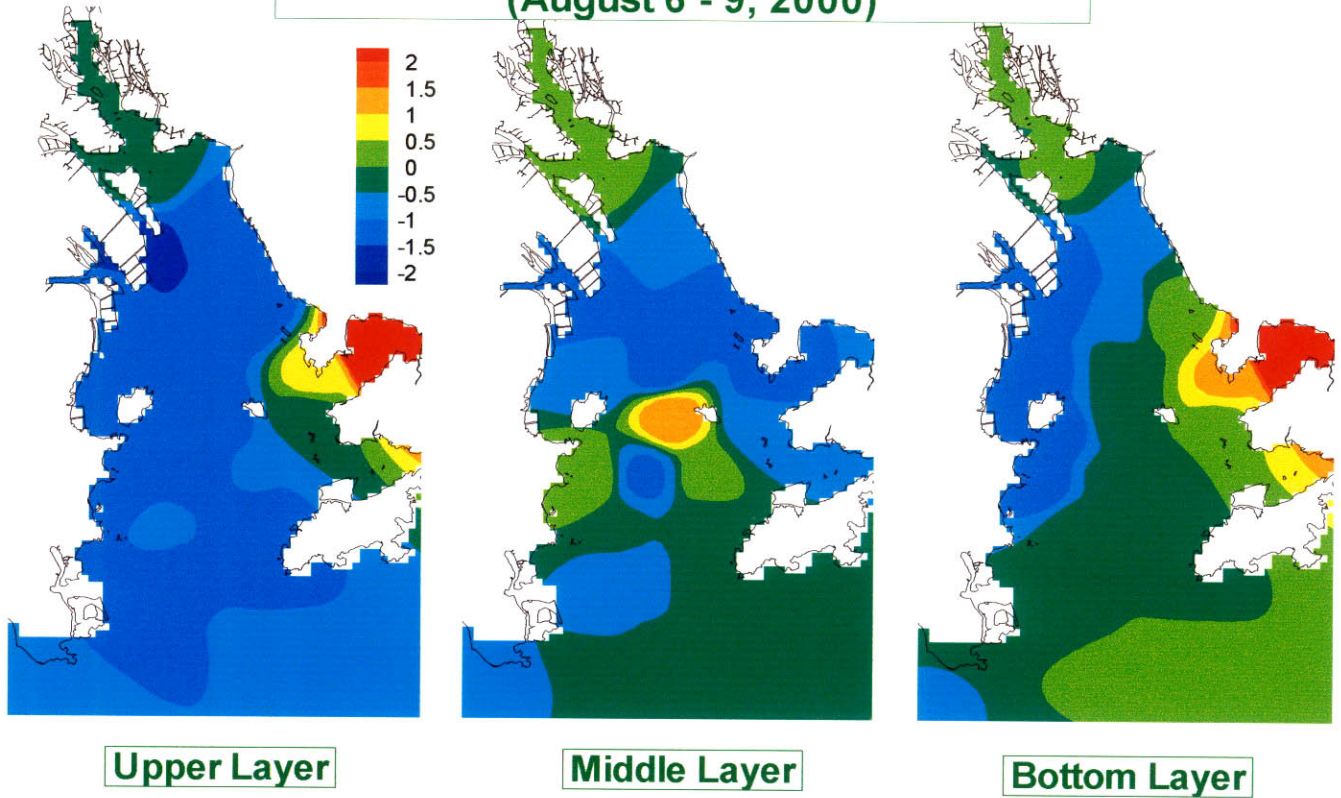


**Component 2 : Rainy Season - Neap Tide
(August 6 - 9, 2000)**



**Component 2 : Rainy Season - Spring Tide
(July 31 - August 3, 2000)**

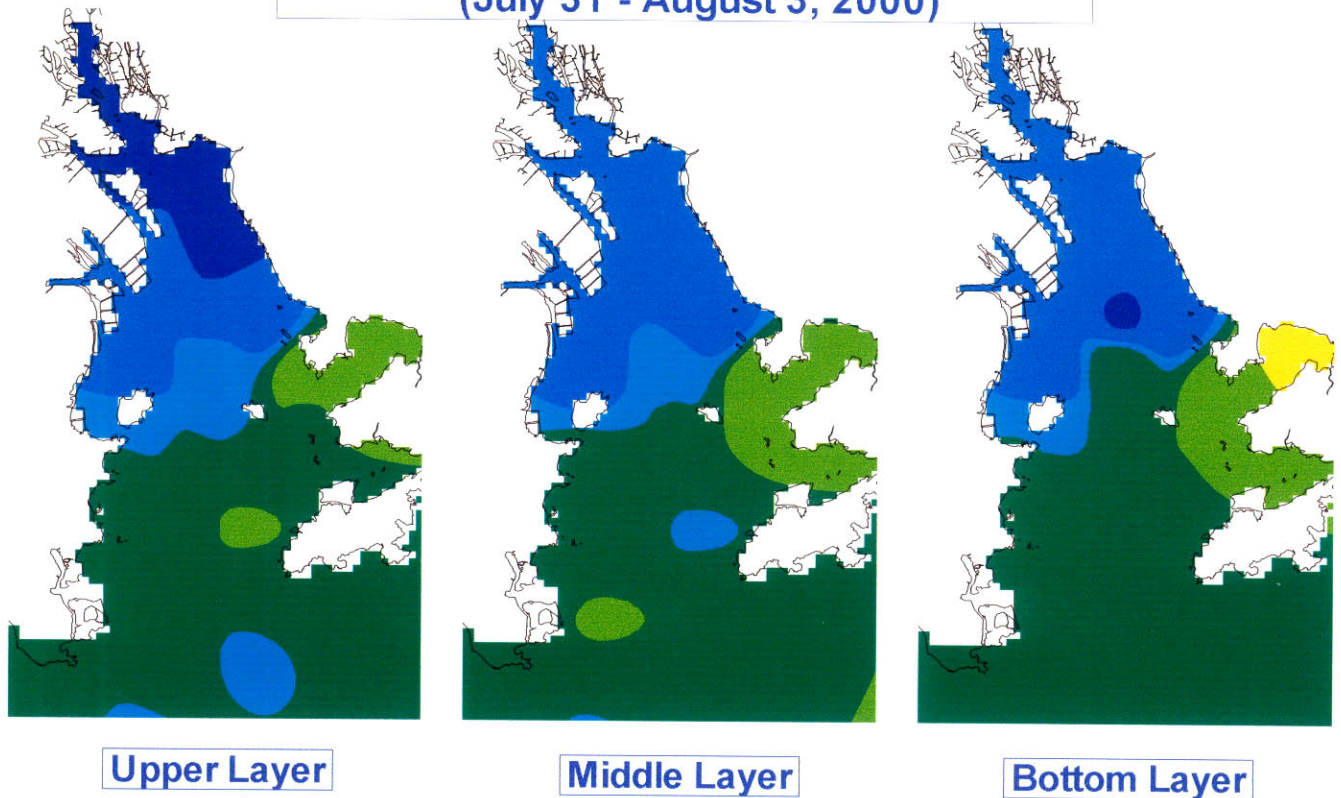
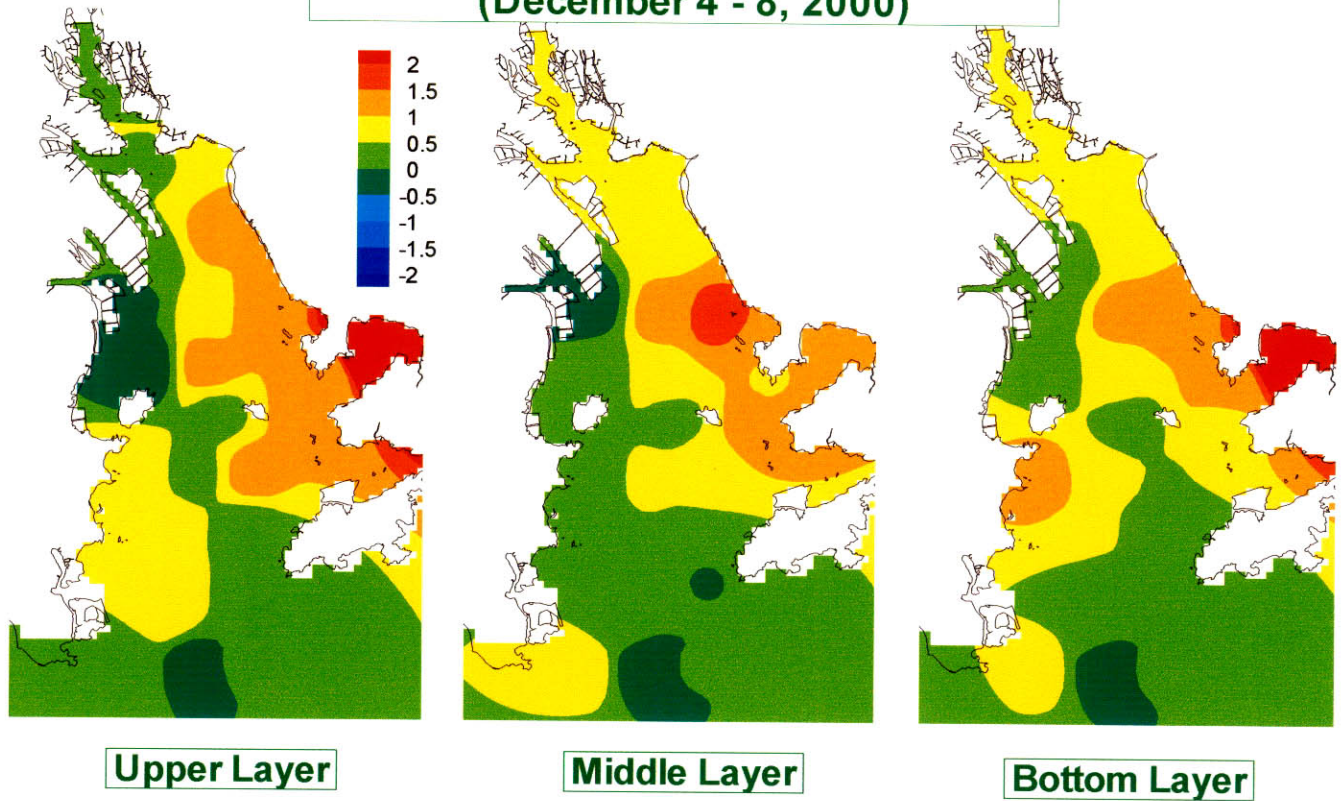


Figure 2.3.4

Water Quality Multiple Component Analysis

**Component 2 : Dry Season - Neap Tide
(December 4 - 8, 2000)**



**Component 2 : Dry Season - Spring Tide
(December 9 - 14, 2000)**

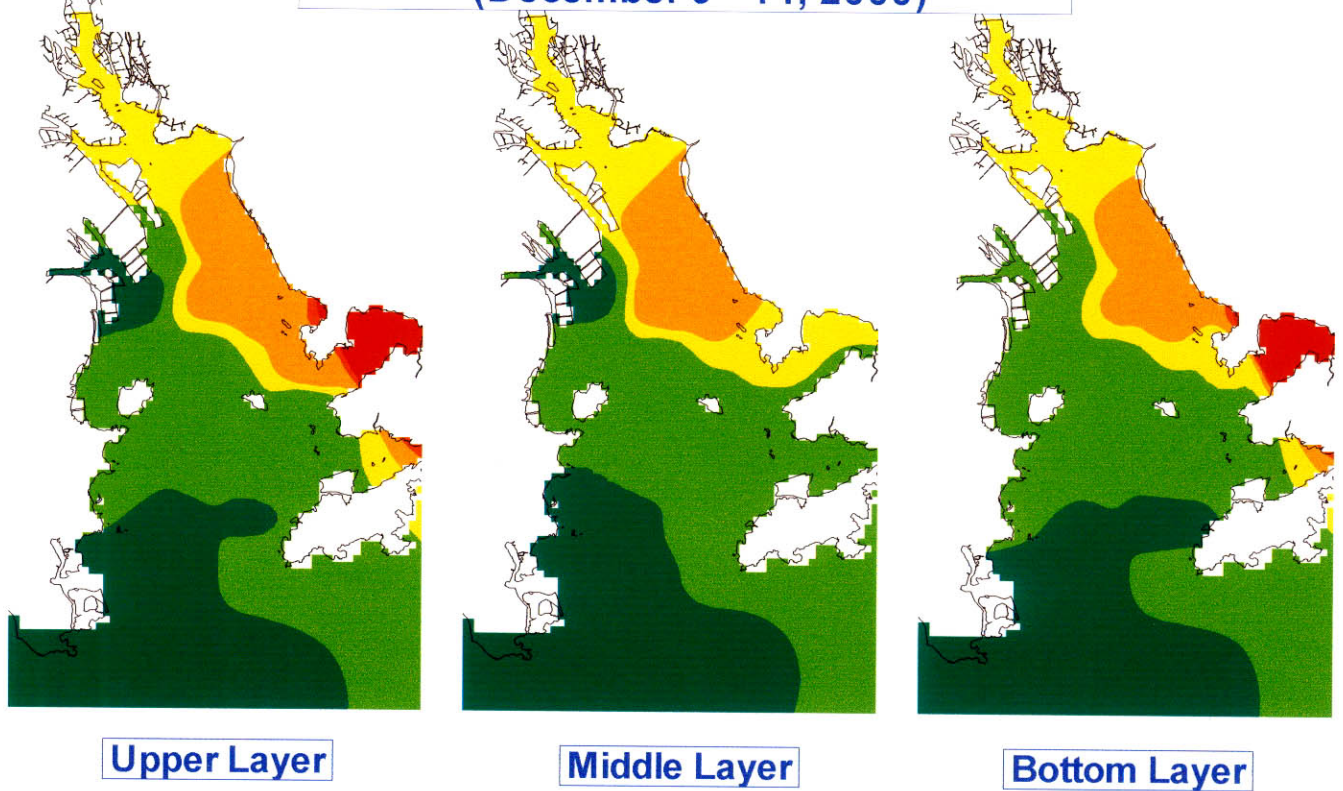
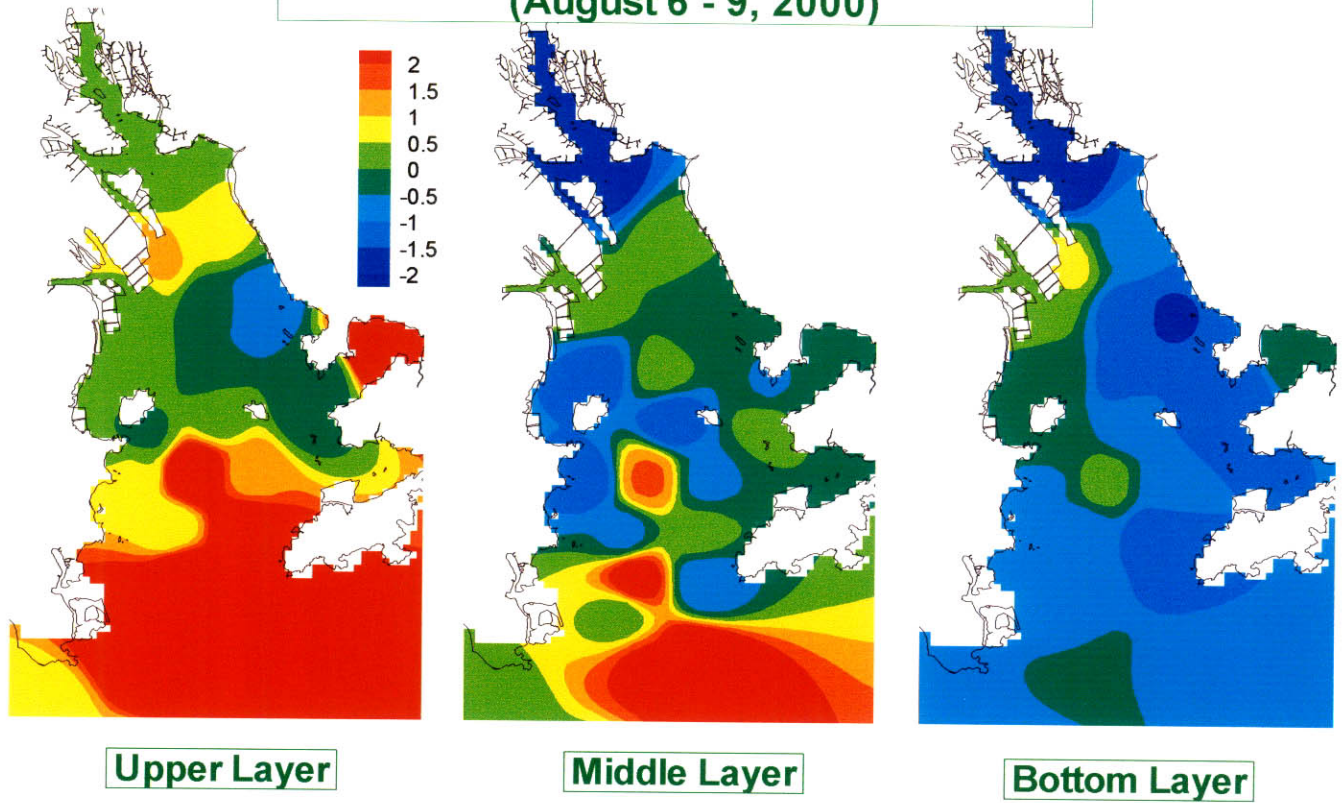


Figure 2.3.5

Water Quality Multiple Component Analysis

**Component 3 : Rainy Season - Neap Tide
(August 6 - 9, 2000)**



**Component 3 : Rainy Season - Spring Tide
(July 31 - August 3, 2000)**

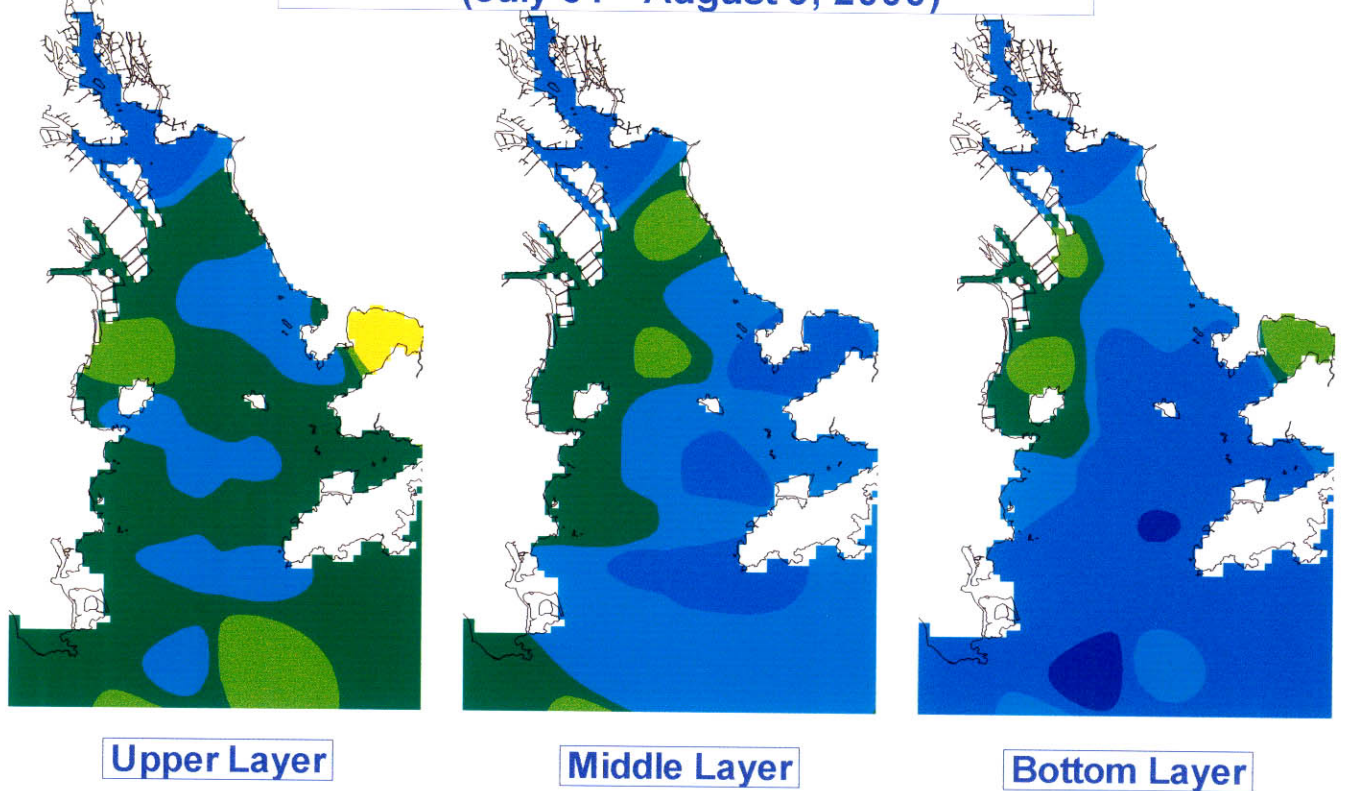
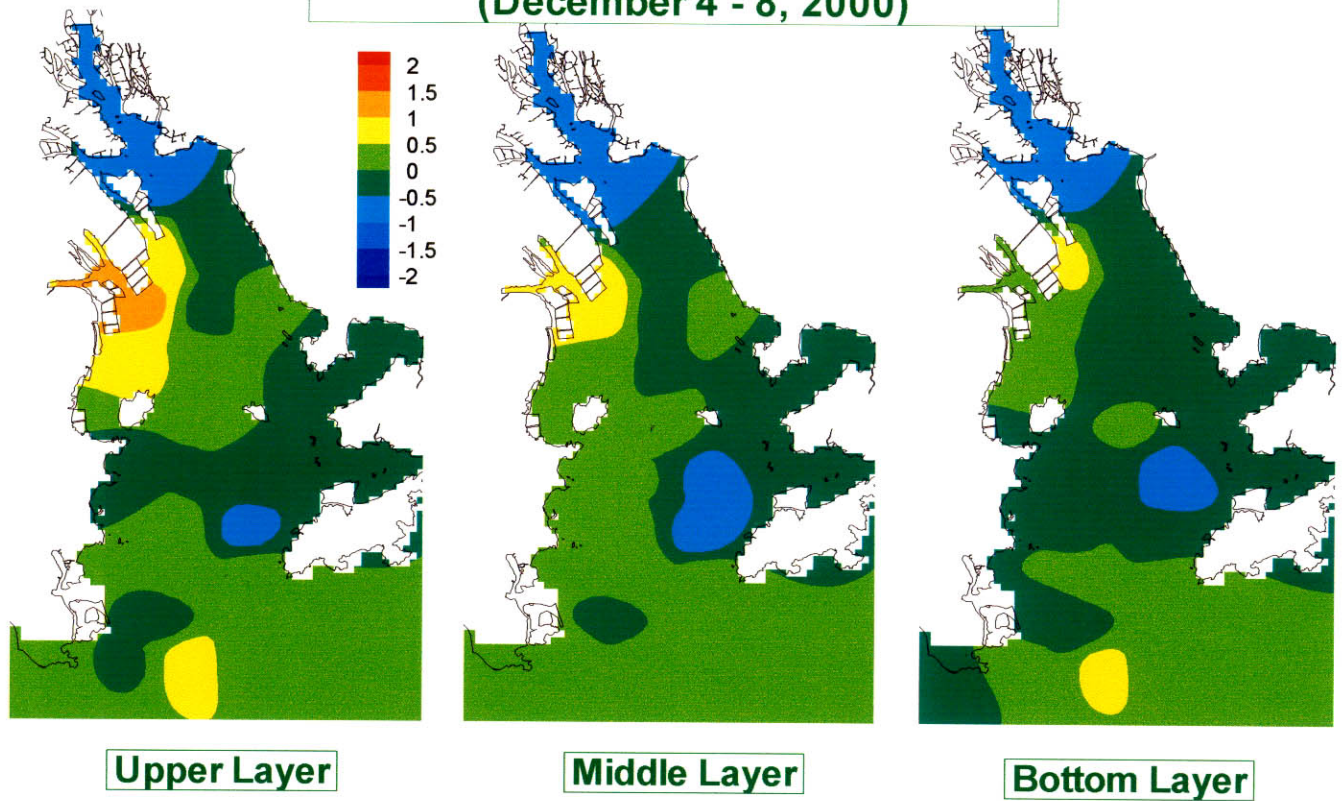


Figure 2.3.6

Water Quality Multiple Component Analysis

**Component 3 : Dry Season - Neap Tide
(December 4 - 8, 2000)**



**Component 3 : Dry Season - Spring Tide
(December 9 - 14, 2000)**

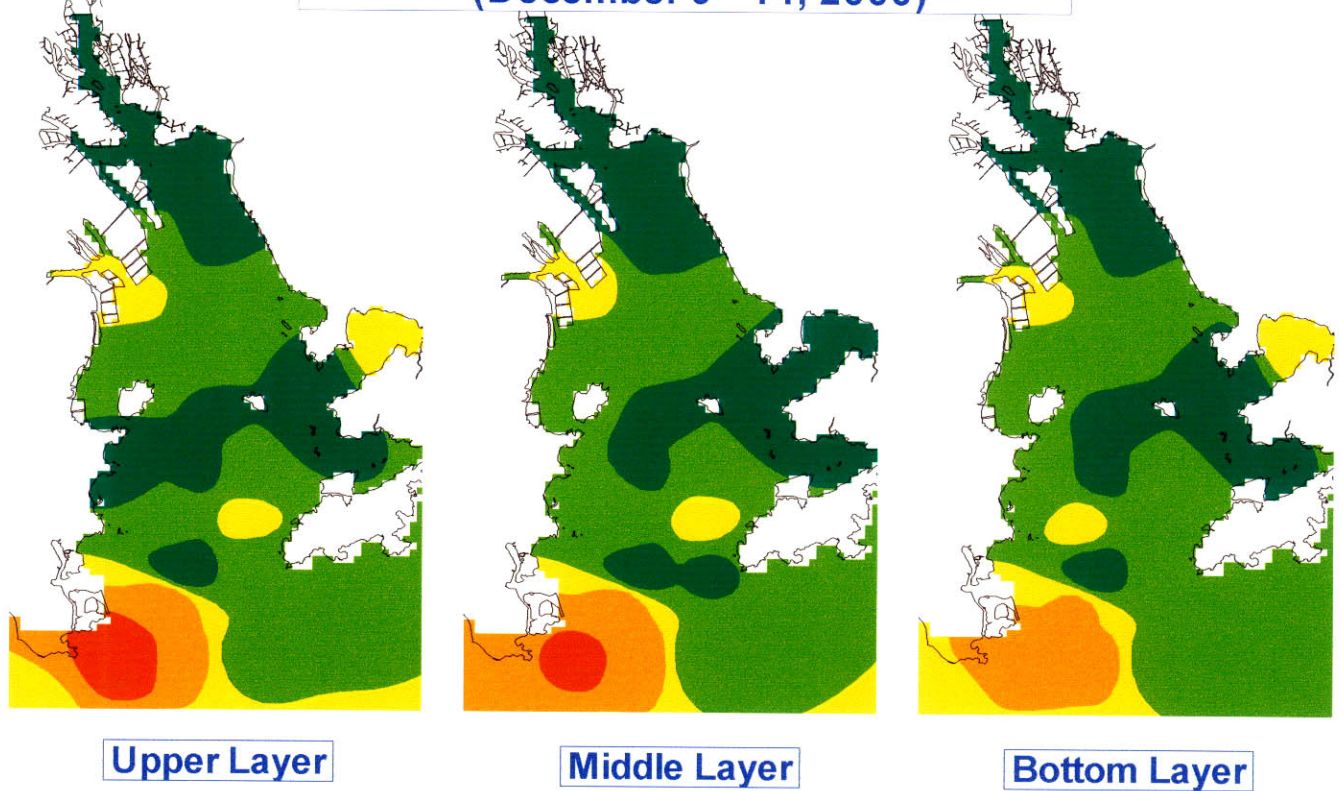


Figure 2.3.7

Water Quality Multiple Component Analysis

2.4. Similarity between Survey Points in Water Quality Characteristics

The similarity between survey points was analyzed by water quality characteristics. Survey points with high similarity during spring tide and neap tide in the rainy and dry seasons were gathered by cluster analysis, based on components of No. 1 to 3 obtained by principal component analysis. Ten groups of high similarity were gathered from 25 points in the dry season and the other ten from 26 points in the rainy season, setting the cluster number as 10. An example of the result of cluster analysis is shown in Figure 2.4.1. High similarity points that belong to the same cluster are summarized in Table 2.4.1. The characteristics of the similarity were as below.

- 1) In the rainy season, the upper bay area from P01 to P07 and bay mouth area from P19 to P23 showed high similarity of water quality in both the upper and bottom layers. The central bay area from P19 to P23 showed high similarity in the upper layer but not very much similarity in the bottom layer.
- 2) In the rainy season, points in the upper layer, forming a central line from P8 of the upper bay towards bay mouth such as P8, P11, P14, and P17, showed high similarity suggesting that inflowing river water goes out through this line. In the lower layer, points of P24, P21, P19, and P8 showed high similarity suggesting that seawater of outer sea enters through this path.
- 3) In the dry season, points of the upper bay from P0 to P5 showed high similarity in the upper layer. Points of the bay mouth from P19 to P25 showed high similarity in both the upper and bottom layer.
- 4) P10 in Shenzhen Bay showed no similarity with other points.
- 5) As a result of a similarity analysis for 2 seasons $\times$ 2 tidal timings $\times$ 2 layers, the following points showed more than 50 % similarity.

Upper Bay Area	P01-P05, P02-P05, P03-P04, P03-P07, P05-P06
Central Bay Area	P11-P17, P11-P19
Bay Mouth Area	P20-P22, P20-P23, P20-P25, P22-P25

Table 2.4.1 Similarity of Water Quality among Monitoring Points by Cluster Analysis
(Number of Cluster: 10 ; put together 25 or 26 points to 10 groups)

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27
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	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27
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P27																											

 : Same Cluster in both of Spring tide and Neap tide
 : Same Cluster in one of Spring tide or Neap tide

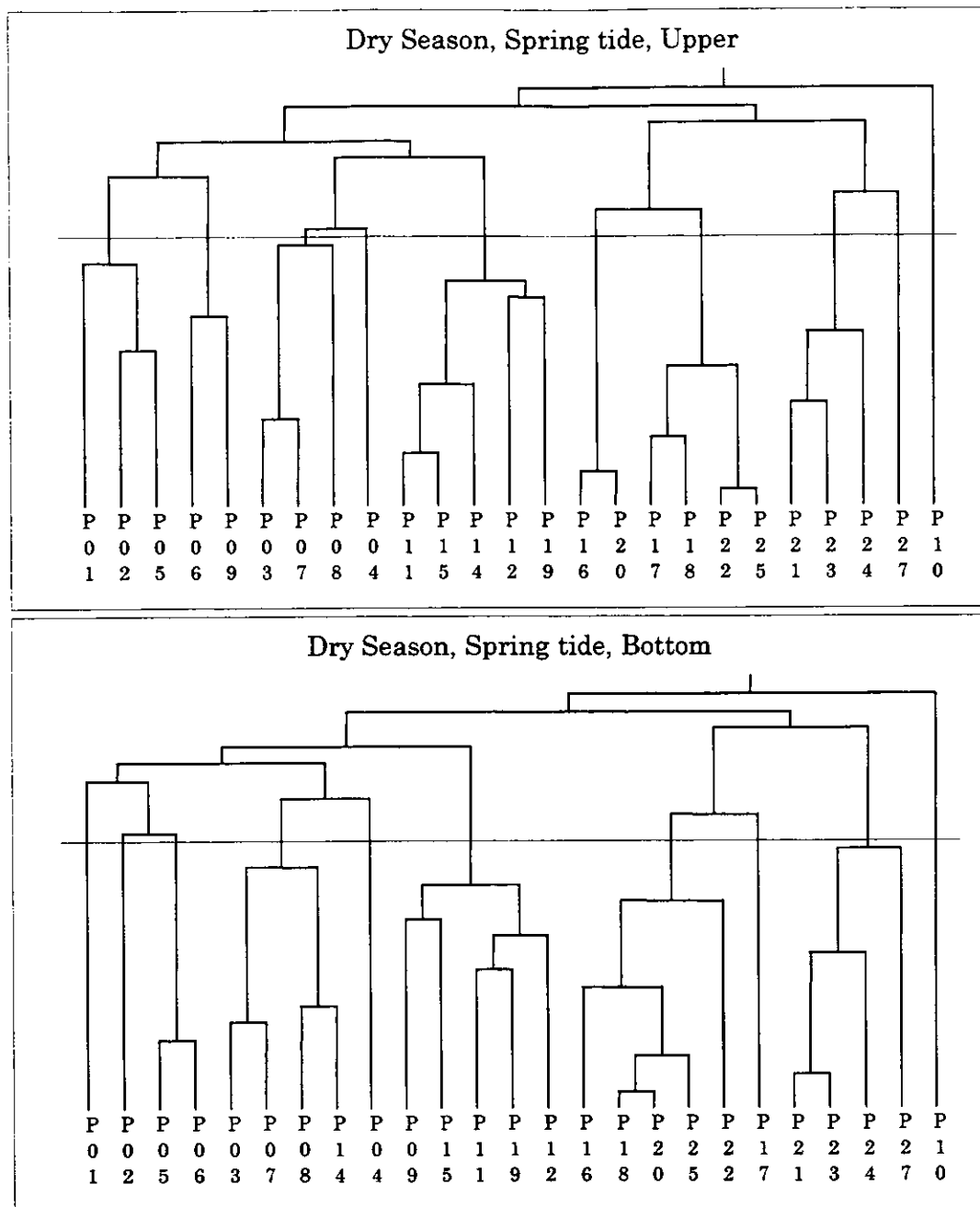


Figure 2.4.1 Results of Cluster Analysis (Case: Dry Season, Spring tide)
(Number of Clusters : 10)

3. Bottom Sediment Quality

3.1. Overview of Existing Information

Heavy metals in seawater may be transferred into the bottom sediment by many pathways, such as adsorption by suspended matters, complexation, flocculation, co-deposition and biological absorption. The enrichment coefficient of heavy metals, dependent on these phenomena, was investigated in Lingdinyang during 1976 to 1977 and March of 1987 (See Table 3.1.1). These results showed that the enrichment coefficients of the 1987 result had increased markedly from those of 1976 to 1977 (Han Wuying et al. 1995).

3.2. Bottom Sediment Quality by the Monitoring Program

Fine grain (silt and clay) is the main size of grain in the Pearl River Estuary. Fine grain composition is over 70% at most survey points, and over 90% in the western part of the bay mouth. As an exception, gravel or sand is dominant composition at a point in the eastern channel of the estuary, where dredging is under way.

Organic matter and oils are not high in the estuary, except in Shenzhen Bay where levels are slightly elevated.

A tendency towards reduction is evident for sulfide and Eh in Shenzhen Bay.

All heavy metals except Hg exceed the standard for coastal bottom sediment quality at many survey points (Hg: <0.2mg/kg, Cu: <30mg/kg, Cd: <0.5mg/kg, Zn: 80mg/kg, Pb: 25mg/kg, As: 15mg/kg) (See Table 3.2.1, 3.2.2, 3.2.3, and 3.2.4).

Horizontal distribution patterns of Zn and As show slightly elevated levels in the western part of the bay mouth and in the upper bay. However, the distribution pattern of other heavy metals do not show any significant distribution characteristics (See Figure 3.2.1).

Table 3.1.1 The heavy metal ion enrichment coefficients in the sediments of
Lingdingyang, the Pearl River Mouth ($\times 10^3$)

	year	Hg	Pb	Cr	Cd	Cu	Zi	As
Enrichment coefficient	1976-1977	4.6-7.3	0.4-3.8	84.8-144	0.2-1.4	2.6-6.3	1.4-4.8	2.5-9.8
	1987	-	25.51	-	6.78	21.86	14.1	-

Table 3.2.1 Bottom Sediment Quality (Organic Matter and Oils Contents)

Items/Season Area/Point		Organic Matter(%)		Oils Contents(mg/kg)	
		Rainy S.	Dry S.	Rainy S.	Dry S.
Bay head	(P01)	2.3	1.4	152	105
River mouth	(P04)	1.5	1.1	47	92
Shenzhen Bay	(P10)	3.2	2.1	85	2585
Western part of bay mouth	(P14)	2.7	2.1	279	129
	(P24)	2.1	1.7	703	791
Eastern part of bay mouth	(P22)	2.1	-	216	-

Table 3.2.2 Bottom Sediment Quality (Sulfide and Eh)

Items/Season Area/Point		Sulfide(mg/kg)		Eh(mV)	
		Rainy	Dry	Rainy	Dry
Bay head	(P01)	7	35	110	360
River mouth	(P04)	17	56	78	88
Shenzhen Bay	(P10)	78	489	18	-20
Western part of bay mouth	(P14)	54	38	29	281
	(P24)	47	100	43	10
Eastern part of bay mouth	(P22)	135	-	49	-

Table 3.2.3 Bottom Sediment Quality (Hg, Cu and As)

Items/Season Area/Point		Hg(mg/kg)		Cu(mg/kg)		As(mg/kg)	
		Rainy	Dry	Rainy	Dry	Rainy	Dry
Bay head	(P01)	0.22	0.09	42	31	24	20
River mouth	(P04)	0.09	0.10	57	27	18	18
Shenzhen Bay	(P10)	0.06	0.14	20	54	12	11
Western part of bay mouth	(P14)	0.20	0.19	57	49	33	30
	(P24)	0.20	0.18	39	40	27	27
Eastern part of bay mouth	(P22)	0.10	-	27	-	15	-

Table 3.2.4 Bottom Sediment Quality (Zn, Pb and Cd)

Items/Season Area/Point		Zn(mg/kg)		Pb(mg/kg)		Cd(mg/kg)	
		Rainy	Dry	Rainy	Dry	Rainy	Dry
Bay head	(P01)	189	121	54	42	0.94	0.98
River mouth	(P04)	97	90	35	29	0.89	1.09
Shenzhen Bay	(P10)	81	86	44	51	0.87	0.70
Western part of bay mouth	(P14)	157	99	47	57	1.29	0.68
	(P24)	187	196	45	55	1.17	0.83
Eastern part of bay mouth	(P22)	90	-	50	-	0.87	-

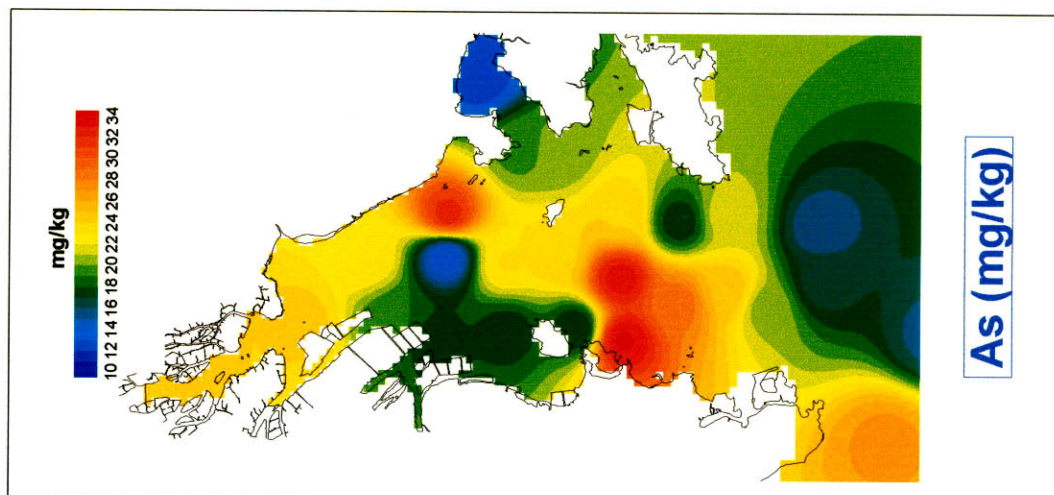
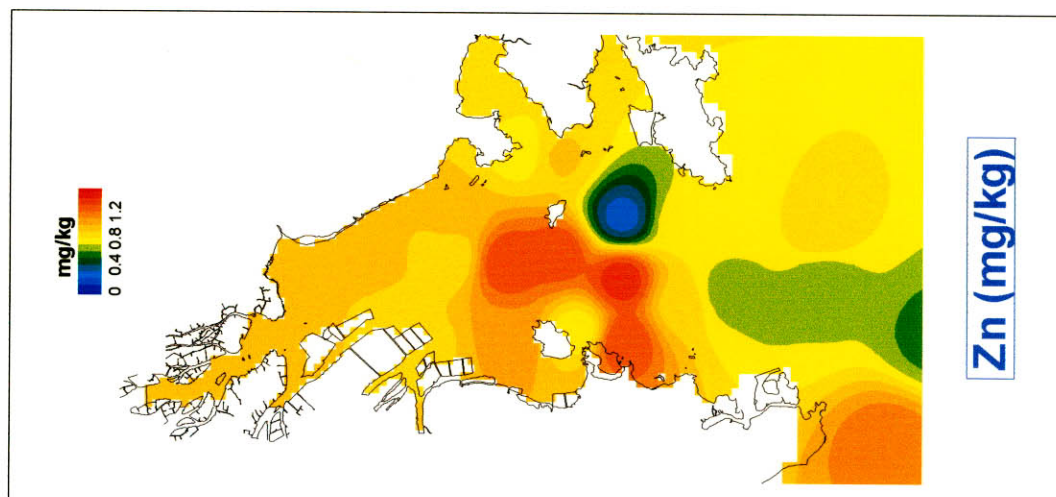


Figure 3.2.1 Horizontal Distribution of Sediment Quality in Rainy Season