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APPENDIX

Appendix A. Dissolved Cd, Cu, Fe, Ni and Pb in The Gulf of Thailand and East Coast of Malay Peninsula in wet season (September-October 1995).

Station	depth (m)	Cd(nM)*	Cu(nM)*	Fe(nM)*	Ni(nM)*	Pb(nM)*
1	0	0.071	7.87	58.37	3.81	0.48
	24	0.285	13.69	39.35	11.55	3.81
3	0	0.036	14.16	17.50	2.81	0.34
	28	0.294	97.57	53.58	17.17	3.67
8	0	0.053	11.02	57.88	9.30	0.72
	5	0.036	6.29	16.88	3.72	0.29
	10	0.036	4.72	32.32	4.97	0.68
	20	0.053	34.62	50.14	7.92	1.74
	30	0.018	6.29	15.22	2.98	0.10
	35	0.027	9.44	9.67	2.81	0.10
10	0	0.027	3.30	32.01	2.90	0.10
	45	0.027	1.89	13.88	2.55	0.08
12	0	0.044	4.72	42.89	5.41	0.10
	55	0.044	4.72	35.90	3.37	0.34
17	0	0.027	4.72	20.86	3.68	0.34
	40	0.053	6.29	19.74	4.59	0.63
20	0	0.018	2.45	20.22	3.29	0.13
	60	0.036	1.42	16.53	2.34	0.04
24	0	0.027	2.80	13.50	2.60	0.08
	26	0.027	1.92	15.37	2.47	0.08
26	0	0.018	3.15	17.41	2.60	0.10
	60	0.027	1.57	13.88	2.25	0.10
28	0	0.009	1.89	8.93	2.29	0.06
	55	0.036	1.09	6.72	1.86	0.06
31	0	0.009	2.99	87.71	2.77	0.08
	26	0.044	22.90	81.32	4.72	0.18
34	0	0.018	3.15	16.34	2.55	0.19
	10	0.018	4.72	23.95	3.42	0.24
	20	0.018	3.15	22.29	2.42	0.10
	30	0.044	6.29	21.44	2.81	0.14
	43	0.027	4.72	15.58	3.20	0.10
	50	0.044	3.15	18.58	3.16	0.10
	60	0.133	9.44	53.18	5.06	0.43
	70	0.036	4.72	29.68	3.20	0.10
	74	0.080	17.31	40.56	4.84	0.72
40	0	0.018	6.29	39.89	2.68	0.10
	19	0.018	7.87	20.77	3.07	2.27
43	0	0.027	2.60	29.37	3.50	0.08
	48	0.027	1.72	12.95	2.90	0.10
46	0	0.044	3.14	23.03	3.42	0.08
	48	0.018	2.65	11.51	2.64	0.07

* data from Southeast Asian Fisheries Development Center, 1996

Appendix A. (Continue)

station	depth (m)	Cd(nM)*	Cu(nM)*	Fe(nM)*	Ni(nM)*	Pb(nM)*
52	0	0.027	3.32	21.87	3.46	0.09
	36	0.027	2.34	22.48	3.37	0.13
54	0	0.027	3.61	30.30	3.76	0.10
	57	0.044	2.94	35.04	3.72	0.08
57	0	0.249	3.62	48.76	2.55	0.08
	58	0.009	3.42	24.41	2.42	0.06
64	0	0.018	6.29	33.44	3.20	0.10
	56	0.018	9.44	34.38	4.24	0.29

* data from Southeast Asian Fisheries Development Center, 1996

Appendix B Sample preparation

1 Seawater sample

Seawater sample preconcentration, coblit-APDC (Ammonium-pyrrolidin-dithio-carbamate) coprecipitation technique (Huizenga, 1981) were used. Seawater samples are acidified to pH 3 for several days and several months before preconcentration. Coblt reagent is added to the sample followed by the APDC reagent. The cobalt is precipitated with the APDC and in the process other trace metals are brought down with the precipitate. The precipitate is collected by filtation with Nuclepore 0.4 µm polycarbonate membrane then taken up in concentrated nitric acid and diluted with distilled water. The concentrate is then stored for 24 hours before analysis.

Procedure of coblit-APDC coprecipitation was

A. Weight the sample and subtract by the container weight to obtain the weight of the sample.
B. Add 2.00 ml of cobalt reagent to sample, cap the sample and shake it.
C. Add 2.00 ml of the APDC reagent and mix well. A yellow-green color should form immediately.
D. Allow the sample to stand at least 30 minutes to allow the precipitate to from.
E. Collect the precipitate by hand vacuum filtration on Nuclepore 0.4 µm membrane.
F. Dissolve the precipitate in 1 ml HNO_3.
G. Dilute The sample with 4 ml of Milli-Q water.
H. Shake the sample several times.
I. After 24 hours the sample is ready for AA analysis.

1.1 APDC reagent preparation

I. Dissolve reagent grade APDC (Ammonium-pyrrolidin-dithio-carbamate) in Milli-Q water to yield a 2% APDC solution. With Fisher APDC (a solution prepared to be 2.7% by weight will yield a solution with 2% active APDC). Shake this solution vigorously for 5 minutes.
II. Let it sit until the foam breaks up so that the solid can settle to the bottom pour the solution into a separatory funnel leaving the solids behind discard the solids.
III. Extract this solution with MIBK (methyl isobutyl ketone) in a ratio of 10:1 of solution to MIBK. Shake for five minutes. The APDC-metal complexes are insoluble in water but soluble in the MIBK.
IV. Crack open the top of the separatory funnel and let the two phases separate for at least one hour.
V. Extract the APDC solution two more times with MIBK in a ratio of 20:1 solution to MIBK.
VI. Keep the clean APDC solution refrigerated when not in use.

1.2 Cobalt reagent preparation

I. Dissolve 0.425 g $CoCl_2.6H_2O$ (MW277.95) in 150 ml of 9 M HCl.

II. Wash the column (1cm x 22 cm) of Dowex 1-x8 resin with 30 ml of 0.01M HCl.

III. Wash with 5 ml of 9 M HCl to condition the column.

IV. Pass the solution from step 1 through the column at its natural flow rate.

V. Wash the column with 20 ml of 9M HCl to wash through all the Ni and Mn.

VI. Elute the column with 40 ml of 4 M HCl watch the color sequence discard the initial solution which is blue. Collect the rose to pink colored solution (about 8 ml.) Discard the clear solution that follows.

VII. Dilute the clean cobalt to 500 ml.

2 Sediment sample

Sediment sample preparation, total decomposition with pressure cooker in the microwave oven were used. Sediment samples were dried with freeze-dryer. The samples were lightly ground in a agate mortar and pestle to break up the particles. The sample were then sieved through 60 μm. plastic mesh. Total decomposition methods use hydrofluoric acid (HF) with concentrated oxidizing acids (aqua regia) (Loring and Rantala, 1992). Total decomposition procedure was following.

A. Weight 10 mg. finely ground sample and transfer to a teflon bomb.

B. Add 1 ml of aqua regia (HNO_3 : HCl , 1:3 v/v).

C. Add 2 ml. of HF very slowly to avoid excessive frothing.

D. Close the bomb tightly and place the bombs in the pressure cooker , place the cooker along with a breaker containing 50 ml. water in the microwave oven.

E. Heat for 7 minute at full power (700 W.).

F. Remove the bomb from the heat source and cool it to room temperature in cold water.

G. Add 30 ml of H_3BO_3 (56.4 g of H_3BO_3 in 900 ml milli-Q water shake briefly. 8. Transfer the contents into the 60 ml PE bottle.

H. Allow solutions to settle overnight the sample is ready for AA analysis.

Appendix C. Concentration of Cd, Cu, Fe, Ni and Pb in The Gulf of Thailand and East Coast of Malay Peninsula in dry season (April-May 1996)

station	*depth(m)*	*Dissolved (nM)*					*Suspended (nM)*					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
1	0	0.094	8.78	41.15	8.71	0.43	0.026	1.77	279.02	1.28	0.50	223.60
	27	0.071	2.96	16.19	6.11	0.36	0.021	3.37	344.74	1.20	0.49	199.86
2	0	0.064	5.01	47.67	6.72	0.46	0.010	1.17	231.71	1.29	0.50	93.65
	5	0.112	6.88	50.40	8.71	0.51	0.009	1.33	211.03	1.32	0.28	144.39
	10	0.077	6.40	85.70	6.05	0.89	0.017	2.18	165.70	1.39	0.32	135.12
	15	0.071	6.18	59.80	7.13	0.51	0.013	1.25	214.45	1.30	0.50	41.60
	20	0.057	2.54	19.63	4.86	0.37	0.013	2.08	292.16	1.06	0.30	271.21
	27	0.086	5.42	51.58	7.31	0.40	0.012	1.06	297.90	1.35	0.41	117.79
3	0	0.077	7.37	52.87	4.92	0.12	0.014	1.03	125.83	1.11	0.25	31.37
	5	0.070	5.19	35.40	4.65	0.14	0.013	0.54	86.63	0.72	0.27	189.44
	10	0.082	3.66	16.92	3.19	0.08	0.008	0.63	87.97	0.61	0.23	173.27
	15	0.120	8.87	30.36	7.75	0.15	0.016	0.90	236.98	0.82	0.32	60.26
	20	0.072	3.54	14.05	2.90	0.08	0.009	0.76	145.83	0.79	0.32	139.50
	31	0.070	3.20	23.40	4.18	0.09	0.020	1.02	439.95	1.22	0.31	153.86
4	0	0.066	3.38	19.51	3.01	0.43	0.007	0.69	117.26	0.70	0.28	83.44
	15	0.088	3.10	14.05	2.49	0.40	0.012	0.84	110.66	0.76	0.56	162.83
	18	0.076	3.77	22.13	3.33	0.46	0.090	0.56	151.07	0.52	0.24	82.69
	20	0.062	3.38	15.76	2.73	0.35	0.088	2.33	141.11	1.12	0.31	144.26
	24	0.061	2.70	11.47	2.53	0.37	0.088	0.84	297.28	1.15	0.46	nd
	26	0.066	3.49	20.59	3.09	0.38	0.089	0.84	312.44	0.96	0.22	172.99
5	0	0.059	3.74	18.97	2.77	0.34	0.090	0.85	57.26	0.69	0.55	82.10
	10	0.076	8.87	21.54	3.06	0.53	0.090	0.75	242.01	0.57	0.29	14.60
	20	0.083	5.48	14.27	3.56	0.48	0.090	0.63	58.88	0.58	0.44	136.23
	26	0.061	2.95	13.82	2.86	0.52	0.090	0.64	67.87	0.77	0.30	84.70
	29	0.062	3.42	16.18	2.82	0.44	0.015	1.08	103.59	1.01	0.65	37.56
6	0	0.060	5.12	51.51	6.65	0.39	0.008	0.74	44.59	0.81	0.59	34.99
	10	0.065	3.34	28.73	6.26	0.40	0.007	0.84	49.70	0.57	0.28	58.52
	20	0.064	2.97	53.97	5.76	0.38	0.031	0.73	56.18	0.67	0.36	17.52
	25	0.082	2.48	50.95	5.59	0.48	0.008	0.57	36.76	0.55	0.45	227.52
	30	0.053	2.43	40.36	5.21	0.44	0.012	1.86	38.57	0.61	0.27	75.54
	40	0.060	2.63	20.93	8.20	0.43	0.011	0.51	129.40	0.45	0.28	6.79
	50	0.101	3.18	28.19	7.39	0.54	0.017	1.15	447.99	1.54	0.49	181.97
7	0	0.079	2.84	12.76	3.62	0.13	0.008	0.51	32.89	0.56	0.30	10.60
	45	0.097	4.15	23.85	4.60	0.07	0.017	0.83	137.48	0.86	0.26	50.03
8	0	nd	nd	nd	nd	nd	0.009	0.69	92.78	0.71	0.49	13.93
	37	0.098	8.57	41.68	4.25	0.13	0.014	0.77	295.04	0.96	0.28	104.53
9	0	0.025	5.60	10.50	5.18	0.56	0.008	0.84	53.90	0.63	0.41	131.70
	20	nd	8.87	32.83	5.23	0.93	0.010	0.53	53.02	0.43	0.41	164.94
	35	nd	4.06	20.21	4.51	0.61	0.016	0.69	276.21	0.95	0.30	161.62
10	0	0.089	2.61	37.53	1.96	0.56	0.009	0.82	106.41	0.50	0.23	179.63
	47	0.085	8.87	20.98	2.25	0.53	0.015	0.90	428.71	1.18	0.26	205.90

nd=no data

Appendix C. (Continue)

station	depth(m)	Dissolved (nM)					Suspended (nM)					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
11	0	0.099	4.07	20.69	4.04	0.57	0.013	0.42	72.78	0.48	0.35	236.04
	53	0.115	6.74	23.28	5.48	0.83	0.017	1.12	339.75	0.96	0.63	202.26
12	0	0.078	4.07	37.46	7.83	0.51	0.011	1.55	52.79	0.54	0.65	210.20
	25	0.067	3.82	27.84	6.37	0.76	0.015	0.86	137.72	0.77	0.20	49.65
	57	0.066	6.13	28.79	6.93	0.64	0.016	4.50	360.04	0.90	0.63	204.61
13	0	0.134	1.83	29.81	5.54	0.60	0.007	0.67	56.34	0.69	0.65	203.03
	40	0.104	6.14	24.80	5.66	0.75	0.013	0.45	32.97	0.55	0.21	205.99
	65	nd	8.12	27.25	4.87	0.93	0.019	0.90	421.66	1.07	0.51	162.26
14	0	0.028	4.59	18.16	3.90	0.68	0.005	0.59	57.58	0.67	0.48	34.33
	45	0.088	5.88	26.25	4.85	0.74	0.012	0.50	41.79	0.35	0.19	20.25
	60	nd	nd	nd	nd	nd	0.015	0.67	462.53	0.89	0.38	123.00
15	0	0.072	4.65	16.02	3.12	0.66	0.005	0.92	132.11	0.68	0.19	147.77
	53	0.134	4.47	20.75	3.02	0.76	0.013	0.73	510.94	0.96	0.34	207.82
16	0	0.078	8.87	10.90	1.77	0.93	0.006	0.54	83.62	0.70	0.32	168.02
	48	0.134	4.54	16.94	1.85	0.92	0.020	0.89	455.13	0.86	0.50	224.20
17	0	0.071	3.34	15.16	1.66	0.65	0.005	0.64	63.05	0.61	0.34	11.68
	10	0.084	3.65	18.01	2.41	0.78	0.018	0.45	44.88	0.52	0.36	13.26
	20	0.076	3.11	14.07	2.67	0.55	0.007	0.32	51.29	0.49	0.19	62.18
	30	0.064	2.37	14.51	1.98	0.43	0.003	0.32	26.25	0.41	0.34	22.90
	38	0.063	1.80	8.70	2.05	0.37	0.027	0.51	325.46	0.69	0.22	122.38
	45	0.134	1.67	36.89	1.84	0.51	0.028	0.65	221.63	0.98	0.35	119.35
18	0	0.087	3.67	22.67	4.20	0.06	0.007	0.46	74.32	0.45	0.32	25.49
	60	0.096	3.18	53.84	3.80	0.39	0.001	0.70	453.59	0.78	0.35	211.51
19	0	0.052	2.71	14.09	1.84	0.34	0.006	0.94	113.82	0.75	0.57	51.48
	62	0.093	3.57	15.25	1.86	0.48	0.005	0.59	309.62	0.82	0.38	119.85
20	0	0.074	3.16	47.44	3.12	0.16	0.005	0.37	83.24	0.47	0.43	37.74
	64	0.110	2.36	12.50	3.88	0.06	0.005	0.89	316.61	0.66	0.15	93.07
21	0	0.059	2.46	33.95	4.38	0.10	0.002	0.81	358.53	0.83	0.38	85.85
	68	0.134	2.47	9.42	4.13	0.06	0.005	0.43	54.36	0.55	0.13	98.41
22	0	0.080	3.03	17.43	4.66	0.19	0.010	0.37	84.75	0.42	0.37	36.46
	56	0.068	2.11	6.66	6.46	0.08	0.011	0.69	366.53	0.71	0.37	42.92
23	0	0.058	3.46	19.16	4.46	0.10	0.005	0.60	85.85	0.48	0.28	78.10
	35	0.082	1.83	11.46	5.94	0.13	0.002	0.93	599.46	1.57	0.65	238.54
24	0	0.061	2.15	9.19	2.19	0.40	0.005	0.64	352.87	0.53	0.17	128.78
	10	0.059	1.88	9.60	1.77	0.49	0.005	0.64	328.02	0.52	0.17	82.33
	20	0.073	2.13	11.17	1.66	0.40	0.004	0.52	194.21	0.46	0.65	63.99
	28	0.081	2.11	12.50	2.19	0.78	0.007	1.47	629.26	1.96	0.53	236.41
25	0	0.069	2.06	8.52	2.08	0.73	0.005	0.68	96.00	0.26	0.11	25.78
	40	0.084	2.36	18.92	2.60	0.44	0.008	0.75	371.21	0.84	0.20	169.82

nd=no data

Appendix C. (Continue)

station	depth(m)	Dissolved (nM)					Suspended (nM)					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
26	0	0.064	2.34	18.62	2.10	0.64	0.001	0.88	44.68	0.57	0.17	26.46
	10	0.053	2.48	12.02	2.74	0.72	0.001	0.42	32.26	0.16	0.26	56.80
	20	0.025	2.06	8.80	2.58	0.33	0.007	0.33	43.46	0.16	0.22	60.44
	30	0.048	1.92	10.83	2.36	0.63	0.001	0.38	26.25	0.21	0.37	160.92
	40	0.028	2.24	5.32	2.59	0.36	0.001	0.34	26.35	0.18	0.27	9.30
	50	0.035	1.66	9.98	2.35	0.59	0.001	0.31	73.34	0.16	0.29	73.97
	63	0.088	1.99	5.65	2.49	0.37	0.002	0.49	374.54	0.52	0.17	126.81
27	0	0.074	4.35	7.83	4.05	0.17	0.003	0.58	74.89	1.96	0.13	171.54
	55	0.102	2.31	9.09	3.22	0.20	0.006	0.54	83.02	0.21	0.10	52.13
	77	0.109	2.27	28.30	4.38	0.29	0.002	0.54	329.14	1.22	0.17	244.48
28	0	0.033	3.78	14.90	5.38	0.33	0.005	0.45	54.82	0.15	0.65	12.75
	58	0.063	2.73	33.35	3.43	0.38	0.002	0.73	527.50	0.96	0.17	137.86
29	0	0.052	3.12	19.69	3.93	0.46	0.001	0.46	79.28	0.16	0.13	247.14
	30	0.084	3.63	23.95	4.68	0.74	0.045	1.25	449.41	1.16	0.13	190.56
30	0	0.073	3.59	21.66	3.26	0.42	0.001	0.83	441.02	0.88	0.24	178.36
	24	0.093	4.27	59.80	5.79	0.56	0.001	2.20	498.63	1.12	0.20	147.84
31	0	0.035	4.05	25.96	3.94	0.26	0.001	0.80	181.61	0.63	0.50	170.30
	27	0.069	4.55	17.99	4.31	0.45	0.007	0.75	629.26	0.73	0.18	157.17
32	0	0.053	3.60	21.07	1.81	0.93	0.002	0.56	31.89	0.31	0.05	126.12
	40	0.043	1.77	7.17	1.66	0.48	0.002	0.61	29.70	0.29	0.02	251.14
	52	0.089	1.88	32.96	1.79	0.40	0.009	0.86	466.62	1.96	0.23	205.64
33	0	0.063	3.09	24.73	6.34	0.52	0.027	0.41	41.88	0.43	0.02	50.05
	45	0.057	2.72	43.37	4.15	0.11	0.008	1.02	21.30	0.23	0.02	8.56
	71	0.082	2.27	15.88	4.57	0.17	0.010	0.67	464.15	0.69	0.20	125.74
34	0	nd	nd	nd	nd	nd	0.001	0.40	58.18	0.21	0.04	18.82
	30	nd	nd	nd	nd	nd	0.005	0.27	39.27	0.21	0.07	61.03
	37	nd	nd	nd	nd	nd	0.008	0.53	22.38	0.21	0.02	13.85
	60	nd	nd	nd	nd	nd	0.009	1.74	98.51	0.26	0.07	26.01
	70	nd	nd	nd	nd	nd	0.006	0.64	411.68	0.63	0.18	149.34
	77	nd	nd	nd	nd	nd	0.035	1.13	377.71	0.54	0.13	144.57
35	0	0.061	2.50	10.45	4.50	0.06	0.004	0.69	42.39	0.17	0.05	19.89
	50	0.063	2.42	12.61	4.57	0.11	0.005	0.32	35.47	0.16	0.02	3.75
	70	0.082	2.65	13.79	4.45	0.15	0.005	0.49	396.64	0.47	0.17	85.47
36	0	0.065	2.60	20.95	4.35	0.14	0.004	0.50	46.85	0.24	0.04	18.40
	65	0.063	1.70	17.33	3.84	0.17	0.007	0.59	413.06	0.58	0.13	156.11
	72	0.049	1.93	10.00	4.51	0.06	0.007	0.68	467.14	0.48	0.17	29.32
37	0	0.057	2.90	48.49	8.71	0.14	0.003	5.65	110.07	0.36	0.11	19.00
	40	0.064	2.53	17.23	6.13	0.12	0.045	0.75	26.27	0.19	0.02	12.19
	58	0.059	6.04	10.30	3.92	0.12	0.013	0.85	484.89	0.75	0.20	136.39
38	0	0.067	3.58	29.20	4.17	0.10	0.003	0.62	74.84	0.38	0.02	31.06
	48	0.121	2.93	31.96	3.60	0.12	0.022	0.71	463.72	1.12	0.13	108.99

nd=no data

Appendix C. (Continue)

station	depth(m)	Dissolved (nM)					Suspended (nM)					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
39	0	0.108	8.87	40.64	4.29	0.12	0.021	0.41	102.36	0.35	0.02	18.93
	27	0.073	3.19	56.58	3.33	0.16	0.009	0.80	598.26	1.47	0.37	160.81
40	0	0.062	4.14	14.85	8.71	0.15	0.008	0.78	497.96	0.89	0.20	86.51
	10	0.079	2.88	6.26	7.79	0.14	0.006	1.41	481.53	1.05	0.22	67.39
	20	0.092	2.32	9.85	5.03	0.14	0.043	0.72	452.57	0.72	0.18	77.19
41	0	0.025	6.94	nd	1.81	nd	0.009	0.73	107.06	0.30	0.07	12.09
	40	0.060	3.31	6.27	8.71	0.08	0.010	2.53	629.26	1.88	0.40	259.53
42	0	0.069	3.82	15.56	4.78	0.17	0.006	0.78	131.05	0.66	0.04	128.79
	30	0.077	4.46	59.80	8.06	0.20	0.005	0.29	99.35	0.33	0.02	65.64
	49	0.054	2.07	25.21	3.98	0.14	0.010	0.96	497.05	1.21	0.16	94.10
43	0	0.078	3.81	21.50	4.96	0.20	0.004	0.50	79.54	0.40	0.02	35.49
	35	0.073	2.73	52.26	4.45	0.14	0.011	0.70	425.49	0.78	0.09	105.32
	49	0.069	2.88	20.90	3.20	0.17	0.011	0.58	431.01	0.92	0.20	124.89
44	0	0.079	3.49	24.73	3.77	0.13	0.006	0.51	77.27	0.33	0.02	19.76
	20	0.064	1.99	21.41	2.78	0.12	0.006	0.42	65.09	0.33	0.02	21.42
	52	0.077	1.77	37.52	2.56	0.12	0.009	0.57	511.83	0.99	0.07	168.22
45	0	0.060	2.42	42.48	2.89	0.14	0.004	0.32	119.96	0.29	0.02	30.55
	15	0.041	1.60	59.80	8.71	0.18	0.005	0.34	42.70	0.24	0.02	51.42
	55	0.053	1.78	29.20	2.61	0.13	0.008	1.19	629.26	1.96	0.53	243.13
46	0	0.032	2.25	38.43	2.68	0.61	0.042	0.56	140.43	0.69	0.04	72.60
	10	0.037	1.03	17.12	2.44	0.38	0.008	0.65	158.57	0.49	0.04	49.53
	30	0.036	1.76	10.77	2.22	0.36	0.008	0.27	113.76	0.39	0.02	35.92
	40	0.056	2.82	21.38	3.48	0.93	0.005	0.27	29.44	0.33	0.04	25.34
	46	0.064	3.45	45.78	3.47	0.47	0.016	0.92	46.35	1.81	0.18	nd
47	0	0.048	2.84	20.80	3.51	0.06	0.012	0.56	21.30	0.56	0.07	60.08
	58	0.060	2.23	46.64	2.88	0.11	0.013	0.67	438.32	0.68	0.12	42.17
48	0	0.051	3.25	16.50	3.22	0.06	0.053	0.51	434.68	0.84	0.14	151.85
	57	0.059	1.74	27.68	3.03	0.08	nd	nd	nd	nd	nd	nd
49	0	0.058	3.00	22.84	2.46	0.43	0.009	0.33	41.98	0.33	0.02	52.24
	30	0.034	1.67	37.96	3.20	0.64	0.009	0.43	21.30	0.27	0.02	58.58
	53	0.050	1.93	23.38	2.71	0.51	0.015	0.86	559.77	1.36	0.31	176.89
50	0	0.063	2.38	11.85	2.80	0.79	0.015	5.65	51.51	0.45	0.52	72.86
	50	0.068	2.28	25.78	2.03	0.50	0.018	1.95	602.81	1.44	0.25	155.68
51	0	0.071	3.38	21.64	2.71	0.13	0.014	1.45	90.70	0.38	0.02	55.34
	10	0.064	2.32	19.83	3.28	0.08	0.013	0.81	48.24	0.31	0.05	31.81
	25	nd	nd	nd	nd	nd	0.051	1.38	27.87	0.51	0.09	8.12
	46	0.99	2.47	38.36	3.96	0.15	0.023	1.18	629.26	1.39	0.04	145.96
52	0	0.065	3.32	33.15	2.50	0.70	0.013	0.88	86.11	0.51	0.04	23.49
	38	0.069	1.76	11.30	2.33	0.86	0.028	0.93	547.32	1.07	0.04	119.77

nd=no data

Appendix C. (Continue)

station	depth(m)	Dissolved (nM)					Suspended (nM)					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
53	0	0.049	2.79	34.77	2.28	0.82	0.015	4.67	136.82	0.82	0.04	45.74
	10	0.051	2.28	16.42	2.20	0.57	0.044	0.57	44.02	1.34	0.22	43.82
	51	0.056	1.94	24.07	2.32	0.70	0.032	1.13	629.26	2.42	0.08	107.67
54	0	0.032	3.43	25.60	2.30	0.65	0.042	0.42	32.08	0.69	0.02	28.98
	60	0.055	2.30	28.15	3.13	0.57	0.013	0.49	391.88	0.97	0.14	59.49
55	0	0.053	3.71	24.04	3.30	0.06	0.009	0.48	57.77	0.55	0.07	52.17
	59	0.060	2.11	49.34	3.18	0.15	0.009	0.89	157.63	0.68	0.04	142.37
56	0	0.052	1.82	15.46	2.62	0.14	0.008	0.88	32.87	0.66	0.04	9.62
	60	0.055	2.18	47.31	3.39	0.19	0.013	0.46	267.64	0.96	0.13	213.14
57	0	0.039	1.62	18.58	3.02	0.19	0.005	0.47	117.23	0.86	0.05	5.69
	30	0.058	2.39	49.77	3.61	0.20	0.009	0.51	36.19	0.73	0.02	143.47
	59	0.067	2.40	18.12	2.90	0.13	0.007	0.49	405.86	1.00	0.13	275.34
58	0	0.064	2.98	14.98	3.12	0.16	0.004	0.39	181.44	0.64	0.09	106.66
	60	0.078	1.87	38.27	3.11	0.17	0.007	0.44	327.50	0.84	0.09	79.78
59	0	0.053	2.23	16.75	3.47	0.06	0.009	5.65	44.29	0.58	0.02	14.70
	63	0.048	1.48	22.56	3.08	0.13	0.002	0.29	66.37	0.51	0.02	33.03
60	0	0.061	2.60	26.78	3.18	0.08	0.003	0.27	30.32	0.64	0.02	17.98
	57	0.062	1.40	12.52	3.12	0.07	0.006	0.46	203.37	0.99	0.09	183.69
61	0	0.101	3.84	54.31	4.32	0.51	0.012	0.66	47.43	1.09	0.09	188.97
	20	0.046	2.74	59.80	5.22	0.21	0.005	0.55	21.30	0.78	0.04	101.01
	48	0.060	1.49	16.66	2.75	0.11	0.012	1.15	286.08	1.37	0.13	48.03
62	0	0.043	2.56	4.38	2.28	0.37	0.004	0.30	30.58	0.94	0.04	16.49
	20	0.031	1.24	4.38	1.93	0.29	0.004	0.27	21.71	0.80	0.02	126.17
	58	0.039	1.82	11.22	2.58	0.29	0.004	1.99	256.18	1.11	0.07	211.55
63	0	0.034	2.95	8.24	3.16	0.25	0.010	0.50	42.54	0.94	0.04	97.51
	64	0.037	1.35	14.77	6.07	0.24	0.008	0.41	114.91	1.96	0.09	83.37
64	0	0.034	3.81	5.87	3.80	0.23	0.008	0.41	66.17	1.16	0.05	36.19
	57	0.049	1.33	4.38	2.63	0.24	0.005	0.68	217.06	1.51	0.14	184.26
65	0	0.036	2.65	4.38	2.55	0.21	0.005	0.36	46.75	0.93	0.05	39.26
	64	0.031	1.42	7.99	2.46	0.23	0.005	0.31	280.77	1.16	0.07	39.31
66	0	0.040	2.27	4.38	2.32	0.20	0.003	0.41	21.30	0.83	0.07	8.45
	70	0.029	1.23	4.38	1.77	0.21	0.004	0.91	354.12	1.39	0.02	45.03
67	0	0.044	2.46	12.49	3.10	0.85	0.006	0.30	62.30	1.12	0.02	15.12
	30	0.029	2.46	16.16	2.62	0.56	0.004	0.37	38.23	1.25	0.04	52.45
	76	0.036	1.20	9.40	2.17	0.32	0.006	0.52	407.36	0.94	0.12	68.85
68	0	0.110	2.86	19.82	3.66	0.08	0.008	0.39	44.34	0.68	0.05	48.22
	40	0.034	1.63	18.74	2.41	0.06	0.006	0.30	24.84	0.60	0.02	66.47
	71	0.045	1.29	10.38	3.43	0.06	0.007	0.76	367.64	1.21	0.09	53.03

Appendix C. (Continue)

station	depth(m)	Dissolved (nM)					Suspended (nM)					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
69	0	0.076	2.67	21.88	3.52	0.88	0.007	0.35	48.49	0.59	0.06	44.21
	20	0.036	2.27	17.51	3.93	0.93	0.006	5.65	36.02	0.62	0.28	22.65
	25	0.039	1.97	16.61	3.38	0.72	0.025	1.17	33.95	0.59	0.07	77.39
	40	0.049	1.93	14.92	2.66	0.93	0.012	0.80	114.35	0.60	0.02	58.54
	45	0.044	1.98	30.35	2.96	0.84	0.009	0.56	241.05	0.70	0.02	109.07
	64	0.064	1.65	23.84	3.21	0.85	0.006	0.50	262.07	0.69	0.02	47.26
70	0	0.046	1.50	6.63	1.79	0.26	0.012	0.35	45.34	0.56	0.02	66.59
	15	0.081	1.24	7.42	1.81	0.24	0.007	0.27	36.46	0.54	0.04	91.69
	38	0.055	1.03	7.11	1.70	0.40	0.010	0.45	246.41	0.59	0.13	70.34
71	0	0.054	5.50	13.63	3.89	0.30	0.009	0.60	232.53	0.66	0.09	100.64
	15	0.075	3.71	5.18	3.37	0.42	0.019	1.40	178.08	0.94	0.04	125.19
	30	0.045	1.26	7.74	2.33	0.39	0.008	1.11	258.98	0.63	0.04	50.54
72	0	0.025	2.52	34.61	4.59	0.45	0.004	0.61	41.78	0.64	0.02	77.17
	20	0.091	1.59	28.03	3.31	0.45	0.009	0.94	35.33	0.46	0.02	61.78
	54	nd	1.46	11.92	4.24	0.36	0.009	1.08	180.59	0.68	0.07	71.36
73	0	0.047	3.38	26.33	3.44	0.07	0.004	0.89	49.03	0.34	0.02	80.36
	30	0.031	1.16	25.17	3.19	0.12	0.031	0.49	42.39	0.62	0.04	65.58
	72	0.042	1.36	15.87	2.65	0.06	0.006	0.59	417.65	0.74	0.04	66.91
74	0	0.082	1.89	14.73	1.90	0.77	0.006	0.34	37.43	0.49	0.04	21.18
	25	0.047	1.03	18.17	1.66	0.60	0.005	0.45	30.69	0.55	0.02	43.25
	66	0.041	1.03	5.37	1.84	0.81	0.006	0.50	283.78	0.71	0.02	41.95
75	0	0.054	1.53	7.03	1.72	0.53	0.002	0.39	21.30	0.50	0.04	6.10
	10	0.032	1.03	10.52	1.66	0.70	0.007	0.39	25.73	0.38	0.02	42.41
	54	0.057	1.03	12.53	1.66	0.77	0.006	0.54	280.08	0.69	0.04	61.30
76	0	0.134	2.13	8.43	1.91	0.40	0.003	0.35	94.94	0.51	0.02	20.20
	10	0.076	1.81	10.58	2.10	0.55	0.007	0.74	91.75	0.54	0.04	83.28
	26	0.032	1.39	10.14	1.99	0.72	0.007	0.40	31.92	0.44	0.02	17.71
77	0	0.056	2.39	13.42	2.51	0.59	0.021	1.07	72.22	0.82	0.28	54.64
	10	0.032	1.45	19.90	2.12	0.90	0.006	0.45	28.27	0.35	0.07	20.51
	48	0.032	1.65	24.28	1.98	0.60	0.016	0.91	292.93	0.65	0.02	121.33
78	0	0.025	2.61	19.45	2.03	0.55	0.007	5.65	85.46	0.39	0.11	69.22
	28	0.025	4.58	32.54	2.19	0.79	0.006	0.56	35.02	0.36	0.04	45.13
	63	0.084	1.11	7.82	2.00	0.37	0.008	5.65	381.98	0.57	0.11	141.31
79	0	0.087	2.67	19.15	2.44	0.87	0.009	2.42	84.35	0.29	0.30	45.21
	10	0.073	2.27	14.13	2.27	0.64	0.004	0.59	58.04	0.28	0.05	31.54
	20	nd	nd	nd	nd	nd	0.007	0.47	45.50	0.37	0.04	22.49
	25	0.073	1.88	17.07	2.12	0.28	0.008	0.52	82.34	0.46	0.10	16.33
	30	0.059	1.78	11.86	1.95	0.33	0.009	0.40	62.35	0.38	0.04	63.77
	50	0.045	1.33	25.29	2.47	0.43	0.006	0.55	284.41	0.71	0.04	54.54
	59	0.050	1.95	11.83	1.84	0.53	0.005	0.54	356.42	0.54	0.04	105.67

nd=no data

Appendix C. (Continue)

station	*depth(m)*	*Dissolved (nM)*					*Suspended (nM)*					
		Cd	Cu	Fe	Ni	Pb	Cd	Cu	Fe	Ni	Pb	Al
80	0	nd	3.16	20.21	3.00	0.27	0.006	0.45	103.93	0.48	0.02	71.24
	15	0.075	2.13	13.23	3.09	0.36	0.0108	0.51	98.11	0.36	0.06	88.61
	31	0.032	2.67	30.79	3.36	0.38	0.010	1.16	149.09	0.74	0.11	134.66
81	0	0.043	2.80	17.58	3.56	0.59	0.005	0.68	76.47	0.73	0.02	69.07
	10	0.060	1.96	41.43	3.04	0.62	0.007	0.47	78.86	0.57	0.02	71.23
	53	0.046	1.85	34.07	3.56	0.50	0.007	0.49	106.43	0.63	0.11	96.13

nd=no data

Appendix D. Cd, Cu, Fe, Ni and Pb in sediments in The Gulf of Thailand and East Coast of Malay Peninsula in dry season (April-May 1996) and wet season (September-October1995).

	Dry season (April-May 1996)					*Wet season (September-October 1995)*			
station	Cd(ug/g)*	Cu(ug/g)*	Fe(%)*	Ni(ug/g)	Pb(ug/g)*	Cd(ug/g)*	Cu(ug/g)*	Fe(%)*	Pb(ug/g)*
1	0.42	29.10	1.00	16.91	52.90	0.24	110.00	2.82	17.50
2	nd	nd	nd	nd	nd	0.51	210.90	2.29	16.40
3	0.10	56.00	1.70	33.64	38.20	0.24	18.90	3.10	21.70
4	0.14	40.00	1.51	35.80	40.10	0.26	17.50	2.17	16.70
5	0.26	37.00	0.91	30.79	68.50	0.48	25.50	2.55	27.80
6	0.24	40.00	1.28	33.84	43.10	0.53	19.40	2.31	20.20
7	0.24	41.00	1.54	46.81	44.20	0.47	28.90	1.91	17.70
8	0.19	61.00	0.99	27.20	43.40	0.52	29.50	2.49	17.60
9	0.15	19.70	1.40	16.76	74.30	0.34	13.00	1.97	17.90
10	0.17	33.00	0.92	26.57	28.90	0.45	23.40	1.79	15.00
11	0.57	27.00	1.21	33.34	46.70	0.30	23.70	1.73	14.50
12	0.35	48.00	1.26	42.07	51.60	0.34	17.00	1.75	16.30
13	0.55	44.00	1.17	31.61	36.10	0.29	19.00	1.86	13.90
14	0.26	37.00	1.14	32.26	52.40	0.53	18.30	1.86	18.10
15	0.33	23.00	0.89	28.77	29.10	0.71	19.40	2.01	15.20
16	0.27	28.00	1.07	32.87	42.60	1.03	39.00	2.58	23.30
17	0.33	31.00	1.85	38.91	29.00	0.60	32.30	2.56	23.10
18	0.94	39.00	1.77	35.34	51.20	0.39	23.20	2.47	24.00
19	0.32	26.00	1.11	31.16	43.10	0.30	16.80	2.01	15.40
20	0.21	15.00	0.89	30.27	24.40	0.35	19.30	1.60	14.40
21	0.25	17.00	1.03	26.59	21.10	0.36	16.50	1.56	11.80
22	0.15	23.00	1.10	32.46	17.00	0.65	31.60	2.30	14.90
23	0.15	25.00	1.61	36.93	26.70	0.80	31.90	2.57	14.50
24	0.06	17.00	0.67	25.71	24.20	0.27	10.80	2.21	12.60
25	0.16	17.80	1.38	34.05	20.20	0.30	11.70	2.54	22.90
26	0.13	19.10	1.05	28.92	16.70	0.32	15.90	2.09	9.01
27	0.13	17.90	0.96	28.04	15.50	nd	nd	nd	nd
28	0.19	17.60	1.03	25.33	19.50	0.30	15.60	1.86	7.02
29	0.06	13.80	0.95	24.89	17.10	0.83	15.70	2.04	8.26
30	0.10	13.10	1.34	27.20	21.90	0.40	11.40	2.49	19.30
31	0.14	12.80	0.95	23.09	15.90	0.42	7.77	1.71	14.30
32	0.08	16.30	0.78	20.87	10.90	0.58	15.20	1.70	19.20
33	0.08	18.00	1.00	25.21	20.40	0.39	19.50	1.55	9.10
34	0.01	17.90	1.34	29.96	17.90	0.29	23.60	2.22	17.00
35	0.15	21.00	2.38	52.61	22.50	0.81	25.90	3.09	18.40
36	0.29	22.00	1.68	38.81	21.80	0.42	21.40	2.17	16.60
37	0.22	17.90	1.43	31.89	16.30	0.26	19.60	2.48	18.60
38	0.44	15.10	1.54	24.07	13.40	0.27	12.80	1.63	10.60
39	0.07	24.30	1.13	19.51	16.40	0.38	17.90	1.95	18.10
40	0.07	10.50	1.40	15.69	15.30	0.39	16.40	2.18	20.40
41	0.36	14.20	1.48	22.44	20.40	0.24	15.40	2.00	9.88

*data from Shazili et al, 1997, nd=no data

Appendix D. (Continue)

	Dry season (April-May 1996)					*Wet season (September-October 1995)*			
station	Cd(ug/g)*	Cu(ug/g)*	Fe(%)*	Ni(ug/g)	Pb(ug/g)*	Cd(ug/g)*	Cu(ug/g)*	Fe(%)*	Pb(ug/g)*
42	0.23	17.40	0.63	24.40	32.60	0.86	19.80	2.24	10.10
43	0.53	12.90	1.32	22.20	22.70	0.26	14.40	1.65	10.70
44	0.20	26.80	0.72	24.91	18.90	0.44	19.00	1.90	13.00
45	0.37	19.70	2.00	31.90	28.10	0.30	20.10	3.04	19.60
46	0.22	17.40	1.38	30.35	22.90	0.32	19.50	2.57	18.10
47	0.12	17.00	1.52	22.37	18.50	0.29	16.00	2.14	12.80
48	0.29	21.00	1.65	27.09	91.00	0.33	17.20	2.77	9.24
49	0.14	15.90	1.67	25.64	20.00	0.30	18.60	2.54	11.00
50	0.10	13.30	1.28	27.13	14.50	0.36	15.90	1.81	18.20
51	0.29	15.90	1.24	20.48	26.60	0.40	15.60	2.08	18.60
52	0.36	18.80	1.32	15.23	30.90	0.39	45.80	1.81	10.10
53	0.32	16.00	1.43	24.95	26.40	0.48	36.60	2.27	2.49
54	0.24	15.60	1.22	24.16	21.30	0.24	15.20	2.17	19.10
55	0.35	18.70	1.46	19.16	33.60	0.30	15.00	2.02	7.30
56	0.15	18.00	2.16	24.28	34.50	0.31	28.80	2.18	14.60
57	0.51	19.00	1.64	22.55	31.50	0.27	16.30	2.27	14.40
58	0.36	14.40	1.38	22.65	13.80	0.36	13.80	1.70	16.10
59	0.15	11.90	1.01	15.46	19.20	0.26	13.50	1.42	14.30
60	0.07	11.80	1.18	15.82	11.80	0.39	12.80	1.89	17.20
61	0.07	14.50	1.43	22.39	9.29	0.64	11.50	1.96	6.84
62	0.22	12.70	1.04	18.65	9.38	0.22	9.70	1.90	12.40
63	0.51	12.60	1.14	20.12	7.68	0.31	10.80	2.04	8.17
64	0.29	16.00	1.48	22.86	7.98	0.27	13.10	2.03	16.50
65	0.07	12.00	0.92	19.72	5.24	0.23	14.10	1.90	6.78
66	0.15	13.60	2.03	40.17	9.61	0.54	18.10	2.45	9.05
67	0.51	18.60	2.26	43.38	16.00	0.24	13.90	2.57	4.17
68	nd	13.60	1.25	nd	11.10	0.25	10.80	2.16	7.43
69	0.44	12.90	0.88	44.35	8.09	0.17	13.80	2.23	11.00
70	0.07	16.70	0.77	27.68	28.90	0.69	14.10	1.89	17.90
71	0.36	16.90	1.06	26.87	13.50	1.02	13.10	0.71	21.80
72	nd	12.40	1.20	nd	12.40	0.54	13.80	2.11	21.60
73	nd	10.30	1.14	34.70	8.97	0.32	13.10	1.33	12.30
74	0.15	11.50	1.01	35.45	10.50	1.10	15.30	1.87	10.40
75	nd	12.90	0.70	nd	12.90	0.35	16.10	2.31	12.80
76	0.80	11.00	1.71	31.00	21.40	0.43	10.00	1.03	13.30
77	0.22	15.10	1.80	41.88	9.80	0.28	12.30	1.95	17.80
78	0.29	13.50	1.14	50.06	8.10	0.36	12.00	1.96	13.20
79	0.36	16.90	1.60	35.21	12.20	0.31	11.30	2.44	17.40
80	0.73	13.40	0.99	22.40	18.70	0.37	12.10	1.56	27.20
81	nd	16.60	1.17	nd	38.60	0.23	11.30	2.14	8.90

*data from Shazili et al, 1997, nd=no data

Appendix E. Environment variables in The Gulf of Thailand and East Coast of Malay Peninsula in dry season (April-May1996).

station	Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
1	0	0.19	0.23	3.81	32.25	4.39	8.20
	27	0.13	0.21	3.99	32.25	4.09	8.19
2	0	0.08	0.17	1.19	32.26	nd	8.23
	5	0.13	0.32	1.11	32.26	4.40	8.23
	10	0.13	0.17	1.80	32.24	4.42	8.24
	15	0.10	0.23	2.45	32.25	4.40	8.23
	20	0.13	0.16	3.18	32.25	4.39	8.24
	27	0.12	0.15	3.20	32.25	4.36	8.24
3	0	0.27	0.14	1.10	32.19	nd	8.23
	5	0.21	0.14	1.16	32.19	4.34	8.22
	10	0.18	0.33	1.15	32.14	4.39	8.23
	15	0.17	0.20	1.15	32.16	4.39	8.23
	20	0.31	0.21	1.27	32.17	4.39	8.23
	31	0.21	0.20	1.86	32.18	4.37	8.23
4	0	0.22	0.14	0.96	32.03	nd	8.24
	15	nd	nd	0.90	32.04	4.40	8.23
	18	0.23	0.15	0.92	32.08	4.40	8.23
	20	nd	nd	0.98	32.12	4.38	8.23
	24	nd	nd	1.17	32.14	4.34	nd
	26	nd	nd	1.31	32.14	4.33	8.23
5	0	0.32	0.14	nd	32.06	nd	8.20
	10	0.26	0.26	nd	32.07	4.43	8.20
	20	0.28	0.40	nd	32.09	4.37	8.21
	26	0.35	0.27	nd	32.13	4.41	8.20
	29	0.31	0.17	nd	32.25	4.32	8.15
6	0	0.50	0.42	nd	32.01	nd	8.21
	10	0.27	0.37	nd	32.00	4.42	8.21
	20	0.39	0.33	nd	32.00	4.44	8.02
	25	0.28	0.21	nd	32.31	4.45	8.21
	30	0.31	0.19	nd	32.37	4.44	8.20
	40	0.28	0.15	nd	32.26	nd	8.19
	50	1.13	0.21	nd	32.54	nd	8.08
7	0	0.30	0.16	0.63	31.88	4.40	8.19
	45	1.64	0.21	3.41	32.23	4.00	8.13
8	0	0.49	0.21	0.81	32.17	4.39	8.20
	37	0.35	0.12	5.01	32.08	4.35	8.19
9	0	0.50	0.12	0.79	32.12	nd	8.14
	20	0.44	0.09	0.82	32.07	4.44	8.13
	35	0.79	0.09	3.30	32.13	4.09	8.09
10	0	0.66	0.09	0.80	31.93	4.41	8.16
	47	2.00	0.18	5.75	32.21	3.42	8.06

* data from Southeast Asian Fisheries Development Center, 1997, nd=no data

Appendix E (Continue)

station	Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
11	0	0.58	0.11	0.72	31.85	4.39	8.16
	53	0.84	0.15	9.19	32.19	4.31	8.10
12	0	0.57	0.12	0.69	31.75	4.37	8.16
	25	0.52	0.06	0.79	31.87	4.41	8.16
	57	1.25	0.12	5.53	32.42	nd	8.08
13	0	0.62	0.11	0.70	31.64	4.42	8.18
	40	0.53	0.05	1.01	31.92	4.61	8.18
	65	1.81	0.15	4.09	32.37	3.74	8.09
14	0	0.52	0.06	0.60	31.63	4.43	8.20
	45	0.60	0.13	1.37	31.93	4.45	8.18
	60	2.06	0.16	5.18	32.31	3.88	8.10
15	0	0.20	0.19	0.71	31.65	4.48	8.19
	53	1.78	0.23	5.46	32.28	3.00	8.08
16	0	0.22	0.12	0.97	31.94	4.40	8.19
	48	6.08	0.53	3.98	32.36	3.27	7.98
17	0	0.28	0.10	0.95	32.00	nd	8.15
	10	0.25	0.09	1.03	32.00	4.45	8.16
	20	0.36	0.11	0.97	31.83	4.44	8.15
	30	0.24	0.13	1.04	31.86	4.55	8.16
	38	0.37	0.17	2.65	32.09	3.95	8.11
	45	nd	nd	4.96	32.28	2.13	7.88
18	0	0.23	0.10	0.63	31.94	4.39	8.19
	60	1.52	0.20	4.07	32.13	3.42	8.10
19	0	1.76	0.18	0.53	31.79	4.38	8.11
	62	0.36	0.11	4.64	32.08	nd	8.10
20	0	0.28	0.13	0.69	31.74	4.36	8.20
	64	1.27	0.33	5.99	32.34	nd	8.07
21	0	0.42	0.23	0.72	31.74	4.41	8.18
	68	0.20	0.40	4.10	32.91	3.02	8.02
22	0	0.28	0.10	0.48	31.93	4.40	8.20
	56	0.35	0.11	4.03	32.51	3.61	8.14
23	0	0.25	0.10	0.71	31.72	4.42	8.18
	35	0.61	0.14	5.71	32.01	4.23	8.14
24	0	0.23	0.10	1.06	31.87	4.41	8.20
	10	0.18	0.11	1.05	31.83	4.45	8.20
	20	0.21	0.10	1.28	31.87	4.50	8.20
	28	0.24	0.21	2.87	31.85	4.35	8.17
25	0	0.22	0.10	0.67	31.89	4.40	8.19
	40	0.21	0.09	1.44	32.20	4.21	8.15

* data from Southeast Asian Fisheries Development Center, 1997, nd=no data

Appendix E (Continue)

station	Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
26	0	0.28	0.13	0.53	31.71	4.42	8.21
	10	0.25	0.12	0.54	31.71	4.42	8.21
	20	0.34	0.13	0.57	31.71	4.42	8.21
	30	0.28	0.10	0.68	31.71	4.39	8.20
	40	0.29	0.13	0.99	31.71	4.20	8.21
	50	0.30	0.12	1.19	31.90	nd	8.19
	63	1.16	0.16	5.00	32.93	nd	8.10
27	0	0.23	0.10	0.60	31.73	nd	8.19
	55	2.50	0.28	4.17	33.66	3.29	8.10
	77	3.22	0.43	3.31	33.74	3.78	8.10
28	0	nd	nd	0.70	31.70	4.44	8.21
	58	2.65	0.39	6.82	33.17	4.23	8.10
29	0	0.32	0.15	0.81	31.87	4.42	8.21
	30	0.40	0.17	1.08	32.30	4.44	8.19
30	0	0.21	0.13	5.02	31.86	3.73	8.16
	24	0.33	0.14	3.91	31.85	4.00	8.13
31	0	0.36	0.19	0.74	32.00	4.43	8.18
	27	0.28	0.16	2.24	32.30	4.38	8.15
32	0	0.43	0.19	0.69	31.93	4.41	8.19
	40	0.31	0.22	2.18	32.88	nd	8.07
	52	2.22	0.28	5.55	33.42	nd	8.08
33	0	0.42	0.15	0.66	31.73	4.43	8.16
	45	0.51	0.21	1.49	33.36	3.56	8.04
	71	3.17	0.31	2.47	33.75	4.04	8.06
34	0	0.35	0.14	0.53	31.93	4.40	8.17
	30	0.23	0.12	1.05	33.85	4.26	8.15
	37	0.22	0.11	0.96	33.88	4.19	8.15
	60	0.69	0.17	1.51	33.86	3.99	8.14
	70	1.48	0.28	4.10	33.86	3.81	8.12
	77	1.15	0.22	4.37	33.86	nd	8.11
35	0	0.42	0.12	0.50	32.63	nd	8.17
	50	0.38	0.13	1.64	33.64	4.39	8.13
	70	0.66	0.17	4.74	33.80	4.28	8.11
36	0	0.34	0.11	0.60	32.40	4.39	8.18
	65	0.98	0.15	4.33	33.80	4.27	8.11
	72	0.92	0.14	5.33	33.80	4.10	8.11
37	0	0.42	0.14	0.88	32.12	4.38	8.20
	40	0.44	0.08	1.05	33.43	3.86	8.15
	58	0.65	0.10	3.61	33.74	4.36	8.12
38	0	0.49	0.11	0.70	31.78	4.43	8.22
	48	0.53	0.15	4.69	33.32	4.20	8.13

* data from Southeast Asian Fisheries Development Center, 1997, nd=no data

Appendix E (Continue)

station	*Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
39	0	0.42	0.15	1.20	31.75	4.42	8.22
	27	0.45	0.11	2.92	32.35	4.37	8.18
40	0	0.42	0.09	1.85	31.92	nd	8.20
	10	0.43	0.10	1.97	31.92	4.42	8.20
	20	0.39	0.10	1.93	31.91	4.45	8.20
41	0	0.37	0.08	0.84	31.86	4.39	8.17
	40	0.51	0.12	3.13	33.24	4.02	8.10
42	0	0.41	0.08	0.54	32.06	4.39	8.23
	30	0.50	0.10	0.84	33.46	4.42	8.21
	49	0.47	0.12	6.10	33.67	nd	8.17
43	0	0.31	0.08	0.68	32.44	nd	8.25
	35	0.42	0.14	3.51	33.60	4.27	8.21
	49	0.38	0.11	4.33	33.61	4.17	8.18
44	0	0.38	0.09	0.68	32.55	nd	8.24
	20	0.63	0.13	0.64	33.21	4.46	8.23
	52	0.43	0.18	4.12	33.70	4.26	8.18
45	0	0.47	0.10	0.66	32.51	nd	8.18
	15	0.62	0.12	0.58	33.21	4.39	8.18
	55	0.37	0.15	2.60	33.91	nd	8.16
46	0	0.40	0.10	0.47	33.39	nd	8.21
	10	0.48	0.11	0.45	33.71	4.39	8.21
	30	0.23	0.07	0.58	33.81	4.48	8.20
	40	0.33	0.09	1.10	33.92	4.49	8.19
	46	0.55	0.11	1.90	33.92	nd	8.19
47	0	0.33	0.06	0.48	33.67	4.37	8.20
	58	0.28	0.13	4.21	33.86	4.49	8.19
48	0	0.39	0.16	0.59	32.87	nd	8.08
	57	0.52	0.20	2.96	33.91	4.39	8.06
49	0	0.50	0.10	0.68	32.41	4.40	8.18
	30	0.42	0.13	0.64	33.96	4.46	8.16
	53	0.42	0.09	3.36	33.86	4.35	8.14
50	0	0.41	0.09	0.64	32.27	4.36	8.20
	50	0.48	0.16	3.89	33.61	4.08	8.14
51	0	0.44	0.10	0.50	32.23	nd	8.20
	10	0.41	0.10	0.58	32.28	4.40	8.20
	25	0.50	0.12	0.70	33.16	4.48	8.13
	46	0.55	0.17	5.58	33.41	3.91	8.12
52	0	0.45	0.85	0.74	32.07	nd	8.19
	38	0.52	0.11	5.29	33.31	3.85	8.10
53	0	0.39	0.08	0.44	31.49	nd	8.21
	10	0.43	0.10	0.73	32.09	nd	8.21
	51	0.39	0.06	3.25	33.81	4.36	8.17

* data from Southeast Asian Fisheries Development Center, 1997, nd=no data

Appendix E (Continue)

station	*Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
54	0	0.39	0.68	0.45	32.71	4.36	8.22
	60	0.40	0.07	3.10	33.88	nd	8.17
55	0	0.42	0.14	0.46	33.44	4.37	8.21
	59	0.42	0.10	2.06	33.86	nd	8.18
56	0	0.41	0.07	0.53	33.70	nd	8.22
	60	0.44	0.07	3.51	33.89	nd	8.19
57	0	0.45	0.10	0.50	33.66	nd	8.20
	30	0.36	0.07	0.67	33.69	4.38	8.20
	59	0.42	0.09	2.42	33.88	4.49	8.18
58	0	0.49	0.08	0.41	33.37	4.37	8.21
	60	0.39	0.06	2.26	33.79	4.48	8.18
59	0	0.41	0.06	0.22	32.66	nd	8.22
	63	0.41	0.11	1.66	33.82	4.36	8.19
60	0	0.45	0.12	0.22	32.33	4.39	8.22
	57	0.35	0.08	2.35	33.86	4.35	8.19
61	0	0.72	0.03	0.28	32.12	4.40	8.19
	20	0.43	0.03	0.58	33.63	4.52	8.19
	48	0.62	0.02	2.70	33.78	4.43	8.14
62	0	0.68	0.05	0.29	32.28	nd	8.20
	20	0.67	0.06	0.50	33.66	4.50	8.19
	58	0.73	0.06	2.47	33.84	4.33	8.18
63	0	0.33	0.17	0.65	32.36	4.39	8.20
	64	0.27	0.03	2.35	33.82	nd	8.17
64	0	0.13	0.03	0.44	32.52	4.40	8.19
	57	0.38	0.10	2.71	33.80	4.41	8.17
65	0	0.19	0.05	0.69	32.13	4.44	8.19
	64	1.25	0.06	2.96	33.84	4.47	8.15
66	0	0.27	0.11	0.63	32.53	4.41	8.22
	70	1.57	0.12	2.81	33.93	nd	8.18
67	0	0.30	0.04	0.60	32.63	nd	8.22
	30	0.23	nd	0.98	33.78	4.66	8.21
	76	1.41	0.02	2.58	34.01	4.30	8.16
68	0	0.25	0.02	0.22	32.60	4.40	8.21
	40	0.43	0.05	0.84	33.68	4.60	8.21
	71	1.44	0.01	0.73	33.94	4.50	8.17
69	0	0.44	0.05	1.20	32.77	4.46	8.21
	20	0.33	0.01	1.16	33.36	4.55	8.21
	25	0.28	0.02	1.12	33.76	4.61	8.21
	40	0.37	0.05	2.22	33.75	4.47	8.19
	45	0.40	0.03	3.00	33.77	4.42	8.19
	64	0.34	nd	2.40	33.77	4.35	8.19

* data from Southeast Asian Fisheries Development Center, 1997, nd= no data

Appendix E (Continue)

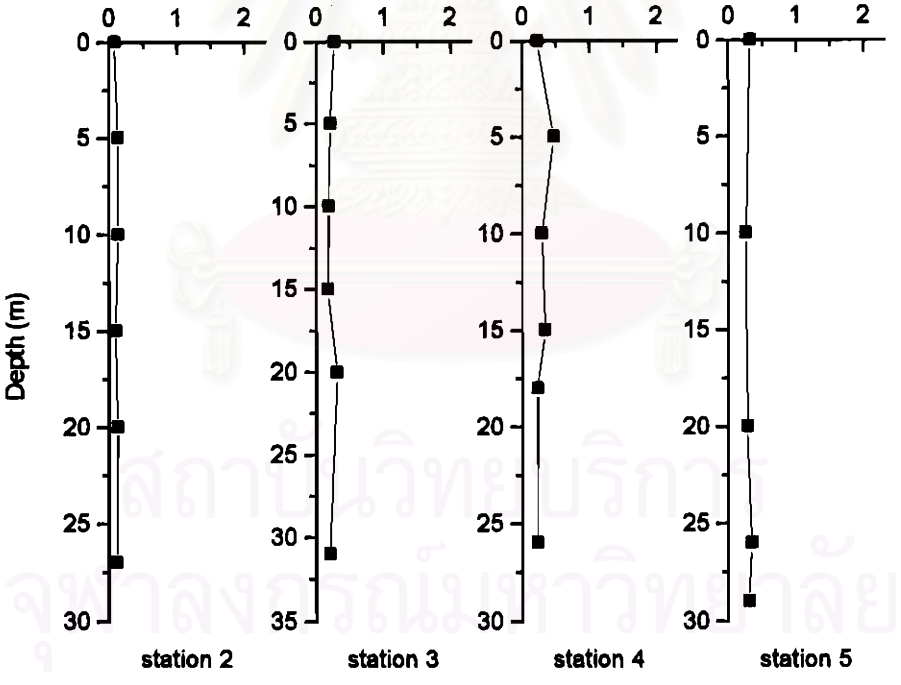
station	Depth (m)	*Nitrate (μM)	*Phosphate (μM)	*Fluorescenc (Volt)	*salinity (psu)	*DO (ml/l)	*pH
70	0	0.47	0.02	0.76	32.94	4.43	8.20
	15	0.25	0.03	1.17	33.48	4.44	8.18
	38	0.61	0.02	4.71	33.70	4.25	8.16
71	0	0.32	0.01	1.83	31.41	4.46	8.21
	15	0.31	0.02	2.45	33.65	4.38	8.18
	30	0.03	0.02	4.75	33.67	4.28	8.18
72	0	0.21	nd	0.72	32.75	4.45	8.21
	20	0.18	nd	0.84	33.69	4.23	8.22
	54	0.21	nd	3.27	33.72	nd	8.17
73	0	0.28	nd	0.63	32.99	4.42	8.23
	30	0.41	nd	0.95	33.56	4.50	8.25
	72	1.18	nd	2.64	33.91	4.46	8.20
74	0	0.25	0.03	0.50	33.09	nd	8.23
	25	0.21	0.04	1.18	33.52	4.61	8.24
	66	0.40	0.04	3.25	33.72	4.31	8.22
75	0	0.32	0.11	0.64	33.02	4.43	8.23
	10	0.18	0.06	0.59	33.31	4.45	8.24
	54	0.22	0.05	4.10	33.72	4.30	8.21
76	0	0.30	0.06	1.02	33.01	4.44	8.17
	10	0.18	0.06	0.95	33.34	4.39	8.17
	26	0.24	0.03	1.63	33.56	4.27	8.16
77	0	0.41	0.04	1.20	33.32	4.48	8.20
	10	0.57	0.02	1.02	33.54	4.51	8.19
	48	0.58	0.01	3.39	33.71	4.47	8.18
78	0	0.40	nd	0.83	33.21	4.47	8.19
	28	0.93	nd	1.36	33.55	4.52	8.20
	63	2.94	nd	3.49	33.69	nd	8.18
79	0	1.59	nd	1.30	32.80	nd	8.19
	10	2.06	nd	1.34	32.94	5.02	8.19
	20	2.02	nd	1.50	33.53	5.00	8.19
	25	0.96	nd	2.14	33.59	5.03	8.19
	30	0.51	nd	2.03	33.62	5.06	8.19
	50	1.84	nd	4.02	33.68	4.85	8.18
	59	1.25	nd	3.26	33.68	4.79	8.18
80	0	1.04	nd	1.07	33.43	nd	8.17
	15	1.10	nd	1.15	33.54	4.81	8.19
	31	1.00	nd	3.98	33.66	4.73	8.18
81	0	0.16	nd	2.41	32.86	nd	8.21
	10	1.15	nd	1.91	33.13	5.16	8.21
	53	1.35	nd	3.26	33.64	4.97	8.20

* data from Southeast Asian Fisheries Development Center, 1997, nd=no data

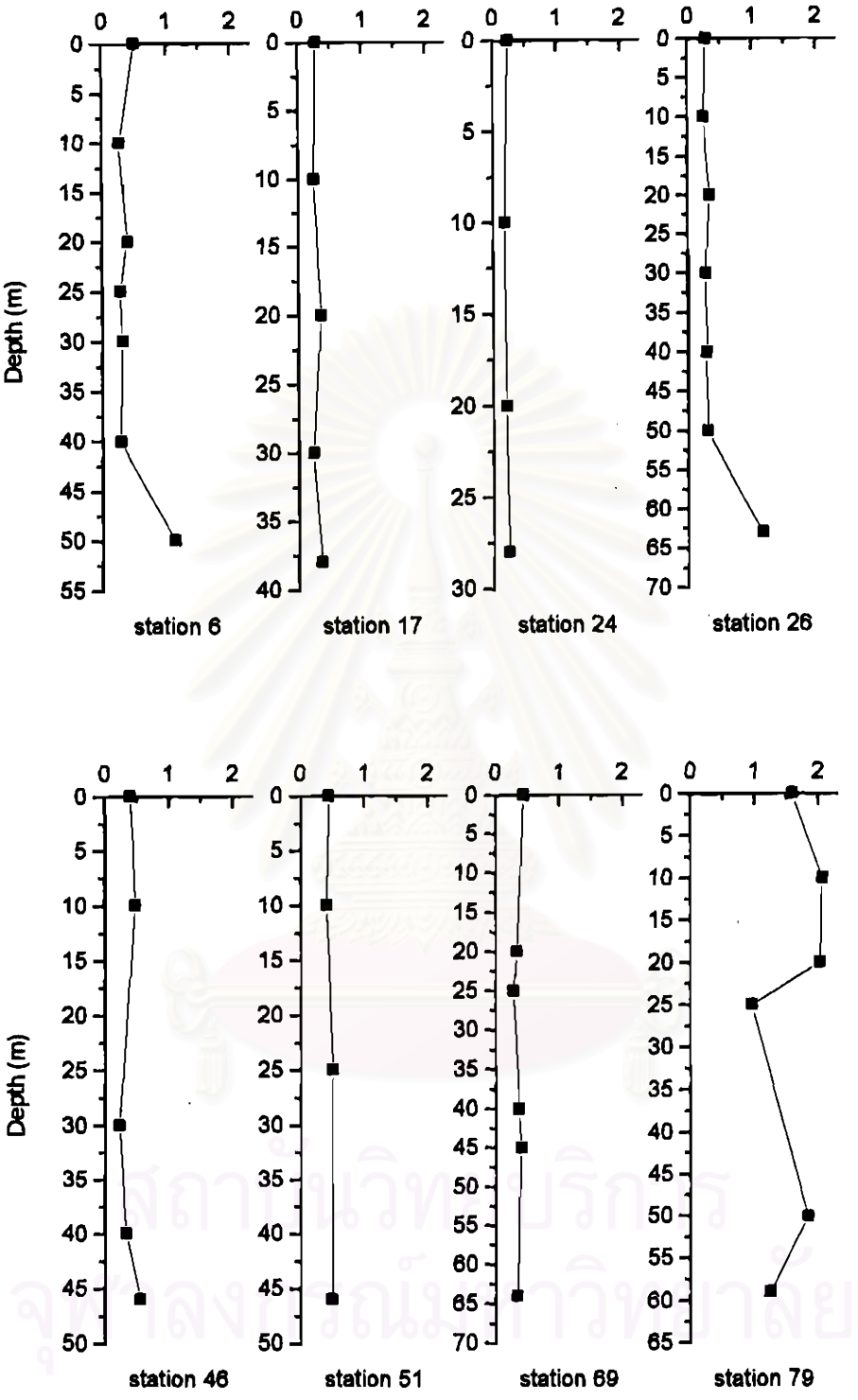
Appendix F Vertical distribution of environment variables at station 2, 3, 4, 5, 6, 17, 24, 26, 46, 51, 69 and 79

The environment variables, nitrate, phosphate, fluorescence, salinity, dissolved oxygen and pH in the Gulf of Thailand and East Coast of Malay Peninsula were determined in the same cruise by other researcher under the collaborative research program between the SEAFDEC Training Department in Thailand and the Marine Fishery Resources Development and Management Department in Malaysia.

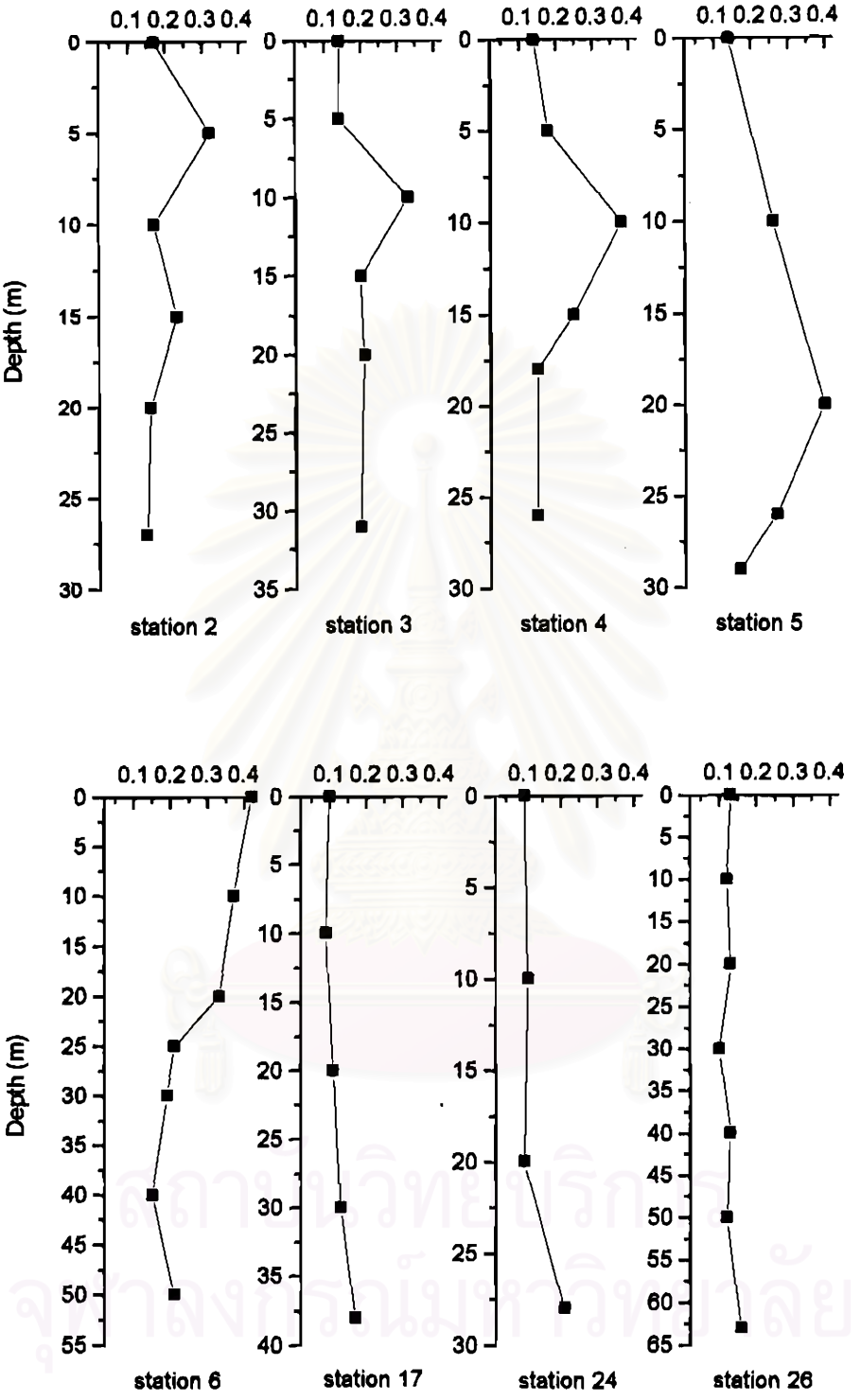
Vertical distribution of nitrate showed that not much different in concentration were found at various depth except at station 79 (FigureF-1). Nitrate concentration varied between 0.03 and 2.94 μM with mean values of 0.43 μM and 0.93 μM at the surface and the bottom, respectively. At station 79 concentration of nitrate was much higher than others station the concentration was 0.9-2.1(μM). Concentration of nitrate at near by stations were also high implying a high input of nitrate in this area. Enrichment of phosphate at depths were more obvious (FigureF-2). Unfortunately no measurement of phosphate was done at station 79 and nearby.



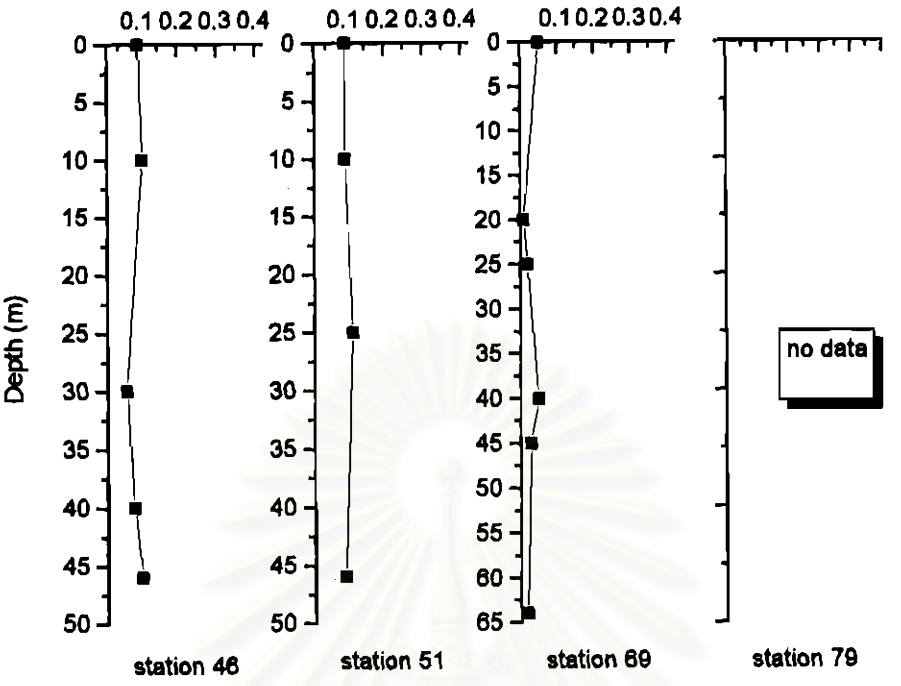
FigureF-1 Vertical profiles of nitrate (μM) station 2,3,4,5,6,17,24, 26,46,51,69 and79



FigureF-1 (continue) Vertical profiles of nitrate (μM) station 2,3,4,5,6,17,24,26,46,51,69 and79

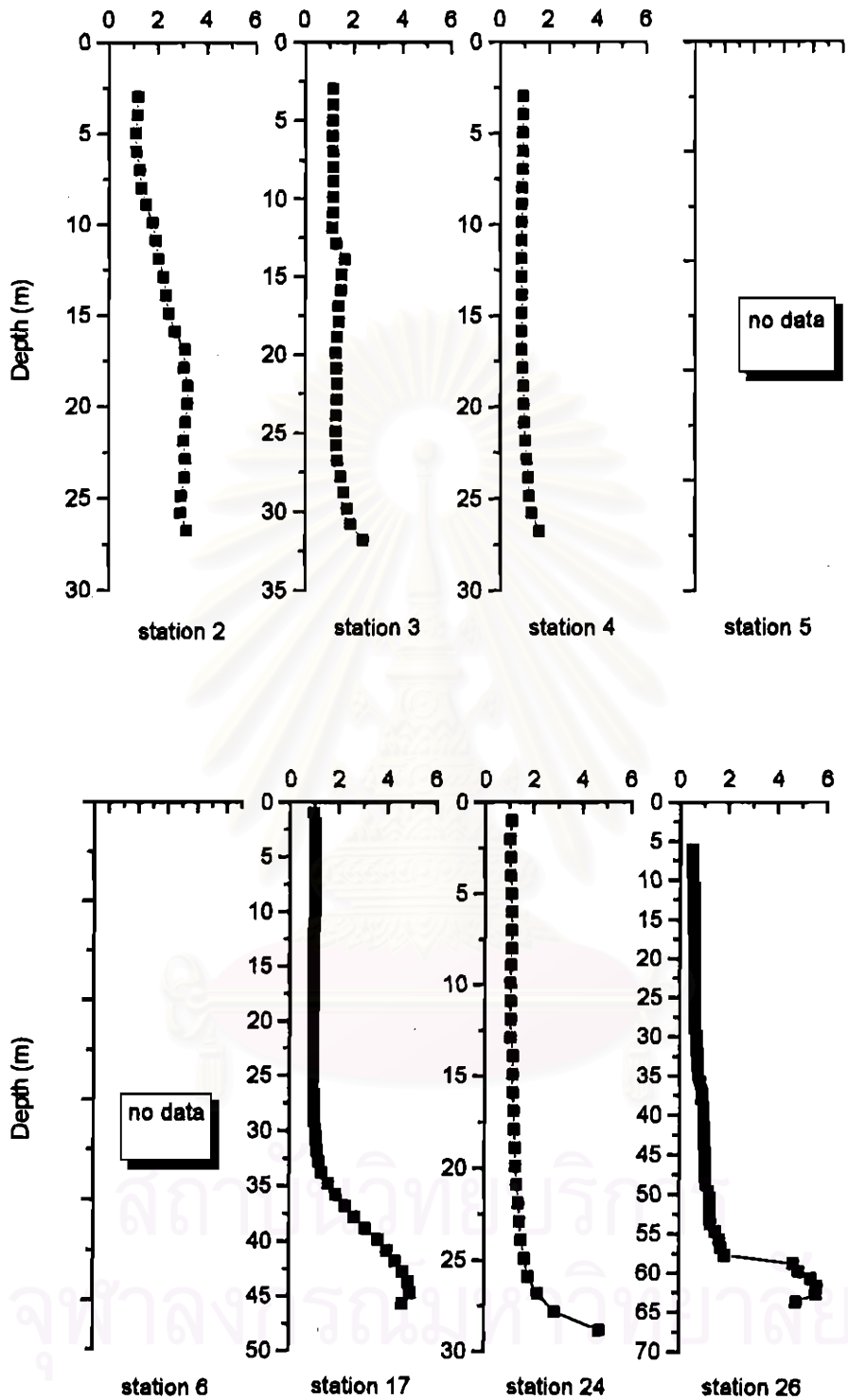


FigureF-2 Vertical profiles of phosphate (μM) station 2,3,4,5,6,17,24, 26,46,51,69 and79

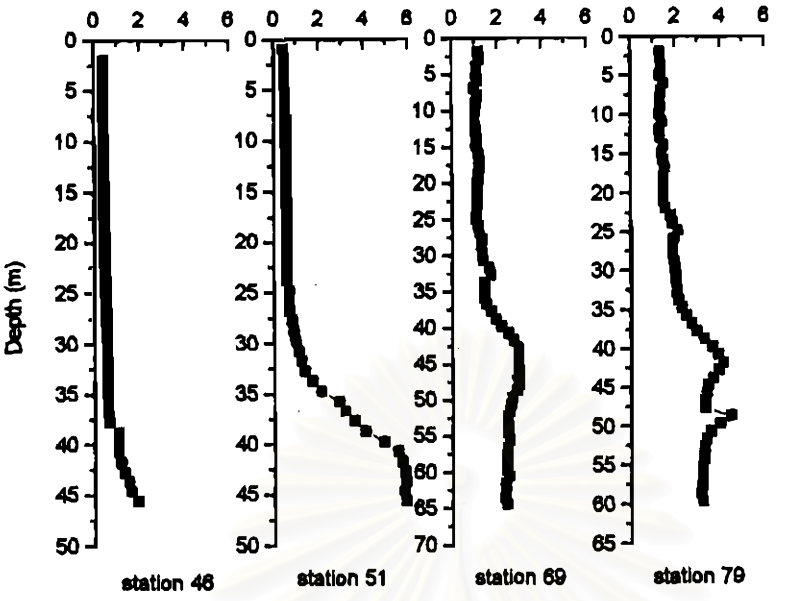


FigureF-2 (continue) Vertical profiles of phosphate (μM) station 2,3,4,5,6,17,24,26,46,51,69 and79

Vertical profiles of fluorescence showed that high concentration were found in water column about 10 m over the bottom. (FigureF-3). The concentrations were 0-8.0 Volts. Shamsudin et al, 1997 collected water samples and measured the concentration of choorophyll a, b and c by spectrophotometry on board the vessel and found a linea correlation of these pigments with observed fluorescence.

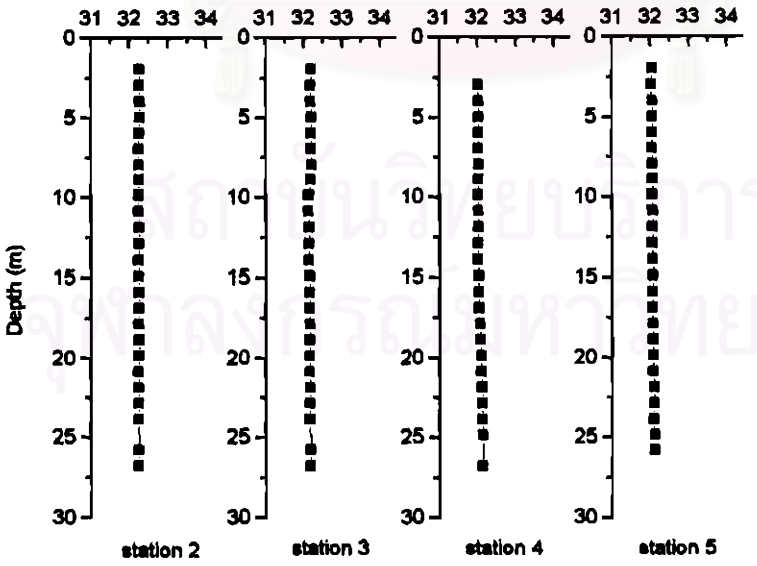


FigureF-3 Vertical profiles of fluorescence(Volt) station 2,3,4,5,6,17,24,26,46,51,69 and79
(datafrom Southeast Asian Fisheries Development Center, 1997)

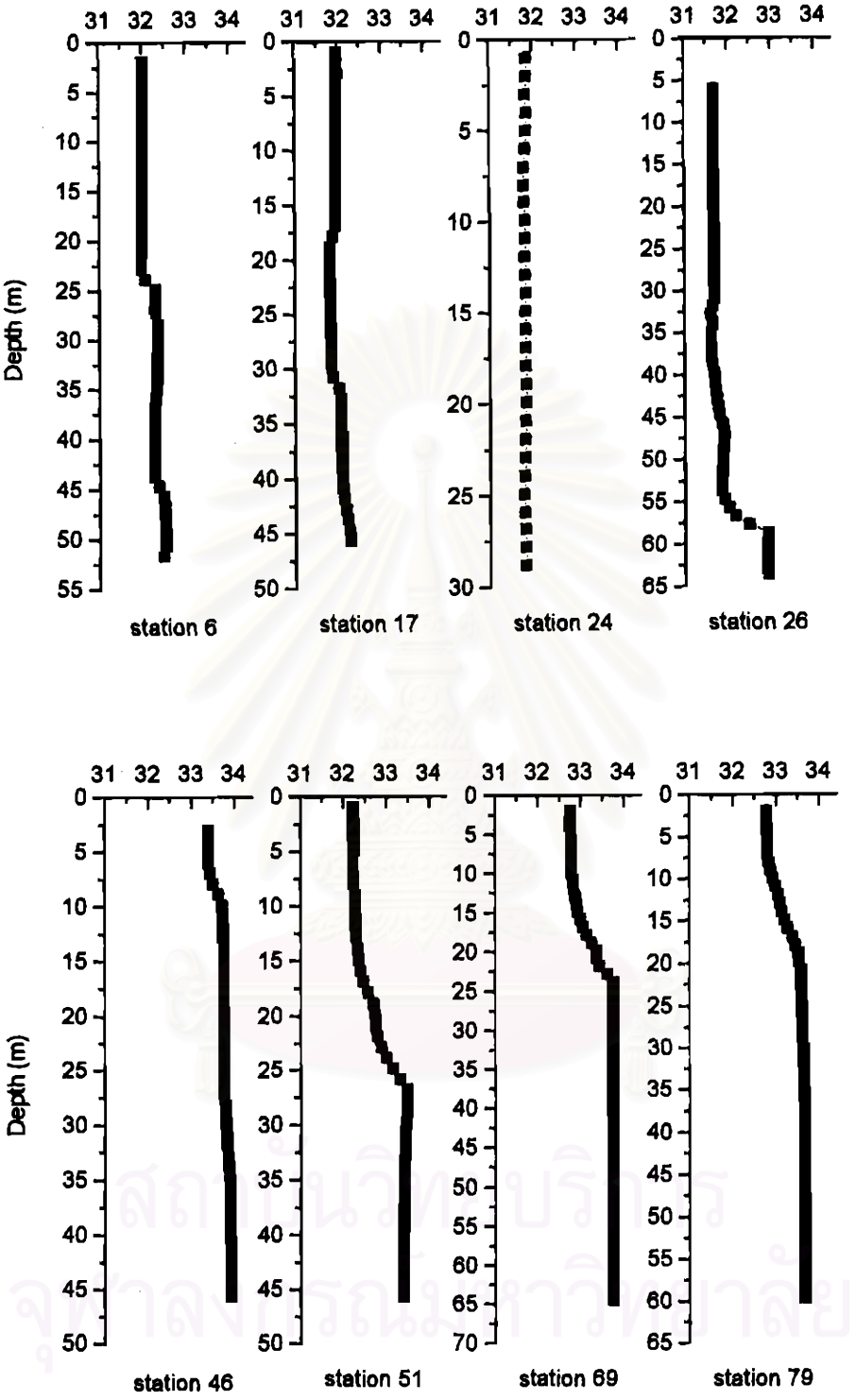


FigureF-3 (continue) Vertical profiles of fluorescence(Volt) station 2,3,4,5,6,17,24,26,46,51,69 and79 (datafrom Southeast Asian Fisheries Development Center, 1997)

Salinity in the Gulf of Thailand and East Coast of Malay Peninsula was between 31.5-34 psu. The average value in the Gulf of Thailand was lower than the East Coast of Malay Peninsula, especially in the coastal area. The vertical profile of salinity show that the salinity was increasing with depth (FigureF-4).

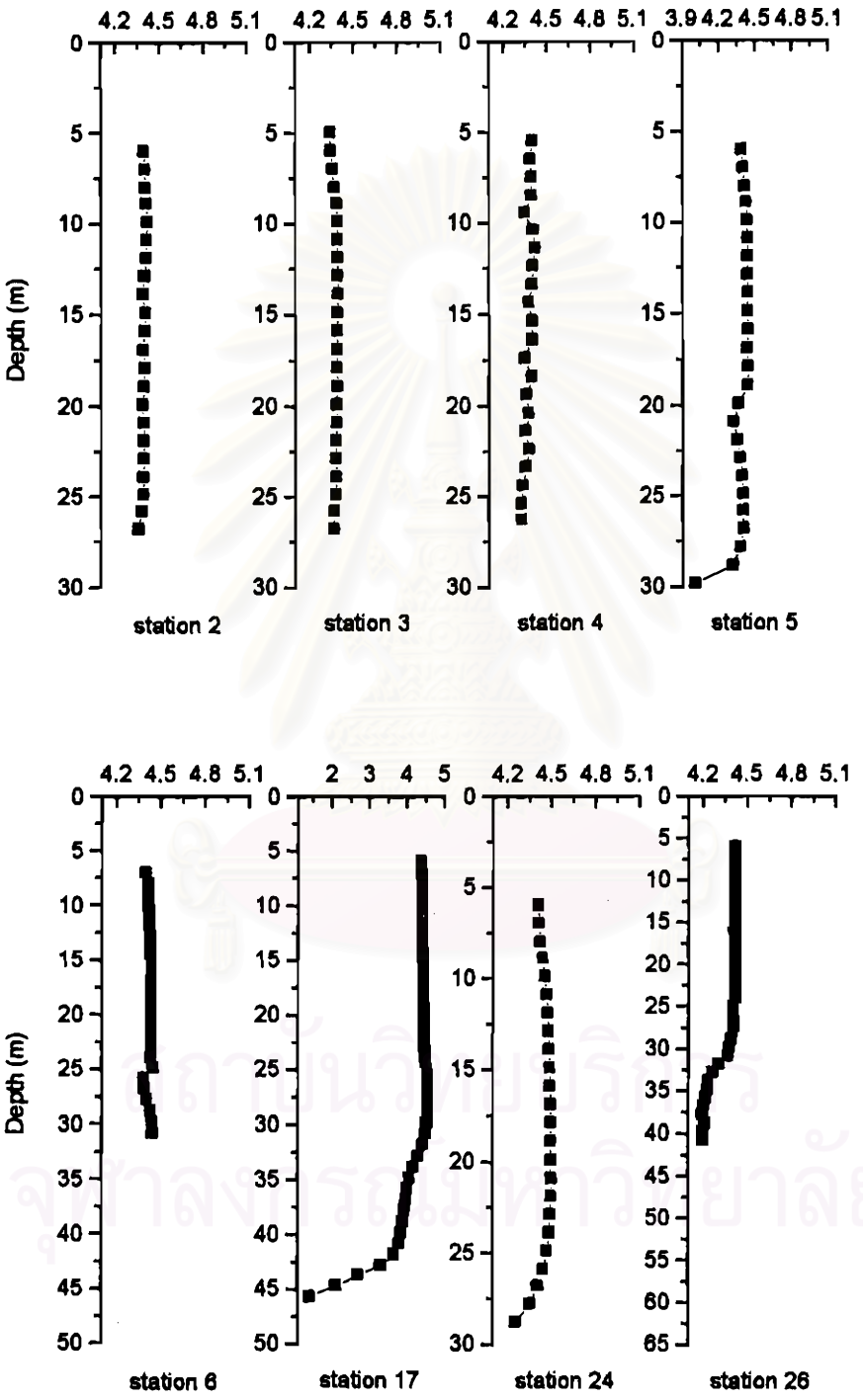


FigureF-4 Vertical profiles of salinity (psu) station 2,3,4,5,6,17,24,26,46,51,69 and79 (datafrom Southeast Asian Fisheries Development Center, 1997)

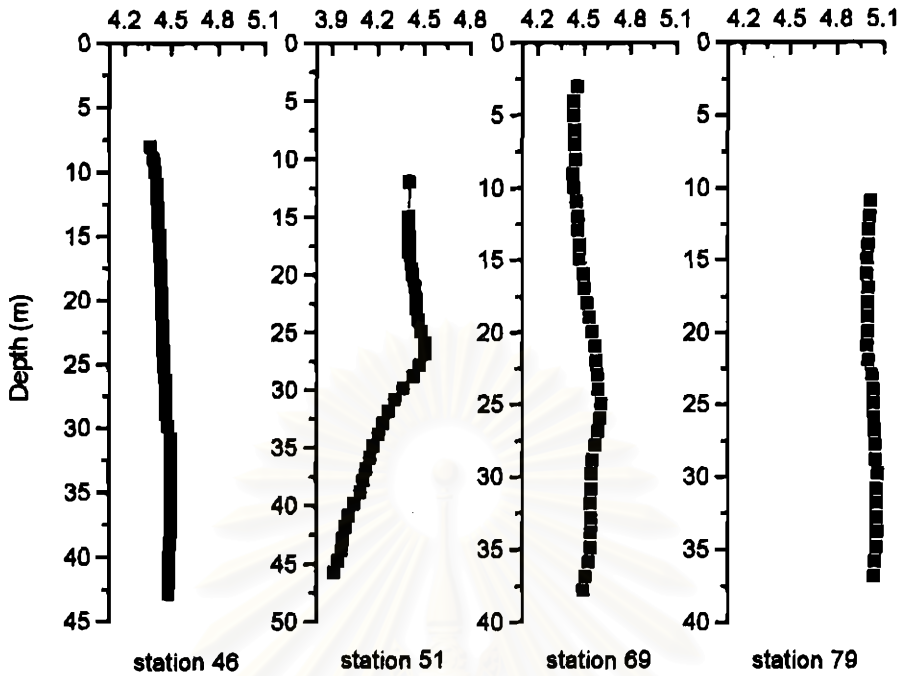


FigureF-4 (continue) Vertical profiles of salinity (psu) station 2,3,4,5,6,17,24,26,46,51,69 and79
(datafrom Southeast Asian Fisheries Development Center, 1997)

The dissolved oxygen concentration from the in situ sensor are shown in FigureF-5, A slighly increase of dissolved oxygen in the subsurface layer as a result of photosynthetic process were observed and then the concentration decreased at the bottom layer.

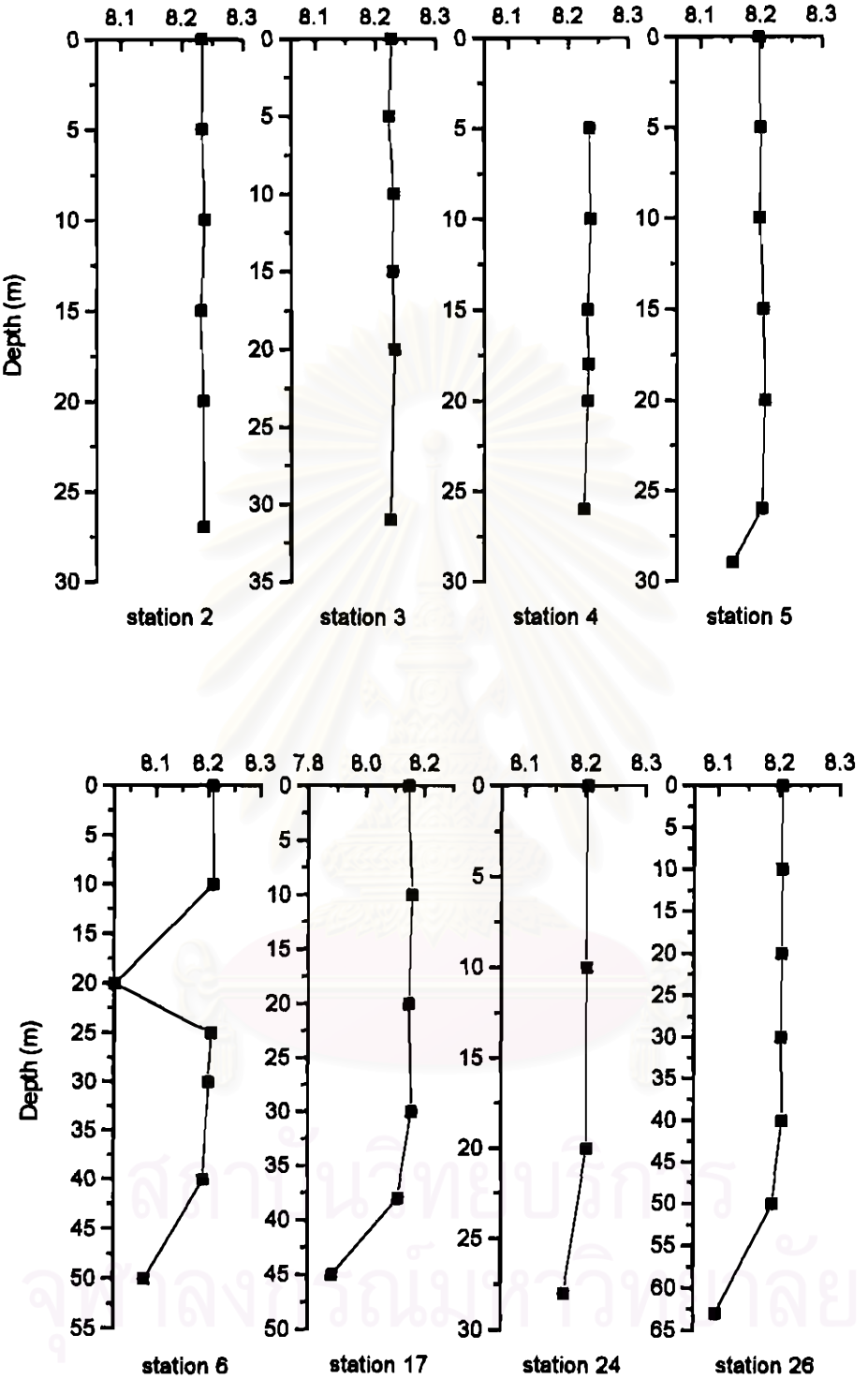


FigureF-5 Vertical profiles of dissolved oxygen (ml/l) station 2,3,4,5,6,17,24,26,46,51,69 and79
(datafrom Southeast Asian Fisheries Development Center, 1997)

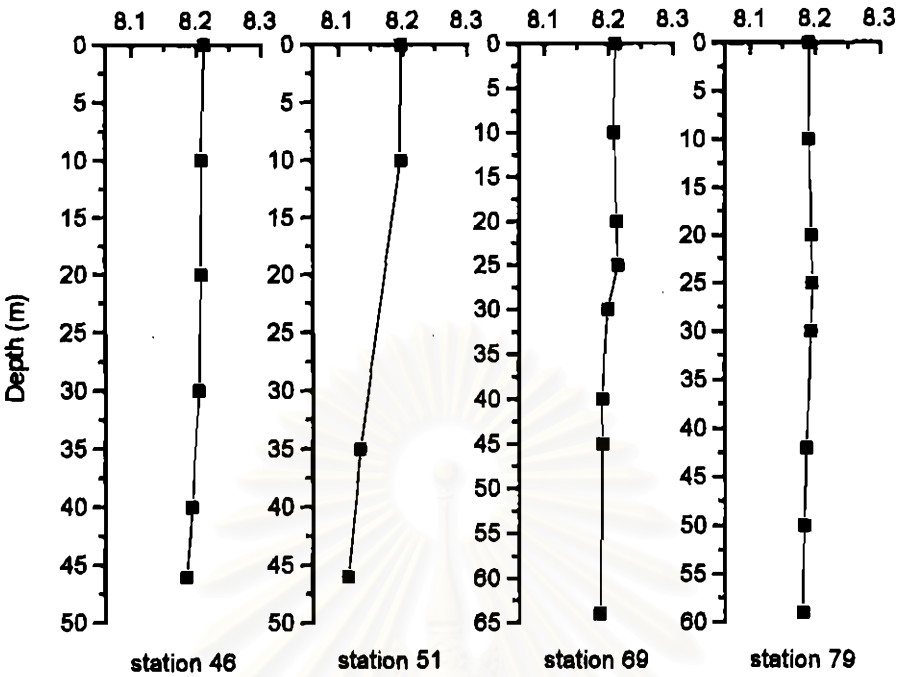


FigureF-5 (continue) Vertical profiles of dissolved oxygen (ml/l) station 2,3,4,5,6,17,24,26,46,51,69 and79
(datafrom Southeast Asian Fisheries Development Center, 1997)

The pH in the study areas was varied between 7.9 and 8.2. The vertical profiles of pH were similar to dissolved oxygen profiles (FigureF-6) in which low pH was observed at the bottom layer.



FigureF-6 Vertical profiles of pH station 2,3,4,5,6,17,24,26, 46,51,69 and 79
(datafrom Southeast Asian Fisheries Development Center, 1997)



FigureF-6 (continue) Vertical profiles of pH station 2,3,4,5,6,17,24,26,46,51,69 and79 (datafrom Southeast Asian Fisheries Development Center, 1997)

BIOGRAPHY

Mr. Saravuth Rattanachongkiat was born on April, 20 1971 at Phranakornsriayutthaya province. He recived a B. Sc. Degree from department of Marines Science, Faculty of Fishery, Kasetsart University in May 1995. After graduation, he enrolled in a Master Degree Program at the Department of Marine Science, Faculty of Science, Chulalongkorn University.