


Prorocentrium and salinity



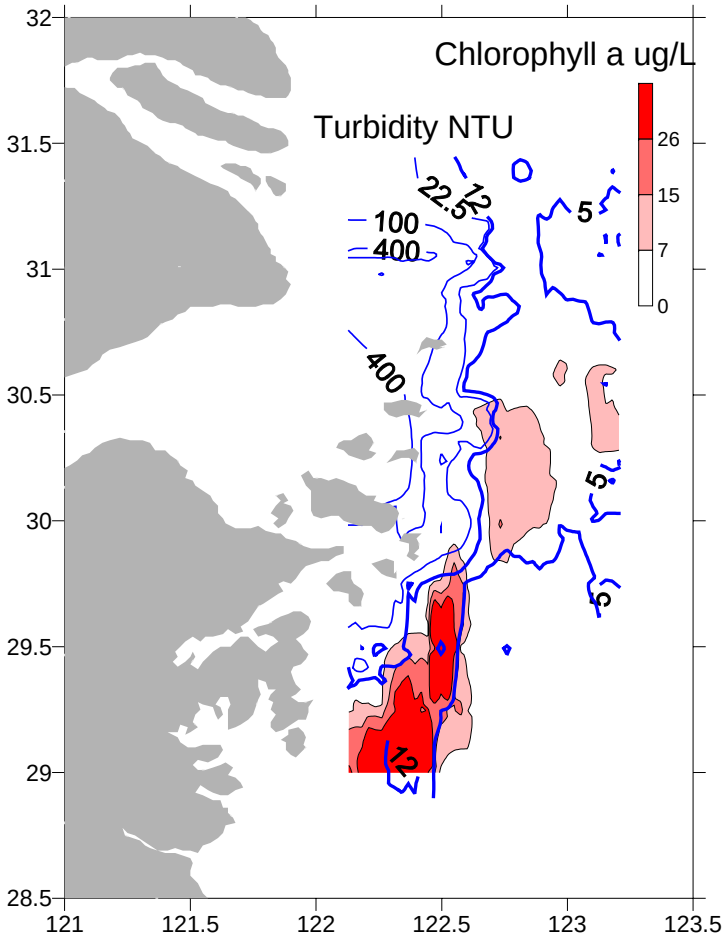
Red tide of Prorocentrium in salinity between 28~30

Prorocentrium and temperature

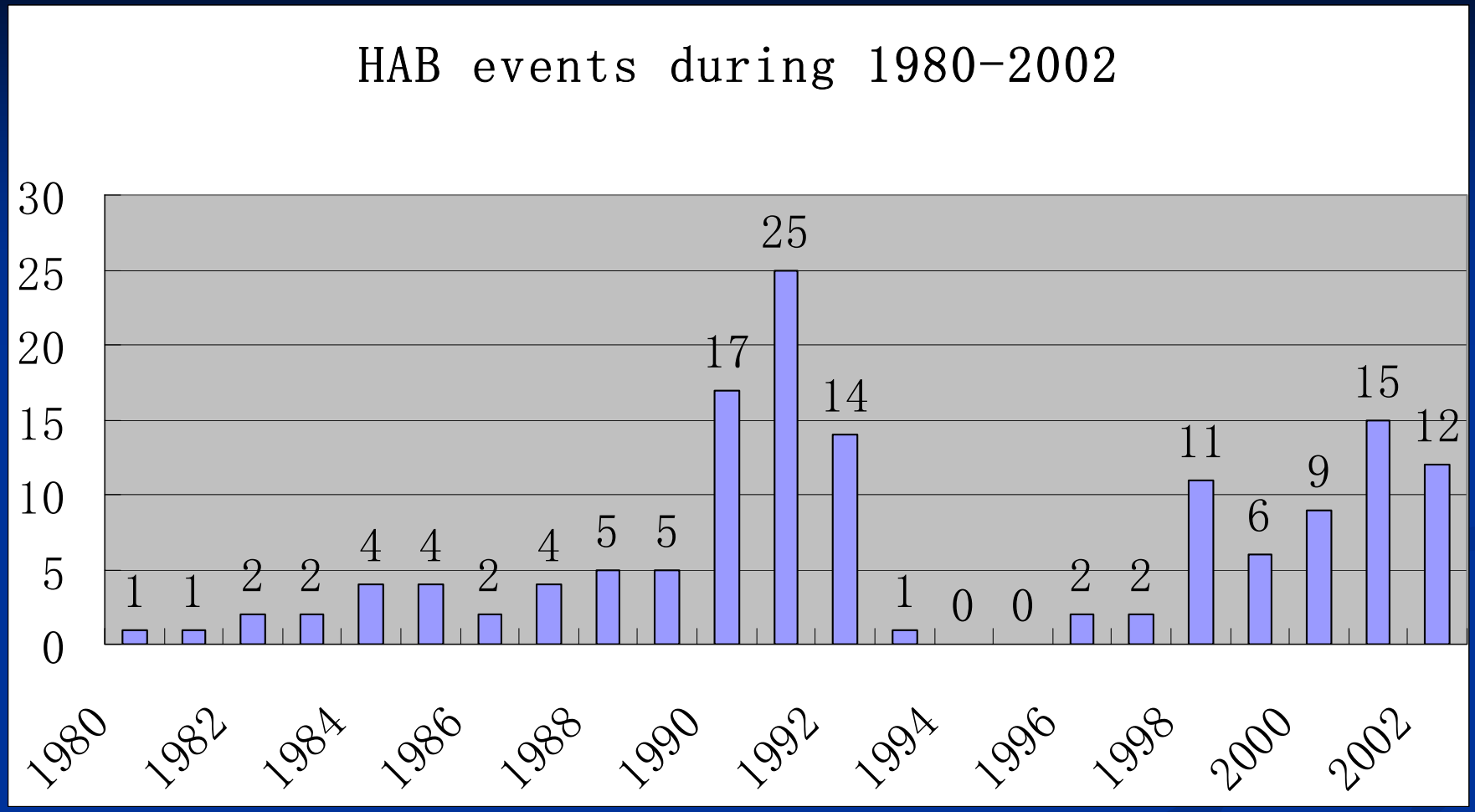


Red tide of Prorocentrium in sea water temperature above17℃

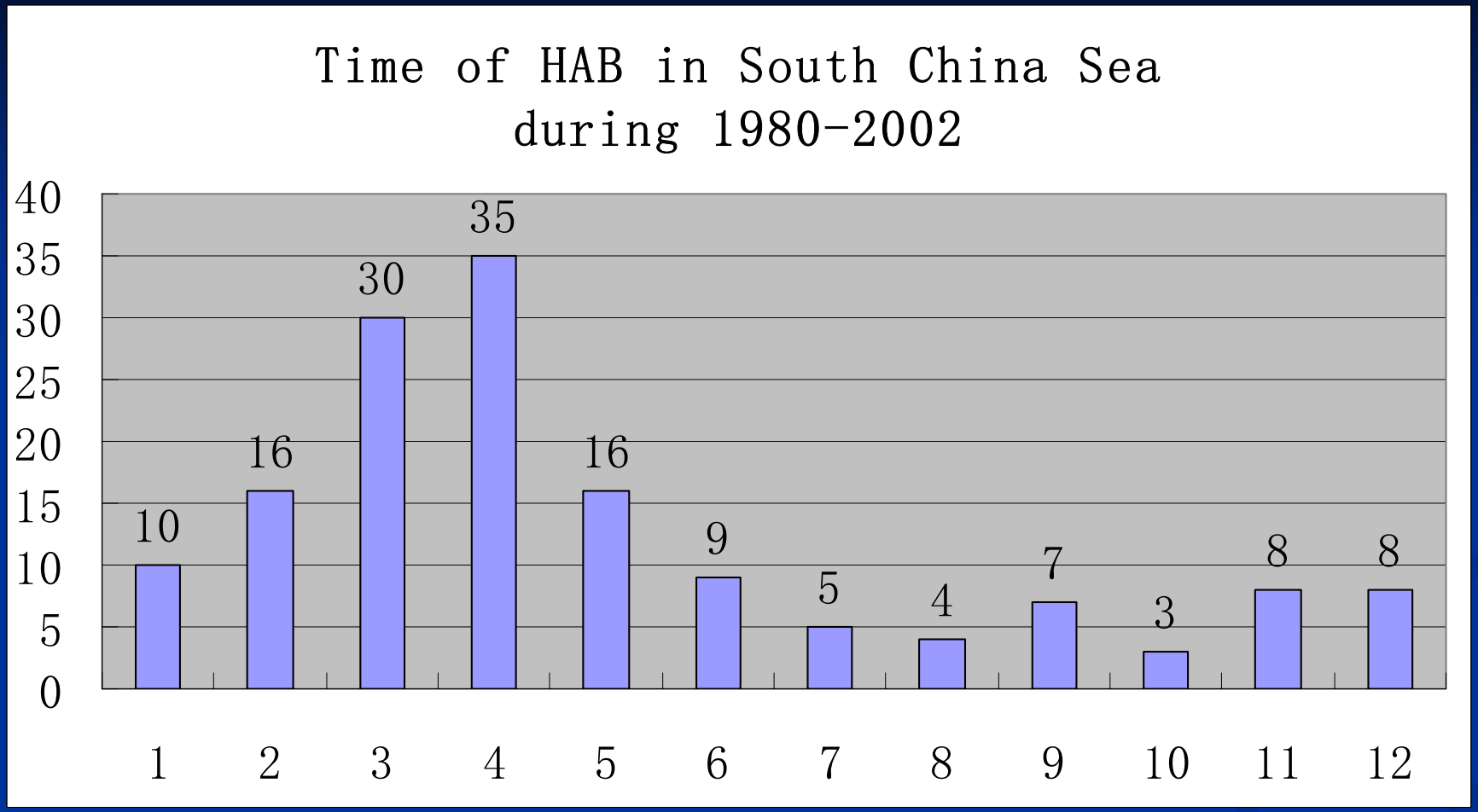
Prorocentrium and turbidity



HAB in South China Sea

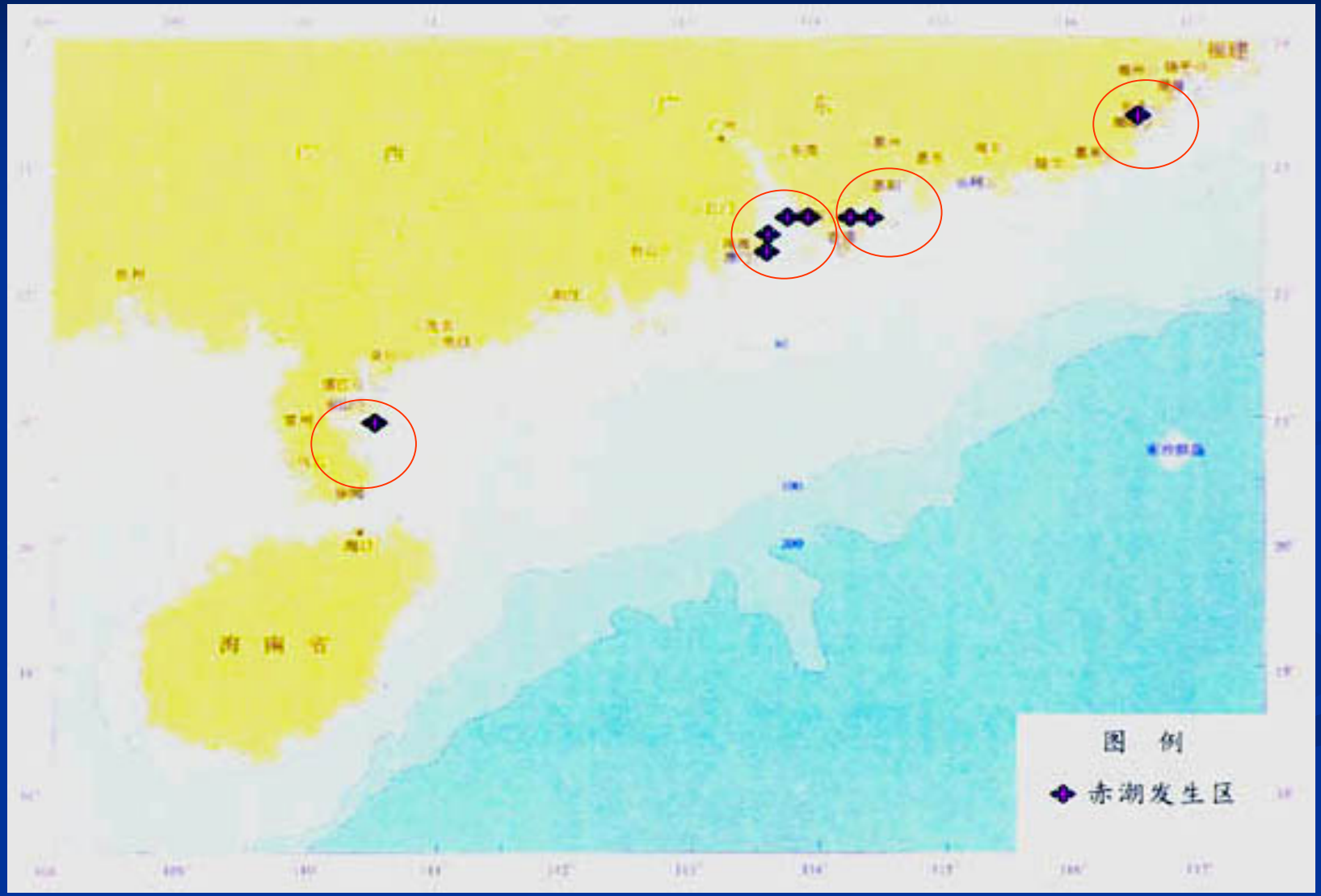


From 1980 to 2002，there were 145 cases of HAB(not including Hong Kong)

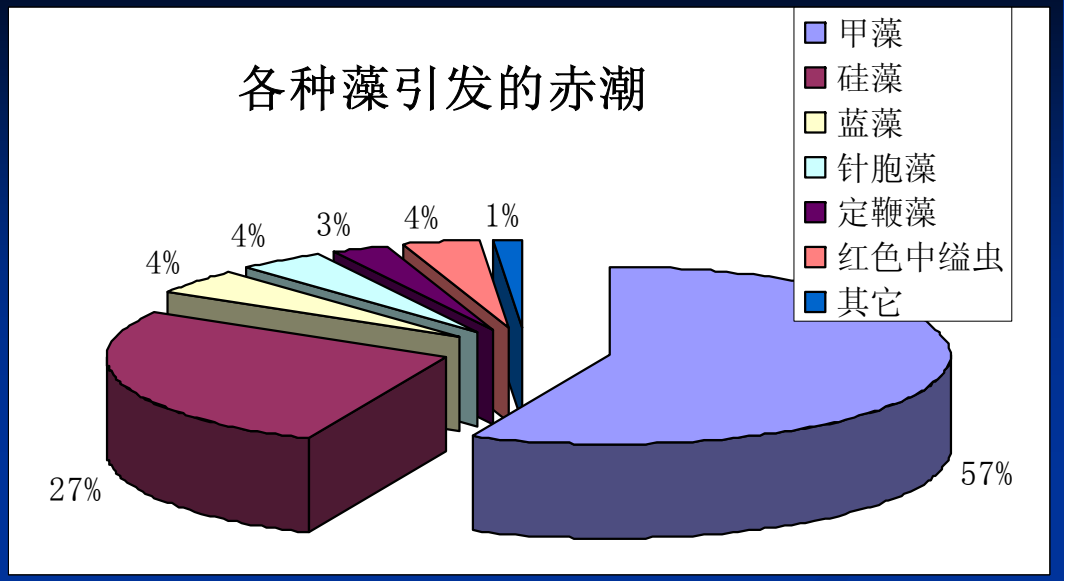


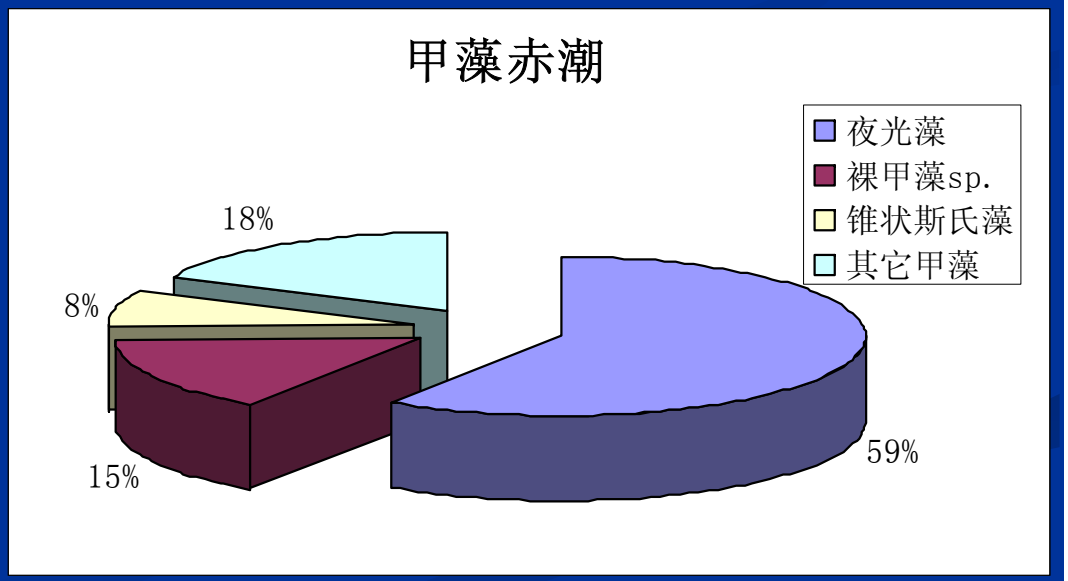
Nov-June with peak in March to April

Estuary of Pear River, Daya Bay Dapeng Bay , Zhiling Bay and Zhejiang are area with more HAB

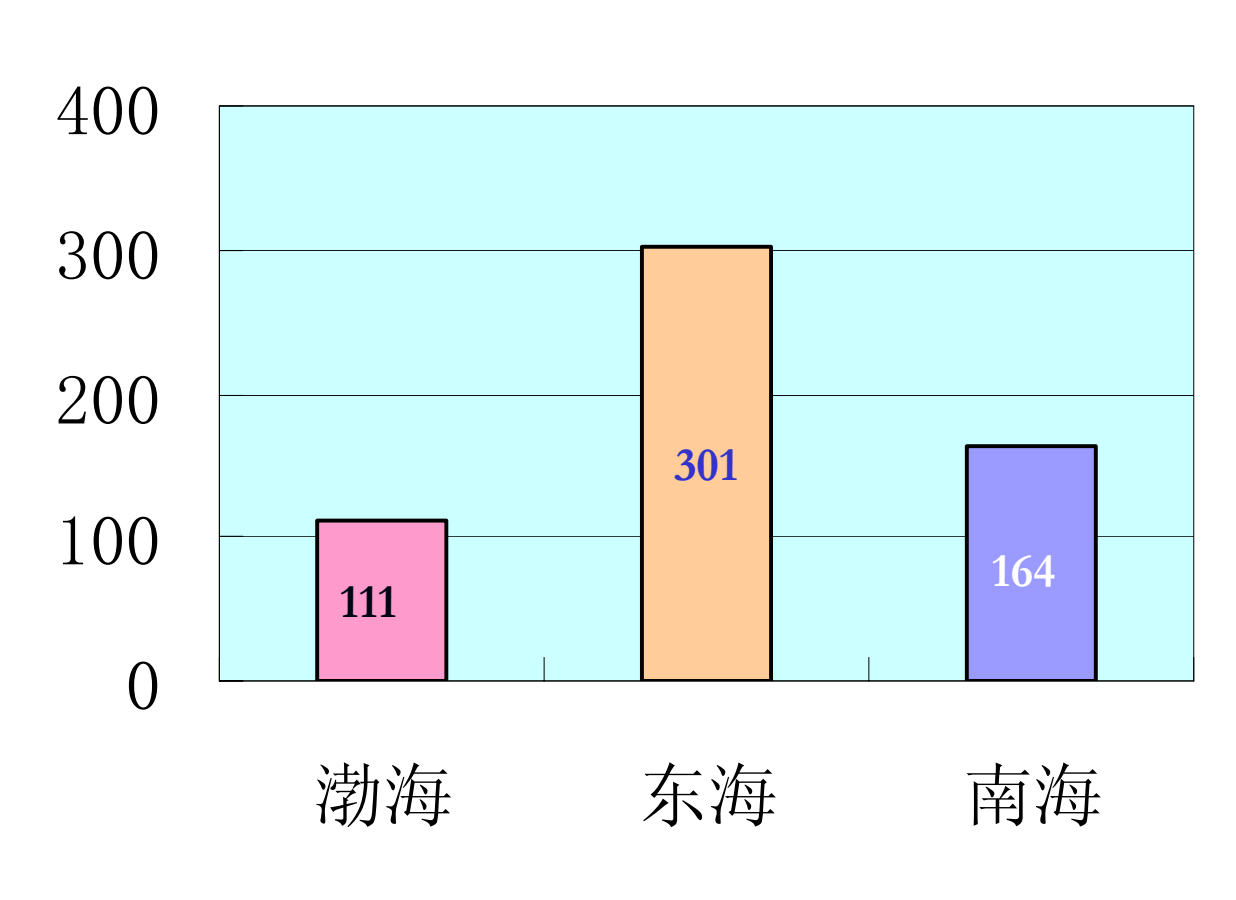


More HAB organisms in South China Sea



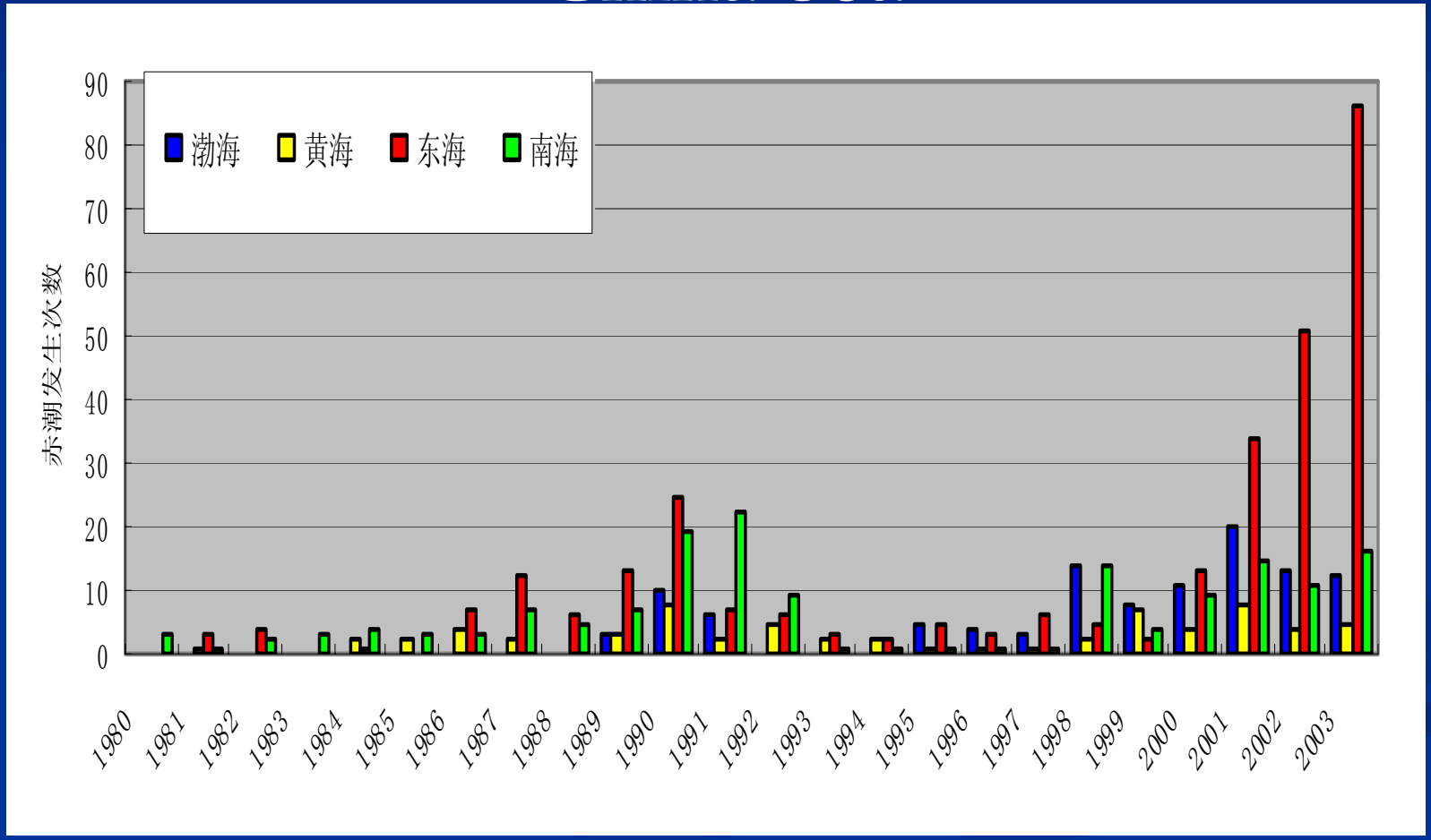


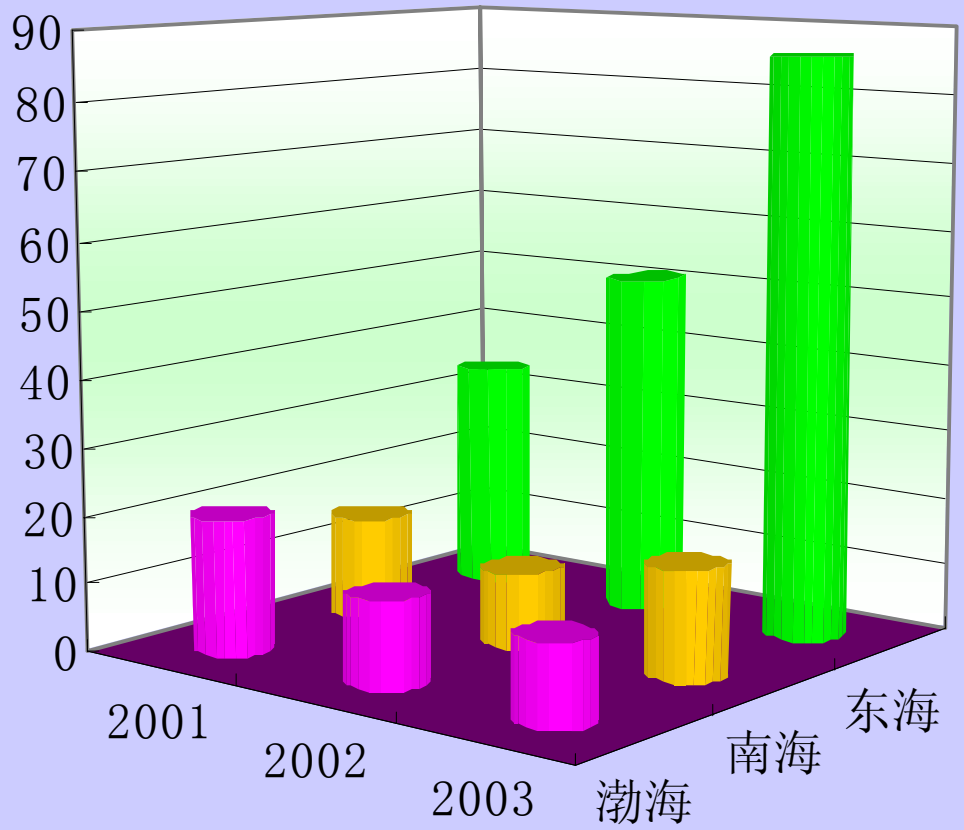
3、 Comparison of HAB in above 3 areas



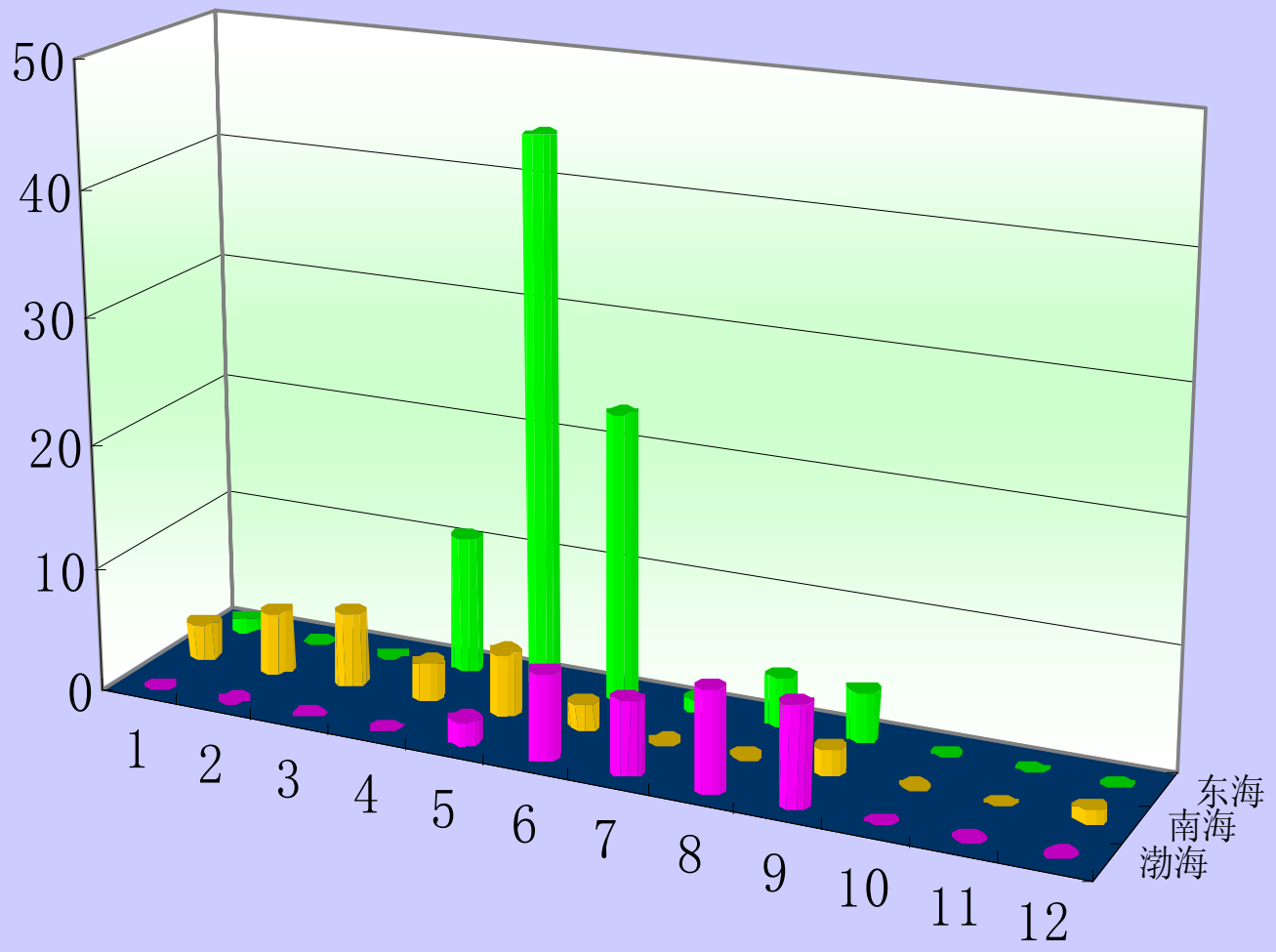
From 1952 to 2003 there were 111 HAB in Bohai Sea， 301 in East China Sea and 164 in South China Sea.

In recent 3 years, HAB in East China Sea increases, but not in Bohai and South China Sea





From 2001 to 2003, HAB in Bohai was 45，
in East China Sea 171，in South China Sea 42.



Time of HAB events in 3 area during 2001 to 2003
It was 6-9 in Bohai, 5-7 in East China Sea,
1-5 in South China Sea.

Concentration and ratio of DIN to DIP in HAB area in China

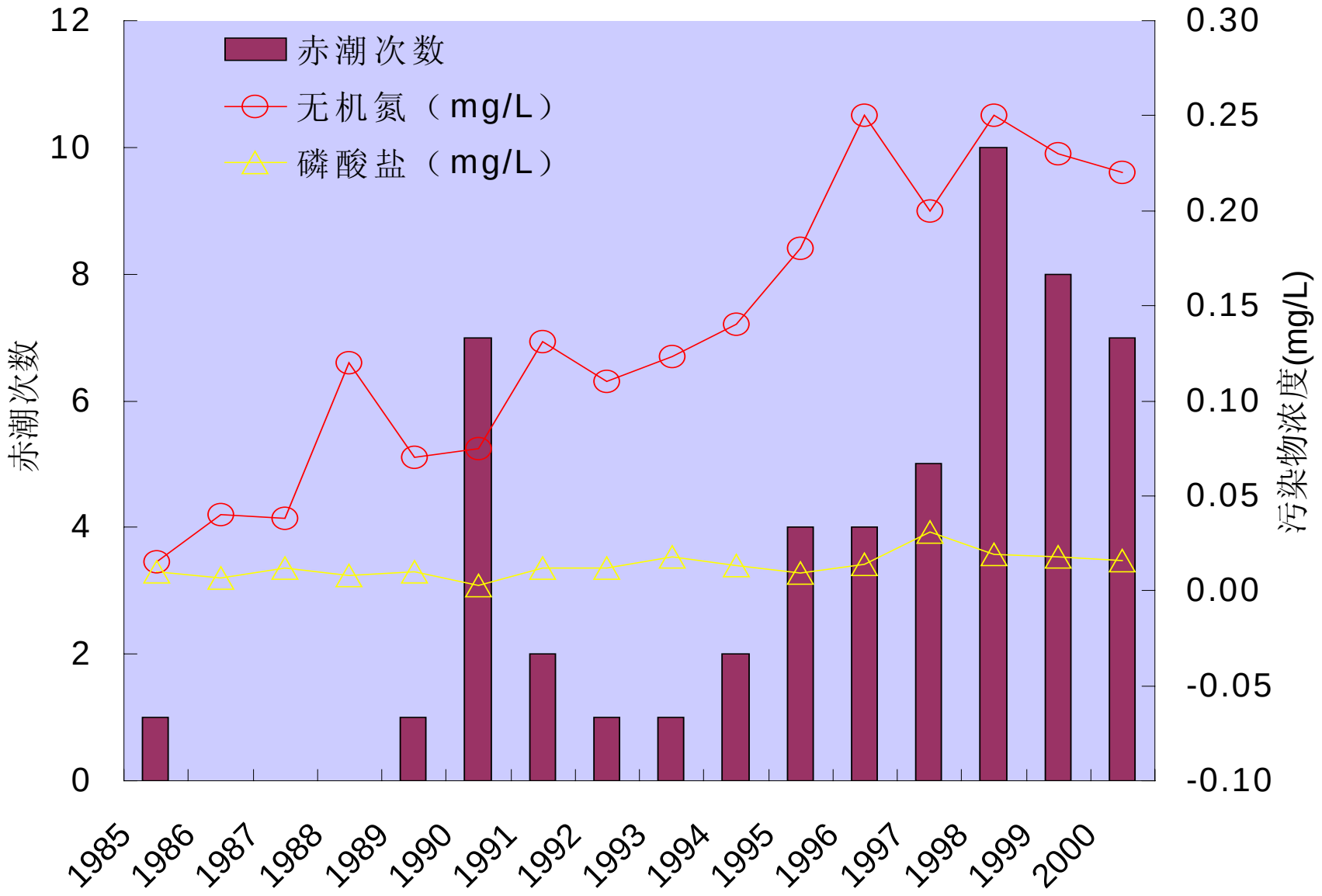
area	site	nutrient（mg/l）		N/P
		N	P	
	珠江口	0.713	0.021	77.6
South	大鹏湾	0.055	0.004	31.4
	大亚湾	0.076	0.005	34.7
	柘林湾	0.353	0.083	9.7
	长江口	1.49	0.029	117.4
East	舟山海域	0.594	0.021	64.7
	杭州湾	1.421	0.041	79.2
	渤海湾	0.365	0.032	26.1
Bohai	莱州湾	0.145	0.025	13.3
	大连湾	1.198	0.017	161.1

HAB species in 3 area during 2001-2002

东海		南海		渤海	
2001年	2002年	2001年	2002年	2001年	2002年
5	8	14	7	8	4
角毛藻 中肋骨条藻 具齿原甲藻 长耳盒形藻 海洋原甲藻	夜光藻 中肋骨条藻 具齿原甲藻 亚历山大藻 红色中缢虫 短裸甲藻 聚生角毛藻 红色裸甲藻	夜光藻 裸甲藻sp. 海链藻sp 叉角藻 多纹膝沟藻 具刺膝沟藻 锥状斯氏藻 亚历山大藻sp 细柱藻sp. 脆根管藻 拟菱形藻sp 细长褐胞藻 赤潮异弯藻 红色中缢虫	夜光藻 中肋骨条藻 无纹环沟藻 海链藻sp 束毛藻sp 棕囊藻 红色中缢虫	夜光藻 圆筛藻 丹麦细柱藻 舟形藻 甲藻 聚生角毛藻 圆筛藻 红色中缢虫	夜光藻 裸甲藻 原甲藻 海洋卡盾藻

Root causes of HAB

- Eutrophication may be the main causes for HAB in Bohai.



Nutrients and HAB in Bohai during 1985~2000

Change of chl-a and nutrients during HAB of *Ceretium farca* in Bohai Sea in 1998

	salinity	DO (mg/L)	DIN (μg/L)	(DIP) (μg/L)	Chl-a mg/m^3
Before	30.7-30.7	5.66-7.01	102.8-328.4	4.4-43.5	<1.0-4.0
after		>8	3.79-5.02	0.3-0.33	12.26-35.61

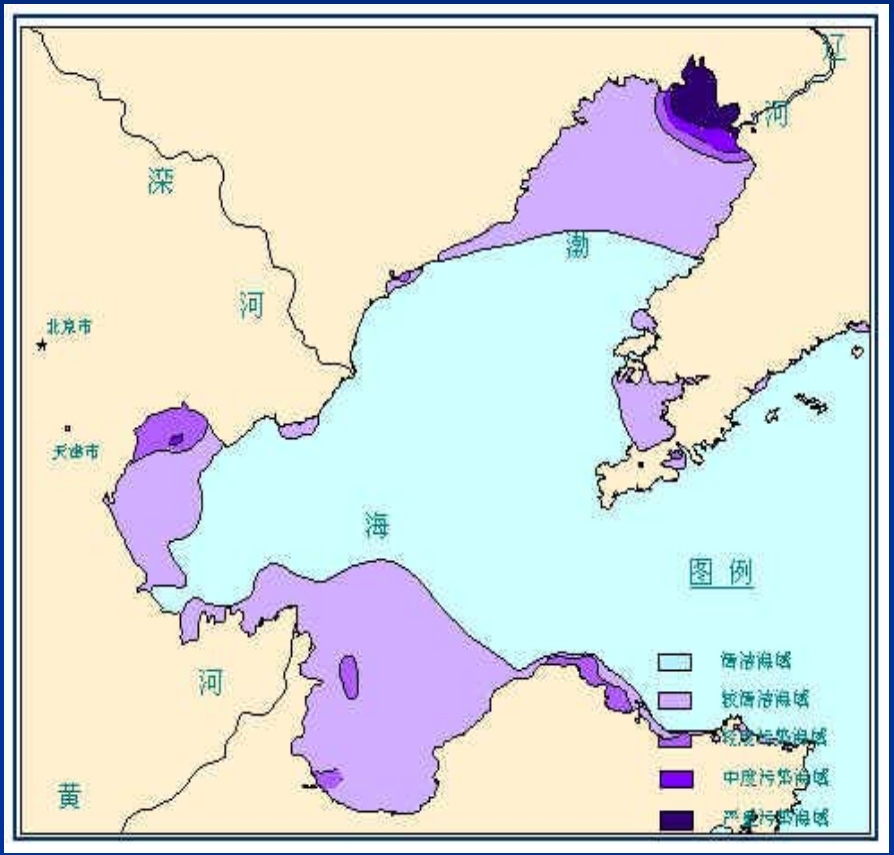
Change of nutrients of *Leptocylindrus danicus* HAB in Bohai Sewa in2001

	DO mg/L	COD mg/L	DIN μg/L	DIP μg/L	Silicate μg/L
赤潮前			439.32	27.59	487.76
赤潮中	8.192	0.75	210.70	4.96	376.32
赤潮后	12.688	2.21	26.74	5.58	113.12

(data from North Sea Monitoring Center)

HAB site in Bohai in 2003

The eutrophicated area reduced from 2003 to 2002, it was 32 *10^3 km^2 in 2002 and 21* 10^3 km^2 in 2003



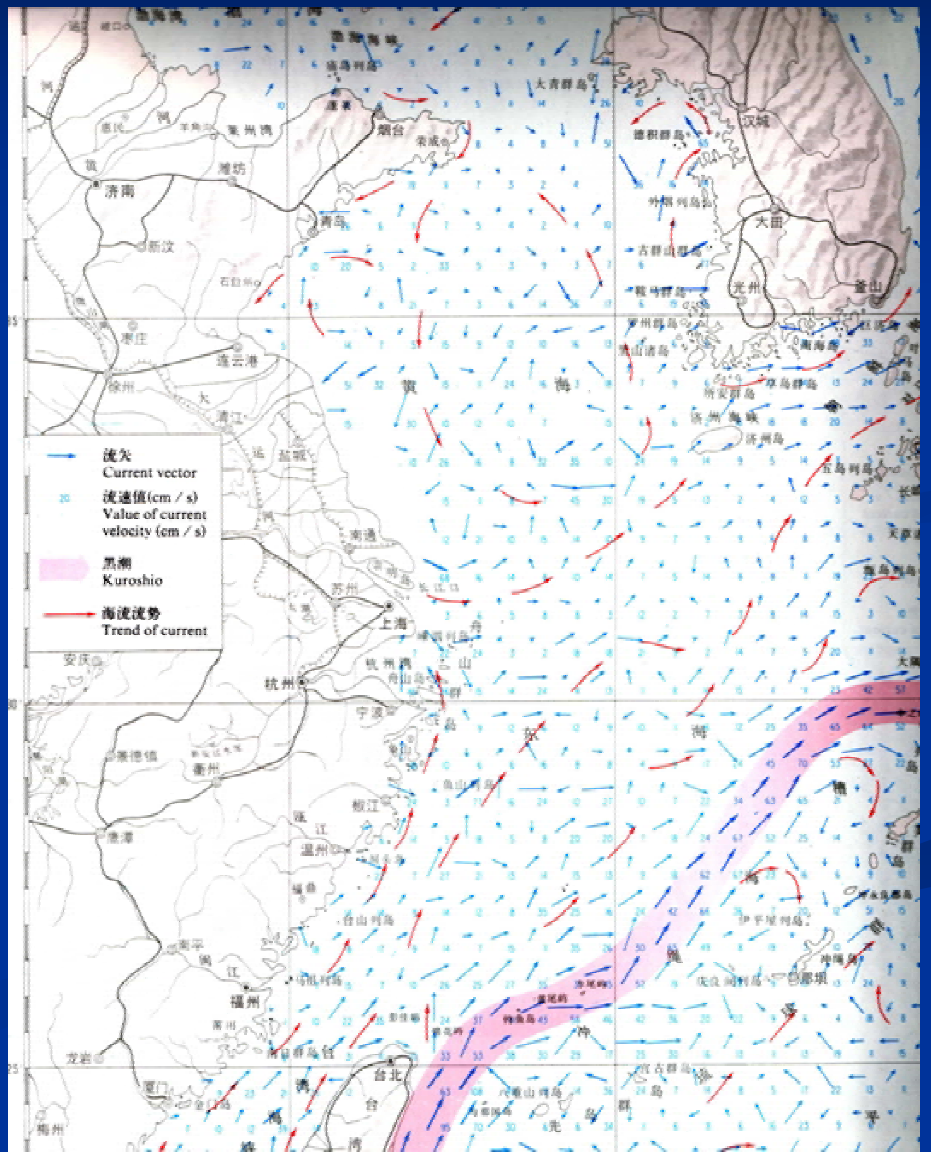
渤海污染海域分布示意图

2002 2003

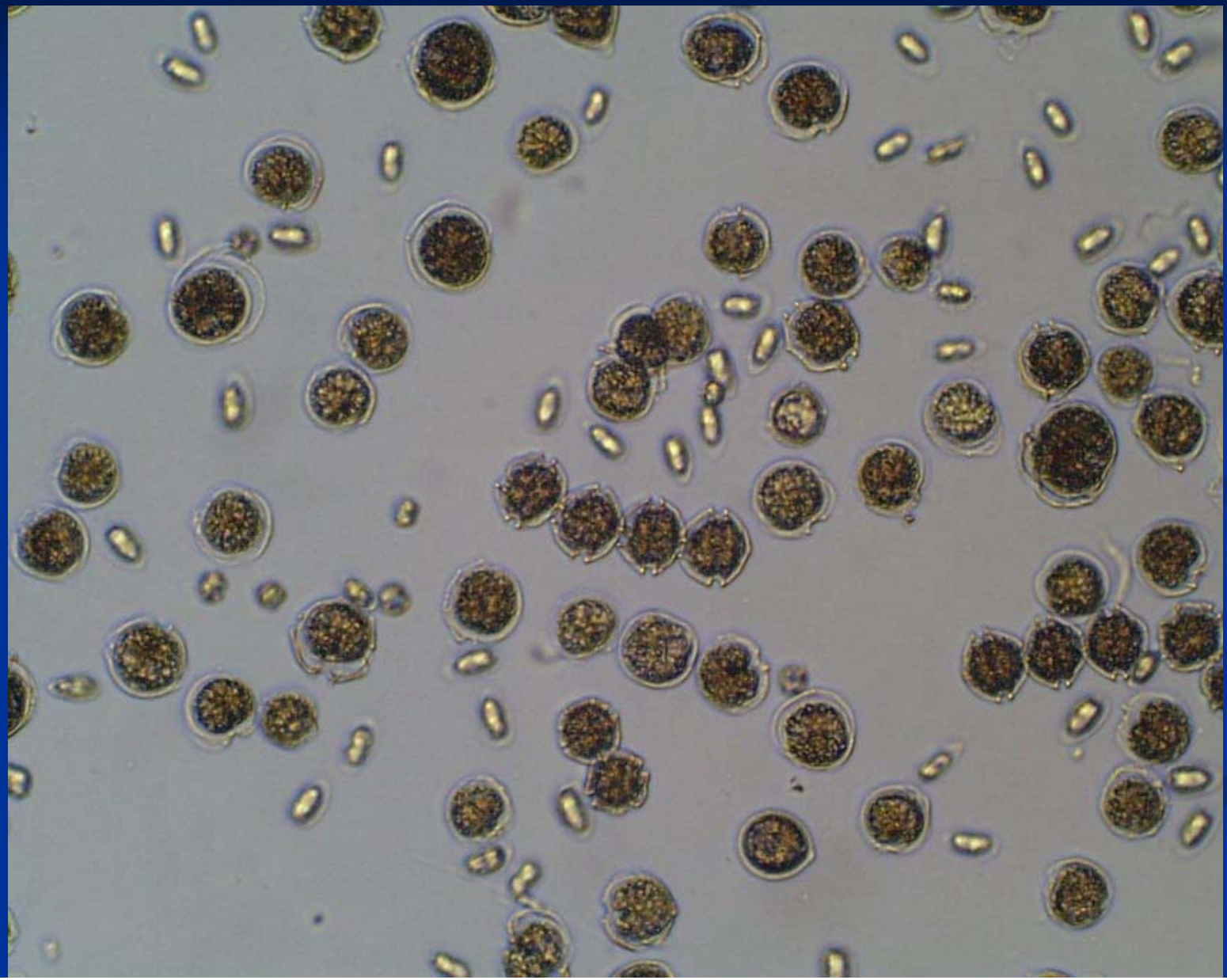
Eutrophicated area in Bohai Sea

In East China Sea

- Eutrophication, diluted water from Yangtze River, upwelling and front as well as unique bethmetry may be responsible for large scale *Prorocentrium* bloom

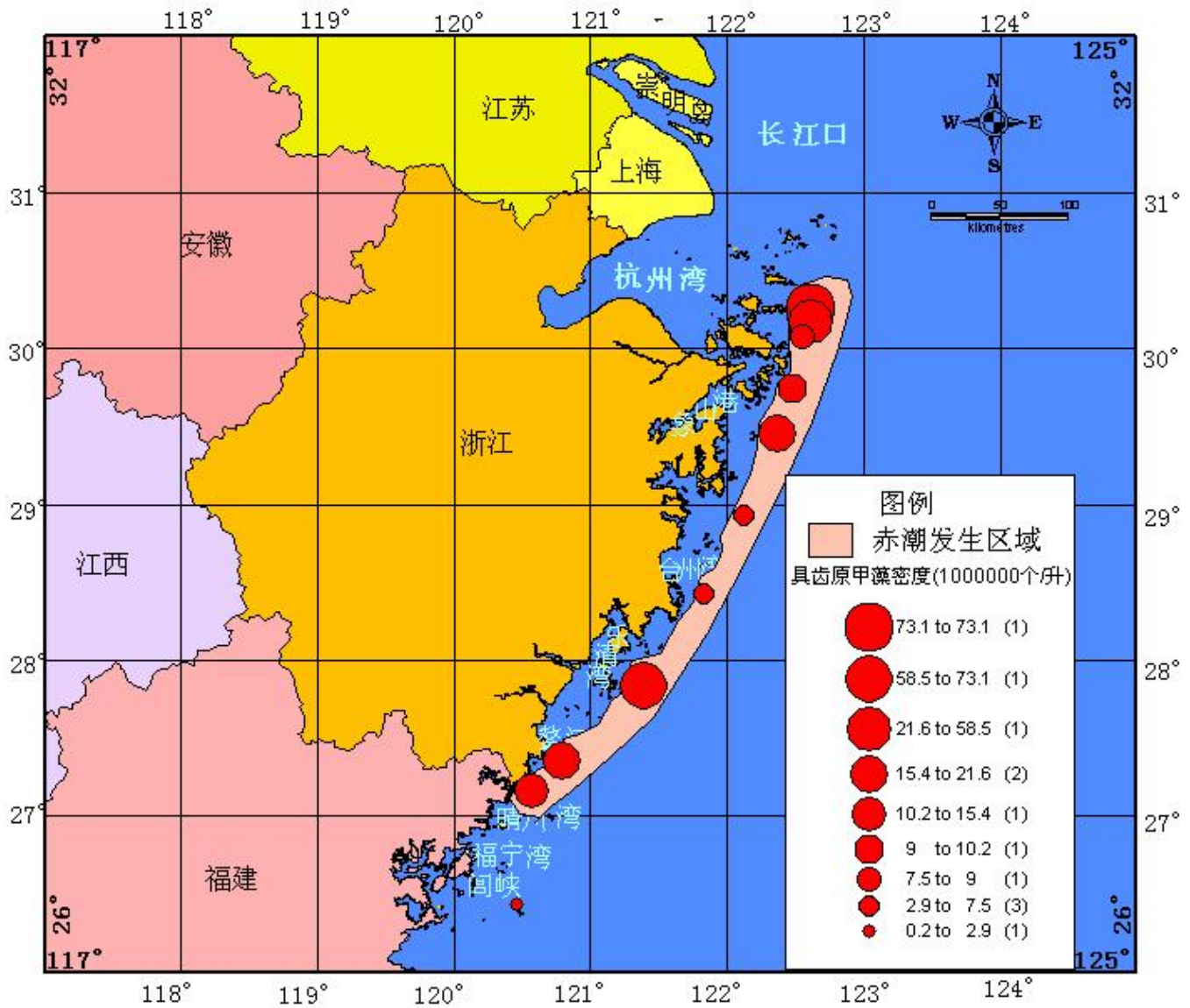


Prorocentrium and Alexantrium Blom in may, 2002



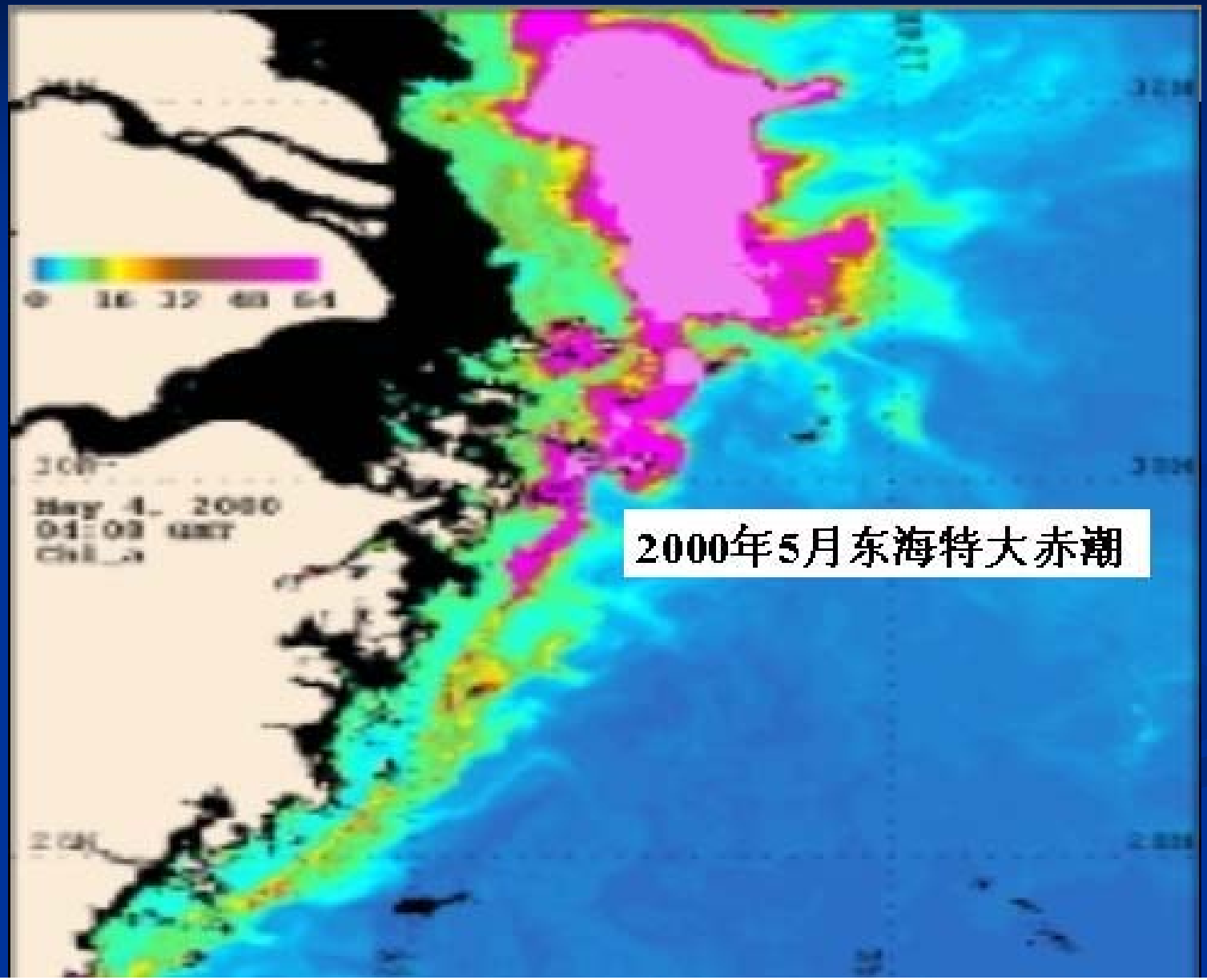
Prorocentrium bloom during May *3 to June 4 , 2002*

Front of bloom

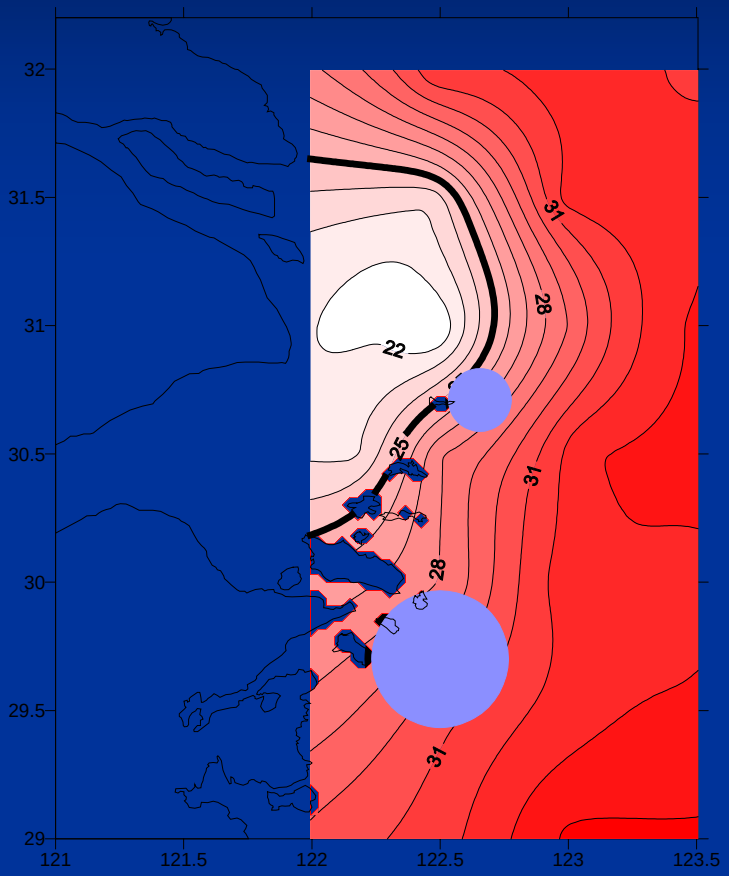


Bloom of prorocentrium in May 2004

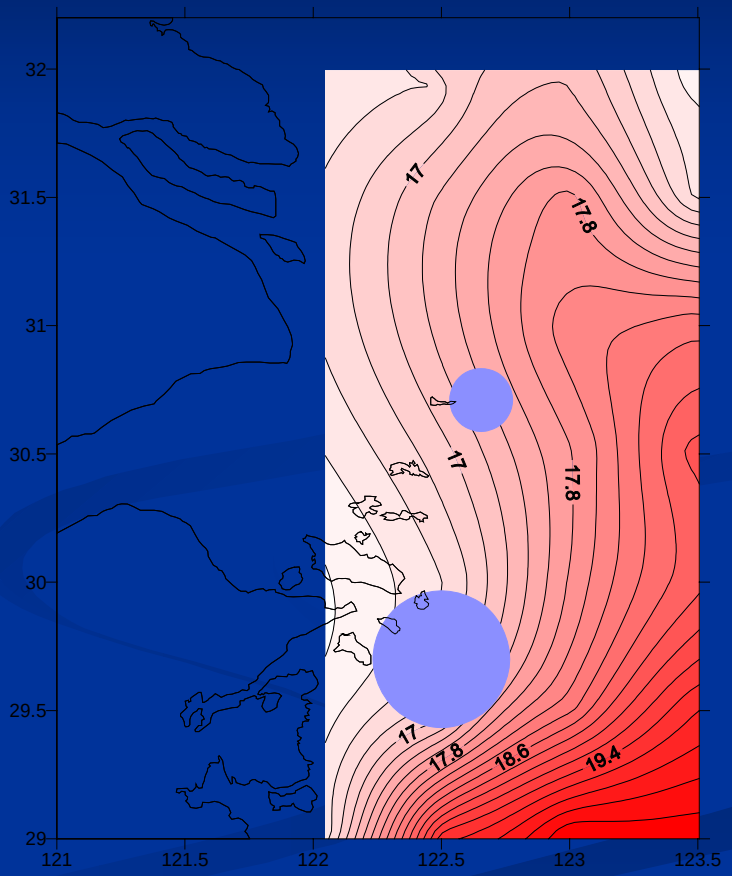
Bloom of *Prorocentrium* in May, 2000



Position of Red-Tide in May

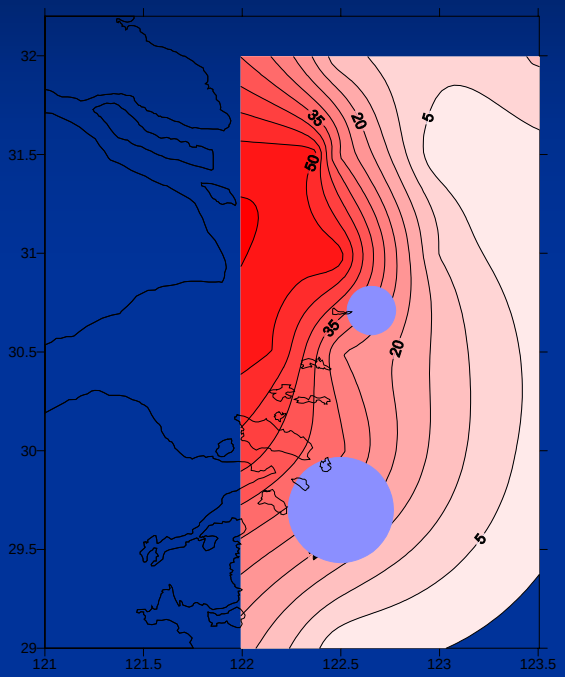


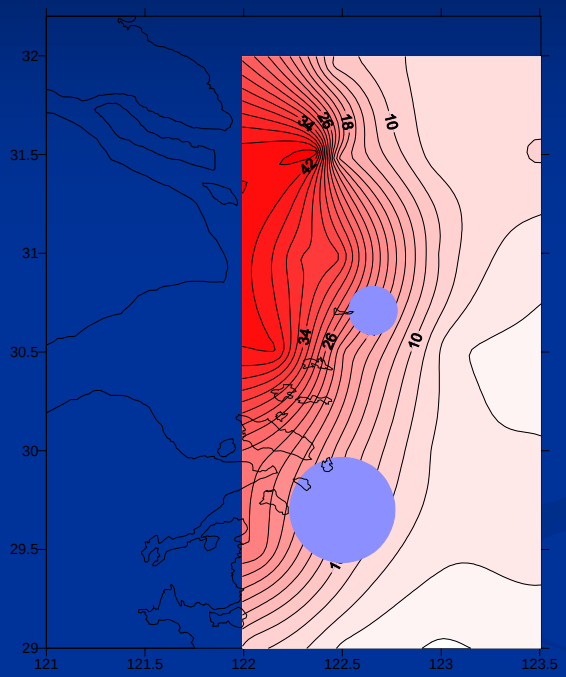
Salinity

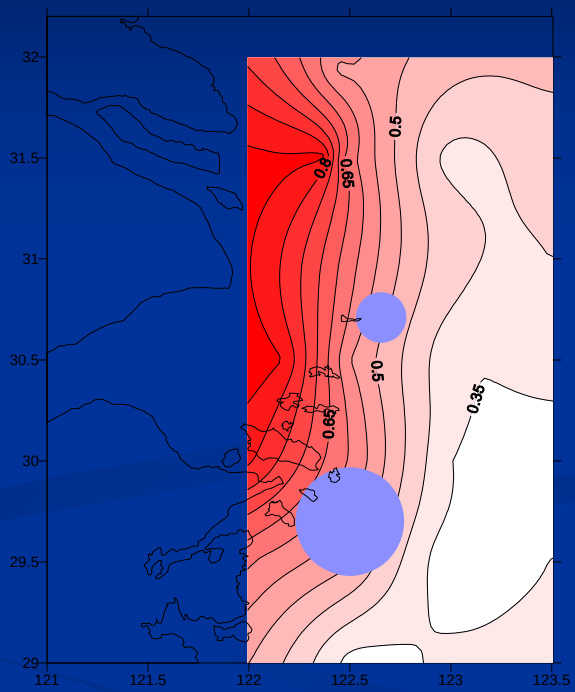


Temperature

Distribution of nutrients before red tides







NO_3-N

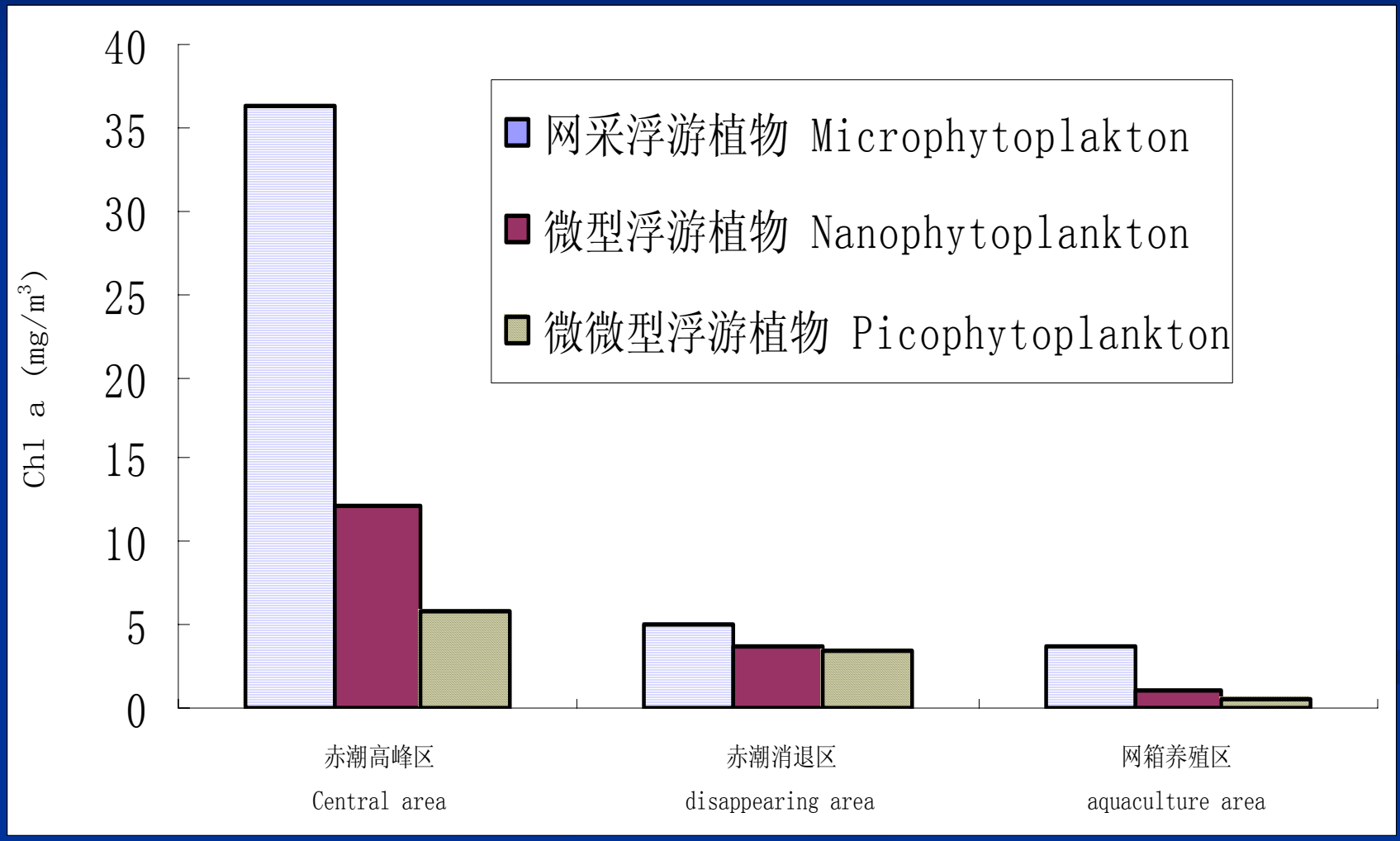
Si

PO_4-P

In South China Sea

- More HAB organisms .
- Dence mariculture and land base pollution caused eutrophication here.
- From march to May, it is the season for monsoon changes from North East to South West. Raining and divergence is favorable for HAB.
- Ei Nino events?。

Chl-a in different site of a bloom in Estuary of Pear River



Condition in different site of HAB in Pear River Estuary

Site	T(°C)	S	DO mg/dm³	PH	O_2%	Si	P	NO_3	NO_2	NH_4	Σ N
						μmol/dm³					
middle	29.72	4.73	13.51	7.86	183.3	78.31	0.28	53.06	2.27	7.42	62.75
Disappearing	29.21	4.16	11.36	7.81	151.6	88.25	1.07	64.96	3.27	6.43	74.66
mariculture	28.32	30.46	4.37	7.82	67.5	73.79	0.09	37.55	2.78	6.51	46.84
Non bloom	29.17	2.93	6.7	7.78	88.8	114.9	0.45	95.09	1.34	1.31	97.74

Nutrients in aquaculture area Oudou, in Aug. 2003

	NO_2-N	P	NO_3-N	Si	NH_3-N	DIN
aquaculture	0.62	0.42	2.18	8.39	4.87	7.67
Outer	0.76	0.27	2.37	9.53	2.66	5.79
mean	0.74	0.31	2.61	9.63	3.38	6.73

N、P was high in aquaculture area

Diversity of phytoplankton

	wharf	culture		outer			mean
		sur	bot	sur	mid	bot	
Aug. 3	1.33	1.68	2.24	2.01	1.93	2.78	2.23
Aug. 7	1.36	1.41	2.45	1.68	2.81	1.51	2.00

4. Preliminary conclusion

In China, HAB events in East China Sea has been increasing rapidly, that in Bohai Sea in North and South China Sea had no clear increase. It may attributed to the control of pollution loading. However, impacted by both natural variation and human activities, HAB in East China increases both in number and affected area.

- Time of HAB occurrence seems a little earlier than before. It is June to Sept in Bohai, April to June in East China Sea and Jan. to May in South China Sea.
- There are more HAB organisms in South China Sea than those in Bohai Sea and East China Sea.


Thank you