Annex V-1

Draft Integrated Report 2003

Prepared and Submitted by CEARAC Secretariat

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Chapter 1 Activities of NOWPAP WG3 in 2003

(Accomplishment of meetings and its Record of Discussions will be compiled.)

Chapter 2 Situation of HAB in NOWPAP Region

1. Scope of HAB for NOWPAP WG 3

It is essential to clarify the definition of the HAB to be coped with in the WG 3 to consolidate the base of discussion. The definition of the HAB of the NOWPAP Members were reviewed using the national reports submitted to the 1st FPM in February 2003. Each member state has its own definition which seems not to coincide with others absolutely (Appendix 1). The definition of the HAB by other organizations were also introduced in Appendix 1 as a reference.

The difference among them appears whether the toxic plankton bloom with the low cell density is involved or not. Therefore, it should be reasonable to recognize that the scope of HABs to be coped with in WG3 embraces the all red tides regardless of the toxicity, and the occurrence of toxic plankton.

The present plan proposes a one-by-one approach, giving the first priority to the red tide. It is because nowadays the red tides occur most coastal waters that receive the intensive impacts of human activities, and are easy to be observed. This feature will help a wide range of individuals/parties/organizations have concerns and participate in the activities coping with HABs. Problems related to toxic plankton will be addressed as the next priority.

2. Present Situation of HAB Problems in the NOWPAP Region

The present situation of HAB problems in the region was reviewed based mainly on National Reports submitted to the first FPM in February 2003.

1) Frequency

(1) Japan

Red tides occur in the target area not so frequent as in the Seto Inland Sea and Pacific coastal waters. The results of interviews with some researchers in Prefectural Fisheries

Research Stations in central Japan suggested that red tides occurred in spring a few times in some bays and coastal areas, though they did not conduct any regular monitoring on red tides. There is no obvious sign to suggest the increase of red tide occurrence.

In the western part of Japanese NOWPAP sea area, red tide events have gradually dereased varing between 20 – 40 events per year. (Figure 1)

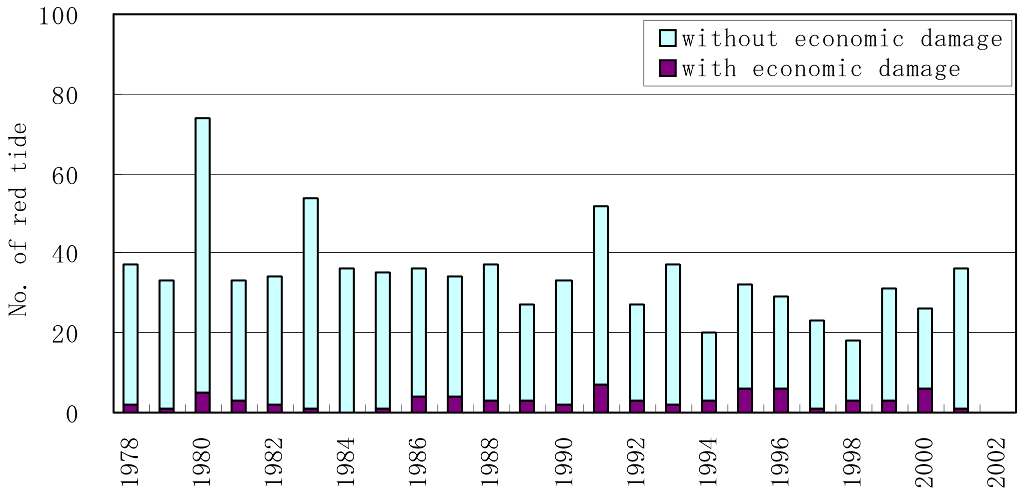


Figure 1. The number of red tide events in the western Japanese NOWPAP area.
Data extracted from Fisheries Agency of Japan (200)

(2) China

Red tides became to happen more frequently in China. According to incomplete statistics, 197 cases of red tide occurred in China coastal waters during 1980 to 1999, 25 times of that in 1970s (Table 1). In 2002, 79 red tides broke out.

Table 1. The number of red tide occurrence in China

Decade	Before 1970s	1970s	1980s	1990s
Times	4	8	75	122

(3) Korea

The number of red tide occurrence has increased since 1981. Only 8 cases were observed in 1982. Recently around 60 red tides are observed every year. (Figure 2)

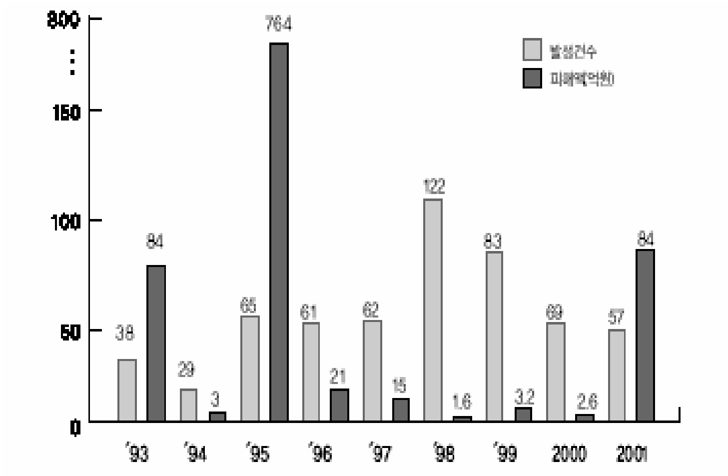


Figure 2. The number of occurrence of red tide (light column) and the amount of economic loss (dark column; x 100 million Wong) in Korean coastal areas.

(4) Russia

Through the observation in the Peter The Great Bay including subsidiary areas of Amursky and Vostok Bays, and Sakhalin Island coast, a total of 20 HAB events were recorded in 1990s, while during three years after the year 2000, 15 HABs already took place within the same area. It is expected in near future the significant growth of aqua-culture and fisheries in coastal waters will induce the increase of HAB events.

2) Duration

(1) Japan

In Nanao and Wakasa Bays located in the west coast of central Japan, a few *Noctiluca* red tides occur in spring and disappear in several days.

The northern coast of Kyushu Island has frequent red tide occurrence from June to August. In remote islands, no seasonal change in the frequency is observed.

(2) China

The months that red tides usually occurred were;

Bohai and Yellow Seas;	July – September
East China Sea;	June – August
South China Sea;	March – May (Yan *et al.*, 2002)

In 2002, however, red tides occurred earlier and lasted longer than before.

(3) Korea

In 1970s, red tides in Korea lasted only a short period during summer. Today, red tides appear in all seasons but winter, and tend to last longer (Lee *et al*., 2002; Kim *et al*., 2002).

(4) Russia

HABs occur during June to November in the Peter The Great Bay. The damage of HABs is reported as a short period.

3) Extensiveness

(1) Japan

In 1980s, red tides occurred only in enclosed bays, such as Fukuoka Bay, etc., which received a large amount of the pollution load. Recently, however, the occurrence area extended to the open coastal area of Kyushu Island and western Honshu Island. (Figure 3)

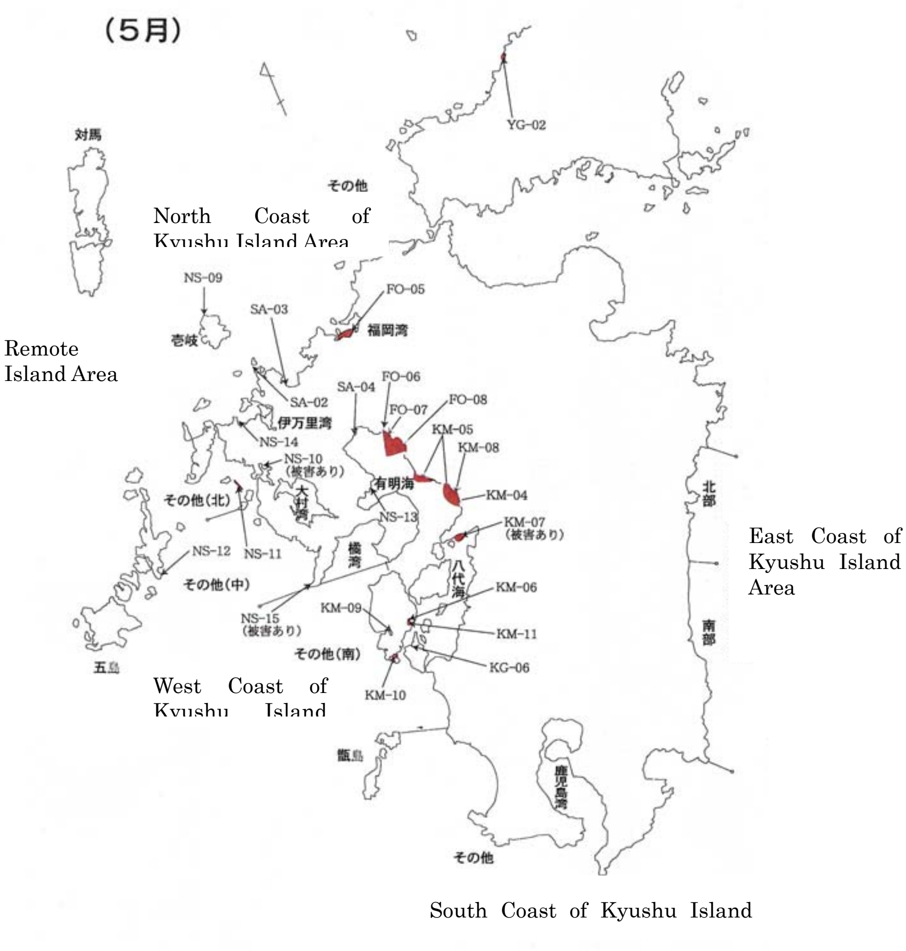


Figure 3. Location of Occurrence of Red Tide in May 2001.

Source: Red tide in Coastal Areas in Kyushu Island

(2) China

The HAB occurrence area of China stretches from Bohai Sea to South China Sea (Table 2 and Figure 4). In 2002, 63 % of HAB events were observed in East China Sea.

Table 2. HAB occurrence area in China

Sea area	During 1933 to 1999		In 2002		
	Number of occurrence	Percentage	Number of occurrence	Percentage	Area (km^2)
South China Sea	88	42	11	14	540
East China Sea	80	38	51	64	9000
Yellow Sea	21	10	17	22	600
Bohai Sea	20	10			

modified from National Report

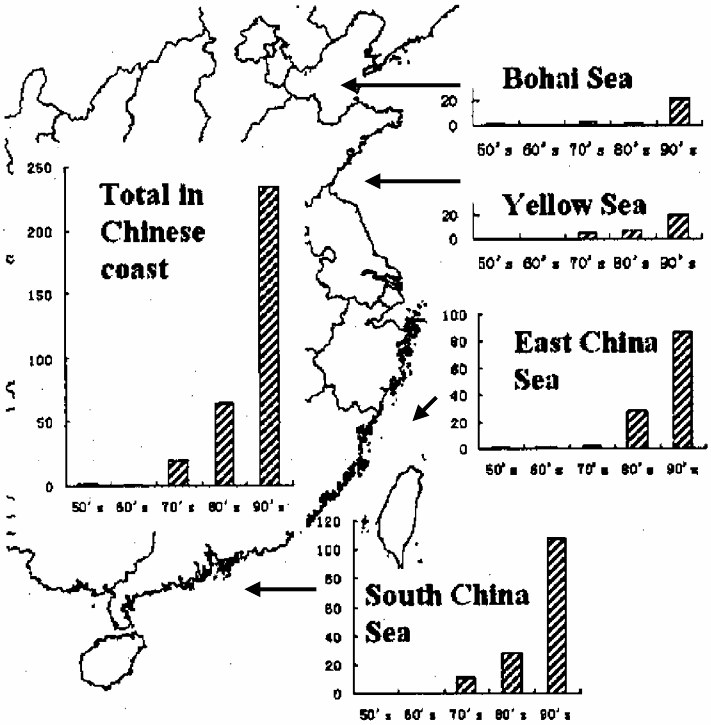


Figure 4. HAB events reported in the coastal seas of China during 1952 to 1998

Source: Yan *et al.* (2002)

(3) Korea

The red tide outbreaks in Korean waters until the late 1970s were mostly restricted to some innermost bays in Chinhae Bay and its vicinity. After a huge red tide in Chinhae Bay in 1981, they spread to the entire south coastal water area of Korea. In the late 1980s, red tides also occurred in east and west coasts of Korea. (Figure 5)

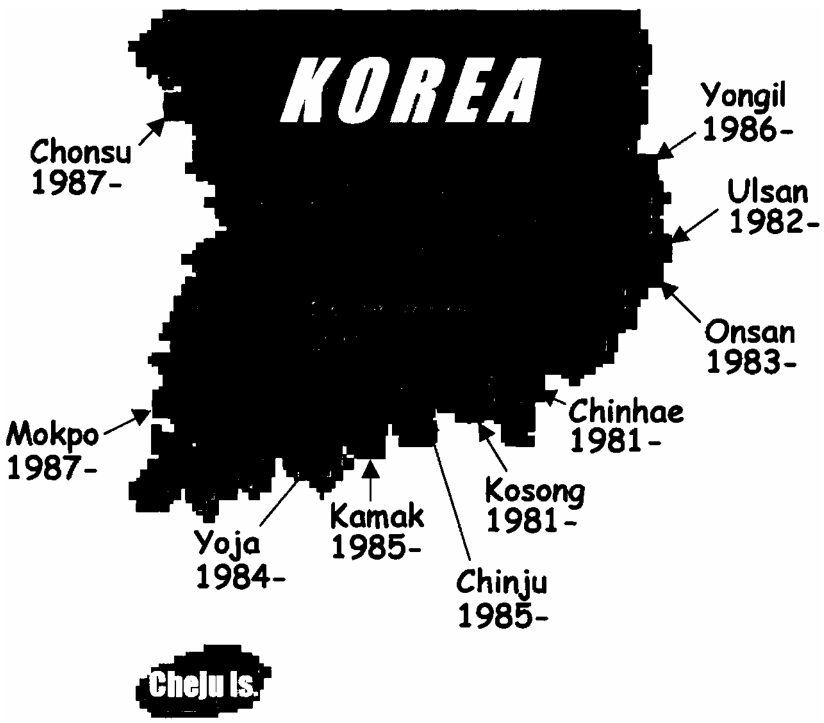


Figure 5. Red tide areas since 1981 in Korean coastal waters.

Source: Lee *et al*. (2002)

(4) Russia

There are two main areas where HAB events have been recorded; Peter The Great Bay and coastal waters of Sakhalin Island. No detailed data showing the extensiveness is available.

4) Toxicity and harmfulness

(1) Japan

1979	Hurue Bay	US$ 80 thousand by *Polykrikos* sp.
1980	Tsushima Bay	US$ 210 thousand by *Cochlodinium* sp., etc.

1981	Imari Bay	US$ 280 thousand by *Gymnodinium* sp., type'65
1982	Tsushima Island	US$ 180 thousand by *Cochlodinium* sp. etc.
1987	Imari Bay etc.	US$ 490 thousand by *Gymnodinium nagasakiense*
1990	Imari Bay	US$ 200 thousand by *Chattonella marina*
1991	Imari Bay	US$ 1,420 thousand by *Gymnodinium nagasakiense*
1991	North Coast of Kyushu Island	US$ 290 thousand by *Cochlodinium* sp., type'78 Yatsushiro
1992	North Coast of Kyushu Island	US$ 410 thousand by *Gymnodinium mikimotoi*
1992	Usuka Bay , Hurue Bay	US$ 90 thousand by *Cochlodinium* sp., type'78 Yatsushiro
1995	Tsushima Island	US$ 60 thousand by *Heterosigma akashiwo*
1999	Imari Bay	US$ 6,330 thousand by *Cochlodinium polykrikoides*

Damages occur scarcely in Nanao Bay and Wakasa Bay, central Honshu Island.

(2) China

Twelve toxic phytoplankton are known to occur in Chinese coastal waters (Qi et al.,1993; Zhu *et al*., 1997). The major HABs in the past 20 years in terms of the economic damage include;

1987	South China Sea	US$ 15,000 by *Gonyaulax*
1989	Bohai Sea	US$ 25 million by *Gymnodinium*
1990	East China Sea	US$ 75 million by *Cochlodinium*
1991	South China Sea	136 people poisoned and 2 people killed by *Alexandrium*
1998	Bohai Sea	US$ 60 million by *Ceratium*

(Yan *et al*., 2002)

(3)Korea

The largest fishery damage reached to US$ 61 million in 1995 due to a red tide by *Cochlodinium polykricoides*. Other large damages were US$ 15.5 million and US$ 6.7 million recorded in 1992 and 2001 caused by *Gyrodinium* sp. and *C. polykricoides*, respectively.

(4) Russia

At inner part of the Peter The Great Bay, HABs cause fish kills almost every year though no quantitative data is available.

Chapter 3 Important Scientific Issue - Relationship between Red Tide Occurrence and Eutrophication

The red tide involves many aspects to be resolved. The one-by-one approach should also be applied here, because it would be rational for WG3 not to make efforts for all scientific aspects at the same time, but to focus on a single issue every year. The eutrophication was a common concern for all Members as one of the mechanisms of red tide occurrence. In addition, other international organizations have not extended their concerns in this issue so much to the NOWPAP Region. Also, this issue must be one of the keys to develop the preventive/mitigation measures to the red tide. Therefore, the relationship between the red tide occurrence and eutrophication should be focused on in the present report. Here examples of studies on this matter are introduced.

3.1 Establishment of Water Quality Standards for Nitrogen and Phosphorus regarding the Prevention of Excessive Algal Blooms

3.1.1 Water Quality Standards

Japan amended water quality criteria of nitrogen (N) and phosphorus (P) concentrations for the selected coastal sea areas that were threatened by excessive phytoplankton blooms to prevent from the eutrophication. They were environmental standard values considering the purpose of different types of water use as follows:

(1) Nature conservation

In order to prevent the degradation of aesthetic value of the seascape, due to the eutrophication and consequent reduced transparency caused by phytoplankton blooms, environmental standards aimed to ensure the transparency of over 10 m. Water quality data in marine park areas, etc. were checked and resulted in the environmental standards of T-N of 0.2 mg/L or less and T-P of 0.02 mg/L or less as a annual mean value at the sea surface layer.

(2) Sea bathing

Transparency were also adopted as an indicator for sea bathing areas. Transparency more than 6 m was necessary for suitable sea bathing area considering the water quality data. T-N of 0.3 mg/L or less and T-P of 0.03 mg/L or less corresponded approximately to that transparency.

(3) Habitat conservation

Generation of oxygen-depleted water at the bottom layer causes smothering of benthic fauna. Therefore, DO over 2 mg/L at the bottom layer was thought necessary. This DO concentration was usually accompanied with T-N of 1.0 mg/L and T-P of 0.09 mg/L.

(4) Fisheries

Coastal water areas for fishing activity were divided into three categories according to the type of fish which is harvested in those areas.

a. Category 1

Category 1 is the area in which a favorable ecosystem indicated by diversified fish-catch is observed. In these areas, water quality usually showed T-N of 0.3 mg/L or less and T-P of 0.03 mg/L or less.

b. Category 2

This category encompasses the area that many species, except for some species sensitive to oxygen-depleted water, are caught. These areas were characterized with the concentrations of T-N of 0.6 mg/L or less and T-P of 0.05 mg/L or less.

c. Category 3

This category is the heavily eutrophicated sea area that shows less biodiversity in fish-catch composed mainly of a few pelagic fish species or bivalves, such as short-necked clam. These areas required concentrations of T-N of 1.0 mg/L or less and T-P of 0.09 mg/L or less.

(5) Industries

Seawater is used for salt manufacture, apart from cooling water. Salt manufacturers sometimes suffer from clogging of the filter of raw water when eutrophicated water is taken. The concentration of T-N of 1.0 mg/L or less and T-P of 0.09 mg/L or less were thought to meet the requirement of this type of water use.

The overall results mentioned above are summarized in the following table.

Environmental standards for T-N and T-P in selected sea area in Japan

Type	Purpose of water use	Standard value (mg/L)	
		T-N	T-P
I	Nature conservation and those included in rows below (other than fisheries category 2 and 3)	0.2 or less	0.02 or less
II	Fisheries category 1, sea bathing, and those in type III and IV (other than fisheries category 2 and 3)	0.3 or less	0.03 or less
III	Fisheries category 2 and those in type IV (other than fisheries category 3)	0.6 or less	0.05 or less
IV	Fisheries category 3, industries, and habitat conservation	1.0 or less	0.09 or less

In this example, different types of water use got to have one systematic criteria, showing the possibility of collaborative monitoring between different industrial or administrative sectors.

3.2 Red Tide Investigation in the Eastern Seto Inland Sea, Japan

3.2.1 Background

The coastal sea areas in Japan, particularly Seto Inland Sea, have suffered from red tides. After they established a red tide monitoring network in 1973, they observed 200-300 HAB events per year, including 20-30 events which caused the fishery damage summed up to US$20-30 million every year.

Owing to the law enforcement in 1973 (Law of Preparatory Measures for Conservation of the Environment of Seto Inland Sea) and 1978 (Law of Special Measures for Conservation of the Environment of Seto Inland Sea), the number of red tide events decreased to one third. Actually, Areawide Total Pollutant Load Reduction Plan regarding COD, which has been introduced since 1973, and establishment of water quality criteria for T-N and T-P in 1993 seemed to have contributed largely to the decrease of the HAB events.

Economic damage, however, still exceeded US$8 million in mid 1980s. Thus the Fisheries Agency of Japan commenced an intensive study on red tide in 1988 in some enclosed coastal seas that suffered from red tides frequently. Here, the investigation in Eastern Seto Inland Sea is introduced, focused on the red tide by *Chattonella antique*.

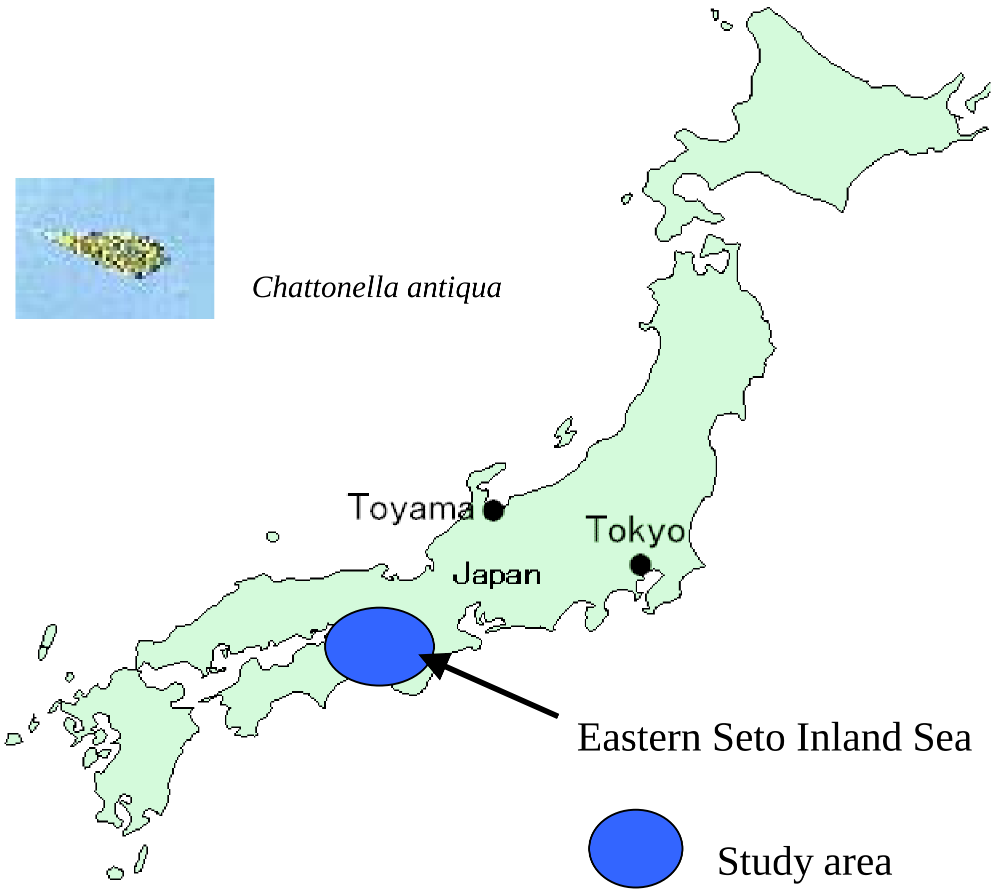
3.2.2 Purpose of the Study

The purpose of the study was to clarify the mechanism of the occurrence of *Chattonella* bloom and to establish a method to predict the red tide occurrence, so as to eliminate or reduce the fishery damage.

3.2.3 Material and Method

Field measurement and sampling were conducted at sampling stations shown below. Temperature and salinity were measured with a STD. Water samples were taken from upper, intermediate and bottom layers with a water sampler to analyze the cell number of *Chattonella* and *Gymnodinium*, NH_3-N, NO_2-N, NO_3-N, PO_4-P, SiO_4-Si, DO, and Chl. *a*. Data on the solar radiation and rainfall were obtained from Japan Meteorological Agency.

Data obtained during 1988 – 1998 were analyzed for the study.


Chattonella antiqua
Toyama
Tokyo
Japan
Eastern Seto Inland Sea
Study area

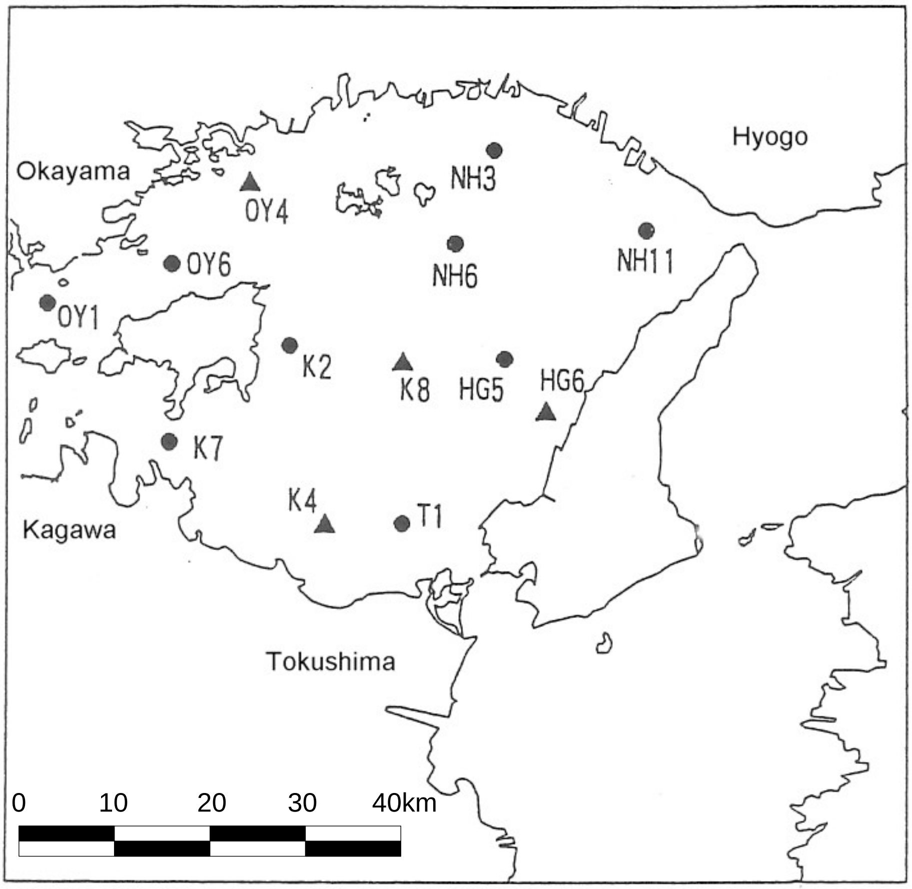


Figure 6 Sampling locations

3.2.4 Results

In order to identify the possible limiting factors to the *Chattonella* bloom, annual fluctuations of a wide range of environmental parameters were examined to find the coincidence with that of *C. antique*, which showed a bloom in 1989 and 1997 (Figure 7 (3)). Careful examination of these datasets (Figure 8 – 12) suggested that the limiting factors included temperature, salinity, solar radiation, and nutrient concentration.

In 1990 when *Chattonella* bloom did not occur, the PO_4-P concentration was lower than the half saturation constant for *C. antique* and seemed to prevent the bloom, while other environmental parameters showed sufficient conditions to bring about the bloom, judging from the conditions in the red tide occurring years. Similarly in 1991 – 1993, temperature and solar radiation were thought to have prevented the bloom. In 1994 – 1996, the rough weather condition was thought to have disturbed the steady bloom.

Calculation of the index of the relative growth rate under each environmental parameter was done to identify the most effective limiting factor. It was suggested PO_4-P was the limiting factor in this study (Figure 14).

The mechanism of *Chattonella* bloom occurrence in this study area can be explained as follows:

(1) Increased bottom water temperature to 20 ℃ or more brings about the germination of the *Chattonella* cyst.
(2) Supply of nutrients due to rainfall induces the possibility of the bloom. But the calm weather condition and sufficient sunshine should continue for several days to allow the steady algal growth.

High water temperature of the bottom layer in this area is realized by warm water intrusion that occurs when the Kuroshio meanders offshore, and by El Nino.

A prediction method for the *Chattonella* bloom occurrence was established based on the results stated above. It consists of three steps as follows (Figure 17):

(1) Foreseason prediction is done in may – June. It evaluates the possibility of high water temperature in the bottom layer by checking the situation of Kuroshio current and El Nino.
(2) Preseason prediction needs the field measurement of bottom water temperature in June – July. Obtained data is compared with that in the basic year of 1988. If the

data shows 1 – 2 ℃ higher than that in 1988, then it suggests the occurrence of *Chattonella* bloom positively and requires the careful environmental monitoring in the following phase.

(3) Beginning season prediction conducts the environmental monitoring, i.e. water sampling and *Chattonella* cell counting. The *Chattonella* cell number of more than several cells/mL accompanied with PO_4-P concentration exceeding the half saturation constant of 0.11 μg-at/L strongly cautions against the bloom. If calm weather and sufficient solar radiation continue for several days, *Chattonella* bloom will occur certainly.

The reliability of this method was verified by applying to the past data. The results of the verification of the three-step prediction method showed a high reliability (Table 3).

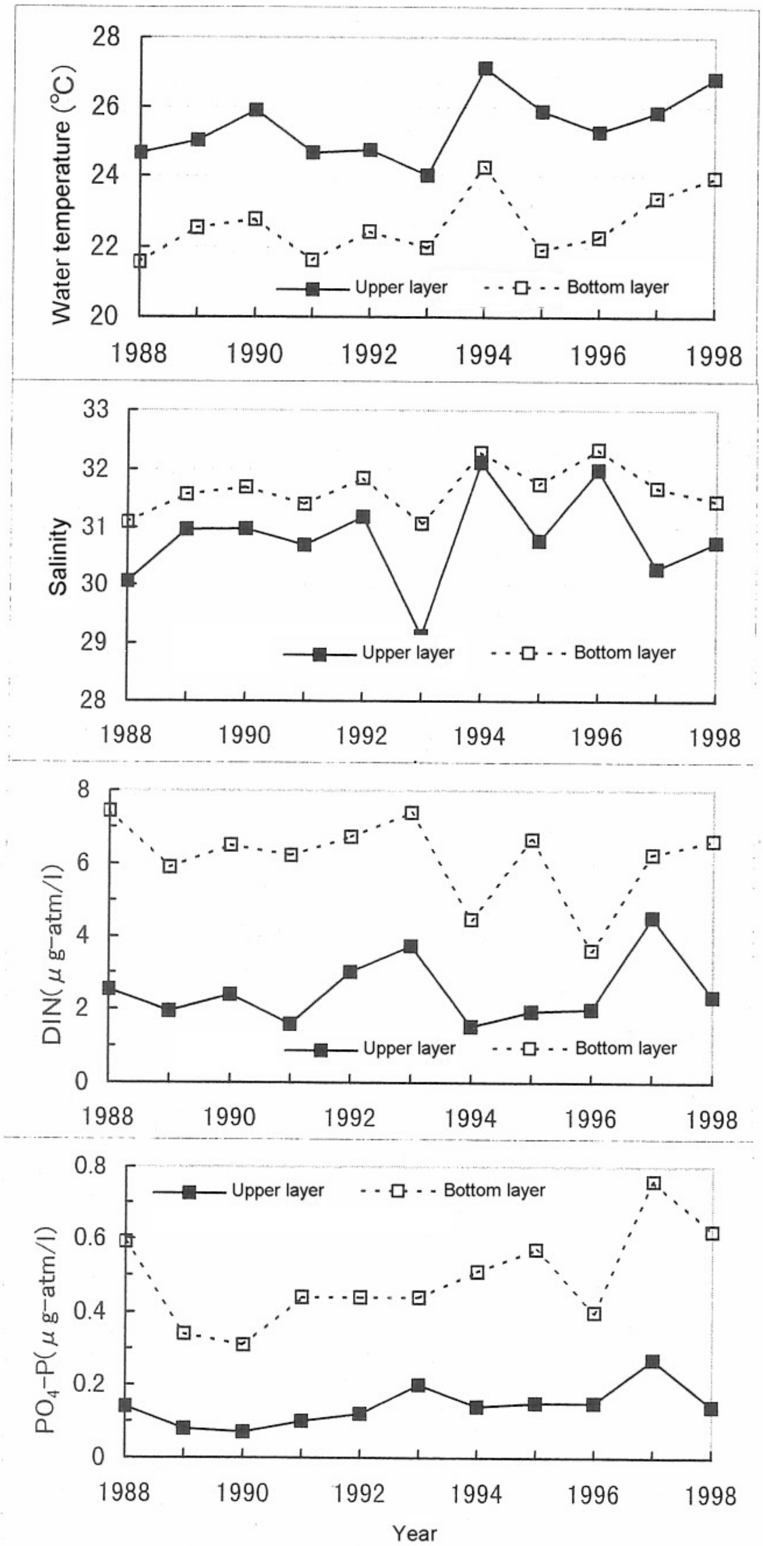


Figure 7 (1) Annual fluctuation of physico-chemical environment and cell number of red tide species during summer in the study area

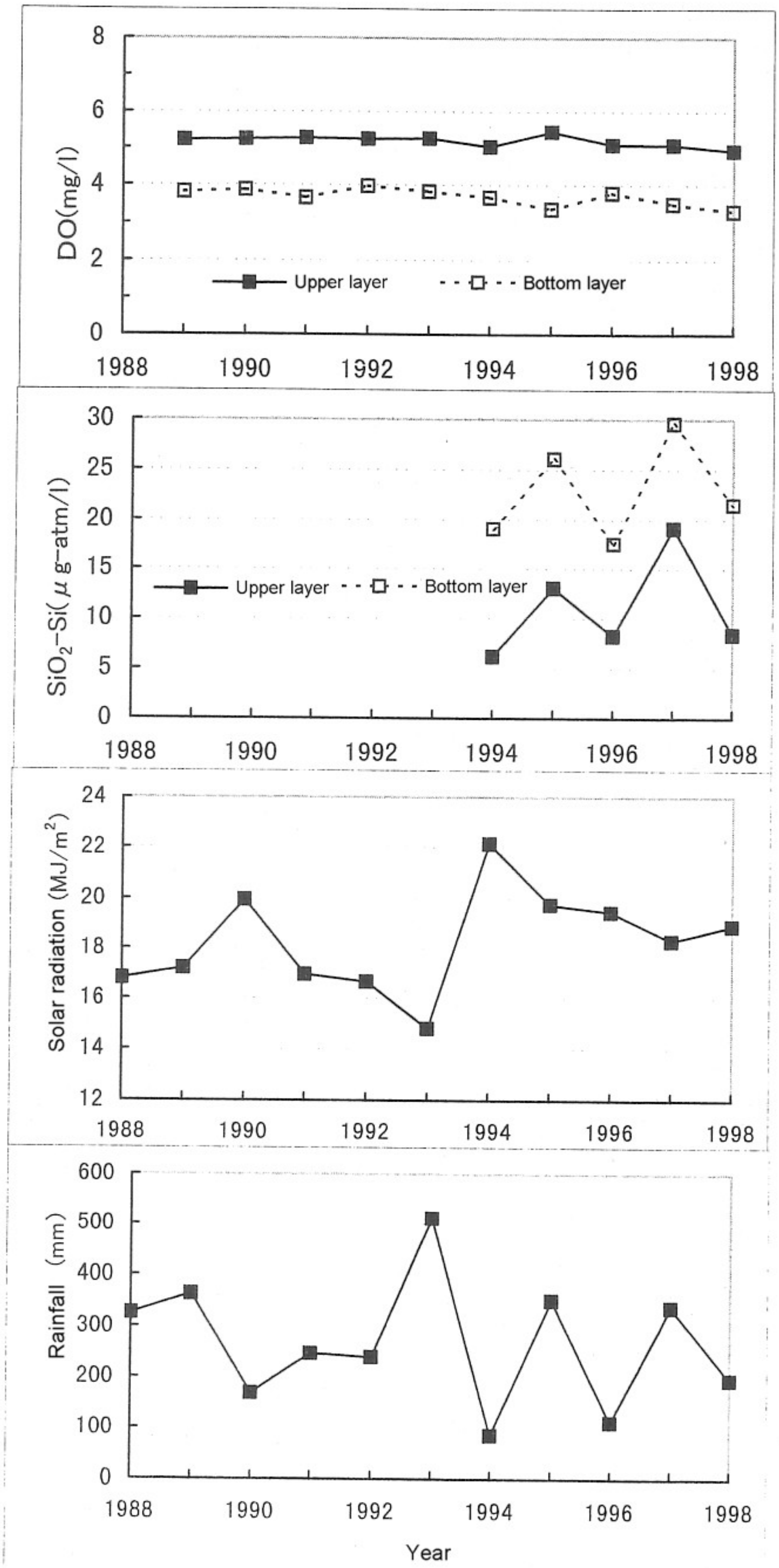


Figure 7 (2) Annual fluctuation of physico-chemical environment and cell number of red tide species during summer in the study area

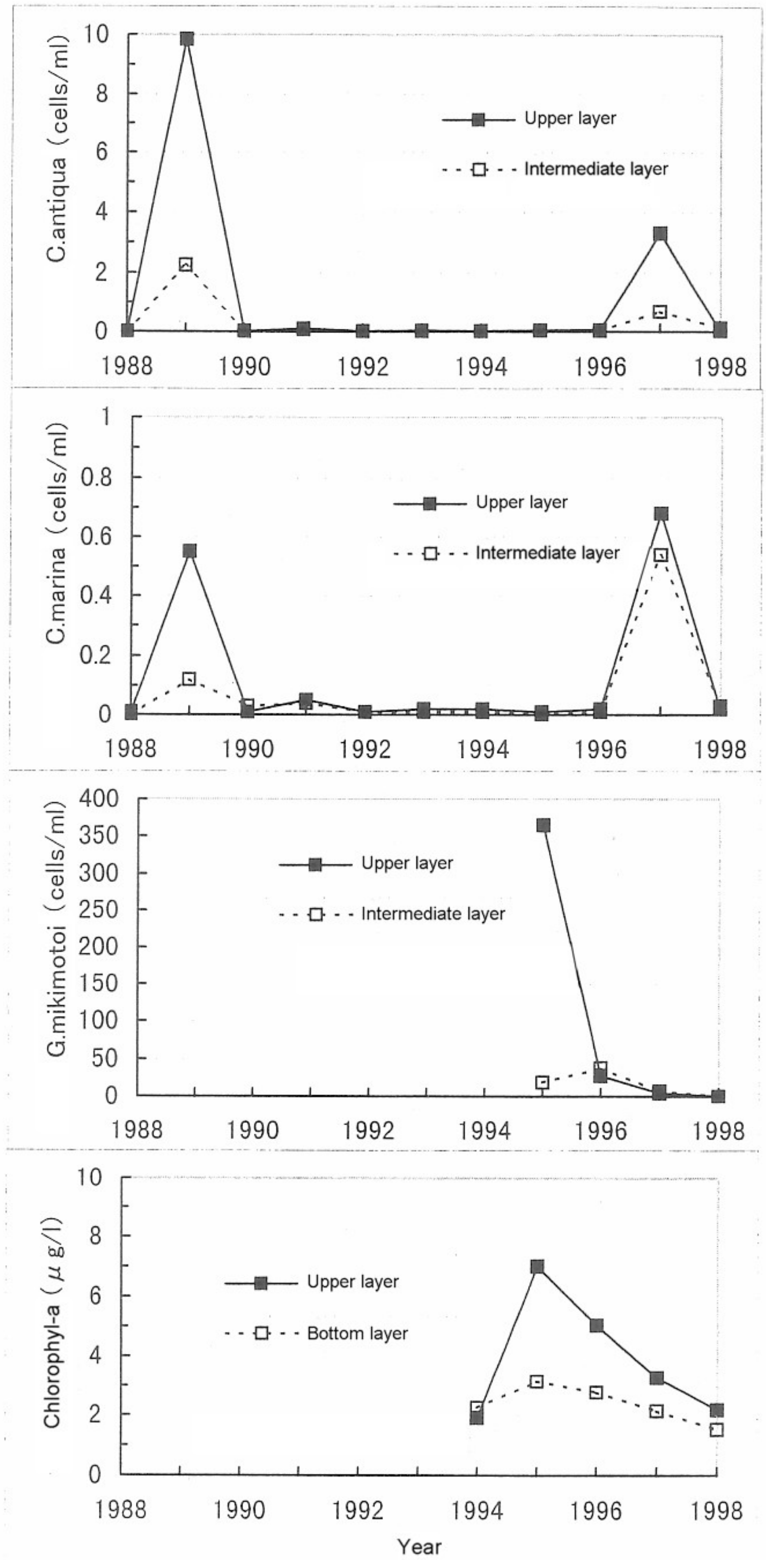


Figure 7 (3) Annual fluctuation of physico-chemical environment and cell number of red tide species during summer in the study area

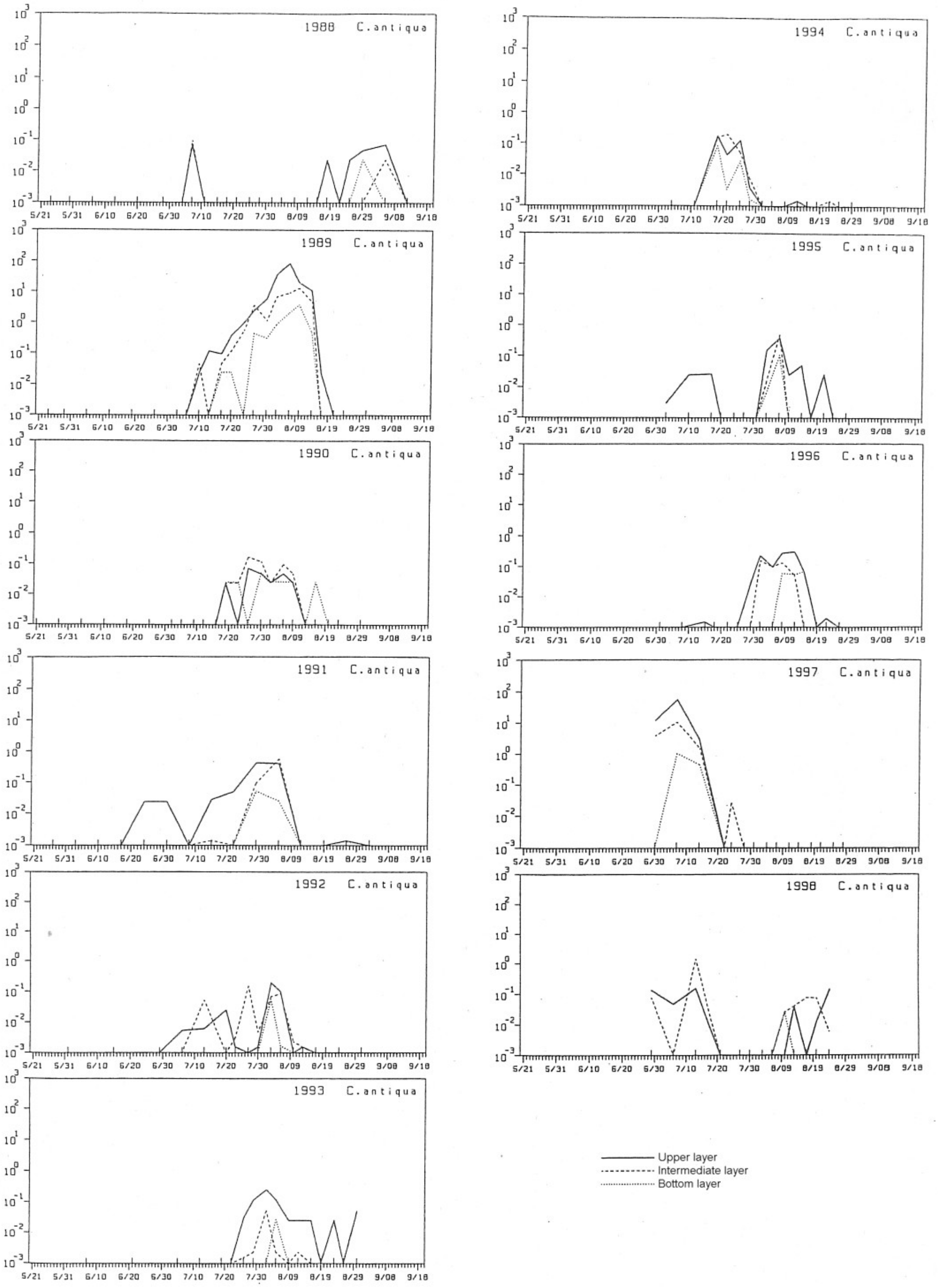


Figure 8 Chronological fluctuation of cell number of *Chattonella antiqua* averaged in the study area (cells/mL)

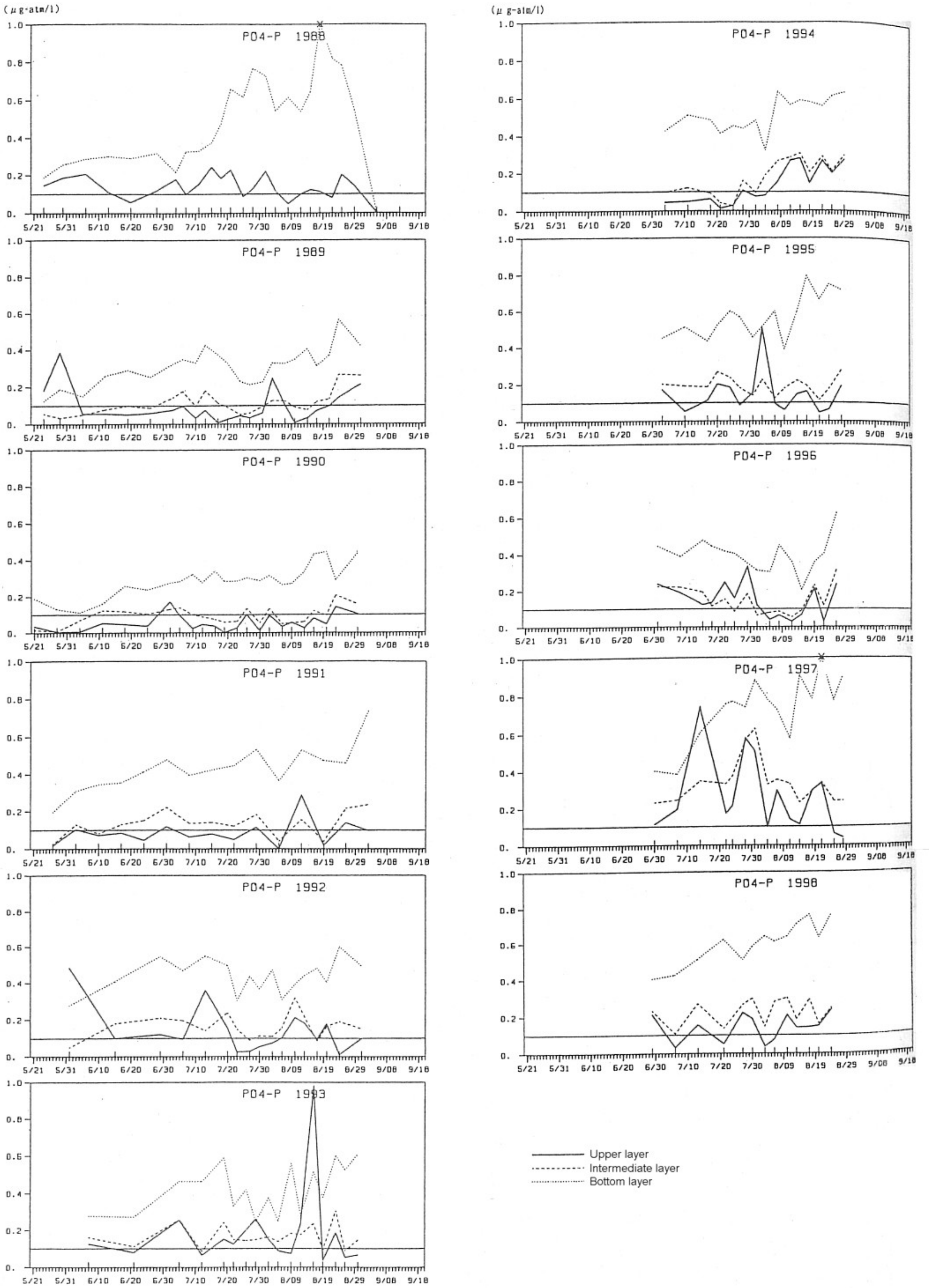


Figure 9 Chronological fluctuation of PO_4-P concentration averaged in the study area (μ g-at/L). Horizontal line shows the half saturation constant for *Chattonella antique.*

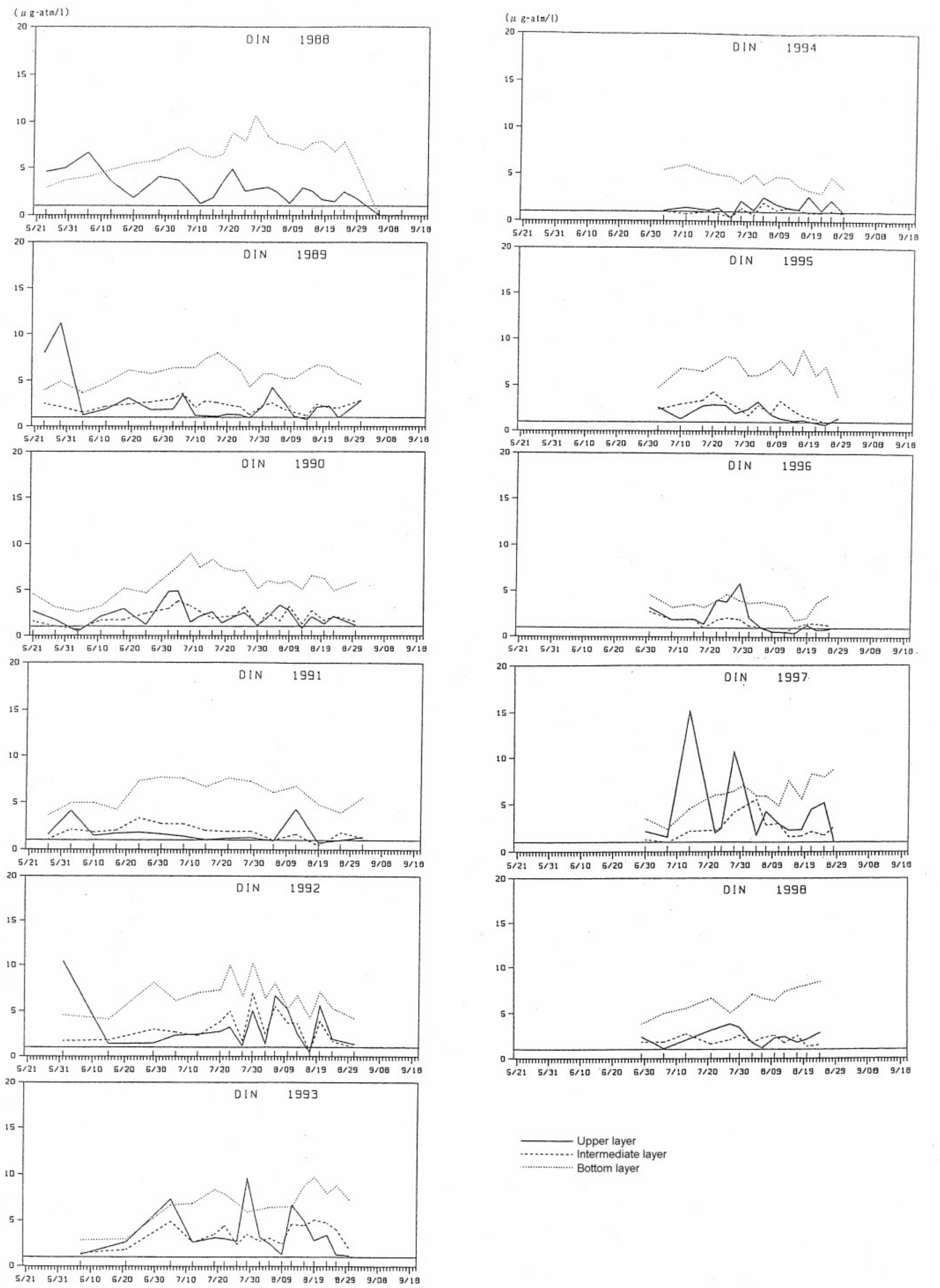


Figure 10 Chronological fluctuation of (NH4-N+NO3-N)-N concentration averaged in the study area (μ g-at/L). Horizontal line shows the half saturation constant for *Chattonella antique.*

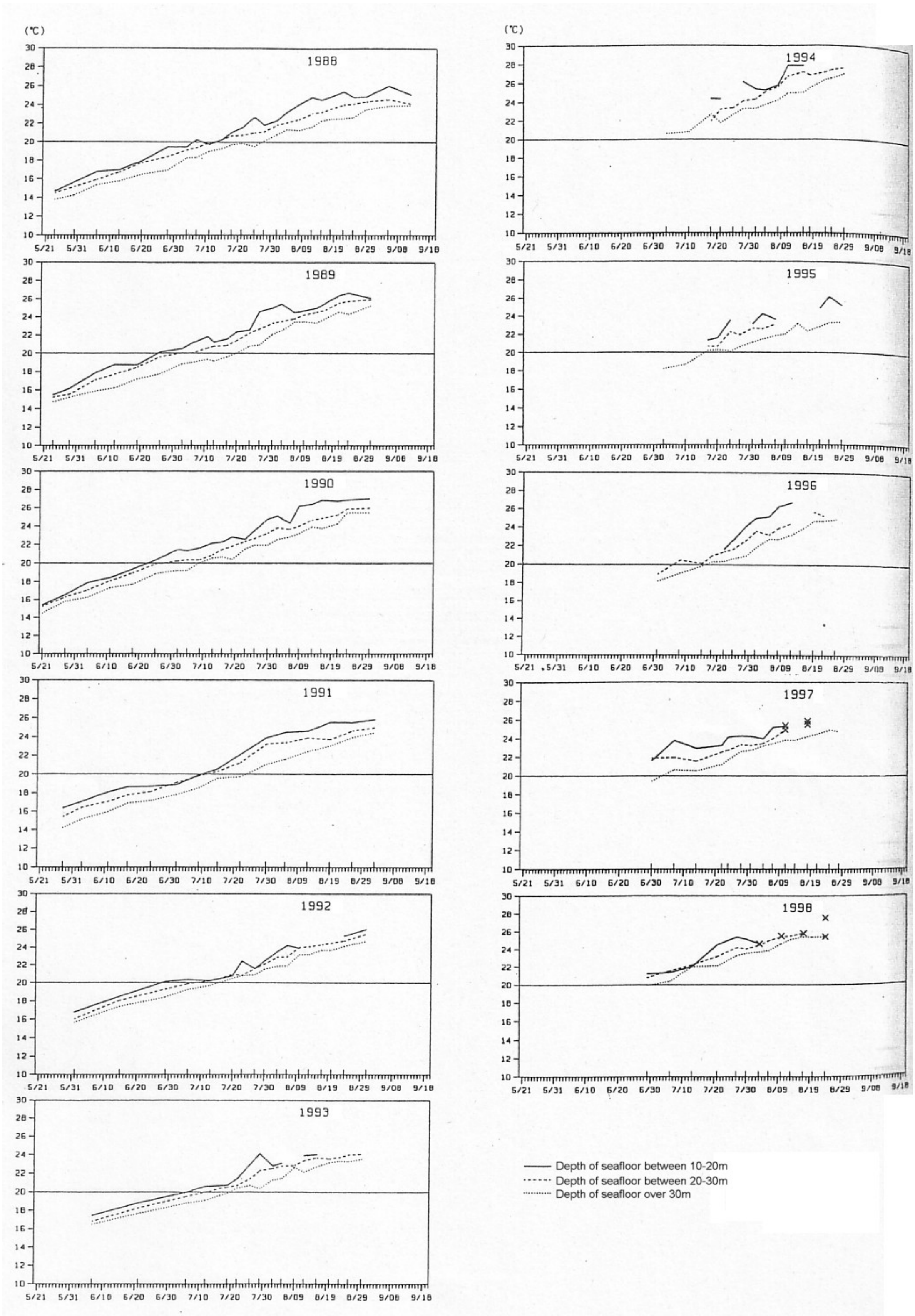


Figure 11 Chronological change in sea bottom sediment temperature (℃) by depth range averaged in the study area

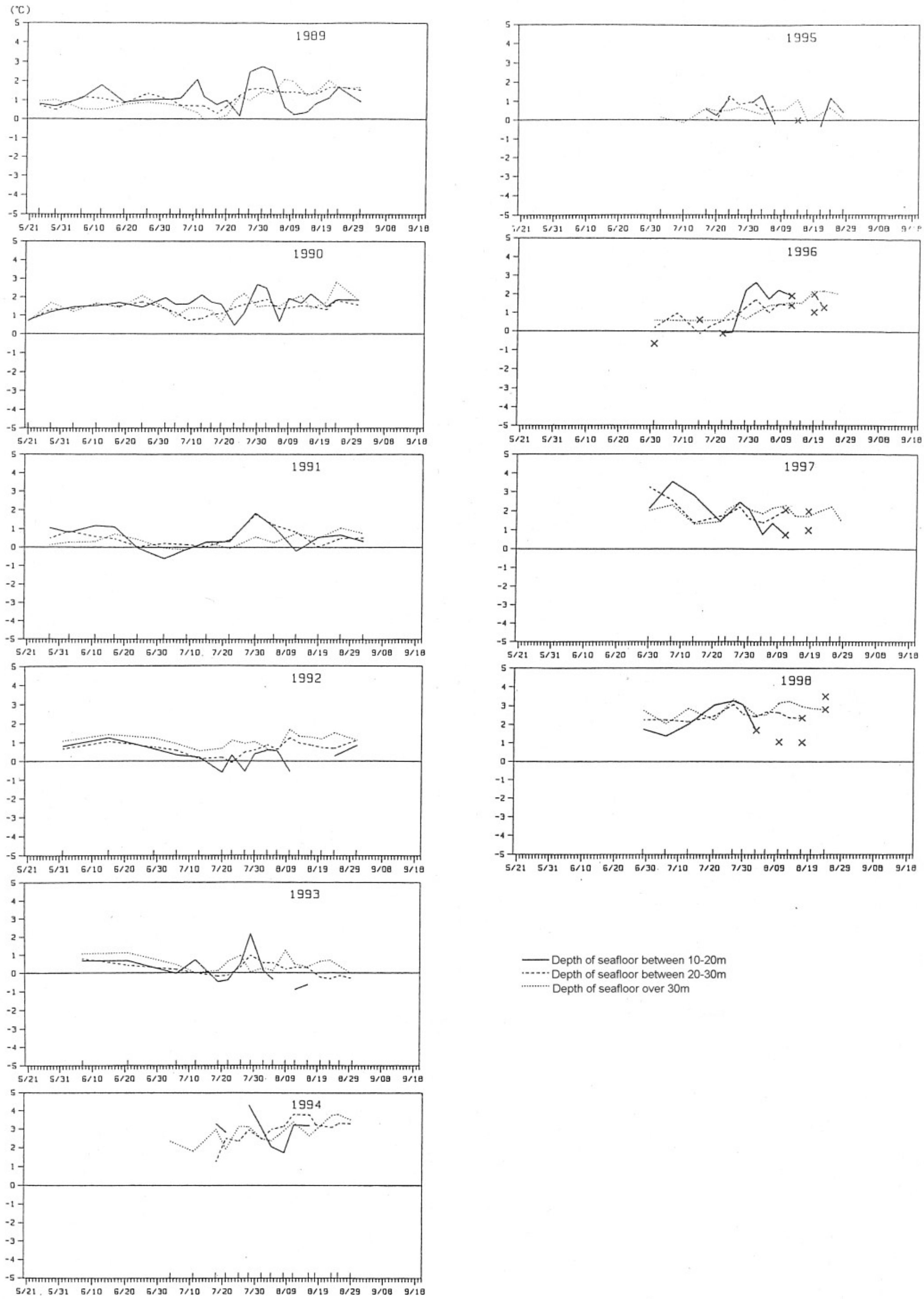


Figure 12 Difference of sea bottom sediment temperature (℃) compared with that in 1988 during spring and summer in every year

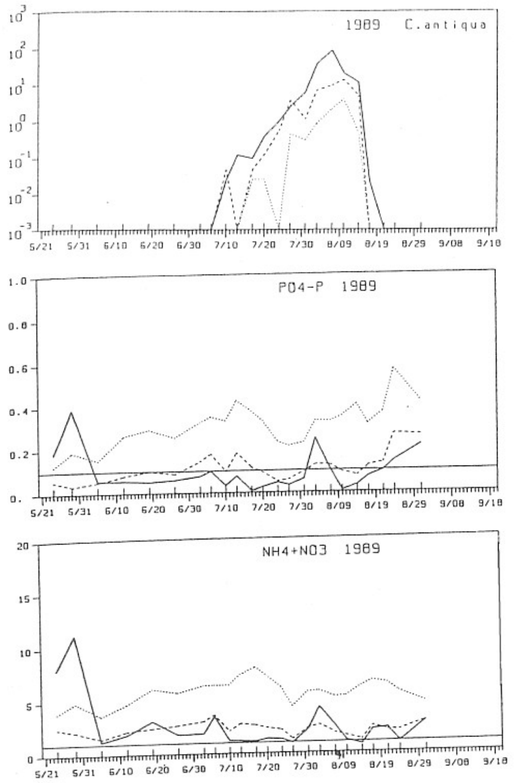


Figure 13 Chronological change in cell number of *Chattonella antiqua* and concentrations of PO4-P and (NH4+NO3)-N in 1989

Upper layer
Intermediate layer
Bottom layer

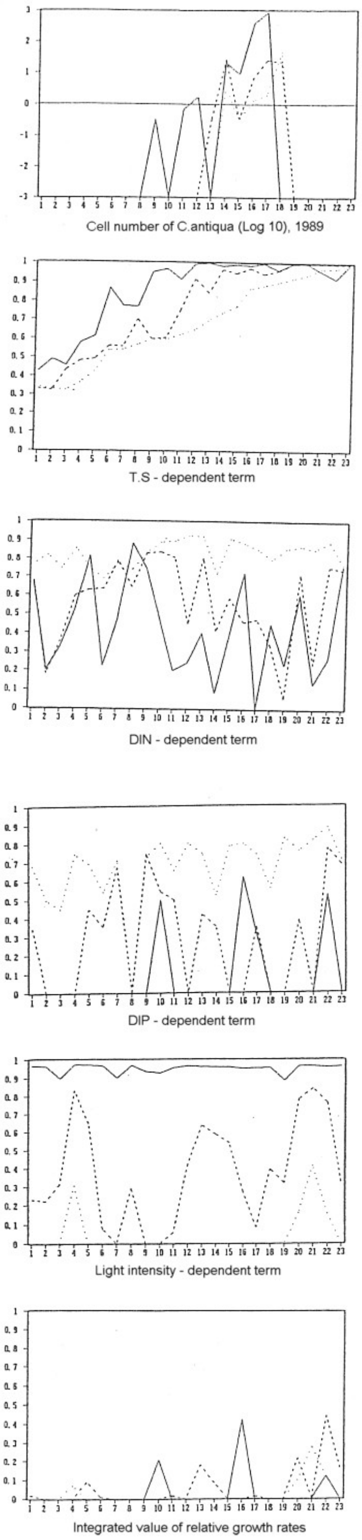


Figure 14 Chronological change in relative growth rate in 1989

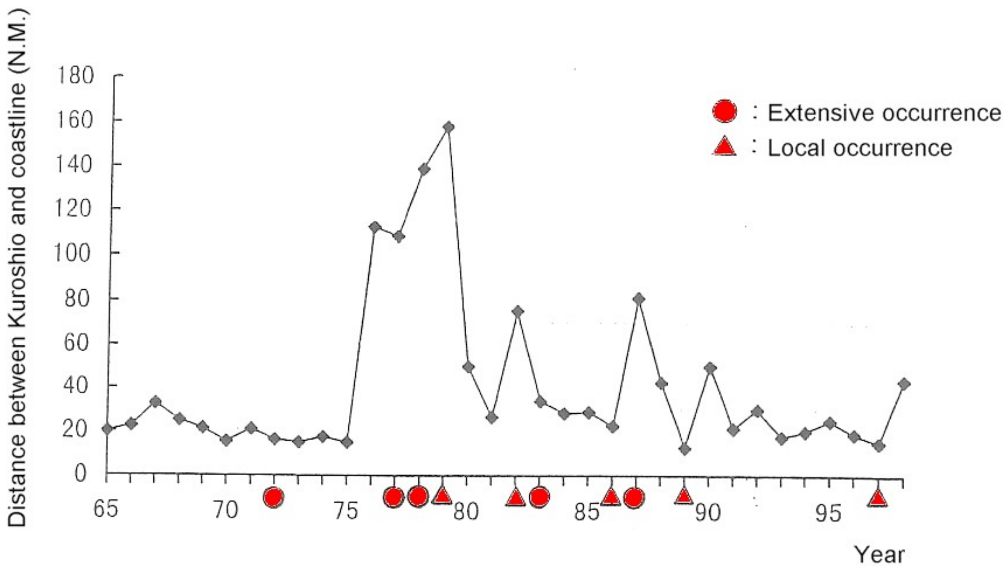


Figure 15 Relationship between occurrence of *Chattonella* bloom and distance of Kuroshio current from Cape Shiono

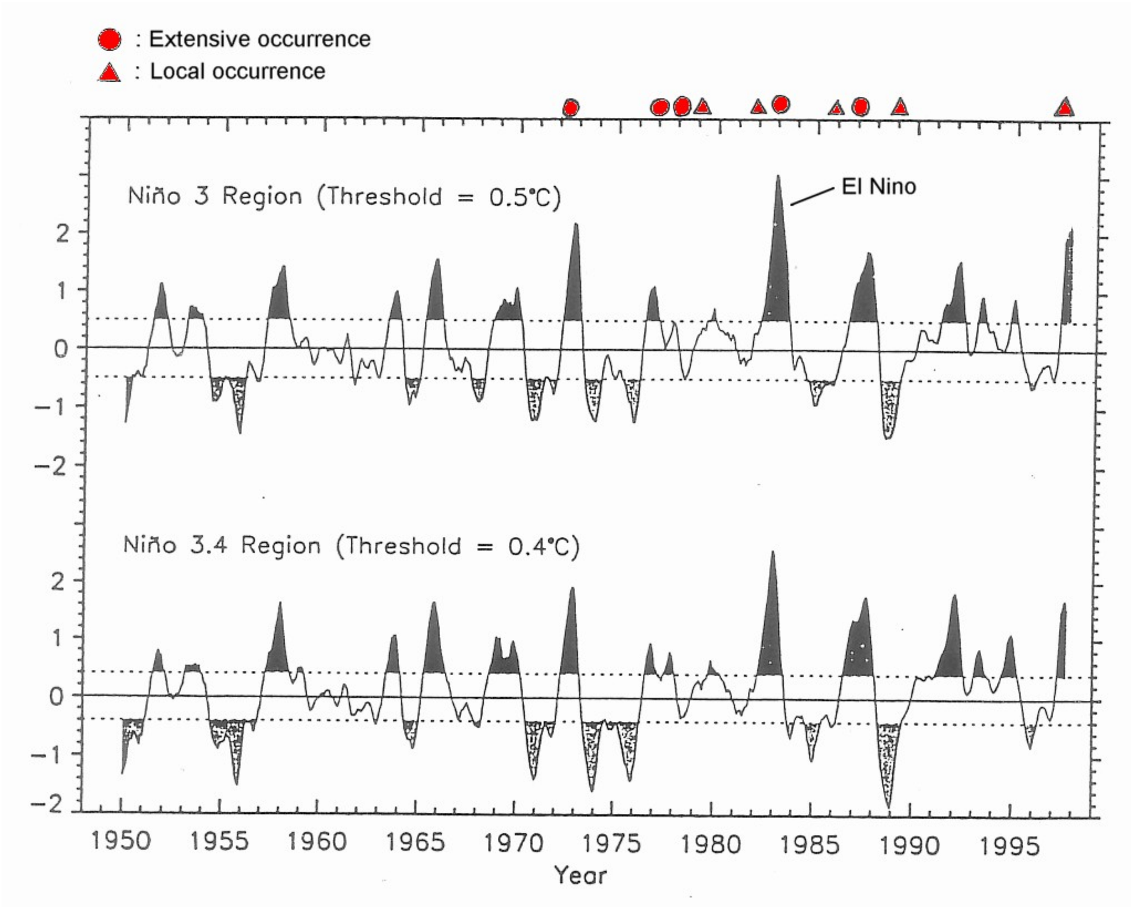


Figure 16 Relationship between occurrence of *Chattonella* bloom and El Nino

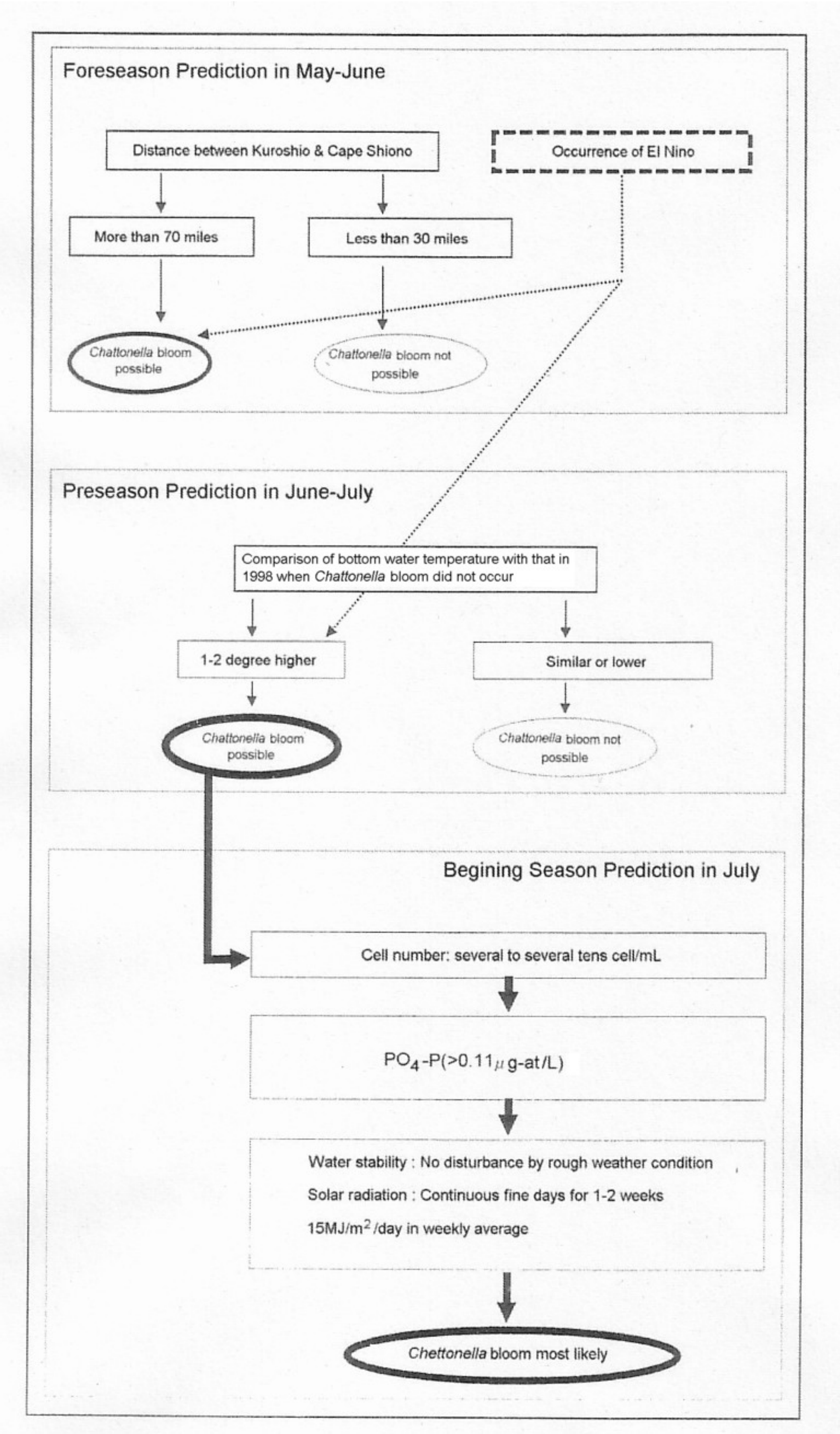


Figure 17 Procedure of Three-step Prediction Method for *Chattonella* Bloom

Table 3 Result of the Verification of Proposed Red Tide Prediction Method

Year	Foreseason prediction	Preseason prediction	Beginning season prediction			Evaluation	
	Distance to Kuroshio (mile)	Bottom water temp.	*Chattonella* cell number/mL	PO_4-P*2	Solar radiation & water disturbance	Observation	Prediction
1988	43 ( )	Norm	-	Med. to high (○)	-	-	-
1989	13 (×)	+1 - +2 (○)	<46 1 Aug (○)	High (○)	3-7 Aug., fine (○)	Occurred	Occurr
1990	50 ( )	+1 - +2 (○)	<4 6 Aug (○)	Low to med. (×)	13-17 Aug., rain 76mm (×)	No	No
1991	21 (×)	+0 - +1 (×)	<7 5 Aug (○)	Med. to high (○)	6 Aug., rain 22mm (×)	No	No
1992	30 (×)	-0.5 - +1 (×)	<5 30 Jul (○)	Med. to high (○)	7 Aug., rain 31mm (×)	No	No
1993	18 (×)	-0.5 - +0.5 (×)	<4 5 Aug (○)	Med. to high (○)	8-18 Aug., rain 120mm (×)	No	No
1994	20 (×)	+2 - +3 (○)	<3 18 Jul (○)	Low (×)	25-26 Jul., rain 20mm (×)	No	No
1995	25 (×)	+0 - +1 (×)	<19 7 Aug (○)	Med. to high (○)	9-11 Aug., wind 10-18m (×)	No	No
1996	19 (×)	+0 - +2 (○)	<4 8 Aug (○)	Low to med. To high (○)	13,14 Aug., rain 30mm (×)	No	No
1997	15 (×)	+1 - +3 (○)	<50 30 Jun (○)	Med. to high (○)	3-7 Jul., fine (○)	Occurred	Occurr
1998	44 ( )	+1 - +3 (○)	<18 13 Jul (○)	Low to med. (×)	19 Jul., rain 70mm (×)	No	No

○: *Chettonela* bloom possible

×: *Chettonela* bloom not possible

*1 Cell number is the maximum observed

*2 PO4-P concentration was compared with the half saturation constant of 0.11 μ g-at/L

Chapter 4 Activities Concerning HAB in NOWPAP Region

4.1 NOWPAP Members

Information on the activities of NOEPAP Members introduced in the National Reports in 2003 was tabulated (Table 3) in order to search activities to be supported by CEARAC. Since the information on the monitoring activity seemed to be insufficient, additional questionnaire survey was done in September 2003. The obtained data were summarized in Table 4.

Table 3. Activities concerning HAB in NOWPAP Members

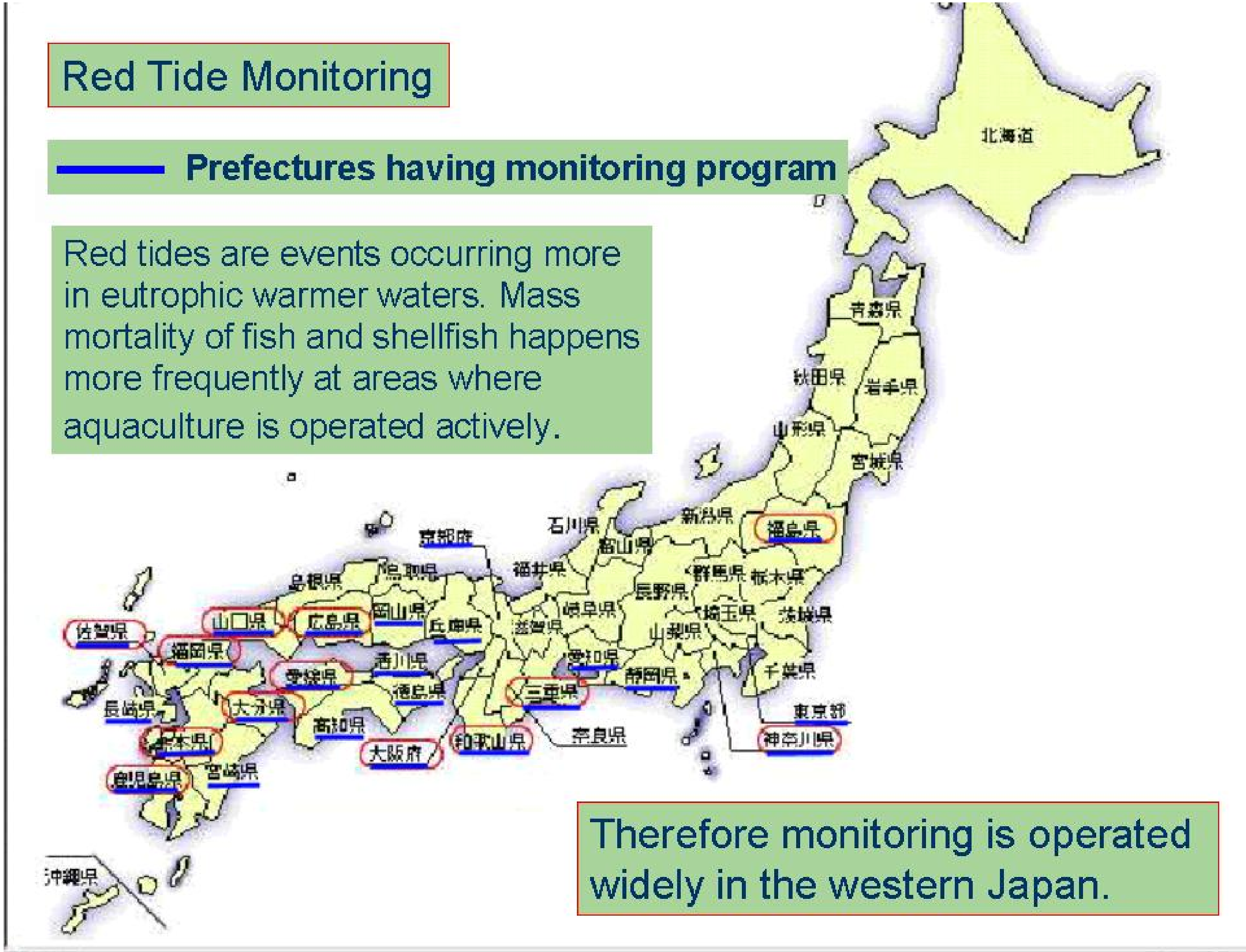
	Baseline study/analysis			Mitigation measures		
	Monitoring	Statistical analysis	Cause finding	Scientific study	Technical development	Institutional framework
Japan	◎Regular monitoring of toxicity in shells, and shell-poisoning plankton by each Prefecture in accordance with the regulation issued by the Fisheries Agency. × No monitoring system implemented for red tides due to its infrequent occurrences	△	◎ Regular monitoring of shell-poisoning plankton	◎ Field, Labo, Model	◎ Clay (conducted in certain sea areas such as Kagoshima) △ Nutrient uptake by diatoms and macroalgae △ Algicidal bacteria / virus △Predation by Cilita and heterotrophic dinoflagellates	◎ Regulation by the Fisheries Agency (reinforcement of monitoring and inspection of toxic shells, and self-regulation in the shipment of toxic shells)
China	◎ 65 sites in ECS, Various measures including aircraft and satellite imagery Parameters - HAB species - Water quality - Hydrology/ Oceanography - Meteorology	◎	○ Eutrophication and cyst	◎ Field, Labo, Model	△ Clay lack of study of adverse effect	△
Korea	◎160 sites in coastal water area Mainly water sampling, and satellite image is being used. Parameters - HAB species - Water quality - Hydrology/ Oceanography Meteorology	◎	○ Eutrophication and cyst	◎ Field, Labo, Model	△ Clay lack of study of adverse effect	◎ Relief bank loans, Experts & instrument, actual practices
Russia	△ No national monitoring program	△	× Eutrophication and cyst	○	×	×

◎: Excellent, ○: Good, △: Insufficient, ×: Lacking

Note: For Japan, the baseline study / analysis refer only to the NOWPAP Region, whereas the mitigation measures refer to the entire country.

Table 4. Detailed Monitoring Activity by NOWPAP Members Based on the Questionnaire Survey

Country	Agencies	Regular monitoring					Trace monitor-ing	Remote sensing	Satellite	Eutrophication parameters	Areas of eutrophication
		Conduc-tion	Stations	Frequen-cy	Method	No. of organiza-tions					
Japan	Prefectural fishery research stations, Prefectural environment divisions, Japan Coast Guard, Japan Meteorological Agency, Fisheries Research Agency, Prefectural institutes of public health	Yes	100s	>10/yr	Water sampling	Several	Yes	Yes	No	COD, TOC, Transparency, TN, TP, IN, IP, DO H_2S and ORP of sediment	Coastal area of Northern Kyushu Bays of Imari, Hakata, Dokai
China	State Oceanic Administration, State Environmental Protection Administration, Ministry of Science and Technology, National Science Foundation, Chinese Academy of Sciences, Ministry of Education	Yes	14 monitoring zones, each having several monitoring points	Vary with the nature of the zone	Water sampling and remote sensing	> 5	Yes	Yes	Yes	TN, IN	Coastal areas of East China Sea, Bohai Sea Bays of Pearl River Esturay, Daya Bay
Korea	National Fisheries Research & Development Institute, Regional Ministry of Maritime Affairs & Fisheries, National Maritime Police Agency	Yes	77 (refer to fig.)	10 / year	Water sampling	7	Yes	Yes	Yes	COD, TOC, Transparency, TN, TP, IN, IP, DO	Coastal areas of Masan, Yeosu, Busan Bays of Chinhae, Ulsan, Yeongil
Russia	Aquaculture and Inshore Bioresources Research Center, Institute of Marine Biology FEBRAS	Yes	5	>10yrs	Water sampling	1	No	No	No	BOD, Transparency	Coastal areas of Primorye and Sakhalin Island

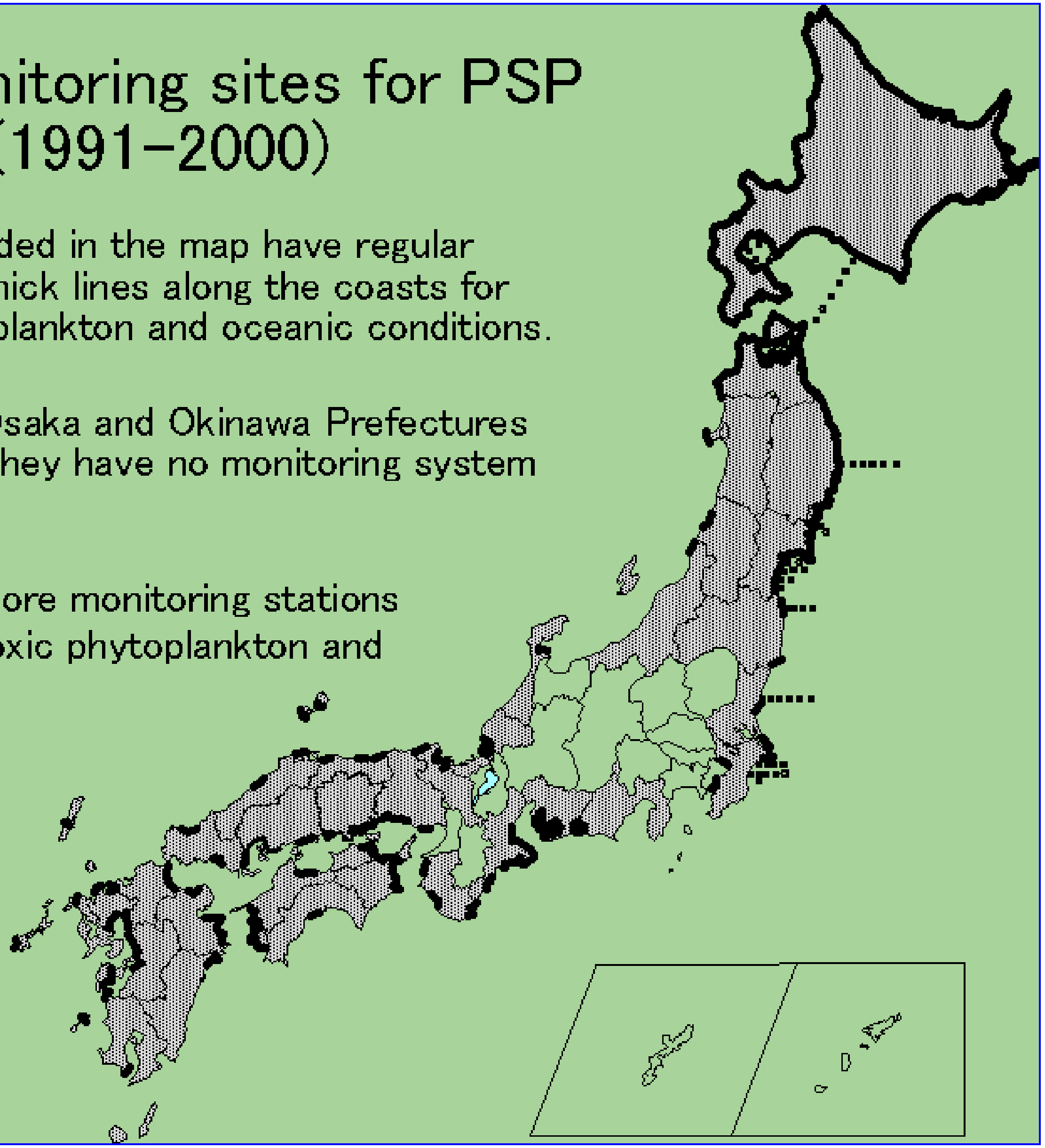

Red Tide Monitoring
Prefectures having monitoring program
Red tides are events occurring more in eutrophic warmer waters. Mass mortality of fish and shellfish happens more frequently at areas where aquaculture is operated actively.
Therefore monitoring is operated widely in the western Japan.
北海道
青森県
秋田県
岩手県
山形県
宮城県
新潟県
福島県
石川県
富山県
京都府
鳥取県
島根県
福井県
群馬県
栃木県
長野県
岡山県
広島県
山口県
佐賀県
福岡県
兵庫県
滋賀県
岐阜県
埼玉県
茨城県
山梨県
愛媛県
香川県
愛知県
静岡県
千葉県
徳島県
三重県
大分県
長崎県
東京都
高知県
熊本県
和歌山県
奈良県
神奈川県
大阪府
鹿児島県
宮崎県
沖縄県

Recent regular monitoring sites for PSP and DSP in Japan (1991–2000)

In Japan, 34 prefectures shaded in the map have regular monitoring sites showed with thick lines along the coasts for shellfish poisoning, toxic phytoplankton and oceanic conditions.

Tokyo, Kanagawa, Toyama, Osaka and Okinawa Prefectures have the coastlines, however, they have no monitoring system for shellfish poisonings.

Some prefectures have offshore monitoring stations showed with open circles for toxic phytoplankton and oceanic conditions.



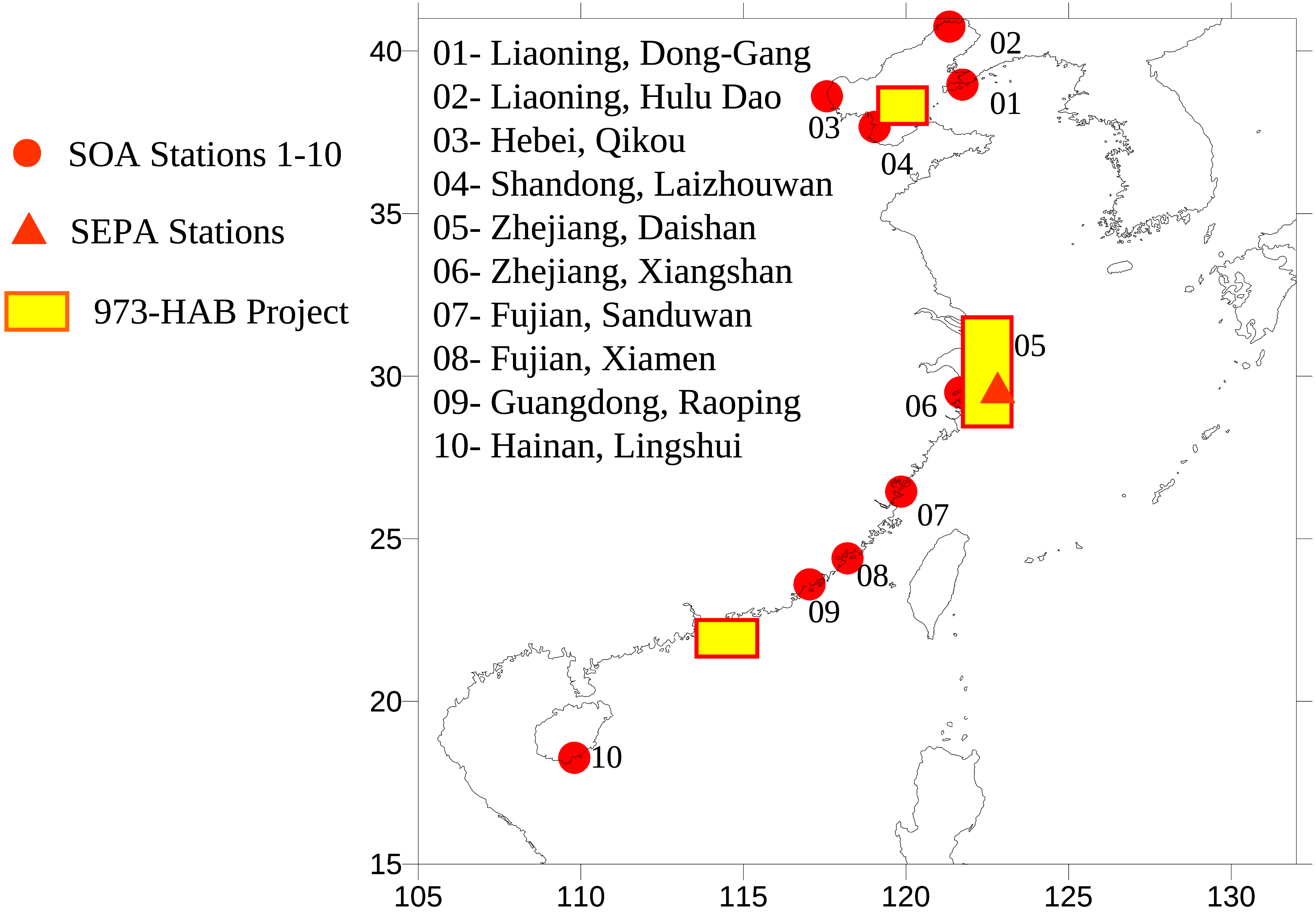

SOA Stations 1-10
SEPA Stations
973-HAB Project
01- Liaoning, Dong-Gang
02- Liaoning, Hulu Dao
03- Hebei, Qikou
04- Shandong, Laizhouwan
05- Zhejiang, Daishan
06- Zhejiang, Xiangshan
07- Fujian, Sanduwan
08- Fujian, Xiamen
09- Guangdong, Raoping
10- Hainan, Lingshui
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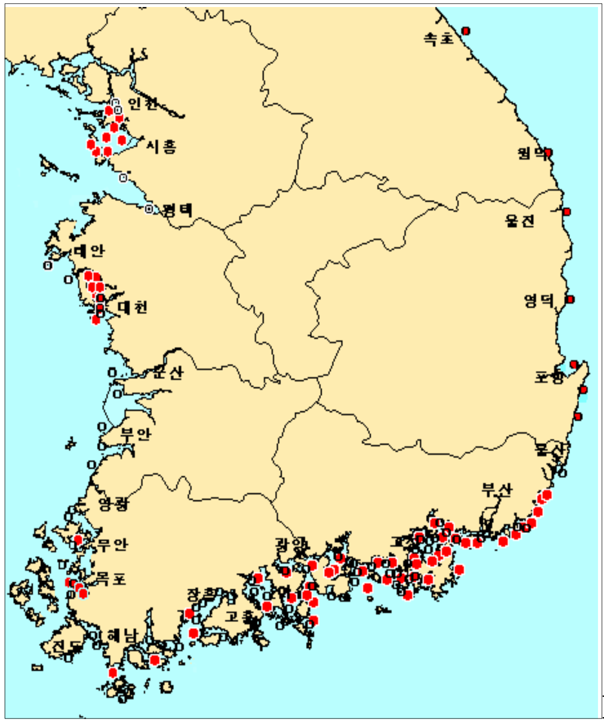
Fig. 1 HABs Monitoring System in Korea



Organization	Area	Methods	Duration
NFRDI	77 station, All coasts	Research Vessels	Monthly (Feb.-Nov.) Daily (HAB period)
Local MOMAF	92 station, 39 costal area	On shore watch & Vessels	Weekly (Apr.-Oct.)
NMPA	All coasts	Helicopter	Daily (HAB period)

NFRDI: National Fisheries Research and Development Institute
MOMAF: Ministry of Maritime Affairs & Fisheries
NMPA: Nation Maritime Police Agency

4.2 International Organizations and Programs

The following table was prepared to identify the activities of other international organizations and programs, thus prevent overlaps in future CEARAC programs. However, we have not obtained much information on the activities of these organizations and programs yet. We expect to obtain the relevant information and fill the list through the WG. Although IOC/WGHABD is a program conducted in North Atlantic Ocean, we included in the list for CEARAC's reference.

Table 5. Activities for solution of HAB problems in international organizations and programs

	IOC (GEOHAB, IOC SCC)	PICES
1. Monitoring		
・Planning	・GEOHAB	
・Preparation of equipments		
・Human resource		
・Fund		
・Sampling	・Monitoring of marine harmful algal species (IOC SCC CPH, IOC SCC VIGO) ・Investigations within various joint research projects (IOC SCC CPH)	
・Analysis	・Identification of marine harmful algal species (IOC SCC CPH, IOC SCC VIGO) ・Identification sheets on harmful marine phytoplankton (IOC SCC CPH)	
・Provision of guidelines for reporting		
・Preparation and distribution of report (including analysis result)		
2. Evaluation	・GEOHAB	
・Mutual evaluation		
・Technical training		
3. Identification of cause		
・Planning	・GEOHAB	
・Preparation of equipments	・The Scandinavian culture collection (IOC SCC CPH) ・Established a reprint collection including a data in taxonomy, ecology, toxicology etc. on toxic algae (IOC SCC CPH)	
・Human resource		
・Fund		

・Research	・Advice in ecological and to some extent in toxicological matters including assessment of potential health risks associated with blooms (IOC SCC CPH) ・Taxonomy of harmful microalgae (IOC SCC VIGO) ・Autoecology and bloom dynamics of harmful microalgae (IOC SCC VIGO) ・Establishment of cultures of toxic algae (IOC SCC CPH, IOC SCC VIGO)	
・ Preparation and distribution of report (including analysis result)	・ Data analysis and development of harmful microalgae related data bases (IOC SCC VIGO)	
・Information sharing		
4. Research on mitigation measures		
・Planning		
・ Preparation of equipments		
・Human resource		
・Fund		
・Research		
・Preparation of reports and research papers (including analysis result)		
・Information sharing		
5. Mitigation measures		
・Planning		
・ Preparation of equipments		
・Human resource	・ Supervision of PhD students from developing countries (IOC SCC CPH)	
・Fund		
・ Implementation of mitigation		
・Preparation of report		
・Dissemination		
・Planning		
・ Preparation of equipments		
・Human resource		
・Fund		
・Preparation of text book for seminar	・Taxonomic identification of occurring phytoplankton species, and the reliable quantitative and qualitative determination of toxins, especially with respect to harmful and toxic phytoplankton (IOC SCC CPH, IOC SCC VIGO) ・Publication of identification material, manuals and guides for harmful algae (IOC SCC CPH)	
・Distribution of text book		
6. Institutional support		
・Legislative support		
・Proposal on provision of organization		

・Proposal on financial reinforcement		
Others		

Chapter 5 Plan of Work for HAB Problems in NOWPAP Region

To be completed based on the discussion of the WG Meeting. Newly proposed activities, if any, will be supplemented.

References

Kim, H.G., S.G. Lee, C.S. Jeong and H.M. Bae (2002) Current situation of harmful algal blooms and mitigation strategies in Korean coastal waters. In: Precautional measures and removal of harmful/toxic algae bloom (eds. Hiroshi, S., Imai, I. and Ishimaru, T.). Suisangaku Series 134, 134-150. (in Japanese)

Lee, S.G., H.G. Kim, E.S. Cho and C.K. Lee (2002) Harmful algal blooms (red tide): management and mitigation in the Republic of Korea. In: Harmful Algal Blooms in the PICES Region of the North Pacific. (eds. F.J.R. "Max" Taylor and V.L. Trainer). PICES Scientific Report, North Pacific Marine Science Organization, 23, 39-45.

Qi, Y., Z. Zhang, Y. Hong, S. Lu, C. Zhu and Y. Li (1993) Occurrence of red tides on the coasts in China. In: Toxic Marine Phytoplankton (eds. Smayda, T.J. and Y. Shimizu). Elsevier, Amsterdam, 43-46.

Yan, T., M.J. Zhou and J.Z. Zou (2002) A national report on harmful algal blooms in China. In: Harmful Algal Blooms in the PICES Region of the North Pacific (eds. By F.J.R. "Max" Taylor and V.L. Trainer). PICES Scientific Report, North Pacific Marine Science Organization, 23, 21-32.

Zhu, M., R. Li, X. Mu and R. Ji (1997) Harmful algal blooms in China seas. Ocean Res., 19, 173-184.

Appendices

Appendix 1 Definition of HAB by NOWPAP Members and selected organizations

Appendix 1. Definition of HAB by NOWPAP Members and selected organizations

Country / Organization	Definition of HAB		Remarks
	Red tide – non toxic	Red tide – toxic	
	Non red tide – non toxic	Non red tide – toxic	
Japan	✔	✔	“Two types of HAB are known to occur in the Japanese coastal waters. The first type is red tide, some of which cause mass mortality of fish and shellfish. The second type is blooming of toxin-producing phytoplankton.” (National Report)
		✔	
China	✔	✔	“HAB is also called ‘red tides’” (National Report) “Red tide is called as harmful algal blooms…. Quite amount of red tides are harmless. However, red tides occurred frequently and widely, which destroyed fishery resources and mariculture, …. (China HAB Web Site)
Korea	✔	✔	National Report did not refer to fish and shellfish poisoning.
Russia	✔	✔	National Report paid attention to the shellfish poisoning and table 3 showing past Russian HABs in the Report included HABs with low density of 10^2 cells/L.
		✔	
IOC/WESTPAC	✔	✔	“About 300 species of micro algae are reported at times to form mass occurrence, so called blooms. Nearly one fourth of these species are known to produce toxins. The scientific community refers to these events with a generic term, ‘Harmful Algal Bloom (HAB)’, recognizing that, because a wide range of organisms is involved and some species have toxic effects at low cell densities, not all HABs are ‘algal’ and not all occur as ‘blooms’.” (http://www.ioc.unesco.org/hab/)
		✔	
US EPA	✔	✔	“The species of marine phytoplankton that cause HABs vary dramatically. While some are toxic only when concentrations reach high densities, others can be toxic at very low densities.” (http://www.epa.gov/owow/estuaries/coastlines/summer98/harmfulalga.html)
		✔	