

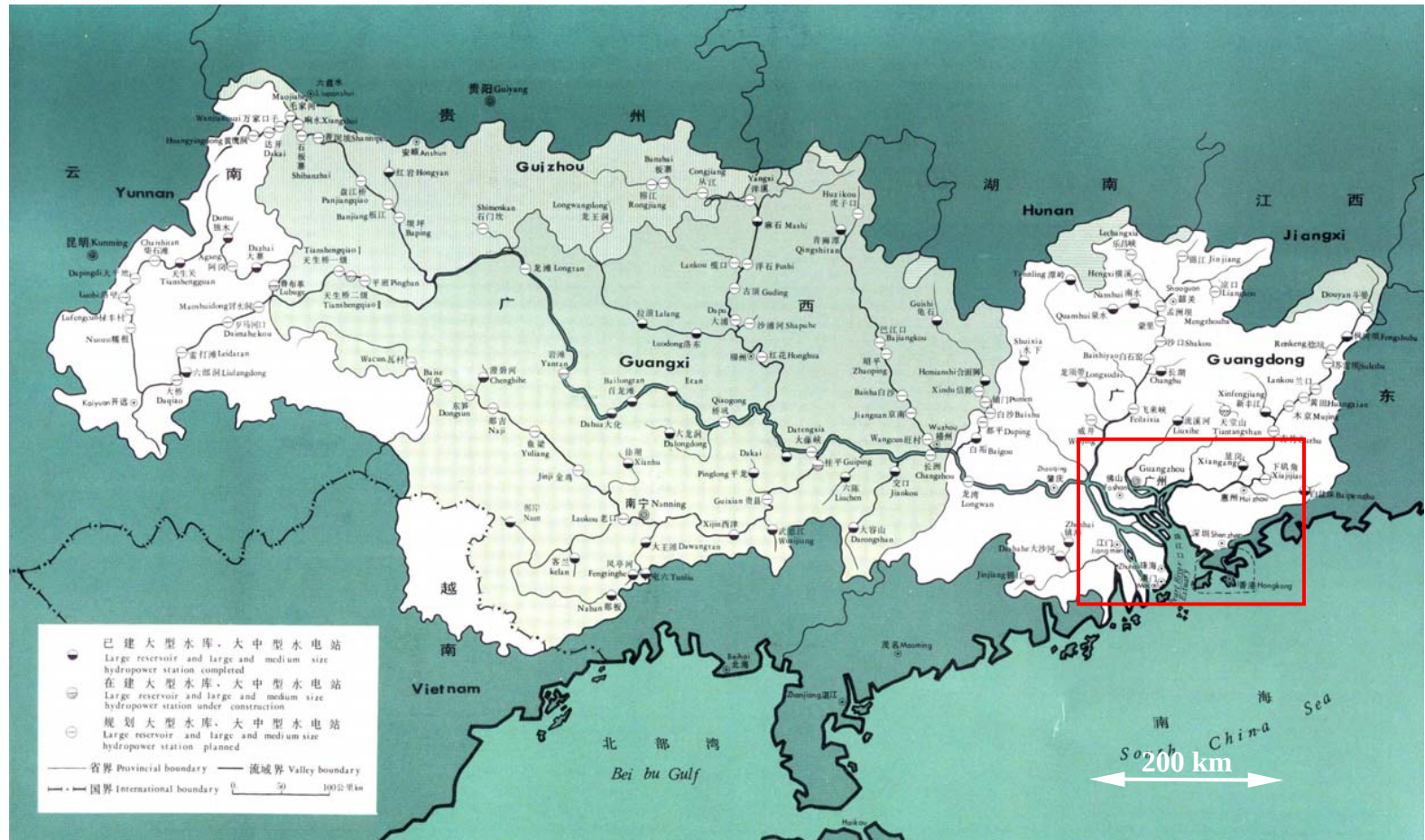
HABs in Hong Kong Waters

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Environment Program
Hong Kong Univ Science & Technology
Hong Kong

South China Sea

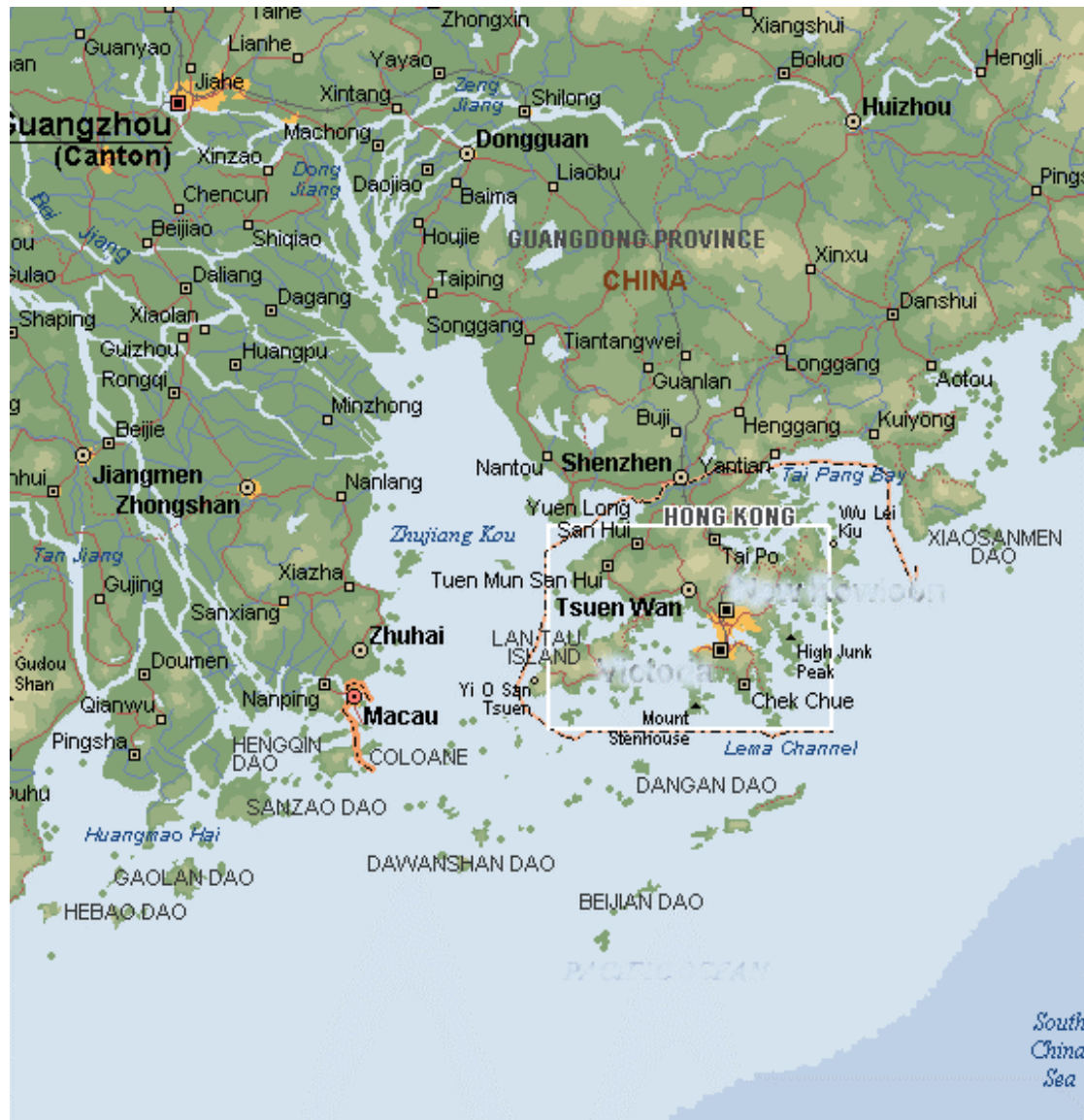


Pearl River and Pearl River Estuary

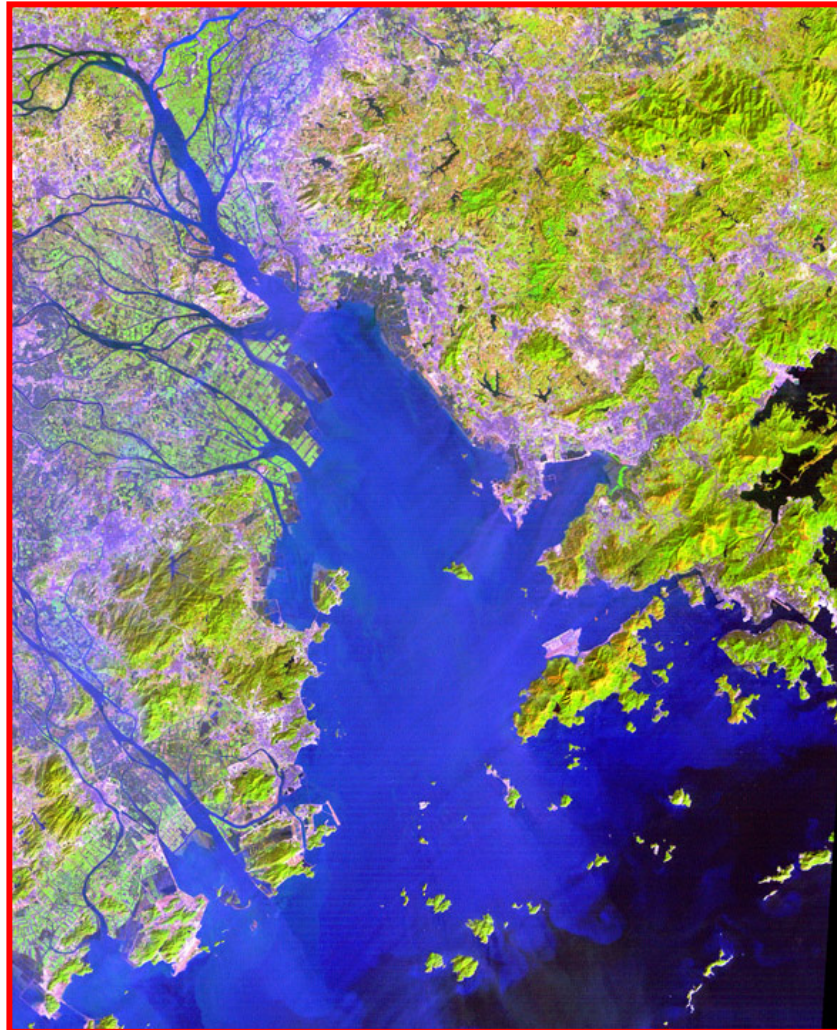


- Growing Population
- Increasing Environmental Stress

Pearl River Estuary



Pearl River Estuarine Coastal Plume



Pearl River Estuary & Hong Kong



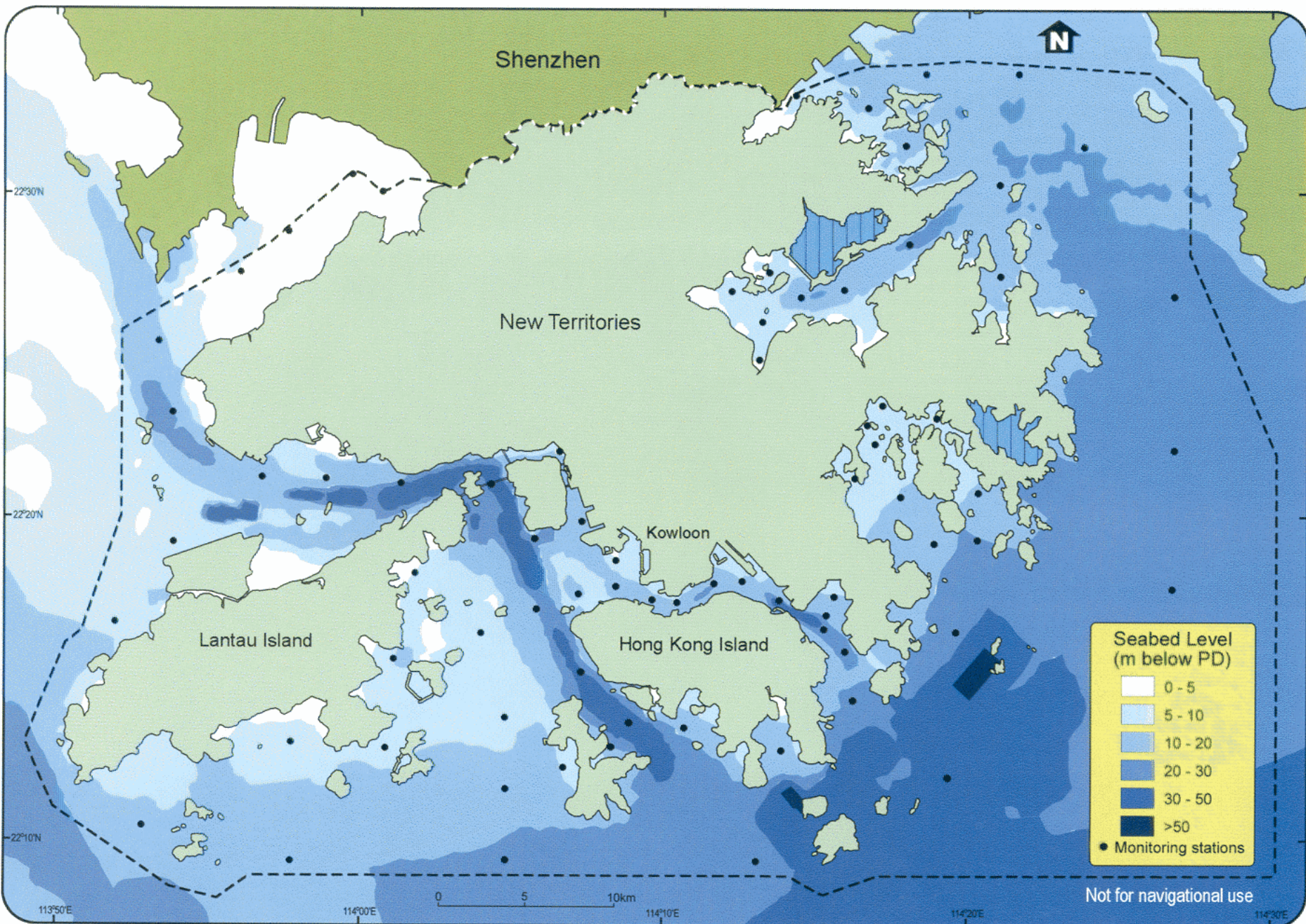


Figure 1.8 Bathymetry of Hong Kong Marine Waters in 2001

Hong Kong Setting

- Spatial and temporal variability
- Spatial Components
 - Pearl River
 - Pearl River Estuary
 - Victoria Harbor
 - Eastern waters (e.g. Mirs Bay)
 - Offshore from South China Sea

Temporal Components

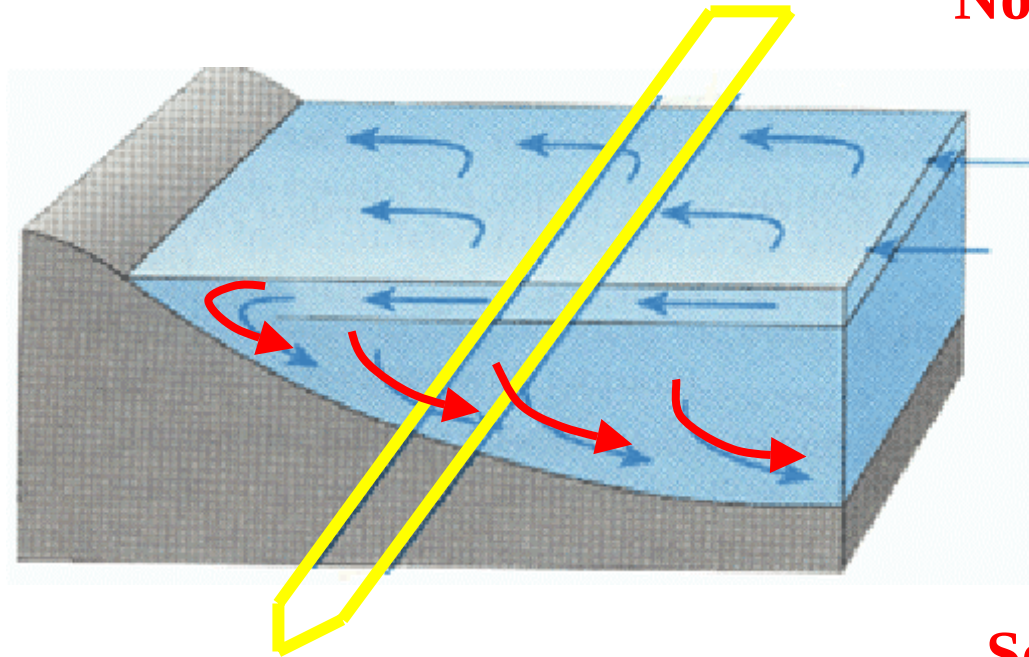
1) Dry Season

- low rainfall, lower T, higher S, clear water

2) Wet Season

- high rainfall, high T, lower S, turbid water
- high Pearl River discharge + other runoff

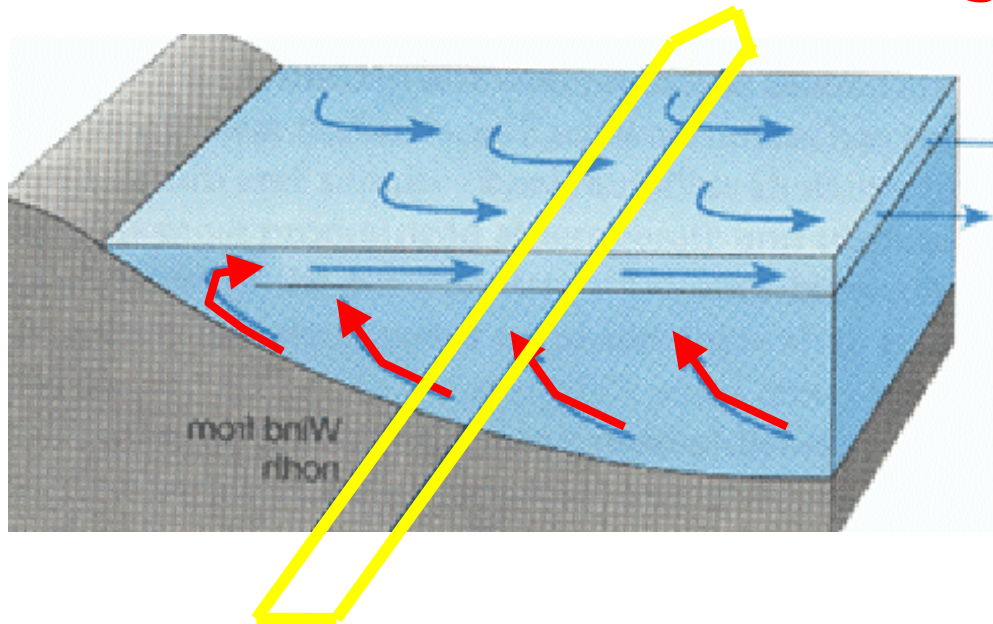
Northeast Monsoon



Winter

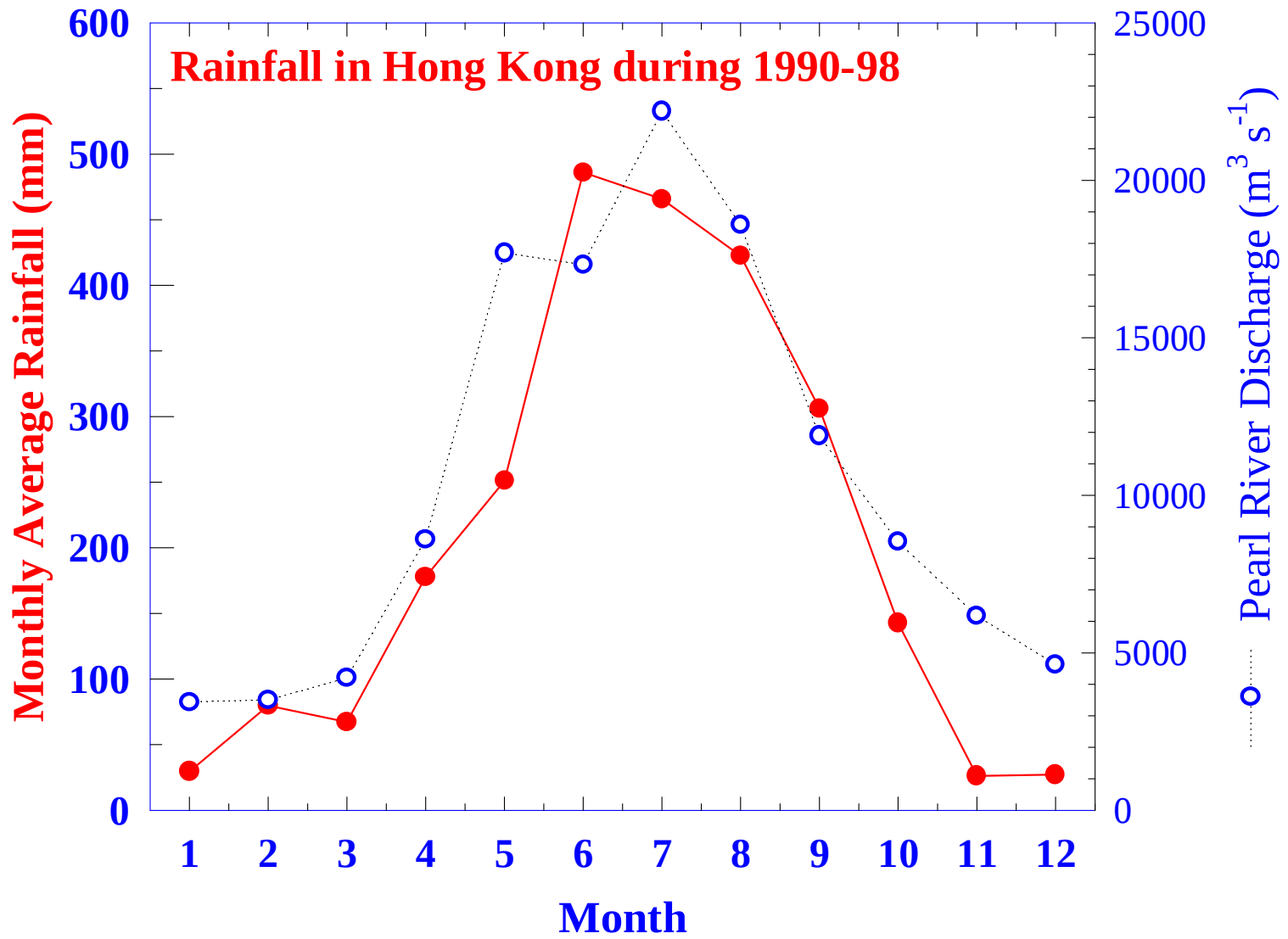
**Coastal
Downwelling**

Southwest Monsoon

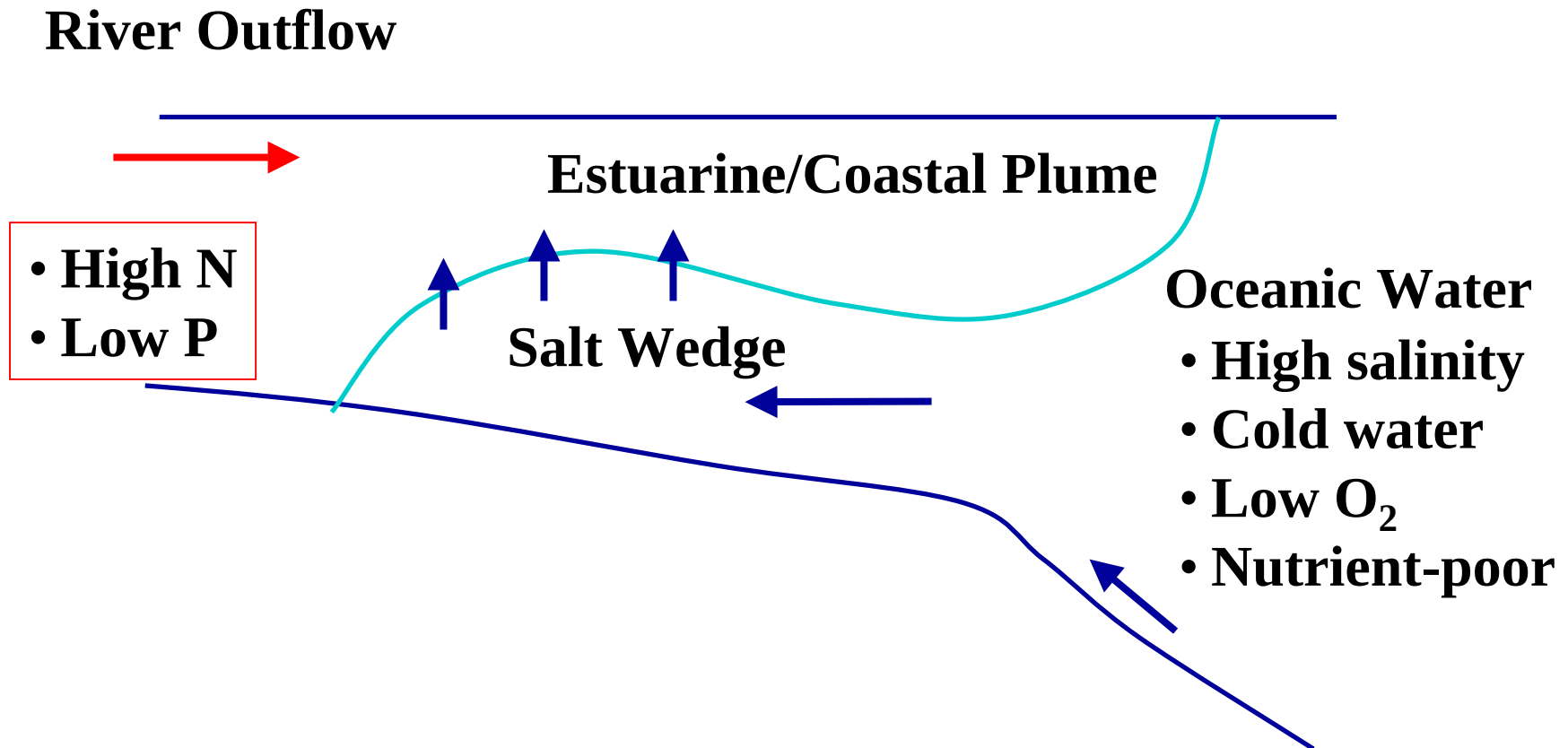


Summer

**Coastal
Upwelling**



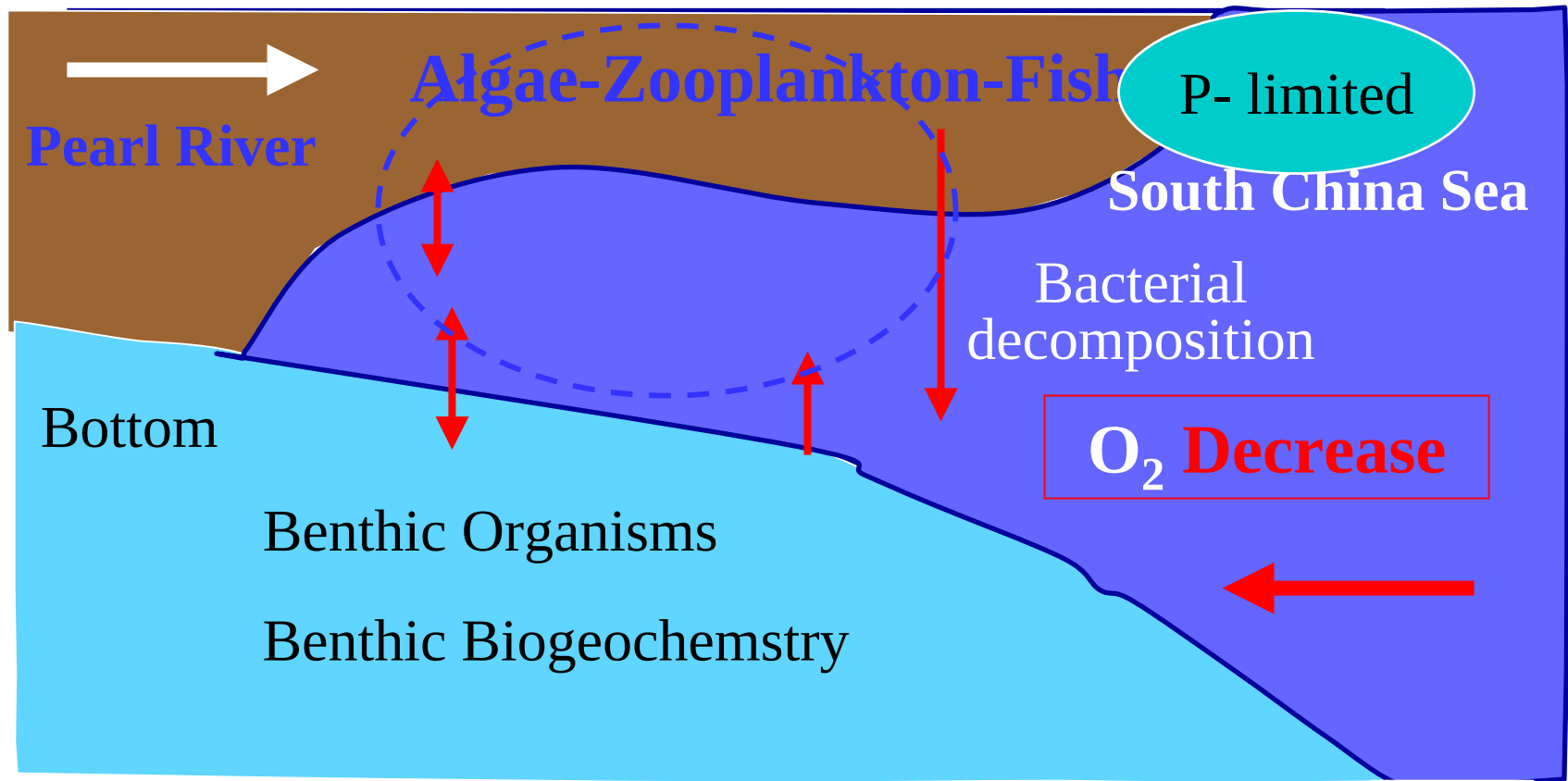
Estuarine Circulation in the Pearl River Estuary and Coastal Waters of Hong Kong

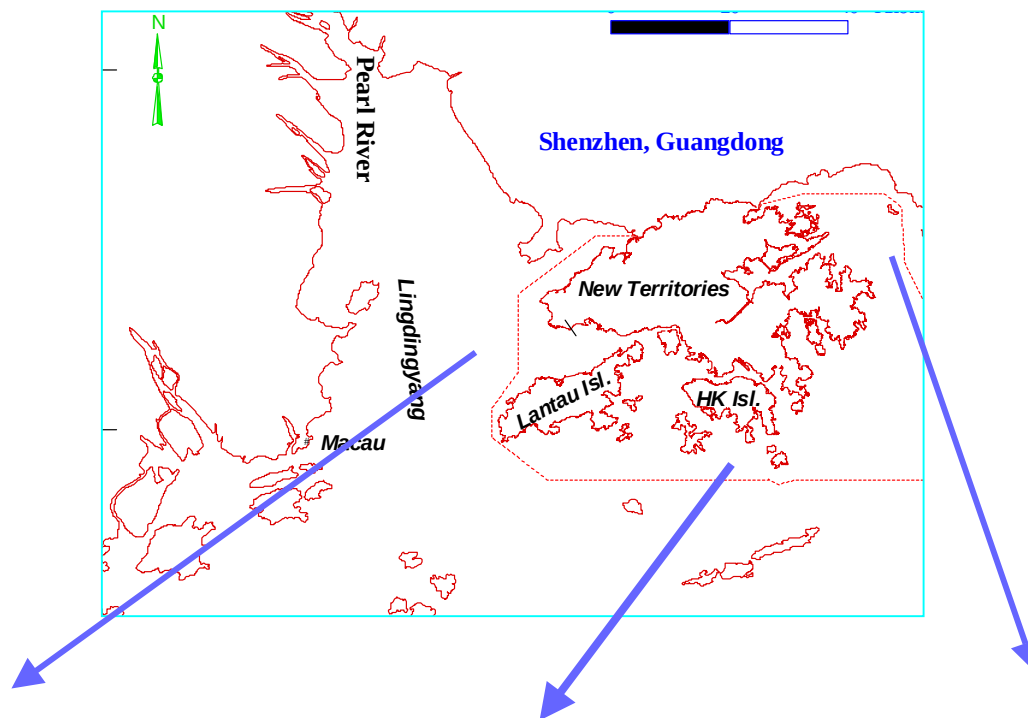


Marine Coastal Ecosystem

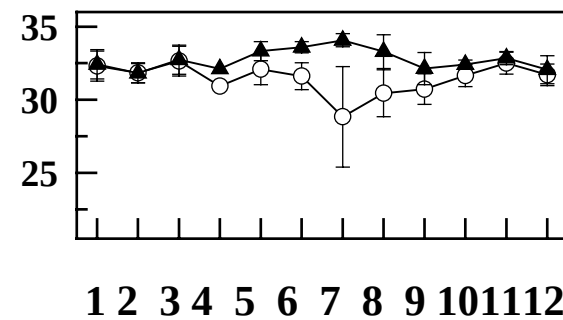
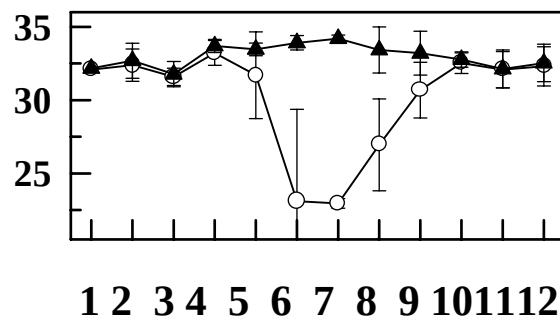
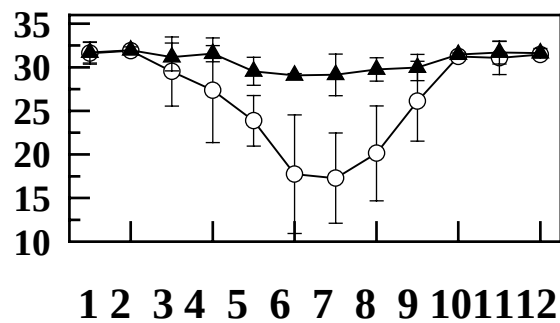
Riverine, Atmospheric,
Sewage Input:

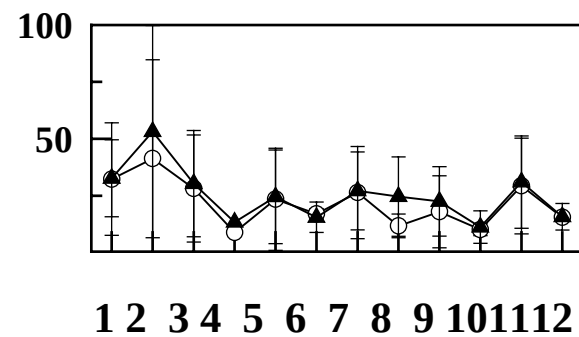
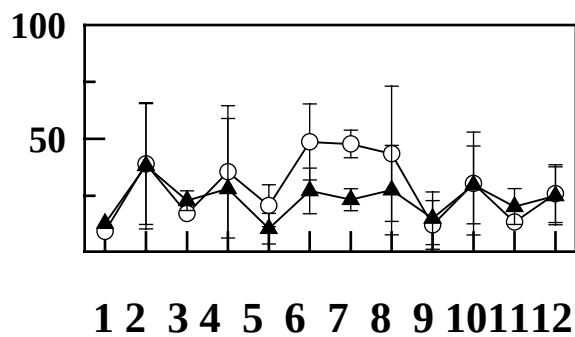
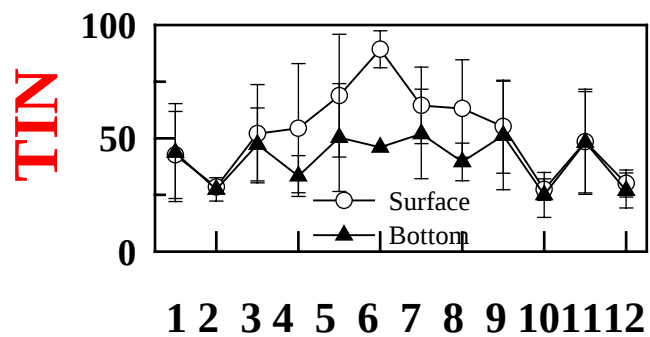
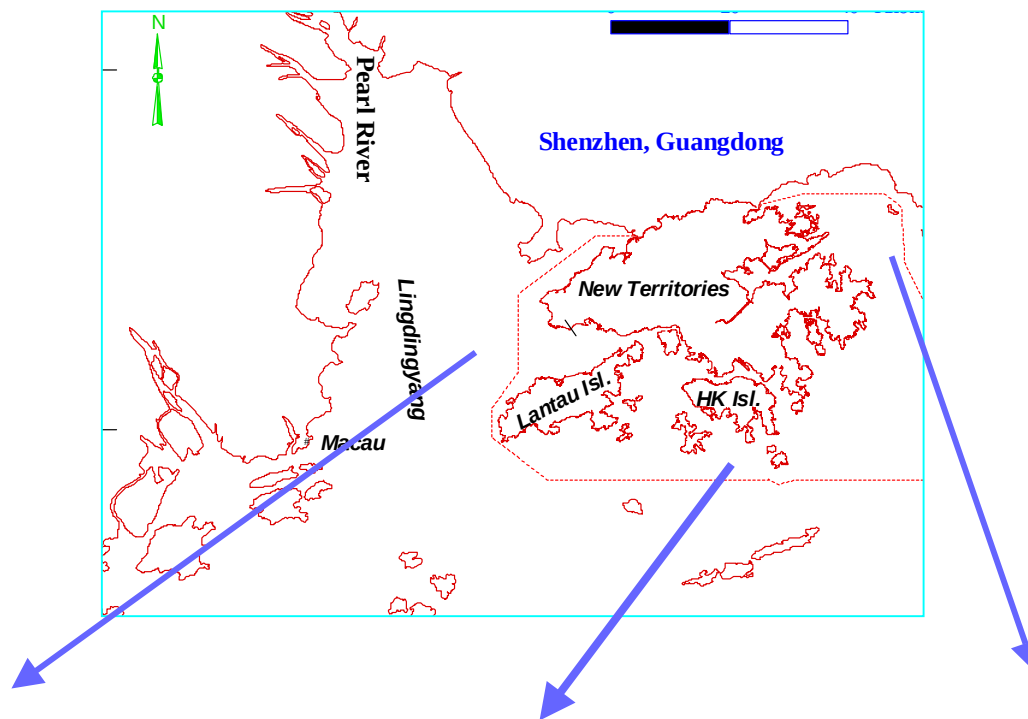
Nutrients, Pollutants



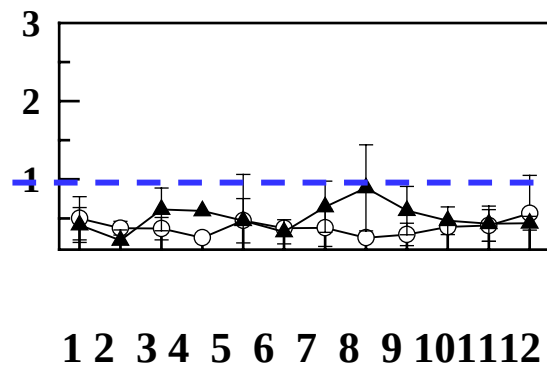
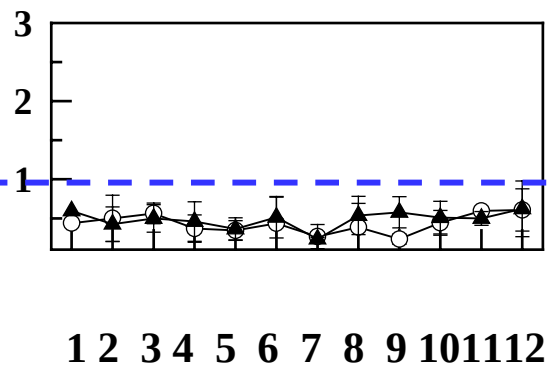
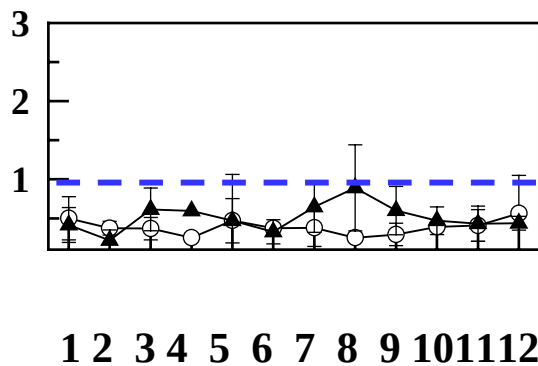
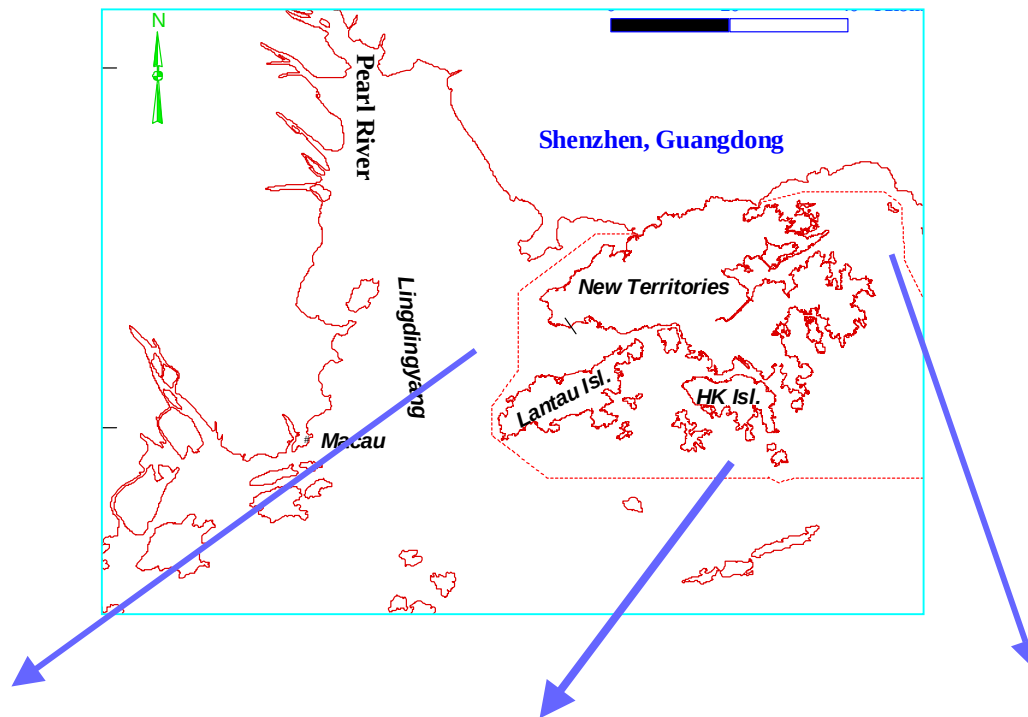


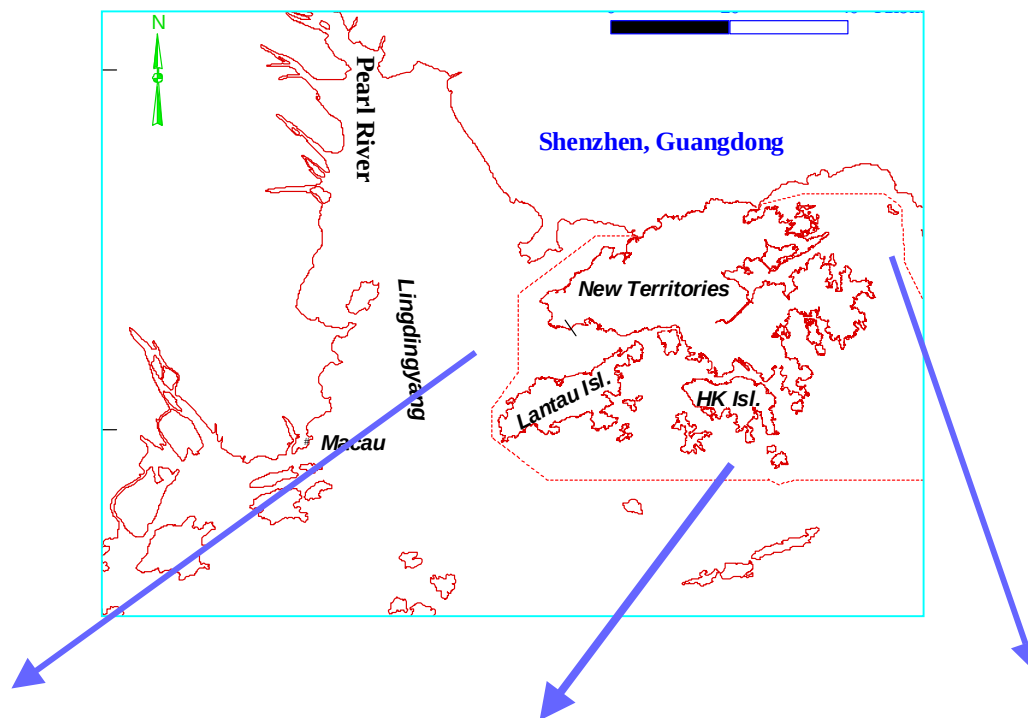
Salinity



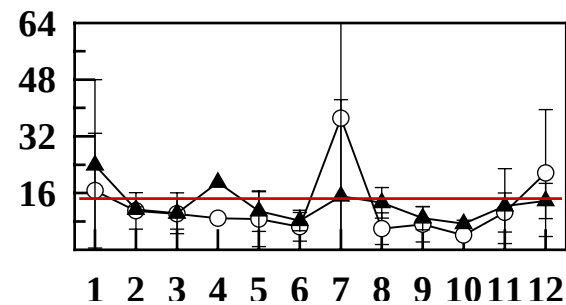
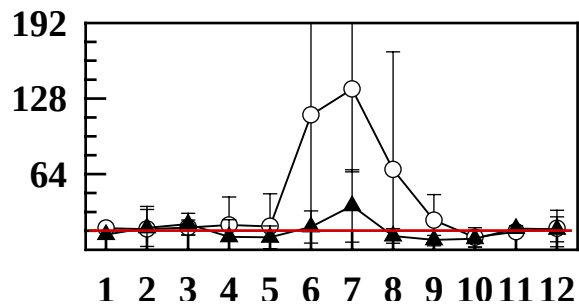
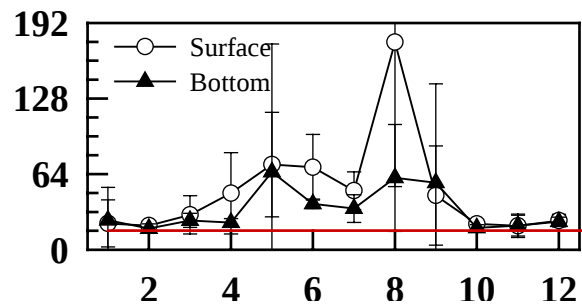


Phosphorus

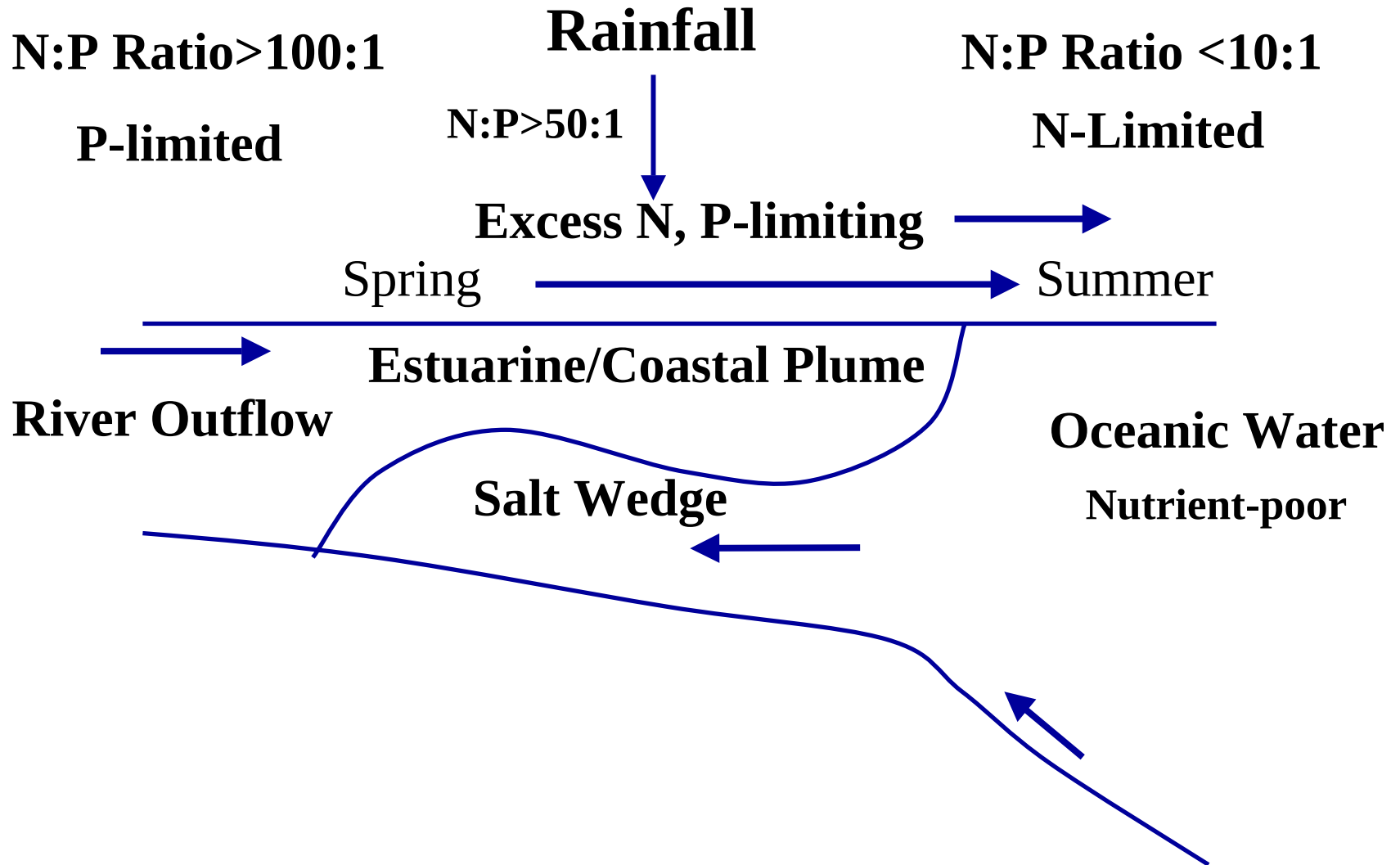




N/P Ratio



Temporal and Spatial Progression of P Limitation Across the Estuarine Coastal Waters



Hong Kong Agencies

Agriculture, Fisheries, and Conservation Dept (AFCD)

- Fish culture zones monitoring
- Red tide management

Environmental Protection Dept (EPD)

- widespread monitoring – 25 stations in 9 WQZ

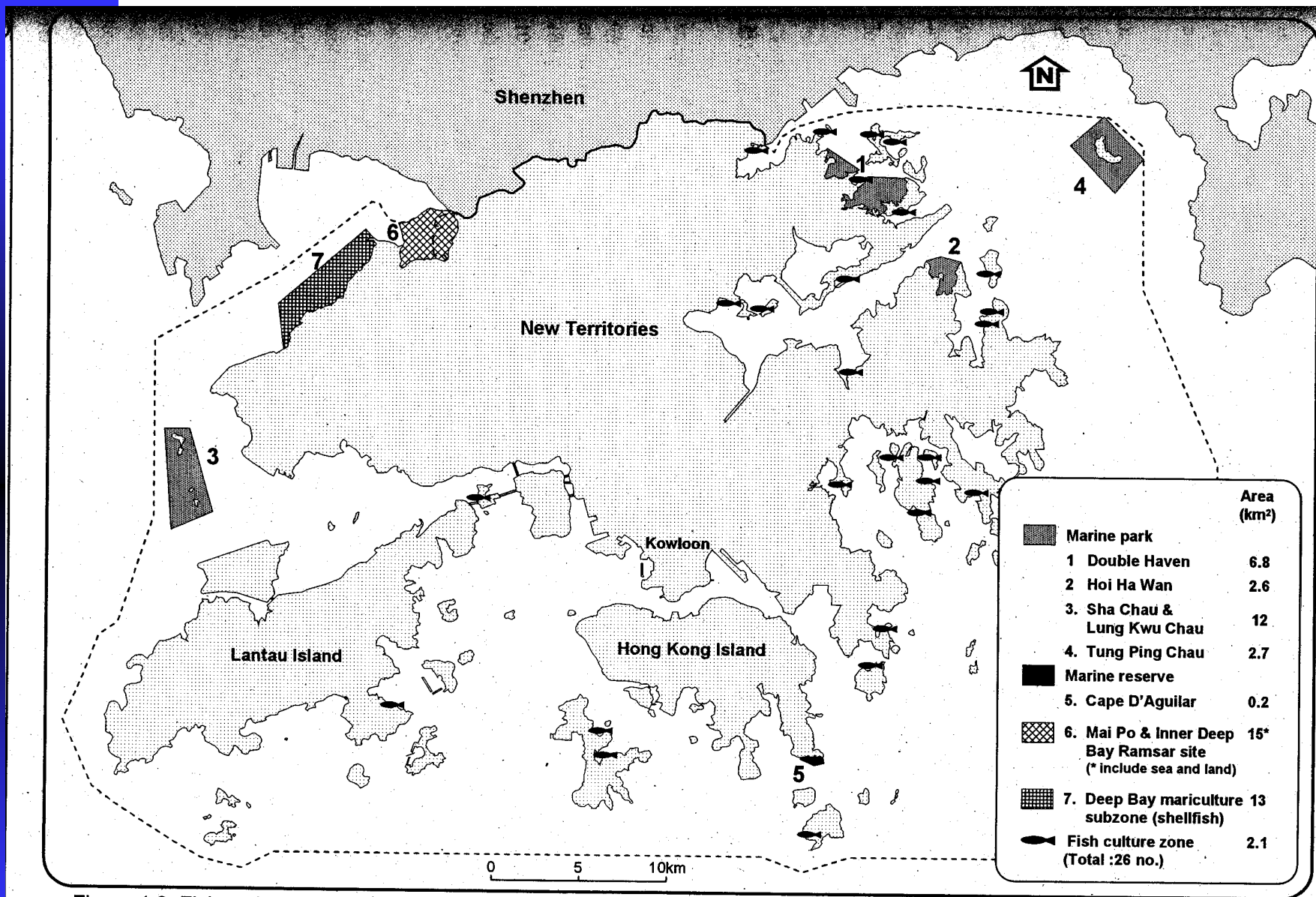


Figure 1.9 Fish and shellfish culture zones and marine conservation sites in Hong Kong in 2001

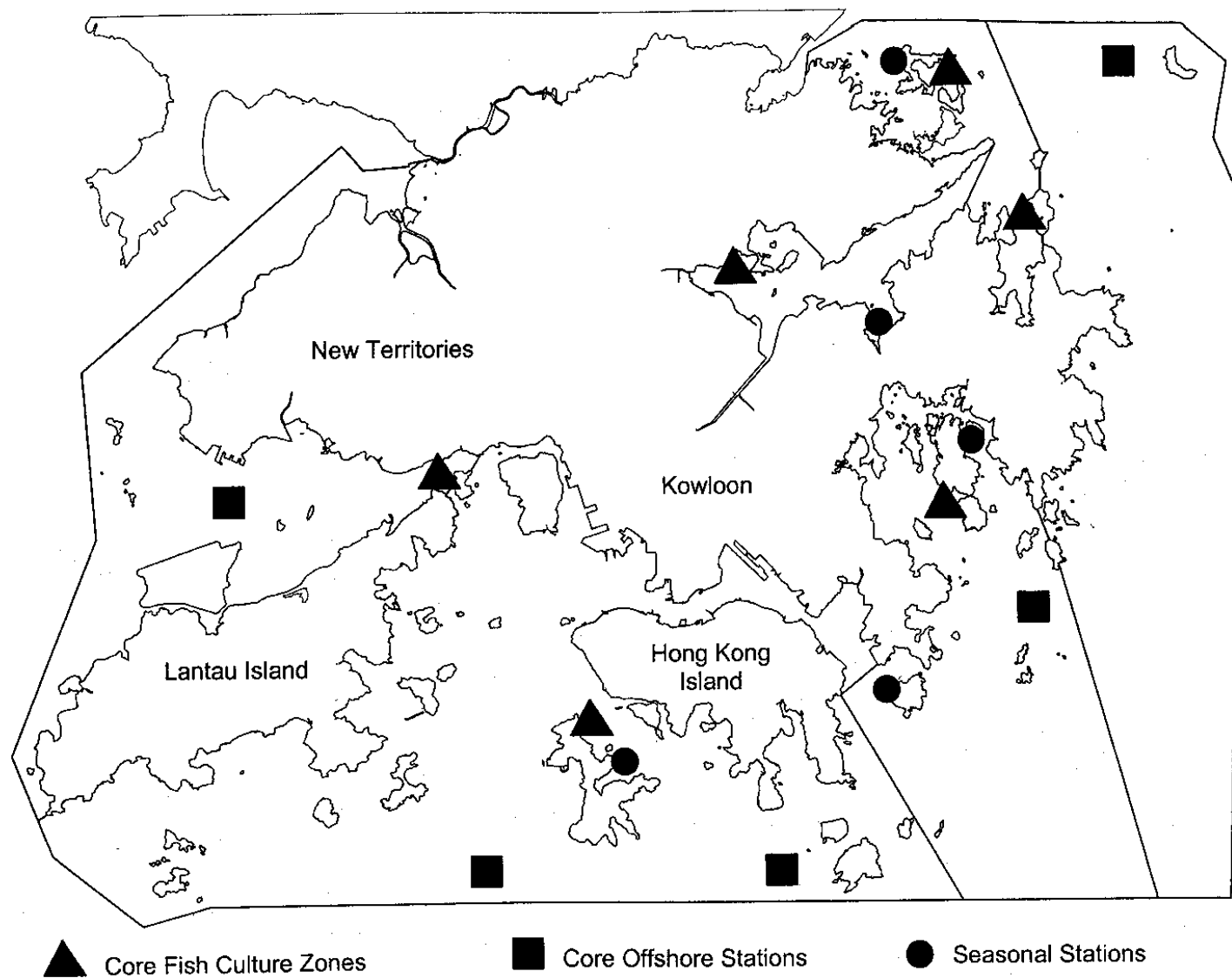


Fig. 5. Locations of the sampling stations in AFCD phytoplankton monitoring programme.

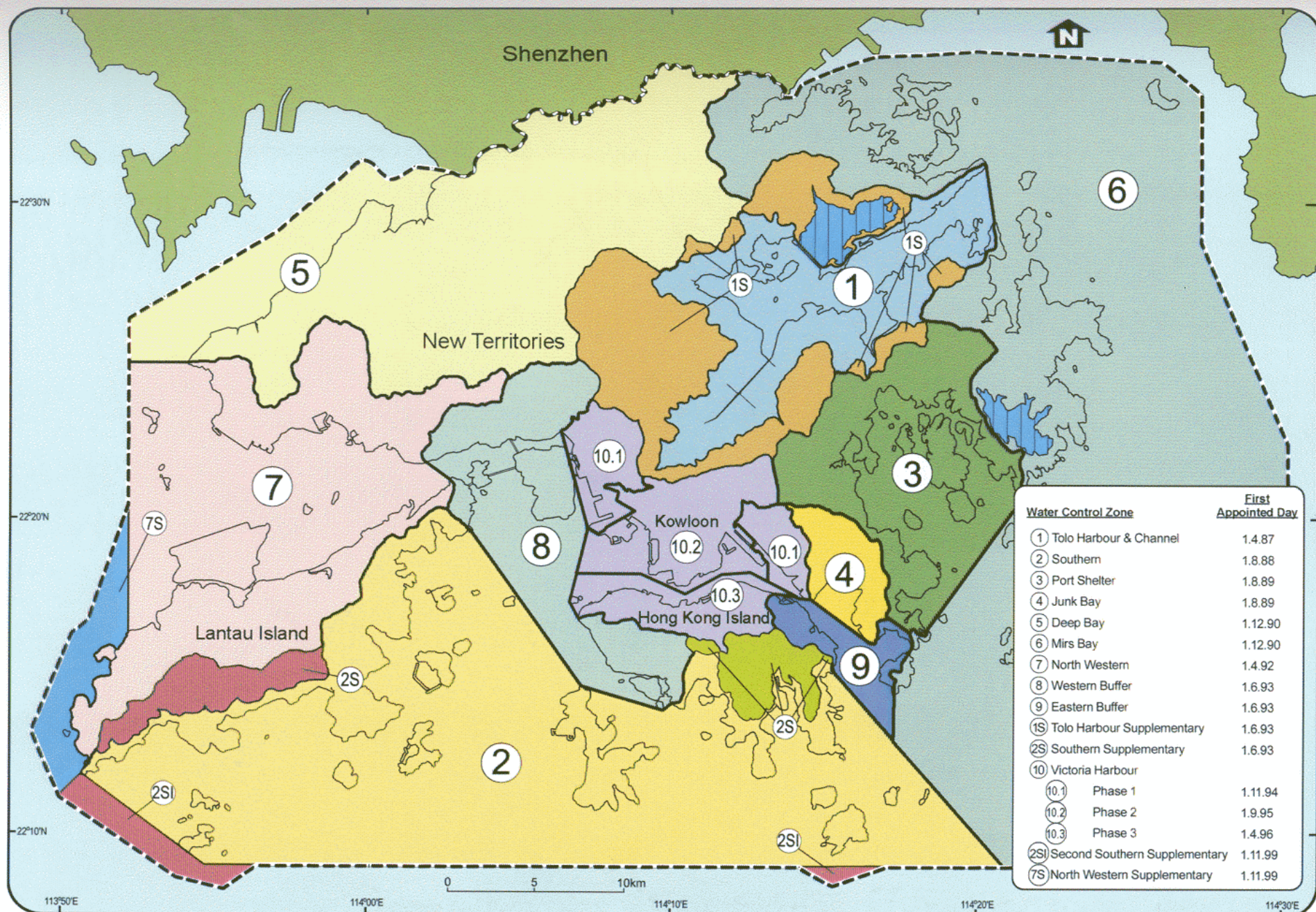


Figure 1.1 Water Control Zones in Hong Kong

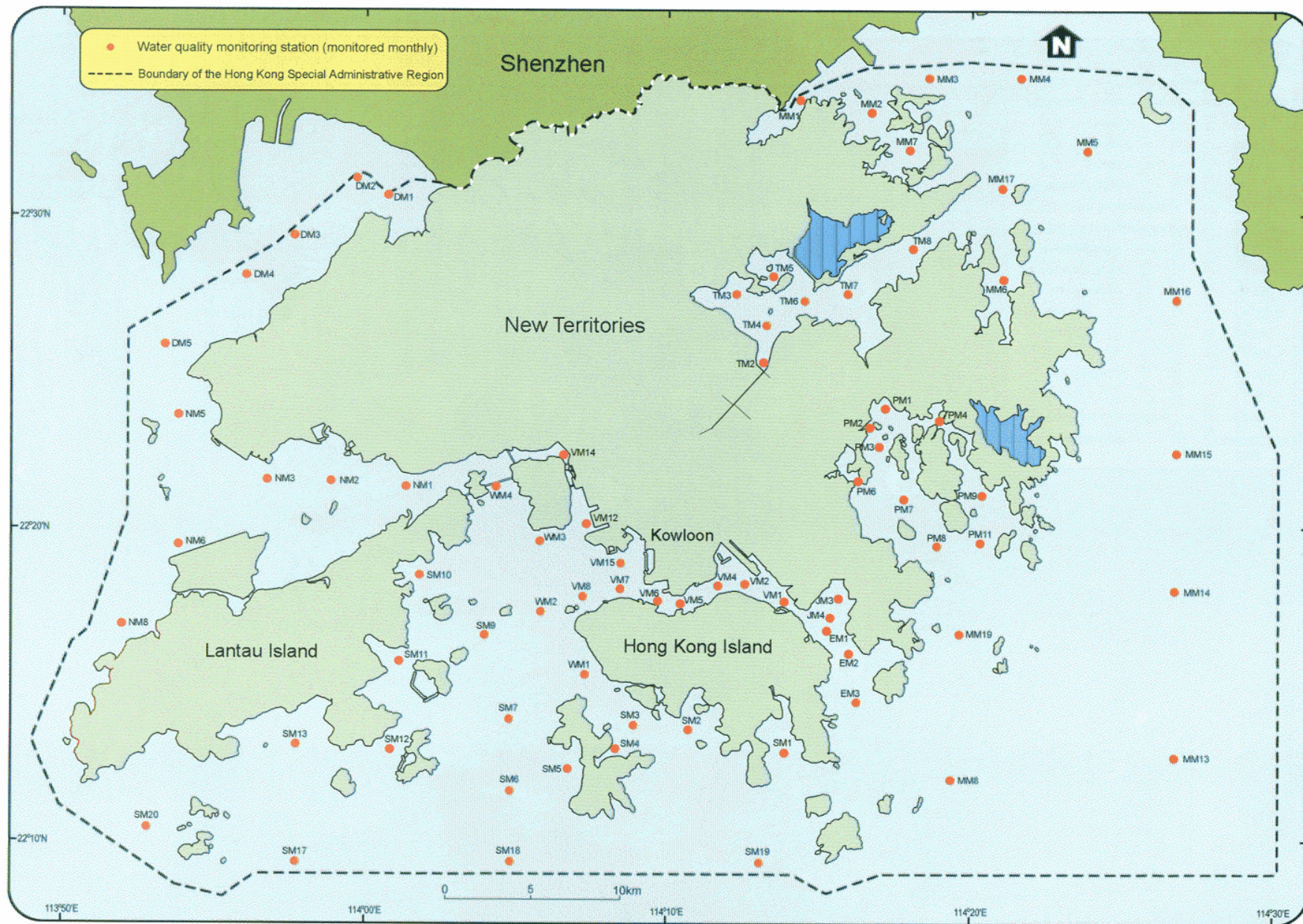


Figure 1.2 76 water quality monitoring stations in open waters of Hong Kong in 2001

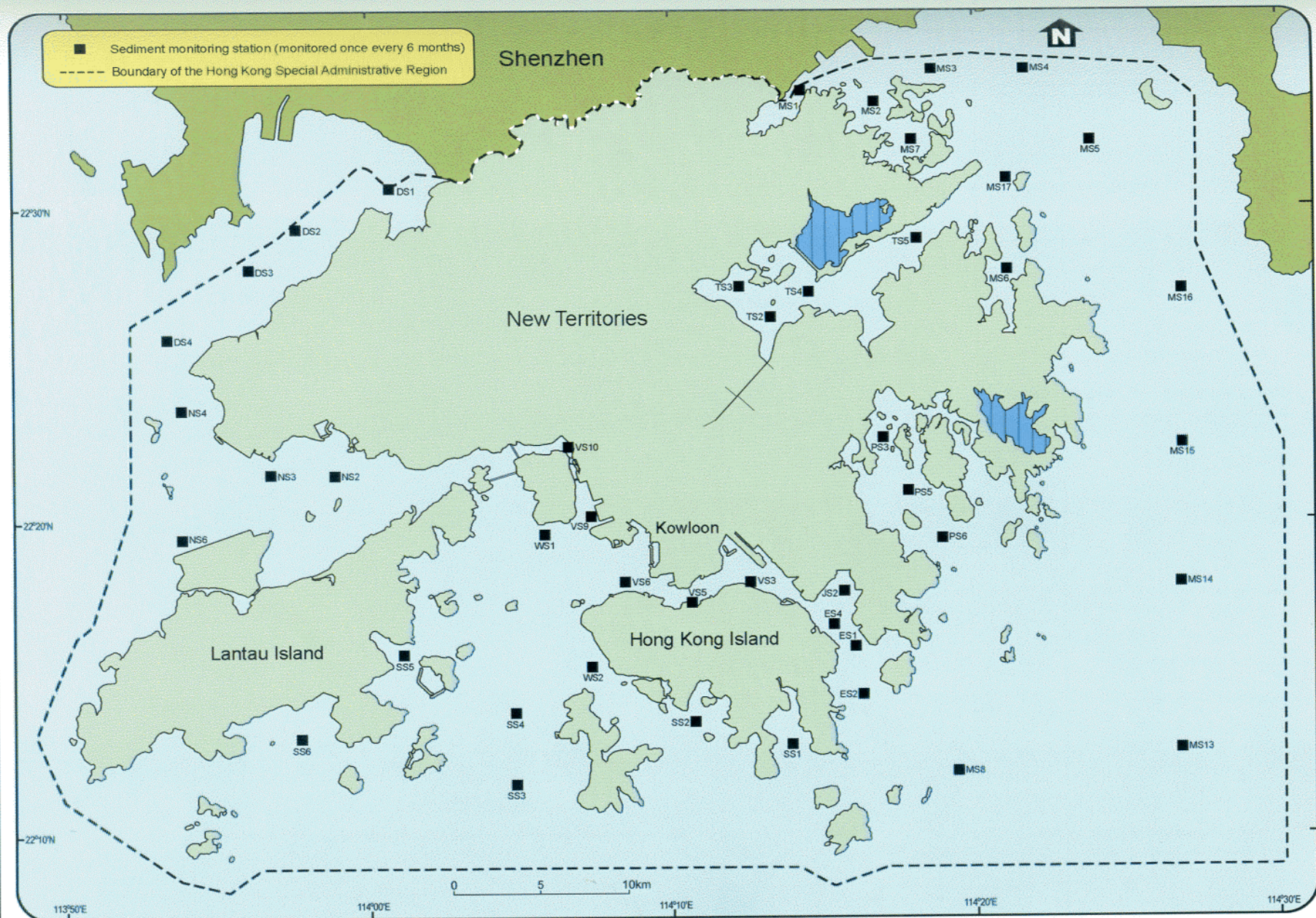


Figure 1.3 45 sediment monitoring stations in open waters of Hong Kong in 2001

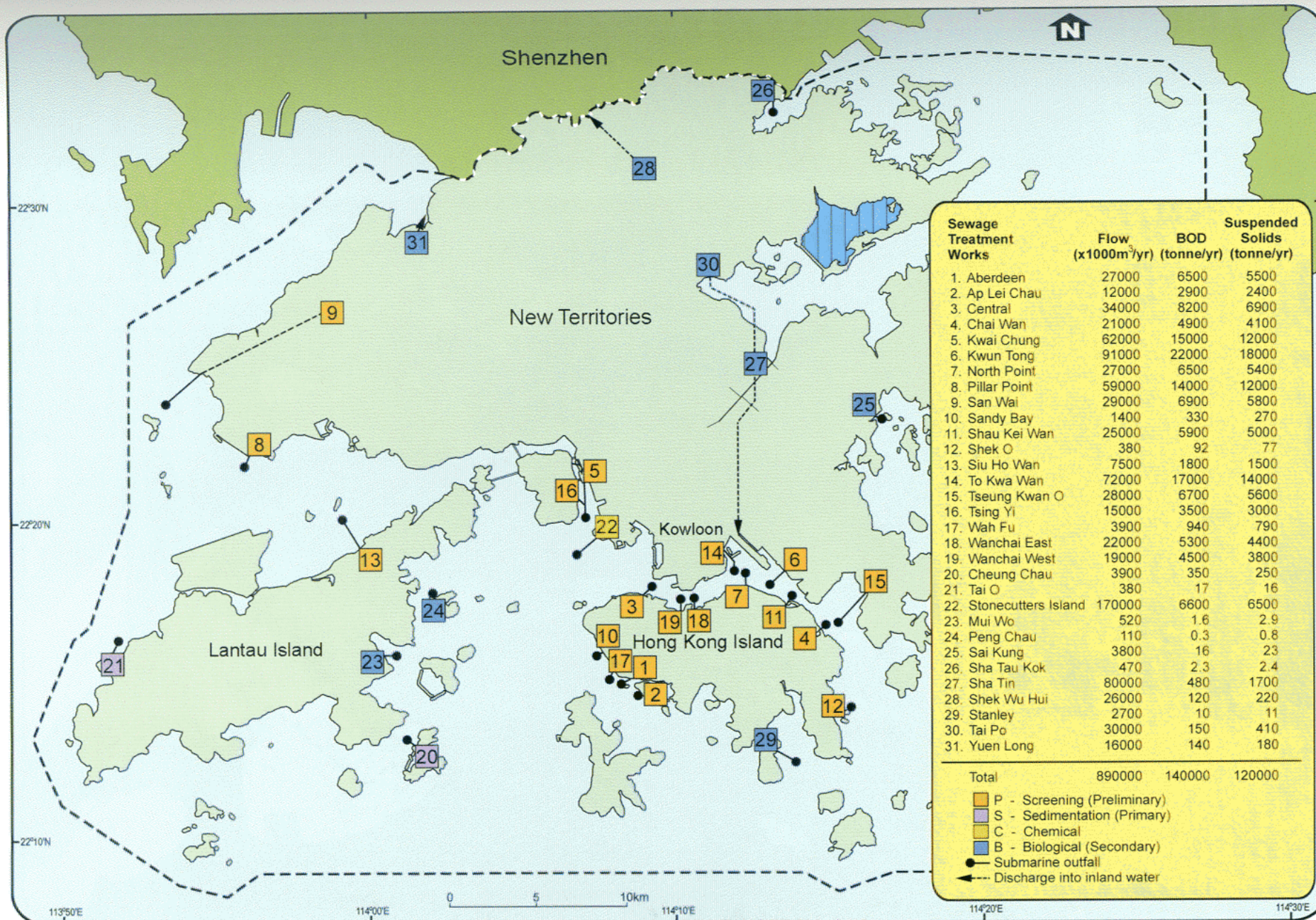


Figure 1.7 Major public sewage treatment works, outfalls and pollution load in Hong Kong in 2001

HAB Data Types - AFCD

Routine monitoring

- fish culture zones (11) –weekly for phytoplankton
 - every 2 weeks for water quality
 - offshore/channel stations – every 2 weeks
- 1) Field Observations – weather sea surface conditions
 - 2) Phytoplankton – species, cell concentration
 - 3) Water Quality – Secchi depth, T, S, DO, turbidity, BOD5
suspended solids, all nutrients, chl

Red Tide Investigation

- 1) Field investigation – date, place, color of water,
dead fish, fish behavior
- 2) Phytoplankton and water quality – as above

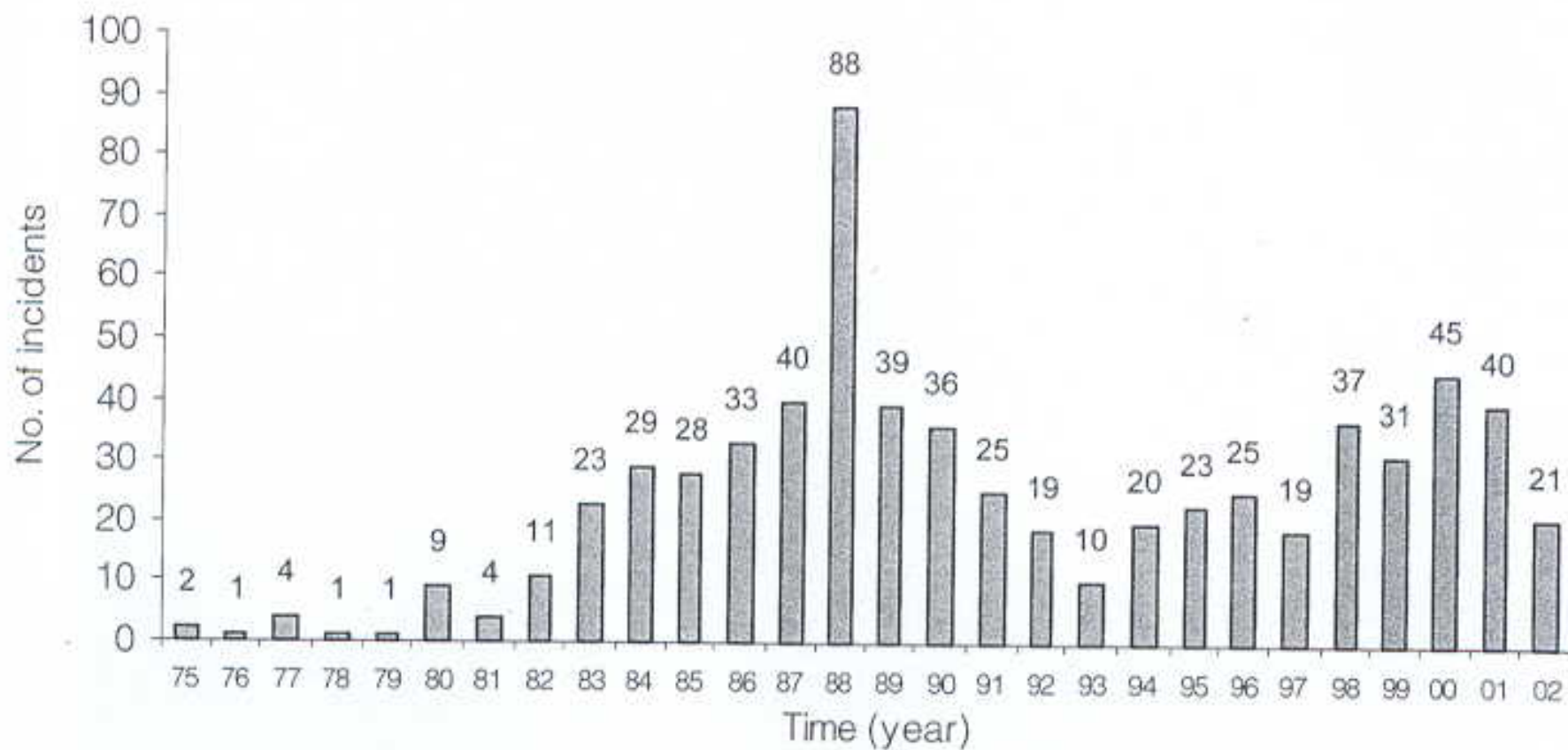


Fig. 1. Number of red tide incidents in Hong Kong from 1975 to 2002.

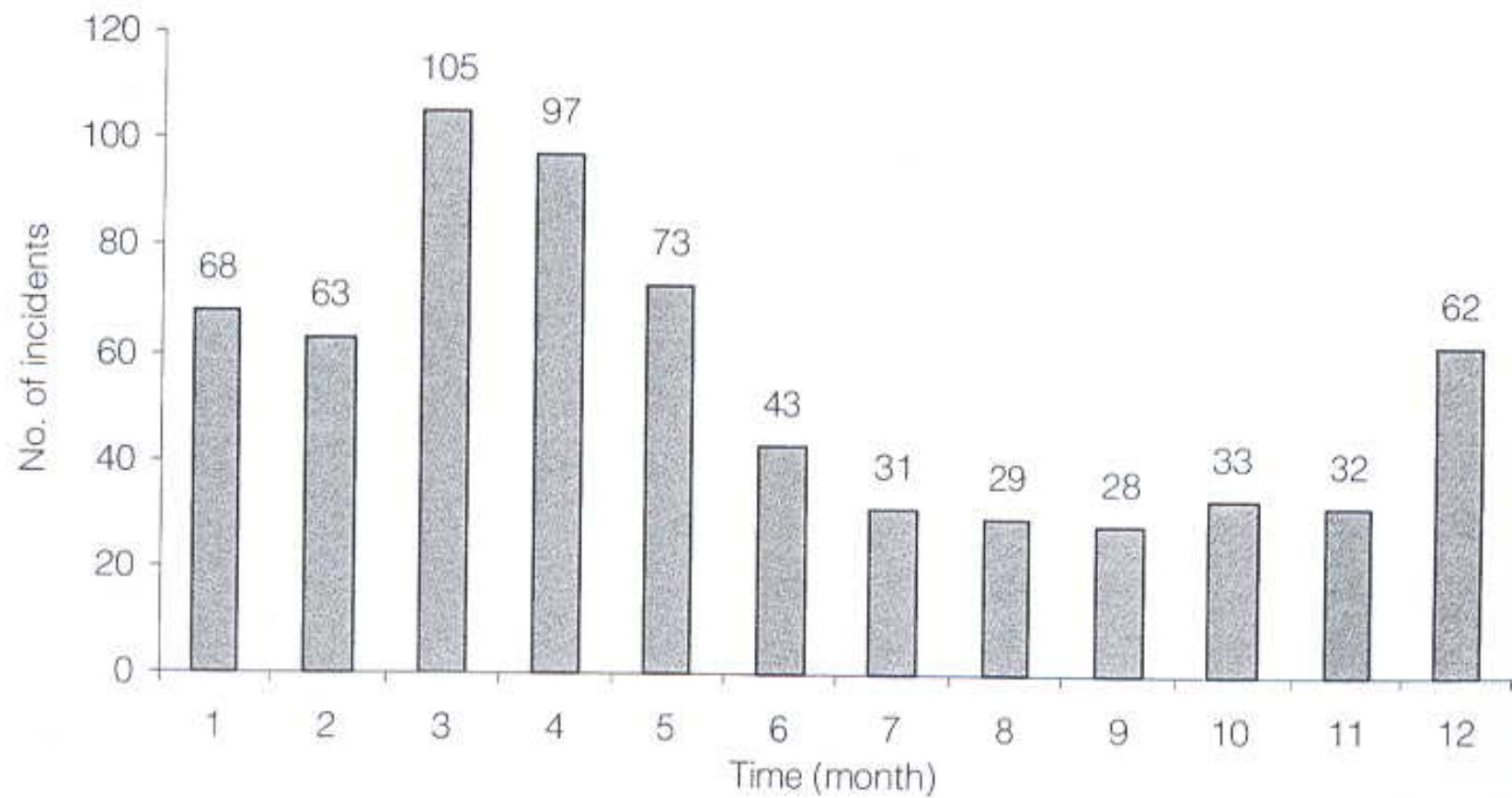


Fig. 2. Seasonal distribution of red tides in Hong Kong from 1975 to 2002.

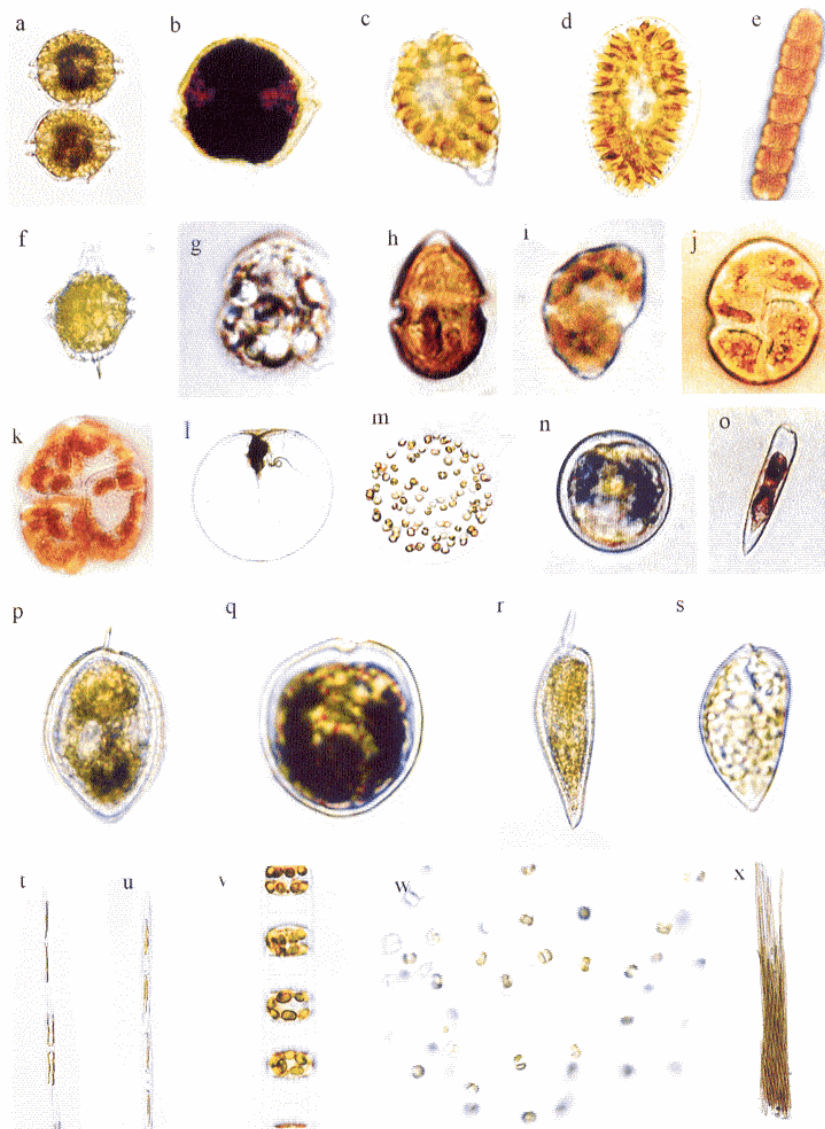


Plate 1. Potentially harmful red tide causative species in Hong Kong from 1975 to 2002

a. *Alexandrium catenella*
 b. *Alexandrium tamarense*
 c. *Chattonella marina*
 d. *Chattonella ovata*
 e. *Cochlodinium polykrikoides*
 f. *Gonyaulax polygramma*
 g. *Gymnodinium* sp. X
 h. *Heterocapsa circularisquama*

i. *Heterosigma akashiwo*
 j. *Karenia digitata*
 k. *Karenia mikimotoi*
 l. *Noctiluca scintillans*
 m. *Phaeocystis globosa*
 n. *Prorocentrum balticum*
 o. *Prorocentrum dentatum*
 p. *Prorocentrum micans*

q. *Prorocentrum minimum*
 r. *Prorocentrum sigmoides*
 s. *Prorocentrum triestinum*
 t. *Pseudo-nitzschia pseudodelicatissima*
 u. *Pseudo-nitzschia pungens*
 v. *Skeletonema costatum*
 w. *Thalassiosira mala*
 x. *Trichodesmium erythraeum*

Table 14.2 Occurrence and distribution of red tide species in different Water Control Zones (WCZs), 1980 - 2001

Species	Number of occurrences											Total
	Tolo Harbour & Channel WCZ	Mirs Bay WCZ	Eastern Buffer WCZ	Port Shelter WCZ	Junk Bay WCZ	Victoria Harbour WCZ	Southern Waters WCZ	North Bay WCZ	Western Harbour WCZ	Deep Bay WCZ		
<i>Noctiluca scintillans</i>	50	57		38		1	46	4	7		203	
<i>Skeletonema costatum</i>	23	2		1	2	7	6	3	7		51	
<i>Gonyaulax polygramma</i>	21	6		12			6	1	2		48	
<i>Mesodinium rubrum</i>	8	7		7	1	1	10	4			38	
<i>Prorocentrum minimum</i>	32	1									33	
<i>Prorocentrum triestinum</i>	33										26	
<i>Ceratium furca</i>	10	7		9			1				20	
<i>Scirpsiella trochoidea</i>	14	3		2							16	
<i>Prorocentrum sigmoides</i>	14	1		1				3			15	
<i>Heterosigma akashiwo</i>	10	2									14	
<i>Heterocapsa circularisquama</i>	12	2									10	
<i>Leptocylindrus minimus</i>	10										9	
<i>Karenia mikimotoi</i>	5	1		3							9	
<i>Prorocentrum dentatum</i>	6	3									8	
<i>Cryptomonas</i> sp.	8										8	
<i>Dactylosolen fragilissimus</i>	6	1		1							7	
<i>Chaetoceros</i> spp.	6			1			1				7	
<i>Karenia digitata</i>	1	3		2			1				7	
<i>Thalassiosira mala</i>	6						1		1		7	
<i>Thalassiosira nordenskioeldii</i>	2	2				1	1			1	6	
<i>Akashiwo sanguinea</i>	2	2									6	
<i>Thalassiosira proschkiniae</i>	5	1			1		2				5	
<i>Thalassiosira</i> spp.	2						1				4	
<i>Dictyocha speculum</i>		2		1			1				4	
<i>Eutrepella</i> spp.	4										4	
<i>Gymnodinium</i> sp.		1		2		1	1		1	1	4	
<i>Gyrodinium instriatum</i>						1					4	
<i>Leptocylindrus danicus</i>	3	1									4	
<i>Prorocentrum micans</i>	3	1							1		4	
<i>Pseudo-nitzschia pseudodelicatissima</i>	1						2				3	
<i>Gymnodinium simplex</i>	3										3	
<i>Plagioselmis prolange</i>	3					2					3	
<i>Pseudo-nitzschia seriata</i>	1						1				3	
<i>Trichodesmium</i> sp.		1		1							2	
<i>Alexandrium tamarense</i>	2										2	
<i>Cerataulina pelagica</i>			1				1				2	
<i>Chaetoceros curvisetus</i>				1							2	
<i>Chattonella ovata</i>		1					1				2	
<i>Chattonella</i> sp.		1					2				2	
<i>Cochlodinium polykrikoides</i>											2	
<i>Cochlodinium</i> sp.	2										2	
<i>Gymnodinium viridescens</i>	1	1					1				2	
<i>Nitzschia longissima</i>	1										2	
<i>Prorocentrum</i> spp.	1	1									2	
<i>Teleaulax acuta</i>	2										2	
<i>Trichodesmium erythraeum</i>		2				1					1	
<i>Alexandrium catenella</i>											1	
<i>Chaetoceros pseudocrinitus</i>	1						1				1	
<i>Chaetoceros socialis</i>											1	
<i>Chaetoceros</i> sp.0105	1										1	
<i>Chaetoceros tenuissimus</i>		1									1	
<i>Chattonella marina</i>		1									1	
<i>Chlamydomonas</i> sp.	1										1	
<i>Cyclotella</i> spp.	1				1						1	
<i>Cyrtarocylis</i> sp.								1			1	
<i>Eucampia zodiacus</i>											1	
<i>Guinardia delicatula</i>	1										1	
<i>Guinardia striata</i>	1						1				1	
<i>Gyrodinium spirale</i>			1								1	
<i>Hermesinium adriaticum</i>											1	
<i>Haematococcus pluvialis</i>	1							1			1	
<i>Katodinium rotundatum</i>							1				1	
<i>Leptocylindrus</i> spp.											1	
<i>Odontella mobilensis</i>	1										1	
<i>Odontella sinensis</i>	1										1	
<i>Pedinomonadaceae</i> species			1								1	
<i>Prorocentrum balticum</i>											1	
<i>Protoperidinium quinquecomae</i>	1						1				1	
<i>Pseudo-nitzschia</i> spp.											1	
<i>Thalassomonas</i> sp.	1										1	
Total : 70 species	325	117	1	85	5	13	88	19	19	2	674	

Note: a red tide incident may involve more than one causative species.
Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

Table 2

Red tide incidents associated with fish kills or shellfish contaminations
in Hong Kong from 1975–2002.

From	To	Location	Causative species
29 May 77	29 May 77	Tai Po Hoi	<i>Gymnodinium</i> sp.
18 Apr 80	18 Apr 80	Crooked Harbour, Double Haven, Long Harbour	<i>Prorocentrum micans</i>
27 Apr 80	27 Apr 80	Yim Tin Tsai, Ha Hang, Sham Wan, Wu Kai Sha, Tap Mun, Tai Mei Tuk	Undetermined
28 Apr 80	28 Apr 80	Kau Sai	Undetermined
28 Sep 80	28 Sep 80	Inner Tolo Harbour	<i>Karenia mikimotoi</i>
14 Feb 81	14 Feb 81	Hang Hau	<i>Karenia mikimotoi</i>
22 Jan 82	22 Jan 82	Silver Mine Bay, Shap Long	Undetermined
7 Feb 82	7 Feb 82	Kau Sai	<i>Karenia mikimotoi</i>
15 Mar 82	15 Mar 82	Sai Kung, Lap Sap Chau	<i>Gymnodinium</i> sp. X
12 May 82	12 May 82	Sai Kung, Lap Sap Chau, Kau Sai	<i>Gymnodinium</i> sp. X
18 Oct 83	18 Oct 83	Tai Po Hoi	<i>Karenia mikimotoi</i>
2 May 84	24 May 84	Tai Po Hoi (East) to Tap Mun	<i>Prorocentrum dentatum</i>
3 Jun 86	12 Jun 86	Tai Po Hoi	<i>Prorocentrum triestinum</i>
28 Jul 87	28 Jul 87	Three Fathoms Cove	<i>Heterocapsa circularisquama</i>
8 Apr 88	12 Apr 88	Yim Tin Tsai (East) FCZ	<i>Gonyaulax polygramma</i>
19 Apr 88	9 May 88	Tai Po Hoi, Tolo Chanel	<i>Gonyaulax polygramma</i> , <i>Skeletonema costatum</i>
10 Mar 89	21 Mar 89	Junk Bay	<i>Alexandrium catenella</i>
21 Apr 92	28 Apr 92	Junk Bay, Port Shelter	<i>Noctiluca scintillans</i>
6 Mar 95	16 Mar 95	Tolo Harbour	<i>Prorocentrum minimum</i>
18 Mar 98	30 Mar 98	O Pui Tong, Kat O Hoi, Yan Chau Tong	<i>Karenia digitata</i>
23 Mar 98	26 Mar 98	Leung Shuen Wan, Kau Sai	<i>Karenia digitata</i>
3 Apr 98	3 Apr 98	Kat O FCZ, O Pui Tong FCZ	<i>Karenia digitata</i>
3 Apr 98	4 Apr 98	Kai Lung Wan FCZ, Tai Tau Chau FCZ	<i>Karenia digitata</i>
9 Apr 98	16 Apr 98	Cheung Sha Wan FCZ, Man Wan FCZ, Sok Kwu Wan FCZ	<i>Karenia digitata</i>
10 Apr 98	16 Apr 98	Sham Wan FCZ, Tap Mun FCZ	<i>Karenia digitata</i>
11 Apr 98	17 Apr 98	Yim Tin Tsai FCZ, Yim Tin Tsai (East) FCZ, Yung Shue Au FCZ	<i>Karenia digitata</i> , <i>Prorocentrum minimum</i>
14 Apr 01	3 May 01	Kat O FCZ, O Pui Tong FCZ, Yan Chau Tong, Sham Wan FCZ, Kau Lau Wan FCZ	<i>Dictyocha speculum</i> , <i>Chattonella marina</i> , <i>Chattonella ovata</i>
21 Apr 01	27 Apr 01	Leung Shuen Wan Hoi near north east of Kau Sai Chau, Tai Tau Chau, Kau Sai FCZ, HKUST Pier, Silverstrand Beach	<i>Chattonella ovata</i> , <i>Dictyocha speculum</i>

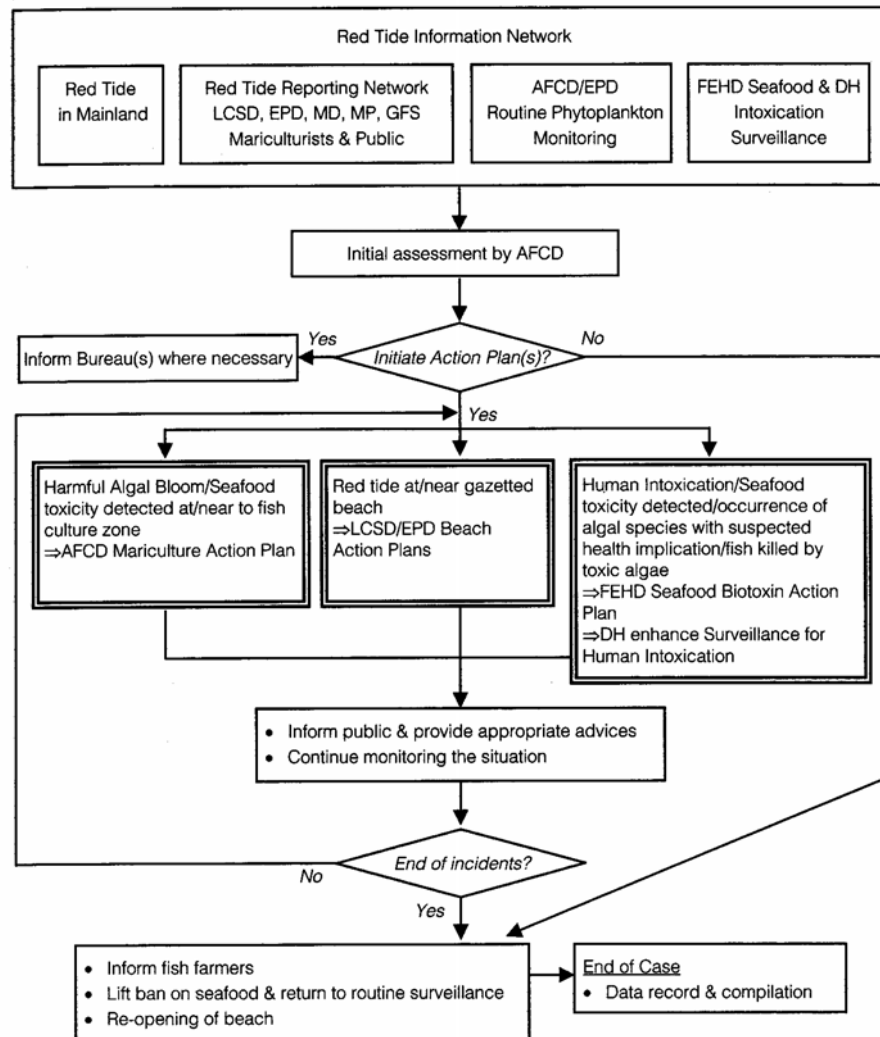


Fig. 4. Hong Kong SAR Government red tide management operational master plan.

AFCD: Agriculture, Fisheries and Conservation Department

DH: Department of Health

EPD: Environmental Protection Department

FEHD: Food and Environmental Hygiene Department

GFS: Government Flying Services

LCSD: Leisure and Cultural Services Department

MD: Marine Department

MP: Marine Police

HAB Data Types -EPD

Routine monitoring

- 1) Stations – 94 in all 10 water quality zones (WQZ)
 - surface, middle, bottom samples
 - 76 stns – open waters – monthly sampling
 - 18 typhoon stns – once/2 months
 - bottom sediments – 2x/year at 60 stations
 - >50 parameters in water column and sediments
- 2) Phytoplankton – species, cell concentration
- 3) Water Quality – Secchi depth, T, S, DO, turbidity, BOD5
suspended solids, BOD5, all nutrients, chl, E. coli

HAB Data Types -EPD

Objectives of Routine monitoring

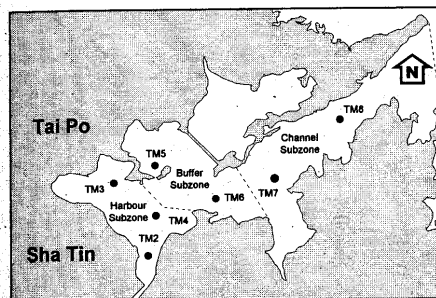
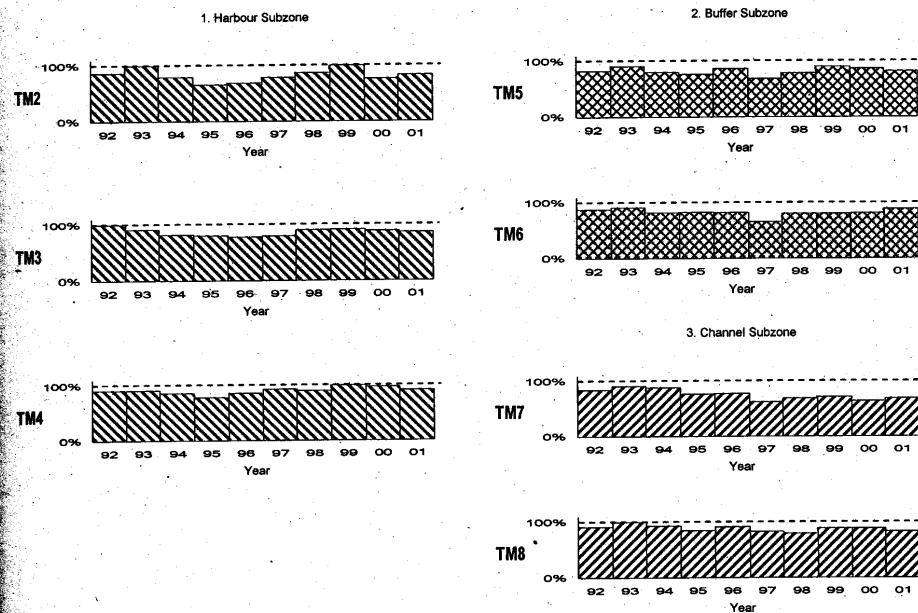
1) Assessment of compliance with water quality objectives

- dissolved oxygen in bottom water
- ammonium and total inorganic nitrogen conc'n
- bacteria , *E. coli* and fecal coliforms
- chlorophyll

2) Assessment of Long Term Water Quality Trends

- 17 year data set (started in 1986)
- DO, nutrients, chl – eutrophication indicators

Chlorophyll-a



Chlorophyll-a

1. Harbour Subzone

% sample (S, M, B) with Chlorophyll-a $\leq 20 \mu\text{g/L}$

WQO: Chlorophyll-a $\leq 20 \mu\text{g/L}$

2. Buffer Subzone

% sample (S, M, B) with Chlorophyll-a $\leq 10 \mu\text{g/L}$

WQO: Chlorophyll-a $\leq 10 \mu\text{g/L}$

3. Channel Subzone

% sample (S, M, B) with Chlorophyll-a $\leq 6 \mu\text{g/L}$

WQO: Chlorophyll-a $\leq 6 \mu\text{g/L}$

Figure 2.2 Level of chlorophyll-a in the Tolo Harbour and Channel WCZ

Table 2.1 Results of the Seasonal Kendall Test for trends in water quality parameters measured in the Tolo Harbour and Channel Water Control Zone, 1986 - 2001

Monitoring Station		TM2	TM3	TM4	TM5	TM6	TM7	TM8
Monitoring Period		1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001	1986 I 2001
Parameter	Water Depth							
Temperature (°C)	Surface	↗	↗	↗	↗	↗	↗	↗
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	↗	↗	↗	↗	↗
Salinity	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
Dissolved Oxygen (mg/L)	Surface	—	—	↘	↘	—	↘	↘
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	—	↗	↗	↗
	Average	—	↗	—	—	—	—	—
Dissolved Oxygen (%)	Surface	—	—	↘	↘	↗	↗	↗
	Middle	NA	↗	↗	NA	↗	↗	↗
	Bottom	↗	↗	↗	↗	↗	↗	↗
	Average	↗	↗	—	↗	—	—	—
pH	Surface	↘	—	—	↘	↘	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	↘	—	—	↘	—	—	—
	Average	↘	—	↘	↘	—	—	—
Secchi disc depth (m)		—	—	—	—	—	—	↘
Turbidity (NTU)	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	↗
	Bottom	—	—	↗	↗	↗	↗	↗
	Average	—	—	—	↗	—	—	↗
Suspended Solids (mg/L)	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
Total volatile solids (mg/L)	Surface	—	—	—	—	—	—	↘
	Middle	NA	—	—	NA	—	—	↘
	Bottom	—	—	↘	—	—	—	↘
	Average	—	—	—	—	—	—	↘
5-day Biochemical Oxygen Demand (mg/L)	Surface	↘	NA	↘	↘	↘	↘	↘
	Middle	NA	↘	↘	NA	—	—	—
	Bottom	—	—	—	—	—	—	↘
	Average	↘	—	↘	↘	—	—	↘
Ammonia nitrogen (mg/L)	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
Nitrite nitrogen (mg/L)	Surface	—	↘	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	↘	—	—
	Average	—	—	—	—	—	—	—
Nitrate nitrogen (mg/L)	Surface	↘	↘	↘	↘	↘	—	—
	Middle	NA	↘	↘	NA	—	—	—
	Bottom	↘	—	—	↘	—	—	—
	Average	↘	↘	—	↘	—	—	—
Total inorganic nitrogen (mg/L)	Surface	↘	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	↘	—	—	—	—	—	—
Total Kjeldahl nitrogen (mg/L)	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
Total nitrogen (mg/L)	Surface	↘	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	↘	—	—	—	—	—	—
Orthophosphate phosphorus (mg/L)	Surface	↘	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	↘	—	—	—	—	—	—
Total phosphorus (mg/L)	Surface	↘	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	↘	—	—	—	—	—	—
Silica (mg/L)	Surface	—	—	—	—	—	—	—
	Middle	NA	↗	↗	NA	↗	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	↗	↗	—	—	—
Chlorophyll-a (µg/L)	Surface	—	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
<i>E. coli</i> (cfu/100mL)	Surface	↘	—	—	—	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	—	—	—	—	—	—
	Average	—	—	↘	—	—	—	—
Faecal coliforms (cfu/100ml)	Surface	—	↗	—	↗	—	—	—
	Middle	NA	—	—	NA	—	—	—
	Bottom	—	↗	—	↗	—	—	—
	Average	—	↗	—	↗	—	—	—

Note 1. Results of the Seasonal Kendall Test shown are statistically significant at $p < 0.05$
 2. — indicates no significant trend is detected
 3. ↗ represents a significant increase over time
 4. ↘ represents a significant decrease over time
 5. NA (Not Applicable) indicates the measurement was not made due to shallow water

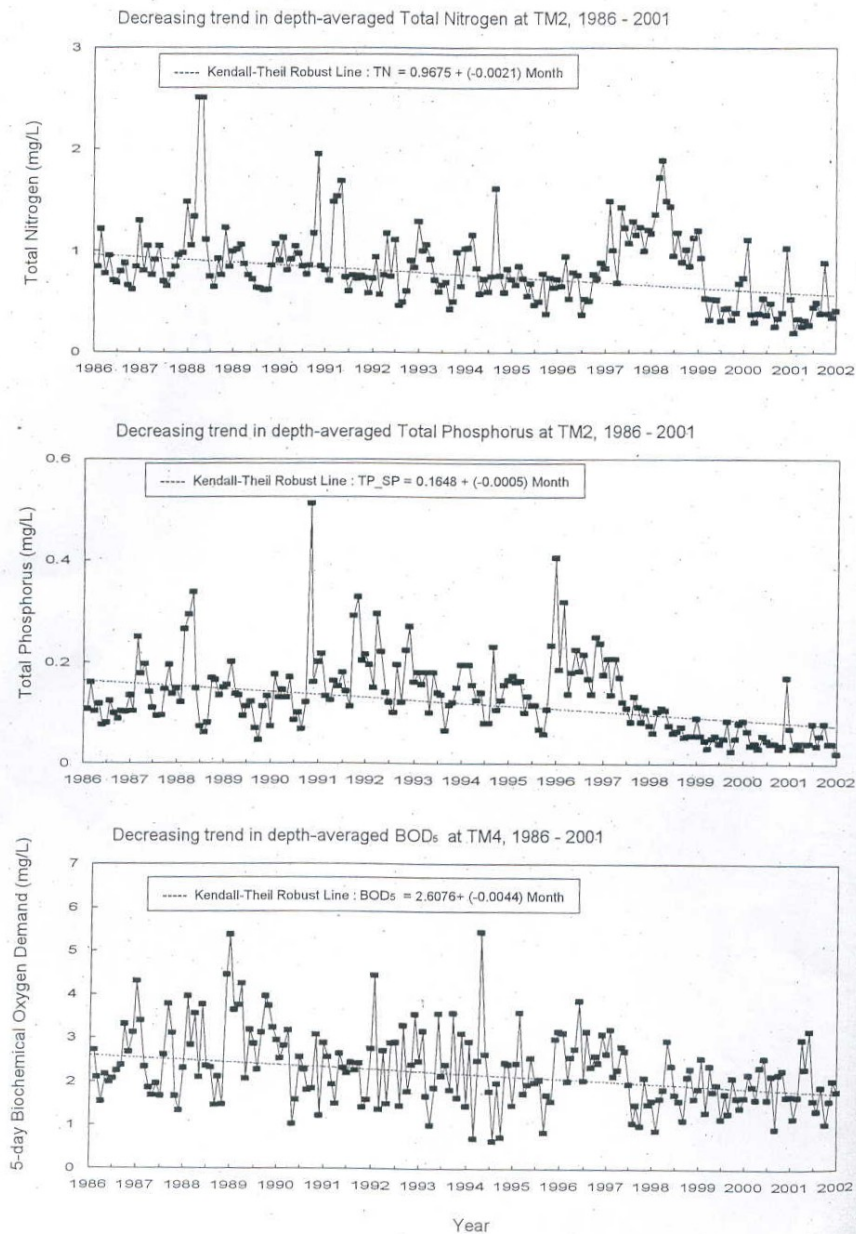


Figure 2.4 Marine water quality trends in the Tolo Harbour and Channel WCZ
(based on the Seasonal Kendall Test significant at $p < 0.05$)

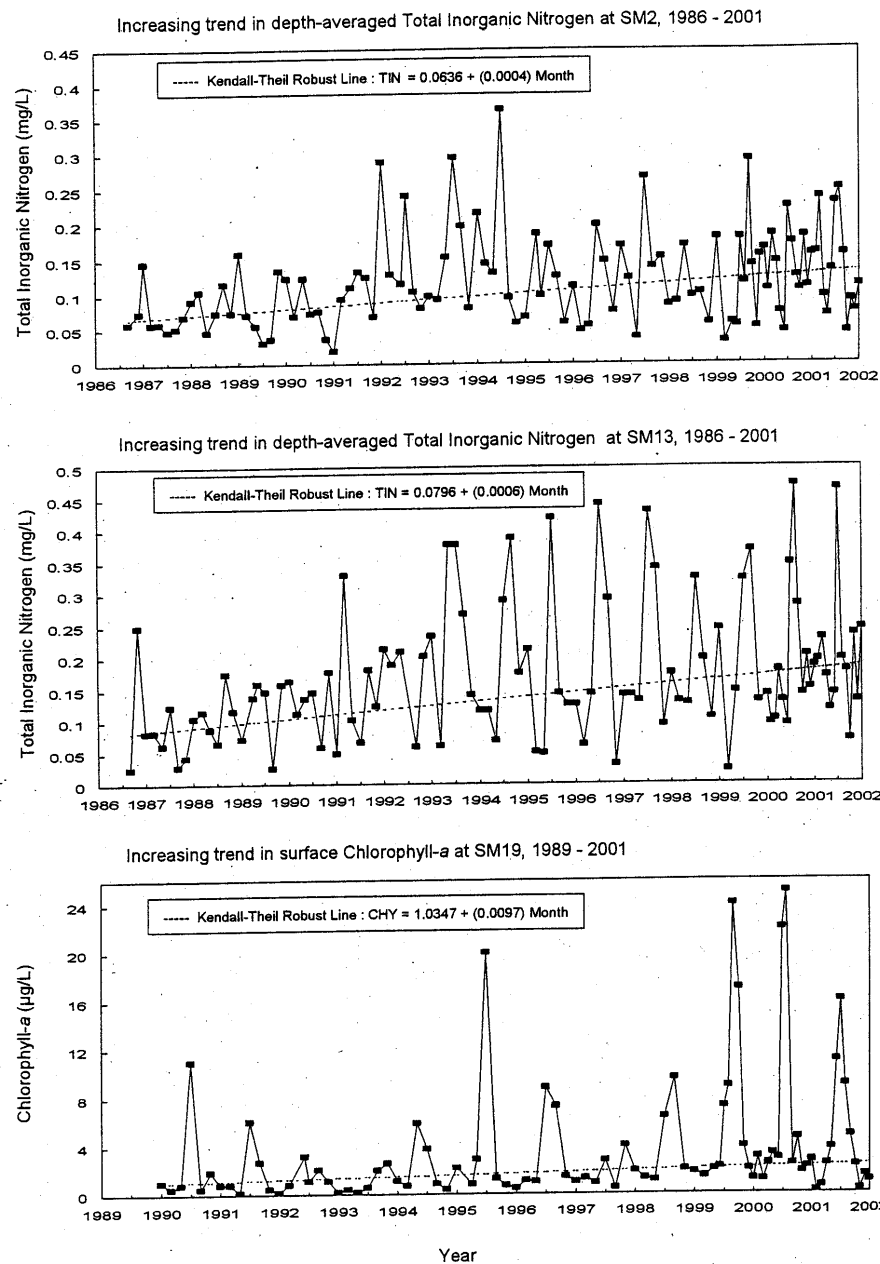


Figure 3.2 Marine water quality trends in the Southern WCZ
(based on the Seasonal Kendall Test significant at $p < 0.05$)

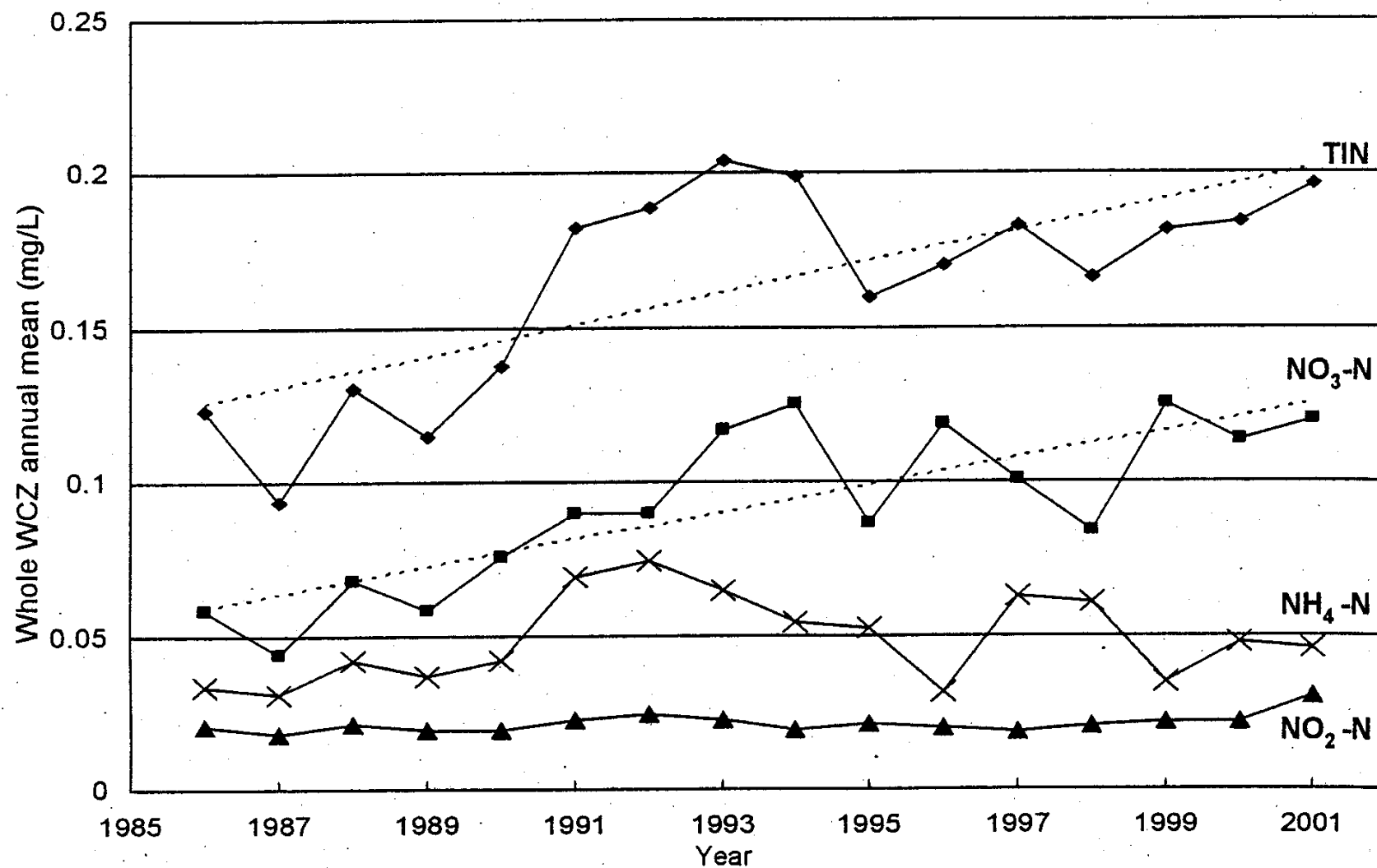
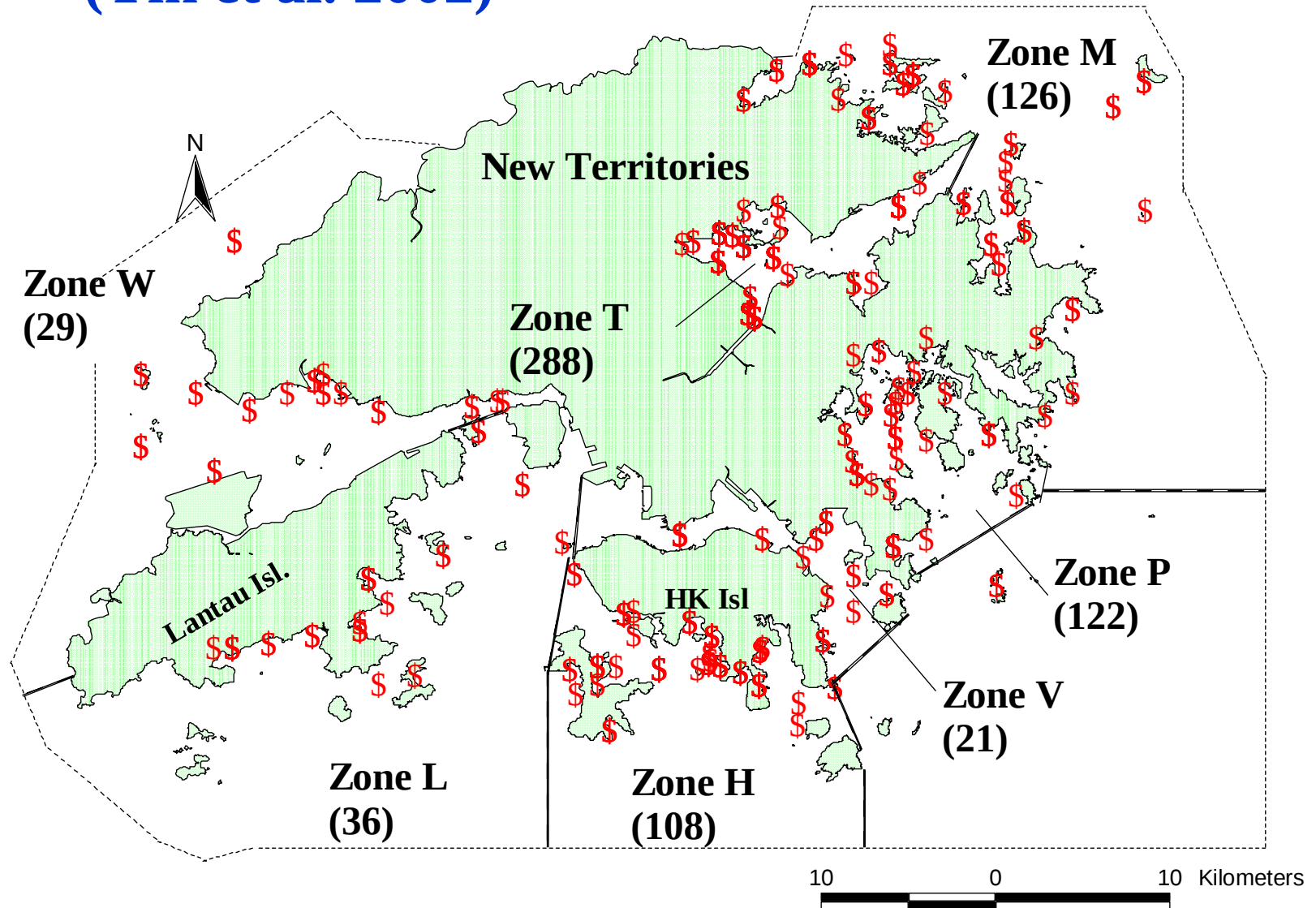
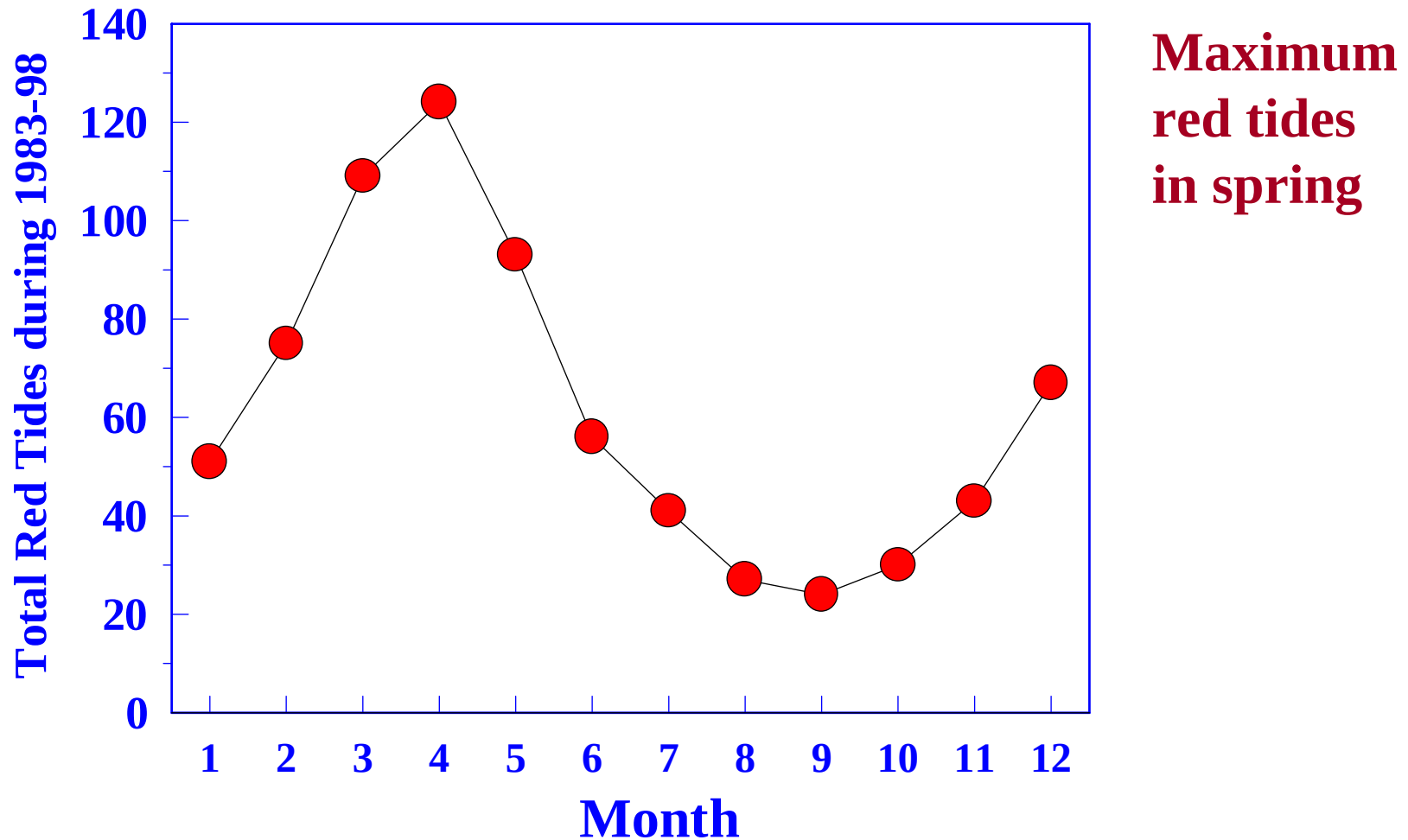


Figure 3.4 Temporal trends of inorganic nitrogen components in the Southern WCZ, 1986 - 2001

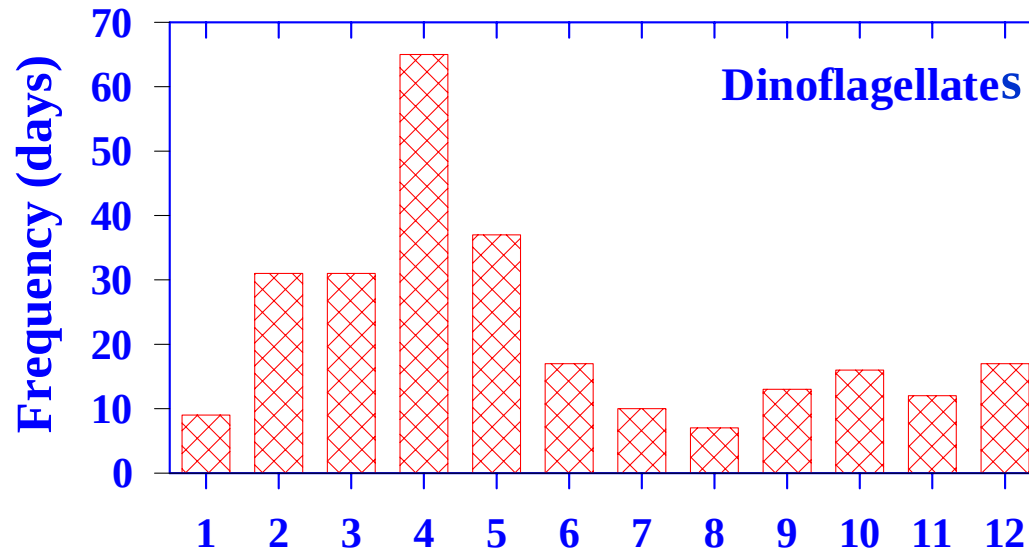
Red Tides in Hong Kong during 1983-98 (Yin et al. 2002)



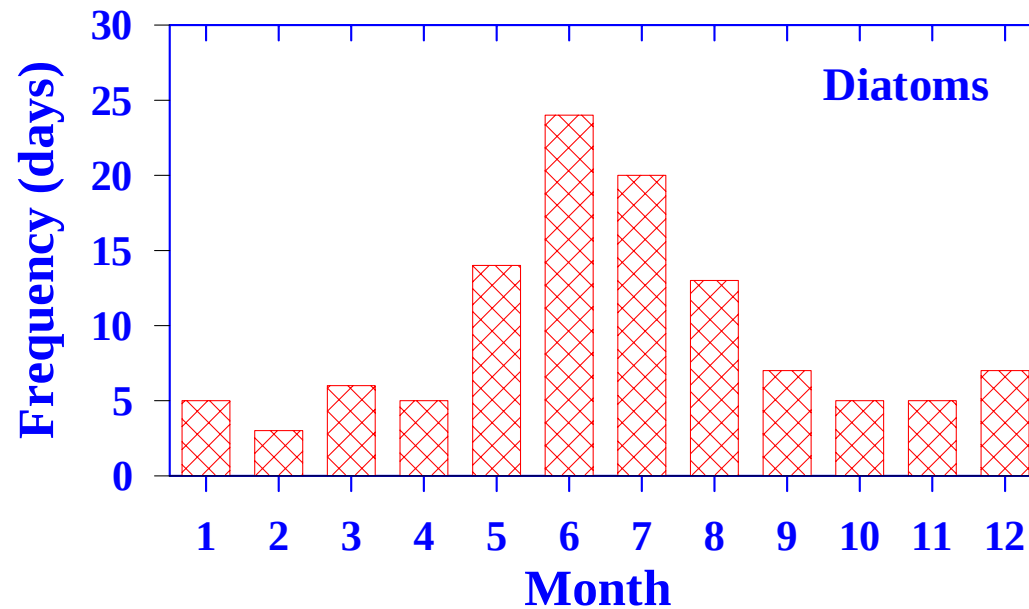
Monthly Distribution of Total Red Tides in Hong Kong during 1983-98



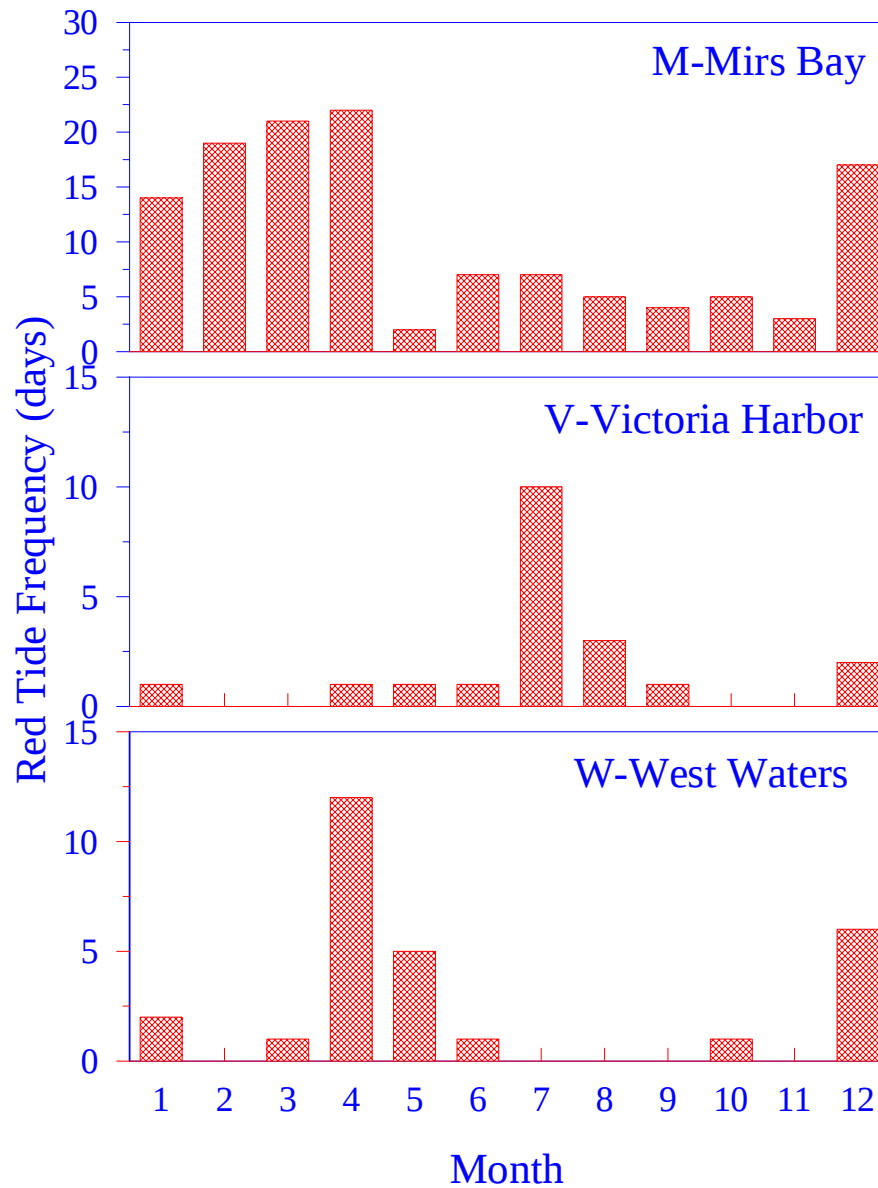
Red Tides in Hong Kong during 1983-98



**Maximum dinos
in spring**

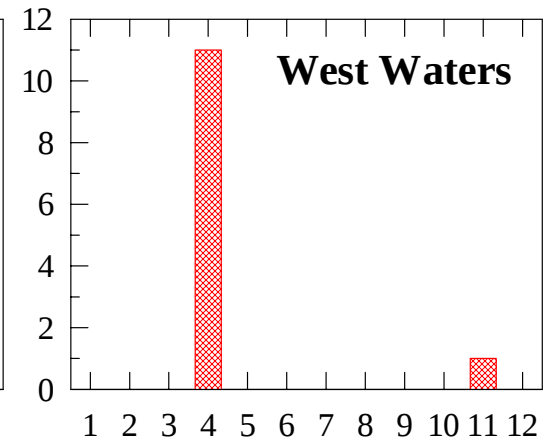
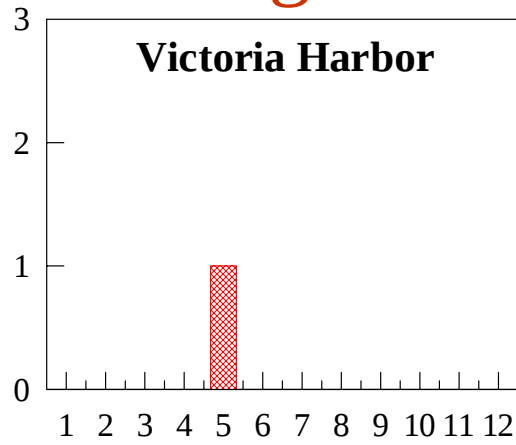
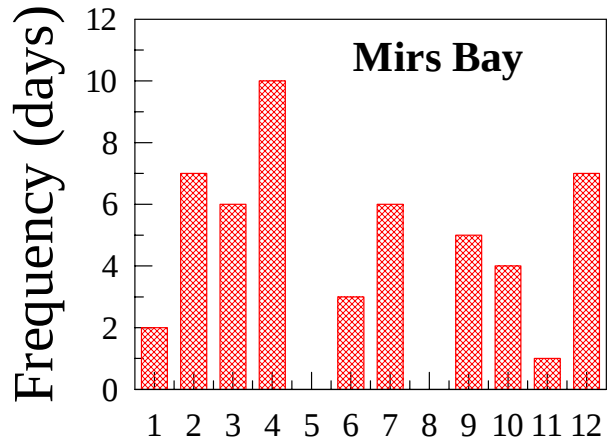


**Maximum
diatoms
in summer**

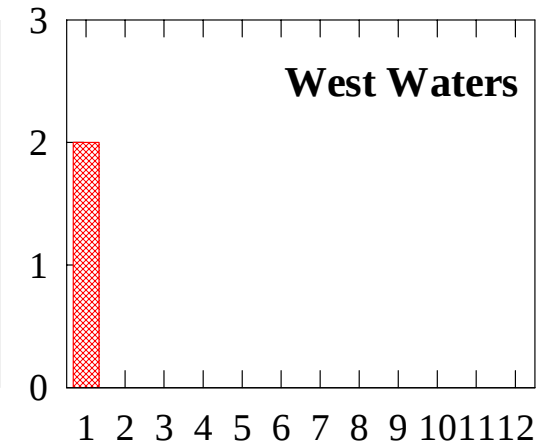
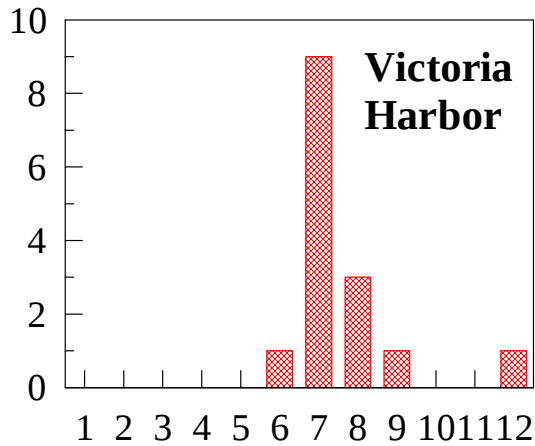
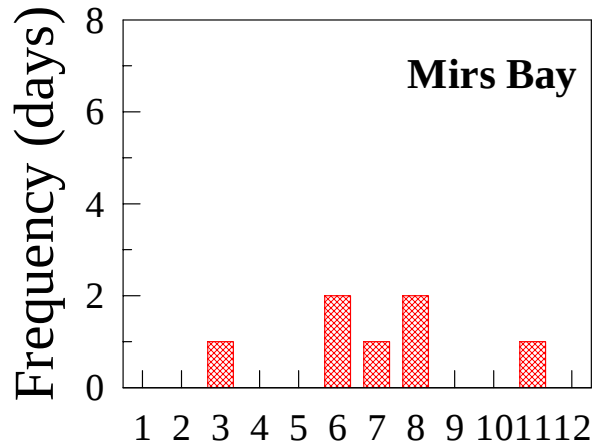


**Maximum red tides
in eastern waters in
spring**

Dinoflagellates

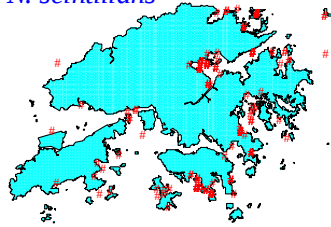


Diatoms

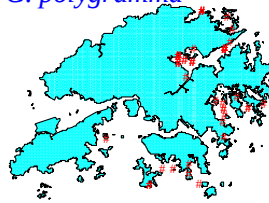


Top 10 Red Tide Species

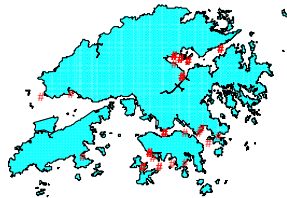
N. scintillans



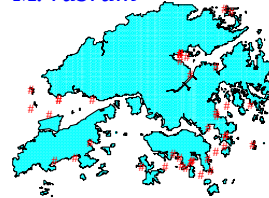
G. polygramma



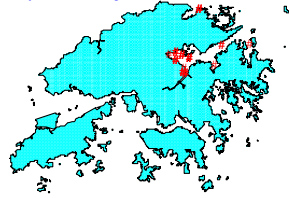
S. costatum



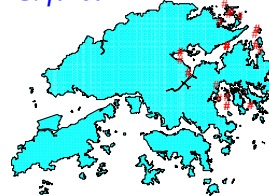
M. rubrum



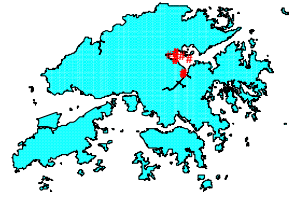
P. minimum



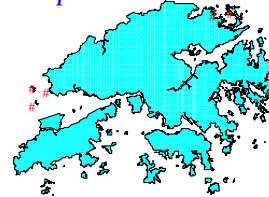
C. furca



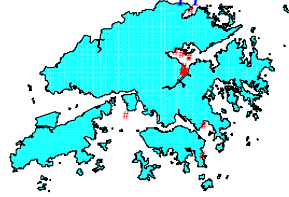
P. triestinum



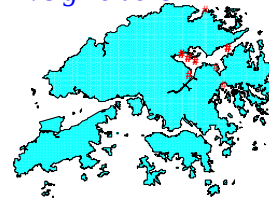
P. splendens

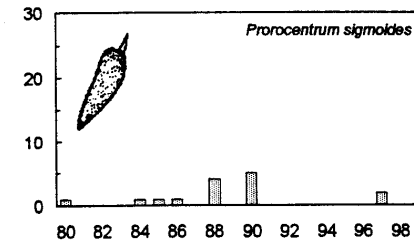
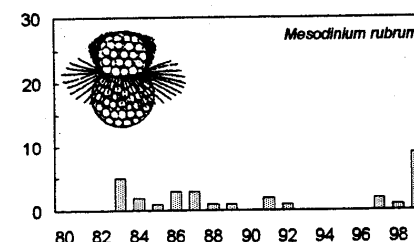
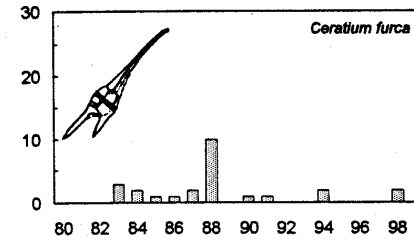
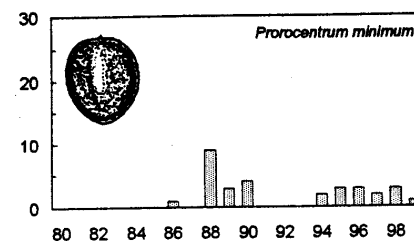
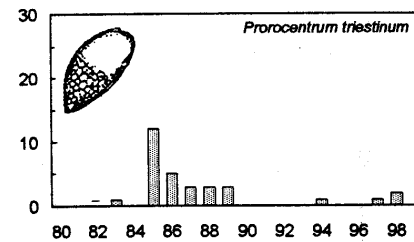
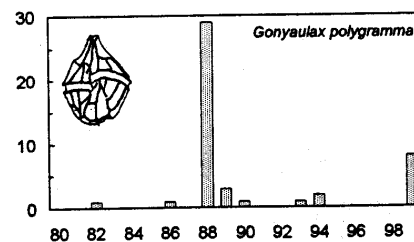
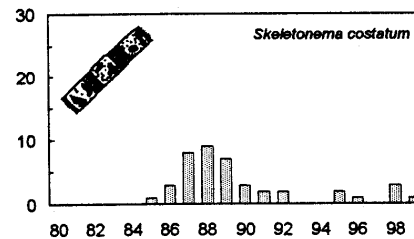
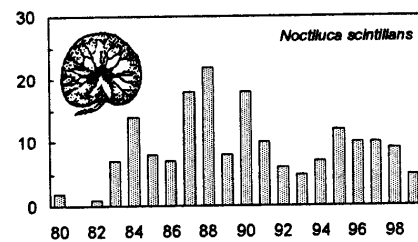


Thalassiosira spp



P. sigmoidens





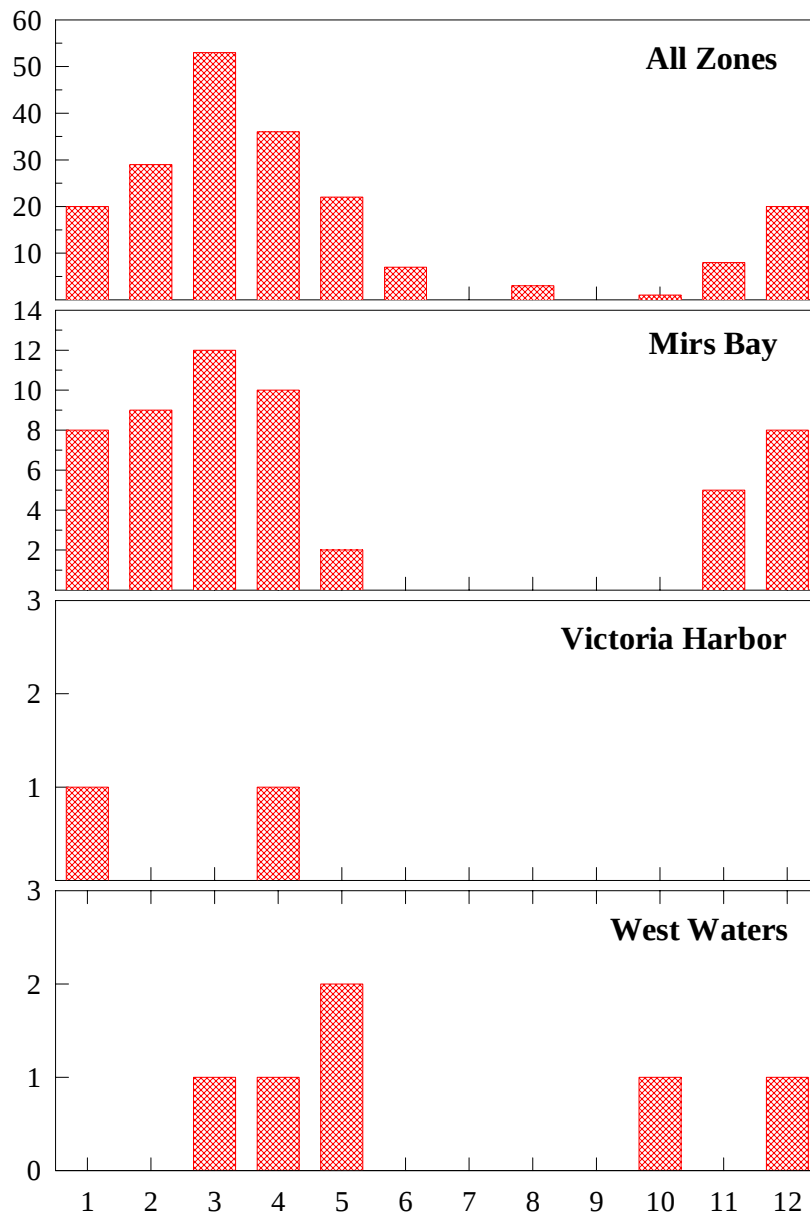
Year

Year

Figure 14.4 The most frequently occurring red tide species in Hong Kong, 1980 - 1999

Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

Frequency (Days)



Noctiluca occurs
mainly in eastern
waters

Data Format - AFCD

Routine Phytoplankton and Water Quality Data

- prior to 1999 – data are digital and stored in MS Excel format
- after 1999 – data are digital and stored in Oracle database

Red Tide Investigation Records

- paper record from 1975-2001 and stored in MS Excel format
- after 2001 – stored in Oracle database
- spatial records – in GIS (ArcMap 8.0)

Data Sharing- AFCD & EPD

EPD and AFCD - provides data in format requested by inquirer

- data sharing based on intended use. Used for series of publications.
- some information exchange with Mainland.

EPD – produced 16 Annual Marine Water Quality Reports

- printed and CD-ROM copies of report are available at public libraries and www.hkpl.gov.hk
- monitoring data available on EPD's web site www.epd.gov.hk

HABs - EPD

- 1) **Stations** – 25 in 9 water quality zones (WQZ)
 - surface samples - monthly
- 2) **Phytoplankton species**
 - 75 species (44 diatoms, 24 dinos, 10 others)
 - diatoms – *Skeletomema*, *Thalassiosira*, *Chaetoceros*,
 - dinos – *Noctiluca scintillans*, *Scrippsiella spp.*,
Gonyaulax polygramma
- 3) **Occurrences**
 - spring most red tides
 - dry season > wet season
 - 20-45 incidents/year (40 in 2001)
 - eastern waters > western waters
- 4) **Fish Kills** – *Chatonella ovata*, *C. marina*, *Dictyocha speculum*

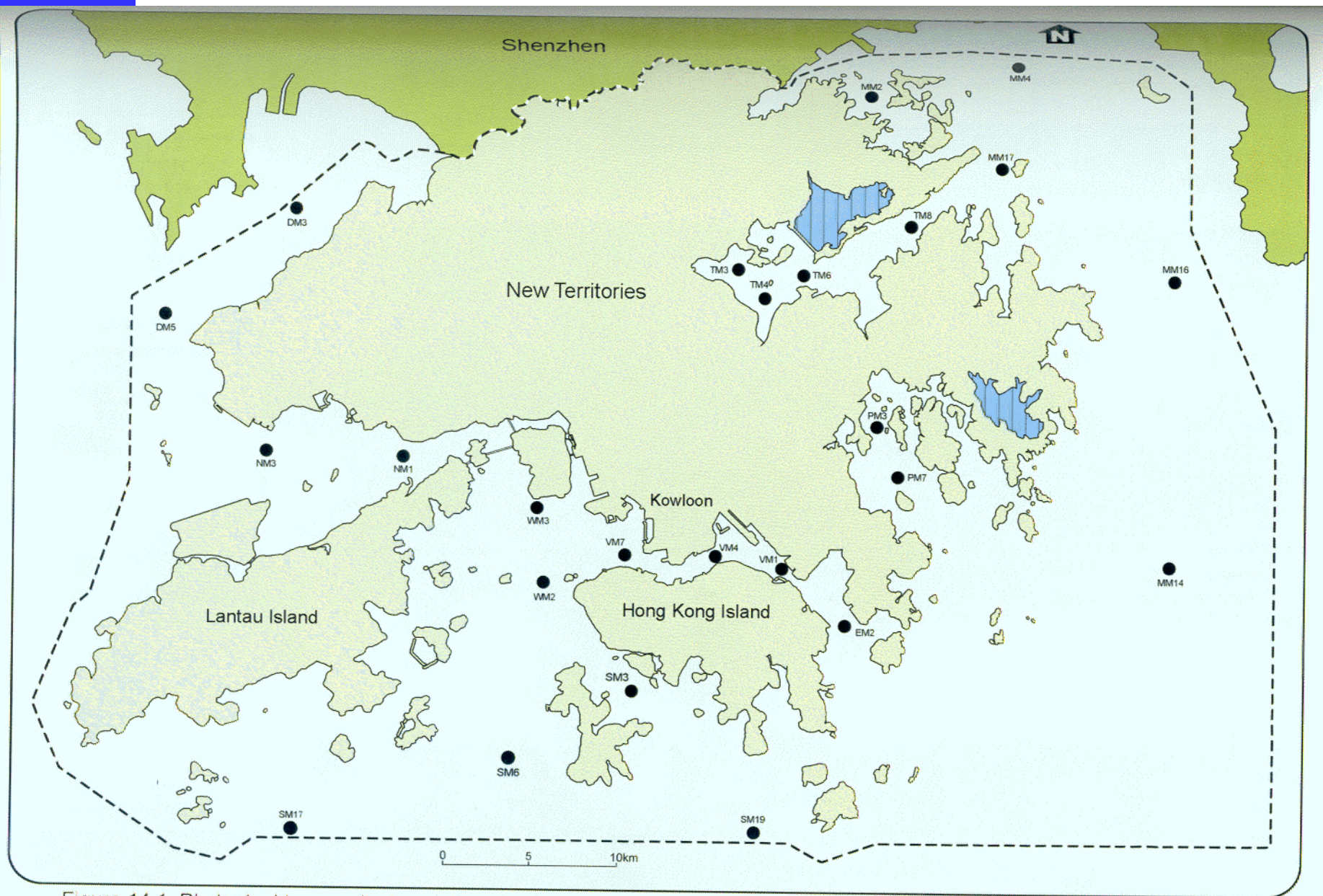


Figure 14.1 Phytoplankton monitoring stations in Hong Kong waters in 2001

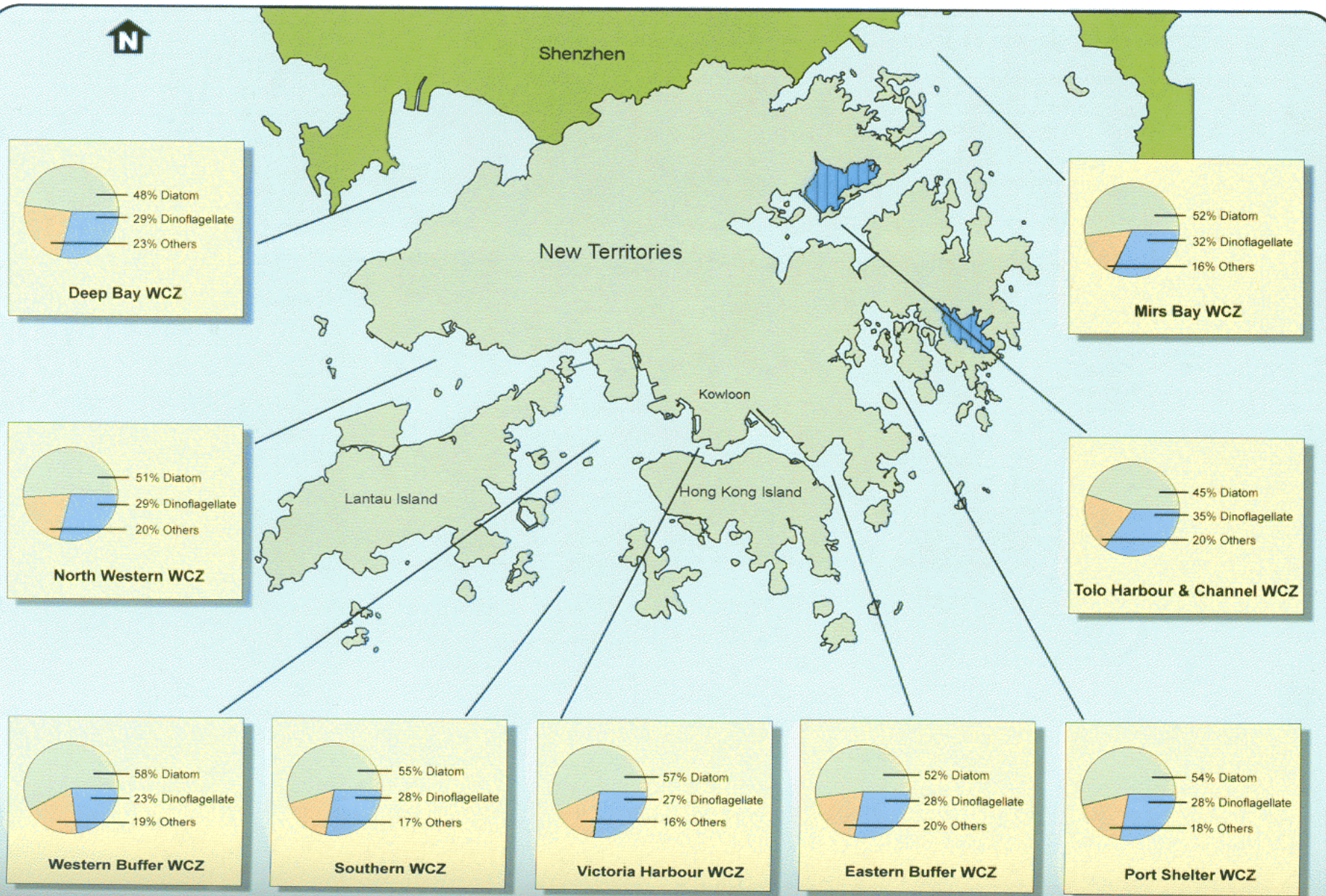


Figure 14.2 Percentage contribution of phytoplankton groups to the total number of species in the nine Water Control Zones (2001)

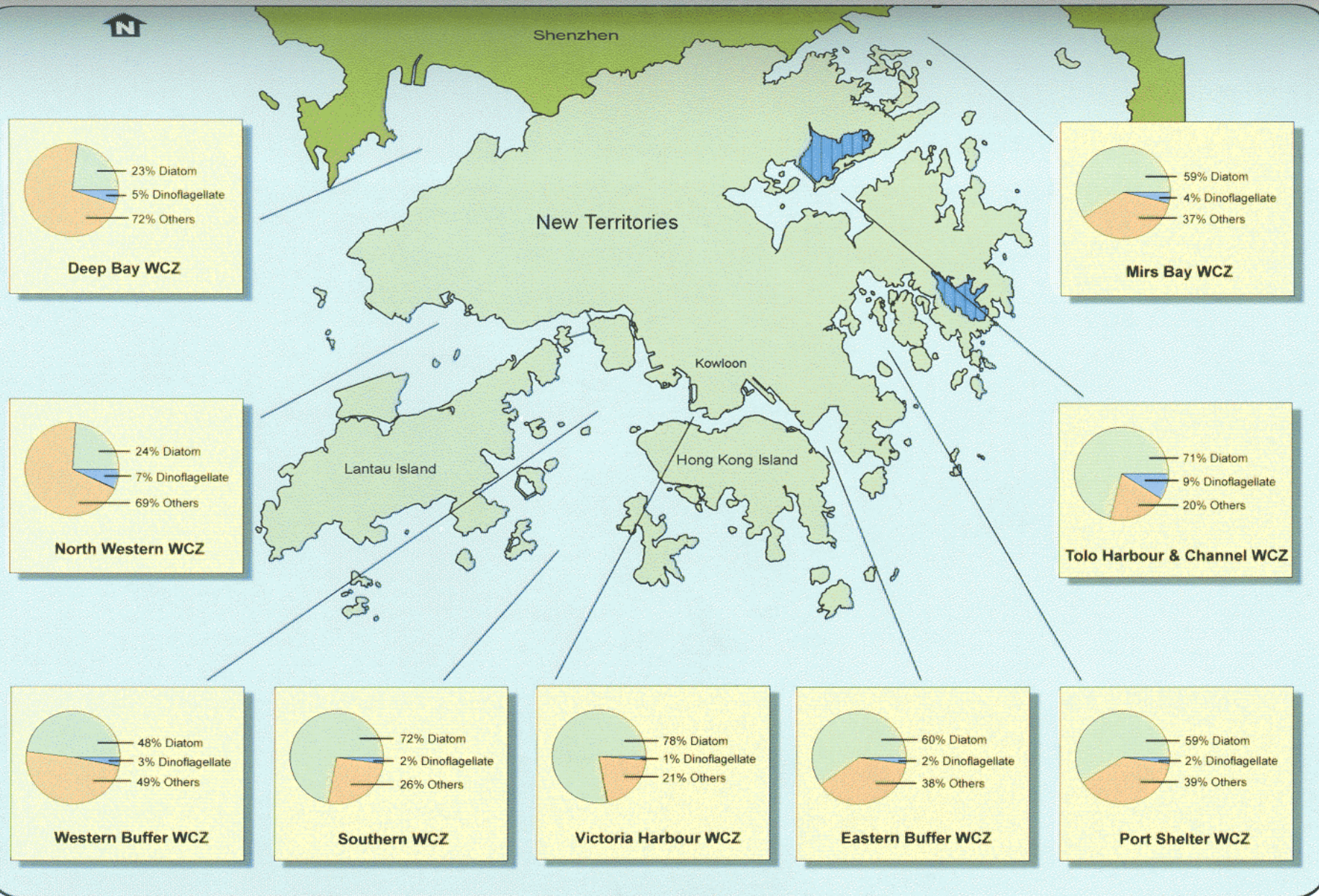


Figure 14.3 Percentage contribution of phytoplankton groups to the total density in the nine Water Control Zones (2001)

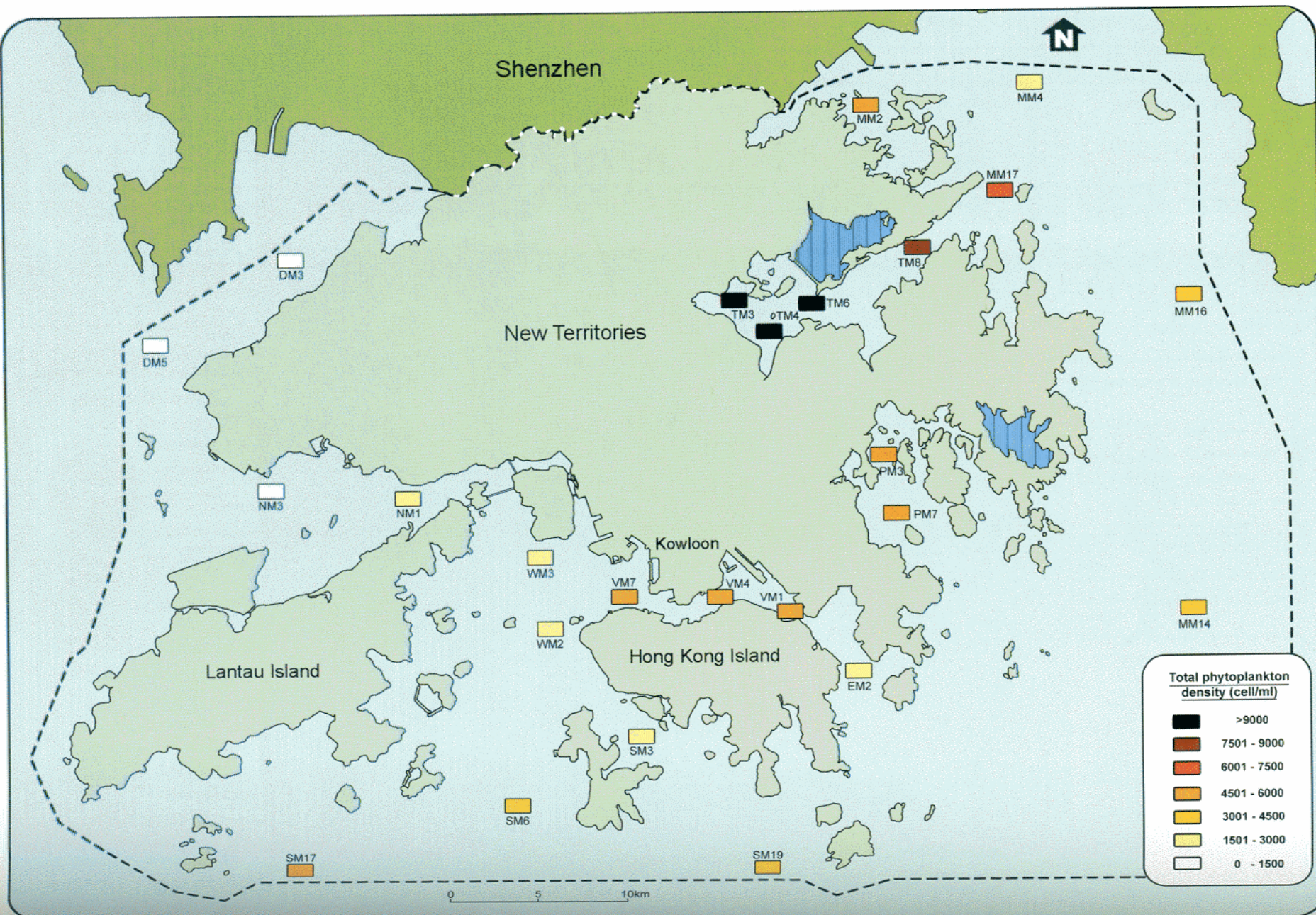


Figure 14.4 Annual mean densities (cell/mL) of total phytoplankton at 25 monitoring stations in Hong Kong waters in 2001

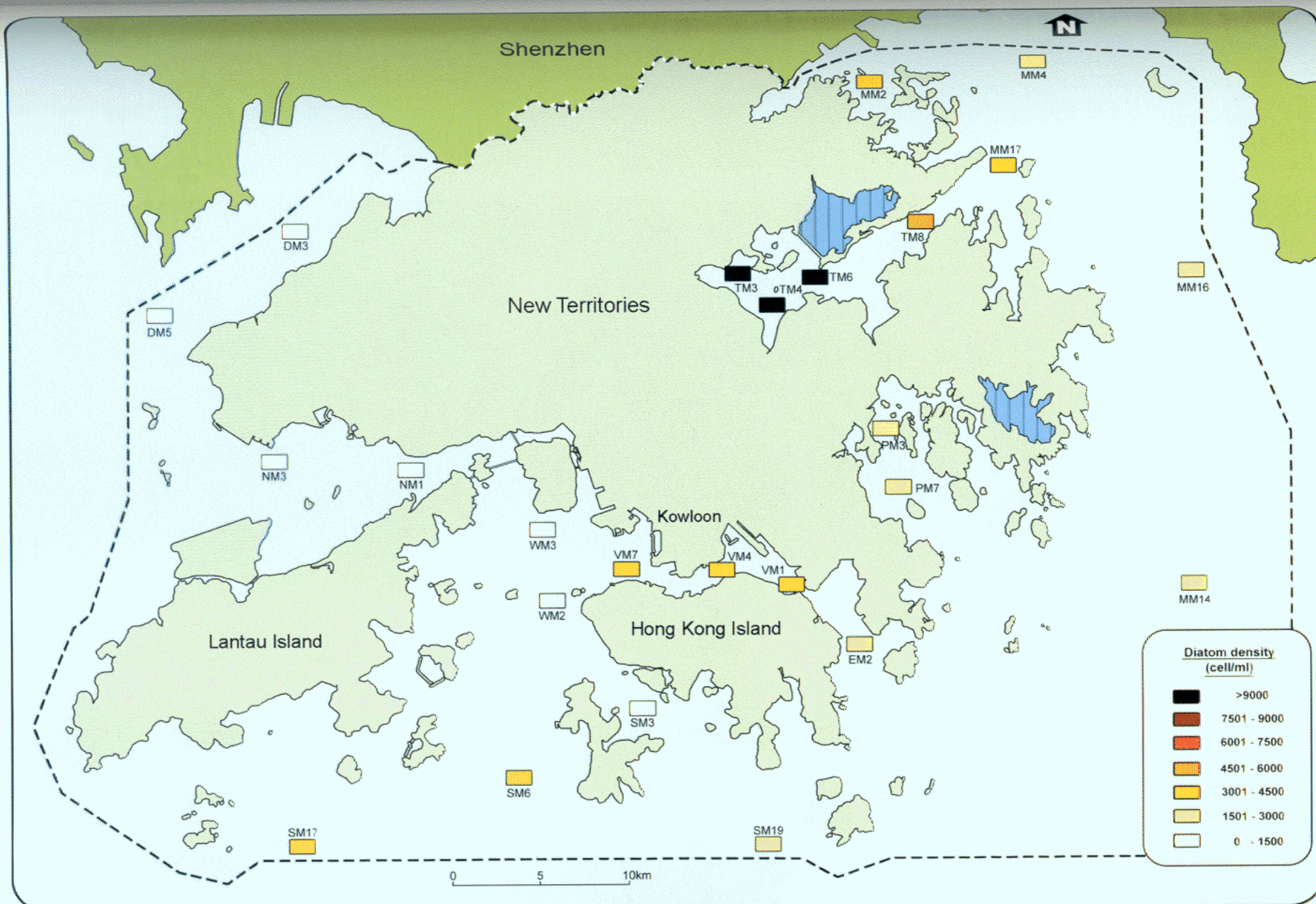


Figure 14.5 Annual mean densities (cell/mL) of diatoms at 25 monitoring stations in Hong Kong waters in 2001

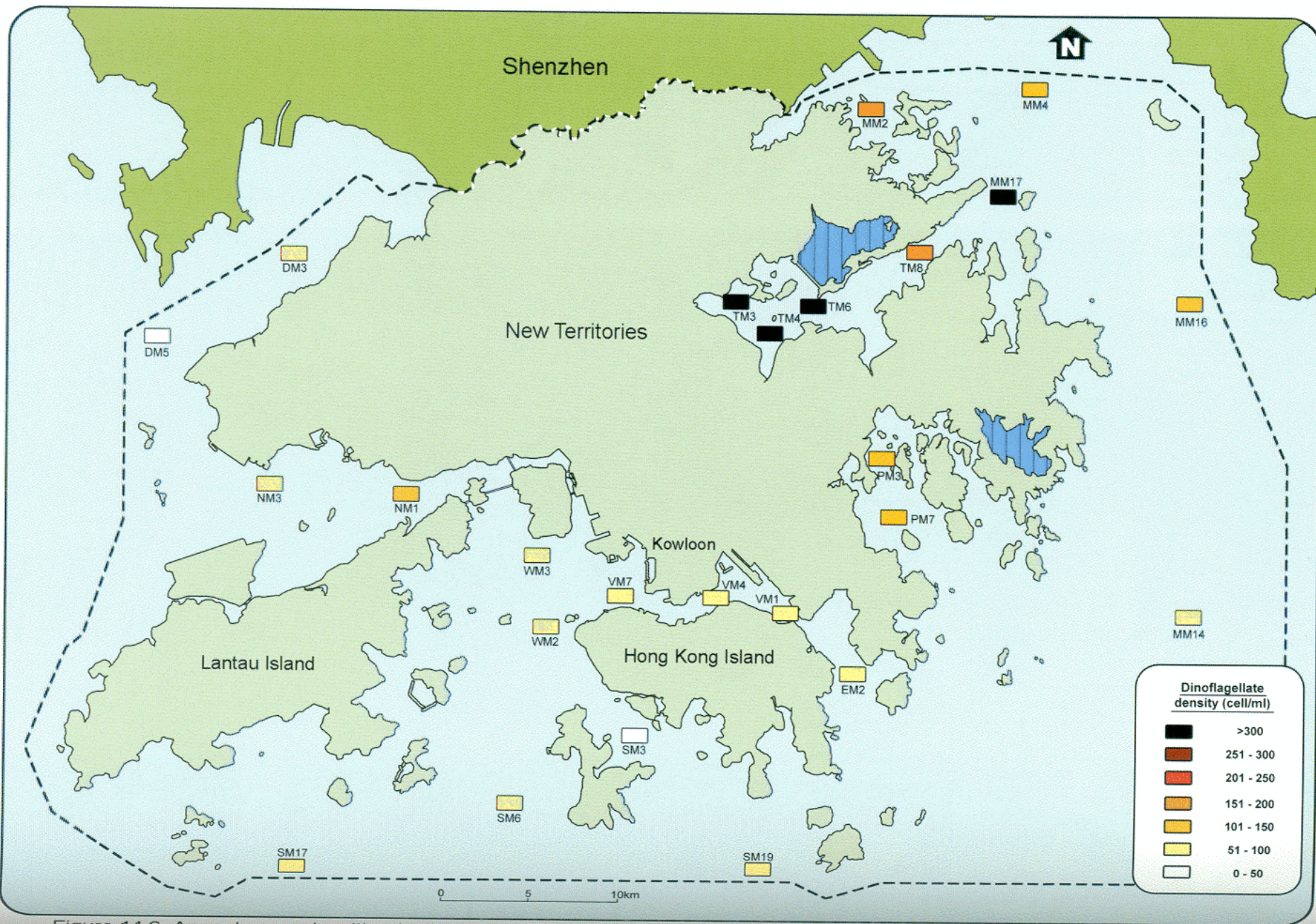


Figure 14.6 Annual mean densities (cell/mL) of dinoflagellates at 25 monitoring stations in Hong Kong waters in 2001

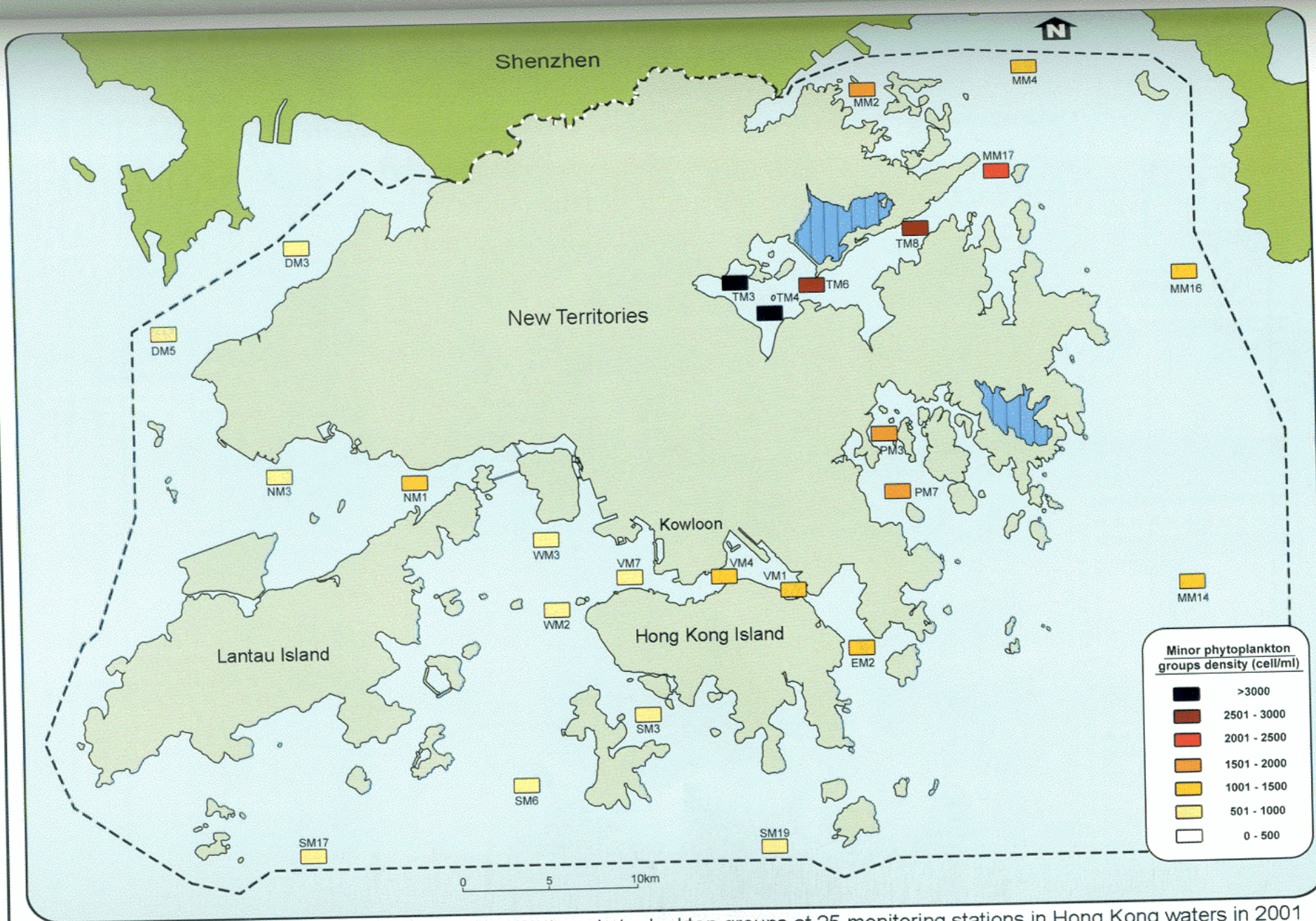


Figure 14.7 Annual mean densities (cell/mL) of other phytoplankton groups at 25 monitoring stations in Hong Kong waters in 2001

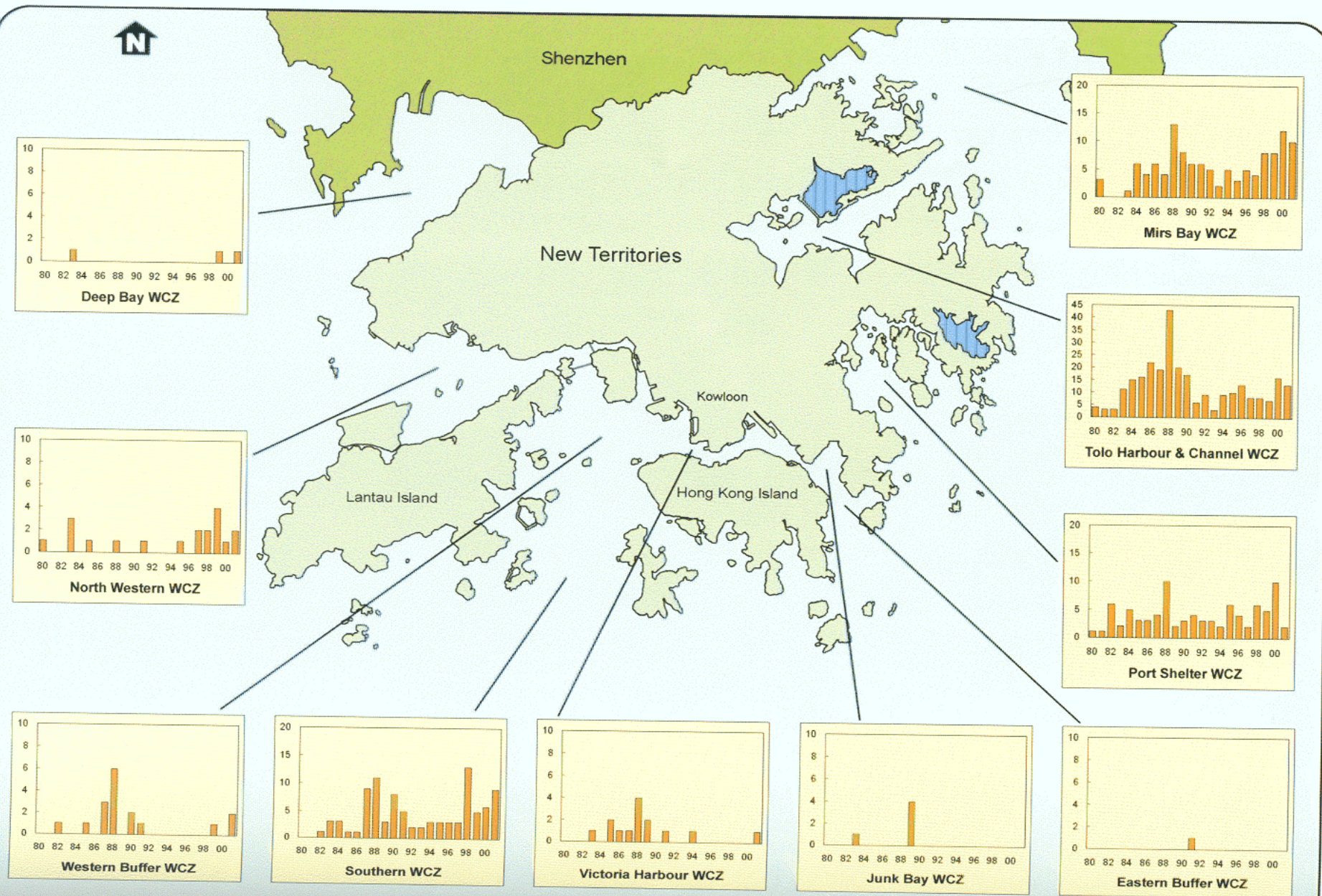


Figure 14.8 Frequency of red tides in 10 Water Control Zones in Hong Kong, 1980 - 2001
 Source: Agriculture, Fisheries and Conservation Department and Environmental Protection Department

Conclusions

- Spatial gradients from river to estuary to oceanic.
- Temporal gradients with the wet season (summer) being the critical period.
- Summer rains & river discharge → stratification which decreases transport of O_2 to deep water
- Summer nitrogen loads are high → high algal biomass and P and Si limitation
- Most HABs occur in spring far away from the Pearl River and nutrient load from Pearl River is low in spring.